September 1994

Coyotes

Jeffrey S. Green
Assistant Regional Director USDA-APHIS Animal Damage Control

Jeffrey S. Green
Assistant Regional Director
USDA-APHIS-
Animal Damage Control
Lakewood, Colorado 80228

F. Robert Henderson
Extension Specialist
Animal Damage Control
Kansas State University
Manhattan, Kansas 66506-1600

Mark D. Collinge
State Director
USDA-APHIS-
Animal Damage Control
Boise, Idaho 83705

COYOTES

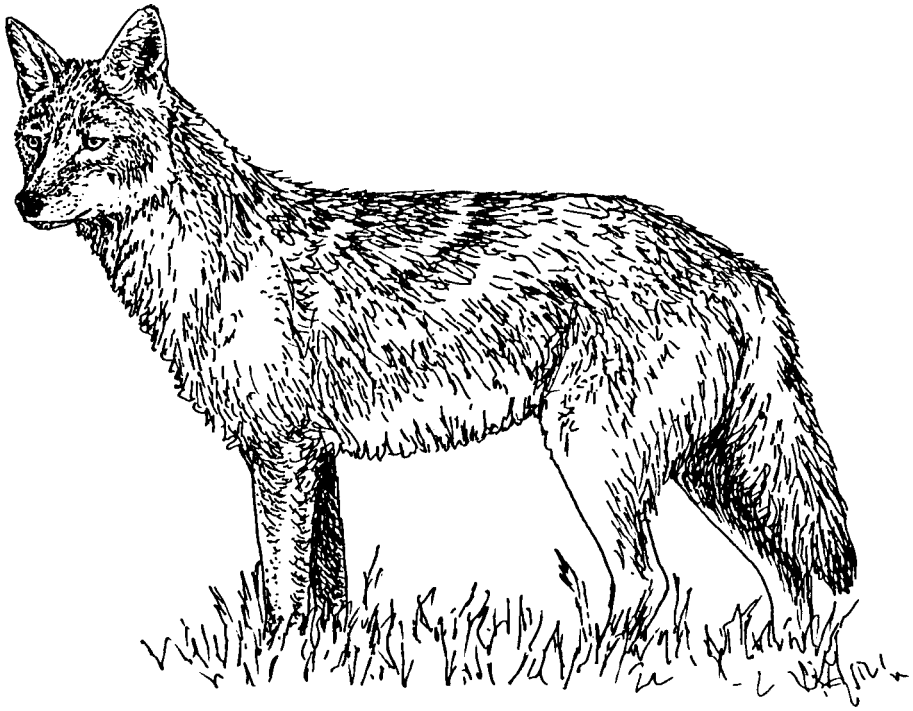


Fig. 1. Coyote, *Canis latrans*

Damage Prevention and Control Methods

Exclusion

Produce livestock in confinement.

Herd livestock into pens at night.

Exclusion fences (net-wire and/or electric), properly constructed and maintained, can aid significantly in reducing predation.

Cultural Methods and Habitat Modification

Select pastures that have a lower incidence of predation to reduce exposure of livestock to predation.

Herding of livestock generally reduces predation due to human presence during the herding period.

Change lambing, kidding, and calving seasons.

Shed lambing, kidding, and calving usually reduce coyote predation.

Remove carrion to help limit coyote populations.

Frightening Agents and Repellents

Guarding dogs: Some dogs have significantly reduced coyote predation.

Donkeys and llamas: Some are aggressive toward canines and have reduced coyote predation.

Sonic and visual repellents: Strobe lights, sirens, propane cannons, and others have reduced predation on both sheep and calves.

Chemical odor and taste repellents: None have shown sufficient effectiveness to be registered for use.

Toxicants

M-44 ejector devices for use with sodium cyanide-loaded plastic capsules. They are most effective during cold weather (fall to spring).

Livestock protection collars (LPC) containing Compound 1080 (sodium monofluoroacetate) are registered for use only in certain states.

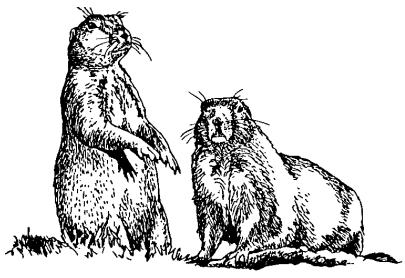
Fumigants

Gas cartridges are registered as a burrow (den) fumigant.

Trapping

Leghold traps (Nos. 3 and 4) are effective and are the most versatile control tool.

Snares are effective where coyotes pass through or under net-wire fences and in trail sets.



PREVENTION AND CONTROL OF WILDLIFE DAMAGE — 1994

Cooperative Extension Division
Institute of Agriculture and Natural Resources
University of Nebraska - Lincoln

United States Department of Agriculture
Animal and Plant Health Inspection Service
Animal Damage Control

Great Plains Agricultural Council
Wildlife Committee

Shooting

Shooting from the ground is effective.

Use rabbit distress calls or mimic howling or other coyote sounds to bring coyotes within shooting distance.

Aerial hunting is effective in removing coyotes where terrain, ground cover, vegetation, regulations, and landownership conditions permit.

Hunting with dogs is effective for trailing coyotes from kill sites, locating dens, running coyotes, and assisting with aerial hunting or calling.

Other Methods

Denning: Remove adult coyotes and/or their young from dens.

Identification

In body form and size, the coyote (*Canis latrans*) resembles a small collie dog, with erect pointed ears, slender muzzle, and a bushy tail (Fig. 1). Coyotes are predominantly brownish gray in color with a light gray to cream-colored belly. Color varies greatly, however, from nearly black to red or nearly white in some individuals and local populations. Most have dark or black guard hairs over their back and tail. In western states, typical adult males weigh from 25 to 45 pounds (11 to 16 kg) and females from 22 to 35 pounds (10 to 14 kg). In the East, many coyotes are larger than their western counterparts, with males averaging about 45 pounds (14 kg) and females about 30 pounds (13 kg).

Coyote-dog and coyote-wolf hybrids exist in some areas and may vary greatly from typical coyotes in size, color, and appearance. Also, coyotes in the New England states may differ in color from typical western coyotes. Many are black, and some are reddish. These colorations may partially be due to past hybridization with dogs and wolves. True wolves are also present in some areas of coyote range, particularly in Canada, Alaska, Montana, northern Minnesota, Wisconsin, and Michigan. Relatively few wolves remain in the southern United States and Mexico.

Range

Historically, coyotes were most common on the Great Plains of North America. They have since extended their range from Central America to the Arctic, including all of the United States (except Hawaii), Canada, and Mexico.

Habitat

Many references indicate that coyotes were originally found in relatively open habitats, particularly the grasslands and sparsely wooded areas of the western United States. Whether or not this was true, coyotes have adapted to and now exist in virtually every type of habitat, arctic to tropic, in North America. Coyotes live in deserts, swamps, tundra, grasslands, brush, dense forests, from below sea level to high mountain ranges, and at all intermediate altitudes. High densities of coyotes also appear in the suburbs of Los Angeles, Pasadena, Phoenix, and other western cities.

Food Habits

Coyotes often include many items in their diet. Rabbits top the list of their dietary components. Carrion, rodents, ungulates (usually fawns), insects (such as grasshoppers), as well as livestock and poultry, are also consumed. Coyotes readily eat fruits such as watermelons, berries, and other vegetative matter when they are available. In some areas coyotes feed on human refuse at dump sites and take pets (cats and small dogs).

Coyotes are opportunistic and generally take prey that is the easiest to secure. Among larger wild animals, coyotes tend to kill young, inexperienced animals, as well as old, sick, or weakened individuals. With domestic animals, coyotes are capable of catching and killing healthy, young, and in some instances, adult prey. Prey selection is based on opportunity and a myriad of behavioral cues. Strong, healthy lambs are often taken from a flock by a coyote even though smaller, weaker lambs are also present. Usually, the stronger lamb is on the periphery and is more active, making it more prone to attack than a weaker lamb that is at the center of the flock and relatively immobile.

Coyote predation on livestock is generally more severe during early spring and summer than in winter for two reasons. First, sheep and cows are usually under more intensive management during winter, either in feedlots or in pastures that are close to human activity, thus reducing the opportunity for coyotes to take livestock. Second, predators bear young in the spring and raise them through the summer, a process that demands increased nutritional input, for both the whelping and nursing mother and the growing young. This increased demand corresponds to the time when young sheep or beef calves are on pastures or rangeland and are most vulnerable to attack. Coyote predation also may increase during fall when young coyotes disperse from their home ranges and establish new territories.

General Biology, Reproduction, and Behavior

Coyotes are most active at night and during early morning hours (especially where human activity occurs), and during hot summer weather. Where there is minimal human interference and during cool weather, they may be active throughout the day.

Coyotes bed in sheltered areas but do not generally use dens except when raising young. They may seek shelter underground during severe weather or when closely pursued. Their physical abilities include good eyesight and

hearing and a keen sense of smell. Documented recoveries from severe injuries are indicative of coyotes' physical endurance. Although not as fleet as greyhound dogs, coyotes have been measured at speeds of up to 40 miles per hour (64 km/hr) and can sustain slower speeds for several miles (km).

Distemper, hepatitis, parvo virus, and mange (caused by parasitic mites) are among the most common coyote diseases. Rabies and tularemia also occur and may be transmitted to other animals and humans. Coyotes harbor numerous parasites including mites, ticks, fleas, worms, and flukes. Mortality is highest during the first year of life, and few survive for more than 10 to 12 years in the wild. Human activity is often the greatest single cause of coyote mortality.

Coyotes usually breed in February and March, producing litters about 9 weeks (60 to 63 days) later in April and May. Females sometimes breed during the winter following their birth, particularly if food is plentiful. Average litter size is 5 to 7 pups, although up to 13 in a litter has been reported. More than one litter may be found in a single den; at times these may be from females mated to a single male. As noted earlier, coyotes are capable of hybridizing with dogs and wolves, but reproductive dysynchrony and behaviors generally make it unlikely. Hybrids are fertile, although their breeding seasons do not usually correspond to those of coyotes.

Coyote dens are found in steep banks, rock crevices, sinkholes, and underbrush, as well as in open areas. Usually their dens are in areas selected for protective concealment. Den sites are typically located less than a mile (km) from water, but may occasionally be much farther away. Coyotes will often dig out and enlarge holes dug by smaller burrowing animals. Dens vary from a few feet (1 m) to 50 feet (15 m) and may have several openings.

Both adult male and female coyotes hunt and bring food to their young for several weeks. Other adults associated with the denning pair may also help in feeding and caring for the young. Coyotes commonly hunt as singles or pairs; extensive travel is common in their hunting forays. They will hunt in the same area regularly, however, if food is plentiful. They occasionally bury food remains for later use.

Pups begin emerging from their den by 3 weeks of age, and within 2 months they follow adults to large prey or carrion. Pups normally are weaned by 6 weeks of age and frequently are moved to larger quarters such as dense brush patches and/or sinkholes along water courses. The adults and pups usually remain together until late summer or fall when pups become independent. Occasionally pups are found in groups until the breeding season begins.

Coyotes are successful at surviving and even flourishing in the presence of people because of their adaptable behavior and social system. They typically display increased reproduction and immigration in response to human-induced population reduction.

Damage and Damage Identification

Coyotes can cause damage to a variety of resources, including livestock, poultry, and crops such as watermelons. They sometimes prey on pets and are a threat to public health and safety when they frequent airport runways and residential areas, and act as carriers of rabies. Usually, the primary concern regarding coyotes is predation on livestock, mainly sheep and lambs. Predation will be the focus of the following discussion.

Since coyotes frequently scavenge on livestock carcasses, the mere presence of coyote tracks or droppings near a carcass is not sufficient evidence that predation has taken place. Other evidence around the site and on the carcass must be carefully examined to aid in determining the cause of death. Signs of a struggle may be evident. These may include scrapes or drag marks on the ground, broken vegetation, or blood in various places around the site. The quantity of sheep or calf remains left after a kill vary widely depending on how recently the kill was made, the size of the animal killed, the weather, and the number and species of predators that fed on the animal.

One key in determining whether a sheep or calf was killed by a predator is the presence or absence of subcutaneous (just under the skin) hemorrhage at the point of attack. Bites to a dead animal will not produce hemorrhage, but bites to a live animal will. If enough of the sheep carcass remains, carefully skin out the neck and head to observe tooth punctures and hemorrhage around the punctures. Talon punctures from large birds of prey will also cause hemorrhage, but the location of these is usually at the top of the head, neck, or back. This procedure becomes less indicative of predation as the age of the carcass increases or if the remains are scanty or scattered.

Coyotes, foxes, mountain lions, and bobcats usually feed on a carcass at the flanks or behind the ribs and first consume the liver, heart, lungs, and other viscera. Mountain lions often cover a carcass with debris after feeding on it. Bears generally prefer meat to viscera and often eat first the udder from lactating ewes. Eagles skin out carcasses on larger animals and leave much of the skeleton intact. With smaller animals such as lambs, eagles may bite off and swallow the ribs. Feathers and "whitewash" (droppings) are usually present where an eagle has fed.

Coyotes may kill more than one animal in a single episode, but often will only feed on one of the animals. Coyotes typically attack sheep at the throat, but young or inexperienced coyotes may attack any part of the body. Coyotes usually kill calves by eating into the anus or abdominal area.

Dogs generally do not kill sheep or calves for food and are relatively indiscriminate in how and where they attack. Sometimes, however, it is difficult to differentiate between dog and coyote kills without also looking at other sign, such as size of tracks (Fig. 2) and spacing and size of canine

tooth punctures. Coyote tracks tend to be more oval-shaped and compact than those of common dogs. Nail marks are less prominent and the tracks tend to follow a straight line more closely than those of dogs. The average coyote's stride at a trot is 16 to 18 inches (41 to 46 cm), which is typically longer than that of a dog of similar size and weight. Generally, dogs attack and rip the flanks, hind quarters, and head, and may chew ears. The sheep are sometimes still alive but may be severely wounded.

Accurately determining whether or not predation occurred and, if so, by what species, requires a considerable amount of knowledge and experience. Evidence must be gathered, pieced together, and then evaluated in light of the predators that are in the area, the time of day, the season of the year, and numerous other factors. Sometimes even experts are unable to confirm the cause of death, and it may be necessary to rely on circumstantial information. For more information on this subject, refer to the section **Procedures for Evaluating Predation on Livestock and Wildlife,** in this book**.**

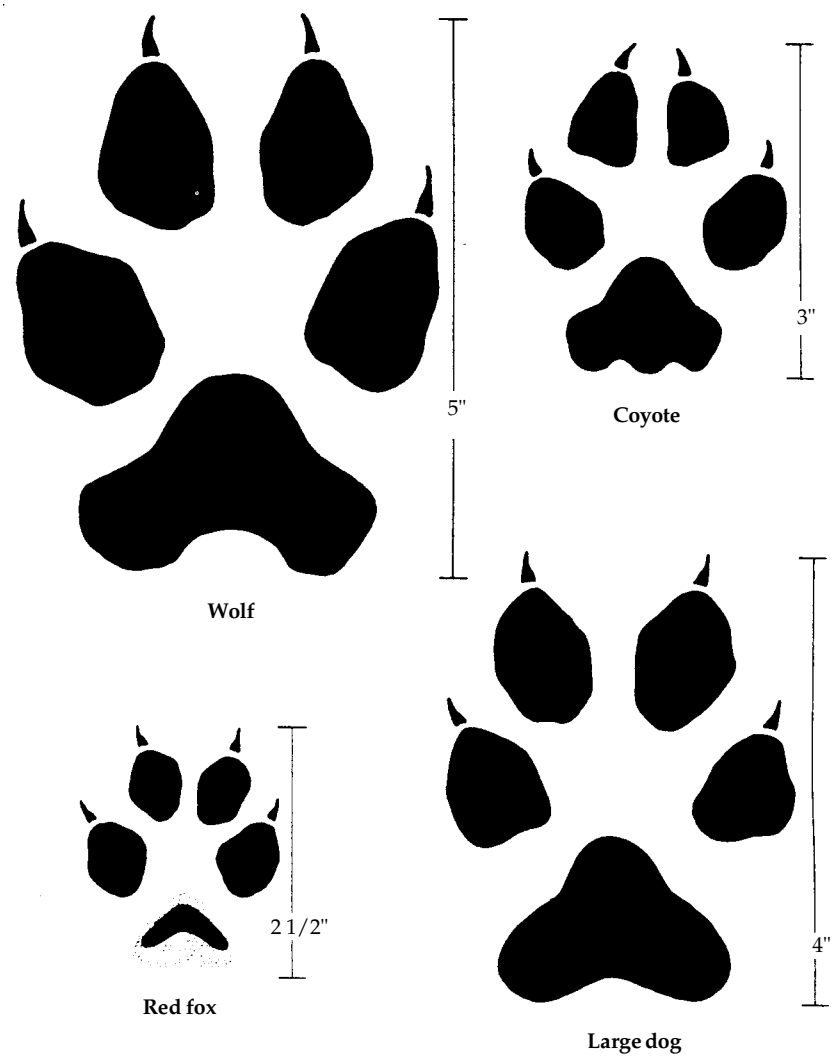


Fig. 2. Footprints of canid predators

Legal Status

The status of coyotes varies depending on state and local laws. In some states, including most western states, coyotes are classified as predators and can be taken throughout the year whether or not they are causing damage to livestock. In other states, coyotes may be taken only during specific seasons and often only by specific methods, such as trapping. Night shooting with a spotlight is usually illegal. Some state laws allow only state or federal agents to use certain methods (such as snares) to take coyotes. Some states have a provision for allowing the taking of protected coyotes (usually by special permit) when it has been documented that they are preying on livestock. In some instances producers can apply control methods, and in others, control must be managed by a federal or state agent. Some eastern states consider the coyote a game animal, a furbearer, or a protected species.

Federal statutes that pertain to wildlife damage control include the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), which deals with using toxicants, and the Airborne Hunting Act, which regulates aerial hunting.

Laws regulating coyote control are not necessarily uniform among states or even among counties within a state, and they may change frequently. A 1989 Supreme Court action established that it was not legal to circumvent the laws relative to killing predators, even to protect personal property (livestock) from predation.

Damage Prevention and Control Methods

For managing coyote damage, a variety of control methods must be available since no single method is effective in every situation. Success usually involves an integrated approach, combining good husbandry practices with effective control methods for short periods of time. Regardless of the means used to stop damage, the focus should be on damage prevention and control rather than elimination of coyotes. It is neither wise nor practical to kill all coyotes. It is important to try to prevent coyotes from killing calves or sheep for the first time. Once a coyote has killed livestock, it will probably continue to do so if given the

opportunity. Equally important is taking action as quickly as possible to stop coyotes from killing after they start.

Exclusion

Most coyotes readily cross over, under, or through conventional livestock fences. A coyote's response to a fence is influenced by various factors, including the coyote's experience and motivation for crossing the fence. Total exclusion of all coyotes by fencing, especially from large areas, is highly unlikely since some eventually learn to either dig deeper or climb higher to defeat a fence. Good fences, however, can be important in reducing predation, as well as increasing the effectiveness of other damage control methods (such as snares, traps, or guarding animals).

Recent developments in fencing equipment and design have made this technique an effective and economically practical method for protecting sheep from predation under some grazing conditions. Exclusion fencing may be impractical in western range sheep ranching operations.

Net-Wire Fencing. Net fences in good repair will deter many coyotes from entering a pasture. Horizontal spacing of the mesh should be less than 6 inches (15 cm), and vertical spacing less than 4 inches (10 cm). Digging under a fence can be discouraged by placing a barbed wire at ground level or using a buried wire apron (often an expensive option). The fence should be about 5 1/2 feet (1.6 m) high to discourage coyotes from jumping over it. Climbing can usually be prevented by adding a charged wire at the top of the fence or installing a wire overhang.

Barrier fences with wire overhangs and buried wire aprons were tested in Oregon and found effective in keeping coyotes out of sheep pastures (Fig. 3). The construction and materials for such fencing are usually expensive. Therefore, fences of this type are rarely used except around corrals, feedlots, or areas of temporary sheep confinement.

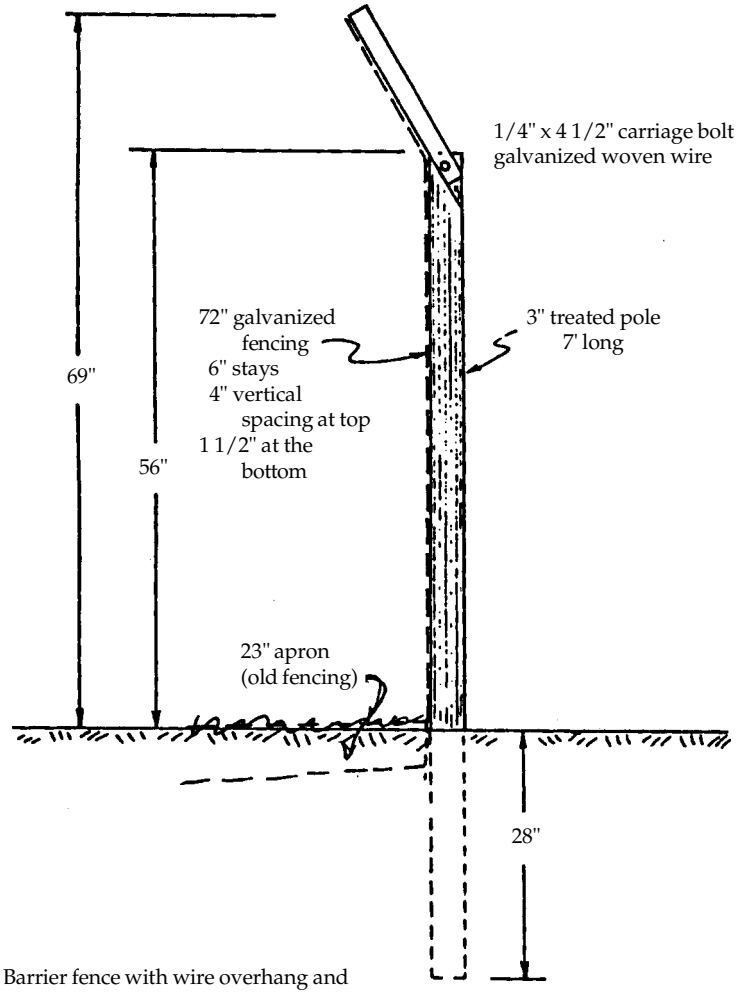


Fig. 3. Barrier fence with wire overhang and buried apron.

Electric Fencing. Electric fencing, used for years to manage livestock, has recently been revolutionized by the introduction of new energizers and new fence designs from Australia and New Zealand. The chargers, now also manufactured in the United States, have high output with low impedance, are resistant to grounding, present a minimal fire hazard, and are generally safe for livestock and humans. The fences are usually constructed of smooth, high-tensile wire stretched to a tension of 200 to 300 pounds (90 to 135 kg). The original design of electric fences for controlling predation consisted of multiple, alternately charged and grounded wires, with a charged trip wire installed just above ground level about 8 inches (20 cm) outside the main fence to discourage digging. Many recent designs have every wire charged.

The number of spacings between wires varies considerably. A fence of 13 strands gave complete protection to sheep from coyote predation in tests at the USDA's US Sheep Experiment Station (Fig. 4). Other designs of fewer wires were effective in some studies, ineffective in others.

The amount of labor and installation techniques required vary with each type of fencing. High-tensile wire fences require adequate bracing at corners and over long spans. Electric fencing is easiest to install on flat, even terrain. Labor to install a high-tensile electric fence may be 40% to 50% less than for a conventional livestock fence.

Labor to keep electric fencing functional can be significant. Tension of the wires must be maintained, excessive vegetation under the fence must be removed to prevent grounding, dam-

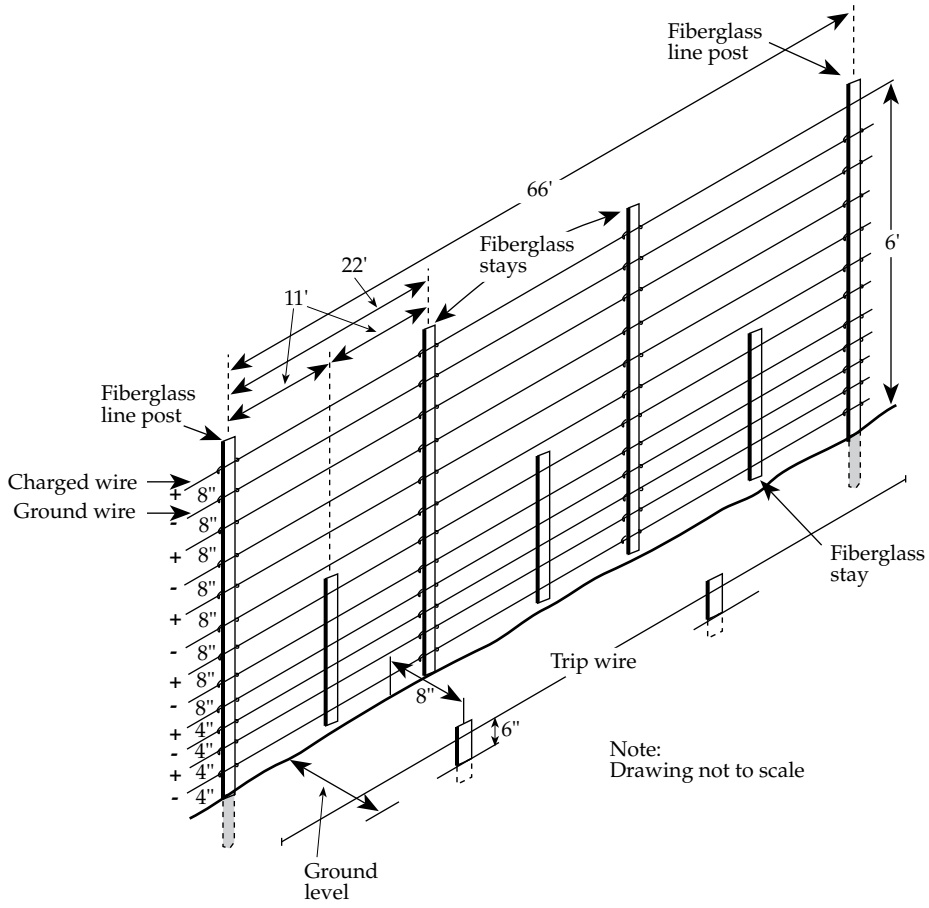


Fig. 4. High-tensile, electric, antipredator fence.

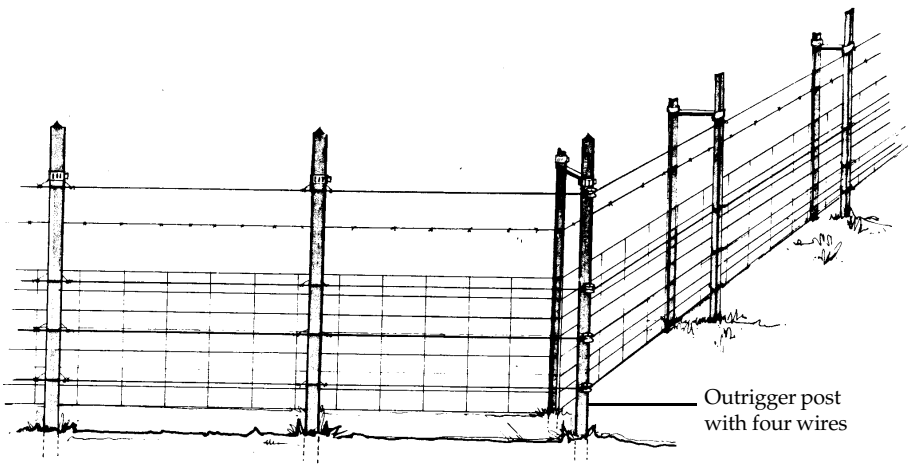


Fig. 5. Existing woven-wire livestock fence modified with electrified wire.

age from livestock and wildlife must be repaired, and the charger must be checked regularly to ensure that it is operational.

Coyotes and other predators occasionally become "trapped" inside electric fences. These animals receive a shock as they enter the pasture and subsequently avoid approaching the fence to escape. In some instances the captured predator may be easy to spot and remove from the pasture, but in others, particularly in large pastures with rough terrain, the animal may be difficult to remove.

Electric Modification of Existing Fences. The cost to completely replace old fences with new ones, whether conventional or electric, can be substantial. In instances where existing fencing is in reasonably good condition, the addition of one to several charged wires can significantly enhance the predator-deterring ability of the fence and its effectiveness for controlling livestock (Fig. 5). A charged trip wire placed 6 to 8 inches (15 to 230 cm) above the ground about 8 to 10 inches (20 to 25 cm) outside the fence is often effective in preventing coyotes from digging and crawling under. This single addition to an existing fence is often the most effective and economical way to fortify a fence against coyote passage.

If coyotes are climbing or jumping a fence, charged wires can be added to the top and at various intervals. These wires should be offset outside the fence. Fencing companies offer offset brackets to make installation relatively simple. The number of additional wires depends on the design of the original fence and the predicted habits of the predators.

Portable Electric Fencing. The advent of safe, high-energy chargers has led to the development of a variety of portable electric fences. Most are constructed with thin strands of wire running through polyethylene twine or ribbon, commonly called polywire or polytape. The polywire is available in single and multiple wire rolls or as mesh fencing of various heights. It can be quickly and easily installed to serve

as a temporary corral or to partition off pastures for controlled grazing.

Perhaps the biggest advantage of portable electric fencing is the ability to set up temporary pens to hold livestock at night or during other predator control activities. Portable fencing increases livestock management options to avoid places or periods of high predation risk. Range sheep that are not accustomed to being fenced, however, may be difficult to contain in a portable fence.

Fencing and Predation Management. The success of various types of fencing in keeping out predators has ranged from poor to excellent. Density and behavior of coyotes, terrain and vegetative conditions, availability of prey, size of pastures, season of the year, design of the fence, quality of construction, maintenance, and other factors all interplay in determining how effective a fence will be. Fencing is most likely to be cost-effective where the potential for predation is high, where there is potential for a high stocking rate, or where electric modification of existing fences can be used.

Fencing can be effective when incorporated with other means of predation control. For example, combined use of guarding dogs and fencing has achieved a greater degree of success than either method used alone. An electric fence may help keep a guarding dog in and coyotes out of a pasture. If an occasional coyote does pass through a fence, the guarding dog can keep it away from the livestock and alert the producer by barking.

Fencing can also be used to concentrate predator activity at specific places such as gateways, ravines, or other areas where the animals try to gain access. Traps and snares can often be set at strategic places along a fence to effectively capture predators. Smaller pastures are easier to keep free from predators than larger ones encompassing several square miles (km^2).

Fencing is one of the most beneficial investments in predator damage control and livestock management where practical factors warrant its use.

As a final note, fences can pose problems for wildlife. Barrier fences in particular exclude not only predators, but also many other wildlife species. This fact should be considered where fencing intersects migration corridors for wildlife. Ungulates such as deer may attempt to jump fences, and they occasionally become entangled in the top wires.

Cultural Methods and Habitat Modification

At the present time, there are no documented differences in the vulnerability of various breeds of sheep to coyote or dog predation because there has been very little research in this area. Generally, breeds with stronger flocking behaviors are less vulnerable to predators.

A possible cause of increased coyote predation to beef cattle calves is the increased use of cattle dogs in herding. Cows herded by dogs may not be as willing to defend newborn calves from coyotes as those not accustomed to herding dogs.

Flock or Herd Health. Healthy sheep flocks and cow/calf herds have higher reproductive rates and lower overall death losses. Coyotes often prey on smaller lambs. Poor nutrition means weaker or smaller young, with a resultant increased potential for predation. Ewes or cows in good condition through proper nutrition will raise stronger young that may be less vulnerable to coyote predation.

Record Keeping. Good record-keeping and animal identification systems are invaluable in a livestock operation for several reasons. From the standpoint of coyote predation, records help producers identify loss patterns or trends to provide baseline data that will help determine what type and amount of coyote damage control is economically feasible. Records also aid in identifying critical problem areas that may require attention. They may show, for example, that losses to coyotes are high in a particular pasture in early summer, thus highlighting the need for preventive control in that area.

Counting sheep and calves regularly is important in large pastures or areas with heavy cover where dead livestock could remain unnoticed. It is not unusual for producers who do not regularly count their sheep to suffer fairly substantial losses before they realize there is a problem. Determining with certainty whether losses were due to coyotes or to other causes may become impossible.

Season and Location of Lambing or Calving. Both season and location of lambing and calving can significantly affect the severity of coyote predation on sheep or calves. The highest predation losses of sheep and calves typically occur from late spring through September due to the food requirements of coyote pups. In the Midwest and East, some lambing or calving occurs between October and December, whereas in most of the western states lambing or calving occurs between February and May. By changing to a fall lambing or calving program, some livestock producers have not only been able to diversify their marketing program, but have also avoided having a large number of young animals on hand during periods when coyote predation losses are typically highest.

Shortening lambing and calving periods by using synchronized or group breeding may reduce predation by producing a uniform lamb or calf crop, thus reducing exposure of small livestock to predation. Extra labor and facilities may be necessary, however, when birthing within a concentrated period. Some producers practice early weaning and do not allow young to go to large pastures, thus reducing the chance of coyote losses. This also gives orphaned and weak young a greater chance to survive.

The average beef cattle calf production is about 78% nationwide. First-calf heifers need human assistance to give birth to a healthy calf about 40% of the time. Cow/calf producers who average 90% to 95% calf crops generally check their first-calf heifers every 2 hours during calving. Also, most good producers place first-calf heifers in

small pastures (less than 160 acres [64 ha]). When all cows are bred to produce calves in a short, discreet (e.g. 60-day) period, production typically increases and predation losses decrease. The birth weight of calves born to first-calf heifers can be decreased by using calving-ease bulls, thus reducing birthing complications that often lead to coyote predation.

Producers who use lambing sheds or pens for raising sheep and small pastures or paddocks for raising cattle have lower predation losses than those who lamb or calve in large pastures or on open range. The more human presence around sheep, the lower the predation losses. Confining sheep entirely to buildings virtually eliminates predation losses.

Corrals. Although predation can occur at any time, coyotes tend to kill sheep at night. Confining sheep at night is one of the most effective means of reducing losses to predation. Nevertheless, some coyotes and many dogs are bold enough to enter corrals and kill sheep. A "coyote-proof" corral is a wise investment. Coyotes are more likely to attack sheep in unlighted corrals than in corrals with lights. Even if the corral fence is not coyote-proof, the mere fact that the sheep are confined reduces the risk of predation. Penning sheep at night and turning them out at mid-morning might reduce losses. In addition, coyotes tend to be more active and kill more sheep on foggy or rainy days than on sunny days. Keeping the sheep penned on foggy or rainy days may be helpful.

Aside from the benefits of livestock confinement, there are some problems associated it. Costs of labor and materials associated with building corrals, herding livestock, and feeding livestock must be considered. In addition, the likelihood of increased parasite and disease problems may inhibit adoption of confinement as a method of reducing damage.

Carrion Removal. Removal and proper disposal of dead sheep and cattle are important since livestock carcasses tend to attract coyotes, habituating them to feed on livestock. Some producers reason that coyotes are less likely to kill livestock if there is carrion available. This may be a valid preventative measure if an adequate supply of carrion can be maintained far away from livestock. If a coyote becomes habituated to a diet of livestock remains, however, it may turn to killing livestock in the absence of carcasses. Wherever there is easily accessible carrion, coyotes seem to gather and predation losses are higher. Conversely, where carrion is generally not available, losses are lower. A study in Canada showed that the removal of livestock carcasses significantly reduced overwinter coyote populations and shifted coyote distributions out of livestock areas.

Habitat Changes. Habitat features change in some areas, depending on seasonal crop growth. Some cultivated fields are devoid of coyotes during winter but provide cover during the growing season, and a corresponding increase in predation on nearby livestock may occur.

The creation of nearly 40 million acres (16 million ha) of Conservation Reserve Program (CRP) acres may benefit many species of wildlife, including predators. These acres harbor prey for coyotes and foxes, and an increase in predator populations can reasonably be predicted. Clearing away weeds and brush from CRP areas may reduce predation problems since predators usually use cover in their approach to livestock. Generally, the more open the area where livestock are kept, the less likely that coyote losses will occur. Often junk piles are located near farmsteads. These serve as good habitat for rabbits and other prey and may bring coyotes into close proximity with livestock, increasing the likelihood for opportunistic coyotes to prey on available livestock. Removing junk piles may be a good management practice.

Pasture Selection. If sheep or beef cattle are not lambed or calved in sheds or lots, the choice of birthing pastures should be made with potential coyote predation problems in mind. Lambs and calves in remote or rugged pastures are usually more vulnerable to coyote predation than those in closer, more open, and smaller pastures. In general, a relatively small, open, tightly fenced pasture that can be kept under close surveillance is a good choice for birthing livestock that are likely targets of coyotes. Past experience with predators as well as weather and disease considerations should also serve as guides in the selection of birthing pastures.

A factor not completely understood is that, at times, coyotes and other predators will kill in one pasture and not in another. Therefore, changing pastures during times of loss may reduce predation. There may seem to be a relationship between size of pasture and predator losses, with higher loss rates reported in larger pastures. In reality, loss rates may not be related as much to pasture size as to other local conditions such as slope, terrain, and human populations. Hilly or rugged areas are typically sparsely populated by humans and are characterized by large pastures. These conditions are ideal for coyotes.

Sheep pastures that contain or are adjacent to streams, creeks, and rivers tend to have more coyote problems than pastures without such features. Water courses serve as hunting and travel lanes for coyotes.

Herders. Using herders with sheep or cattle in large pastures can help reduce predation, but there has been a trend away from herders in recent years because of increasing costs and a shortage of competent help. Nevertheless, tended flocks or herds receive closer attention than untended livestock, particularly in large pastures, and problems can be solved before they become serious. We recommend two herders per band of range sheep. If herders aren't used, daily or periodic checking of the livestock is a good husbandry practice.

Frightening Devices and Repellents

Frightening devices are useful for reducing losses during short periods or until predators are removed. The devices should not be used for long

periods of time when predation is not a problem. To avoid acclimation you can increase both the degree and duration of effectiveness by varying the position, appearance, duration, or frequency of the frightening stimuli, or using them in various combinations. Many frightening methods have been ridiculed in one way or another; nevertheless, all of the techniques discussed here have helped producers by saving livestock and/or buying some time to institute other controls.

Lights. A study involving 100 Kansas sheep producers showed that using lights above corrals at night had the most marked effect on losses to coyotes of all the devices examined. Out of 79 sheep killed by coyotes in corrals, only three were killed in corrals with lights. Nearly 40% of the producers in the study used lights over corrals. There was some indication in the study that sheep losses to dogs were higher in lighted corrals, but the sample size for dog losses was small and the results inconclusive. Most of the producers (80%) used mercury vapor lights that automatically turned on at dusk and off at dawn.

Another advantage of lighted corrals is that coyotes are more vulnerable when they enter the lighted area. Coyotes often establish a fairly predictable pattern of killing. When this happens in a lighted corral, it is possible for a producer to wait above or downwind of the corral and to shoot the coyote as it enters. Red or blue lights may make the ambush more successful since coyotes appear to be less frightened by them than by white lights.

Revolving or flashing the lights may enhance their effectiveness in frightening away predators. There is some speculation that the old oil lamps used in highway construction repelled coyotes, presumably because of their flickering effect.

Bells and Radios. Some sheep producers place bells on some or all of their sheep to discourage predators. Where effects have been measured, however, no difference in losses was detected.

Some producers use a radio tuned to an all-night station to temporarily deter coyotes, dogs, and other predators.

Vehicles. Parking cars or pickups in the area where losses are occurring often reduces predation temporarily. Effectiveness can be improved or extended by frequently moving the vehicle to a new location. Some producers place a replica of a person in the vehicle when losses are occurring in the daylight. If predators continue to kill with vehicles in place, the vehicle serves as a comfortable blind in which to wait and shoot offending predators.

Propane Exploders. Propane exploders produce loud explosions at timed intervals when a spark ignites a measured amount of propane gas. On most models, the time between explosions can vary from about 1 minute to 15 minutes. Their effectiveness at frightening coyotes is usually only temporary, but it can be increased by moving exploders to different locations and by varying the intervals between explosions. In general, the timer on the exploder should be set to fire every 8 to 10 minutes, and the location should be changed every 3 or 4 days. In cattle pastures, these devices should be placed on rigid stands above the livestock. Normally, the exploder should be turned on just before dark and off at daybreak, unless coyotes are killing livestock during daylight hours. Motion sensors are now available and likely improve their effectiveness, though it is still only temporary. Exploders are best used to reduce losses until more permanent control or preventive measures can be implemented. In about 24 coyote depredation complaints over a 2-year period in North Dakota, propane exploders were judged to be successful in stopping or reducing predation losses until offending coyotes could be removed. "Success time" of the exploders appears to depend a great deal on how well they are tended by the livestock producer.

Strobe Lights and Sirens. The USDA's Denver Wildlife Research

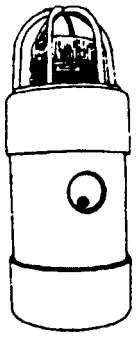


Fig. 6. Electronic Guard frightening device

Center developed a frightening device called the Electronic Guard (EG) (Fig. 6). The EG consists of a strobe light and siren controlled by a variable interval timer that is activated at night with a photoelectric cell. In tests conducted in fenced pastures, predation was reduced by about 89%. The device is used in Kansas and other states to protect cows/calves from coyote predation. Most research on the effectiveness of this device, however, has been done on sheep operations. Suggestions for using the unit differ for pastured sheep and range operations.

To use the EG in fenced pastures (farm flocks):

1. Place EGs above the ground on fence posts, trees, or T-posts so they can be heard and seen at greater distances and to prevent livestock from damaging them.
2. Position EGs so that rain water cannot enter them and cause a malfunction.
3. Locate EGs so that light can enter the photocell port or window. If positioned in deep shade, they may not turn on or off at the desired times.
4. The number of EGs used to protect sheep in fenced pastures depends on pasture size, terrain features, and the amount and height of vegetation in or around the pasture. In general, at least two units should be used in small (20 to 30 acres [8 to 12 ha]), level, short-grass pastures. Three to four units should be used in larger (40 to 100 acres [16 to 40 ha]), hilly, tall grass, or wooded pastures.

5. Don't use EGs in pastures larger than about 100 acres (40 ha) because their effective range is limited. The device could be useful in larger pastures when placed near areas where sheep congregate and bed at night.
6. EGs should be placed on high spots, where kills have been found, at the edge of wooded areas, near or on bedgrounds, or near suspected coyote travelways. They should be moved to different locations every 10 to 14 days to reduce the likelihood of coyotes getting used to them.

To use the EG in open range (herded or range sheep):

1. The number of EGs used will depend on the number of sheep in the band and the size of the bedground. Four units should be used to protect bands of 1,000 ewes and their lambs.
2. When possible, place one EG in the center of the bedground and the other three around the edge of the bedground. Try to place the units on coyote travelways.
3. EGs should be placed on high points, ridge tops, edges of clearings, or on high rocks or outcroppings. Hang the devices on tree limbs 5 to 7 feet (1.5 to 2.1 m) above ground level. If used above timberline or in treeless areas, hang them from a tripod of poles.
4. Herders who bed their sheep tightly will have better results than those who allow sheep to bed over large areas. Sheep that are bedded about 200 yards (166 m) or less in diameter, or are spread out not more than 200 to 400 yards (166 to 332 m) along a ridge top, can usually be protected with EGs.

Repellents. The notion of repelling coyotes from sheep or calves is appealing, and during the 1970s, university and government researchers tested a wide variety of potentially repellent chemical compounds on sheep. Both olfactory (smell) and gustatory (taste) repellents were examined. The underlying objective was to find a compound that, when applied to sheep, would prevent coyotes from killing them. Tests were conducted with various prey species including rabbits, chickens, and sheep. Some repellents were applied by dipping target animals in them, others were sprayed on, and some were applied in neck collars or ear tags.

Coyotes rely heavily on visual cues while stalking, chasing, and killing their prey. Taste and smell are of lesser importance in actually making the kill. These factors may in part account for the fact that the repellent compounds were not able to consistently prevent coyotes from killing, although some of the repellents were obviously offensive to coyotes and prevented them from consuming the killed prey. Several compounds were tested on sheep under field conditions, but none appeared to offer significant, prolonged protection.

If an effective chemical repellent were to be found, the obstacles in bringing it to industry use would be significant. The compound would not only need to be effective, but also persistent enough to withstand weathering while posing no undue risk to the sheep, other animals, or the environment. It would also have to withstand the rigorous Environmental Protection Agency (EPA) approval process.

High-frequency sound has also been tested as a repellent for coyotes, but the results were no more encouraging than for chemical repellents. Coyotes, like dogs, responded to particular sound frequencies and showed some aversion to sounds broadcast within one foot (30 cm) of their ear. Researchers, however, were unable to broadcast the sound a sufficient distance to test the effects under field conditions.

Aversive Conditioning. The objective of aversive conditioning is to feed a coyote a preylike bait laced with an aversive agent that causes the coyote to become ill, resulting in subsequent avoidance of the prey. Most of the research on this technique has involved the use of lithium chloride, a salt, as the aversive agent.

Aversive conditioning is well documented for averting rodents from food sources, but significant problems must be overcome before the method can be used to reduce coyote predation on sheep. Coyotes must be induced to eat sheeplike baits that have been treated with the aversive chemical. The chemical must cause sufficient discomfort, such as vomiting, to cause coyotes to avoid other baits. Furthermore, the avoidance must be transferred to live sheep and must persist long enough without reinforcement for the method to offer realistic protection to sheep.

To date, pen and field tests with aversive conditioning have yielded conflicting and inconclusive results. It does not appear that aversive conditioning is effective in reducing predation, but additional field tests would be useful.

Guarding Animals.

Livestock Guarding Dogs. A livestock guarding dog is one that generally stays with sheep or cattle without harming them and aggressively repels predators. Its protective behaviors are largely instinctive, but proper rearing plays a part. Breeds most commonly used today include the Great Pyrenees, Komondor, Anatolian Shepherd, and Akbash Dog (Fig. 7). Other Old World breeds used to a lesser degree include Maremma, Sharplaninetz, and Kuvasz. Crossbreeds are also used.

The characteristics of each sheep operation will dictate the number of dogs required for effective protection from predators. If predators are scarce, one dog is sufficient for most fenced pasture operations. Range operations often use two dogs per band of sheep. The performance of individual dogs will differ based on age and experience. The size, topography, and habitat of the pasture or range must also be considered. Relatively flat, open areas can be adequately covered by one dog. When brush, timber, ravines, and hills are in the pasture, several dogs may be required, particularly if the sheep are scattered. Sheep that flock and form a cohesive unit, especially at night, can be protected by one dog more effectively than sheep that are continually

Fig. 7. Livestock guarding dog (Akbash dog)

scattered and bedded in a number of locations.

The goal with a new puppy is to channel its natural instincts to produce a mature guardian dog with the desired characteristics. This is best accomplished by early and continued association with sheep to produce a bond between the dog and sheep. The optimum time to acquire a pup is between 7 and 8 weeks of age. The pup should be separated from litter mates and placed with sheep, preferably lambs, in a pen or corral from which it can't escape. This socialization period should continue with daily checks from the producer until the pup is about 16 weeks old. Daily checks don't necessarily include petting the pup. The primary bond should be between the dog and the sheep, not between the dog and humans. The owner, however, should be able to catch and handle the dog to administer health care or to manage the livestock. At about 4 months, the pup can be released into a larger pasture to mingle with the other sheep.

A guarding dog will likely include peripheral areas in its patrolling. Some have been known to chase vehicles and wildlife and threaten children and cyclists. These activities should be discouraged. Neighbors should be alerted to the possibility that the dog may roam onto their property and that some predator control devices such as traps, snares, and M-44s present a danger to it. Many counties enforce stringent laws regarding owner responsibility for damage done by roaming dogs. It is in the best interests of the owner, dog, and community to train the dog to stay in its designated area.

The use of guarding dogs does not eliminate the need for other predation control actions. They should, however, be compatible with the dog's behavior. Toxicants (including some insecticides and rodenticides) used to control various pest species can be extremely hazardous to dogs and are therefore not compatible with the use of guarding dogs.

The M-44 is particularly hazardous to dogs. Some people have successfully trained their dogs to avoid M-44s by allowing the dog to set off an M-44 filled with pepper or by rigging the device to a rat trap. The unpleasant experience may teach the dog to avoid M-44s, but the method is not foolproof—one error by the dog, and the result is usually fatal. With the exception of toxic collars, which are not legal in all states, toxicants should not be used in areas where guarding dogs are working unless the dog is chained or confined while the control takes place.

Dogs caught in a steel trap set for predators are rarely injured seriously if they are found and released within a reasonable period of time. If snares and traps are used where dogs are working, the producer should: (1) encourage the use of sets and devices that are likely not to injure the dog if it is caught, and (2) know where traps and snares are set so they can be checked if a dog is missing. Aerial hunting, as well as calling and shooting coyotes, should pose no threat to guarding dogs. Ensuring the safety of the dog is largely the producer's responsibility.

Dogs may be viewed as a first line of defense against predation in sheep and cow/calf operations in some cases. Their effectiveness can be enhanced by good livestock management and by eliminating predators with suitable removal techniques.

Donkeys. Although the research has not focused on donkeys as it has on guarding dogs, they are gaining in popularity as protectors of sheep and goat flocks in the United States. A recent survey showed that in Texas alone, over 2,400 of the 11,000 sheep and goat producers had used donkeys as guardians.

The terms *donkey* and *burro* are synonymous (the Spanish translation of *donkey* is *burro*) and are used interchangeably. Donkeys are generally docile to people, but they seem to have an inherent dislike of dogs and other canids, including coyotes and foxes. The typical response of a donkey to an intruding canid may include braying, bared teeth, a running attack, kicking, and biting. Most likely it is acting out of aggression toward the intruder rather than to protect the sheep. There is little information on a donkey's effectiveness with noncanid predators such as bears, mountain lions, bobcats, or birds of prey.

Reported success of donkeys in reducing predation is highly variable. Improper husbandry or rearing practices and unrealistic expectations

probably account for many failures. Donkeys are significantly cheaper to obtain and care for than guarding dogs, and they are probably less prone to accidental death and premature mortality than dogs. They may provide a longer period of useful life than a guarding dog, and they can be used with relative safety in conjunction with snares, traps, M-44s, and toxic collars.

Researchers and livestock producers have identified several key points to consider when using a donkey for predation control:

1. Use only a jenny or a gelded jack. Intact jacks are too aggressive and may injure livestock. Some jennies and geldings may also injure livestock. Select donkeys from medium-sized stock.
2. Use only one donkey per group of sheep. The exception may be a jenny with a foal. When two or more adult donkeys are together or with a horse, they usually stay together, not necessarily near the sheep. Also avoid using donkeys in adjacent pastures since they may socialize across the fence and ignore the sheep.
3. Allow about 4 to 6 weeks for a naive donkey to bond to the sheep. Stronger bonding may occur when a donkey is raised from birth with sheep.
4. Avoid feeds or supplements containing monensin or lasolacid. They are poisonous to donkeys.
5. Remove the donkey during lambing, particularly if lambing in confinement, to avoid injuries to lambs or disruption of the lamb-ewe bond.
6. Test a new donkey's response to canids by challenging it with a dog in a pen or small pasture. Discard donkeys that don't show overt aggression to an intruding dog.
7. Use donkeys in smaller (less than 600 acres [240 ha]), relatively open pastures with not more than 200 to 300 head of livestock. Large pastures with rough terrain and vegetation and widely scattered livestock lessen the effectiveness of a donkey.

Llamas. Like donkeys, llamas have an inherent dislike of canids, and a growing number of livestock producers are successfully using llamas to protect their sheep. A recent study of 145 ranches where guard llamas were used to protect sheep revealed that average losses of sheep to predators decreased from 26 to 8 per year after llamas were employed. Eighty percent of the ranchers surveyed were "very satisfied" or "satisfied" with their llamas. Llamas reportedly bond with sheep within hours and offer advantages over guarding dogs similar to those described for donkeys.

Other Animals. USDA's Agricultural Research Service tested the bonding of sheep to cattle as a method of protecting sheep from coyote predation. There was clearly some protection afforded the sheep that remained near cattle. Whether this protection resulted from direct action by the cattle or by the coyotes' response to a novel stimulus is uncertain. Later studies with goats, sheep, and cattle confirmed that when either goats or sheep remained near cattle, they were protected from predation by coyotes. Conversely, goats or sheep that grazed apart from cattle, even those that were bonded, were readily preyed on by coyotes.

There are currently no research data available on the ideal ratio of cattle to sheep, the breeds of cattle, age of cattle most likely to be used successfully, or on the size of bonded groups to obtain maximum protection from predation. Multispecies grazing offers many advantages for optimum utilization of forage, and though additional study and experience is needed, it may also be a tool for coyote damage control.

Any animal that displays aggressive behavior toward intruding coyotes may offer some benefit in deterring predation. Other types of animals reportedly used for predation control include goats, mules, and ostriches. Coyotes in particular are suspicious of novel stimuli. This behavior is most likely the primary reason that many frightening tactics show at least temporary effectiveness.

Toxicants

Pesticides have historically been an important component in an integrated approach to controlling coyote damage, but their use is extremely restricted today by federal and state laws. All pesticides used in the United States must be registered with the EPA under the provisions of FIFRA and must be used in accordance with label directions. Increasingly restrictive regulations implemented by EPA under the authority of FIFRA, the National Environmental Policy Act (NEPA), presidential order, and the Endangered Species Act have resulted in the near elimination of toxicants legally available for predator damage control.

The only toxicants currently registered for mammalian predator damage control are sodium cyanide, used in the M-44 ejector device, and Compound 1080 (sodium monofluoroacetate), for use in the livestock protection collar. These toxicants are Restricted Use Pesticides and may be used only by certified pesticide applicators. Information on registration status and availability of these products in individual states may be obtained from the respective state's department of agriculture.

Sodium Cyanide in the M-44. The M-44 is a spring-activated device used to expel sodium cyanide into an animal's mouth. It is currently registered by EPA for use by trained personnel in the control of depredating coyotes, foxes, and dogs.

The M-44 consists of a capsule holder wrapped in an absorbent material, an ejector mechanism, a capsule containing approximately 0.9 grams of a powdered sodium cyanide mixture, and a 5- to 7-inch (15- to 18-cm) hollow stake (Fig. 8). For most effective use, set M-44s in locations similar to those for good trap sets. Drive the hollow stake into the ground. Cock the ejector unit and secure it in the stake. Screw the wrapped capsule holder containing the cyanide capsule onto the ejector unit, and apply fetid meat bait to the capsule holder. Coyotes attracted by the bait will try to bite the baited capsule holder. When the M-44 is pulled, the

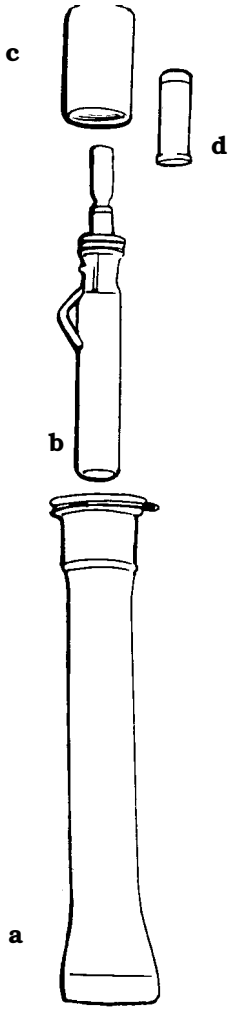


Fig. 8. The M-44 device consists of the (a) base, (b) ejector, (c) capsule holder, and (d) cyanide-containing plastic capsule.

spring-activated plunger propels sodium cyanide into the animal's mouth, resulting in death within a few seconds.

The M-44 is very selective for canids because of the attractants used and the unique requirement that the device be triggered by pulling on it. While the use of traps or snares may present a hazard to livestock, M-44s can be used with relative safety in pastures where livestock are present. Although not recommended, they can also be used in the presence of livestock guarding dogs if the dogs are first successfully conditioned to avoid the devices. This can be done by allowing them to pull an M-44 loaded with pepper. An additional advantage of M-44s over traps is their ability to remain effective during rain, snow, and freezing conditions.

While M-44s can be used effectively as part of an integrated damage control program, they do have several disadvantages. Because canids are less responsive to food-type baits during warm weather when natural foods are usually abundant, M-44s are not as effective during warmer months as they are in cooler weather. M-44s are subject to a variety of mechanical malfunctions, but these problems can be minimized if a regular maintenance schedule is followed. A further disadvantage is the tendency for the cyanide in the capsules to absorb moisture over time and to cake, becoming ineffective. Maximum effectiveness of M-44s is hampered by the requirement to follow 26 use restrictions established by the EPA in the interest of human and environmental safety. The M-44 is not registered for use in all states, and in those where it is registered, the state may impose additional use restrictions. A formal training program is required before use of M-44s. Some states allow its use only by federal ADC specialists, whereas other states may allow M-44s to be used by trained and certified livestock producers.

1080 Livestock Protection Collar. The livestock protection collar (LP collar or toxic collar) is a relatively new tool used to selectively kill coyotes that attack sheep or goats. Collars are placed on sheep or goats that are pastured where coyotes are likely to attack. Each collar contains a small quantity (300 mg) of Compound 1080 solution. The collars do not attract coyotes, but because of their design and position on the throat, most attacking coyotes will puncture the collar and ingest a lethal amount of the toxicant. Unlike sodium cyanide, 1080 is slow-acting, and a coyote ingesting the toxicant will not exhibit symptoms or die for several hours. As a result, sheep or goats that are attacked are usually killed. The collar is registered only for use against coyotes and may be placed only on sheep or goats.

The LP collar must be used in conjunction with specific sheep and goat husbandry practices to be most effective. Coyote attacks must be directed or targeted at collared livestock. This may be accomplished by temporarily placing a "target" flock of perhaps 20 to 50 collared lambs or kids and their uncollared mothers in a pasture where coyote predation is likely to occur, while removing other sheep or goats from that vicinity. In situations where LP collars have been used and found ineffective, the common cause of failure has been poor or ineffective targeting. It is difficult to ensure effective targeting if depredations are occurring infrequently. In most instances, only a high and regular frequency of depredations will justify spending the time, effort, and money necessary to become trained and certified, purchase collars, and use them properly.

The outstanding advantage in using the LP collar is its selectivity in eliminating individual coyotes that are responsible for killing livestock. The collar may also be useful in removing depredating coyotes that have eluded other means of control. Disadvantages include the cost of collars (approximately $20 each) and livestock that must be sacrificed, more intensive management practices, and the costs and inconvenience of complying with use restrictions, including requirements for training, certification, and record keeping. One use restriction limits the collars to use in fenced pastures only. They cannot be used to protect sheep on open range. Also, collars are not widely available, because they are registered for use in only a few states.

Fumigants

Carbon monoxide is an effective burrow fumigant recently re-registered by the EPA. Gas cartridges, which contain 65% sodium nitrate and 35% charcoal, produce carbon monoxide, carbon dioxide, and other noxious gases when ignited. They were registered by the EPA in 1981 for control of coyotes in dens only. This is the only fumigant currently registered for this purpose.

Trapping

There are many effective methods for trapping coyotes, and success can be enhanced by considering several key points. Coyotes learn from past events that were unpleasant or frightening, and they often avoid such events in the future. In spring and summer, most coyotes limit their movements to a small area, but in late summer, fall, and winter they may roam over a larger area. Coyotes follow regular paths and crossways, and they prefer high hills or knolls from which they can view the terrain. They establish regular scent posts along their paths, and they depend on their ears, nose, and eyes to sense danger.

The following describes one method of trapping that has proven effective for many beginners.

Items Needed to Set a Coyote Trap:

1. One 5-gallon (19-l) plastic bucket to carry equipment.
2. Two No. 3 or No. 4 traps per set.
3. One 18- to 24-inch (46- to 61-cm) stake for holding both traps in place.
4. Straight claw hammer to dig a hole in the ground for trap placement and to pound the stake into the ground.
5. Leather gloves to protect fingers while digging the trap bed.
6. Cloth (or canvas) feed sack to kneel on while digging a trap bed and pounding the stake.
7. Roll of plastic sandwich bags to cover and prevent soil from getting under the pan of the trap.
8. Screen sifter for sifting soil over the traps.
9. Rib bone for leveling off soil over the traps once they are set in place and covered.
10. Bottle of coyote urine to attract the coyote to the set (keep urine away from other equipment).

Locating the Set. Coyotes travel where walking is easy, such as along old roads, and they have preferred places to travel, hunt, rest, howl, and roam. Do not set traps directly in a trail but to one side where coyotes may stop, such as on a hilltop, near a gate, or where cover changes. Make the set on level ground to ensure that the coyote walks across level ground to it.

Good locations for a set are often indicated by coyote tracks. The following are good locations on most farms and ranches for setting traps: high hills and saddles in high hills; near isolated land features or isolated bales of hay; trail junctions, fences, and stream crossings; pasture roads, livestock trails, waterways, game trails, and dry or shallow creek beds; near pond dams, field borders, field corners, groves of trees, and eroded gullies; sites near animal carcasses, bone or brush piles; and under rim rocks.

Making the Set. Place three to five trap sets near the area where coyotes have killed livestock.

1. First, observe the area where the losses are occurring and look for tracks and droppings to determine the species responsible. Study the paths used by predators. If you have 4 hours to spend setting traps, spend at least 3 of them looking for coyote sign.
2. Decide where to place the trap sets. Always place them in an open, flat area because of wind currents, dispersion of scent, and visibility. Never place traps uphill or downhill from the coyote's expected path of approach. Look for open places where coyote tracks indicate that the animal milled around or stopped.
3. Place the set upwind from the path (or site of coyote activity) so the prevailing wind will carry the scent across the area of expected coyote activity.
4. Choose a level spot as close as possible to, but not directly on, the coyote's path. The coyote's approach should never be over dry leaves, tall grass, stones, sticks, weeds, or rough ground. Make each set where the coyote has clear visibility as it approaches.
5. Place the set using two No. 3 traps with a cold-shut chain repair link affixed to the top of a steel stake. The link should swivel around the stake top. The stake should be at least 18 inches (46 cm) long, or longer if the soil is loose. Use two stakes set at an angle to each other if the soil will not hold with a single stake.

Figures 9 through 29 illustrate the procedures for making a set.

Fig. 9. A piece of canvas, about 3 feet x 6 feet, used as a kneeling cloth, makes preparing the trap site much easier.

Fig. 10. Kneel down on the cloth and outline a trench approximately 3 feet long, 7 inches wide, and 2 inches deep. Dig the trench so that it runs lengthwise to the prevailing wind.

Fig 11. Dig out the soil with tools and by hand.

Fig. 12. Pile the excavated soil from the trench on the kneeling cloth.

Fig. 13. Place one of the traps on your left leg just above your knee. Grasp the trap spring nearest your right leg as shown, and compress the spring.

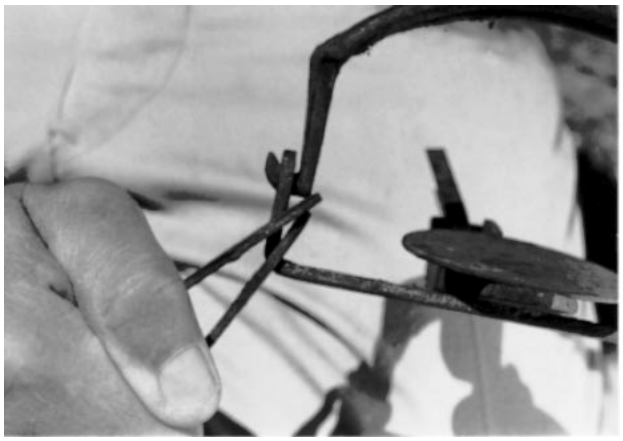


Fig 14. Compress this spring below the jaw hinge, then bend the spring as shown above.

Fig 15. Hold the compressed spring with your right leg as shown above, then compress the left spring. Hold this spring down with your left hand.

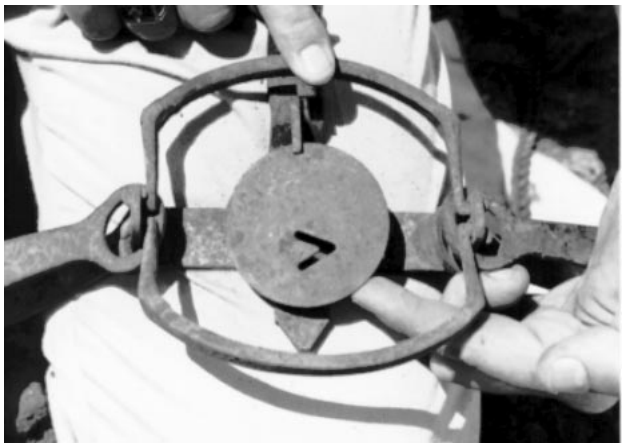


Fig. 16. Carefully spread the jaws. Reach under the jaws with your left hand, holding the pan up while you ease the two springs' tension so that the trap will remain set.

Fig. 17. Twist the springs back toward the trigger. Always set the trap in the ground so that the animal walks into it over the jaw that is nearest to the bottom of the trench, as shown above.

Fig 20. Take out or add soil until the trap pan and jaws are about 1/2 inch below the level of the surrounding ground. Build a ridge for the jaw opposite the trigger to sit on. On the side of the trap that has the trigger, place soil under the trap pan cover on either side of the trigger to hold the pan cover up tight against the bottom of the jaws.

Fig. 18. Drive a steel stake into the center of the trench so that the top of the stake is even with the bottom of the trench. Place one of the set traps at each end of the trench. Place the trap so it sits solidly and will not tip if the coyote steps on the spring or jaws.

Fig 21. Stretch the pan cover tightly across the pan and under the jaws. Pan and jaws should be level and flat. In cold weather, plastic can be placed under the trap. Place plastic baggies on each spring and mix table salt with dry soil or peat moss to cover the trap. Set the other trap as shown above. Place the pan cover so that the dog or trigger can move upward without binding it in. Anything that slows the action of the trap can cause a miss or a toe hold.

Fig. 19. Place canvas, plastic, screen, cloth, wax paper, or a similar material over the pan and under the trap jaws. Be sure the pan sits level with the trap jaws.

Fig. 22. Use a sifter of 1/4-inch hail screen on a wood frame, 7 inches by 10 inches and 2 inches deep. Sift soil from the canvas kneeling cloth over the set, covering the entire trench back to ground level (except directly over the traps).

Fig. 23. The trap should be set about 1/4 inch below the level of the surrounding ground. The set must look natural. The soil around the trap and over the springs, chains, and stake should be packed to the same firmness as the ground the coyote walks on in its approach to the set. Only soft soil should be directly over the trap pan within the set jaw area. Use a curved stick, brush, or rib bone to level soil over the trap.

Fig. 24. Place an object over the buried stake that can be easily seen; the further away it can be seen, the better. Use an old, dried bleached bone, a dried cow chip, a small bush or clump of grass, an old dried root, a small stake, or a stump. The object should be about 6 to 8 inches high and be very visible.

Fig. 25. Place a tablespoon of coyote urine on the projection. When smelling the scent and seeing the projection, the coyote will likely walk directly into the wind and step into a trap as it approaches the projection. A coyote dropping placed nearby will improve the set.

Fig. 26. Carefully brush out all tracks and signs of activity.

Fig. 27. Use the canvas kneeling cloth to carry away all loose soil. This cloth can also be used to carry soil to the set. In summer it is a good idea to store fine dry soil for use in winter. You can often locate dry soil in wet weather under bridges, on cut banks, or in old sheds.

Fig. 28. Discard the material removed from the trap site.

Fig. 29. Leave the trap area as near to its original condition as possible. The coyote's keen sense of sight and smell will quickly alert it to danger.

Always bury the traps and stake in the ground using dry, finely sifted soil. One of the most difficult aspects of using traps is trapping when the ground is frozen, muddy, wet, or damp. If the weather is expected to turn cold and/or wet, you should use one or a combination of the following materials in which to set and cover the traps: Canadian sphagnum peat moss, very dry soil, dry manure, buckwheat hulls, or finely chopped hay. A mixture of one part table salt or calcium chloride with three parts dry soil will prevent the soil from freezing over the trap. When using peat moss or other dry, fluffy material, cover the material with a thin layer of dry soil mixed with 1/4 teaspoon of table salt. This will blend the set with the surrounding soil and prevent the wind from blowing peat moss away from the trap. As an alternative, traps could be set in a bed of dry soil placed over the snow or frozen ground.

Guiding Coyote Footsteps. Use a few strategically placed dirt clods, sticks, small rocks, or stickers around the set to guide the coyote's foot to the traps. Coyotes will tend to avoid the obstacles and place their feet in bare areas. Do not use this method to the extent that the set looks unnatural.

Care of Coyote Traps. New traps can be used to trap coyotes, but better results may be obtained by using traps that have been dyed. Dyeing traps helps prevent rust and removes odors. Wood chips or crystals for dyeing traps are available from trapping supply outlets. Some trappers also wax their traps to prevent them from rusting and to extend the life of the traps.

Inevitably, rusting will occur when traps are in use. It does not harm the traps, but after their continued use the rust often will slow the action of the trap and cause it to miss a coyote. Traps also become contaminated with skunk musk, gasoline, oil, blood, or other odors. It is important that traps be clean and in good working condition. Rusted traps should be cleaned with a wire brush to ensure that the trigger and pan work freely. Check the chain links for open links. File the triggers and receivers to eliminate all rounded edges. Make any adjustments necessary so that the pan will sit level and the trap perform smoothly.

Size of Traps for Coyotes. There are many suitable traps for catching coyotes. Both the No. 3 and No. 4 are good choices. Many trappers prefer a No. 3 coilspring round-jawed off-set trap. It is a good idea to use superweld kinkless chain. The length of chain varies depending on whether the trap is staked or a drag is used. A longer chain should be used with a drag. The off-set jaws are designed to reduce broken foot bones, which can allow the coyote to escape by wriggling out of the trap. Traps with coil springs are good coyote traps, but they require more upkeep than a double longspring trap. The type and size of trap may be regulated in each state. Body gripping traps are dangerous and illegal in some states for catching coyotes. When pet dogs might be present, use a padded-jaw No. 3 double coilspring trap.

While additional testing needs to be conducted, results of research to reduce injury using padded-jaw traps have been encouraging. In tests with No. 3 Soft-Catch® coilsprings, No. 3 NM longsprings, and No. 4 Newhouse longsprings, capture rates for coyotes were 95%, 100%, and 100%, respectively. Soft-Catch traps caused the least visible injury to captured coyotes.

Anchoring Traps. Chain swivels are necessary for trapping coyotes. One swivel at the stake, one in the middle of the chain, and one at the trap are recommended. Drags (Fig. 30) instead of stakes can be used where there is an abundance of brush or trees or where the ground is too rocky to use a stake. Use a long chain (5 feet [1.5 m] or more) on a drag.

Lures and Scents. Coyotes are interested in and may be attracted to odors in their environment. Commercially available lures and scents or natural odors such as fresh coyote, dog, or cat droppings or urine may produce good results. Coyote urine works the best.

Problems in Trapping Coyotes. A great deal of experience is required to effectively trap coyotes. Trapping by experienced or untrained people may serve to educate coyotes, making them very difficult to catch, even by experienced trappers. Coyotes, however, exhibit individualized patterns of behavior. Many, but not all, coyotes become trap-shy after being caught and then escaping from a trap. There is a record of one coyote having been caught eight times in the same set. Some coyotes require considerably more time and thought to trap than others. With unlimited time, a person could trap almost any coyote.

If a coyote digs up or springs a trap without getting caught, reset the trap in the same place. Then carefully set one or two traps near the first set. Use gloves and be careful to hide the traps. Changing scents or using various

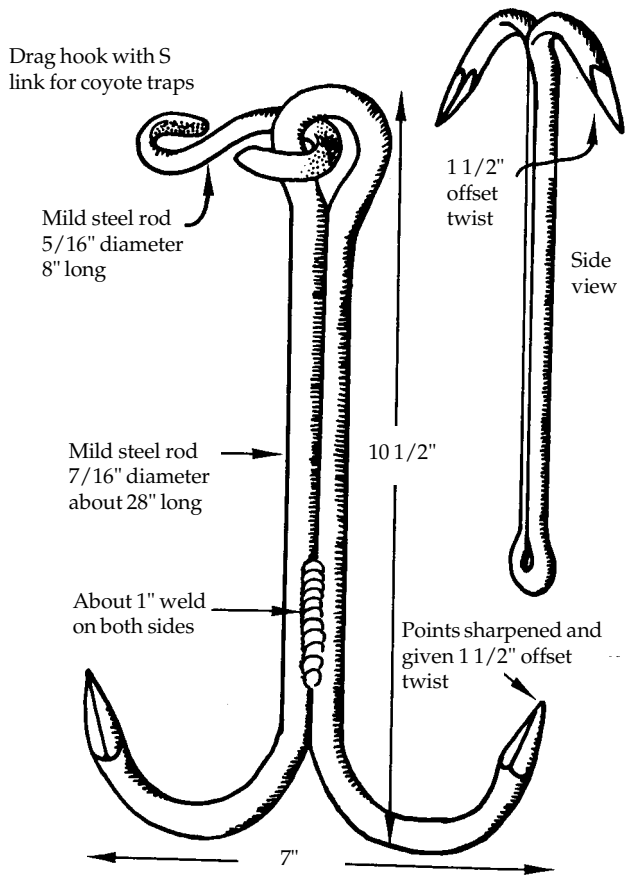


Fig. 30. Trapping drag

tricks, such as a lone feather as a visual attraction near a set, or a ticking clock in a dirt hole set as an audible attraction, may help in trying to catch wary coyotes.

Resetting Traps and Checking Trap Sets. Once a coyote is caught at a set, reset the trap in the same place. The odor and disturbance at the set where a coyote has been caught will often attract other coyotes. Sometimes other coyotes will approach but not enter the circle where the coyote was caught. If signs indicate that this has happened, move the trap set outside of the circle. Leave all sets out for at least 2 weeks before moving the traps to a new location. Check the traps once every 24 hours, preferably in the morning around 9 or 10 o'clock. Reapply the scent every 4 days, using 8 to 10 drops of coyote urine.

Human Scent and Coyote Trapping. Minimize human scent around trap sets as much as possible. If traps are being set in warm months, make sure the trapper has recently bathed, has clean clothes, and is not sweating. Leave no unnecessary foreign odors, such as cigarette butts or gum wrappers, near the set. Wear clean gloves and rubber footwear while setting traps. A landowner may have an advantage over a stranger who comes to set traps since the coyotes are acquainted with the landowner's scent and expect him/her to be there. Coyotes have been known to leave an area after encountering an unfamiliar human scent.

Because of human scent, coyotes are more difficult to catch with traps in wet or humid weather. Wear gloves, wax traps, and take other precautionary measures in areas where humans are not commonly present, where wet weather conditions are common, and where coyotes have been trapped for several years and have learned to avoid traps.

Killing a Trapped Coyote. A coyote will make its most desperate attempt to get out of the trap as a person approaches. As soon as you get within a few feet (m) of the coyote, check to see that the trap has a firm hold on the coyote's foot. If so, shoot the coyote in the head, with a .22 caliber weapon. It is often a good idea to reset the trap in the same place. The blood from the coyote will not necessarily harm the set as long as it is not on the trap or on the soil over the reset traps. Reset the trap regardless of the species of animal captured, skunks included.

Draw Stations. Draw stations are natural areas or places set up intentionally to draw coyotes to a particular location. For example, the straw and cleanings from a chicken house can be placed in an area where coyote tracks are found. Traps can then be set around the edges of the straw. Areas around carcasses or parts of animals, such as a cow's head, are good places to set traps. Wire the carcass to a stake driven into the ground and out of sight. Once coyotes start feeding, set traps 30 to 60 feet (9 to 18 m) upwind from the carcasses or draw station. Never set traps very close to carcasses because nontarget animals such as vultures, eagles, hawks, skunks, and opossums will be caught. If sheep graze in an area where traps are set, cover the traps with a disc blade or brush during the day and uncover them at night when the sheep are penned.

Opposition to Traps. Opposition to foothold traps is based primarily on two objections: (1) a lack of selectivity for the animal which the trap is set for and (2) foot injury sustained by the captured animal. Trap pan tension devices such as sticks, forked twigs, springs, and sponges placed under the trap pan have been used for many years to reduce captures of nontarget species. Many coyote traps have an adjustable pan tension screw. One study evaluated two pan tension devices. Preliminary results indicated that the use of either device could exclude nearly 90% of the gray foxes, swift foxes, striped skunks, opossums, and jackrabbits that stepped on traps,

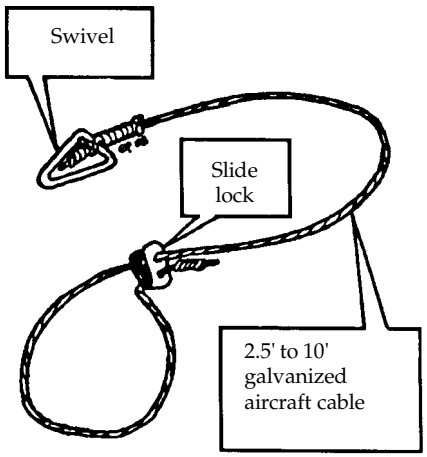


Fig. 31. Coyote snare

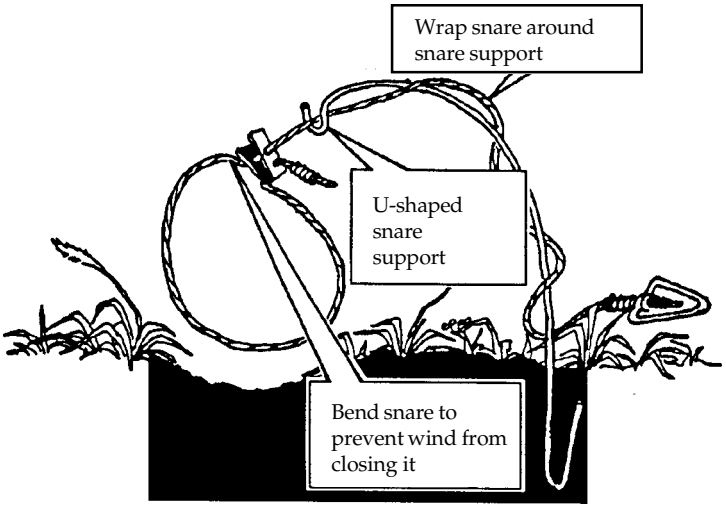


Fig. 33. Setting the snare

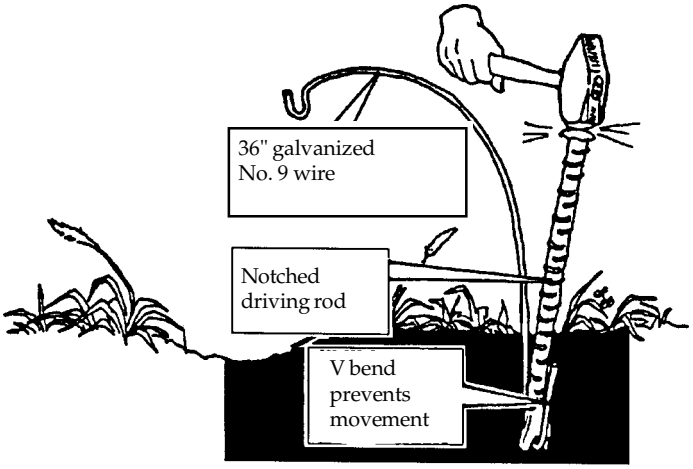


Fig. 32. Driving the support wire

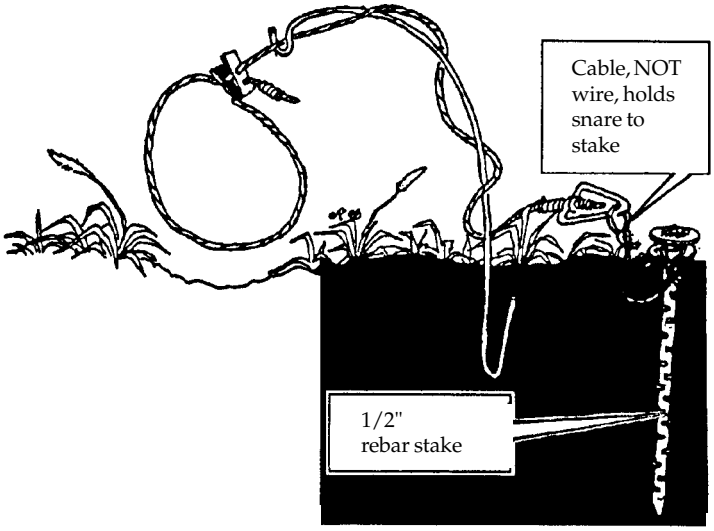


Fig. 34. Fastening the snare to the stake

as compared with 24% on average for unequipped traps. A variety of other species were excluded at even higher rates. Some coyotes were also excluded, but because more traps remained functional, the net result appeared to be an increase in coyote trapping efficiency. Advances in trap design, including off-set jaws and padded-jaw traps, have increased the humaneness of foothold traps. Traps should be checked once or twice each day to minimize the length of time that an animal must remain in a trap.

Snares

Snaring is the technique of setting a steel-cable loop in an animal's path to capture it by the neck, body, or leg. Snares usually consist of a 2.5- to 10-foot (0.75- to 3.0-m) long piece of galvanized aircraft cable containing a slide lock that forms a loop in the cable (Fig. 31). On short snares, a swivel to prevent twisting and breaking the cable is attached to the end of the cable opposite the loop. On longer snares, swivels can be located near the middle of the cable and at one end.

Snares offer several advantages over steel foothold traps. They are light-weight, compact, simple in function, affected little by weather, easy to set, low in cost, and offer a high degree of human safety. In a south Texas study, snares were 10 times more selective over steel foothold traps for target species of coyotes and bobcats. Snares, however, can be a greater hazard than traps to livestock. Recent research has produced deer stops and break-away or relaxing locks that have significantly improved snare specificity.

Preparation of Snares. New commercial snares and extension cables can be cleaned by boiling each dozen snares in a pan or bucket of water with 4 tablespoons (16 gm) of baking soda for one hour. The snares will turn a dull gray after being removed from this bath and hung up to dry outdoors. Darken snares by boiling them in

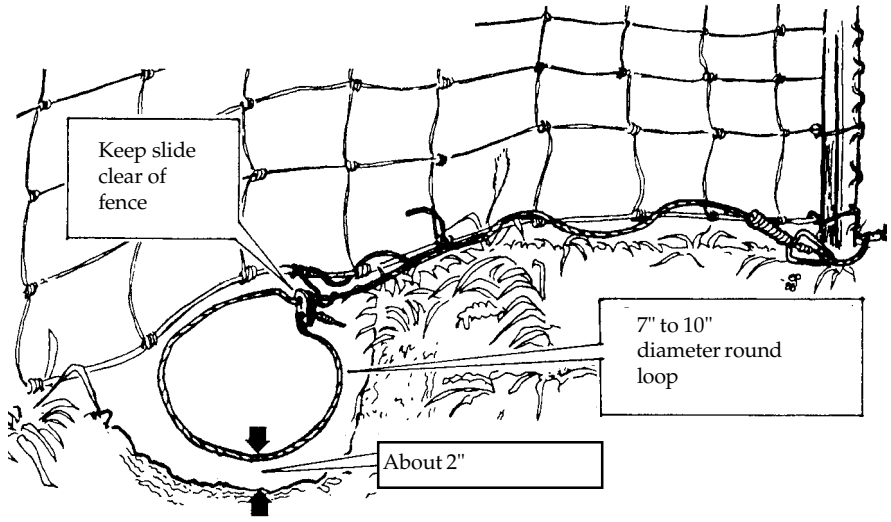


Fig. 35. Snare set for woven wire

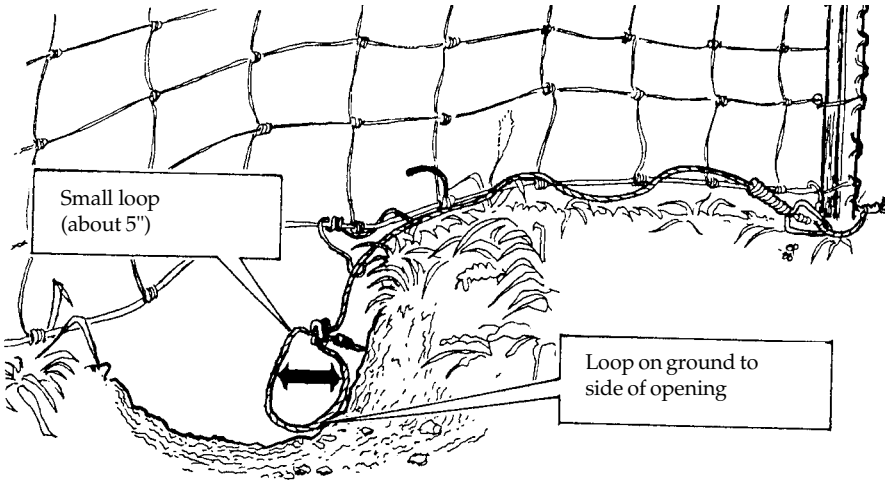


Fig. 36. Leg snare set

brown logwood crystals and dye. After boiling, snares should be kept clean of foreign odors. Wear clean gloves when handling and setting snares.

How to Set Snares. Snares designed to capture predators by the neck or leg are set directly in the animal's path of movement and are held in place using various techniques. One support that works particularly well can be constructed from a 36-inch (0.9-m) piece of 12-gauge galvanized or 9-gauge soft wire. Form a V bend in the support wire, about 4 inches (10 cm) from the end, and drive the wire into the ground with a notched rod (Fig. 32) to prevent the support from moving in the wind. Wrap the snare around the support about three times and hold it in place with a U bend formed in the upper end of the snare support. Bend the snare cable upward slightly, just inside the lock, to ensure that the snare loop is not closed by the wind (Fig. 33).

Snares should be attached to a solid object so that captured animals cannot escape (Fig. 34). A steel 1/2-inch (1.3-cm) diameter rebar, 24 to 30 inches (61 to 72 cm) long (depending on soil hardness), makes a good anchor for coyotes and smaller predators. Attach snares to the rebar with a strong swivel to prevent tangling and breaking. A lead cable that is at least as strong as the snare cable can be used to attach short snares to the rebar stake. Avoid using 9-gauge (0.38-cm) wire or several strands of 14-gauge (0.21-cm) wire to anchor snares to a rebar stake because they may bend back and forth, crystallize, and break. When used for coyotes, snares also can be secured to a dead tree limb that is at least 6 inches (15 cm) in diameter and 6 feet (2 m) long.

Snares set in holes under woven-wire fences can be held in place about 1 to 2 inches (2.5 to 5 cm) from the fence with the snare support system (Fig. 35). The snare should be set far enough away from the fence to prevent the lock from catching on the bottom wire of the fence. The bottom of the loop should be about 2 inches (5 cm) above the bottom of the hole. The snares can be anchored to the heavy-gauge wire on the bottom of the fence. Two strands of baling wire or S hooks can be used to fasten the snare to the bottom wire.

If there is a chance of accidentally catching a pet dog, a leg snare set is recommended (Fig. 36). Set a small loop about 5 inches (13 cm) or less to one side of the opening, and set the bottom of the loop on the ground. When a coyote goes under a fence, it places both front feet firmly on the ground, and sticks its head just under the bottom wire. Once its head is past the bottom wire, the coyote begins to raise its head. The idea is to set the leg snare so that one front foot will pass through the snare.

Snares are usually set in the form of a round or oval loop. In a trail set (Fig. 37), a round loop that is 12 inches (30 cm) in diameter can form an oval loop that is about 14 inches (36 cm) high and 10 inches (25 cm) wide. Use a 5/64- or 3/32-inch (0.2- or 0.24-cm) diameter galvanized aircraft cable for snaring coyotes. Varying round loop diameters and heights above ground is recommended when snaring coyotes (Table 1). The loop size in a hole in a fence should vary depending upon the size of the hole.

Table 1. Specific loop dimensions for snaring coyotes.

Type of set	Round loop diameter in inches	(cm)	Height of loop above ground in inches	(cm)
Trail	9-12	(23-30)	10-12	(25-30)
Under fence	7-10	(18-25)	2	(5)

Where to Set Snares. Animals usually follow the easiest route through heavy cover. These routes, which generally consist of trails, are excellent locations to snare predators. Snares are effective along trails leading to draw stations. Some effective locations for snaring coyotes include: (1) along trails in thickets or heavy vegetation leading to a carcass, (2) on trails under fences, (3) on livestock trails in vacant pastures, (4) in the bottoms of ravines, and 5) on narrow paths inside weeds or brush. Trails can be created by driving on weeds or stubble with a pickup, by walking in snow, or by mowing a trail through weeds or grass with a weed eater.

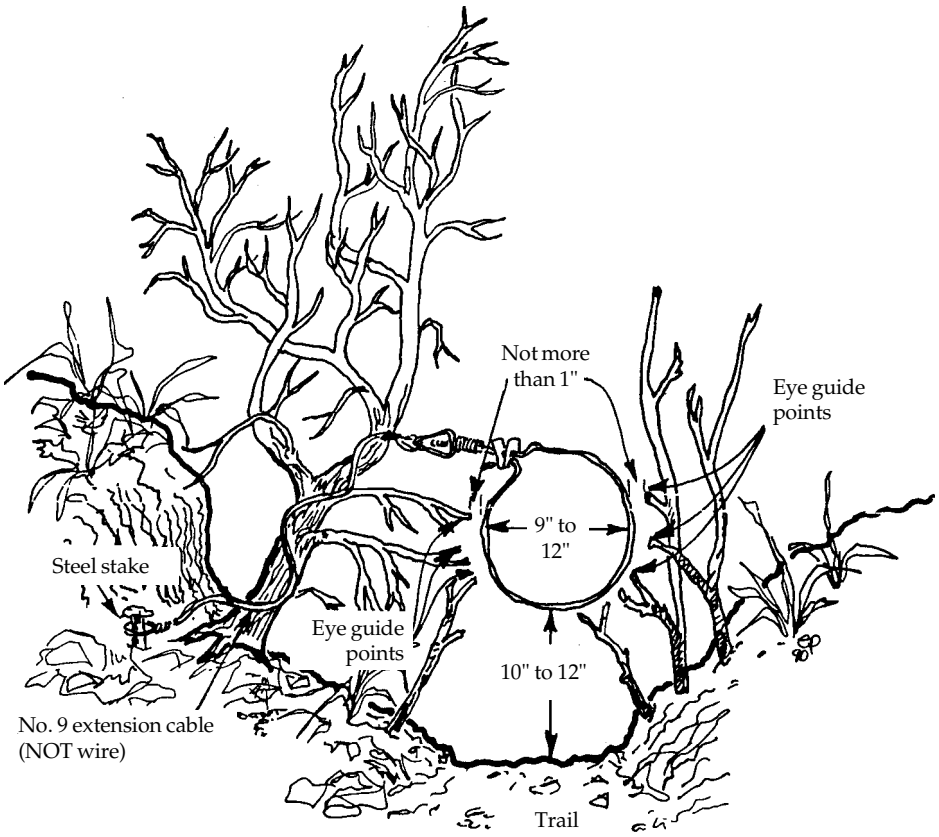


Fig. 37. Trail snare set

Regulations for Snaring. Snares are not legal in all states. Where snares are legal, most states have regulations which require that snares be visually inspected every 24 hours. Snares should be checked early in the morning to increase the probability of releasing nontarget animals unharmed.

Methods to Avoid Capturing Nontarget Animals. Sites where snares are set should be carefully selected to avoid capturing nontarget animals. Avoid setting snares: (1) in pastures with livestock, (2) within 25 yards (23 m) of animal carcasses (to prevent capturing birds of prey and other scavengers), (3) within major deer, elk, or antelope wintering areas (these big game animals are much less susceptible to foothold traps), (4) on any trails being used by livestock, deer, elk, and other nontarget animals (attract predators away from these trails with specific baits and lures), (5) under fences where livestock, antelope, deer, or nontarget dogs are using the "crawl space," and (6) where people can readily view captured animals.

Use a short snare cable to reduce injuries where accidentally captured dogs might jump over a fence or a tree branch. Also avoid using entangling devices (attachments that increase the chance of killing the snared animal) where dogs might be captured. Use the lightest snare lock (breakaway lock) possible to capture the desired animal. If livestock, deer, elk, or antelope are captured by a leg, they can usually break a light lock but may be held by heavy locks. Record the location and number of snares on a map so they can be found, and remove all snares when damage stops or when they cannot be checked frequently.

Shooting

Shooting coyotes is legal in many situations, and it often ranks high among the choices for removing a predator. Safety, however, is a critical factor that in some circumstances may preclude the use of firearms (for example, local laws may prohibit shooting, or neighbors may be too close).

For shooting coyotes, a medium-powered bolt-action rifle fitted with a scope is recommended. The .223 Remington, .22-250, .220 Swift, or the .243 Winchester are all capable of killing a coyote up to a distance of 250 yards (225 m). Since coyotes are able to detect human scent, the shooter should take a stand downwind from where the coyote will likely approach. An elevated location where the lighting works to the shooter's advantage is a good choice. If predators are killing sheep in the daytime, construct a comfortable blind at a vantage point in the pasture where the killing has occurred. Whenever possible, rest the rifle on a solid support while aiming. A homemade shooting stick will improve accuracy over shooting freehand.

A shotgun, preferably a 12-gauge semi-automatic, can be used for shooting at short range (less than 50 yards [45 m]). Often it is advisable to have both a 12-gauge shotgun and a scoped rifle available. Copper-coated (BB) lead shot, No. 4 buckshot (lead), and in newer shotguns, the larger-sized steel shot works well for killing coyotes.

Shooting From Ground Vehicles. Shooting from vehicles (snowmobiles, motorcycles, and pickups) in open, flat prairie country can be effective and provide immediate results. Under most circumstances, however, this method is not practical as it requires keen driving skills, is dangerous, and is illegal in most states.

Calling and Shooting Coyotes. Coyotes may respond to predator calls. Calling, like other methods of predation control, should be used sparingly and only when needed. Coyotes can be called at any time of the day although the first couple of hours after dawn and the last few hours before darkness are usually best. Call in areas where there are signs of coyotes, such as tracks or droppings.

In some situations, coyotes can be located by listening to their howling at sundown and sunrise. Some hunters use sirens to elicit howls from coyotes. Often a voice imitation of a coyote howl works as well. Coyotes often come to a howl without howling back, so the prudent hunter is always ready to shoot.

Hunting at Night. Not many people have witnessed predators killing livestock because it usually occurs at night, away from human activity. As stated previously, calling and shooting predators at night is illegal in many states. Where legal, however, hunting at night with the use of artificial lights may be effective. Red or blue light tends to spook predators less readily than white light does. Calling without the use of artificial lights is effective only with snow cover and the light of a full moon.

Aerial Hunting. The use of aircraft for shooting coyotes is strictly regulated by the provisions of the Airborne Hunting Act and is allowed only under special permit in states where legal. Aerial hunting is selective and allows taking only the target species. Although it is costly, it may be one of the most cost-effective methods of reducing predator damage when all factors are considered. It is often the best method where conditions are right for removing depredating animals that have successfully evaded traditional ground control methods such as trapping.

Fixed-wing aerial hunting is limited primarily to open areas with little vegetative cover. The greater maneuverability of helicopters makes them more useful for hunting in areas of brush, scattered timber, and rugged terrain.

Although aerial hunting can be conducted over bare ground, it is most effective where there is deep snow cover. Animals are more visible against a background of snow and are much less mobile in their attempts to avoid the aircraft. Under optimal conditions of clear, sunny skies and fresh snow cover, much of the hunting can be accomplished by searching for and following fresh coyote tracks. Aerial hunting success can be increased when conducted with the assistance of a ground crew. Before the plane arrives, a ground crew can locate coyotes in the hunting area by eliciting howls with a siren, a mouth-blown howler call, or a voice howl. Two-way radio communication allows the ground crew to direct the aircraft toward the sound of the coyotes, thus reducing hunting time.

Aerial hunting is not recommended for, nor undertaken by, most livestock producers because of the special skills required of both pilot and gunner and the danger inherent with the low-level flight. Although weather, terrain, and state laws limit the application of this method, it can often provide a prompt resolution to depredation problems.

Denning

Predation can frequently be resolved by locating coyote dens and removing the pups and/or the adults responsible for depredations. Denning may also be warranted as a preventive control strategy if coyote predation has historically and consistently occurred in a particular area during the lambing season.

Breeding pairs of coyotes are extremely territorial. They vigorously defend their territories against other canine intruders. Coyotes often den year after year in the same general location. If a particular denning pair of coyotes has a history of existing with and not preying on livestock, it may be to the producer's advantage to leave them alone. Their removal will open up a territory that may become occupied with coyotes that are more likely to prey on livestock.

Although tracking a coyote from a livestock kill back to its den requires skill and persistence, it is probably the most foolproof method to locate the den of the offending animals. If tracking is not feasible because of poor tracking conditions or lack of the required skills, there are alternatives that may be used.

Coyotes will usually howl in response to a howl from another coyote near their den. One or both adult coyotes will often be near the den between 7:30 to 9:00 a.m. A response can be elicited by voice howling, blowing a coyote howler call, or broadcasting recorded calls from a tape player. It is usually best to wait 30 minutes to 1 hour between howls because the same coyotes may not respond again within that period.

Once the approximate location of a den is determined, careful planning is required to ensure the best chance of immediately removing the adult coyotes. The hunter should approach the den unseen and downwind to within calling distance, armed with a high powered rifle and/or repeating shotgun loaded with heavy shot. A call that imitates the whines or yelps of a coyote pup can be very effective under these circumstances, especially when used in conjunction with a dog to act as a decoy. A small- to medium-sized dog moving in the vicinity of the den gives the coyotes something to focus on and reduces the likelihood that the hunter will be detected. The sounds of a pup in distress along with the sight of a dog so near the den will cause most coyotes to display highly aggressive behavior, frequently chasing the dog back to within close proximity of the hunter.

After the adults are removed, the pups can be killed by fumigating the den with a gas cartridge registered for this purpose, or the pups can be dug out by hand. If attempts to shoot one or both adults are unsuccessful, the chances of trapping or snaring them are improved if the pups are left alive and confined in the den. This can be accomplished by driving stakes 2 inches (5 cm) apart down through the den entrance. Carefully place blind sets in the den trails or at the den mound. Capture will often result when the adults return to investigate the area. If the adults are not captured within a reasonable period of time, the pups should be destroyed. Removal of the pups is often effective in stopping predation even if the adult coyotes are not removed.

An airplane can be used very effectively to locate coyote dens when depredations occur in spring or early summer in open prairies or sagebrush terrain. Early morning hours provide the best light conditions for locating adult animals near the den site or as they return from hunting. The low angle light reflects on the coyote and provides good contrast with the surrounding vegetation and soil. Actual den sign, however, shows up better during the middle of the day with light coming from directly overhead. Dens are most easily located after the pups have begun venturing outside. The pups soon trample down the vegetation around the den, making the site more visible from the air. If aerial shooting is legal, it is often possible to remove the adults and pups in one operation. In open terrain, landings can often be made within walking distance of the den.

Although denning requires special skills, training, and often considerable time, the advantages can be significant. A cost-benefit analysis conducted during one study determined that the cost to remove a den of depredating coyotes could be recovered if only 3.6 lambs were saved. In the same study, the average number of lambs killed by each depredating pair of coyotes was 4.9 per week. While these findings indicate that denning could be cost effective after only a few days, the benefits actually continue in most instances for the duration of the season. Denning can be very selective for the offending animals and can resolve some depredation problems at relatively low cost.

Hunting with Dogs. Several breeds are generally known as trailing hounds, including Walkers, Julys, redbones, blueticks, black and tans, Plott hounds, and English fox hounds. Trail hounds follow the scent left by a predator and run it to tree or bay it on the ground. Coyotes are seldom caught and killed by trail hounds. In most instances, trail hounds are used in combination with sight hounds. The trail hounds run coyotes into the open, and then sight hounds are released to capture the fleeing coyote. More commonly, coyotes are shot as they run from the pack of hounds. Sight hounds, generally greyhounds or Russian wolf hounds, are used in open prairie country to run coyotes down and kill them.

Economics of Damage and Control

Sheep numbers in the United States have declined about 80% from 1942 to 1976 (Gee et al. 1977). Former sheep producers reported that the principal reasons for leaving the sheep industry included high predation losses, low lamb and wool prices, a shortage of good hired labor, and the producer's age.

The US Fish and Wildlife Service (1978) estimated the economic impact of coyote predation on producers with predator problems, on producers without predator problems, and on consumers during 1977. They used an average lamb loss rate of 4% (267,000 lambs) and a ewe loss rate of 1.5% (125,000 ewes) to estimate an economic loss of $19 million to producers from coyote predation in the 17 western states. The reduced number of sheep and lambs resulted in a higher market price, which benefited producers by $6 million. The net impact of coyote predation on sheep producers was a loss of $13 million, and the impact on consumers was $4 million in additional costs. The General Accounting Office (GAO 1990) estimated that coyotes in 17 western states killed sheep and lambs valued at $18 million in 1989. The National Agricultural Statistical Service (NASS 1991) reported that sheep and lamb losses to coyotes in the United States were valued at $18.3 million in 1990.

The US Fish and Wildlife Service (1978) reported calf losses between birth and weaning to coyotes across the United States at 0.4%, with predation decreasing to nearly zero by weaning time. Dorrance (1982) reported that coyotes were responsible for 16% of the 1,520 confirmed predation losses of cattle in Alberta from 1974 to 1978. Coyote predation on calves caused producers with coyote problems across the United States to lose an estimated $20 million. However, because of the greater price flexibility of beef compared with sheep, the reduction in the number of beef calves marketed (estimated at 0.4%, or 115,000 fewer calves) resulted in a higher price, which benefited beef producers by $81 million. The net impact of the reduced supply of beef as a result of coyote predation was a gain of $61 million to beef producers, but it cost consumers an additional $98 million in higher prices for beef, resulting in an overall loss of $37 million. NASS (1992) reported that cattle and calf losses to coyotes in the United States were valued at $24.3 million in 1991.

Coyote predation also can cause substantial losses of domestic goats. In three studies in Texas, where an estimated 1.1 million goats (about 90% of the goats in the United States) are raised (Scrivner et al. 1985), predators were reported to take 18.1% of the adults and 33.9% of the kids (Pearson 1986). NASS (1991) reported that goat losses to coyotes in the United States were valued at $5.7 million in 1990.

Pearson (1986) stated that predators, particularly coyotes, accounted for

losses of hundreds of chickens and turkeys in the 14 western states. In one study, Andelt and Gipson (1979) reported that between June 4 and August 31, 1976, a mated pair of coyotes apparently killed 268 domestic turkeys in Nebraska valued at $938.

Although the average value of livestock losses to coyotes reflected the overall impact on producers, it did not reflect the severity of losses to some individuals. Balser (1964) and Gee et al. (1977) indicated that coyote predation is much more serious for some producers than others. Most sheep producers suffer no or minor predator losses, whereas 20% to 25% of the producers suffer losses that are significantly higher than the average (US Fish Wildl. Serv. 1978). These losses can drive producers out of business because of low profit margins. Nonfatal injuries and harassment of livestock by coyotes also can result in reduced weight gain and subsequent reductions in profit.

Acknowledgments

Much of the information and several of the figures for this chapter were adapted from the *SID Sheep Production Handbook,* Predator Damage Control chapter, published by the American Sheep Industry Association, Inc. (1990) and various publications authored by F. R. Henderson, J. S. Green, W. F. Andelt, G. E. Connolly, and D. A. Wade.

The section on economics of damage and control was adapted from Andelt (1987).

Figure 1 by Emily Oseas Routman.

Figure 6 adapted from a USDA-APHIS-ADC illustration by Renee Lanik, University of Nebraska-Lincoln.

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Editors

Scott E. Hygnstrom
Robert M. Timm
Gary E. Larson