MORTALITY OF WHITE-TAILED DEER FAWNS IN THE WICHITA MOUNTAINS

William S. Bartush* and James C. Lewis†

Oklahoma Cooperative Wildlife Research Unit, Oklahoma State University, Stillwater, Oklahoma 74074

Forty-eight fawns of white-tail deer (*Odocoileus virginianus*) were captured, radio-tagged, and released in the Wichita Mountains of Oklahoma to study their ecology and causes of death. Ninety percent of the fawns died within 90 days postcapture. Predation, primarily by coyotes (*Canis latrans*), was involved in 88% of the losses. Only 27% of 852 fawn bedsites was in savanna and edge habitat, but 58% of the deaths due to predation occurred in that habitat.

INTRODUCTION

Deer inhabiting the Wichita Mountains of Oklahoma are the Texas white-tail subspecies (*O. v. texanus*) which is adapted to prairie and savanna-woodland (1). The Wichita Mountains deer herd population has apparently been stable but low (2.8-8 deer/km^2) since the early 1960's. Midwinter fawn/doe ratios declined from 1.46 in 1956 to 0.07 in 1964 (Steele 1969, Final P-R job Rep., Proj. W-87-R, Okla. Dep. Wildl. Conserv., Okla. City) and Steele theorized that fawn mortality was regulating the deer population. Garner *et al*. (2) studied the population in 1974 and 1975 and found 1.36 corpora albicantia/doe; they estimated average fawning ratios of 1.0-1.2 fawns/doe and at least 88% of the fawns died before age 6 months. Thirty-five fawns were radio-tagged; coyotes and bobcats (*Felis rufus*) were involved in 97% of the observed mortality. In 1976 and 1977 we continued the study of fawn mortality by attaching radio transmitters to fawns and monitoring their activities.

Study Area

The study area was the contiguous Fort Sill Military Reservation and Wichita Mountains National Wildlife Refuge in southwestern Oklahoma. The Wichita Mountains rise 427 m above surrounding plains to an elevation of 755 m and are separated from other deer range by agricultural land. The area is predominantly open prairie with woods confined to creek bottoms and to coarse soils on rocky slopes. Transitions between prairie and closed canopy woodland are abundant and these occur as an abrupt edge or as a savanna-woodland.

METHODS

Two techniques were used to capture fawns. In the first, does and their fawns were observed from elevated sites until the fawn (s) bedded, then a 3- or 4-man crew captured the fawns. In the second technique pregnant does were captured in box traps, fitted with radio collars, and then released. After the latter does had given birth, we were able to locate and capture their fawns.

Fawns were marked and monitored by use of two techniques that were assigned alternately as the fawns were captured. To each fawn in treatment group T_1 a radio collar, numbered metal ear tags, and colored ear streamers (4 by 7.5 cm) were affixed, the left ear was tattooed, and blood and fecal samples were taken. To each fawn in group T_2 we affixed a radio collar but no other identifying markings. Fawns in both groups were weighed and a rectal swab was taken. Estimates of fawn age were based on hoof length (3). The School of Veterinary Medicine, Oklahoma State University, examined blood samples for parasites, and analyzed rectal swabs for *Salmonella.*

T_1 fawns were radio located and closely observed daily and their physical appearance and behavior noted to help determine their condition. T_1 fawns more than 14 days old usually flushed from the bedsite when closely observed. The location

*Present address: Florida Game and Fresh Water Fish Commission, 226 Airport Drive, Panama City, FL 32405
†Present address: U. S. Fish and Wildlife Service, 270 Aylesworth Hall, CSU, Fort Collins, CO 80523

of each T_2 fawn was determined daily at distances of 50-250 m. Thus, T_1 fawns were approached closer and disturbed more by the researchers. General habitat use data were recorded at fawn bedsites.

The radio package affixed to each fawn weighed 110 g and contained temperature-sensitive units (Wildlife Materials, Inc., Carbondale, IL[†]); pulse rate of a transmitter changed at death when the host animal's temperature dropped below 32 C. Disposition of the carcass, characteristics of wounds, evidence at the death site, carcass consumption, and collar condition (2) were used to determine cause of death. Four intact carcasses were taken to the Oklahoma Animal Disease Diagnostic Center, Stillwater, for necropsy; partial remains or decomposed carcasses were frozen and examined later at the Oklahoma State University School of Veterinary Medicine.

Ten fawns obtained from the Texas Parks and Wildlife Department were asphyxiated after capture, frozen, and kept as free as possible from unnatural odors. Five of the carcasses were marked similar to T_1 fawns and five like T_2 fawns. The carcasses were then placed within the study area in bedsites used previously by fawns. Carcasses were examined daily to see if turkey vultures, coyotes, or other species had fed on them in order to determine the time elapsed until disturbance and the characteristics of the subsequently scavenged carcasses, and to compare these characteristics with those at the death site of fawns killed by predators.

RESULTS

Forty-eight fawns were captured — 20 in 1976 and 28 in 1977. The average age at capture was 8.7 days in 1976 and 7.7 days in 1977 (range 1-18 days). Physical parameters of the fawns were interpreted as indicating that the fawns were in good condition and the does were existing on a good nutritional plane (4:254; 5:Appendixes A and B). The interpretation of fawn condition was based on weight, body measurements, blood and fecal samples, general external appearance and behavior and, with the exception of two fawns abandoned by their dams, all were in good health when last observed before death.

Forty-three fawns (90%) died within 3 months postcapture (Table 1); 39 (91%) of the deaths occurred within 30 days postcapture. Days surviving after capture averaged 15 in 1976 and 18.8 in 1977. Predators were involved in the deaths of 38 fawns (88% of mortality), 2 fawns starved or were abandoned, causes of death of 2 were unknown, and 1 drowned (Table 1). Deaths due to predation occurred at an average age of 21 days (range 3-78 days). Mortality of males (23 of 25) was not

TABLE 1. *Survival and causes of death among 48 white-tailed deer fawns grouped by T_1 and T_2 treatments, Wichita Mountains, Oklahoma, 1976 and 1977.*

Status of fawns	T_1	T_2	Total no.	Total %
Total marked	24	24	48	100
Survived 6 mo. +	4	1	5	10.4
Deaths: predator involved				
Coyote	3	7	10	20.8
Probable coyote	7	6	13	27.1
Bobcat	1		1	2.1
Probable bobcat		1	1	2.1
Unknown predator	6	6	12	25.0
Unknown predator + other factors	1		1	2.1
Predator-involved subtotal	18	20	38	86.9
Deaths: predator not involved				
Starvation	1	1	2	4.2
Drowning		1	1	2.1
Unknown factors	1	1	2	4.2

† Mention of the manufacturer of a product does not constitute endorsement by the authors or agencies they represent.

significantly different from that of females (20 of 23).

Theileria and other blood parasites were not found in the blood samples taken when the fawns were captured. Rectal swab cultures were positive for *Salmonella enteriditis var. muenchen* only in 1977 when 3 of 28 fawns were infected. None of the animals that tested positive exhibited clinical symptoms (e. g., emaciation, perianal hair stained yellow, distended small intestine) of the disease. Two of the three fawns found positive in 1977 lived in excess of 2 weeks after capture and appeared in good health until killed by predators. The third fawn died 2 days after capture and, although the cause of death was a coyote, disease may have made the fawn weaker and, therefore, more susceptible to predation.

Twenty of the T_1 fawns (83%) and 23 of the T_2 fawns (96%) died during the study (Table 1). The mortality rates of the two marking techniques did not differ significantly but was lowest among fawns marked and monitored most intensively. Deaths in which predators were involved totaled 18 in group T_1 (75%) and 20 in group T_2 (83%), again indicating no significant difference — no increase in vulnerability to predators as a consequence of the more intensive marking and monitoring technique used on group T_1.

Necropsy results indicated fawns C3 and T14 died from starvation. Fawn C3 (group T_2) was observed nursing a doe 2 days after capture. On the fourth day postcapture, C3 was observed making two attempts to approach a pair of adult does but was rejected each time. On the fifth day, emaciated C3 was dead; since this fawn was cared for by the dam for at least 2 days after capture, we assume C3s death was unrelated to capture and marking.

Fawns T14 and D13 were siblings captured soon after birth; their dam was a radio-collared 2-year-old. T14 was marked and monitored by T_2 procedures and D13 was a member of group T_1. Fawn T14 was apparently abandoned at or near the birth site. The doe took care of D13; thus she accepted the sibling that had been marked more intensively. D13 remained in good physical condition until 36 days of age when it was killed by a coyote. The fawns were probably the first offspring of the doe, which may account for the acceptance of one fawn and rejection of the other.

Among the 10 fawns sacrificed and placed in previously used bedsites, scavenging always occurred more than 24 hr after placement; the odor associated with decay appeared to be important in helping scavengers locate carcasses. Eight of 10 carcasses had been fed on by vultures as evidenced by feathers, tracks, and droppings around the carcasses. Between 24 and 48 hours after placement, three carcasses were disturbed by predators and vultures, and one carcass was scavenged only by vultures. Between 48 and 72 hours after placement an additional four carcasses were scavenged by vultures. Two carcasses were not disturbed by scavengers before being consumed by maggots within 80 hr after placement.

In contrast, there was no evidence of scavenging by vultures on carcasses of the 43 fawns released alive and found after the fawn's death. The amount of flesh consumed was less and extent of decomposition was greater on scavenged fawn carcasses than on radio-collared fawns that died after release. These observations and other characteristic signs (e.g., tracks, hair, feathers, droppings, blood, evidence of a struggle by the prey) at the death site indicated that scavenged carcasses are distinguishable from carcasses of fawns killed by predators. The latter evidence helped verify that regular monitoring of fawns provided accurate information on the status of radio-collared individuals, and that predation was the principal cause of fawn death.

Bartush (5) examined fawn bedsites on 852 occasions and noted that fawns preferred savanna ($P < 0.05$) and edge habitat as bedsites (Table 2). Fawns bedded in savanna and edge habitat almost twice as frequently as would be expected if bedsites had been distributed randomly throughout the study area. Closed forest was used for bedsites only slightly more than would be expected if use was random. Fawns that bedded in savanna and edge habitat appeared to be more vulnerable to predation than fawns bedding in other habitat; only 27% of the bedsites were in savanna and edge habitat (Table 2), yet 58% of the predator-killed fawns were bedded in the latter habitat the last time they were seen alive.

TABLE 2. *Habitat used as fawn bedsites on 852 occasions compared to use expected if there were no habitat preferences and compared to bed-side habitat used by 38 fawns just before they were killed by predators.*

Category	Prairie	Closed forest	Savanna and edge
Bedsites (N)	483	135	234
Expected use[a] (%)	70.1	14.7	15.2
Observed use (%)	56.7	15.8	27.5
Observed vs expected (%)	−19.1	+7.5	+80.9
Deathsites (N)	14	2	22
Observed (%)	36.8	5.3	57.9
Observed vs expected use (%)[a]	−47.5	−63.9	+280.9
Observed vs expected use (%)[b]	−35.1	−66.5	+110.5

[a]Expected bedsite use assumes random distribution of bedsites among all available habitat.

[b]Expected deathsite location assumes random distribution corresponding to use of habitat for bedsites.

Radio-collared coyotes used savanna more and prairie less than expected ($P < 0.05$) based on the availability of these habitats within Wichita Mountains National Wildlife Refuge (6). Coyotes' preference for savanna habitat may partially explain the high mortality (greater vulnerability) of fawns bedded in savanna and edge.

CONCLUSIONS

This study provided insight into the mechanisms controlling the white-tailed deer population of the Wichita Mountains. The 90% fawn mortality was due primarily to predation by coyotes, which resulted in low recruitment of fawns into the adult population. There was no evidence that disease substantially influenced the predator-prey relationship. Color marking, intensive handling, and close daily monitoring activities did not appear to increase mortality above that experienced by fawns not color marked and usually monitored from a distance.

McGinnes and Downing (7) stated that handling, marking with ear tags with 1.9 by 6.4-cm streamers attached, and ear tattooing appeared to have no adverse effect on fawn survival in Virginia. White *et al.* (8) indicated that capture and marking increased predator-related deaths of fawns by 6 to 18% at Welder Wildlife Refuge in southern Texas. Visibility of 3.8 by 15-cm ear streamers was the factor ascribed by White *et al.* (8) as causing this increased mortality of fawns; fawns with smaller markers (3.8 cm^2) experienced less loss to predators. The ear streamers we used were only one half as long as the 3.8 by 15-cm streamers used by White *et al.* (8). We do not know the extent to which, if any, the presence of radio collars might have increased mortality.

Predators killed substantial numbers of healthy fawns in the Wichita Mountains and predation appeared important in regulating the deer population. Predation is consistent with the policy of "natural" regulation of deer on the Wichita Mountains National Wildlife Refuge where deer hunting is not permitted.

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REFERENCES

1. J. S. LINDZEY, *The white-tailed deer in Oklahoma, ecology, management and production,* Ph. D. Dissertation, Oklahoma A. and M. College, Stillwater, 1951.
2. G. W. GARNER, J. A. MORRISON and J. C. LEWIS, Proc. Annu. Conf. Southeast. Assoc. Fish Wildl. Agencies 30: 493-506 (1978).
3. A. O. HAUGEN and D. W. SPEAKE, J. Wildl. Manage. 22: 319-321 (1958).
4. W. S. BARTUSH and G. W. GARNER, Proc. Annu. Conf. Southeast. Assoc. Fish Wildl. Agencies 33: 250-258 (1980).
5. W. S. BARTUSH, *Mortality of white-tailed deer fawns in the Wichita Mountains, Comanche County, Oklahoma-Part II,* M. S. Thesis, Oklahoma State Univ., Stillwater, 1978.
6. J. A. LITVAITIS and J. H. SHAW, J. Wildl. Manage. 44: 62-68 (1980).
7. B. S. McGINNES and R. L. DOWNING, Proc. Annu. Conf. Southeast. Assoc. Game Fish Comm. 23: 188-191 (1970).
8. M. WHITE, F. F. KNOWLTON and W. C. GLAZENER, J. Wildl. Manage. 36: 897-906 (1972).