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INTERPRETING PHYSICAL EVIDENCE OF COYOTE PREDATION

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Abstract: There are situations where it is necessary to determine the cause of death of livestock, game animals, or other wildlife. Criteria used for recognizing predator kills are well known and scientifically documented. These criteria include the attack, killing and feeding behavior of predators as well as the characteristics of their tracks, droppings, and canine teeth size and spacing. Diagnostic criteria for recognizing coyote (*Canis latrans*), domestic dog, fox (*Urocyon cinereoargenteus*, *Vulpes vulpes*), cougar (*Felis concolor*), bobcat (*Lynx rufus*), bear (*Ursus* spp), and eagle (mostly *Aquila chrysaetos*) predation are presented in this paper.

Predation and its impacts on livestock and wildlife continue to generate interest and controversy among livestock producers, environmental groups, wildlife managers, hunters, researchers, students and the general public. An accurate assessment of the damage actually done by each predator species is prerequisite for reconciling the concerns of these diverse interests, and for developing effective predator management and control policies. Such cause-specific diagnoses require the ability to recognize predation events and the respective predators involved

Predation is usually a secretive event that occurs in areas remote from human habitation, thus it is rarely witnessed. Therefore, it is necessary to use physical evidence to document that (1) a kill has occurred and (2) to determine which predator species was involved. The purpose of this paper is to present detailed descriptions of predator characteristics and behaviors that can be used to (1) distinguish predator kills from other causes of death, and (2) identify the predator when a kill has occurred

Interpreting physical evidence of predation

Animals die from many causes, e.g., starvation, exposure, parasites, disease, bloat, suffocation, poisonous plants, and lightning, all of which can be determined by appropriate examination of the carcass and the kill site. Often, however, a veterinarian or other expert is needed for an accurate determination. In such a case, the carcass and nearby soil and vegetation should not be disturbed

Death caused by predation can be recognized by characteristic wounds and consumption of the

carcass, as well as by the position or orientation of the carcass. Identification of specific predators assumes that each predator species follows a general pattern of killing and feeding, and therefore, leaves similar evidence. However, it must be recognized that individual predators vary in their behavioral patterns.

A suspected predator kill should be approached carefully to avoid unnecessary disturbance taking care to not disturb tracks or droppings that may be found near the carcass, along trails, fence lines, creeks, water holes or dry washes. Note the position of the carcass, look for drag trails, blood on the ground or on vegetation, and if the carcass has been covered by soil and/or plants. Look for obvious wounds which are often located on the neck, head or shoulders. Examine the carcass for the feeding pattern, especially check the udder, viscera, shoulders and hind quarters. Skin the carcass and look for tooth punctures, subcutaneous hemorrhaging, tissue damage, bruising and broken bones, especially broken necks. Where punctures are found, note their number, size, depth and location.

Coyotes

Coyotes are the most common and the most serious predator of livestock in the western U.S. (Wade and Bowns 1982). Connolly et al (1976) considered coyote predation on sheep as a serious economic and political problem

In attacks on adult sheep, goats and older lambs, coyotes typically bite the throat just behind the jaws and below the ear (Wade and Bowns 1982). On smaller prey, such as small lambs and kids, coyotes

may bite the head, neck, or back, causing massive tissue and bone damage.

Connolly et al. (1976) considered the sheep killing technique of coyotes to be remarkably consistent. Each coyote ran alongside the fleeing sheep, clamped its jaws on the neck laterally (sometimes dorsally) just behind the ear, and braced its feet to stop the sheep. The coyote's grip then shifted to the larynx region, and it simply held on and waited for the sheep to succumb (primarily by suffocation). Sheep killed by coyotes exhibited tooth marks and hemorrhaging (sometimes only subcutaneously) in the larynx region.

Bowns (1976) concluded that blood on the throat wool was *prima facie* evidence of predation. Where external bleeding was not apparent, the hide should be skinned from the neck, throat, and head of the carcass. A coyote kill reveals subcutaneous hemorrhages, tooth punctures in the hide, and tissue damage. The tooth punctures are usually located below the ear and on the throat immediately behind the mandibles. On very small lambs, however, the coyote's upper jaw may penetrate the top of the neck or the skull.

It is often difficult, if not impossible, to determine the cause of death if the carcass has reached an advanced stage of decomposition. However, if the head is positioned higher than the rest of the body and the bitten side has not touched the ground, evidence of the bite may still be distinguishable. Blood on the ground near a long-dead animal is also indicative of predation.

Young, inexperienced coyotes may not bite the throat but tear the flank or hindquarters of the sheep. Other atypical attacks may occur in late winter or early spring when sheep are attacked frequently at the hindquarters. It is assumed that this behavior occurs because the winter wool is long and thick on the neck while the hind quarters are exposed and vulnerable.

Bitten or wounded lambs are commonly observed in herds that are exposed to coyote predation. These lambs usually have blood on their neck or throat, and often trail along at the rear of the herd. These bitten lambs can be identified by drooping ears, and a stiff neck carried in a low horizontal position. Actual damage may vary from little or no external blood to severed trachea, broken jaws, or hide torn from the sides or legs. These

animals can be treated with a combination of antibiotics, pine tar, and insect repellents.

Coyotes normally begin feeding on lambs in the flank or just behind the ribs. They often consume the viscera first; a milk-filled stomach is a preferred item. Multiple kills are common but many carcasses are not eaten.

Calves are also vulnerable to coyote predation. Evaluations are often difficult because everything but the skeleton and part of the hide may be consumed. Subcutaneous hemorrhage, blood on the ground and vegetation, and bloody drag trails help to characterize coyote predation. Some dead calves have tooth punctures in the nose or have the nose chewed off.

Calves that have been bitten, but not killed, often have wounds in the flank, hindquarters or front shoulders. "Bob-tailed" calves are often common when coyotes are involved. Dead calves and severe injuries to the genital organs and hindquarters of cows are characteristic when coyotes attack cows while they are giving birth. This is most common with first-calf heifers.

Deer (*Odocoileus* spp.), especially fawns, are common prey for coyotes. Nielsen (1975) concluded that most mule deer fawns were killed in a manner similar to the way coyotes kill sheep. Bowns (1976) examined a fawn that had extensive tissue damage to the forepart of the neck and tooth punctures in the hide. This fawn was bitten on both sides of the neck from below rather than from the side as occurs with most lamb kills. Fawn carcasses are often completely dismembered and eaten which makes verification difficult. Mature mule deer (*O. hemionus*) are often pulled down from behind, but some carcasses show bites or bruises in the neck.

White (1973) recognized coyote predation as the major mortality factor for young white-tailed (*O. virginianus*) fawns in south Texas. These fawns were frequently bitten in the head or neck, but some had bites in the back or elsewhere. Sometimes the only remaining evidence of a kill was blood, hair, and bits of flesh, bone, and fat. He concluded that coyotes started feeding at the abdomen and ate the stomach of young fawns which contained mainly milk.

Pronghorn (*Antilocapra americana*) fawns are common prey of coyotes and other predators. Neff

and Woolsey (1979) used hounds to locate pronghorn kills. The hounds were able to locate buried caches of meat, scat, coyote dens and sleeping coyotes. Without hounds they would not have located the meager evidence of hair and bone chips left after a coyote had consumed a fawn. Knowlton (1968) reported that frequently there was little evidence that remains after a fawn has been killed by a large predator. Fawns killed by coyotes may be totally consumed, leaving little more than blood spots on the grass.

Tucker and Garner (1980) developed several criteria which they used to determine coyote predation on pronghorn. These criteria included (1) carcasses lying in the open with no attempt to conceal the carcass or sometimes the carcass was buried, (2) carcass remains are scattered, (3) skull punctured or crushed, (4) underside of the neck bruised but without puncture wounds, (5) broad bruises on the back of the neck and throat, and (6) the entire carcass consumed except for the scattered leg bones, bone fragments, etc

Spacing of the teeth of an average coyote is 1 1/8 to 1 3/8 inches between the upper canines and 1 to 1 1/4 inches between the lower canines. This spacing of punctures observed in the hide or tissue may be an aid in confirming coyote predation. Coyotes may also urinate, defecate and scratch after feeding

Coyote tracks are more oval and compact than tracks of dogs. Nail marks are less prominent on coyote tracks and the tracks tend to follow a straight line more closely than dogs. A normal coyote track is about 2 inches wide and 2 1/2 inches long, with the hind track slightly smaller than the front

Other predators

Although this is a coyote symposium, we should also discuss the characteristics of other predators in order to illustrate the differences between them, and make verifications of predator involvement more accurate

Dogs. Domestic dogs are a serious problem when they are permitted to roam freely. This problem is increasing as housing subdivisions expand into historic sheep-producing areas. Domestic dogs do not normally kill for food and their attacks usually

lead to indiscriminate mutilation. True feral dogs are more apt to kill for food.

Sheep-killing dogs usually work in pairs or larger groups and can inflict considerable damage. Sheep are likely to be bitten in the head, neck, flank, ribs, and front shoulders, and the ears of mature sheep are often badly torn. Often sheep attacked by dogs are not killed but are mutilated to the point where they must be destroyed. The external appearance of some dog bites may not look serious but a necropsy reveals serious tissue damage (Bowns 1976).

Domestic dogs can also be a serious problem with wintering deer herds. Dogs often harass or attack deer that are already stressed by cold temperatures, deep snow, and lack of forage

Foxes Both red and gray foxes may prey on livestock and poultry. Foxes usually kill only young or small animals, but red foxes may kill larger lambs and kids, adult sheep and goats, and small calves. Foxes usually attack the throat of lambs and kids, but sometimes inflict multiple bites to the neck and back. They do not have the size and strength to hold and immobilize adult animals, therefore repeated bites may be required to subdue their prey.

Foxes generally prefer the viscera and begin feeding behind the ribs, but some prefer the nose and tongue, and may even consume the head of small prey. Red foxes are known to carry small carcasses back to their dens, which probably accounts for the disappearance of some prey.

The spacing of the canine teeth is narrower than in coyotes. Upper canines are approximately 1/2 to 3/4 inches apart on gray foxes and 11/16 to 1 inch apart on red foxes. They rarely cause severe bone damage, which helps to distinguish fox kills from coyotes or other large carnivores

Fox tracks are typically smaller than coyotes and foxes have a shorter stride. Red fox tracks are normally about 1 3/4 inches wide and 2 1/4 inches long; gray fox tracks are slightly smaller (Wade and Bowns 1982)

Cougars. Cougars usually kill sheep and goats by biting the top of the neck or head. Removing the hide will expose large holes made by the canine

teeth. The cougar bite often breaks the neck. Cougars may kill older ewes by biting the side of the neck or the throat. Cougars also may kill by grasping the head of a sheep, goat or deer and pulling the head until the neck is broken. Cougars kill calves in the same manner as sheep and goats.

Multiple kills of sheep and goats by cougars are common; cases of 100 or more animals in a single incident have been recorded. The U.S. Fish and Wildlife Service Animal Damage Control in Utah documented an incident in June 1985 where cougars killed 6 adult sheep and 112 lambs in one incident. Usually only 1 or 2 of the sheep are fed upon by the cougar.

Larger animals such as deer, elk (*Cervix canadensis*), horses, cattle, and probably bighorn sheep (*Ovis spp*) are killed by cougars leaping on the shoulders or back and breaking the neck. Claw marks on the neck, face, back, and shoulders are characteristic of these kills. The neck may be broken by the bite or when the animal falls.

Cougars often carry or drag their kills to a secluded area to feed, leaving frequently leaving drag marks at kill sites. They may feed on the viscera, neck, shoulders or hindquarters. Like most carnivores, the feeding pattern varies from individual to individual. They frequently try to cover their kills with soil, vegetation, or snow. The viscera, particularly the rumen, may be covered separately. "Scrapes" or "scratches" composed of mounds of soil, grass, leaves, or snow are often found around carcasses and trails.

A cougar's canine teeth are massive compared to coyotes or bobcats. The upper canines of an adult cougar are approximately 1 1/2 to 2 1/4 inches apart, the lower teeth are approximately 3/8 to 1/2 inch narrower.

Cougar tracks are relatively round and rarely show claw marks. Tracks of the front feet of a large adult male may be 4 inches or more long and about the same or slightly less in width; hind tracks are slightly smaller. The rear pads of the feet are distinctly different from those of other carnivores. Typically there are 2 lobes on the anterior and 3 on the posterior portion of the rear pads.

Bobcats A bobcat's hunting and killing behavior is similar to that of the cougar's. On small prey such as lambs, kids and fawns, they bite into the skull or

back of the neck. There may be claw marks on any part of the body, but they are usually concentrated on the neck, shoulders and ribs. On larger prey, they leap on the back and shoulders which also leaves claw marks.

Bobcats also bite the neck or throat where they secure a lethal hold on the prey until it stops struggling. This grip over the larynx suffocates the animal quickly and there is little bleeding. They generally begin feeding on the viscera by entering behind the ribs. Bobcats, like cougars, also tend to cover their prey.

Bobcats are serious predators of pronghorn. Beale and Smith (1973) found that bobcats were by far the most significant cause of mortality among pronghorn fawns in the Great Basin. All fawns killed by bobcats, except the very young, had numerous tooth punctures on the neck just behind the head. Death apparently resulted from strangulation and canine tooth punctures in the neck.

Most kills (66%) took place near some type of dry wash or drainage channel. In every instance fawn carcasses were either dragged or carried from the kill sites. Small fawns were carried to shrub or tree cover and the only remains were the legs, bits of skin, and skull fragments. Larger fawns were dragged into or toward a wash.

About half the time attempts were made to cover the carcass with vegetation, gravel, sand, and hair. Usually the head and hind quarters were the only parts covered. The carcass may be covered, moved and eaten, and covered again. The neck and hind quarters, particularly the anal area were fed upon most often. Seventy five percent of the time the bobcat returned to feed again on the carcass.

Adult bobcat canine teeth are normally 3/4 to 1 inch apart and the spacing is easier to see than on fox or coyote kills because bobcats normally do not bite repeatedly.

Like cougar tracks, bobcat tracks are round and lack claw marks, but are only 2 to 3 inches in diameter. The rear pad is relatively straight in front, with a lobe at each side of the posterior end (Wade and Bowns 1982).

Bears Grizzly bears (*U. arctos*) are omnivorous and consume large quantities of vegetation and wild

fruits in addition to carrion and prey. They will kill any domestic animal but cattle and sheep are their most common prey.

Roy and Dorrance (1976) found that grizzly bears usually kill with a blow to the anterior region of large prey which results in a broken skull, neck or shoulder bones. Cattle may have claw marks on the face or shoulders and tooth marks on their head, neck and back. Smaller prey are killed by a bite to the head or neck. Murie (1948) insisted that the grizzly bear does not attack by striking with its paws, but instead seizes and holds its victim with its "arms" so as to administer the killing bite.

Grizzly bears prefer meat over viscera. They characteristically cover their prey and readily feed on carrion (Roy and Dorrance 1976).

Black bears (*U. americana*) are also omnivorous and vegetation is a significant part of their diet. They attack adult cattle and horses but seem to prefer sheep, goats, calves and pigs. Griffel and Basille (1981) found that sheep killed by bears typically had 2 or more puncture wounds in the nape and/or skull accompanied by subcutaneous hemorrhage. Apparently a deep bite to the nasal or facial regions of sheep induces shock and paralysis. In this respect, the biting and killing method of a bear differ from that of other mammalian predators which involves either suffocation or brain and spinal cord damage.

Griffel and Basil (1981) made reference to observations made by sheepmen and predator control agents where: 1) bears straddle and claw the backs of sheep, 2) there were bites to the neck, and 3) there was evidence of clawing and batting. One agent reported that he had seen more sheep killed by powerful blows than had been killed by neck bites. They concluded that the usual mode of attack in their study had been a grasping action rather than a striking blow. All subcutaneous hemorrhages were associated with bite wounds, and every bear-killed carcass bore claw-inflicted lacerations over the cervical, thoracic or lumbar regions.

Griffel and Basil (1981) reported that the feeding point of entry was the udder (74%) or the flank (26%); on all lactating ewes the udder was consumed first. The heart and liver were eaten next and then the fleshy parts. Bears tend to skin their prey, leaving the inverted skin attached to the bones.

Black bears commonly bite and claw the top of the neck and back of cattle, but smaller prey are sometimes killed with a blow to the head or neck. Griffin and Basile (1981) reported more claw marks on black bear kills than grizzly bear kills, and Roy and Dorrance (1976) reported that black bears also readily feed on carrion.

Bear tracks are distinctive with 5 toes and a broad, short pad on the front foot and 5 toes with a triangular pad on the rear foot. The rear foot oversteps the front foot in normal travel.

Eagles Both bald (*Haliaeetus leucocephalus*) and golden eagles are known to prey on livestock. Eagles are efficient predators and can cause severe losses to livestock. Generally they prey on young animals, primarily sheep and goats, although they are capable of killing adults.

Talon punctures are typically deeper than those caused by canine teeth and are somewhat triangular to oblong in shape. Compression fractures of the skulls of small animals may occur and bruises are common. Small lambs or kids are seized anywhere on the head, neck or body; lambs are frequently grasped from the front or side. Larger animals are killed by multiple talon stabs into the ribs and back. The talons puncture the large internal arteries and/or lungs causing massive internal hemorrhage (Wade and Bowns 1982).

Eagles skin out the carcasses, turning the hide inside out. On very young animals the ribs are neatly clipped off close to the backbone and eaten. Sometimes they clip off and eat the mandible, nose, and ears. Often, the palate and floor pan of the skull are removed and the brain consumed.

Eagles may defecate around a carcass, leaving characteristic white streaks of feces on the soil and their tracks may be visible in soft or dusty soil.

Beale and Smith (1973) found a 12 day-old pronghorn fawn that had been killed by a golden eagle. They observed eagle feathers, wing marks and foot tracks in the sand. The fawn had talon punctures on the back and side and about 2 pounds of tissue had been eaten from the neck, chest and leg.

Goodwin (1977) observed eagles in the process of killing pronghorn fawns in Wyoming. He concluded that the fawns died from shock, exhaustion, and initial feeding attempts combined.

with muscle and possible spinal damage. Deep talon cuts were observed in the thoracic and lumbar regions.

Miscellaneous predators Other species including ravens (*Corvus* spp), crows (*Corvus* spp.), magpies, hawks, gulls, hogs and rattlesnakes (*Crotalus* spp) may cause localized problems. It is beyond the scope of this paper to describe these predators in detail

Conclusions

The intent of this paper has been to compile and present the killing and feeding characteristics of the major North American predators as they apply to domestic livestock and game species. The descriptions presented here can be used in conjunction with the slide series developed by Bowns and Wade (1980.Revised), and the photographs in *Procedures for Evaluating Predation on Livestock and Wildlife* (Wade and Bowns 1982).

It is often difficult to determine the cause of death of an animal and to distinguish between the killing and feeding patterns of the different predator species. However, experience and knowledge of physical evidence, such as presented here, should provide a level of proficiency and confidence in the verification of predator kills

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