Survival Rates of Radio-equipped Wild Turkey Gobblers in East-central Mississippi

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Abstract: Seasonal and annual survival rates were determined for 130 radio-equipped eastern wild turkey (*Meleagris gallopavo silvestris*) gobblers on Tallahala Wildlife Management Area, Mississippi, 1986–90. Annual survival rates varied from 0.39–0.54. Spring gobbler hunting (SGH) season survival rates within a year and annual survival rates for that year did not differ ($P > 0.10$). SGH survival rates were significantly lower than all other periods within each year, and no other differences were detected within years. Our data suggest that mortality during SGH season had a significant affect on gobbler survival; however, experimental testing is needed to determine whether hunting acts as an additive or compensatory mortality factor.

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With the increase in wild turkey populations over the past 30 years, greater demands have been placed on the species by hunters (Mosby 1973, Wunz 1982, Palmer 1990). In Mississippi, hunting generally involves harvest of gobblers during the spring season. Radio-telemetry data have been used to estimate survival and causes of mortality for turkey hens (Kimmel and Kurzejeski 1985, Kurzejeski et al. 1987, Seiss 1989) and poults (Speake 1980, Metzler and Speake 1985). However, quantitative data on gobbler survival rates are limited.

Determining seasonal survival and cause-specific mortality provides insight into the importance of natural, legal, and illegal mortality. This information is essential for effective management of turkey populations (Kurzejeski et al. 1987). Therefore, our objectives were to determine annual and seasonal survival rates and causes of mortality for radio-equipped gobblers on a publicly hunted area in Mississippi.

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Methods

Study Area

The study area was Tallahala Wildlife Management Area (TWMA), a 14,140-ha tract in the Bienville National Forest, and adjacent lands. The study area was in Jasper, Newton, Scott, and Smith counties, within the Hilly Coastal Plain Province and the Blackland Prairie Soil Resource Area (Pettry 1977). Climatic conditions were mild with a mean annual temperature and precipitation of 18° C and 144 cm, respectively.

Mature pine (primarily *Pinus taeda*) stands, pine-hardwood stands, and pine regeneration areas comprised 67% of the area. Hardwood-pine stands, bottomland hardwood stands, hardwood regeneration areas, and an 81-ha old-field comprised the remaining 33% of the area.

Gobblers were legally harvested on TWMA during the spring hunting season (approximately 15 Mar to 1 May). Averages of 32 gobblers harvested and 502 hunter-days of effort were recorded annually (Palmer et al. 1990).

Data Collection and Analysis

Gobblers were captured by cannon-netting (Bailey 1976) or drugging with alpha-chloralose (Williams 1966). Capture efforts were conducted from 7 January to 4 March, and 1 July to 25 August each year. Each gobbler was fitted with a "back-pack" radio transmitter, and marked with patagial wing tags (Knowlton et al. 1964) and metal leg bands. Age (subadult, adult) was determined for each gobbler (Williams 1981). Summer-captured poults were considered juveniles, and were not fitted with transmitters.

We monitored radio-equipped gobblers from 1 February 1986–30 September 1990. Number of telemetry locations/gobbler averaged from 1–2/week (Sept–Dec 1986–88) to >7/week during other periods of the study. Transmitter motion switches (Miller and Speake 1978) and gobbler movements were used to monitor gobbler activity. If a mortality was suspected, we attempted to flush the gobbler to determine its status. Cause of death was determined (when possible), based on evidence at the mortality site. Gobblers were legally harvested during the spring hunting seasons (15 March–1 May), and hunters were required to check in all gobblers at TWMA headquarters. Gribben (1986) reported a 95% check in rate for harvested gobblers on TWMA.

Survival rates were determined annually and for the following periods within years: 16 December–1 February, 2 February–14 March, 15 March–1 May, 2 May–15 June, 16 June–1 August, 2 August–15 September, 16 September–1 November, and 2 November–15 December. These periods were selected because they were approximately equal in length, and included the spring hunting season.

Seasonal and annual survival rates with 95% confidence intervals were calculated using the Kaplan-Meier procedure (Kaplan and Meier 1958), modified by Pollock et al. (1989), to allow for staggered entry of animals. This procedure allows animals which disappear during the study (e.g., radio failure, unreported legal and illegal harvest) to be "censored" from analysis. Maximum and minimum survival rates were estimated for all periods. Maximum survival was based on known recorded deaths, and minimum survival assumed that gobblers of unknown status were dead. Statistical differences ($P < 0.10$) in survival probabilities among age classes, seasons, and years were tested using an approximately normal test statistic (Pollock et al. 1989). Annual survival probability distributions were calculated. Gobblers found dead within 2 weeks of capture were excluded from analysis.

Results

One-hundred thirty radio-equipped gobblers were monitored. Adult and subadult gobbler survival rates were similar ($P > 0.10$), therefore age classes were pooled for analysis. Five gobblers died within 14 days of capture and were excluded from analysis.

Annual survival rates were 0.54, 0.39, 0.54, 0.42, and 0.41 for 1986–1990, respectively. Annual survival in 1987 was lower ($P = 0.09$) than in 1986 and 1988; no other significant differences in annual survival rates were detected. In no case did spring gobbler hunting (SGH) season survival rates among years and annual survival rates for that year differ.

SGH survival rates ranged from 0.42 (1987) to 0.63 (1986 and 1988) (Table 1). SGH survival rates were significantly different from all other periods within each year. There were no other differences among periods within years.

Seventy four of the 81 known mortalities (91%) occurred during the 6-week SGH periods. Reported harvest (63) accounted for 78% of all gobbler mortality during the study. Cause of mortality was unknown for 15 gobblers. Most of these gobblers were found disturbed by mammals, especially opossum (*Didelphis virginiana*), raccoon (*Procyon lotor*), and, in 1 case, coyote (*Canis latrans*). However, it was unclear whether this disturbance represented predation or scavenging. Eight (53%) of the deaths due to unknown causes occurred during SGH, and 27% occurred during the fall squirrel and deer hunting seasons. Lead shot was present in 2 gobblers found during the SGH period, and crippling was considered the cause of mortality. Avian fowl pox was considered causal in the death of 1 gobbler during the SGH period.

More gobblers were censored during March, May, and October than other periods (Fig. 1). Maximum survival during the 1988 SGH period was not significantly lower than the minimum survival rate of the 16 June–1 August period during that year, due to a relatively high level of censorship during the latter period.

Table 1. Survival rates by period for radio-equipped gobblers, Tallahala Wildlife Management Area, Mississippi, 1986–1990[a].

Year	Period	Survival rate	95% CI
1986	02 Feb–14 Mar	1.000	1.000–1.000
	15 Mar–01 May[b]	0.627	0.467–0.787
	02 May–15 Jun	1.000	1.000–1.000
	16 Jun–01 Aug	0.941	0.833–1.000
	02 Aug–15 Sep	0.955	0.865–1.000
	16 Sep–01 Nov	1.000	1.000–1.000
	02 Nov–15 Dec	1.000	1.000–1.000
1987	16 Dec–01 Feb	1.000	1.000–1.000
	02 Feb–14 Mar	0.966	0.903–1.000
	15 Mar–01 May	0.424	0.266–0.582
	02 May–15 Jun	1.000	1.000–1.000
	16 Jun–01 Aug	0.933	0.811–1.000
	02 Aug–15 Sep	1.000	1.000–1.000
	16 Sep–01 Nov	1.000	1.000–1.000
	02 Nov–15 Dec	1.000	1.000–1.000
1988	16 Dec–01 Feb	1.000	1.000–1.000
	02 Feb–14 Mar	1.000	1.000–1.000
	15 Mar–01 May	0.625	0.468–0.781
	02 May–15 Jun	0.950	0.855–1.000
	16 Jun–01 Aug	0.894	0.786–1.000
	02 Aug–15 Sep	0.938	0.856–1.000
	16 Sep–01 Nov	1.000	1.000–1.000
	02 Nov–15 Dec	1.000	1.000–1.000
1989	16 Dec–01 Feb	1.000	1.000–1.000
	02 Feb–14 Mar	1.000	1.000–1.000
	15 Mar–01 May	0.477	0.326–0.628
	02 May–15 Jun	1.000	1.000–1.000
	16 Jun–01 Aug	1.000	1.000–1.000
	02 Aug–15 Sep	1.000	1.000–1.000
	16 Sep–01 Nov	0.941	0.829–1.000
	02 Nov–15 Dec	0.938	0.823–1.000
1990	16 Dec–01 Feb	1.000	1.000–1.000
	02 Feb–14 Mar	1.000	1.000–1.000
	15 Mar–01 May	0.438	0.194–0.681
	02 May–15 Jun	1.000	1.000–1.000
	16 Jun–01 Aug	1.000	1.000–1.000
	02 Aug–15 Sep	1.000	1.000–1.000

[a]Data from 1986–1987 from Kelley (1987).
[b]15 Mar–01 May = Spring hunting season (gobblers-only).

Otherwise, maximum and minimum survival rates for SGH periods were significantly lower than those of other periods within years.

Discussion

Assumptions for the Kaplan-Meier procedure were outlined by Pollock et al. (1989). One assumption was that gobblers within an age class were sampled ran-

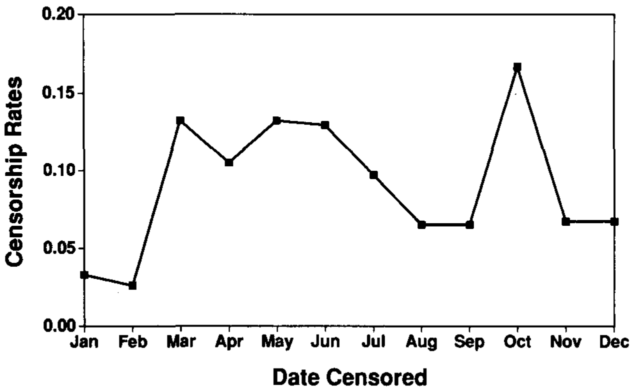

Figure 1. Censorship rates of radio-equipped gobblers by date on Tallahala Wildlife Management Area, Mississippi, 1986–1990.

domly. For example, Pollock et al. (1989) noted that smaller individuals within an age class may have lower survival rates, and samples with disproportionate numbers of individuals among weight classes could bias survival estimates. This assumption also was relevant to mark-recapture studies on TWMA, and was discussed by Lint (1990). Another assumption was that survival times were independent for individual gobblers. Because most mortality (93%) during this study occurred during the SGH period when radio-equipped gobblers were rarely together, we believe this assumption was met. Violation of this assumption would not cause bias in survival estimates, but would make survival estimates appear to have smaller variances than they actually do (Pollock et al. 1989).

We assumed that capturing and marking gobblers had negligible effect on survival probability. Since 1983, researchers on TWMA have captured >900 wild turkeys. This amount of capture experience helped researchers reduce handling time, which should reduce stress and capture-related mortality. To reduce effects of this possible source of bias, a conditioning period (14 days) was implemented. A gobbler's survival probability was not considered until it survived the 14-day period after capture and handling. Nenno and Healy (1979) observed radio-equipped, human-imprinted turkeys and concluded that such equipment had little effect on behavior after the first few days. Another assumption was that the censoring mechanism was random and not related to gobbler mortality. The temporal distribution of censorship (Fig. 1) suggested that gobblers were not censored randomly. Additionally, because censorship peaked during the SGH and fall squirrel (*Sciurus* spp.) hunting seasons, it may be invalid to assume that the censoring mechanism was not related to gobbler mortality. Therefore, extreme bounds were calculated for the survival curves by considering all censored gobblers to be alive (maximum survival) or dead (minimum survival). These bounds depict absolute best- and worst-case survival for gobblers in this study. However, these extreme bounds were generally not significantly different from the standard Kaplan-Meier rates, and the 3 curves suggested similar trends in gobbler survival.

The final assumption was that newly-tagged gobblers have the same survival probabilities as previously tagged birds. Because gobblers were added to the study in small groups (generally 1–3) adequate assessment of this assumption was prohibited (Pollock et al. 1989).

Survival rates did not vary between age classes. However, these results may be imprecise since the sample of subadult gobblers was usually low during the SGH period when most mortality was observed.

During the 5-year study only 9% of all gobbler mortality occurred outside the 6-week SGH period. Mortality during periods other than SGH had no significant effect on annual gobbler survival for any year. Harvest was the most significant cause of mortality during the study. Mortality due to unknown causes peaked during the SGH period, and many of these deaths were suspected to be crippling losses based on circumstantial evidence. However, crippling loss was not confirmed unless pellets were found in the carcass during an x-ray examination. Mammalian scavenging frequently made determining the exact cause of mortality impossible.

Many authors (e.g., Allen 1956, Bailey and Rinell 1965, Gardner et al. 1972) have reported that spring gobblers-only hunting seasons do not impact reproductive success of the polygamous wild turkey. However, increased demands are being placed on the male segment of turkey populations. For example, demand for wild turkeys is expected to exceed supply on national forests in Mississippi (USDA 1987). Therefore, an assessment of the effect of spring gobblers-only hunting on the male segment of turkey populations may now have important management implications.

Our results suggest that mortality during the SGH period has an important impact on gobbler survival. Throughout the 5-year study, annual survival rates calculated, based only on mortality during non-hunting periods, were not significantly different than 100%. Mortality during the brief SGH periods accounted for nearly all mortality during each year (Fig. 2). These data suggest that hunting functioned as an additive mortality factor. However, because survival was studied longer than the average life expectancy of a wild turkey in a natural environment, it is probably invalid to assume that the low proportion of non-hunting period mortality observed during this study would occur in the absence of hunting. Higher non-hunting mortality than observed would be expected, if only due to gobblers dying of old age. Because no significant non-hunting mortality was detected, mortality during the SGH period may have compensated for natural mortality that would have occurred in the absence of hunting. However, data from planned experiments (Romesburg 1981, Macnab 1983, Nichols et al. 1984, and Anderson et al. 1987) are needed to make inferences regarding the additive/compensatory nature of mortality during the SGH period.

Seiss (1989) reported that predation was the most significant cause of mortality of female turkeys in the TWMA population. Predation was especially high during nesting and brood-rearing periods. Principal predators of hens were great horned owls (*Bubo virginianus*) and bobcats (*Felis rufus*). However, predation had no significant effect on the male segment of the population. Gobblers may be less

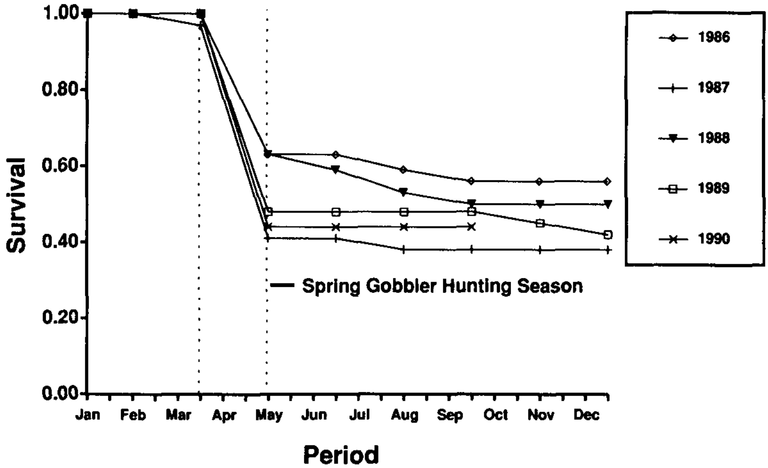

Figure 2. Distribution of survival probabilities for radio-equipped gobblers on Tallahala Wildlife Management Area, Mississippi, 1986–1990.

susceptible to predation than hens due significantly larger body sizes. Additionally, gobblers are not affected by stress due to nesting and brood-rearing efforts.

Many authors (e.g., Kimmel and Kurzejeski 1985, Williams et al. 1978, Kurzejeski et al. 1987, Seiss 1989) have reported illegal harvest of turkeys (especially hens) as a significant mortality factor. Holbrook and Vaughan (1985) noted that high turkey mortality coincided with hunting seasons in Virginia. There was no confirmed gobbler mortality due to illegal harvest during this study. However, the number of deaths due to unknown causes was slightly higher during the fall squirrel and white-tailed deer (*Odocoileus virginianus*) hunting seasons. Additionally, the number of gobblers censored from the study was often high during the first days of the squirrel season. Censorship was also high during the SGH period. Most turkey hunters on TWMA were aware of this study, and Gribben (1986) reported a high check-in rate of harvested gobblers. However, some hunters, unaware that radio-equipped gobblers were legal game, may not have reported harvesting these birds. Also, some hunters may have taken over the 3-gobbler limit and therefore avoided reporting additional harvests. Illegal harvest may have been a major mortality factor during this study; however, it appears to be more significant to the female segment of the population (Seiss 1989).

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