Habitat Characteristics of Wild Turkey Nest Sites in Central Mississippi

Darren A. Miller,[1] *Department of Wildlife and Fisheries, Mississippi State University, Box 9690, Mississippi State, Mississippi 39762*

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

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

Patrick D. Gerard, *Experimental Statistics, Mississippi State University, Mississippi State, Mississippi, 39762*

Abstract: Nest success strongly influences wild turkey *(Meleagris gallopavo)* reproduction. Understanding selection of nesting habitats may provide information for management opportunities to increase turkey nest success. Therefore, we examined the landscape scale habitat selection of wild turkey hens during nesting. A logistic regression model with 89 nest locations and 89 random locations indicated an intercept term, elevation, and distances to mature pine burned $\leq$3 years ago and mature pine not burned within 3 years differed significantly (P<0.04) between used and random sites. Nest success was higher in mature pine stands (36.1%) than in regeneration stands (P=0.04; 11.1%), but no difference in nest success was detected between bottomland (18.8%) and upland habitats (34.8%; P=0.214). Distance to edge did not influence nest success. Higher densities of carnivore prey in regeneration stands may increase probability of nest/predator interactions, thus decreasing nest success in this habitat type. Providing mature pine stands, burned on a 3-year rotation and juxtaposed with riparian areas and bottomland hardwood stands may increase nest success on our study area.

Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 53: 434–443

Nest success has a strong influence on population dynamics of eastern wild turkey *(Meleagris gallopavo silvestris)* populations (Vangilder and Kurzejeski 1995, Roberts and Porter 1996). Because nest success may be influenced by habitat (Leopold and Hurst 1994), it is important to examine nest success in the context of habitat (Weinstein et al. 1996). Although numerous studies in the Southeast have described

1. Present Address: Weyerhauser Company, Southern Forestry Research, Box 2288, Columbus, MS 39704.

nest habitat (e.g., Everett et al. 1985, Smith 1988, Campo et al. 1989), including on our study area (Seiss et al. 1990), none of these studies have quantified the potential impact of location of habitats at the landscape scale on nest site selection. Donovan et al. (1987) developed a habitat suitability index for wild turkey nesting and brood-rearing ranges in Michigan that considered the spatial configuration of habitats. Information on effects of the juxtaposition and interspersion of habitats on a landscape may be useful for managers responsible for scheduling activities (e.g., timber harvest, right-of-way maintenance) that may influence wild turkey habitat at a landscape scale. Our objectives were to develop a model to describe wild turkey nesting habitat and examine influence of habitat on nest success.

Funding and support for this study was provided by the National Wild Turkey Federation (NWTF), the Mississippi Chapter of the NWTF, the Mississippi Department of Wildlife, Fisheries and Parks (through Federal Aid in Wildlife Restoration Funds), and the U.S. Forest Service (Bienville National Forest). We thank Weyerhaeuser Company, Southern Forestry Research, for paying page charges and allowing the senior author time to publish this manuscript. This manuscript was a contribution of the Mississippi Cooperative Wild Turkey Research Project and the Forest and Wildlife Research Center, Mississippi State University. We thank the many tireless "Tallahala" graduate students and technicians whose efforts made this research possible.

Methods

Study Area

We conducted our study on the 14,410-ha Tallahala Wildlife Management Area (TWMA) located within the Bienville National Forest in Jasper, Newton, Scott, and Smith counties in central Mississippi. The study area was located within the Lower Coastal Plain Province and the Blackland Prairie Resource Area (Pettry 1977). Cover types on TWMA were mature bottomland hardwood forests (30%), mature pine (*Pinus* spp.) forests (37%), mature mixed pine-hardwood (30%–70% pine) forests (17%), and 1- to 14-year-old loblolly pine (*P. taeda*) regeneration (both natural and artificial; 11%). The remaining area (5%) was composed of primarily small (<2ha) open areas (pastures, old fields) and human habitations. Prescribed burning of pine stands occurred at a mean frequency of 6.25 years. Mean patch size ranged from approximately 121 ha for pine sawtimber (>30 years old) burned within 3 years, to 9 ha for mixed pine-hardwood regeneration (<16 years old) stands (Miller 1997). Mean annual temperature was 18 C, and mean annual precipitation was 152 cm. Topography was flat to gently rolling. Short term (3–5 days) flooding occurred periodically along 3 primary drainages during spring. Bottomland hardwood stands (most >80 years old) were under custodial management and were not harvested during the study.

Hen Capture

We captured wild turkey hens during 1984–1994 by cannon net (Bailey 1976) or with alphachloralose (Williams et al. 1966) from 7 January to 4 March and 1 July to 25 August. We removed hens from the net and placed them into cardboard boxes, sized (76.2 × 35.6 × 61 cm) for wild turkeys. We classified turkeys as adults or juveniles (Williams and Austin 1988) and marked them with 2 patagial wing tags (Knowlton et al. 1964) and 2 metal, trip-lock leg bands. We used backpack harnesses to attach 108-g, motion-sensitive, radiotransmitters (Wildl. Mat., Carbondale, Ill.). Cannon-netted hens were released within 10–45 minutes of capture. We transported tranquilized turkeys to TWMA headquarters for marking and recovery and released them the next day. All hens were released at their site of capture.

Habitat Delineation

We used the geographic information system (GIS) developed by TWMA by Miller et al. (1999). Following their work, we classified stands by habitat type ($N=12$; Table 1) based on forest characteristics (pine, mixed pine/hardwood, hardwood, non-forested, miscellaneous [e.g., residential, water]), stand age, years since burned, and years since thinned.

Pine and hardwood regeneration age class represented stands before canopy closure occurred (Miller et al. 1999). We defined pine poletimber stands as stands after complete canopy closure until 30 years of age; stands became candidates for burning and commercial thinning during this stage (approx. 15 years old). Because most oak (*Quercus* spp.) species begin to produce substantial mast at 40 years old (U. S. Dep. Agric. 1980), we defined hardwood/mixed poletimber stands as occurring from canopy closure until 40 years of age. We defined mature pine as ≥30 years old and mature hardwood and pine/hardwood as ≥ 40 years old. We classified stands as burned 0- to 3-years ago and >3 years because of importance of burning pine stands

Table 1. Descriptions of variables and habitat types used to quantify habitat selection by nesting hens, from use and random points, Tallahala Wildlife Management Area, Mississippi, 1984–1994.

Variable	Description
HAB1	distance to nearest hardwood regeneration (<16 years) stand
HAB2	distance to nearest hardwood poletimeber (16–40 years) stand
HAB3	distance to nearest hardwood sawtimber (>40 years) stand
HAB4	distance to nearest pine regeneration (<8 years old) stand
HAB5	distance to nearest pine poletimber (8–30 years old) stand, not burned ≤ 3 years ago
HAB6	distance to nearest pine sawtimber (>30 years) stand, burned ≤ 3 years ago
HAB7	distance to nearest pine sawtimber (>30 years) stand, not burned ≤ 3 years ago
HAB8	distance to nearest mixed regeneration (<16 years) stand
HAB9	distance to nearest mixed poletimber (16–40 years) stand, not burned ≤ 3 years ago
HAB10	distance to nearest sawtimber (>40 years) stand, burned ≤ 3 years ago
HAB11	distance to nearest sawtimber (>40 years) stand, not burned ≤ 3 years ago
HAB12	distance to nearest opening/field
Aspect	Aspect in 8 classes of 45° each
ELEV	Elevation in 8 equal classes of 100 units
Slope	Slope in 8 equal classes of 90° each
INTER	interspersion; average distance to all other habitat types
CREEKS	distance to nearest creek
ROAD	distance to nearest road

every 3 years for wild turkey management (Hurst 1981, Everett 1982, Palmer et al. 1996). We classified thinning as 0- to 3- years since thinned because thinning opens up pine stands for about 3 years after the thin.

Data Analysis

Beginning 14 March 1984–1994, we located hens ≥1 time/day by triangulation. We recorded initiation of incubation when (1) we found hens in the same location for 2 consecutive days, or (2) the radiotransmitter emitted a mortality signal (Miller et al. 1998). After 9–12 days of apparent incubation behavior, we approached to within 50 m of nests and recorded azimuths toward nests from marked locations. After cessation of nesting activity, we located nests to confirm occurrence of incubation and documented if nesting was successful (Miller et al. 1998). We excluded any nests abandoned due to observer interference. Because geographic location of nest sites was not recorded, we averaged all x,y coordinates taken on a radiotagged hen during nesting (N= 1 to 34) and we used the mean x,y location to define her nesting site. We created a random data set with an equal number of random points as nest sites, that matched nest site points in a year. We used random points to estimate values of independent variables that would be expected if hens selected nesting habitat at random.

We used point location (nest sites and random) to create GIS point coverages in ARC/INFO (Environ. Systems Res. Inst. 1994). We subsequently truncated these point coverages to be contained within a 100 m buffer strip around the coverages to prevent locations on the very periphery of the defined areas from being included. We also excluded any points falling inside an undefined habitat (i. e. unknown). We overlaid point coverages upon year-appropriate habitat coverages to obtain the habitat in which each point was contained (Table 1). We also obtained distances (m) to each of the 12 habitat types and to the nearest creek and road. We assigned a distance of 0 to the habitat type where the point resided.

We determined aspect, slope and elevation of each point using U.S. Geologic Service (USGS) digital elevation models (DEMs; Conner 1995). We partitioned aspect into 8 classes with each class representing 45°. Slope also was partitioned into 8 classes with each class encompassing 11°, with the midpoint of the first class at 5.5° and the midpoint of the last class at 83.5°. Likewise, we divided elevation into 8 equal classes which translated into ARC/INFO elevation units with each class representing 100 units. We averaged all distances to each habitat type to produce an interspersion index and distance to nearest edge was calculated (Table 1).

Although slope, elevation, and aspect were continuous variables in reality (i.e., they had a continuous, measurable value), the USGS DEMs classify slope and elevation values into discrete classes as noted above. Because we wanted to preserve the continuous nature of these variables in our analyses, we selected the midpoint in the range of values for each class for analyses. In effect, we used a typical value for that variable when its true value occurred within that range.

We used logistic regression (LR; Afifi and Clark 1990) to test the hypothesis that nest sites did not differ from random sites with respect to habitat variables quantified. We also wanted to examine differences among successful nests (those hatching ≥1 poult) and unsuccessful nests with respect to habitat variables. However, given a low number of successful nests (N=28), efficiency of LR was doubtful. Therefore, we used t-tests to univariately examine differences in habitat between successful and unsuccessful nests. To adjust for experimental error rate, the α level for each t-test was 0.002 (0.05/19 comparisons). Previous work on TWMA indicated nest success may be influenced by habitat type and distance to edge (Seiss et al. 1990, Hurst 1995). To address this, we compared (1) proportion of successful nests between poletimber/sawtimber habitats and regeneration habitats, regardless of habitat type (i.e., includes upland and bottomland habitats of the appropriate ages) and (2) nest success between bottomland hardwood habitats and upland pine habitats, regardless of age. Hypotheses of no difference in nest success with respect to nesting habitat were tested using the binomial test of 2 proportions at α=0.05.

Table 2. Stepwise logistic regression coefficients (EST) and standard errors (SE), means, standard deviations (SD), t-values, degree of freedom (DF), and P-values for t-tests for nest location habitat variables, Tallahala Wildlife Management Area, Mississippi, 1984–1994.

	Logistic regression		Unsuccessful nests (not hatching any poults, N = 62)		Successful nests (hatching ≥1 poult, N = 28)		Test statistics		
Variable[a]	EST	SE	Mean	SD	Mean	SD	t-value	DF	P-value
Intecept	2.4811	0.63200	—	—	—	—	—	—	—
Aspect	NIM[b]	NIM	228.62	97.88	188.04	104.68	1.78	88.0	0.0781
ELEV	−0.0086	0.00282	175.81	72.28	182.14	61.18	−0.4029	88.0	0.6880
Slope	NIM	NIM	24.48	9.99	24.36	10.31	0.0552	88.0	0.9561
HAB1	NIM	NIM	2045.00	1767.00	1833.00	1742.00	0.5270	88.0	0.5995
HAB2	NIM	NIM	2154.00	1769.00	2104.00	1792.00	0.1239	88.0	0.9017
HAB3	NIM	NIM	1635.00	1889.24	1562.86	1692.57	0.1748	88.0	0.8616
HAB4	NIM	NIM	437.04	448.58	266.38	239.03	2.3474	85.5	0.0212
HAB5	NIM	NIM	651.75	519.98	784.93	438.97	−1.1780	88.0	0.2420
HAB6	−0.0007	0.00023	512.33	543.77	446.80	591.17	0.5151	88.0	0.6078
HAB7	−0.0007	0.00033	304.69	443.39	310.42	430.78	−0.0573	88.0	0.9544
HAB8	NIM	NIM	2899.00	1306.00	2428.44	1324.00	1.5757	88.0	0.1187
HAB9	NIM	NIM	1605.00	862.49	1955.43	892.82	−1.7633	88.0	0.0813
HAB10	NIM	NIM	1532.00	1007.00	1895.00	1213.00	−1.4822	88.0	0.1419
HAB11	NIM	NIM	1762.00	1260.00	1442.00	837.77	1.4228	75.5	0.1589
HAB12	NIM	NIM	1392.00	1062.00	1617.00	822.65	−0.9909	88.0	0.3245
CREEKS	NIM	NIM	236.19	149.19	261.04	191.78	−0.6675	88.0	0.5062
ROADS	NIM	NIM	332.82	351.26	243.18	163.73	1.6512	87.9	0.1023
INTER	NIM	NIM	1411.00	368.44	1387.00	298.25	0.2997	88.0	0.7651
EDGE	NIM	NIM	78.71	83.50	128.97	196.57	−1.3012	31.5	0.2026

a. Variables were: aspect (8 classes of 45° each), ELEV (elevation in 8 equal classes of 100 units), slope (8 equal classes of 90° each), HAB1 (distance to nearest hardwood regeneration [<16 years] stand), HAB2 (distance to nearest hardwood poletimber [16–40 years] stand), HAB3 (distance to nearest hardwood sawtimber [>40 years] stand), HAB4 (distance to nearest pine regeneration [<8 years old] stand), HAB8 (distance to nearest pine poletimber [8–30 years old] stand, not burned ≤ 3 years ago), HAB10 (distance to nearest pine sawtimber [>30 years] stand, burned ≤ 3 years ago), HAB12 (distance to nearest pine sawtimber [>30 years] stand, not burned ≤ 3 years ago), HAB13 (distance to nearest mixed regeneration [<16 years] stand), HAB15 (distance to nearest mixed poletimber [16–40 years] stand, not burned ≤ 3 years ago), HAB16 (distance to nearest mixed sawtimber [>40 years] stand, burned ≤ 3 years ago), HAB17 distance to nearest mixed sawtimber (>40 years] stand, not burned ≤ 3 years ago), HAB18 (distance to nearest opening/field), INTER (interspersion; average distance to all other habitat types). CREEK (distance to nearest creek), ROAD (distance to nearest road), and EDGE (distance to closest edge).

Results

We documented 89 nest locations of 69 different nesting hens. Of these 89 nest locations, 28 (31.5%) were successful. We used 89 nest locations and 89 random location to model nesting habitat selection. Four variables were significant in the model: an intercept term ($P<0.001$), ELEV ($P=0.016$), HAB6 ($P=0.001$) and HAB7 ($P=0.039$). The model correctly classified 66.3% of used locations and 61.8% of random locations. It misclassified 36.6% of random locations as used and 35.3% of used locations as random. Nest sites were lower in elevation and closer to HAB6 and HAB7 than random sites (Table 2). Univariate *t*-test of habitat variables detected no significant differences when comparing successful and unsuccessful nest sites (Table 2). Twenty-six of 72 (36.1%) nests located in mature stands were successful as compared to 2 of 18 nests (11.1%) located in regeneration stands; this difference was significant ($Z=2.049$, $P=0.040$). Of 16 nests located in bottomland hardwood sites, 3 (18.8%) were successful as opposed to 23 successful nest out of 66 (34.8%) located in upland pine habitats; this difference, however, was not significant ($Z=1.24$, $P=0.214$).

Discussion

Overall, it appears that location of different habitats on the landscape had little influence on location of nest sites by hens on TWMA. However, some potential landscape-scale habitat choices were revealed by our analyses. Nesting sites were located lower in elevation than random and closer than expected to pine sawtimber, both burned ≤3 years ago (HAB6) and not burned within 3 years (HAB7). Locating nests in lower elevations may place hens closer to potential brood-rearing areas (i.e., bottomland hardwood stands; Palmer 1990) thus enabling hens with broods to reach these preferred habitats soon after hatching. Hens on TWMA also used riparian zones to travel between upland nesting habitats and bottomland brood-rearing habitat (Palmer and Hurst 1996). Lower elevations of nesting sites also may be indicative of hens choosing to locate nests near these corridors. Importance of nests located near brood habitat has been observed in Alabama (Everett et al. 1985) and Minnesota (Lazarus and Porter 1985). Locations of nesting hens near HAB6 and HAB7 were expected given the large proportion (73%) of nests actually located in these habitats.

Several authors have reported that successful nests tend to be located closer to edges than random points or unsuccessful nests (Everett 1982, Holbrook et al. 1987), including one study on TWMA (Seiss et al. 1990). However, we detected no significant difference in mean location to edge between successful and unsuccessful nests nor random points and all nests. The reason for the differences in this study and that of Seiss et al. (1990) is unclear. However, it may be due to the smaller sample and shorter time span examined by Seiss et al. (1990) (cf. Leopold et al. 1996). Another factor may be the preponderance of edge habitats on TWMA. Numerous roads on the area, in addition to many edges created among mostly small (<150 ha) stands reduced the maximum potential distance random points, or turkey nests, could be located from edges. This would tend to reduce potential differences in distance to edge measurements between nest sites and random locations.

In accordance with Seiss et al. (1990), hens in mature/poletimber stands were more likely to successfully incubate nests than those in regenerating stands. Hens on TWMA more often nested in mature forest types (72 of 90 nests), suggesting hens recognize mature habitats as providing better quality nesting habitat (Badyaev et al. 1996, Miller et al. 1999). However, it is important to recognize that the larger number of nests in mature/poletimber stands in the present study was not referenced by habitat availability, as were data from Seiss et al. (1990), which indicated a preference for regeneration areas, even though less hens nested in that habitat (i.e., used greater than available). Hens were likely attracted to regeneration areas because of the preponderance of lateral, concealing cover, considered ideal for nesting hens (Hurst and Dickson 1992, Porter 1992). However, these habitats supported dense populations of small mammals, possibly increasing predation risk to hens from carnivores hunting for small mammals (Conner 1995, Chamberlain et al. 1996).

Management Implications

Our results indicated that hens on TWMA were more successful when nesting in mature pine stands. On TWMA, hens used riparian areas to travel between bottomland hardwood sites and upland nesting sites (Palmer and Hurst 1996). In addition, amount of time spent by hens searching potential nesting sites also may increase nest success (Badayev et al. 1996, Miller et al. 1999). Therefore, a potential management action to increase wild turkey nest success on TWMA may be to provide mature pine stands juxtaposed with bottomland hardwood stands and riparian areas. Hens moving out of bottomland areas and riparian zones may then encounter mature pine stands first, potentially encouraging nesting in this habitat type, instead of in regenerating stands. It also may be desirable to prescribe burn these stands every 3–5 years to make them even more conducive to use by hens (Palmer et al. 1996).

Predation is the leading cause of nest failure in wild turkeys (Miller and Leopold 1992) and on TWMA specifically (Miller et al. 1998). Research has demonstrated that habitat management can decrease predation rates. For example, providing adequate herbaceous cover allowed wild turkey broods to better escape detection by predators (Glidden and Austin 1975, Everett et al. 1980, Metzler and Speake 1985). On TWMA, coyotes *(Canis latrans)* and bobcats *(Felis rufus)* preferred habitats with high prey densities (Lovell 1996). For bobcats, this was reflected in a preference for regeneration habitats (Conner 1995, Lovell 1996). On TWMA, providing mature pine stands juxtaposed with bottomland hardwood and riparian sites may encourage hens on TWMA to nest in areas not preferred for foraging by some predators (e.g., bobcats in regenerating stands).

For many landowners or persons interested in managing for wild turkeys, habitat management is not an option, either due to financial constraints or lack of control over landscape-scale management opportunities (e.g., hunting leases on forest industry timberlands). However, in some cases, such as land under public ownership, opportunities may exist to manage for several species, including turkeys, across a landscape. For example, the Bienville National Forest, of which TWMA is a part, is a red-cockaded woodpecker *(Picoides borealis)* recovery area. Maintenance of mature pine stands with low basal area and minimal understory to manage for red-cockaded woodpeckers may also benefit turkeys, especially if a 3-year burning rotation is implemented. Managers on TWMA may consider leaving frequently burned (3-year rotation) mature pine areas along bottomland stands and riparian areas to manage both for turkeys and red-cockaded woodpeckers.

Literature Cited

Afifi, A. A. and V. Clark. 1990. Computer aided multivariate statistics. Lifetime Learning Publ. Belmont, Calif. 458pp.

Badyaev, A. V., T. E. Martin, and W. J. Etges. 1996. Habitat sampling and habitat selection by female wild turkeys: ecological correlates and reproductive consequences. Auk 113:636–646

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

Campo, J. J., C.R. Hopkins, and 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.

Chamberlain, M. J., D. A. Miller, B. D. Leopold, and G.A. Hurst. 1996. Comparison of predation rates on wild turkey hens between two forest ecosystems in Mississippi. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 50:428–435.

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, Miss. 125pp.

Donovan, M. L., D. L. Rabe, and C. E. Olson, Jr. 1987. Use of geographic information systems to develop habitat suitability models. Wildl. Soc. Bull. 15:574–579.

Environmental Systems Research Institute (ESRI), Inc. 1994. ARC/INFO Vers. 7.01. ESRI, Redlands, Calif.

Everett, D. D. Jr. 1982. Factors limiting populations of wild turkeys on state wildlife management areas in north Alabama. Ph.D. Diss. Auburn Univ., Auburn, Ala. 135pp.

———, D. W. Speake, and W. K. Maddox. 1980. Natality and mortality of a north Alabama turkey population. Proc. Natl. Wild Turkey Symp. 4:117–126.

———, ———, and ———. 1985. Habitat use by wild turkeys in Northwest Alabama. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 39:479–488.

Glidden, J. W. and D. E. Austin. 1975. Natality and mortality of wild turkey poults in southwestern New York. Proc. Natl. Wild Turkey Symp. 3:48–54.

Holbrook, H. T., M. R. Vaughan, and P. T. Bromley. 1987. Wild turkey habitat preferences and recruitment in intensively managed piedmont forests. J. Wildl. Manage. 51:182–187.

Hurst, G. A. 1981. Habitat requirements of the wild turkey on the Southeast Coastal Plain. Pages 2–13 *in* P. T. Bromley and R. L. Carlton, eds. Proceedings of a symposium on habitat requirements and habitat management of the wild turkey. Southeast Va. Wild Turkey Found., Elliston. 180pp.

———. 1995. An ecological study of the wild turkey on the Tallahala Wildlife Management Area, Mississippi. Compl. Rep., Fed. Aid in Wildl. Restor. Proj. W-48, study 30. Miss. Dep. Wildl. Fish. and Parks. Jackson. 65pp.

——— and J. G. Dickson. 1992. Eastern turkey in southern pine-oak forests. Pages 265–285 *in* J. G. Dickson, ed. The wild turkey: biology and management. Stackpole Books. Harrisburg, Pa.

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

Lazarus, J. E. and W. F. Porter. 1985. Nest habitat selection by wild turkeys in Minnesota. Proc. Natl. Wild Turkey Symp. 5:67–82.

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

———, ———, and D. A. Miller. 1996. Long- versus short-term research and effective management: A case study using the wild turkey. Proc. North Am. Wildl. Nat. Resour. Conf. 61:477–487.

Lovell, C. D. 1996. Bobcat, coyote, and gray fox micro-habitat use and interspecies relationships in a managed forest in central Mississippi. M.S. Thesis, Miss. State Univ., Miss. State, Miss.

Metzler, R. and D. W. Speake. 1985. Wild turkey poult mortality rates and interspecies relationship to brood habitat structure in northeast Alabama. Proc. Natl. Wild Turkey Symp. 5:103–112.

Miller, D. A. 1997. Habitat relationships and demographic parameters of an eastern turkey population in central Mississippi. Diss., Miss. State Univ., Miss. State, Miss.

———, G. A. Hurst, and B. D. Leopold. 1999. Habitat use of eastern wild turkeys in central Mississippi. J. Wildl. Manage. 63:210–222.

———, B. D. Leopold, and G. A. Hurst. 1998. Reproductive characteristics of a wild turkey population in central Mississippi. J. Wildl. Manage. 62:903–910.

Miller, J. E. and B. D. Leopold. 1992. Population influences: predators. Pages 101–118 *in* J. G. Dickson, ed. The wild turkey, biology and management. Stackpole Books, Harrisburg, Pa.

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

——— and G. A. Hurst. 1996. Drainage systems as minimum habitat management units for wild turkey hens. Proc. Natl. Wild Turkey Symp. 7:97–104.

———, ———, K. David Godwin, and D. A. Miller. 1996. Effects of prescribed burning on wild turkeys. Proc. North Am. Wildl. Nat. Resour. Conf. 61:228–236.

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

Porter, W. F. 1992. Habitat analysis and assessment. Pages 188–201 *in* J. G. Dickson, ed. The wild turkey: biology and management. Stackpole Books, Harrisburg, Pa.

Roberts, S. D. and W. F. Porter. 1996. Importance of demographic parameters to annual changes in wild turkey abundance. Proc. Natl. Wild Turkey Symp. 7:15–20.

Seiss, S. D., R. S. Phalen, and G. A. Hurst. 1990. Wild turkey nesting habitat and success rates. Proc. Natl. Wild Turkey Symp. 6:18–24.

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

U. S. Department of Agriculture (USDA). 1980. USDA For. Serv. Wildl. Habitat Manage. Handb., Southern Reg. FSH 2609.23R. Atlanta, Ga.

Vangilder, L. D. and E. W. Kurzejeski. 1995. Population ecology of the eastern wild turkey in northern Missouri. Wildl. Monogr. 130:1–50.

Weinstein, M. D., D. A. Miller, L. M. Connor, B. D. Leopold, and G.A. Hurst. 1996. What affects turkeys? A conceptual model for future research. Proc. Natl. Wild Turkey Symp. 7:135–142.

Williams, L. E., Jr. and D. H. Austin. 1988. Studies of the wild turkey in Florida. Fla. Game and Fresh Water Fish Comm. Tech. Bull. 10. Tallahassee, Fla. 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.