MORTALITY OF WHITE-TAILED DEER FAWNS IN THE WICHITA MOUNTAINS, OKLAHOMA

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ABSTRACT

Thirty-five white-tailed deer (Odocoileus virginianus) *fawns 1 to 28 days of age were captured in 1974 and 1975. Survival and causes of mortality were determined by radio telemetry. Average annual mortality was 87.9 percent, based on a 63 percent mortality rate in 1974 and a 96 percent mortality rate in 1975. Predation by coyotes* (Canis latrans) *and bobcats* (Lynx rufus) *was involved in 96.6 percent of the observed mortality. Salmonellosis was detected in three 1975 fawns at capture but clinical symptoms of the disease were not noted during the study. Coyote and bobcat predation combined to exert long-term postnatal pressure (up to 16 weeks) on the fawn segment of the deer herd. Study results suggest the experimental use of short-term seasonal predator control to allow fawn survival to increase on those portions of the county open to deer hunting, but compensatory natural mortality may offset this anticipated gain. These results also underscore the effectiveness of coyotes and bobcats as natural deer population controls on areas where hunting is not allowed.*

The Comanche County white-tailed deer range in southwestern Oklahoma is primarily confined to the Wichita Mountains complex in the northwest portion of the county (Fig. 1) and is somewhat isolated from adjacent deer ranges by agricultural lands surrounding the mountain complex. The Wichita Mountains National Wildlife Refuge (WMNWR 23,917 ha) and Fort Sill Military Reservation (FSMR 38,164 ha) contain the major part of this mountain complex and include the center of the county's deer herd.

The Wichita Mountain's herd has a history of overpopulation (Lindzey 1951) and was classified by Leopold et al. (1947) as an "incipient" irruptive area. The predicted irruption was probably delayed by extensive live-trapping from 1945 to 1965 when 4,309 deer were removed from WMNWR for transplanting purposes (Halloran 1969). Hunting on FSMR also removed a minimum of 4,650 deer during this same time period. The herd increased rapidly from 1955 to 1961, then decreased sharply from 1961 to 1965 (Steele 1969, Final P-R Job Rep., Proj. W-87-R, Okla, Dept. Wildl. Conser., Okla. City) and has apparently fluctuated little since 1965 (R. Johnson and G. Bartnicki, U. S. Fish and Wildlife Service, 1973 personal communication; O. B. Hamblin, Okla. Dept. of Wildlife Conservation, 1973 personal communication). Approximate average deer density since 1965 on the WMNWR and FSMR was estimated to be 2.8 deer/km^2 (unpublished Refuge estimates, U. S. Dept. Army 1971), although the authors believe that the portions of the Wichitas used for this study support 8 deer/km^2.

Mid-winter fawn/doe ratios declined from 1.46 fawn/doe in 1956 to 0.07 fawn/doe in 1964 (Steele 1969, Final P-R, Job Rep., Proj. W-87-R, Okla. Dept. Wildl. Conserv., Okla, City). Johnson, Bartnicki, and Hamblin (1973 personal communication) indicated that satisfactory natality was occurring but that fawns did not survive through the summer months.

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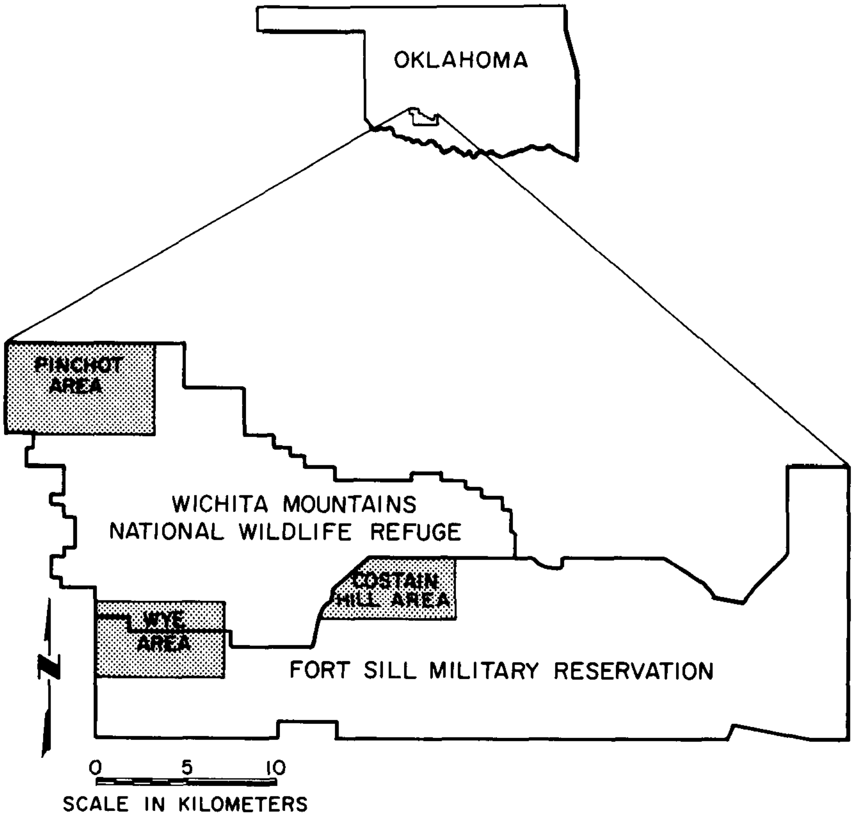

Figure 1. Location of study area in Oklahoma and location of the three sampling areas in the Wichita Mountains, Comanche County, Oklahoma.

Recent studies of neonatal mortality in white-tailed deer in Texas (Knowlton 1964, White 1966, Cook et al. 1971, White et al. 1972), Virginia (McGinnes and Downing 1969), and Oklahoma (Bolte et al. 1970, Logan 1972) were conducted in areas supporting relatively high deer densities. In those studies, densities ranged from 21 to 76 deer/km^2, but only Logan considered the herd he was investigating to be overpopulated (76 deer/km^2). The role of fawn mortality as a population-regulating mechanism in lower density deer herds has not been investigated directly. The present study was conducted from May 1974 to January 1976 to measure the extent and to identify the causes of fawn mortality affecting the relatively low density Wichita Mountains deer herd.

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DESCRIPTION OF STUDY AREA

The study area included portions of the contiguous FSMR and WMNWR (Fig. 1), which are located in the Central Rolling Red Plains and Central Rolling Red Prairies land resource areas of Oklahoma (Gray and Galloway 1969). The topography ranges from nearly level to slopes exceeding 20 percent. Numerous outcrops of barren granitic mountain peaks, cliffs, and escarpments are evident in the central mountains area of the FSMR (Soil Conservation Service 1967) and in the more rugged portions of the WMNWR (Buck 1964). Soils are primarily derivatives of sedimentary (limestone and shale) and igneous (granite, gabbro, and rhyolite) parent materials. The climate is classified as temperate, continental, and of the dry-subhumid type. Average annual precipitation is 74.1 cm with rainfall occurring in a general spring-summer pattern (Soil Conservation Service 1967, 1970).

A wide variety of vegetation types are present on the study area and are primarily a result of variation in soil types. Open prairie comprises a majority of the area. Tall-grass species such as big bluestem (*Andropogon gerardi*), little bluestem (*Schizachyrium scoparium*), sand bluestem (*A. halli*), switchgrass (*Panicum virgatum*), and Indiangrass (*Sorghastrum nutans*) predominate on deep soils having good soil moisture relationships. Forbs and legumes are also abundant on these deeper soils. Mid and short grasses such as blue grama (*Bouteloua gracilis*) and side-oats grama (*B. curtipendula*) are dominant on the more droughty hardland and slickspot soils. Mesquite (*Prosopis juliflora*) is also common on many of these droughty soils in the FSMR. Hairy grama (*B. hirsuta*), fall witchgrass (*Leptoloma cognatum*), and side-oats grama are the dominant grass species on the very shallow rocky soils (U. S. Department of Army 1971, Crockett 1964).

Wooded areas are primarily confined to stream-courses and the more sandy and gravelly soils. Typical stream-course species include elm (*Ulmus americana*), pecan (*Carya illinoensis*), hackberry (*Celtis reticulata*), red oaks (*Quercus spp.*) post oak (*Q. stellata*), bur oak (*Q. macropcarpa*), and chinquapin oak (*Q. muhlenbergii*). On the stony upland soils, common species include blackjack oak (*Q. marilandica*) (Buck 1964).

Three locations believed to be major fawning areas were selected within the general study area to be used for capturing fawns (Fig. 1). The Costain Hill area (approximately 1,550 ha) is entirely on FSMR and consists primarily of hilly, open grasslands containing numerous large boulders and occasional clumps of woody vegetation. The Wye area (approximately 2,900 ha) is on contiguous portions of FSMR and WMNWR. Habitat types include rolling grasslands, post oak-blackjack oak woodlands, and mesquite infested grasslands. This location contains a major artillery impact area and an Air Force bombing range on FSMR. The Pinchot area (approximately 3,900 ha) is entirely in the northwestern mountainous region of WMNWR. This area has steep topography and consists of open plains intermingled with rocky hills.

The WMNWR has been protected from fire since its establishment in 1901 (Dana 1956). About one-third of the refuge is open for public use, whereas the remainder is reserved for wildlife use. FSMR is headquarters for the U. S. Army Artillery and Missile Center. It maintains six artillery impact areas, multiple firing points, observation posts, and numerous surveyed target locations throughout the reservation (Soil Conservation Service 1970). Uncontrolled range fires caused by artillery firing are common throughout the year on FSMR.

Two big game species are present on the FSMR. Population estimates in 1975 included 1,250 white-tailed deer and 100 elk (*Cervus canadensis*). Either-sex deer and elk hunting to regulate population levels are allowed on the reservation. In 1975, WMNWR supported approximately 600 buffalo (*Bison bison*) and 300 Texas longhorns (*Bos taurus*) in addition to 500 white-tailed deer and 550 elk. Eighty km of 2.4-m-high ungulate-proof fence surround the refuge. Surplus buffalo and longhorns are sold annually and surplus elk are harvested by hunters to maintain populations within carrying capacity of the range. Deer populations have not been regulated since deer trapping and transplanting ceased in 1965.

MATERIALS AND METHODS

Radiotelemetry equipment was utilized to locate fawns and to aid in determining the status of their health (Cook et al. 1967). Fawn transmitters weighed approximately 110 g each and were attached to individual fawns by an expandable, elastic neck collar (Wildlife Materials, Inc.[2], Carbondale, Illinois). AVM model LA12 portable receivers in conjunction with four-element yagi antennae (AVM Instrument Company, Champaign, Illinois) were used for monitoring. Transmitters and receivers operated at frequencies between 164.425 and 164.725 mHz.

We used various methods described by Downing and McGinnes (1969) and White et al. (1972) to capture neonatal fawns. The terrain of the study area allowed use of high vantage points (military observation towers and high mountains) from which to observe doe behavior and locate fawns. Binoculars and spotting scopes were used to observe single does until a fawn was sighted. The fawn was allowed to complete nursing and select a new bedsite. After the doe left the area, the three- to four-man capture crew proceeded to the general vicinity of the fawn. The site was then surrounded and a slow, inward-proceeding approach was made until the fawn was sighted in its bed. Normally, the fawn would be alert and watching one of the capture crew members approach. This crew member would stand quietly and hold the fawn's attention while the crew member behind the fawn approached cautiously and leaped on the fawn. Successful fawn captures were possible with this observe, surround, and leap technique following sightings of does with fawns at distances of 0.5 to 1.6 km from the observer. This technique was most effective in early mornings and late evenings.

Captured fawns were aged, measured, sexed, weighed, marked, and released at the respective capture sites. Age estimates were based on new hoof length and other physical characteristics described by Haugen and Speake (1958). Fawns were color marked with round 1.9 cm colored aluminum Perfect ear tags (Salt Lake Stamp Company, Salt Lake City, Utah) in combination with colored 2.5 x 7.5 cm strips of Saflag material (Safety Flag Company of America, Pawtuckett, Rhode Island) attached as described by Downing and McGinnes (1969). This small-sized Saflag strip was chosen because White et al. (1972:902) noted that fawns marked with 3.8 × 15 cm ear markers had mortality rates twice as great as those tagged with 3.8 cm^2 markers. Ear tags were attached to both ears at the upper edge of the ear near the head. Tag losses were nil. Each fawn also received a tattoo in the left ear. Blood samples and rectal swabs were collected from all fawns during the 1975 capture period. These samples were analyzed by personnel at the OSU College of Veterinary Medicine. The time required to process individual fawns (capture to release) ranged from 15 to 30 min. Recommendations outlined by White et al. (1972:905) for minimizing the probability of increasing fawn mortality due to handling and marking techniques (i.e. small markers, processing fawns at the capture site, etc.) were followed throughout this study.

Marked fawns were monitored by triangulation and their locations were recorded on standardized forms. During the fawn capture period (15 May to 30 June), marked fawns were located daily and observed undisturbed if possible. Following the fawn-capture period, fawn locations were triangulated twice daily until 15 August, and then monitored less frequently until the transmitter failed 12 to 14 months postcapture. If a fawn remained in the same location on any two consecutive tringulations, it was observed visually to determine its status. When a mortality occurred, a detailed inspection of the surrounding area was made to detect signs of predators or other evidence of the mortality agent. Criteria used in assigning the mortality to a certain agent (Table 1) were a combination of criteria presented by Smith (1945), Dill (1947), Cooke et al. (1971), Beale and Smith (1973), and White (1973). Special emphasis was placed on their techniques (i.e. blood around wounds, etc.) for differentiating between predator-killed carcasses and predator-scavenged carcasses. Mortality categories corresponded to the predation-excluded and predation-involved categories of Cook et al. (1971). Fawn remains ranged from only blood and hair, with the radio-transmitter and collar, to intact carcasses. Three partial carcasses were frozen and later were transported to the OSU College of Veterinary Medicine for necropsy, whereas the two intact carcasses were immediately transported to

Table 1. Criteria used to determine predator species in predator-involved mortalities.

Criteria	Interpretation
1. Characteristics of wounds or death site	
A. Blood around wounds, in nostrils, ears, throat, and around mouth	predator involved
B. Blood not around wounds, carcass remains show no evidence of bruises or hemorrhaging	predator scavenged
C Blood on grass in area and/or evidence of struggle by fawn at death site	predator involved
D. Fawn observed within 48 hours prior to location of carcass and at that time appeared in good physical condition according to criteria outlined by Cook et al (1971:49)	predator involved
E. Carcass lacks signs of being bitten	predator not involved
2. Carcass Disposition	
A. Laying in open, no attempt at concealment, carcass remains not scattered	unknown predator
B. Laying in open, no attempt at concealment, remains scattered	probable coyote
C. Buried underground	probable coyote
D. Partially covered with ground litter or leaves with evident fan-like scraping pattern	bobcat
3. Carcass Injuries	
A. Skull punctured or crushed	coyote
B Underside of neck bruised but without puncture wounds	probable coyote
C. Underside of neck bruised and small puncture wounds evident	bobcat
D. Narrow scratch marks on ears, neck, forelegs or back	probable bobcat
E. Broad scratch (bruises) marks on back of neck and throat	probable coyote
4. Carcass Consumption	
A. All consumed	unknown predator
B. All consumed except for bone chips, ear tags, bits of skin, etc.	unknown predator
C. All consumed except for scattered leg bones, bone fragments, etc.	probable coyote
D. Small fawns(<60 days old) all viscera consumed	unknown predator
E. Large fawns (>60 days old) all viscera except intestines and rumen consumed	unknown predator
5. None	unknown predator
5. Collar Conditions	
A. Collar expanded or unexpanded, large tooth marks on transmitter, bloody collar	probable coyote
B. Collar not expanded, no tooth marks, collar not bloody	unknown predator
6. Predator Sign in Areas	
A. Fresh coyote tracks	probable coyote
B. Fresh bobcat tracks	probable bobcat
C. Coyote fur around carcass	coyote

OSU for necropsy for evidence of disease pathogens and parasites. The remaining partial carcasses which provided insufficient material for necropsy were collected and examined by the principal investigator. Predator scats were collected bimonthly along designated road systems to measure the incidence of fawn hair in scats (Salwassar 1974).

Fawn/doe counts were initiated in June each year and continued periodically until January of the following year. Observers travelled slowly by truck along designated roads and all deer sighted were classified as to sex and age whenever possible. These same routes were counted from both trucks and helicopters in 1975. FSMR provided OH-58 helicopters for use in this phase of the study. Reproductive tracts from 24 does harvested during the 1975 fall deer season on FSMR were used to obtain corpora albicantia counts (Cheatum 1949, Teer et al. 1965) for estimating the initial, postpartum rate of fawn production in spring 1975.

RESULTS

Physical condition of all fawns at capture was judged to be excellent. Lone Star tick (*Amblyomma americanum*) loads were low; an average of three ticks occurred per fawn, ranging from 0 to 17 ticks. Peak of fawning occurred around 1 June each year. Fawn drop ranged from early May to late June. Analysis of blood smears from fawns in 1975 revealed no blood parasites, although *Theileria cervi* has been detected in the adult segment of this deer herd. Rectal swab cultures were positive for *Salmonella enteriditis* var. *muenchen* in three fawns in 1975 (B-8, B-10, and B-12). Clinical symptoms of salmonellosis (Robinson et al. 1970) (i.e. emaciation, perianal hair stained yellow, distended small intestine) were not evident in any fawn or fawn carcass during this study.

Twenty-nine of the 35 fawns died during the 2-year study period (Table 2). Two of 10 fawns disappeared during the 1974 study period and their fate is unknown; therefore, subsequent calculations of mortality rates exclude these two fawns from the sample. Five of the remaining eight fawns died in 1974 (63 percent mortality rate) and 24 of 25 died in 1975 (96 percent mortality rate). The high mortality rate observed in 1975 was obviously a

Table 2. Survival and causes of mortality among 35 radio-collared white-tailed deer fawns captured during 1974 and 1975 in the Wichita Mountains.

Fate category	*N. of fawns*	*% of known fate*	*% of total dying*
Survived to at least 1 year	4	12.1	
Fate unknown	2		
Mortalities:	29	87.9	100.0
Predation-excluded deaths:	1	3.0	3.4
Probable abandonment (starvation)	1	3.0	3.4
Predation-involved deaths:	28	84.9	96.6
Coyote	10	30.3	34.4
Bobcat	5	15.2	17.2
Coyote plus other factors	1	3.0	3.4
Coyote predation probable	9	27.3	31.0
Bobcat predation probable	1	3.0	3.4
Predator species undetermined	2	6.1	6.9

short term phenomena because the herd could not sustain itself with such high loss rates . The authors recognize that these mortality rates may be slightly greater than those of unmarked fawns (Cook et al. 1971:53). The effect of marking techniques and monitoring procedures is currently being studied by the Oklahoma Cooperative Wildlife Research Unit.

Probable causes of mortality were determined for each of the 29 fawn losses (Table 3). No fawn carcass examined during this study was classified as a predator-scavenged carcass. With two exceptions described later, all fawns were in good condition the last time they were observed prior to their death. The number of fawns dying in each 5-day age increment is presented in Fig. 2. Age of fawns at capture ranged from 1 to 28 days and averaged 12 days. Average age at death was 38 days within a range of 6 to 111 days. Over one-half (55.2 percent) of the observed mortality occurred during the first 30 days of life, whereas 82.7 percent occurred during the first 60 days of life (Fig. 2).

Fawn/doe ratios in 1974 (Fig. 3) were variable, but a ratio of 0.48 fawn/doe was obtained in late July at the Wye area. This ratio gradually declined to 0.25 fawn/doe in December (0.48 fawn/doe vs. 0.25 fawn/doe; $x^2 = 4.73$, 1 df, $0.025 < P < 0.05$). The Pinchot area ratio fluctuated but remained in a range of 0.08-0.13 fawn/doe. Small sample sizes on the Costain Hill area indicated a ratio of 0.3-0.4 fawn/doe. In 1975, counts in late July disclosed a ratio of 0.71 fawn/doe in the Pinchot area whereas the ratio at the Wye area was 0.09 fawn/doe (Fig. 4). The Wye area ratio remained at 0.09-0.11 fawn/doe, but the Pinchot area ratio declined to 0.39-0.45 fawn/doe in November and December (0.71 fawn/doe vs. 0.45 fawn/doe; $x^2 = 3.28$, 1 df, $0.05 < P < 0.10$). A majority of the observed mortality had occurred before meaningful fawn/doe ratios could be obtained because fawns remain secluded until 6 to 8 weeks of age and are therefore not readily visible. In general, trends in these fawn/doe ratios tend to support the extent and timing of fawn mortality rates derived from the radio-collared fawns.

Analyses of predator scats (Fig. 5) indicated that they contained fawn hair most frequently in June and July, but that fawn hair occurred to some degree in predator scats from May through September. This peak incidence in June and July agrees with the chronology of fawn losses described earlier (Fig. 2).

Corpora albicantia counts from does harvested at FSMR, November through December 1975 (including the 1.5 year-old age class) indicated 1.36 corpora albicantia/doe. Adult does and yearling does had 1.61 and 0.25 corpora albicantia/doe respectively. Teer et al. (1965) found that corpora albicantia rates overestimated actual ovulation rates by an average of 19 percent in Texas. Teer et al. (1965) also found that actual fertilization rates were lower than ovulation rates. Therefore, initial fawn production in the Wichita Mountains in 1975 probably was something less than 1.35 fawn/doe (perhaps 1.00-1.25 fawn/doe) but the applicability of the Texas fertilization rates to the Wichita herd is unknown.

DISCUSSION

Predation-Excluded Deaths

Fawn B-16 was the only predation-excluded mortality during this study (Table 3). This fawn was 12 days old at capture on 24 June 1975 and was found dead on 29 June. The fawn had lost 0.6 kg of weight and was not fed upon by predators. This fawn was born late in the fawning season and the doe was not observed with the fawn after capture. Necropsy was negative for pathogenic organisms and milk was not present in the digestive tract, which suggested starvation and probable abandonment.

Predation-Involved Deaths

Predation was the immediate cause of death in 28 (96.6 percent) of the 29 mortalities (Table 2), although other factors were also involved in fawn A-7's death. This fawn was observed in a weakened state on 24 June 1974 (6 days post-capture) and was thereupon recaptured and remeasured. Skeletal growth had occurred but weight had decreased 0.9 kg. The fawn was emaciated and very weak. On 27 June a range fire swept over the Costain Hill area and burned to within 10 m of fawn A-7 where Army personnel extinguished the

Table 3. Characteristics of fawn carcasses and criteria used to determine primary cause of mortality, Wichita Mountains, 1974 and 1975.

Fawn Number	*Estimated age at capture (days)*	*Days surviving post capture*	*Predator involved in death*	*Estimated percent of carcass remaining*	*Hours since last observed in good cond.*	*Characteristics of kill site and carcass (Table 1)*
B-13	1	14	Coyote	10	28	1A, 1D, 2C, 3A & B, 4D, 5B, 6A
B-2	3	13	Bobcat	20	27	1A, 1D, 2C & D, 3C, 4D, 5B
B-7	3	21	Coyote	0	26	1D, 4A, 5A, 6A
B-10	4	1	Coyote	0	24	1D, 2A, 4B, 5A
B-4	5	92	Coyote	0	87	2B, 3A, 4C, 5A
A-4	6	28	Bobcat	75	22	1A, 1D, 2D, 3C, 4D, 5B, 6B
C-2	6	53	Bobcat	30	26	1A, 1D, 2C&D, 3C&D, 4E, 5B
A-6[1]	7	40	Coyote	0	15	1D, 4B, 5B, 6A
B-5	8	6	Coyote	30	25	1A&D, 2C, 3B 4B&D
B-8	8	13	Coyote	0	16	1D, 4A, 5A
C-6	9	44	Coyote	0	32	1D, 2B, 4C, 5A, 6A
A-05[1]	10	21	Coyote	0	48	1D, 4B, 5A, 6A
C-3	10	94	Bobcat	77	33	1A, 1C&D, 2A, 3C&D, 4E, 5B
B-3	11	11	Coyote	0	25	1D, 4A, 5A
B-9[1]	11	7	Coyote	0	51	2A, 4B, 5A, 6A&C
B-12	11	4	Coyote	0	22	1D, 2A, 4B, 5A, 6A
B-16	11	5	Abandon ment	100	20[2]	1E
A-7[1]	12	10	Coyote + others	100	13[2]	1A&D, 2A, 3A, 4F, 6A
C-5	12	9	Coyote	10	27	1A, 1D, 2C, 3A 4D, 5A
A-01	14	68	Unk. predator	0	23	1D, 4A, 5B
B-1	14	23	Bobcat	85	25	1A&D, 2D, 3D, 4D, 5B
B-6	14	2	Coyote	40	25	1A&D, 2C, 3B, 4D, 5B, 6A
C-1	15	9	Unk. predator	0	31	1D, 4A, 5B
B-11	17	5	Coyote	0	28	1D, 4A, 5A
B-14	17	59	Coyote	50	3	1A, 1C&D, 2A, 3A&B, 4E, 5A, 6A
C-9	18	21	Coyote	0	25	1D, 4A, 5A
B-15[1]	19	3	Coyote	0	21	1C&D, 4A, 5A
C-7	20	12	Coyote	10	49	1A, 2A, 3A, 4D, 5A
C-8	21	90	Bobcat	40	78	1A, 2A, 3C, 4E, 5B

[1] Fawns marked on Fort Sill
[2] Fawn emaciated and not in good condition

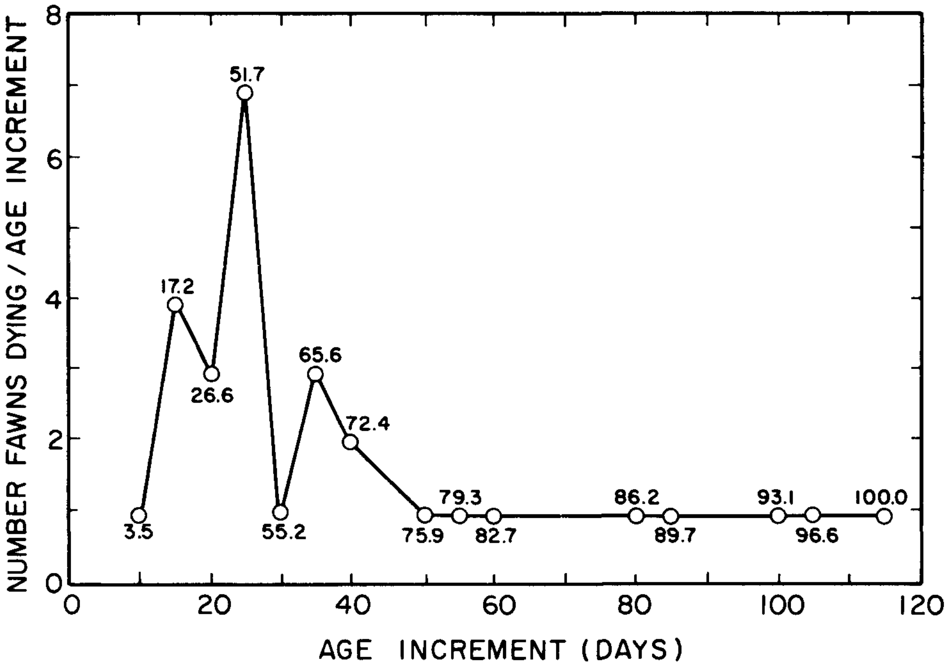

Figure 2. Number of fawns dying within each 5 day age increment, Witchita Mountains 1974 and 1975 combined data.
[1]Cumulative percent of total mortality, 1974, 1975 combined data.

blaze. The fawn was observed alive at 1935. At 0915 on 28 June the fawn was found dead, an obvious coyote kill. Coyotes had been attracted to the fire and tracks were numerous along the edge of the burn. The fawn had been killed by a bite to the head, but no other wounds were found on the carcass and it had not been fed upon by coyotes. Necropsy for pathogenic organisms was negative. Abandonment was not considered a contributing agent in the death because the doe was regularly observed with the fawn from capture to death.

Four fawn carcasses (C-5, B-5, B-6, and B-13) were buried by coyotes during the 1975 study period. These carcasses consisted of the anterior half of the body or only the head and neck. The carcasses were usually covered by 1 cm of soil, but B-13 was covered by 7 cm of soil. White (1973) does not mention the caching of fawn carcasses by coyotes, but Young and Jackson (1951) mentioned the habit briefly concerning coyotes feeding on jackrabbits.

Age-specific data on fawns killed by coyotes and bobcats suggest that the two predators may exert long-term (up to 16 weeks of age) pressure on fawns at the Wichita Mountains (Fig. 6). Coyote predation usually occurred on fawns less than 8 weeks of age when they are normally associated with the more open prairie habitat (31 days average age at death). Bobcat predation usually occurred after fawns became associated with forest edge or steeper rocky slopes. Bobcats also killed more mature fawns (54 days average age at death) than very young ones. Beale and Smith (1973) and Young (1958) have also noted this ability of bobcats to subdue larger prey. These data suggest that opportunistic coyotes may actively seek the more easily captured young fawns while bobcat predation is more adventitious and is not confined to small, easily captured fawns. Observations of

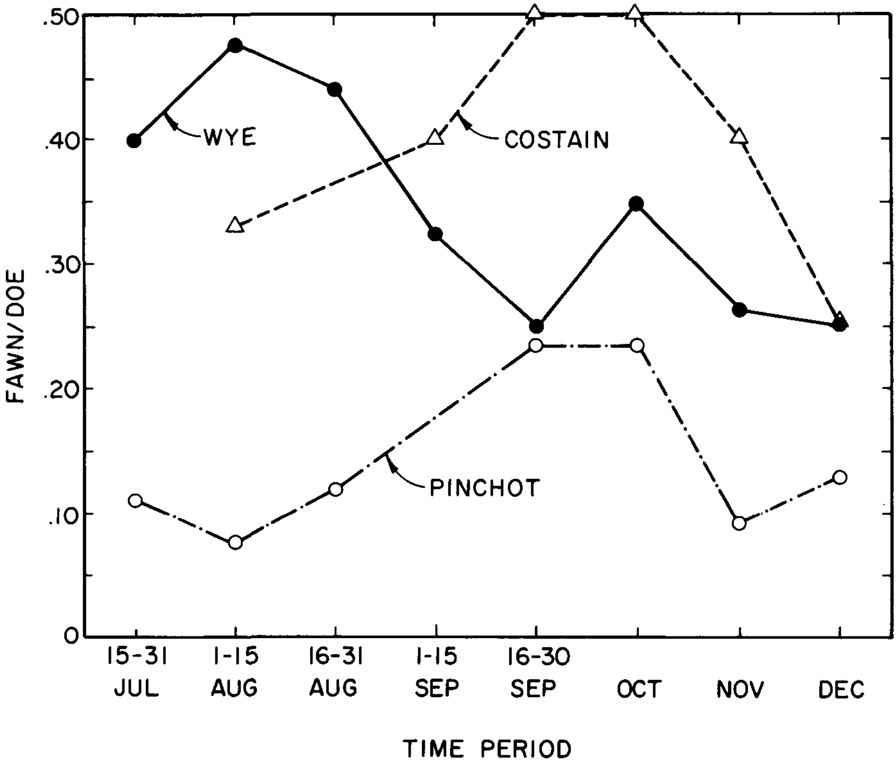

Figure 3. Fawn/doe ratios for each study location by time period, Witchita Mountains, 1974.

interspecific behavior between predators and deer support these conclusions (Garner and Morrison 1976).

The total mortality rate of 87.9 percent in this study (Table 2) is higher than the mortality rate of 72 percent reported by Cook et al. (1971); however, their study was limited to approximately 60 days postpartum, at which time field work was terminated each year. The Wichita Mountains study was not limited to this time period and additional mortalities were observed in fawns older than 60 days. If a 60-day postpartum mortality rate at the Wichita Mountains was calculated, it would be 72.7 percent, which agrees with the South Texas findings.

Management Implications

Two management tactics are suggested by our findings. First, in areas where hunting is not compatible with other uses, coyote and bobcat predation could be a very useful aid in establishing natural population control. The present management strategy on WMNWR is to establish natural regulation of deer numbers. Annual productivity rates of 0.1 to 0.4 fawn/doe are therefore not a major concern of WMNWR personnel. In view of the irruptive history of this herd; predation may now be providing the needed natural check on its size.

A second management tactic can be suggested for FSMR and surrounding private and state lands where annual deer harvests occur. Predation may be contributing to the

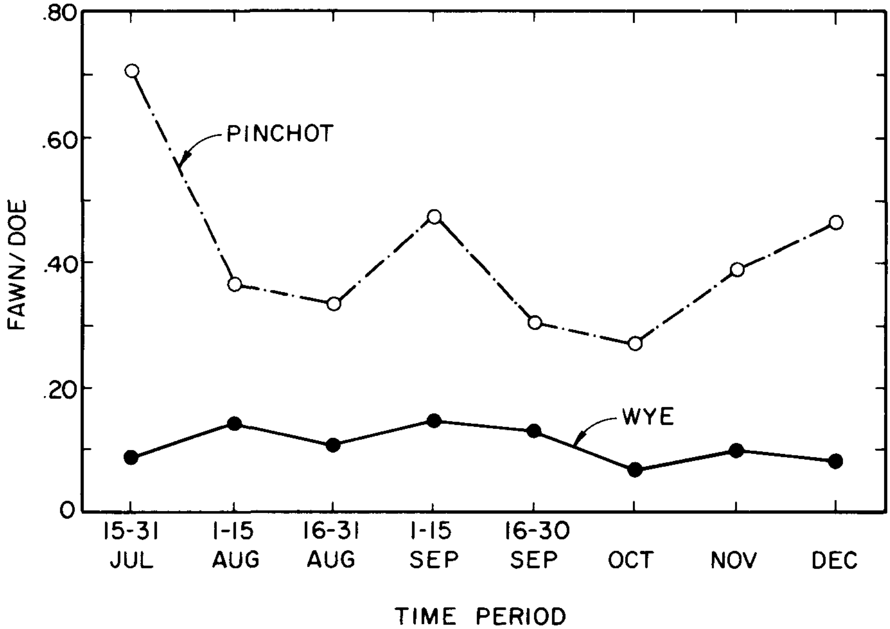

Figure 4. Fawn/doe ratios for each study location by time period, Wichita Mountains, 1975.

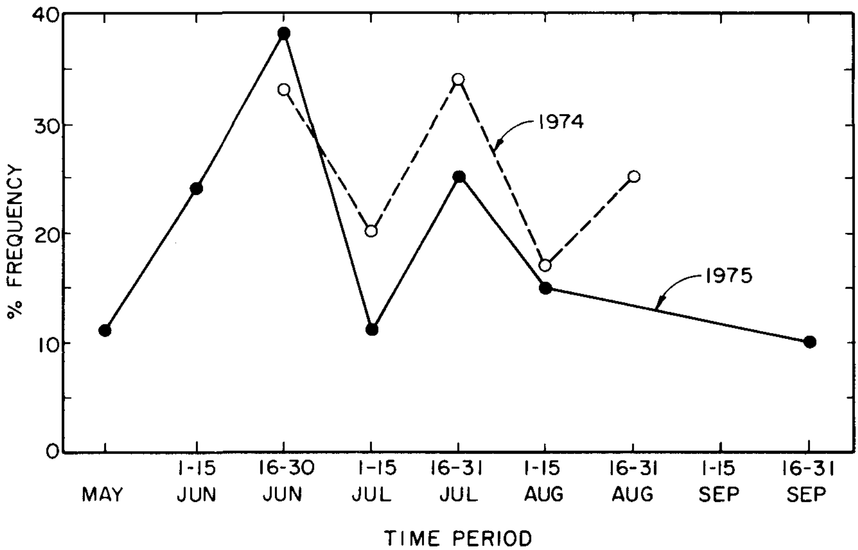

Figure 5. Frequency of occurrence for fawn hair in predator scats by time period, Wichita Mountains, 1974 and 1975.

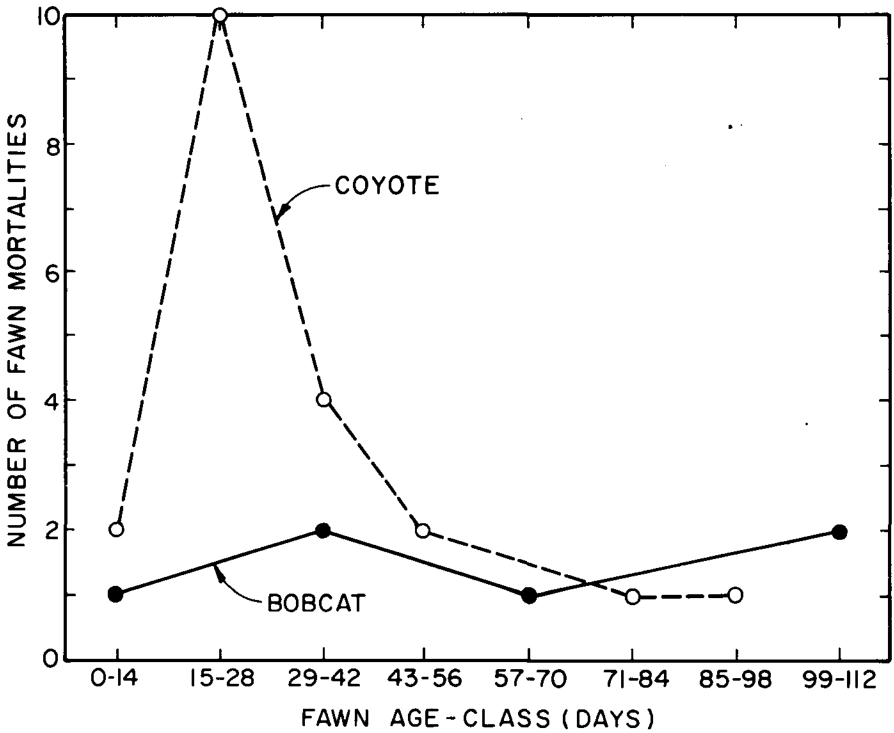

Figure 6. Number of fawn mortalities in which coyote and bobcat predation was involved, by two weeks fawn age increments, Wichita Mountains, 1974 and 1975 combined data.

relatively low harvest rates of deer. With a constant annual hunter pressure of 750 man-days, FSMR harvested only 10.6, 13.6 and 12.3 percent of its estimated deer herd in 1973, 1974, and 1975 either-sex hunting seasons, respectively (U. S. Department Army 1975). It should also be noted that the average mortality rate for sample fawns on FSMR was 62.5 percent (five fawns died out of eight marked) during the study, which suggests a possible compensatory relationship between herd losses by hunting and predation.

A possible conclusion based on the results of this study is that predator control on FSMR might increase fawn survival and, thus, might increase potential harvest of deer. The same conclusion may not apply to lands in private ownership in Comanche County or other portions of Oklahoma because the fawn mortality factors may differ there. Beasom (1974a) demonstrated that intensive short-term predator removal in south Texas did significantly increase white-tailed deer populations. He also determined that this type of control was economically feasible (Beasom 1974b), but he cautioned that an increasing deer population must be closely monitored to avoid problems of overpopulation, therefore, the agency responsible for management of the deer herd being manipulated must be able to adjust deer harvest rates to avoid overpopulation problems.

The possibility of compensatory mortality factors replacing predation as the population-regulating mechanism must also be considered. *Salmonella* and *Theileria* organisms are two potentially effective mortality agents that were noted during this study, but their role in deer population regulation in the Wichitas is unclear. The nutritional status of prepartum and/or postpartum does could be predisposing young fawns to predators, while intensive interspecific competition among deer, elk, buffalo, and longhorns for various habitat requirements may also be involved in the unusually high predation. Continuing studies of fawn mortality, predation, and deer ecology in the Wichitas are being conducted to assess the potential impacts of these various factors on deer populations.

Predators are apparently able to take a significant number of healthy fawns, in this type of habitat, even when deer densities are low (8 deer/km^2). If the continuing studies of fawn mortality in the Wichitas verify these initial results, an experimental predator control program, similar to the short-term control described by Beasom (1974a), could be implemented on those portions of Comanche County open to deer hunting to determine if deer productivity and deer harvest can be increased.

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