

AGE AND CONDITION OF DEER KILLED BY PREDATORS AND AUTOMOBILES

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Abstract: We evaluated the condition of mule deer (*Odocoileus hemionus*) and white-tailed deer (*O. virginianus*) killed by mountain lions (*Felis concolor*), coyotes (*Canis latrans*), and automobiles from December through March, 1969-81 in western Montana. Predators killed prime-aged animals and automobiles killed ($G = 41.4$, $P < 0.001$) more fawns and old-aged animals. Fifty-three deer (90%) killed by automobiles were in poor condition, but only 2 (7%) deer killed by predators were in poor condition. Predator selectivity could not be inferred from the sample of deer killed by automobiles.

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The influence of predation on young and old animals and animals in poor condition is important in population dynamics. To assess selectivity, standing age structure or herd condition from a representative sample of the herd is needed. In studies that do not involve capturing and marking herbivores, hunter kills (Fritts and Mech 1981) and accidental kills (e.g., automobiles: Pimlott et al. [1969], Franzmann and Arneson [1976]) are commonly used to obtain data. Although the potential for bias in a sample of hunter-killed animals is often recognized (Frazer 1976, McCullough 1979, Downing 1980), less attention has been paid to possible biases in accidental kills. We present age structures and condition of deer killed by predators and by automobiles in western Montana, and examine possible biases in each sample.

STUDY AREA

Predator kills were found on mule deer winter ranges in the foothills of the Bitterroot Mountains and white-tailed deer ranges of the Swan and Clearwater valleys in western Montana. Automobile kills were collected from major highways around Missoula, Montana.

Mule deer winter ranges were primarily on south-facing slopes. These areas support a foothills bunchgrass habitat interspersed with Douglas-fir (*Pseudotsuga menziesii*)-ninebark (*Physocarpus malvaceus*) and ponderosa pine (*Pinus ponderosa*)-Savannah vegetation types (Pfister et al. 1977).

White-tailed deer ranges were mostly in old-growth forests. The Clearwater and Swan rivers, interspersed with lakes, generally divide the

study area, and level lowlands extend to the east and west from them to meet an east-facing slope on the western edge and a west-facing slope on the eastern edge of the study area. Bunchgrass habitats of the ponderosa pine series are present in limited portions of the study area. All but 4 of the 15 habitats within the Douglas-fir series described by Pfister et al. (1977) are distributed in a mosaic pattern within the study area. The major highways where deer killed by automobiles were collected ran along rivers below mule deer winter ranges and through white-tailed deer ranges and agricultural lands.

METHODS

We determined ages and condition of mule and white-tailed deer killed by mountain lions, coyotes, and automobiles from December through March, 1969-81. Ages of deer were estimated by comparison of jaws to known-age jaws and criteria from Severinghaus (1949) and Robinette et al. (1957). Physical condition was estimated by color and consistency of femur marrow (Cheatum 1949, Bischoff 1954) and dental, skeletal, and visceral remains were examined for signs of disease, particularly necrotic stomatitis, arthritis, old fractures, pneumonia, infections, and internal parasites. These investigations were performed in the field when little remained but teeth and bare bones. Bones with meat on them and visceral remains were brought into a laboratory for more complete diagnosis. Percentages of lungs affected by pneumonia were estimated ocularly, and pneumonic areas were determined primarily by feel. Snow depth was measured as close as possible to trampled or plowed kill sites, and only kills for which the cause of death could be positively identified by characteristics of wounds (O'Gara 1978) and tracks in snow were used.

Deer mortalities were cross-tabulated by species, sex, age class, cause of death, and femur marrow consistency. We tested null hypotheses of independence among categories using the log-likelihood-ratio test and Fisher's exact test (Sokal and Bohlf 1981:135). We rejected null hypotheses when $P < 0.05$.

RESULTS

Eighty-seven deer carcasses were collected: 45 mule deer (25 M, 20 F) and 42 white-tailed deer (20 M, 22 F). Nineteen and 22 mule and white-tailed deer, respectively, were fawns. Mountain lions killed 11 and 5, coyotes killed

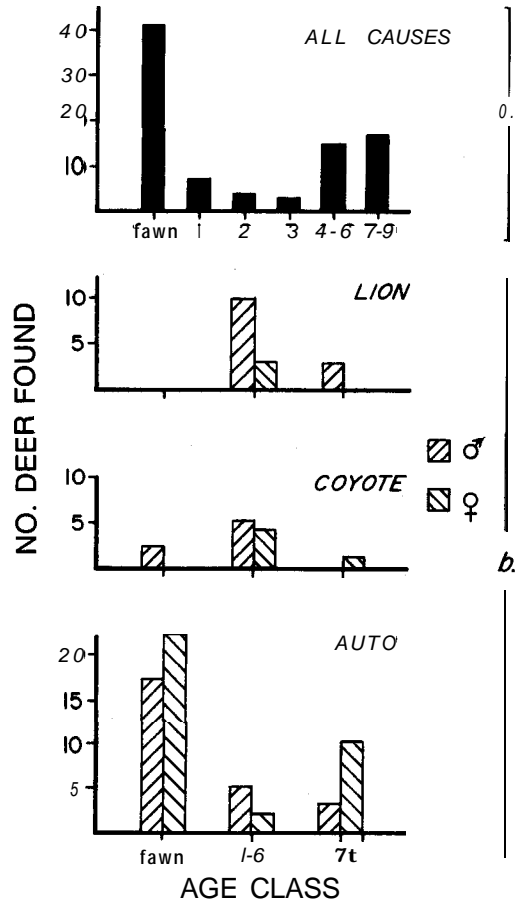


Fig. 1. Age structure of deer killed by mountain lions, coyotes, and automobiles combined (a) and separately (b) in western Montana during winters, 1969-61.

10 and 2, and automobiles killed 24 and 35 mule and white-tailed deer, respectively. The age structure of the entire sample resembled the expected exponential distribution in age classes 0-3, although a relatively high proportion (53%) of all kills were ≥ 4 years old (Fig. 1a). Separation of age classes by cause of death indicated that predators killed more deer 1-6 years old (86%), and automobiles killed more fawns and deer ≥ 7 years old (88%) (Fig. 1b, $G = 41.4, P < 0.001$).

The 11 mule deer killed by mountain lions were in ≤ 5 cm of snow and the 5 white-tailed deer were in 15-25 cm ($\bar{x} = 18$ cm) of snow. The 12 deer of both species killed by coyotes were in 2-28 cm ($\bar{x} = 21$ cm) of snow. The 59 deer killed by automobiles were in 0-45 cm ($\bar{x} = 42$ cm) of snow.

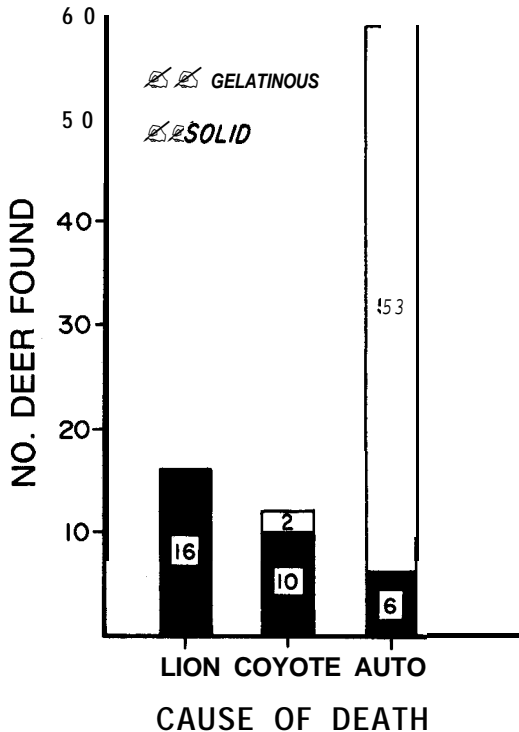


Fig. 2. Marrow consistency in deer killed by mountain lions, coyotes, and automobiles in western Montana during winters, 1969-81.

Because marrow fat was not assayed, we were unable to provide a detailed assessment of carcass condition. However, Bischoff (1954) found that, "With a high degree of accuracy, a gelatinous bone marrow . . . is indicative of a poor deer resulting . . . from malnutrition." Categorizing deer as having either gelatinous marrow (malnourished), or solid or soft marrow (condition uncertain, but probably not severely malnourished), we found that 53 of 59 automobile kills had gelatinous marrow, but only 2 of 28 predator kills were in similarly poor condition (Fig. 2). We recognize that marrow consistency provides definitive information only when an animal is already in poor condition (Mech and Delgiudice 1985).

The pattern of autos killing malnourished deer and predators killing deer with solid marrow was significant when all deer were combined ($G = 53.7$, $P < 0.001$) or separated (mule deer only: $G = 35.3$, $P < 0.001$; white-tailed deer only: $G = 14.8$, $P < 0.001$; M only: $G = 37.4$, $P < 0.001$; F only: Fisher's $P = 0.0009$; fawns only: Fisher's $P = 0.018$; ages 1-6 only: Fisher's

$P = 0.001$; and ages ≥ 7 only: Fisher's $P = 0.027$). More males were killed by predators ($G = 5.4$, $P < 0.05$) than by automobiles.

DISCUSSION

Mountain lions on deer winter ranges in western Montana killed deer in prime condition. It is not surprising that a stalk-and-wait predator nearly as large as its prey can do this, but it is not clear why they select prime animals. Geist (1981) found that mule deer males, especially large ones, are often in poor condition; hind feet are matted from frequent urination, probably increasing odors perceivable to predators; about 10% carry visible antler wounds; and large males enter a stage of protracted rest and hiding following the rut. All of these conditions could increase susceptibility to mountain lion predation. However, such deer should not have the crisp, white marrow found in all but 1 of the mountain lion kills. The skeleton of the 1 white-tailed deer male that had soft (although not gelatinous) marrow was intact, no anomalies could be found, and the teeth were in excellent condition. This male was killed during December shortly after the rut. Most of the mountain lion kills occurred later in the winter after male deer had recovered from the rut. None of the deer killed by mountain lions had enough viscera left to completely evaluate health of the prey. Mule deer males in prime condition used the upper edges of the hillsides on winter ranges much more than did females or fawns; thus, males were among rocks and near trees more often than other deer, probably predisposing them to mountain lion predation.

Flatter terrain and more trees precluded ascertaining whether white-tailed deer males were in any way predisposed to predation during this study. Because they carry antlers and are less abundant and larger than females, large males stand out in female groups and may be focal points for predators (Geist 1981). Also, if white-tailed deer males winter peripherally to females in yards, as mentioned by Geist (1981), they would logically be the first deer encountered by predators. Wolves (*Canis lupus*) in Ontario took 2.5 X more white-tailed deer males than females (Kolenosky 1972) during winter, suggesting some differential use of habitat that predisposed males to predation.

The 12 deer killed by coyotes indicated that these small, coursing predators took more fawns and deer in poor condition than did mountain

lions. Of the coyote-killed deer in apparently good condition, 1 had a healed break in a hind foot and another had arthritis in the toes of a front foot. A yearling female mule deer killed by coyotes had pneumonia in about 5% of her lungs, and another, 7-9 years old, had pneumonia in about 20% of her lungs.

Coyotes made most of their kills when snow was ≥ 20 cm deep, but a pack of 8 coyotes was seen chasing and killing a 1-year-old female mule deer in 2 cm of snow. The kill took place about 2 km from BWO, and when he reached it, little was left to necropsy, but the skeleton did not have any detectable anomalies and the femur marrow was solid and white. Two coyotes killed a 4-6-year-old white-tailed deer male with white, solid femur marrow during January in 25 mm of snow. They jumped the deer from its bed on a steep slope and caught it twice within 200 m as indicated by spurts of bright blood and body marks of the deer in the fresh snow. The deer hit a fence along a county road before it had gone 300 m and was killed there. The coyotes were driven away, so all viscera was available for necropsy. The male was fat, weighed 102 kg, and had no detectable skeletal or visceral anomalies. Coyotes may have taken most deer in fairly deep snow because their favorite prey, voles (*Microtus* spp.), was not available under the snow (Henderson 1977) and because the deer were more vulnerable. However, data gathered during this study indicated that ≥ 2 coyotes can kill deer when snow depths are negligible.

Coursing predators are generally expected to take prey in poorer condition than prey taken by stalking predators, but cooperative hunting and cover that allows a close approach may predispose all suitable prey, strong or weak, to predation by coursing predators. In Canada, elk (*Cervus elaphus nelsoni*) killed by wolves were in good condition (Carbyn 1980). In Poland, wolves killed red deer (*C. e. elaphus*) in good condition, similar to that of deer killed by hunters, and lynx (*Lynx lynx*) killed only fawns in poor condition (Okarma 1984). The size of the predators and cooperative hunting apparently reversed the expected selectivity of these coursing and stalking predators.

Only 6 of the 59 deer killed by autos appeared to be in good condition. Snow was 30-45 cm deep near the roads where 54 (91%) of the 59 deer were killed. Sick or malnourished deer apparently go downslope and travel on highways

that are plowed clear of snow. Travel is obviously easy there but weakened deer sometimes cannot easily jump or climb the snowbanks along the roads. Also, such deer apparently are not very alert.

Thirty-one of the 59 deer killed by automobiles had pneumonia in 5-75% of their lungs, 3 had advanced necrotic stomatitis, 1 had 3 giant liver flukes (*Fasuloides magna*), 1 had a healed femur that had been shattered by a bullet, 1 had a healed break in a hind toe, 1 had no incisiform teeth, and 1 7-9-year-old was missing 4 molariform and 3 incisiform teeth. Although we lack an independent sample of deer condition during the period of this study, we find it unlikely that this magnitude of disease, injury, and malnourishment characterized either mule or white-tailed deer in the general area. Thus, it seems that automobile kills were not representative of the condition of the herds in general.

Deer killed by automobiles at times of year other than winter or in other terrain undoubtedly would reflect different age and condition categories than those found during this study. However, because of the apparently nonrandom nature of automobile kills indicated during this study, such kills should not be used to estimate population structures or to infer the selectivity of predators.

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