Survival and Nest Success of Female Wild Turkeys in a Louisiana Bottomland Hardwood Forest

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Abstract: Survival of female wild turkeys (*Meleagris gallopavo*) influences turkey productivity. Although patterns of survival and productivity have been extensively researched in most forested landscapes, little information is available for female turkeys in bottomland hardwood systems, although importance of these systems is widely recognized. Therefore, we captured and radiomarked 39 female wild turkeys in a bottomland hardwood forest in south-central Louisiana during 2001–2004. Mean annual survival was 0.67. Survival was greatest during preincubation (1.00) potentially because of increased habitat sampling and movement during this period. Fall–winter survival was high (0.93), likely attributable to stable foraging resources and a lack of illegal and legal harvest during this period. Lowest survival occurred during incubation (0.75) and brood-rearing (0.83), primarily as a result of increased risks of predation associated with nesting and brood rearing. Nest initiation rates (33%) were among the lowest reported, likely attributable to high nest loss from predation and flooding prior to completion of laying. Nest success of females reaching onset of incubation was 38%. Our findings suggest that the wild turkey population on our study site balances exceptionally low productivity with relatively high adult female survival. To ensure sustainable populations of wild turkeys, managers should monitor relationships between survival and productivity. Specific to our study site, improvements in nesting habitat may be needed to increase nest success and recruitment.

Key words: bottomland hardwood forest, Louisiana, *Meleagris gallopavo*, predation, survival, reproduction, wild turkey.

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To most effectively manage wild turkey populations, relationships between patterns of survival and productivity need to be understood. Wild turkey populations are thought to be controlled by three closely related factors: nest success, poult survival, and adult survival (Roberts et al. 1995, Vangilder and Kurzejeski 1995, Godfrey and Norman 1999). The effect of nest success is intuitive in that turkeys must successfully produce offspring to sustain a population, poults must live to adulthood to reproduce, and adults must survive to propagate, especially females.

Numerous studies have evaluated survival and productivity of female wild turkeys in a variety of landscape types (Palmer et al. 1993, Roberts et al. 1995, Wright et al. 1996, Miller et al. 1998*a*, Nguyen et al. 2003), but information specific to bottomland hardwood systems is lacking. Bottomland hardwood forests have long been recognized for their importance to ecological functions (Walbridge 1993), and have traditionally been considered high quality wild turkey habitat (Dickson 2001). Because of regional concerns over losses of bottomland forests, significant reforestation and afforestation efforts have begun through programs such as the Wetland Reserve Program (WRP). This places an increasing importance on improving our understanding of wild turkey ecology in these forest systems as distribution and quality of these forests continues to change across our landscapes. Our objectives were to estimate annual and seasonal survival rates, quantify causes of mortality, and assess productivity using measures of nest initiation and success for a population of wild turkey females in a bottomland hardwood forest in 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 (Spicer et al. 1977, Murphy 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 these state and federal lands. Sherburne was bordered on the north by Highway 190, on the south by Interstate 10, 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. Because of 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 because of 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 allow regeneration of dominant canopy species and increase stand diversity.

Common overstory species on Sherburne included eastern cottonwood (*Populus deltoids*), 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 box-elder (*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). Remaining openings consisted of rights-of-way, levees, or natural regeneration from forest cuts.

Methods

We captured female wild turkeys at bait sites from mid June to mid August 2001–2004 using rocket nets. We established bait sites (N = 25) in openings and rights-of-way and baited them with cracked corn. We monitored sites for activity twice daily, and we planned capture attempts following a determination of consistent use by females. Once captured, females were hooded to reduce capture stress, weighed (kg), aged (juvenile or adult), and marked with a leg band on the left leg. We fitted females with 75 g (≤ 3% body weight) mortality-sensitive backpack radiotransmitters (Advanced Telemetry Systems, Isanti, Minnesota). If multiple turkeys were captured, they were placed in appropriately-sized boxes until they could be processed. 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 three-element Yagi antenna and a Telonics T–2 receiver (Telonics Inc., Mesa, Arizona) to monitor radiomarked females from 6 March 2001–12 June 2001 and 11 February 2002–27 August 2004. We located females ≥3 times a week from mid August to late December and ≥1 time each day the rest of the year. When a mortality signal was detected, we located the radiotransmitter as quickly as possible to determine fate of the female.

We grouped mortalities into four categories based on cause of death: bobcat (*Lynx rufus*), canids [i.e., coyote (*Canis latrans*) and/or domestic dog], unknown predator, and unknown. Our canid grouping resulted from difficulty in separating responsible species given presence of both on our study area. We classified females as being killed by a bobcat if the female was cached, or if bobcat tracks, scat, and/or fur were found at the kill site. We classified females as being killed by a canid if tracks, scat, and/or fur from a canid were found at the kill site. If no sign was detected and depredation was evident, or if sign from multiple predators was found, we classified cause of death as unknown predator.

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 used the Heisey-Fuller method to estimate seasonal and daily survival rates (Heisey and Fuller 1985). Intervals (seasons) without observed mortalities were likely reflective of low samples sizes, and thus no variance was associated with the estimate. Therefore, we estimated confidence intervals following suggestions provided in Dugger et al. (1994) for daily survival rates during intervals with no mortalities. For presentation and estimation of seasonal survival rates, we pooled across years. Although we recognize potential biases associated with pooling across years (e.g., substantial variation present within years), it was necessary in our analysis to increase sample size within seasons. Regardless, interpretation of our findings should occur with the forethought that data were pooled across years. We estimated annual survival during 2002–2004, beginning on 15 February of each year, and concluding on 14 February of the subsequent year. This corresponded to a complete annual cycle based on our delineation of seasons. We did not estimate an annual survival rate for 2001 because females were not monitored during fall. We excluded females that died ≤ 7 days after capture from the analysis to minimize error from capture-related mortality (Miller et al. 1998*a*). 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 we either adults (>1 year old), or subadults being recruited into the adult population at the time they were captured (June–August).

To assess nest success and initiation, we located all females at least once daily during preincubation to determine when nesting activity occurred. This typically included females restricting their daily movements for a number of days prior to ultimately incubating a nest. When a female remained stationary for two consecutive days, the corresponding nest was considered active. After the female had been incubating for at least five days, we approached the nest within 50 m and took azimuths toward the nest from surrounding reference locations and marked them with flagging tape for purposes of locating the nest later (Chamberlain and Leopold 2000). We subsequently monitored nesting females at least once daily for the duration of incubation. At the termination of incubation, we located the nest to determine nest fate. If nest fate was not apparent, the female was approached at night to determine if roosting occurred, assuming females with newly hatched broods would not roost off the ground. We defined a successful nest as one that successfully hatched at least one egg.

Table 1. Daily and seasonal survival rates (with associated 95% confidence intervals; CI) for female wild turkeys on Sherburne Wildlife Management Area, Atchafalaya National Wildlife Refuge, and Bayou des Ourses, Louisiana, 2001–2004.

Season[a]	*N*[b]	Interval rate	CI	Daily rate	CI
Fall–winter	35	0.93	0.85–1.00	0.999	0.999–1.0
Preincubation	31	1.00	0.89–1.00[c]	1.00	0.999–1.0[d]
Incubation	26	0.75	0.62–0.92	0.994	0.990–0.998
Brood-rearing	39	0.83	0.72–0.96	0.998	0.997–0.999

a. Fall–winter = 1 October–14 February, Preincubation = 15 February–nest initiation, Incubation = nest initiation–hatch/nest loss, Brood-rearing = nest termination–30 September.
b. Number of females available during respective seasons.
c. Calculated using normal approximation method following Zar (1984).
d. Calculated from binomial distribution following Dugger et al. (1994).

Results

We monitored 39 females from 6 March 2001 to 12 June 2001 and from 11 February 2002 to 27 August 2004. Mean annual survival during 2002–2004 was 0.665 (2002 = 0.929, *N* = 16; 2003 = 0.50, *N* = 20; 2004 = 0.571, *N* = 8). Survival rates (both interval and daily) tended to be lowest during incubation, and greatest during preincubation (Table 1). We recovered 16 dead females, whereas 23 were censored due to transmitter-failure or loss after variable lengths of monitoring, or they lived to the end of the study. Causes of death included bobcat (*N* = 2), canid (*N* = 4), unknown predator (*N* = 7), and unknown (*N* = 3). Two of 3 brooding females suffered mortalities prior to the end of the brood-rearing season.

We monitored 24 females for nesting activities in 2001–2004. Nest initiation, as measured by number of females confirmed to have begun incubation, was 33% (8 of 24). Most (>50%) of the remaining females displayed movements indicative of laying behavior (reduced movements in a particular geographic area) but did not initiate incubation. Nest success was 38% (3 of 8 known nests). Predation (*N* = 1) and flooding (*N* = 4) accounted for all nest loss. We only documented renesting on one occasion; that attempt was unsuccessful because of depredation of the incubating female.

Discussion

Our estimates of survival during preincubation were higher than in other studies (Palmer et al. 1993, Chamberlain 1995, Roberts et al. 1995, Vangilder and Kurzejeski 1995, Wright et al. 1996, Hubbard et al. 1999, Nguyen et al. 2003). Albeit a bit surprising, consistently high survival during preincubation could have been a synergistic function of foraging conditions and space use patterns. Relatively mild winters in southern Louisiana contribute to consistent availability of herbaceous forage during late winter and early spring periods, coinciding with our preincubation season. For instance, species such as yellowtop frequently dominate understory plant communities on Sherburne and other bottomland sites during late winter and into spring, and can be an important forage item for turkeys in bottomland systems (Savage 1977, Kimmel 1984). Alternatively, female survival may increase with increasing space use, presumably because of increased habitat sampling and reduced risks of predation (Badyaev et al. 1996, Hubbard et al. 1999). Space use on Sherburne was consistently greatest during preincubation (Wilson 2005).

Reduced survival during nesting season relative to other seasons was not surprising because of increasing risks of predation associated with incubation (Little et al. 1990). Specific to Sherburne, persistent annual flooding resulted in relatively sparse understory vegetation throughout many forested stands. Topographically higher stands with suitable vegetation for nesting were restricted, possibly concentrating females during nest initiation, similar to observations noted by Chamberlain (1995) in a similar bottomland forest system. Concentrations of nests could promote increased predator activity in these systems (Kimmel 1984, Chamberlain et al. 1996) and increased female mortality during incubation. However, it is of note that survival estimates for the nesting period in our study were relatively high compared to previous studies (Chamberlain 1995; Vangilder and Kurzejeski 1995; Miller et al. 1998*a*,*b*; Hubbard et al. 1999). This observation is at least partially explained by the exceptionally low nest initiation rates in our study.

Although most (> 90%) females we monitored exhibited constricted movements for brief periods during latter stages of our preincubation season, indicative of a potential incubation effort, relatively few females reached incubation. We suspect this was due to high rates of nest predation and flooding. Low nest success on Sherburne was likely influenced greatly by the dominate understory plant community. Wild carrot and bedstraw were common plants throughout Sherburne; these plants formed dense stands that provided concealment for nests, but senesced during early to mid-April, leaving these areas open. Females nesting in areas dominated by these plants were not successful in our study, and incubating birds using these sites would routinely flush from 50 m away (Wilson 2005).

Nest site selection combined with potentially high rates of nest loss prior to incubation could increase survival of females during nesting periods, the tradeoff being low productivity annually. Similarly, reduced survival for brood-rearing females is prevalent in wild turkeys (Miller et al. 1998*a*), attributable to costs associated with parental care, a loss of security from roosting on the ground during initial stages of brooding, and increased susceptibility of females to predation while foraging broods (Healy 1992, Porter and Gefell 1996). Poor nest initiation and success on Sherburne corresponded to large proportions of the female population being removed from increased predation risk and reduced security associated with caring for broods; 2 of 3 successful females in our study suffered mortalities while brooding.

Survival during fall–winter was high on Sherburne relative to previous studies (Palmer et al. 1993, Chamberlain 1995, Roberts et al. 1995, Hubbard et al. 1999, Nguyen et al. 2003). One possible explanation for increased survival is that foraging conditions were relatively stable on Sherburne, even in winter. Although hard mast was relatively scarce on Sherburne because of previous logging practices, the mild winters enabled green vegetative material to grow all year in areas not subjected to flooding, and the area contains an extensive network of openings maintained in a variety of cool season forages. Typically, accessing quality foraging resources drives movement and space use during fall–winter (Dickson 1992) and relatively consistent foraging resources during fall–winter may promote increased female survival during this period. Additionally, illegal kill during fall–winter sport hunting seasons is an important factor affecting female survival in many wild turkey populations (Kimmel and Kurzejeski 1985, Vangilder and Kurzejeski 1995) but did not affect survival in our study.

Management Implications

As previously mentioned, nest success, poult survival, and adult survival are the three main factors influencing turkey population dynamics (Roberts et al. 1995, Vangilder and Kurzejeski 1995, Godfrey and Norman 1999). The wild turkey population on Sherburne has been relatively stable since the mid 1990s based on known harvest of males during spring (Louisiana Department of Wildlife and Fisheries, unpublished data). Although mean annual survival was within rates reported in the literature, it was high relative to other studies in the region (Miller et al. 1998*a*) and considerably higher than that reported by Chamberlain (1995) in a bottomland hardwood forest system in Mississippi. Conversely, productivity on our study site was exceptionally low, and it appears that the current sustainability of the population results from a tradeoff between low productivity and relatively high female survival. Notably, the population studied by Chamberlain (1995) also exhibited low productivity, but was in a state of decline, and spring harvest was ultimately discontinued (J. Fleeman, Mississippi Department of Wildlife, Fisheries and Parks, personal communication). Thogmartin and Johnson (1999) reported low rates of nest initiation (<65%) and female survival (<75%) during nesting were related to population declines in Arkansas, but determined the ultimate factor to be poor female condition. Similarly, Miller et al. (1995) suggested that female condition was likely related to nest initiation rates being greater on a landscape with greater habitat diversity, relative to more simplified forest landscapes. The relationships between female condition, nest initiation, and patterns of survival on our study site are unclear, but warrant investigation.

Clearly, efforts to improve nest success on Sherburne would benefit the wild turkey population. Managers should consider implementing forest management strategies to improve nesting habitat throughout Sherburne, but particularly on sites with reduced susceptibility of flooding. Individual tree and group selection harvests have been recently used on a small scale. Both increase herbaceous understory vegetation and will likely improve nesting habitat.

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