Predation Rates on Wild Turkey Hens in a Hardwood Bottomland Forest and a Mixed Forest in Mississippi

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Abstract: Concern has arisen about effects of predation on wild turkey (*Meleagris gallopavo*) populations because of increases in predator abundance. We examined differences in canid (*Canis spp.*) and bobcat (*Felis rufus*) predation of adult wild turkey hens between a hardwood bottomland forest and a mixed forest in Mississippi. Daily mortality rate from canids and bobcats was higher on the hardwood bottomland forest (0.002) than on the mixed forest (0.0006), but overall daily survival rates were similar. A higher predation rate on the hardwood bottomland forest from large predators may have been caused by its insular nature, a lack of a groundstory vegetation layer, and/or use of small (<4 ha) hardwood regeneration areas by wild turkeys for nesting. A higher prey base (i.e., small mammals) on the hardwood bottomland forest may have contributed to higher canid/felid populations. Selective timber harvest within the forest may improve turkey nesting habitat conditions. Managers may need to consider predator management on insular forests when attempting to manage for high wild turkey densities.

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Predation is the primary cause of natural mortality in wild turkeys (Kurzejeski et al. 1987, Vander Haegan et al. 1988, Miller and Leopold 1992). Further, predation may limit reproduction in some populations (Speake et al. 1985, Palmer et al. 1993, Miller et al. 1995*a*). Primary predators of adult turkey hens in the southeastern United States are great horned owl (*Bubo virginianus*), bobcat (*Felis rufus*), and canids (i.e., coyote [*Canis latrans*], domestic dog [*C. domesticus*], gray fox [*Urocyon cineraeoargenteus*]) (Stoddard 1963, Miller and Leopold 1992).

Predation varies with habitat type and spatial distribution of habitats within landscapes (Leopold and Hurst 1994). However, no studies have quantified cause-specific mortality rates between forested habitat types within different landscapes. Understanding depredation of wild turkeys within different landscapes is necessary before biologically sound management options that minimize predation loss can be developed and implemented. Therefore, our objective was to compare predation of adult eastern wild turkey (*M. g. silvestris*) hens by bobcats and canids (coyotes and dogs) between an area within a contiguous mixed forest system and an insular hardwood bottomland forest.

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Methods

Twin Oaks Wildlife Management Area (OAKS) was located within the Mississippi Alluvial Valley (Delta region) in Sharkey County, Mississippi, and was adjacent to the 30,000-ha Delta National Forest (DNF). The 2,302-ha area was 88% mature hardwood bottomland forests, 6% hardwoods replanted in March 1994, and 6% agricultural fields. Because >60% of OAKS was surrounded by private agricultural land and was separated from DNF by the Little Sunflower River, it was considered insular. Topography on OAKS was flat with 0–4% slopes. Dominant tree species included oaks, sweetgum, sweet pecan (*Carya illinoensis*), ash (*Fraxinus* spp.), and sugarberry (*Celtis laevigata*). Replanted areas contained various hardwood seedlings and common invader species such as Johnson grass (*Sorghum halapense*), goldenrod (*Solidago* spp.), and ragweed (*Ambrosia* spp.).

Tallahala Wildlife Management Area (TWMA) was located in central Mississippi within the Bienville National Forest (BNF). The 14,410-ha area was composed of 30% mature hardwood bottomlands, 37% mature pine (*Pinus* spp.) forests, 17% mature mixed pine-hardwood forests, and 15% in 1- to 14-year-old loblolly pine (*P. taeda*) plantations (Leopold et al. 1995). Topography was gently to moderately rolling, with 0–16% slopes. Dominant tree species on the area included loblolly pine, oaks (*Quercus* spp.), hickories (*Carya* spp.) and sweetgum (*Liquidambar styraciflua*). Silvicultural practices included clear-cutting followed by establishment of pine plantations by planting or the seed-tree method. Mature pine stands were thinned every 10 years and prescribed burned on a 5–7 year rotation. On TWMA, the U.S. Forest

Service established policies preventing clear-cutting adjacent to stands <5 years of age. Management on TWMA provided a high diversity of habitats and, because it was within a larger, similarly managed matrix (BNF), was considered a contiguous system as opposed to the insular, low diversity OAKS.

Hebs were captured using cannon nets at bait sites (Bailey 1976) during July–August and January–March from 1990 to 1994 on TWMA and during 1994 on OAKS. Once captured, hens were tagged patagially (Knowlton et al. 1964), given numbered leg bands, and fitted with a 108-g mortality-sensitive radio-transmitter. Hens were located at least once/day during reproductive periods (14 March–30 June) and a minimum of twice weekly during other periods.

Program MICROMORT was used to determine unbiased estimates of daily cause-specific mortality rates (Trent and Rongstad 1974, Heisey and Fuller 1985). We entered hens into the model 7 days after capture and used data from censored hens up until the day they were censored (Sheriff and Vangilder 1990). Causes of death were placed into 4 categories: predation from bobcat/canids (i.e., coyote and/or domestic dog), other predators, unknown predation, and other. Other predators included raccoons (*Procyon lotor*) and great-horned owls. Other included unknown mortality, accident, and poaching. Hens were classified as having been killed by bobcats if only bobcat sign was present at the kill site. Sign included caching of the hen and/or bobcat tracks and scat. Similarly, hens were considered killed by coyotes or dogs if only coyote/dog sign (i.e., tracks, scat, hair) was found at the kill site. We combined canid predation events because of difficulties associated with distinguishing between species. If sign of multiple predators was found at the kill site, the cause of death was classified as unknown predation.

Categories were devised to test the hypothesis that mortality due to bobcats/canids was similar between TWMA and OAKS. However, deaths from unknown predators and unknown causes could have been caused by felids/canids. Therefore, we made 4 comparisons to account for these possibilities. We compared daily mortality rates between areas within (1) the felid/canid mortality category; (2) the felid/canid and unknown predator categories combined; (3) the felid/canid, unknown predators, and unknown categories combined; and (4) all predator-induced mortalities combined. We tested the null hypotheses of no difference between area mortality rates at $\alpha = 0.05$ using a Z-statistic (Steel and Torrie 1980). We also compared daily survival rates and estimated the annual mortality rate.

Results

We monitored 86 hens for 12,125 radio-days on TWMA and 23 hens for 3,909 radio-days on OAKS. Causes of death on OAKS were bobcat and coyote ($N = 7$), unknown predator ($N = 2$), and poaching ($N = 3$). On TWMA, unknown factors ($N = 8$), predators ($N = 14$), poaching ($N = 3$), and accidents ($N = 5$) (i.e., fatalities by cars and capture stress) were primary mortality factors. Daily mortality rate from bobcat/coyote predation was 0.002 OAKS and 0.0006 on TWMA (Table 1). Known felid/canid predation was significantly higher ($Z = 1.74$, $P = 0.041$) on OAKS ($N = 7$) than

Table 1. Daily survival and mortality rates with associated variances for wild turkey hens on Twin Oaks Wildlife Management Area (OAKS), 1994–1995, and Tallahala Wildlife Management Area (TWMA), 1990–1995, Mississippi.

Area	Category	Rate estimated	Variance
OAKS	FC[a]	0.002	4.57E-07
TWMA	FC	0.0006	4.76E-08
OAKS	AP[b]	0.002	5.88E-07
TWMA	AP	0.001	9.51E-08
OAKS	PU[c]	0.002	5.88E-07
TWMA	PU	0.002	1.35E-07
OAKS	PK[d]	0.002	5.87E-07
TWMA	PK	0.0009	8.15E-08
OAKS	SU[e]	0.996	7.82E-07
TWMA	SU	0.998	2.03E-07

[a]Felid/canid predation.
[b]All predation types combined.
[c]Felid/canid and unknown predation combined.
[d]Felid/canid, unknown predation, and unknown mortalities combined.
[e]Daily survival rate.

on TWMA (N = 7). The combined mortality of felids/canids and unknown predators was higher on OAKS than on TWMA (Z = 1.64, P = 0.051). Mortality rates did not differ when the felid/canid, unknown predation and unknown categories were combined (Z = 0.76, P = 0.224) nor when all predation causes were combined (Z = 1.25, P = 1.25). Daily survival rates for OAKS and TWMA were 0.996 (30.8% annual survival) and 0.998 (39.9% annual survival), respectively. Daily survival rates did not significantly differ (Z = 1.01, P = 0.156).

Discussion

The mortality rate estimated by combining all mortality factors was very conservative by assuming all deaths were caused by canids/felids. The comparison between the combined canid/felid and unknown predator category was less conservative and still indicated a significant difference between areas. Based on these comparisons, it appears that although daily survival rates were not different, hens on OAKS were more likely to be killed by canids/felids. This is further substantiated in that all known predation on OAKS was attributable to canids/felids. A further caveat is warranted. A potential bias exists in the high number of unknown deaths on TWMA (N = 8) versus OAKS (N = 0). This disparity resulted from differential proficiencies among observers between the 2 areas. If all unknown on TWMA were in fact canid/felid depredation, then observed differences are inflated. However, we contend that it is unlikely that all unknown mortalities were in fact predation events. The estimated annual survival rate should be interpreted with caution because an inherent assumption in calculation of interval rates is that daily survival rates are constant with the interval; this assumption was likely violated.

If depredation by coyote-bobcat is indeed higher on OAKS, it may have resulted from habitat availability and the insular nature of OAKS. Highly fragmented and insular habitats have contributed to increased predation of ground nests (Bowman and Harris 1980, Wilcove 1985, Small and Hunter 1988, Burger et al. 1994). The same mechanism may be causing higher predation rates of adult hens on OAKS. OAKS is surrounded on 3 sides by expansive agricultural (i.e., soybean, cotton) fields. Available habitat on OAKS, especially nesting habitat, was limited. High basal area and annual flooding limited groundstory density, making hardwood regeneration areas (1 year old) with old-field vegetation attractive as nesting areas (Chamberlain 1995). TWMA is within a matrix of different habitats. Lower habitat diversity and availability on OAKS, compared to TWMA, may have increased predator hunting efficiency by allowing them to search small (e.g., 2–3 ha) isolated blocks of suitable nest habitat (White 1986).

Overlap of preferred habitat of both turkeys and predators on OAKS may have increased predation rates (Miller et al. 1995*b*). Seasonal track counts conducted on OAKS roads that transected hardwood regeneration areas revealed consistently high numbers of coyote and bobcat tracks relative to other habitats on OAKS (Chamberlain and Leopold 1995). These areas also had higher numbers of cotton rats (*Sigmodon hispidus*) than any habitat on TWMA (M. J. Chamberlain, unpubl. data). Leopold et al. (1995) reported cotton rats and eastern cottontails (*Sylvilagus floridanus*) to be the primary prey items of bobcats in central Mississippi. Based on track counts, predators appeared to use replanted fields within OAKS with greater frequency than other habitats, probably due to high prey availability. Hen use of replanted fields was high with onset of nest initiation and incubation (Chamberlain 1995). Therefore, depredation of hens in replanted fields may have been a function of predators hunting small mammals in these areas, rather than searching for hens.

Highest cotton rat abundance on TWMA occurred in pine plantations 1–6 years old and lowest abundance occurred in hardwood bottomland forests (M. J. Chamberlain, unpubl. data). Seiss (1989) reported highest turkey nest success rates in mature pine forests and lowest rates in pine plantations. Palmer (1990) determined hens preferred hardwood bottomland forests except during nesting periods. On TWMA, hens were able to use habitats away from high predator use areas. This difference in habitat use between turkey hens and prey species may decrease probability of hen/predator interactions outside the nesting period.

Carnivores use roads for travel and hunting (Conner et al. 1992). Roads and levees function as corridors and also may have contributed to higher predation rates on OAKS than on TWMA. Roads on OAKS are planted annually in wheat and clover, providing abundant herbaceous forage and high insect abundance that are attractive to turkeys (Martin and McGinnes 1975, Speake et al. 1975, Phalen et al. 1986). Some roadsides on OAKS contained blackberry (*Rubus* spp.) thickets providing soft mast during spring and summer for turkeys (Exum et al. 1987), but cover for predators. High hen use of roads during summer, in conjunction with consistent use by predators, may have increased opportunities for predation. Most (71%) hens depredated on OAKS were within 50 m of a road.

TWMA also has an extensive road network that provides travel and hunting edges for predators. Many roads on TWMA contain roadsides with abundant hardwood saplings and brush that provide cover for predators. However, TWMA has a higher amount and diversity of habitat types that may provide turkeys more opportunities to avoid areas preferred by coyotes and bobcats. Bobcats on TWMA tended to place home ranges in areas of early successional habitats; coyotes were habitat generalists (Lovell 1996). Because hens spend most of the year in bottomland hardwoods on TWMA (Palmer 1990), bobcat/hen interactions were unlikely, except during nesting periods. As habitat generalists, coyotes were unlikely to concentrate foraging efforts within bottomland stands, thus possibly minimizing turkey/coyote interactions.

Management Implications

Alternative forest management strategies may need to be developed on OAKS. Management may include selective cuts over the entire area to promote growth of a herbaceous understory, thus increasing nesting and brood-rearing habitat and possibly decreasing predator efficiency. However, managers must realize that creation of small clearcuts may actually compound problems associated with predation on hens by creating sink habitats conducive to predation. Although cuts may increase small mammal abundance, long term management would likely increase available nesting habitat, reducing interactions between turkey and predators. Effects of predator management in an insular situation to increase and/or maintain desirable species should be investigated. Future research also should be conducted to determine feasibility of using habitat manipulation to decrease predator/turkey interactions. Monitoring changes in nest habitat selection and hen depredation rates is essential.

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