Seasonal Space Use and Habitat Selection of Female Wild Turkeys in a Louisiana Bottomland Hardwood Forest

Walker B. Wilson, *School of Renewable Natural Resources, Louisiana State University Agricultural Center, Baton Rouge, LA 70803*

Michael J. Chamberlain, *School of Renewable Natural Resources, Louisiana State University Agricultural Center, Baton Rouge, LA 70803*

Frederick G. Kimmel, *Louisiana Department of Wildlife and Fisheries, Baton Rouge, LA 70808*

Abstract: Significant losses to bottomland hardwood forests have occurred throughout the southeastern United States, and considerable efforts are ongoing to restore bottomlands. Understanding ecology of wild turkeys (*Meleagris gallopavo*) in these systems will become increasingly important as distribution and availability of these forests continues to change through time. Although considerable research has examined space and habitat use of wild turkeys in upland forests, information is lacking for bottomland hardwood systems. We captured and radiomarked 32 female wild turkeys in a bottomland hardwood forest in south-central Louisiana. We used radiotelemetry to estimate patterns of space use and habitat selection during 2002–2004. Space use was greatest during preincubation when females typically search for suitable nest sites and was least during brood-rearing. Space use relative to other studies was greater during nesting periods, a consequence of low nest initiation rates and poor nest success. Upland and lowland forests were selected by females when establishing home ranges, but water-based forest, upland forest, and openings were selected when establishing core use areas. Females consistently used water-based forest within their home ranges throughout all seasons. Increased space use during preincubation suggests that habitat management scenarios likely to increase early successional plant communities in the understory are needed. Forests associated with permanent water features were clearly important to female turkeys at multiple spatial scales, and should be managed to promote conditions that optimize habitat quality throughout the annual cycle.

Key words: bottomland hardwood forest, compositional analysis, habitat selection, home range, Louisiana, *Meleagris gallopavo*, space use, wild turkey

Proc. Annu. Conf. Southeast. Assoc. Fish and Wildl. Agencies 59:114–125

During the 1960s and 1970s, large expanses of bottomland hardwood forests were harvested and converted to agriculture throughout the lower Mississippi Alluvial Valley (Reinecke et al. 1989, Stanturf et al. 2001). Bottomland forests have long been recognized for their importance to wildlife (Glasgow and Noble 1971, Reinecke et al. 1989) and a variety of ecological functions such as nutrient cycling (Walbridge 1993). Concern over losses in bottomland hardwood forests has prompted region-wide efforts to regenerate these forests through programs such as the Conservation Reserve Program (CRP) and the Wetland Reserve Program (WRP; Mitsch and Gosselink 2000). During the next few decades, the southeastern United States will undoubtedly continue to witness landscape-level changes in distribution and abundance of bottomland hardwood forests, mandating research that provides a thorough understanding of species ecology within these forest systems.

Bottomland hardwood forests have been considered high quality habitat for wild turkeys (Dickson 1992). Although space use and habitat selection of wild turkeys in upland areas are well understood, little research has been conducted in bottomland systems (Cobb et al. 1993, Cobb and Doer 1997), and no information is available in the published literature detailing these parameters in the lower Mississippi Alluvial Valley (see Hyde 1970, Savage 1977, Kimmel 1984, Chamberlain 1995). Properly managing wild turkey populations in bottomland hardwood systems throughout the southeastern United States requires science-based information on space use and habitat selection. Our objectives were to estimate seasonal space use and quantify seasonal habitat selection of female wild turkeys in a bottomland hardwood forest of Louisiana.

Study Area

We conducted research on a 17,243-ha tract (hereafter Sherburne) of bottomland hardwood forest in Iberville, St. Martin, and Point Coupee parishes, Louisiana, located in the Atchafalaya floodway system. Soils were poorly-drained and alluvial in nature, consisting of occasionally flooded Convent, Fausse and Sharky series (Murphy et al. 1977, Spicer et al. 1977, Powell et al. 1982). Sherburne included Sherburne Wildlife Management Area (4,767 ha) owned by the Louisiana Department of Wildlife and Fisheries (LDWF), Bayou des Ourses (6,317 ha) owned by the U.S. Army Corps of Engineers, and the Atchafalaya National Wildlife Refuge (6,159 ha) owned by the U.S. Fish and Wildlife Service. Additionally, there were approximately 770 ha of private lands interspersed throughout the state and federal lands. Sherburne was bordered on the north by Highway 190, on the south by Interstate10, on the west by the Atchafalaya River, and on the east by the East Protection Guide Levee.

Sherburne was approximately 87% forested, 11% openings, and 2% open water. Due to logging practices of previous landowners (i.e., high-grading), relatively few hard mast producing species were found away from riparian zones or sites where persistent flooding made logging difficult. Although much of the area was logged extensively in the 1950s, many areas had not received additional logging disturbance due to a change in land ownership (Walter Stokes, Bennett and Peters, Inc., personal communication). More recent forest management practices included seed tree cuts and individual selection cuts to release regeneration of dominant canopy species and increase stand diversity.

Individual overstory species most commonly found on Sherburne included eastern cottonwood (*Populus deltoids*; plant nomenclature follows Godfrey and Wooten 1982), American sycamore (*Platanus occidentalis*), willow oak (*Quercus phellos*), water oak (*Q. nigra*), overcup oak (*Q. lyrata*), American elm (*Ulmus americana*), winged elm (*U. alata*), sweetgum (*Liquidambar styraciflua*), sugarberry (*Celtis laevigata*), green ash (*Fraxinus pennsylvanicus*), black willow (*Salix nigra*), and baldcypress (*Taxodium distichum*). Midstory was composed primarily of boxelder (*Acer negundo*), Drummond red maple (*A. rubra* var. drummondii), tallowtree (*Triadica sebifera*) and rough-leaf dogwood (*Cornus drummondii*), with regeneration of the canopy species also present. Understory was relatively sparse because of shading and annual persistent flooding. Common understory species included yellowtop (*Senecio glabellus*), rattan vine (*Berchemia scandens*), greenbrier (*Smilax* spp.), bedstraw (*Gallium* spp.), horsetail (*Equisetum hyemale*), Virginia creeper (*Parthenocissus quinquefolia*), stinging nettle (*Urtica chamaedryoides*), poison ivy (*Toxicodendron radicans*), and southern shield fern (*Thelypteris kunthii*). Wildlife food plots dominated forest openings and were comprised primarily of brown top millet (*Panicum ramosum*), wheat (*Triticum* spp.) or sunflowers (*Helianthus* spp.). The remaining openings consisted of rights-of-way, levees, or natural regeneration from forest cuts.

Methods

Capture and Telemetry

We captured female wild turkeys at bait sites from mid-June to mid-August 2001–2004 using rocket nets. We established bait sites ($N = 6$ to 25) in openings and rights-of-way and baited them with cracked corn. We monitored sites for activity twice daily, and we planned capture events following a determination of consistent use by females. Once captured, females were hooded to reduce capture stress, weighed (kg), aged (juvenile, adult), and marked with a leg band on the left leg. Although we aged females upon capture, we collapsed all females into one age category for analysis. Because we trapped only during summer, all females we captured were either adults (>1 year old), or subadults being recruited into the adult population at the time they were captured (June–August). We fitted females with 75g (≤ 3% body weight) mortality-sensitive backpack radio-transmitters (Advanced Telemetry Systems, Isanti, Minnesota). If multiple turkeys were captured, we placed them in appropriately-sized boxes until they could be processed. Louisiana Department of Wildlife and Fisheries personnel captured females during winter 2000; they were similarly handled, provided transmitters and released. We released all birds at the capture site. We conducted research under Louisiana State University Institutional Animal Care and Use Protocol Number A-03-04.

We used a hand-held 3-element Yagi antenna and a Telonics T-2 receiver (Telonics Inc., Mesa, Arizona) to locate radiomarked females from 6 March–12 June 2001 and 11 February 2002–27 August 2004. Females captured by Louisiana Department of Wildlife and Fisheries personnel during winter 2000 were monitored during March–June 2001. We obtained locations using triangulation from 2–6 fixed telemetry stations (N = 115), within a 20-minute interval to minimize error from movement. We located females ≥3 times a week from mid August to late December and ≥ 1 time each day the rest of the year in both years. We used LOCATE II (Pacer; Truro, Nova Scotia, Canada) to obtain Universal Transverse Mercator (UTM) coordinates on all female locations. We estimated telemetry error by comparing azimuths of radiotransmitters (N = 52) in known locations to the true azimuth. We placed these transmitters at similar height and orientation of a live female. Average angle error was ± 7.7°.

We divided monitoring periods into four biologically meaningful seasons: preincubation, incubation, brood-rearing and fall–winter (Chamberlain et al. 2000). Preincubation extended from 15 February (coinciding with approximate breakup of winter flocks) until initiation of incubation for each reproductive female. The earliest recorded incubation (10 April) was set as the end of preincubation for non-reproductive females. Incubation ended when broods left the nest, or 31 May for non-reproductive females. Brood-rearing extended from nest termination to 30 September for reproductively active females, and from 1 June–30 September for non-reproductively active females. Fall–winter (1 October–14 February) was identical for both reproductive and non-reproductive females.

We imported triangulated locations into ArcView 3.2 (ESRI, Redlands, California) and converted them to point themes. We performed area observation curves on 5 females and determined number of locations needed to obtain accurate estimates of space use was 20. Therefore, we used only females with ≥ 20 locations in a season. We calculated kernel density home ranges (95%) and core areas (50%) for females in each season with the Animal Movement extension (Hooge and Eichenlaub 1997) in ArcView. We used a one-way analysis of variance (ANOVA) to examine variations in space use across seasons using SAS V8 (SAS 1996).

We developed a digital land cover for Sherburne in ArcView 3.2 using 1998 digital orthophoto quarter quadrangles (DOQQs). Due to a lack of detailed stand-specific inventory data on all of the lands involved, we delineated habitats into broad categories from visual characteristics of the landscape visible on the DOQQs. Habitat types included water-based forests (forest associated with water, such as cypress-tupelo swamps or riparian areas), lowland forest (low elevation, wet forests that lack standing water most of the year), openings (areas where most of the ground was exposed to direct sunlight) and upland forest (forests that were relatively dry and higher in elevation than other forest types; Fig. 1). Stands delineated as upland forest were not prone to flooding. Our water-based forest included two distinct habitat types, but we combined them to reduce type I error rates (see Bingham and Brennan 2004) because cypress-tupelo swamps were not a prominent habitat type (comprised < 3% of study area).

To quantify habitat selection across seasons, we intersected home range, core area, and point themes with the land cover using ArcView. We subsequently used

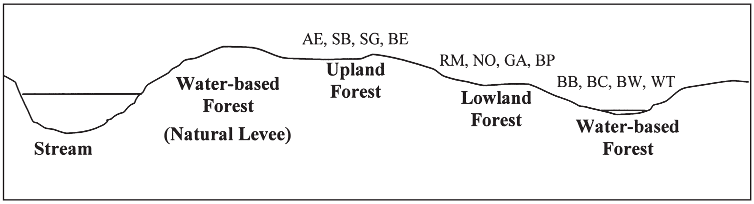

Figure 1. General plant assemblages of forest-types located on Sherburne Wildlife Management Area, Atchafalaya National Wildlife Refuge, and Bayou des Ourses, Louisiana. (AE = American elm, AS = American sycamore, BB = buttonbush, BC = baldcypress, BE = boxelder, BP = bitter pecan, BW = black willow, DO = delta post oak, EC = eastern cottonwood, GA = green ash, NO = Nuttal oak, RM = red maple, SB = sugarberry, SG = sweetgum, WO = water oak, WT = water tupelo).

compositional analysis (Aebischer et al. 1993) to examine habitat selection at three scales: home ranges vs. habitats available in the study area (1st order), core areas vs. habitats available in the home ranges (2nd order), and locations vs. habitats available in the home ranges (3rd order; Chamberlain and Leopold 2000). When a habitat-type was not represented in a female's space use at a given scale, the small non-zero value of 0.1 was substituted for purposes of analysis. Additionally, we substituted 0.3 and 0.7 for zero availability, as suggested by Bingham and Brennan (2004) for minimizing type I error, to provide a measure of sensitivity in our analyses. Unless otherwise noted, we report findings based on the analyses using 0.1 for nonzero values. We examined differences of log-ratio habitat use and availability percentages using a multivariate analysis of variance (MANOVA) with season as a main effect. Because significant differences between habitat availability and selection were found, we constructed a ranking matrix of *t*-tests to determine order of habitat selection. We performed statistical analyses using SAS V8 (SAS 1996).

Results

We estimated 99 seasonal home ranges and core areas for 32 females (11 subadults, 21 adults) from 6 March 2001 to 12 June 2001, and from 11 February 2002 to 27 August 2004. Mean home range and core area size for reproductively successful females ($N = 3$) during incubation was 15.39 ± 12.95 and 2.46 ± 1.56 ha, respectively. Because of this small sample size, we pooled these females with all other females for subsequent analyses. Home ranges ($F_{3,92} = 4.06$, $P = 0.009$) and core areas ($F_{3,92} = 3.39$, $P = 0.021$) differed by season, with largest ranges during preincubation and smallest during brood-rearing (Table 1).

Females selected habitats seasonally within their home ranges relative to habitats available across the study area ($F_{3,93} = 14.45$, $P < 0.001$; Table 2). Upland forest was consistently selected relative to other habitat-types. The composition of core ar-

Table 1. Mean seasonal home range and core area size (ha) and associated standard errors (SE) from radio-marked female wild turkeys (*N* = 39) on Sherburne Wildlife Management Area (LDWF), Atchafalaya National Wildlife Refuge (USFWS), and Bayou des Ourses (USACE), Louisiana from 2001–2004.

	N	HR[a] Size	SE	CA[b] Size	SE
Preincubation	24	902.87	146.48	145.69	35.19
Incubation	25	495.91	141.79	72.91	21.23
Brood-rearing	32	434.12	34.31	60.68	6.19
Fall–winter	18	621.84	103.43	102.62	18.19

a. Home range.
b. Core area.

Table 2. Seasonal and mean ranks (1 = lowest, 3 = highest) of habitat selection across three spatial scales (habitat selection in home ranges vs. habitat availability across study area [1st order], habitat selection in core areas vs. habitat availability across home ranges [2nd order], and habitat used vs. habitat availability across home ranges [3rd order]) based on compositional analysis of female wild turkeys at Sherburne Wildlife Management Area, Atchafalaya National Wildlife Refuge, and Bayou des Ourses, Louisiana, 2002–2004.

	1st order					2nd order					3rd order				
	Season[a]					Season					Season				
Habitat type	*FW*	*PI*	*I*	*BR*	*Mean*	*FW*	*PI*	*I*	*BR*	*Mean*	*FW*	*PI*	*I*	*BR*	*Mean*
WB[b] forest	1	1	0	1	0.75	2	2	3	1	2.00	3	3	3	3	3.00
Lowland forest	3	2	1	2	2.00	1	1	0	0	0.50	1	0	0	0	0.25
Opening	0	0	2	0	0.50	3	0	1	3	1.75	2	2	2	2	2.00
Upland forest	2	3	3	3	2.75	0	3	2	2	1.75	0	1	1	1	0.75

a. Seasons are fall–winter (FW), preincubation (PI), incubation (I) and brood-rearing (BR).
b. Water-based.

eas relative to home ranges also differed seasonally; ($F_{3,93} = 3.82$, $P = 0.013$). Openings were selected in fall–winter and brood-rearing, whereas upland forest and water-based forest were selected in preincubation and incubation. Lastly, females used habitats differentially by season ($F_{3,93} = 23.89$, $P < 0.001$), but consistently used water-based forest.

Using 0.3 and 0.7 as a small non-zero substitute for 0 habitat use, the 3 habitat selection scales were re-examined. Similar to our findings when using 0.1 as the substitution value, we noted that females selected habitats seasonally within their home ranges relative to habitats available across the study area (0.3 – $F_{3,93} = 14.61$, $P < 0.001$; 0.7 – $F_{3,93} = 13.99$, $P < 0.001$). Upland forest was consistently selected with both small non-zero values, similar to our original analysis. The composition of core areas differed from availability of habitats within the home range (0.3 – $F_{3,93}$ = 4.59, *P* = 0.005; 0.7 – $F_{3,93}$ = 5.51, *P* = 0.002). Females used openings in fall–winter and brood-rearing, whereas upland forest and water-based forest were selected in preincubation and incubation regardless of whether 0.3 or 0.7 were used. Similarly, this finding tracked our original analysis. Lastly, females used habitats differentially within their home ranges (0.3 – $F_{3,93}$ = 28.54, *P* < 0.001; 0. – $F_{3,93}$ = 29.63, *P* < 0.001). Water-based forest and openings were consistently used relative to other habitats available within home ranges.

Discussion

Females consistently exhibited greater space use during preincubation. Portions of Sherburne consistently flood during spring, coinciding with flood pulses on the Atchafalaya River. This flooding resulted in sparse understory vegetation, likely requiring females to increase space use to locate suitable nest sites (Hon et al. 1979). Beletsky and Orians (1987) theorized that increased space use could be beneficial to individuals occupying areas with poor nesting habitat within their home ranges, and Cobb and Doerr (1997) found supporting evidence of increased space use on an area with few quality nest sites in North Carolina. In upland forest systems, Badyaev et al. (1996), and Chamberlain and Leopold (2000) both found that females tended to maintain smaller home ranges during preincubation relative to other seasons, and attributed this observation to the availability of quality nesting habitats across the landscape.

Space use on Sherburne was considerably larger during nesting periods than in many previous studies (Speake et al. 1975, Smith and Teitelbaum 1986, Kurzejeski and Lewis 1990). Although females would be expected to maintain smaller spaces and move less during nesting periods (Smith and Teitelbaum 1986), poor nest success on Sherburne (see Wilson et al. 2005) contributed to increased movements and space use by females, particularly following nest loss. Despite this fact, nest initiation and incubation by a small portion of our sample influenced our estimates of space use, resulting in estimates of space use during incubation being less relative to other seasons. Likewise, brooding females generally restrict daily movements when young poults are present and frequently restrict their activities to localized sites offering quality brood habitat (Miller et al. 1997). Although our sample mostly included females classified as non-reproductive and hence our space use estimates would be expected to be larger than in previous studies, mean home range during brood-rearing was well within the range of those previously reported (111–455 ha: Speake et al. 1975, Pack et al. 1980, Porter 1980, Peoples et al. 1996, Godfrey and Norman 1999). We suspect this observation was due to ubiquitous foraging resources on Sherburne. Succulent vegetation and early successional herbaceous communities were available in openings distributed throughout Sherburne and were common in water-based forests and upland forests, allowing females to secure quality foraging opportunities without greatly expanding space use. Alternatively, some non-reproductive females may attempt to decrease likelihood of experiencing a mortality event by associating with flocks (Jullien and Clobert 2000) containing broods, thereby subjecting themselves to movement restrictions. We noted at least one instance of this behavior on Sherburne and similar observations have occurred elsewhere (M. J. Chamberlain, personal observation). Additional research on behavior and interactions of reproductive and non-reproductive females is needed to fully understand space use during brood-rearing.

Availability of upland forests was important to females when selecting home ranges. Because of the flood-prone nature of Sherburne, upland forests likely fulfill a variety of ecological requirements for females throughout the annual cycle. Relative safety from flooding and the relatively consistent availability of herbaceous vegetation may increase the importance of upland forests to females during incubation and brood rearing. During preincubation, nest searching can take precedence over forage quality (Thogmartin 2001), and locating nest sites with sufficient herbaceous vegetation can be important determinants of nest selection (Seiss 1989, Chamberlain and Leopold 1998). During fall, turkeys in bottomland systems may shift their diet as they focus habitat selection from openings to forested areas (Savage 1977) and later in winter, green herbaceous material found in upland forests become important food items (Bittner 1973, Savage 1977). The lack of consistent flooding in these forests on Sherburne resulted in consistent availability and quality of foraging conditions within upland forests relative to other habitats.

At successively smaller spatial scales, water-based forests and openings, in addition to upland forests, were important to females, illustrating importance of examining habitat selection across multiple scales. Females selected openings in fall–winter and brood-rearing, likely to take advantage of forage in food plots and rights-of-way. Openings have long been recognized for their importance during brood-rearing (Savage 1977, Ross and Wunz 1990, Swanson et al. 1994, Peoples et al. 1996), as high protein and energy demands of poults make abundant insects and grass seed in openings valuable during early development; these same foraging resources can be particularly important to females during this period (Dickson 1992). Notably, water-based forest was selected during our incubation season. Our sample included mostly non-reproductive females, which resulted from high nest loss during laying (Wilson et al. 2005). Therefore, we offer that our observations are likely indicative of females attempting to nest, in addition to those that were successful in reaching incubation. Although water-based forest included cypress-tupelo swamp, it also included natural levees near bayous, which were among the topographically higher land features on Sherburne, increasing their relevance to females in flood-prone landscapes (Kimmel 1984).

In Mississippi, creek drainages were used by females in an upland forest system to acquire hard mast in winter and quality foraging resources in other seasons (Palmer 1990, Palmer and Hurst 1996). Because most hard mast producing trees are associated with waterways on Sherburne because of prior land use, water-based forest likely becomes more important during fall–winter. Additionally, quality roost sites were found in this habitat-type, because mature oaks and baldcypress have horizontal branches that are favorable for perching (Flake et al. 1996), and turkeys often select roosting sites over water (Chamberlain et al. 2000). Observations made during this study supported these findings because 8 marked and 2 unmarked turkeys were seen roosting in baldcypress, near or over water (Wilson 2005).

The validity of compositional analysis has recently come under criticism. Bingham and Brennan (2004) stated that compositional analysis had unacceptable type I error rates when there were 0% use rates for resource types and called into question results of studies using this resource selection technique. They suggested a value of 0.3–0.7 be used for the small non-zero value substituted for 0% use when it occurred, claiming those values minimized type I error. We grouped similar habitat-types to minimize 0% use for habitats in home ranges and core areas of turkeys in this study, and notably our analyses using different substitution values failed to change our inferences regarding habitat selection. Although we certainly realize that our analyses were crude in respect to formally evaluating potential biases associated with compositional analysis, our findings nonetheless provide further support that our conclusions about habitat selection of female turkeys are appropriate.

Management Implications

Significant efforts to restore bottomland hardwood forests are ongoing throughout the southeastern United States, and considerable focus has centered specifically on the Mississippi Alluvial Valley. Distribution, abundance, and quality of restored and existing bottomland forests will be dynamic during the next several decades, as considerable acreage succeeds into later seral stages and mature forests continue to be managed for a variety of land uses. Our findings are important to making predictions about behavior and ecology and wild turkeys in bottomland systems, as wild turkeys continue to be an important economic and sociological species throughout the Southeast (Dickson 2001).

High-grading has occurred throughout many existing bottomland forests, and from a wildlife perspective has changed quality and suitability of these forests at the stand and landscape level. Our findings illustrate importance of areas where high-grading has not occurred to wild turkeys, and future land management on Sherburne, and likely other similar bottomland forests, should focus on maintaining hard mast producing tree species where they exist. Specific to Sherburne, these tree species existed primarily along riparian zones and areas subjected to periodic flooding (cypress-tupelo swamps). Additionally, our observations of large preincubation home ranges relative to other studies, and other biological seasons, suggests that habitat management directed at improving nesting habitat may be warranted. Forest management strategies aimed at reducing overstory canopy cover, increasing availability and quality of herbaceous understory vegetation, and ensuring quality nest habitat secure from persistent flooding should be beneficial to wild turkeys on Sherburne.

Acknowledgments

We thank T. Blair, H. Hanna, and numerous volunteers for assistance with trapping and data collection. Funding and support were provided by the School of Renewable Natural Resources at Louisiana State University (LSU), the LSU Agricultural Center, the Louisiana Department of Wildlife and Fisheries through the Federal Aid in Wildlife Restoration Program Project W-48 Study 40, and the Louisiana Chapter of the National Wild Turkey Federation. This manuscript was approved for publication by the Director of the Louisiana Agricultural Experiment Station as manuscript number 04-40-0248.

Literature Cited

Aebischer, N. J., P. A. Robertson, and R. E. Kenward. 1993. Compositional analysis of habitat use from animal radio-tracking data. Ecology 74:1313–1325.

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.

Bingham, R. L. and L. A. Brennan. 2004. Comparison of type I error rates for statistical analysis of resource selection. Journal of Wildlife Management 68: 206–212.

Beletsky, L. D. and G. H. Orians. 1987. Territoriality among male red-winged blackbirds I: site fidelity and movement patterns. Behavioral Ecology and Sociobiology 20:21–34.

Bittner, S. R. 1973. Wild turkey food habits, movements, and populations on the winter quarters hunting club, Tensas Parish, Louisiana. Thesis. Louisiana State University, Baton Rouge.

Chamberlain, M. J. 1995. Ecology of wild turkeys in bottomland hardwood forests in the Mississippi Alluvial Valley. Thesis. Mississippi State University.

______, and B. D. Leopold. 1998. Microhabitat characteristics of wild turkey prenest and nest site selection in central Mississippi. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 52:274–282.

______ and _____. 2000. Habitat sampling and selection by female wild turkeys during preincubation. Wilson Bulletin 112:326–331.

______, ______, and L. W. Burger. 2000. Characteristics of roost sites of adult wild turkey females. Journal of Wildlife Management 64: 1025–1032.

Cobb, D. T., P. D. Doerr, and M. H. Seamster. 1993. Habitat use and demography of a wild turkey population subjected to human-induced flooding. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 47:148–162.

______ and ______. 1997. Eastern wild turkey reproduction in an area subjected to flooding. Journal of Wildlife Management 61:313–317.

Dickson, J. G., editor. 1992. The Wild Turkey: Biology and Management. Stackpole Books. Harrisburg, Pennsylvania.

______. 2001. Wild turkey. Pages 108–121 *in* Wildlife of Southern Forests: Habitat and Management, J. G. Dickson, editor. Hancock House Publishers, Blaine, Washington.

Flake, L. D., R. A. Craft, and W. L. Tucker. 1996. Vegetation characteristics of wild turkey roost sites during summer in south-central South Dakota. Proceedings from the National Wild Turkey Symposium 7: 159–164.

Glasgow, L. and R. H. Noble. 1971. The importance of bottomland hardwoods to fish and wildlife. Pages 30–43 *in* Proceedings of Southeastern Hardwoods. U.S. Forest Service, Dothan, Alabama.

Godfrey, R. K. and J. W. Wooten. 1982. Aquatic and wetland plants of the Southeastern United States. University of Georgia Press, Athens.

Godfrey, C. L. and G. W. Norman. 1999. Effect of habitat and movement on wild turkey poult survival. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 53: 330–339.

Hon, T., D. P. Belcher, B. Mullis, and J. R. Monroe. 1979. Nesting, brood range and reproductive success of an insular turkey population. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 32: 137–149.

Hooge, P. N. and B. Eichenlaub. 1997. Animal movement extension to ArcView. ver. 1.1. Alaska Science Center–Biological Science Office, U.S. Geological Survey, Anchorage, Alaska.

Hyde, K. M. 1970. A study of a reintroduced turkey population in bottomland hardwoods of Louisiana. Thesis. Louisiana State University, Baton Rouge.

Jullien, M. and J. Clobert. 2000. The survival value of flocking in neotropical birds: reality or fiction. Ecology 81: 3416–3430.

Kimmel, F. G. 1984. Habitat use by wild turkey hens in the Mississippi River Floodplain. Thesis, Louisiana State University, Baton Rouge.

Kurzejeski, E. W. and J. B. Lewis. 1990. Movements and habitat use of wild turkey hens in northern Missouri. Proceedings from the National Wild Turkey Symposium 6: 67–71.

Miller, D. A., B. D. Leopold, and G. A. Hurst. 1997. Seasonal home ranges of wild turkeys in central Mississippi. Proceedings of the Southeastern Association of Fish and Wildlife Agencies 51:414–425.

Mitsch, W. J. and J. G. Gosselink. 2000. Wetland creation and restoration. Wetlands. Third edition. John Wiley & Sons, Inc., New York, New York.

Murphy, K. E., B. A. Touchet, A. G. White, J. J. Daigle, and H. L. Clark. 1977. Soil survey of St. Martin Parish, Louisiana. U.S. Department of Agriculture, Soil Conservation Service, in cooperation with the Louisiana Agricultural Experiment Station, Baton Rouge.

Pack, J. C., R. P. Burkert, W. K. Igo, and D. J. Pybus. 1980. Habitat used by wild turkey broods within oak-hickory forests of West Virginia. Proceedings from the National Wild Turkey Symposium 4: 213–224.

Palmer, W. E. 1990. Relationships of wild turkey hens and their habitat on Tallahala Wildlife Management Area. Thesis. Mississippi State University.

______ and G. A. Hurst. 1996. Drainage systems as minimum habitat management units for wild turkey hens. Proceedings from the National Wild Turkey Symposium 7: 97–104.

Peoples, J.C., D.C. Sisson, and D.W. Speake. 1996. Wild turkey brood habitat use and characteristics in coastal plain pine forests. Proceedings of the National Wild Turkey Symposium 7: 89–96.

Porter, W. F. 1980. An evaluation of wild turkey brood habitat in southeastern Minnesota. Proceedings from the National Wild Turkey Symposium 4: 203–212.

Powell, J. W., G. L. Bowden, D. L. Latiolais, and L. Morris. 1982. Soil survey of Point Coupee and West Baton Rouge Parishes, Louisiana. U.S. Department of Agriculture, Soil Conservation Service, in cooperation with the Louisiana Agricultural Experiment Station and Louisiana Soil and Water Conservation Committee, Baton Rouge.

Reinecke, K. J., R. M. Kaminski, D. J. Moorhead, J. D. Hodges, and J. R. Nassar. 1989. Mississippi alluvial valley *in* L. M. Smith, R. L. Pederson, and R. M. Kaminski, editors.

Habitat management for migrating and wintering waterfowl in North America. Texas Tech University Press, Lubbock.

Ross, S. R. and G. A. Wunz. 1990. Habitats used by wild turkey hens during the summer in oak forests in Pennsylvania. Proceedings of the National Wild Turkey Symposium 6: 39–43.

SAS. 1996. SAS/Stat user's guide. Version 8. SAS Institute, Inc., Cary, North Carolina.

Savage, J. L. 1977. Status and Habitat selection of two introduced turkey populations in bottomland hardwoods of Louisiana. Thesis. Louisiana State University, Baton Rouge.

Seiss, R. S. 1989. Reproductive parameters and survival rates of wild turkey hens in east-central Mississippi. Thesis. Mississippi State University, Mississippi State.

Smith, W. P. and R. D. Teitelbaum. 1986. Habitat used by eastern wild turkey hens in southeastern Louisiana. Proceedings of the Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 40:405–415.

Speake, D. W., T. E. Lynch, W. J. Flemming, G. A. Wright, and W. J. Hamrick. 1975. Habitat use and seasonal movements of wild turkeys in the southeast. Proceedings from the National Wild Turkey Symposium 3: 122–130.

Spicer, B. E., S. D. Matthews, R. E. Dance, K. R. Milton, and W. H. Boyd. 1977. Soil survey of Iberville Parish, Louisiana. U.S. Department of Agriculture, Soil Conservation Service in cooperation with the Louisiana Agricultural Experiment Station, Baton Rouge.

Stanturf, J. A., S. H. Schoenholtz, C. J. Schweitzer, and J. P. Shepard. 2001. Achieving restoration success: myths in bottomland hardwood forests. Restoration Ecology 9:189–200.

Swanson, D. A., J. C. Pack, C. I. Taylor, P. W. Brown, and D. E. Samuel. 1994. Habitat use of wild turkey hens in northwestern West Virginia. Proceedings of the Southeastern Association of Fish and Wildlife Agencies 48:123–133.

Thogmartin, W. E. 2001. Home-range size and habitat selection of female wild turkeys (*Meleagris gallopavo*) in Arkansas. American Midland Naturalist 145: 247–260.

Walbridge, M. R. 1993. Functions and values of forested wetlands in the southern United States. Journal of Forestry 91:15–19.

Wilson, W. B. 2005. Seasonal space use, habitat preference and survival of female wild turkeys in a Louisiana bottomland hardwood forest. Thesis. Louisiana State University, Baton Rouge.

Wilson, W. E., M. J. Chamberlain, and F. G. Kimmel. 2005. Survival and nest success of female wild turkeys in a Louisiana bottomland hardwood forest. Proceedings of the Southeastern Association of Fish and Wildlife Agencies. 59:in press.