Effect of Habitat and Movement on Wild Turkey Poult Survival

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Abstract: Poult survival is an important factor in the dynamics of eastern wild turkey *(Meleagris gallopavo silvestris)* populations. We captured wild turkeys in western Virginia and monitored radio-tagged hens (N=26) to determine the effect of brood habitat, brood movements and brood range size on poult survival. Poult survival to 21 days post-hatch averaged 0.203 (SE=0.05) during 1992 and 0.418 (SE=0.11) during 1993 (T=1.37, P>0.10). No correlations were detected (P≥0.10) between macrohabitat and forest cover type variables and poult survival. Poult survival was correlated with the percentage of brood habitat composed of herbaceous understory vegetation (P=0.058). Poult survival was also examined in relation to a simple brood habitat classification system; however, no correlations were detected (P≥0.10). Average daily distance moved during the first week after hatching (T=0.69, P>0.10), average daily distance moved during the first month after hatching (T=1.15, P>0.10), and brood range size (T=−0.34, P>0.10) did not differ between hens with high and low poult survival. High quality brood rearing habitat (i.e., managed forest and non-forested areas) may be limited in western Virginia and could be enhanced through forest management activities and creation of herbaceous openings.

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Poult survival is an important factor in the dynamics of wild turkey populations. Roberts et al. (1995) suggested annual fluctuations of northern wild turkey populations in mixed agricultural and forested habitats rarely result from changes in annual survival but rather result from annual variations in nest success and poult survival. Decreasing poult mortality was reported to have a large influence on wild turkey population dynamics for a population model developed in Missouri (Vangilder and Kurzejeski 1995).

The quality of available brood habitat and brood movements affect poult survival rates. Hillestad and Speake (1970), Glidden and Austin (1975), Everett et al.

(1980), Healy (1985), and Metzler and Speake (1985) investigated the effect of brood habitat on poult survival. Rich herbaceous growth, mesic forest types, and high site quality characterized high quality brood habitat (Healy 1985). Pack et al. (1988) developed a simple classification system for evaluating potential brood range. This system offers wildlife managers a potentially useful habitat evaluation tool that does not require extensive quantitative measurements. Little attention has been given to the impact of movement on wild turkey poult survival, but we hypothesized that survival would decrease as daily movements and home range size increased. Our objective was to determine the effect of brood habitat, brood movements, and brood range size on wild turkey poult survival.

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Methods

We conducted our research on 11 study sites in the Alleghany Mountains of western Virginia (Norman et al. 2001). Mountain bedrock is composed of sandstone and shale, and soils are generally sloping to very steep and well to excessively well drained (Soil. Conserv. Serv. 1985). White oak *(Quercus alba),* northern red oak *(Q. rubra),* scarlet oak *(Q. coccinea),* black oak *(Q. velutina),* red maple *(Acer rubrum),* hickory (*Carya* spp.), pitch pine *(Pinus rigida),* and eastern white pine *(P. strobus)* are common overstory species (U.S. Dep. Agric. 1985).

Trapping

We captured wild turkeys during fall and winter 1991–92 and 1992–93 with rocket nets. We determined age (juvenile or adult) and sex by feather coloration (Pelham and Dickson 1992). Sex of juveniles captured prior to the post juvenile molt was determined by measuring leg and primary length (Healy and Nenno 1980). We fitted all turkeys with numbered aluminum leg bands and attached radio transmitters (Telonics, Inc., Mesa, Ariz.; Advance Telemetry Systems, Isanti, Minn.) to hens using a backpack harness (Norman et al. 1997). We released all turkeys at the capture site.

Telemetry

We located turkeys using portable receivers (Advance Telemetry Systems, Isanti, Minn.) and hand-held H-antennas (Telonics, Inc., Mesa, Ariz.) from fixed telemetry stations. We located hens 2 nights/week in April and May to determine the onset of nesting and incubation initiation. We attempted to locate successful hens 3 days/week during daylight hours, for the first 4 weeks after hatching. We randomly selected times for locating successful hens, but all times were prior to 1400 hours. Telemetry error was ±3.0 degrees (Burhans 1996).

We estimated each hen's location with Andrew's maximum likelihood estimator for 3 or more bearings (Lenth 1981, Garrott and White 1990). We defined acceptable telemetry locations for brood range analysis as those locations with error ellipses ≤5% (12.5 ha) of the home range typically used by a female turkey and brood (Porter 1980). We calculated brood range size (minimum convex polygon) with RangesV (Inst. for Terrestrial Ecol., Dorset, Engl.) if ≥6 acceptable locations were recorded for a hen and brood. We calculated average daily distance traveled by a hen and brood as the distance between subsequent locations divided by the number of days between locations.

Poult Survival

We assumed hens were incubating if the bearing from each telemetry station was ±10 degrees of the bearing recorded for that station during the previous location. We located areas containing turkey nest sites by circling the nesting hen at a distance of 50–100 m and recording bearings from several points along the circle. We marked points where bearings were recorded to facilitate nest site location following the hen's departure.

We located nest sites to determine the number of poults hatched from each nest. We determined poult survival at 21±2 days after hatching by visual observation of successful hens. We estimated poult survival as percentage of poults hatched that were alive after 21 days. We used tape recordings of "lost poult" and "fright call" vocalizations to lure hens with broods to a location where individual turkeys could be counted (Kimmel and Tzilkowski 1986). Broods not responding to the calls were flushed for counting (Glidden and Austin 1975). When multiple broods responded to vocalizations, we assumed the brood size of the radio-tagged female was equal to the poult:hen ratio of the multiple brood (Roberts et al. 1995). We defined high and low poult survival as broods with >55.0% and <35.0% of the poults surviving to 21 days, respectively.

Brood Range Habitat

We sampled brood range habitat with 10 randomly selected 50-m transects. Along each transect, we established 5 points at 10-m intervals. At each point, we classified the macrohabitat type as managed forest, unmanaged forest, or nonforested. We reported forest cover types based upon the dominant tree species growing on the site and categorized sites as pine (*Pinus* spp.), white oak, northern red oak, hickory, red maple, tulip poplar *(Liriodendron tulipifera),* and other. We based understory habitat types on vegetative structure and categorized the understory as herbaceous (grasses and forbs), mosses, short shrubs (<1.5 m tall), tall shrubs (≥1.5 m tall), hardwood regeneration, or conifer regeneration. We used percent woody vegetation and percent herbaceous vegetation variables to classify each plot into 1 of the numerical categories developed by Pack et al. (1988) (Table 1).

Table 1. Combined percent woody vegetation and percent herbaceous vegetation categories used to define eastern wild turkey brood range habitat in Virginia, 1992–1993.

Category	% Woody vegetation	% Herbaceous vegetation
1	< 20	< 30
2	< 20	30–70
3	< 20	> 70
4	20–60	
5	> 60	

Data Analysis

We compared the average number of eggs hatched per nest and poult survival per brood between years with Wilcoxon rank sum tests. We compared average daily movements and brood range size between hens with high and low poult survival with Wilcoxon rank sum tests. Relationships between poult survival and brood habitat composition were determined with Kendall's tau-b correlations. Statistical significance for all analyses was at the $\alpha = 0.10$ level.

Results

Poult Survival

The number of eggs hatched per nest averaged 10.1 (SE=0.57, N=13) in 1992 and 10.6 (SE=0.67, N=13) in 1993 (T=−0.18, P>0.10) (Table 2). Poult survival ranged from 0.000–0.600 and 0.000–1.000 per brood during 1992 and 1993, respectively. Average poult survival per brood was 0.203 (SE=0.05, N=13) during 1992 and 0.418 (SE=0.11, N=13) during 1993 (T=1.37, P>0.10). The number of poults alive at 21 days per successful hen averaged 2.15 and 4.42 during 1992 and 1993, respectively.

Brood Habitat

No correlation (P>0.10) was detected between poult survival and the percentage of brood habitat composed of unmanaged, managed, or non-forested areas (Table 3). Forest cover types used as brood habitat were not correlated (P>0.10) with poult survival. Poult survival was correlated (P=0.058) with the percent of brood range understory composed of herbaceous vegetation. No other understory vegetation parameter (mosses, short shrubs, tall shrubs, or hardwood regeneration) was correlated (P>0.10) with poult survival.

Brood Movement and Range Size

Average daily distance traveled during the first week posthatch averaged 507.8 m (SE=224.5, N=9) for hens with low poult survival and 672.1 m (SE=341.8, N=4) for hens with high poult survival (T=0.69, P>0.10). Average daily distance moved during the first month posthatch averaged 270.0 m (SE=35.8, N=9) for hens

Table 2. Poult survival for eastern wild turkey broods monitored in Virginia 1992–1993.

Hen	*N* eggs hatched	Brood observation			Survival (%)
		N hens	*N* poults	Poults/hen	
1992					
1,808	13	2	9	4.5	0.346
1,810	11	1	0	0	0.000
1,823	8	1	0	0	0.000
1,955	13	3	12	4	0.308
2,038	11	1	3	3	0.308
2,042	10	1	6	6	0.600
2,206	10	!	0	0	0.000
2,327	11	4	15	3.75	0.341
2,350	10	1	0	0	0.000
2,352	10	3	5	1.67	0.167
2,356	5	1	1	1	0.200
2,465	11	1	2	2	0.182
2,499	9	1	2	2	0.222
1993					
1,761	10	3	3	1	0.100
2,269	9	2	13	6.5	0.722
2,291	15	1	0	0	0.000
2,327	9	1	1	1	0.111
2,352	13	1	13	13	1.000
2,447	12	1	10	10	0.833
2,467	12	1	0	0	0.000
2,481	9	1	7	7	0.778
3,009	6	1	2	2	0.333
3,012	13	1	0	0	0.000
3,516	9	1	5	5	0.556
3,574	12	1	12	12	1.000
3,588	9	1	0	0	0.000

with low poult survival and 329.9 (SE=44.3, N=4) for hens with high poult survival (T=1.15, P>0.10). Brood range size did not differ (T=–0.34, P>0.10) between hens with high and low poult survival. Brood range size averaged 222.1 ha (SE=46.1, N=11) and 181.6 ha (SE=63.2, N=5) for hens with low and high poult survival, respectively.

Discussion

We calculated poult survival using the brood as our sample unit rather than individual poults. This method eliminates the problem of independent survival between poults of the same brood. However, estimates of poult survival between these 2 methods differed by <0.6%. Poult mortality rates we observed were within the range reported for other wild turkey populations. Speake et al. (1985) reported a poult mortality rate of 69.8% in northern Alabama. In southern Iowa, Hubbard (1997) reported a 54% poult mortality rate at 4-weeks posthatch. Roberts and Porter (1998) observed a poult mortality rate of 55.1% in New York. Poult mortality rates at 4-weeks post-

Table 3. Kendall's tau-b correlations between poult survival and brood range habitat for eastern wild turkeys in Virginia 1992–1993.

Habitat variable	Correlation coefficient	*P*-value
Macrohabitat		
Unmanaged forest (%)	−0.125	0.560
Managed forest (%)	0.104	0.631
Non-forested (%)	0.146	0.511
Forest cover type		
Pine (%)	0.022	0.916
White oak	−0.233	0.268
Red oak	−0.011	0.958
Hickory	0.038	0.867
Red maple	0.240	0.265
Tulip poplar	0.104	0.648
Other	0.045	0.833
Understory vegetation		
Herbaceous	0.424	0.058
Mosses	0.023	0.916
Short shrubs	−0.146	0.492
Tall shrubs	−0.060	0.788
Hardwood regeneration	−0.242	0.262
Conifer regeneration	0.095	0.677
Percent woody/herbaceous categories		
Woody vegetation <20%/herbaceous vegetation <30%	0.224	0.291
Woody vegetation <20%/herbaceous vegetation 30%–70%	0.265	0.233
Woody vegetation <20%/herbaceous vegetation >70%	0.326	0.134
Woody vegetation 20%–60%	−0.146	0.492
Woody vegetation >60%	−0.233	0.268

hatch varied from 41.9% to 70.5% in Missouri (Vangilder and Kurzejeski 1995). Peoples et al. (1995) reported a poult mortality rate of 90.8% for coastal plain pine forests in south Georgia and north Florida.

Our data suggest poult survival in Virginia is variable. Although poult survival per brood more than doubled, it did not differ between 1992 and 1993. Our choice of the brood as the sampling unit adversely affected our ability to detect differences in poult survival between years. Yearly sample sizes for hens with broods were small and estimates of poult survival per brood were highly variable, resulting in low statistical power and a low probability of detecting differences. Had we used individual poults as our sample unit, we could have greatly increased our sample size, and the difference in poult survival between years would have been significant ($P<0.001$).

Brood range is an essential component of wild turkey habitat, and the lack of quality brood range may be a limiting factor for wild turkeys (Hillestad and Speake 1970, Metzler and Speake 1985). The percentage of brood habitat composed of herbaceous understory was positively correlated with poult survival, concurring with other investigations of wild turkey brood habitat. Healy and Nenno (1983) stated that adequate herbaceous cover was an essential feature of turkey brood habitat. Healy (1981) reported that herbaceous ground cover in the range of 600 kg/ha to 3,000 kg/ha dry weight provided adequate brood cover for wild turkeys. In Pennsylvania oak forests, hens with broods chose areas with a more dense tree canopy, more dense herbaceous ground cover, and less dense woody ground cover (Ross and Wunz 1990). Broods in West Virginia preferred openings, white oak stands, basal areas between 9–18 m^2/ha, and avoided stands with a dense woody understory and basal areas >23 m^2/ha (Pybus 977, Pack et al. 1980).

Managed forests and non-forested areas composed <20.0% of wild turkey brood habitat in western Virginia. In West Virginia, Swanson et al. (1996) reported poult survival was higher in selectively harvested timber stands than in unharvested timber stands. Increased poult survival was attributed to increased structural heterogeneity of understory vegetation, increased cover, and increased food supplies following timber harvesting (Swanson et al. 1996). Agricultural fields, old fields, pastures, and permanent forest openings have been previously identified as excellent brood habitat (Blackburn et al. 1975, Hon et al. 1978, Everett et al. 1980, Hillestad and Speake 1980, Porter 1980). It appears that quality brood habitat may be limited in western Virginia and could be enhanced through forest management activities and creation of herbaceous openings.

The brood habitat classification system proposed by Pack et al. (1988) offers managers a relatively quick and easy means to evaluate potential brood habitat. The classification system uses occular estimates to categorize habitats into 5 numerical (1–5) classes. Pack et al. (1988) found that broods preferred category 3 and avoided categories 1 and 5 (Table 1). Although we found no significant correlation between any of categories and poult survival, category 3 had a positive correlation that was nearly significant (P=0.134). Pack et al. (1988) reported hens with broods avoided category 5. We found a negative correlation with this category and survival, although it was not statistically significant. These results suggest a tendency for brood survival to be higher in habitats categorized as preferred and lower in habitat types that were avoided.

Movements to brood rearing areas may cover long distances and occur over several days. We hypothesized that increasing the distance that a hen must move her brood to reach adequate brood habitat would increase the probability of poults succumbing to mortality factors, resulting in lower poult survival. However, we found no difference in the average daily movements during the first week posthatch or first month posthatch between hens with high and low poult survival. Peoples et al. (1996) also reported there was no difference in the movements of successful and unsuccessful broods in southern Georgia and northern Florida.

Numerically, the average daily distance moved during the first month posthatch by broods with high poult survival was greater than that for broods with low poult survival. In western Virginia, these movements by broods with high poult survival may indicate a lack of quality brood habitat. During our study, the vast majority of brood habitat was composed of oak stands on well to excessively well drained soils. Healy (1985) suggested oak stands growing on dry sites do not provide a sufficient food source for turkey broods. It is possible that broods in the mountains of western Virginia may need to travel greater distances to find sufficient food sources to attain high poult survival.

Brood range size in western Virginia was within the range reported in previous studies. In West Virginia, Pack et al. (1980) reported brood range size averaged 455 ha. Porter (1980) reported brood range size averaged 250 ha in Minnesota. Brood range size averaged 140 ha in eastern Alabama (Hillestad and Speake 1970). Speake et al. (1975) reported home range size averaged 111 ha for hens with broods, and home range size of hens with broods averaged 169.9 ha for the first month posthatch in southern Georgia and northern Florida (Peoples et al. 1996).

Exum et al. (1987) suggested that part of the variation in brood range size was probably related to habitat quality. If habitat quality is directly related to poult survival, our data might support this hypothesis. Numerically, broods with high poult survival used smaller home ranges than broods with low poult survival in western Virginia. However, we found no difference in brood range size between hens with high and low poult survival.

Management Implications

In wild turkey populations where poult survival is variable, annual fluctuations in poult survival can have a great influence on wild turkey population dynamics (Roberts and Porter 1998). Our data suggest that poult survival in western Virginia can be highly variable. Unfortunately, managers have little control over poult survival (Vangilder and Kurzejeski 1995); thus, effective management requires monitoring population parameters such as poult survival to determine annual fluctuations and provide input into management decisions.

The importance of herbaceous vegetation as brood habitat for wild turkeys is well documented. In western Virginia, most brood habitat was composed of unmanaged (i.e., unharvested) forests. Forest clearings can provide more insect and plant foods for poults than forest communities (Martin and McGinnes 1975). However, the number and size of forest clearings on public lands in western Virginia was very limited. Agricultural openings on private lands (pasture, row crops) were also limited in this predominately forested mountainous area. Maintenance of existing clearings on public lands is recommended. Development of new clearings is expensive; development of linear clearings in conjunction with road construction projects offers an attractive alternative. These areas can provide good brood habitat and daylighting roads may reduce road maintenance costs. However, to maximize the effectiveness of these areas, we recommend that they be gated.

The greatest opportunity to improve brood habitat in western Virginia and other similar areas probably lies in management of forested areas. The key to effective brood habitat development in forested areas is the stimulation of understory herbaceous growth while controlling understory woody vegetation. Uneven age timber harvesting systems reduce overstory canopy cover and stimulate understory growth. Swanson et al. (1996) stated understory and herbaceous cover in brood-rearing habitats were greater in harvested than unharvested forest stands and that selective timber harvesting improved the quality of the habitat for wild turkey broods. Thinning stands can improve understory development but will ultimately favor woody vegetation

(Sharp 1963). Pack et al. (1988) used prescribed burning in conjunction with thinning to increase herbaceous understories and control woody vegetation in oak-hickory forests. Planting logging roads and logging landings to clover, orchardgrass, or both will increase herbaceous growth and arthropod densities (Hollifield and Dimmick 1995).

Literature Cited

Blackburn, W. E., J. P. Kirk, and J. E. Kennamer. 1975. Availability and utilization of summer foods by eastern wild turkey broods in Lee County, Alabama. Proc. Natl. Wild Turkey Symp. 3:86–96.

Burhans, B. J. 1996. Influence of forest clearings on the winter survival, reproduction, and movements of wild turkey hens in southwestern Virginia. M.S. Thesis, Frostburg State Univ., Frostburg, Md.

Everett, D. D., D. W. Speake, and W. K. Maddox. 1980. Natality and mortality in a northern Alabama wild turkey population. Proc. Natl. Wild Turkey Symp. 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 Res. Sta. Bull. 23. 70pp.

Garrott, R. A. and G. C. White. 1990. Analysis of wildlife radio tracking data. Acad. Press, Inc., San Diego, Calif. 383pp.

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.

Healy, W. M. 1981. Habitat requirements of wild turkeys in the southeastern mountains. Pages 24–34 *in* P. T. Bromley and R. L. Carlton, eds. Proc. Symp.: Habitat requirements and habitat management for the wild turkey in the southeast. Richmond, Va. 180pp.

———. 1985. Turkey poult feeding activity, invertebrate abundance, and vegetation structure. J. Wildl. Manage. 49:466–472.

——— and E. S. Nenno. 1980. Growth parameters and sex and age criteria for juvenile eastern wild turkeys. Proc. Natl. Wild Turkey Symp. 4:168–185.

——— and ———. 1983. Minimum maintenance versus intensive management of clearings for wild turkeys. Wildl. Soc. Bull. 11:113–120.

Hillestad, H. O. and D. W. Speake. 1970. Activities of wild turkey hens and poults as influenced by habitat. Proc. Annu. Conf. Southeast. Assoc. Game and Fish Comm. 24:244–251.

Hollifield, B. K. and R. W. Dimmick. 1995. Arthropod abundance relative to forest management practices benefiting ruffed grouse in the southern Appalachians. Wildl. Soc. Bull. 23:756–764.

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.

Hubbard, M. W. 1997. Behavior and survival of nesting wild turkeys in southern Iowa. Ph.D. Diss., Iowa State Univ., Ames. 136pp.

Kimmel, V. L. and W. M. Tzilkowski. 1986. Eastern wild turkey response to a tape-recorded chick call. Wildl. Soc. Bull. 14:55–58.

Lenth, R. V. 1981. On finding the source of a signal. Technimetrics 23:149–154.

Martin, D. D. and B. S. McGinnes. 1974. Insect availability and use by turkeys in forest clearings. Proc. Natl. Wild Turkey Symp. 3:70–75.

Metzler, R. and D. W. Speake. 1985. Wild turkey poult mortality rates and their relationship to brood habitat structure in northeast Alabama. Proc. Natl. Wild Turkey Symp. 5:103–111.

Norman, G. W., J. C. Pack, and G. A. Hurst. 1997. Transmitter selection and attachment technique for wild turkey research. Natl. Wild Turkey Fed. Tech. Bull. 6. Edgefield, S.C.

———, ———, C. I. Taylor, D. E. Steffen, and K. E. Pollock. 2001. Reproductive ecology of wild turkey hens in Virginia and West Virginia. 2000. J. Wildl. Manage. 65:1–9.

Pack, J. C., R. P. Burkert, W. K. Igo, and D. J. Pybus. 1980. Habitat utilized by wild turkey broods within oak-hickory forest of West Virginia. Proc. Natl. Wild Turkey Symp. 4:213–224.

———, W. K. Igo, and C. I. Taylor. 1988. Use of prescribed burning in conjunction with thinning to increase wild turkey brood range habitat in oak-hickory forests. Trans. Northeast. Sec. Wildl. Soc. 45:37–48.

Pelham, P. M. and J. G. Dickson. 1992. Physical characteristics. Pages 32–45 *in* J. G. Dickson, ed. The wild turkey: biology and management. Stackpole Books, Harrisburg, Pa. 463pp.

Peoples, J. C., D. C. Sisson, and D. W. Speake. 1995. Mortality of wild turkey poults in coastal plain pine forests. Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 49:448–453.

———, ———, and ———. 1996. Wild turkey brood habitat use and characteristics in coastal plain pine forests. Proc. Natl. Wild Turkey Symp. 7:89–96.

Porter, W. F. 1980. An evaluation of wild turkey brood habitat in southeastern Minnesota. Proc. Natl. Wild Turkey Symp. 4:203–212.

Pybus, D. J. 1977. Understory characteristics and utilization by wild turkey broods in West Virginia. M.S. Thesis. West Va. Univ., Morgantown. 106pp.

Roberts, S. D. and W. F. Porter. 1998. Influence of temperature and precipitation on survival of wild turkey poults. J. Wildl. Manage. 62:1499–1505.

———, J. M. Coffey, and W. F. Porter. 1995. Survival and reproduction of female wild turkeys in New York. J. Wildl. Manage. 59:437–447.

Ross, A. S. and G. A. Wunz. 1990. Habitats used by wild turkey hens during the summer in oak forests in Pennsylvania. Proc. Natl. Wild Turkey Symp. 6:39–43.

Sharp, W. M. 1963. The effects of habitat manipulation and forest succession on ruffed grouse. J. Wildl. Manage. 27:664–671.

Soil Conservation Service. 1985. Soil survey of Giles County Virginia, southern and central parts. Soil Conserv. Serv., U.S. Dep. Agric. Washington, D.C.

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. 3:122–130.

———, R. Metzler, and J. McGlincy. 1985. Mortality of wild turkey poults in northern Alabama. J. Wildl. Manage. 49:472–474.

Swanson, D. A., J. C. Pack, C. I. Taylor, D. E. Samuel, and P. W. Brown. 1996. Selective timber harvesting and wild turkey reproduction in West Virginia. Proc. Natl. Wild Turkey Symp. 7:81–88.

U.S. Department of Agriculture. 1985. Final environmental impact statement. Jefferson National Forest Resource Management Plan. U.S. For. Serv. 365pp.

Vangilder, L. D. and E. W. Kurzejeski. 1995. Population ecology of the eastern wild turkey in north Missouri. Wildl. Monogr. 130. 50pp.