Predation on White-tailed Deer Fawns by Bobcats, Foxes, and Alligators: Predator Assessment

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Abstract: Forty-eight white-tailed deer fawns (*Odocoileus virginianus*) were marked during the spring and early summer of 1981 and 1982. Forty-one (85.4%) of these fawns died, 26 (63%) due to predation. In 18 of the 26 predator-caused deaths, the species of predator could be determined. Bobcats (*Felis rufus*) accounted for 12 deaths, while red foxes (*Vulpes vulpes*), gray foxes (*Urocyon cinereoargenteus*) and alligators (*Alligator mississippiensis*) were responsible for a total of at least 6 fawn deaths. Criteria for determining predator damage are discussed. Foxes and alligators have not previously been documented as predators on white-tailed deer fawns.

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The feeding habits of bobcats, red foxes, and gray foxes are well-documented. The feeding habits of alligators are less well-known. Few studies have suggested that foxes or alligators actively prey on white-tailed deer fawns. Deer in the diets of foxes mainly have been attributed to scavenging (Hatfield 1939, Scott 1943, Trapp 1978, Pils and Martin 1978, Fritzell and Haroldson 1982). Most researchers do not consider foxes "serious" predators of deer (Mitchell et al. 1973, Ozoga et al. 1982*a*). This paper reports the findings of a telemetry study of white-tailed deer mortality involving 3 predator species on 2 coastal islands in South Carolina.

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Study Area

This study was conducted on the South and Cat Island portions of the Tom Yawkey Wildlife Center, Georgetown County, South Carolina. Elevation ranges from sea level to 12.8 m.

South Island, about 2,700 ha in size, includes upland maritime forest, numerous impoundments of emergent plant species and widgeon grass (*Ruppia maritima*), tidal marshes, and cultivated areas of annual winter ryegrass (*Lolium* spp.). Deer density has remained stable for the last 30 years with levels up to 2.8 deer/ha or greater (R. Joyner, unpubl. data), and is among the highest in the coastal sea island region. There is no hunting on South Island and daily supplemental feeding (shelled corn) has been provided throughout the year for 30 years.

Cat Island, about 2,720 ha in size, is more typical of the mainland with an overstory dominated by long-leaf pine (*Pinus palustris*), and understory that is controlled by burning half the upland area each year on a rotational basis. There also are marsh impoundments, freshwater ponds and cultivated wildlife openings. The mean density of deer is about 0.2/ha. Supplemental feeding occurs 3 days a week, and the herd has been selectively harvested since 1978 to produce trophy-antlered bucks (see Brothers and Ray 1975). Access is controlled and generally only wildlife center personnel are present.

Methods

Fawns were captured and fitted with radio collars using 3 techniques: (1) walking a grid pattern in areas where does were believed to be fawning; (2) observing solitary does and isolated fawns from an automobile during the day, and (3) spotlighting at night (Downing and McGinnes 1969, White et al. 1972, Carrol and Brown 1977, Steigers and Flinders 1980). A dog was used in the daytime during the 1981 field season to help locate fawns, but proved unsuitable because of the abundance of alligators on the study area.

A long-handled hoop net aided hand captures of fawns. Once fawns were captured, a 5-cm wide elastic bandage was used to cover the eyes and snout. This considerably reduced a fawn's vocal and physical struggle. The capture procedure took from 10 to 25 minutes; older fawns required more time.

Handling procedures included attachment of collar, determination of sex and age, tagging, and recording the general physical condition of fawns. Age was estimated mainly by characteristics outlined by Haugen and Speake (1958). General appearance and size of fawns were also important (Cook et al. 1971).

Some fawns were marked with tuff-flex ear tags for individual recognition in the field, while others were left untagged. Very young fawns (1 to 4 days) were not tagged, or were recaptured and tagged after their first week of life. The tuff-flex tags were placed in the ear above the small ridge of cartilage as described by Downing and McGinnes (1969). Metal tags were attached at the base of the ear as described by Lund (1975). These were small and inconspicuous, and these fawns were considered to be "untagged". Transmitters were mounted on fully expandable, drop-off collars. During 1982, 10 collars were cryptically colored and 15 were red. Collars were recycled from dead fawns after being sterilized. All collars were stored in a bag of detritus before use to help remove unnatural odors (Steigers and Flinders 1980).

Locational fixes were taken from 1 to 3 times daily on each fawn. If dead fawns were recovered, necropsies of carcass remains were performed following the procedures outlined by Nettles (1981) and Wobeser and Spraker (1980). Criteria used to determine predator-involved mortalities were generally adapted from Garner et al. (1976), Bowns (1976), White (1973*b*), and Hawthorn (1980). The main criteria used to verify predator-involved mortalities were evident signs of trauma: bite or claw marks, puncture wounds and subcutaneous or external hemorrhaging. Knowledge of the general physical condition of fawns prior to death was also important (Cook et al. 1971). Criteria used to discriminate between kills of different predator species were based on carcass disposition and injuries. During the second field season, selected fawns were necropsied by the Southeastern Cooperative Wildlife Disease Study Group at Athens, Georgia. Also, training on identification of fawn diseases and predator-induced trauma was provided in the field (V. Nettles and C. E. Couvillion, pers. commun.). Fawn carcasses were returned to the site of mortality whenever possible to reduce the possibility of increasing the predation rate. Seven fawns that had died of disease, accident, or starvation were returned to selected sites with transmitters attached to assess the extent of scavenging. Predator scats were collected on a random basis as a temporal indicator of fawn mortality (Salwasser 1974). Refer to Epstein (1983) for details of the study area and marking procedures.

Results

Of 48 fawns captured, 47 were fitted with radio collars. Mortality rate of fawns during the study period was 85.4% (41 of 48). Of the 41 fawn mortalities, 26 (63.4%) were attributed to predation (Epstein 1983). The predator was determined for 18 of the 26 mortalities. Bobcats accounted for 12 (66.7%) deaths, red and gray foxes for 4 (22.2%), and alligators for at least 2 (11.1%). Thus, foxes and alligators accounted for 33.3% of the fawn mortality in which the predator could be determined.

In all predator-involved mortalities, hemorrhages indicated fawns were alive when attacked. No fawn carcasses were scavenged by a predator during this study. No data were collected on carcasses which were returned to the kill site. However, between 20 June and 3 August 1982, 7 fawn carcasses with attached transmitters were placed in locations of known fox predation or activity. Turkey vultures (*Cathartes aura*) scavenged 1 carcass; the remaining carcasses were not disturbed and they decomposed within 5 days. We have no explanation as to why foxes did not locate or utilize these carcasses.

Mortality of fawns relative to type of tag and color of the collar is given in Table 1. Different collars and tag combinations used to mark fawns are presented in Table 2. There were no differences in survival of fawns based on collar color and tagging ($P > .05$; Fisher's exact test, Finney et al. 1963). However, the test was significant for tagged fawns, which suggests that tagging may have increased survival of fawns. We have no explanation of why survival was biased toward tagged fawns.

Bobcat Predation.—At least 6 individual bobcats were observed on the study area during the study period. Two females were observed with litters of 3 kittens (Cat Island, 1981) and 4 kittens (South Island, 1982). Predators

Table 1. Affect of tagging and collar color on mortality of white-tailed fawns on the Yawkey Center, Georgetown County, South Carolina, during the field seasons of 1981 and 1982.

Type of tag	*N* killed	*N* not killed	Total
Type of tag			
Large visible	24	7	31
Small and cryptic, or untagged	17	0	17
Totals	41	7	48
Collar color[a]			
Red	30	7	37
Cryptic	10	0	10
Totals	40	7	47

[a] Calculations do not include 1 tagged but uncollared fawn.

Table 2. Collar and tag combinations of marked fawns on the Tom Yawkey Wildlife Center, Georgetown County, South Carolina, 1981–1982.

Collar color	Tagged	*N* killed	*N* not killed	Total *N* of fawns marked
Red	Tuff-flex	24	4	28
Red	Untagged	9	0	9
Cryptic	Untagged	5	0	5
Cryptic	Tuff-flex	3	2	5
None	Tuff-flex	0	1	1
Totals		41	7	48

are unexploited on the Yawkey Center and populations are believed to be quite high.

Predator damage criteria observed for bobcats in this study were very similar to White's (1973*b*) description of fawns killed by coyotes. However, the 2 main differences were: (1) bobcats usually cached carcass remains under a small scrape similar to Hawthorn's (1980) description, and (2) fawn remains were never scattered in various fragments.

Most scrapes were a small mound of ground litter which was readily recognized when located. However, some were located along marsh edges and constructed of marsh detritus, and were very inconspicuous; the only evidence was the radio signal coming from the telemetry collar. Like coyotes (White 1973*b*), bobcats usually ate the viscera first. This may have been due to the presence of milk curd in the abomasum (Young 1958). Much of White's (1973*b*) description of coyote-killed fawns was very similar to bobcat-killed fawns that is, feeding upon the ribs, shoulders, and hams and the prevalence of light feeding on the remainder of the carcass.

Only on 2 occasions did bobcats devour the heads of fawns; the remains (body) were then cached on site. Both cases occurred in the same general area and the same bobcat may have been involved. Small mandible, teeth, and cranial fragments were under the carcass at the cache site. Thus, the bobcat had fed on the head and covered the remains at the same site.

Fox predation.—Foxes were believed responsible for 3 known fawns' mortalities in 1981 and 1 in 1982. Five red foxes were observed on Cat Island during the study period, and at least 1 pair raised a litter of pups annually. Three gray foxes were observed during the same period, 2 on Cat Island and 1 on South Island.

Fawns preyed upon were active and appeared healthy prior to death. In 1 case, a 4-day-old radio collared fawn was visually observed in good condition on 12 May 1981. Telemetry readings indicated this fawn was active and in the same general area on 13 May. On the morning of 14 May, the fawn could not be located. That afternoon, a red fox was observed in the area carrying portions of a fawn. This fawn's radio collar was then found at an

active red fox den which was located in an open pasture on Cat Island. The linear distance from the den to the last locational fix of the fawn was 2.1 km, within the home range area of a red fox (Samuel and Nelson 1982). In another case, a 20-day-old fawn was visually observed in good condition 24 hours prior to our finding its radio collar near the last observed location. The remains and ear tags of this fawn were found at the same fox den the next day. We believe this red fox was responsible for both fawn deaths. The capture of the latter fawn by a red fox, and a 27-day-old fawn captured by a black bear (*Ursus americanus*) (Ozoga and Verme 1982) is curious because older fawns usually have the speed and agility to evade capture.

Gray foxes captured fawns 6 and 10 days of age. On 1 occasion, a five-day-old fawn was captured and fitted with a cryptic radio collar and metal tags on 8 June 1982. This fawn was visually observed in good condition on 10 June 1982. Two consecutive radio locations on 13 June and 14 June 1982 indicated the fawn had not moved. The radio collar, head, and right front leg were then located under an abandoned woodpile which was believed to be a gray fox den. The den was located along a Maritime forest-marsh edge on South Island. Gray foxes commonly use woodpiles as den sites (Samuel and Nelson 1982). Also, no red foxes were observed on South Island during this study. Necropsy was performed by a SCWDS field team on South Island. There was hemorrhaging in the subcutis of the occipital region associated with a small (4 mm diameter) compression fracture in the right occipital bone. Blood clots also were noted in the epidural region. In 1981, a gray fox was observed the evening prior to finding the carcass of the 6-day-old fawn approximately 30 m from the above den site. We believe the same gray fox was responsible for both fawn deaths.

Fox predator damage criteria were similar in all cases. Fawn remains were chewed around the snout and ears, the long bones were chewed and the carcass strewn about.

Alligator predation.—We believe alligators were responsible for at least 2 fawn deaths, 1 in 1981 and another in 1982. There are about 850 alligators on the study area (P. Wilkinson, unpubl. data).

The home ranges of the 2 radio collared fawns killed by alligators encompassed brackish marsh and freshwater areas inhabited by at least 6 alligators, ranging from 0.46 to 2.74 m in length. However, several large alligators were in the general area (P. Wilkinson and M. Hudson, pers. commun.). Although drowning is a reported cause of fawn mortality (Klimstra et al. 1978, Steigers and Flinders 1980, Ozoga et al. 1982*b*), necropsies of 2 fawns which were retrieved from a nontidal freshwater pond indicated cause of death was due to trauma from predator attack. In the first case (1981), the head, left shoulder and spinal area of a 95-day-old fawn had multiple, large puncture wounds, and there were several fractures of the cranial bones. The left front leg was severed at the shoulder. In the second case (1982), a 26-day-old fawn found in the same pond had similar puncture wounds and

cranial fractures. Also, the anterior half of an uncollared 21-day-old fawn was found in this pond in 1981. We suspect alligators were responsible for the disappearance of several fawns listed as unknown predator mortalities. Fawn home ranges encompassed dikes and impounded marsh areas inhabited by approximately 25 to 30 large alligators (up to about 3.8 m). These fawns commonly bedded on marsh-water interfaces and suddenly vanished, although their twins and/or dams were highly visible. Earthen dikes, marsh impoundments and adjacent channels are used extensively by alligators (Sandifer et al. 1980).

Discussion

Capture, collaring, and tagging fawns did not increase the overall mortality rate (Epstein 1983). Random collections of bobcat scats indicated that bobcats were taking uncollared fawns 2 weeks prior to our observing bobcat-involved mortalities of collared fawns. Moreover, late summer fawn-to-doe ratios on South Island were consistent with the high fawn mortality rate. Four night counts at the end of each field season on South Island indicated fawn-to-doe ratios of 1 : 42 and 1 : 39 in 1981 and 1982, respectively. This suggests that uncollared fawns were dying as well as collared fawns.

Bobcats were the most important predator during this study. Beale and Smith (1973), Garner et al. (1976) and Trainer et al. (1981) concluded that bobcats can be effective predators on antelope (*Antilocapra americana*), white-tailed deer fawns, and mule deer (*O. hemionus*) fawns, respectively. This contrasts to the findings of Cook et al. (1971) and Carrol and Brown (1977) with white-tailed fawns in South Texas. In the south and southwestern regions of the United States, bobcats are a less significant predator on newborn or young ungulates than are coyotes (*Canis latrans*). This may be due to disproportionately high coyote densities in these regions. Barick (1969) ranked bobcats the third most important predator on deer in the southeastern United States after man and dogs (*Canis familiaris*). There were no coyotes or feral dogs on the study area. Beasom and Moore (1977) found that bobcats will eat deer more frequently during periods of low alternative prey abundance. Cottontail rabbits (*Sylvilagus floridanus*) occur uncommonly on the study area. Marsh rabbits (*S. palustris*) usually are very common, although population densities have declined for an unknown reason(s): so few marsh rabbits were observed in 1980 that a reintroduction was considered. Marsh rabbits are a principal food item for bobcats inhabiting the sea island region (Sandifer et al. 1980).

There is little question regarding the capability of bobcats capturing and consuming young fawns. However, we are unaware of previous reports of fox predation of fawns. Numerous researchers have acknowledged the possibility (Hamilton 1943:404, Dahlberg and Guettinger 1956:112, Errington 1967:30,

Richardson and Peterson 1974:32, Lloyd 1975:208, Doutt et al. 1977:191, Halls 1978:54, Hamilton and Whitaker 1979:320). Bartlett (*in* Hasley 1956:220) stated that "Foxes may rarely kill fawns, but this loss is insignificant." Schueler (1951:463) noted that for foxes "deer flesh, mostly carrion, was important in the winter and early spring." Barick (1969) reported foxes were suspected predators on deer, however, no "known" kills were observed.

This study shows that foxes are capable of predation on young white-tailed deer fawns. This may be especially true on coastal islands or areas with high levels of insect annoyance and/or deer density. Predation of fawns by foxes may not be a wide-spread phenomenon and may be limited to individual foxes (Alexander et al. 1967, Korschgen 1959) which specialize on particular prey (Errington 1963, 1967, Fox 1971, Lloyd 1980, Sequeira 1980). We feel that fawn predation by foxes was a function of the opportunistic feeding habits (Korschgen 1959, Lloyd 1975), the food energy gained from assimilation of fawns vs. their relative ease of capture, and decreased availability of alternative prey species (Gibbons and Coker 1978, Dueser and Brown 1980). We observed some aggressive behavior of dams toward foxes, again suggesting foxes are potential predators (Garner and Morrison 1980). However, given the high deer density on the study area and the probability of associated density-dependent disrupted maternal behavior (Ozoga et al. 1982*b*) the number of unprotected fawns may have been quite high. Also, Rosenzweig (1966) found that 30% to 40% of the prey of red and gray foxes were within the weight range of white-tailed deer fawns. Moreover, red foxes prey upon several other cervids including red deer (*Cervus elaphus*) calves in Scotland (Darling 1937) and caribou calves (*Rangifer tarandus*) in Canada (Miller 1982). Arctic foxes (*Alopex lagopus*) are believed to cause some neonatal mortality of cervids (Calef 1981). Also, foxes prey upon domestic animals within the size range of fawns, especially young pigs and lambs (Korschgen 1959, Rowley 1970, O'Gara et al. 1983).

There is little question concerning the capability of alligators to capture and consume fawns. However, we are unaware of documented occurrences of alligators preying upon white-tailed deer fawns. Large alligators are capable of preying upon adult feral hogs (*Sus scrofa*) and mature cattle (McIlhenny 1935, Neill 1971, Wood and Brenneman 1977), species which are larger and more mobile than young fawns. Nonetheless, McNease and Joanen (1977) found deer hair in only 1 of 314 alligator stomachs and did not speculate as to whether or not it was carrion. Valentine et al. (1972) found no evidence of deer remains in 413 alligator stomachs, nor have other researchers studying alligator food habits (Kellogg 1929, Giles and Childs 1949, Chabreck 1972).

We encountered 2 main obstacles in attempting to monitor alligator predation: (1) many of the channels and marsh areas are tidal which means that tidal flushing could remove fawn carcasses from the study area, and (2) transmitters would not operate when submerged in salt or brackish water.

The 2 radio collared fawns killed by alligators during this study were retrieved from a nontidal freshwater pond. Also, 1 uncollared fawn killed by an alligator was found in this pond. Three other fawns we believe were alligator-kills were in the same nontidal pond during 1980. Previously, 2 adult does were found in the pond, again due to suspected alligator predation. Following the doe mortalities, all occurring during a 1-week period, a 3.7 m-long alligator was captured and removed from the pond. No additional adult deer mortalities occurred in that pond, but similar mortalities were noted in brackish impoundments on the study area (P. Wilkinson, pers. commun.). Although there is no direct evidence, we feel alligators were responsible for at least 2 other radio collared fawn mortalities during the study period.

Foxes and alligators were less significant predators on white-tailed deer fawns than were bobcats. However, during spring and summer, when young fawns are most vulnerable, foxes and alligators may be responsible for a greater amount of predation than has been previously acknowledged.

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