# Capítulo 12
# Depredation management techniques for coyotes and wolves in North America: lessons learned and possible application to Brazilian carnivores

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# Introduction

Many carnivore populations throughout the world are declining due to expansion of human populations, habitat loss and fragmentation, illegal poaching, competition with other predators, legal hunting, introduction of exotic species, disease, declines in native prey, and increased competition with livestock and other human land uses (SCHALLER, 1996). In Brazil, detailed knowledge of carnivore-human interactions and conflicts involving livestock is an emerging, but necessary, element for the conservation of many species. A major obstacle facing conservation efforts, reintroduction programs, and recovery plans for many carnivore species throughout the world is the continual issue of depredations by carnivores on agricultural interests (MECH, 1996). In the United States, efforts to reintroduce and/or recover wolves (*Canis lupus*) and grizzly bears (*Ursus arctos*) in the northern Rocky Mountains has been met with much opposition by the livestock industry with depredations on livestock cited as the main reason for resistence. Gaining local support for carnivore conservation and swiftly dealing with depredation problems will always be an issue for biologists and managers as human populations continue to expand into and reduce carnivore habitat, and conflicts between humans and carnivores increase (MECH, 1996).

Predation on domestic livestock and poultry by carnivores is a historical and continuing problem faced by agricultural producers throughout the world (HARRIS; SAUNDERS, 1993). In the United States alone, producers lost 273,000 sheep and lambs valued at $16.5 million to predators in 1999 (U.S. DEPARTMENT OF AGRICULTURE, 2000). These losses to predators represented 36.7% of total losses to all causes. In 1999, depredations on sheep and lambs were principally caused by coyotes, *Canis latrans* (61%), dogs (15%), mountain lions, *Puma concolor* (6%), and bobcats, *Lynx rufus* (5%). Losses of sheep and lambs due to specific predators varie geographically (Table 1). Cattle and calf losses to predators in the U.S. totaled 147,000 head during 2000 with an estimated loss of $51.6 million (U.S. Department

of Agriculture, 2001). Coyotes caused 64.6% of predator losses on cattle and calves, followed by dogs (18%), and mountain lions and bobcats (7% combined). The loss of goats to all predators was estimated to be about $3-4 million annually. While losses of poultry to predators are not well documented, they are considered to be substantial.

The coyote is a generalist carnivore that adapts to landscape modifications and is actually doing better today (in terms of population size and distribution) than when North America was first settled by Europeans. Wolves are increasing in the northern Rockies and Great Lakes region due to federal protection and reintroduction programs. Wolves are doing so well in parts of the U.S. they were downlisted from Endangered to Threatened status in 2003 (FEDERAL REGISTER, v. 68, n.. 62, April 1, 2003). As stated previously, coyotes are a leading cause of depredations on domestic livestock in North America. As such, the coyote has received considerable attention and persecution (current estimate: >100,000 coyotes removed annually in the U.S.) in an attempt to reduce depredation losses (Wagner, 1988). Due to public pressure and increasingly fragmented ranch/farm operations, large-scale population reduction programs are becoming less pronounced (WAGNER, 1988, KNOWLTON et al., 1999). In contrast, techniques that are more benign and focus on solving the actual depredation problem are receiving more attention. Non-lethal techniques are becoming more popular and are readily accepted by the general public (ARTHUR, 1981; REITER et al., 1999). However, after >40 years of research on methods to reduce predation (FALL; MASON, 2002), it is quite clear that protecting livestock from carnivores is a complex endeavor with each depredation event and management situation requiring an assessment of the legal, social, economic, biological, ethical, and technical aspects (KNOWLTON et al., 1999). No one technique will solve the problem in all circumstances. Successful resolution of conflicts with predators involves an analysis of the efficacy, selectivity, humaneness, and efficiency of all the various management scenarios available (CLUFF; MURRAY, 1995; KNOWLTON et al., 1999).

Control techniques may be considered either corrective (after a depredation event) or preventive (before the event). Techniques can also be classed as lethal or non-lethal. Some techniques can be further classed as either selective or non-selective. Selectivity of the technique is extremely important when attempting to actually solve the depredation problem. General population reduction through lethal means may not solve the depredation problem (CONNOR et al., 1998). Techniques that selectively remove the offending individual (SACKS et al., 1999a, b; BLEJWAS et al., 2002) are preferred over non-selective techniques that the killers may avoid. However, identifying the "problem" animal can be very difficult (LINNELL et al., 1999). Methods that are more selective for the target species are also preferred (KNOWLTON et al., 1999).

The purpose of this paper is to present the various techniques that were developed to reduce or prevent depredations on livestock by coyotes and wolves in North America. These techniques are the result of decades of research, evaluation, and funding (FALL; MASON, 2002). While the techniques were developed for coyotes and wolves, depredation problems for many carnivore species in Brazil may also be controlled in similar situations. Most of these techniques have direct application to carnivores in Brazil of similar body size (Table 2) and behavioral characteristics, and would be useful for depredation problems involving many of the different species of felids and canids in Brazil.

# Determination of predation

One of the first priorities when dealing with carnivore-livestock conflicts is determining or verifying the species responsible for the predation event (FRITTS, 1982). Examination of the carcass and surrounding kill site requires careful observation (WADE; BOWNS, 1984: ACORN; DORRANCE, 1998). Determining the cause of death is best done when the carcass is fresh (WADE; BOWNS, 1984; DOLBEER et al., 1994). Skinning out the carcass, particularly around the head, throat, neck, and flanks, will generally reveal hemorrhaging in the tissue if the victim was killed by a predator. Animals that die and then are fed on by a carnivore (but not killed by a predator), will not show hemorrhaging. For animals that are considered to have been depredated, the location of the attack site, presence of blood, trampled vegetation, size and spacing on canine punctures, claw marks causing hemorrhaging under the skin, presence of scats and tracks, and even the behavior of the herd (alert or nrevous livestock, injured stock, females calling or searching for young), will assist in determining if predation occurred and who the culprit may have been (O'GARA, 1978; WADE; BOWNS, 1984; DOLBEER et al., 1994; ACORN; DORRANCE, 1998). Many carnivores will scavenge carcasses and should not be confused with predation.

Maintaining records of depredation events in a centralized location will allow agencies to develop databases on the magnitude of the depredation problem. In the U.S., the National Agricultural Statistics Service (USDA) maintains and compiles the livestock losses due to predators. This database then provides an avenue for examining the severity of the problem, geographical distribution, the predatory species responsible, the vulnerability of particular type and ages of livestock, the monetary value of the losses, and where management actions may be warranted in the future. This database also compiles the efforts by livestock producers in terms of what techniques they employ to prevent or reduce depredations (particularly non-lethal methods), the costs of employing those methods, and the frequency of such efforts. This database is summarized annually and published (U.S. DEPARTMENT OF AGRICULTURE, 2001).

# Predator management in the U.S.

The various techniques for managing predation discussed below are the result of decades of changing attitudes and ideas. The history of predator management in the U.S. is certainly one of shifting paradigms (WAGNER, 1988). Over 300 years ago and up to about the 1930's, the main belief in predator management was "kill them all." Protection of livestock and big game herds was the principle motivation for the mass killing of predators throughout North America. Much of this attitude was a carryover of European beliefs in wildlife management (WAGNER, 1988) and ideals on providing protection for stocks (both domestic and native). In the late 1930's, some biologists and ecologists began to question these beliefs and proposed that predators had a place in the environment and a role to play in maintaining healthy and robust game populations (WAGNER, 1988; CLARKSON, 1995). At this time the general public was apathetic toward predators and protection of livestock was still viewed largely as justification to kill predators.

With the coming of the environmental movement in the 1960's and passage of the Endangered Species Act in the early 1970's, there began to be an understanding and demand by the general public to begin to question and rethink the past perceptions of predators (LEOPOLD, 1964; HORNOCKER, 1972; WAGNER, 1988, CLARKSON, 1995). As the general populace shifted from rural to urban, public opinion of predators became more favorable, and reintroduction, management, and preservation of large carnivores became a controversial issue in many states (WAGNER, 1988; CLARKSON, 1995; MECH, 1996). With these changing attitudes towards conservation of predators, demand for more humane techniques and non-lethal methods grew (ARTHUR, 1981; REITER et al., 1999). Where once agencies removed predators with mass population reduction programs, these same agencies were now being told to be selective and work on a smaller scale. One of the primary aspects of lethal control is that it generally must be reapplied each year. Selective (site or individual specific), yet lethal, removal is now preferred over wide-spread removal programs (FRITTS et al., 1992; JAEGER et al., 2001). In contrast, it is hoped that some non-lethal techniques will prevent the depredation problem from beginning, possibly last several years, and not need application yearly (e.g., reproductive interference).

Solving the actual depredation problem without removing the predator lead to the development of more non-lethal techniques. While lethal techniques are still employed and will be discussed, focus and demand is shifting to non-lethal techniques (REITER et al., 1999; FALL; MASON, 2002). It should be emphasized that for coyotes, depredation control is a management issue, not a conservation issue (KNOWLTON et al., 1999). In contrast, depredation management for wolves is principally a conservation issue to reduce conflicts with livestock and the rural community (MECH, 1996).

# Lethal techniques

The concept of lethal control of predators was indeed the first and sometimes only, consideration when Europeans settled North America. The land was big, untamed, and predator populations seemed endless. As such, most lethal techniques have been around a long time (e.g., steel traps). Today, many lethal techniques require special training, certification, or licensing in order to use. Several methods are best left to professional specialists trained in wildlife damage management. Some techniques are available for use by livestock producers, but local regulations need to be checked before implementing any of these lethal techniques. Lethal techniques are viewed less favorably by the general public to control predators than non-lethal methods (ARTHUR, 1981).

*Livestock protection collar* – Livestock protection collars (LPC's) consist of rubber pouches or bladders filled with Compound 1080 attached around the throat of lambs and kid goats (ACORN; DORRANCE, 1998). The LPC is designed to kill predators when they puncture the bladders during an attack on a lamb or kid. The main advantage of LPC's is that they kill the problem animal and frequently kill individual predators that have evaded other control techniques (CONNOLLY; BURNS, 1990; BURNS et al., 1996; BLEJWAS et al., 2002). The LPC comes in two sizes, large and small, with the larger LPC working effectively on larger lambs. The major disadvantages of LPC's are the initial purchase costs and labor required to place the collars of the lambs or kids, the collar being punctured by thorns, wire, or snags, anticipating which lambs or kids are most likely to be attacked (use of a sacrificial herd has been tried with limited success), and the required training and accountability of the collars (ACORN; DORRANCE, 1998; KNOWLTON et al., 1999). Because of the use of compound 1.080 in these collars, generally their application is limited and may require assistance or training from agency personnel.

*M-44* – M-44 is a mechanical device that ejects sodium cyanide into an animal's mouth after they pull on the device (CONNOLLY, 1988; ACORN; DORRANCE, 1998). Because of the use of cyanide as the poisoning agent, application of this technique in the U.S. generally requires certified agency personnel. M-44 consists of a holder wrapped with cloth, fur, wool, or steel wool; a plastic capsule or case that holds the cyanide; and a spring-loaded unit that ejects the cyanide. When assembled, the components are encased in a tube driven into the ground and baited with fetid meat, a lure, or tallow (DOLBEER et al., 1994). When an animal tries to pick up the bait with its teeth, the cyanide is ejected into its mouth. Non-target species are sometimes attracted to the bait used on M-44s; however, species specificity can be enhanced by proper site and lure selection (DOLBEER et al., 1994). A study on coyotes in California found that M-44 was not a selective technique in targeting or removing the breeding animals involved in sheep depredations (SACKS et al., 1999b; JAEGER et al., 2001).

*Aerial hunting* – Aerial hunting is a commonly used method for reducing predator numbers (WAGNER, 1988; CLUFF; MURRAY, 1995). Different types of fixed- and rotary-wing aircraft have been used to control wolves, coyotes, bobcats, and foxes in North America. A 12-gauge semiautomatic shotgun is most commonly used with number 4 buck-shot, BB, or number 2 shot. Aerial hunting can be more efficient if a ground crew works with the aircraft. The ground crew induces coyotes to howl by using a horn, siren, voice, or recorded howl. When animals respond, the aircraft is directed to the area by two-way radios. Early morning and late afternoon appear to be the most productive times for aerial hunting. In the U.S., federal law requires each state to issue aerial hunting permits; some states also require low-level flying waivers. This technique is usually performed by trained agency personnel and pilots.

*Denning* – Denning was an effective method to reduce wolf numbers in Canada (CLUFF; MURRAY, 1995), but is no longer practiced due to the public viewpoint that it kills the innocent. In the intermountain west of the U.S., the removal of pups from the den to reduce depredations by coyotes is still practiced (WAGNER, 1988). Increased depredations of livestock (mainly lambs) during the spring and summer by coyotes may indicate that a pair of adults is provisioning a litter of pups nearby (TILL; KNOWLTON 1983). Removal of only the pups and leaving the adults in place was equally effective in reducing depredations as removing both the pups and adults (TILL; KNOWLTON, 1983). Den hunting is difficult and time-consuming, particularly on hard ground and in heavy cover (DOLBEER et al., 1994). Some people use a dog to locate the den. Caution should be taken while digging out dens because of cave-ins. Use of a chemical smoke cartridge is often employed to remove the pups. An alternative to denning is the use of sterilization (see *Reproductive Interference*) which worked effectively without the requirement of finding the den every year and the effects lasted several years (BROMLEY; GESE, 2001a,b).

*Box traps* – Trapping the problem animal is a technique that producers can often do themselves. Regulations should be consulted as there may be restrictions of the type of trap that can be used. Box traps are available from several companies in various sizes, materials, and configurations to capture various sizes of predators. Generally, most large predators are difficult to capture in box traps because of their caution and reluctance to enter the confined area of a trap, but can work effectively with smaller carnivore species (DOLBEER et al., 1994).

*Leg-hold traps* – Steel leg-hold traps have been used for centuries to remove problem carnivores (WAGNER, 1988, CLUFF; MURRAY, 1995). Setting of leg-hold traps does require a bit more experience than setting box traps, but is still a technique that producers can do themselves. Local trappers will often offer instruction in the proper use and setting of traps. In the U.S., regulations vary among states on the types of traps, baits, sets, and

trap visitation schedule allowed. In the U.S., some states no longer allow the use of leg-hold traps. Leg-hold traps are manufactured in various sizes for capture of different carnivore species (DOLBEER et al., 1994). Modification of traps (e.g., padded jaws) and attachment of a trap tranquilizer device can diminish injuries to the animal (SAHR; KNOWLTON, 2000). Tension devices should be used to exclude non-target species (PHILLIPS; GRUVER, 1996). Selectively removing the offending animal causing the depredations with a trap can be difficult (SACKS et al., 1999b; JAEGER et al., 2001). Success in trapping really depends on the placement of the trap (along travel routes such as dirt roads and trails). The trap can be set unbaited on a trail, or set off the trail and baited with a lure, bait or natural substance (scat or urine). The type of lure and trap location are very important in selectively targeting the intended species (DOLBEER et al., 1994). When placed beside a carcass, a trap can catch non-target animals (e.g., vultures, eagles, badgers). In the U.S., many states no longer allow trapping in the vicinity of a carcass.

*Calling and shooting* – Calling and shooting can be used as a means to control certain predators (COOLAHAN, 1990). Calling and shooting, with or without the help of lure dogs, can be a selective means of removing the offending animals that kill livestock, particularly during the denning and pup-rearing seasons (SACKS et al., 1999b). Commercial calls and recorded calls are available from various manufacturers. Predator or duck calls that imitate the sound of a rabbit in distress work well, but require some practice. Some individual predators can become wise to the call. Conversely, the call may be an effective method to remove a trap-wise animal. Some recommendations when trying to call in a predator: (1) Ensure that the area being called is upwind to prevent the predator from detecting the caller's scent. (2) Have a full view of the area so that the predator will be unable to approach unseen. (3) Avoid being seen by wearing camouflage clothing and hiding in vegetation. (4) Most effective times to call predators are early morning and late afternoon (DOLBEER et al., 1994).

*Hunting dogs* – The expense of hunting dogs often precludes the use of this technique for most producers, but a local houndsman may be employed to remedy a predation problem. Two types of dogs can be used (DOLBEER et al., 1994). Dogs that hunt by sight, such as greyhounds, which are kept in a box or cage until the predator is seen, then released to catch and kill the animal (effective only in open terrain). The other type of dog is the trail hound, which follows an animal by its scent. Trail hounds hunt on bare ground; however, heavy dew can make trailing easier. Hot, dry weather makes trailing difficult; therefore, early morning is the most effective time. Several breeds such as bluetick, black and tan, Walker, and redbone, in packs of 2-5 dogs are used as trail hounds. Trained trail hounds are used to catch and "tree" predators (e.g., raccoons, opossums, bears, and cougars). Often these dogs are able to track the offending animal from a kill, thus making this control method highly selective.

*Snares* – Similar to trapping, snaring is a technique that can be implemented by producers themselves, but also requires some level of expertise to be successful and not educate the problem animal by being inexperienced setting a proper snare (DOLBEER et al., 1994). Snares are made of varying lengths and sizes of wire or cable looped through a locking device that allows the snare to tighten. There are generally two types of snares: body and foot. The body snare is used primarily on coyotes and foxes. This snare is set where the animals crawl under a fence, at a den entrance, or in some other narrow passageway. The foot snare has been used to capture large predators and is spring-activated (LOGAN et al., 1999). When the animal steps on the trigger the spring is released, lifting the noose and tightening it around the foot. Deer and livestock can be prevented from interfering with the snare with a pole or branch placed across the trail (0.9 m above the ground). The selectivity of the foot snare may be improved by placing sticks under the trigger that break only under the weight of the heavier animals. Open-cell foam pads can be placed under the trigger pan to prevent unintentional triggering of the snare by small mammals (LOGAN et al., 1999). Foot snares have advantages over large traps because they are lighter, easier to carry, and less dangerous to humans and non-target animals (DOLBEER et al., 1994).

*Sport hunting* – Sport hunting or public harvest of large carnivores as a management technique is practiced in the U.S. and Canada (BOERTJE et al., 1995). In several African countries, sport hunting of large cats provides a financial incentive for ranchers to keep predators that may otherwise cause unacceptable livestock problems in their area. Rather than losing money to these predators, the rancher can profit from their presence. Setting up lodging and guide services can provide ranchers with increased revenue and make these large predators an asset rather than a liability. Permits and harvest quotas would need to be closely regulated to maintain a harvestable predator population. These hunts can also provide funds for conservation of these predators in areas where recovery is still an issue. Returning some of the profits of these hunts back to the local community can also increase tolerance of these large predators by local farmers and producers.

# Non-lethal techniques

Most non-lethal procedures fall within the operational purview of the agricultural producer. Most livestock producers (83%) utilize at least one non-lethal method to prevent or reduce predation (Table 2). During 1999, producers spent $8.8 million on non-lethal methods to protect sheep and lambs, and $184.9 million to protect cattle and calves (U.S. Department of Agriculture, 2000). While there are reports of success with some non-lethal methods, failures are common, few have been subjected to critical evaluation or testing, and none have proven universally successful (KNOWLTON et al., 1999).

*Livestock husbandry practices* – One of the first lines of defense against depredations that a livestock producer can enact themselves is examining, and perhaps modifying, their animal husbandry practices (ROBEL et al., 1981; FRITTS, 1982; WAGNER, 1988; ACORN; DORRANCE, 1998). Several livestock management practices have been suggested as a means of reducing depredation losses. As a general rule, the more time you spend with your livestock, the less likely a predation event will occur. Several recommendations follow: (1) Using herders is a time-tested tradition that can alleviate predation. (2) Dead livestock can attract coyotes and other predators. Thus, removal or burial of carrion will not encourage predators to remain in the area and perhaps kill livestock (FRITTS, 1982). Taking carcasses to a rendering plant can also be useful, although rendering plants generally will not accept sheep carcasses because the wool fouls the rendering equipment. (3) Confining or concentrating flocks during periods of vulnerability (for example, at night or during lambing) can decrease depredation problems. Calves and lambs are very vulnerable after birth, as well as ewes or cows following a difficult birth. Removing the afterbirth or stillborn lambs and calves can also reduce attractiveness of the area following a birth. Lambs that are weak or light-weight are especially vulnerable to predators and confining them for 1-2 weeks will reduce their potential to be killed. (4) Shed lambing, synchronizing birthing, and keeping young animals in areas with little cover and in close proximity to human activity will also reduce the risk of predation. The largest drawback of these procedures is that they generally require additional resources and effort, and may only delay the onset of predation (FRITTS et al., 1992, KNOWLTON et al., 1999). For these methods to be effective, producers must develop strategies that will work for their own situations.

*Guard dogs* – The use of guard dogs to deter coyotes and wolves from livestock has been a traditional use by many livestock producers, particularly in fenced pastures, and is gaining increased acceptance and use throughout the livestock industry (CLUFF; MURRAY, 1995; COPPINGER; COPPINGER, 1995; ACORN; DORRANCE, 1998). In Colorado, 11 sheep producers estimated that their guard dogs saved them an average of $3,216 of sheep annually and reduced their need for other predator control techniques (ANDELT, 1992). Several key points should be made with regards to guard dogs: (1) The dog breeds most commonly used as livestock guardians include the Great Pyrenees, the Komondor, the Akbash, the Anatolian shepherd, the Shar Planinetz, the Kuvasz, and the Maremma. While there does not appear to be one breed of dog that is most effective, livestock producers rated the Akbash as more effective at deterring predation because it is more aggressive, active, intelligent, and faster (ANDELT, 1999). The Great Pyrenees is the most common guard dog breed used to protect flocks of sheep in Alberta (ACORN; DORRANCE, 1998). (2) Studies investigating the effectiveness of guard dogs have shown the dogs to be effective in some situations and ineffective in others (LINHART et al., 1979; COPPINGER et al., 1983; GREEN et al.., 1984; GREEN; WOODRUFF, 1987; COPPINGER; COPPINGER, 1995; ANDELT;

HOPPER, 2000). This disparity may be due to the inherent difficulty of guard dogs to effectively protect large flocks that are dispersed over rough terrain and in areas where thick cover conceals approaching predators. Thus, the effectiveness of guard dogs can be enhanced by confining flocks to more open pastures which allow a good view of the area. (3) Training and close supervision of the dogs seem important for this technique to be successful. Introducing the dogs to the flock at an early age (a pup at 7-8 weeks of age) seems to increase their effectiveness by bonding the dog to the sheep. (4) Check for reputable breeders when purchasing a pup. Some breeders will certify their dogs to be free from hip dysplasia and some will even guarantee replacement of a dog if it fails to perform properly.

Some poorly trained or supervised guard dogs have killed sheep and lambs, harassed or killed wildlife, and threatened people that intrude into their area. As compared to guard llamas, a main drawback of guard dogs is the need to feed and water the dog in the area containing the sheep and the possible bonding of the dog to humans if the flock is near human habitation. Another disadvantage is that the use of guard dogs precludes the use of other control devices (e.g., traps, snares, M-44's) and techniques (e.g., calling and shooting). Dogs can be killed or injured by poisons, snares, and traps used for predator control. In recent tests using 4 guard dogs together to protect calves from wolves in Montana, the wolves (about 50-60 kg body weight) eventually killed all 4 dogs in the pasture and continued to depredate calves.

*Guard llamas* – The use of llamas for protecting livestock from predators is growing in popularity. Studies have found llamas to be a practical and effective technique to deter predators from depredating livestock (FRANKLIN; POWELL, 1994; MEADOWS; KNOWLTON, 2000). The llamas behavioral trait of chasing predators out of pastures is likely a result of its evolution with native predators in South America. A major advantage of guard llamas is that they can be kept in fenced pastures with sheep or goats, do not require any special feeding program, are relatively easy to handle, and live longer than guard dogs (KNOWLTON et al., 1999). Several recommendations have been made when using llamas as livestock guardians: (1) Do not use an intact male as they may kill or injure ewes when attempting to breed with them. Female llamas also do not appear to work well and may be aggressive towards the stock they are supposed to be protecting. (2) Using 2 or more llamas in single or adjacent pastures is also discouraged as they will bond with one another and ignore the sheep. (3) Traits that may be useful in selecting a llama for use as a livestock guardian include leadership, alertness, and weight of the llama (CAVALCANTI; KNOWLTON, 1998). (4) Finding a reputable breeder is a good precaution when looking to purchase a guard. (5) Flocks in pastures with heavy cover may reduce their effectiveness similarly to guard dogs. Open pastures with good visibility are the best situations for guard animals to effectively operate. Attempts to use llamas to protect calves from wolves have been met with limited success with wolves reducing visitation in some

pastures, while in other cases the wolves killed the guard llama. This technique would probably not be useful for jaguars (*Panthera onca*) due to their innate predatory abilities (i.e., they would probably kill the guard animal).

*Guard donkeys* – Similar to guard llamas, donkeys have also been used as livestock guardians (GREEN, 1989; ACORN; DORRANCE, 1998). The protective behavior displayed by donkeys apparently stems from their apparent dislike of dogs. A donkey will bray, bare its teeth, chase and try to kick and bite any canid (including ranch dogs). Recommendations on the use of donkeys as livestock guardians include: (1) Use only a jenny or gelded jack (intact jacks are too aggressive towards livestock). (2) Use one donkey per flock or group and keep other donkeys or horses away or the animal will bond with them. (3) The donkey should be introduced to the livestock about 4 to 6 weeks prior to the onset of predation to properly bond with the group. (4) Donkeys are most effective in small, fenced pastures. (5) Check with a reputable breeder when shopping around for a donkey. Similar to guard llamas, donkeys do not require special feeding; can be kept penned with the sheep, and live longer than guard dogs.

*Supplemental feeding* – Supplemental or diversionary feeding as a non-lethal technique to divert a predatory species away from a vulnerable commodity for a period of time has received some attention (BOERTJE et al., 1995; CLUFF; MURRAY, 1995), but has not been tested to prevent predation on livestock. Many predators will readily consume food provisioned by humans. In the northwest U.S., black bear (*Ursus americanus*) damage to coniferous trees (they feed on the sapwood during the spring) could be reduced with supplemental feeding (COLLINS, 1999; PARTRIDGE et al., 2001; NOLTE et al., 2002). Supplemental feeding should only be used for the duration of protection of the resource that is required, as continued feeding could actually increase the number of predators in an area by increased reproduction and emigration (i.e., a numerical response).

*Fencing and barriers* – Livestock and poultry may sometimes be protected from predators with a properly constructed and placed barrier, such as a predator exclosure, electrical fencing, screening, or even a moat (de CALESTA; CROPSEY, 1978; GATES et al., 1978; LINHART et al., 1982, NASS; THEADE, 1988, ACORN; DORRANCE, 1998). Some recommendations suggested for predator fencing include: (1) Ordinary fencing will not keep most predators from entering areas as they learn to jump over or dig under the fencing. (2) Many large predators may be deterred or excluded by adding an electrified single-wire strand charged by a commercial fence charger along a wire mesh fence. The electrified wire needs to be placed 20 cm out from the fence and 20 cm above the ground. A fence 1.5 m high with 9 to 12 alternating ground and charged wires spaced 10-15 cm apart is an effective barrier against coyotes (GATES et al., 1978; DOLBEER et al., 1994; ACORN; DORRANCE, 1998). (3) A wire mesh fence can also be used and is more versatile, longer lasting, and can be stretched tighter than a conventional farm

mesh wire (DOLBEER et al., 1994). (4) Smaller carnivores may be deterred by use of a 0.9-m wire-netting fence placed 0.6-m above ground and 0.3 m below the surface; a 15-cm length of the fence below the ground is bent outward at a right angle and buried 15 cm deep (DOLBEER et al., 1994). Fencing gives the additional advantage of increased efficiency during herd management, not often realized by producers. The costs of materials, installation, and maintenance usually preclude the use of fences for protecting livestock in large pastures or under range conditions (KNOWLTON et al., 1999).

*Frightening devices* – Devices such as lights, distress calls, loud noises, scarecrows, plastic streamers, propane exploders, aluminum pie pans, and lanterns have been used to frighten away predators (ACORN; DORRANCE, 1998). Most testing has been with devices that periodically emit bursts of light or sound to try to deter coyotes from sheep in fenced pastures and open-range situations (LINHART. 1984; LINHART et al., 1992), but the benefits are often short-lived (BOMFORD; O'BRIEN, 1990; KOEHLER et al., 1990). While all of these devices can provide some level of temporary relief in reducing damage or deterring predators, habituation by the predator to the device is common. The usefulness of the device can be prolonged by frequently changing the location of the devices, changing the pattern of the stimuli, or combining several techniques (LINHART et al., 1992; KNOWLTON, et al., 1999). Using a combination of warbling-type sirens and strobe lights reduced coyote predation on lambs by 44% (LINHART, 1984). These battery-operated devices were activated in the evening by a photocell set on a schedule of 10-second bursts at 7- to 13-minute intervals. The use of propane exploders delayed or prevented lamb losses to coyotes for a period of time (PFEIFER; GOOS, 1982).

A recent development used to deter wolf predation is the Radio Activated Guard (RAG) box (SHIVIK; MARTIN, 2001; BRECK et al., 2002). This device is activated only when a radio-collared wolf is in the vicinity and its radio-collar activates the device, preventing habituation of the animal to the lights and siren. This has application only in areas with radioed animals, but can deter endangered predators from causing problems to livestock producers (BRECK et al., 2002). The use of frightening devices is not widespread, mainly because the use of sirens and strobe lights at night near people is generally not acceptable (KNOWLTON et al., 1999).

*Repellents and learned aversions* – Presently, there are no commercially available repellents that effectively deter the act of predation (KNOWLTON et al., 1999). Several noxious compounds have been tested (e.g., thiabendazole, pulegone, cinnamaldehyde, allyl sulfide) with a few of these reducing food consumption among predators. There are some areas where chemicals apparently have repelled animals from certain objects. Quinine hydrochloride and capsaicin appeared to discourage coyotes from chewing on irrigation hoses (WERNER et al., 1997), but these repellents do not deter predation. Thiabendazole has been used to condition black bears to avoid beehives (POLSON, 1983). Probably one technique that received much heated debate

and attention in the past couple of decades was the use of conditioned taste aversion using lithium chloride to reduce coyote predation on sheep. The main problem was that results of studies were mixed. Some researchers reported success (GUSTAVSON et al., 1974, 1982; FORTHMAN-QUICK et al., 1985a,b), while others were either unable to replicate those findings or found it to be ineffective in field situations (BURNS, 1980, BOURNE; DORRANCE, 1982; BURNS, 1983; BURNS; CONNOLLY, 1985). While lithium chloride indeed does reduce prey consumption, it apparently does not deter the act of predation. Ten years after extensive field trials using lithium chloride, a survey of the same sheep producers revealed that only one producer still used it (CONOVER; KESSLER, 1994). Current available evidence suggests that conditioned taste aversions are either ineffective or unreliable for deterring predation, but may limit food consumption (KNOWLTON et al., 1999).

*Electronic training collar* – A new device receiving some attention as a non-lethal method to deter predation on livestock is the use of an electronic training (shock) collar usually used for training dogs (ANDELT et al., 1999, SHIVIK; MARTIN 2001). Using captive coyotes, researchers reported that the training sequence with the electronic collar stopped all attempted attacks on lambs, decreased the probability of an attempted attack, eliminated successive chases, and even caused avoidance of lambs (ANDELT et al., 1999). Application may be limited under field conditions because the predator must be captured and the training collar attached (batteries would need to be occasionally changed), but does suggest avenues of future research on response-contingent aversive stimuli that changes the behavior of the predator during the attack phase of a predatory sequence (SHIVIK; MARTIN, 2001).

*Reproductive interference* – In the 1960's there was interest in the use of chemical sterilants to influence the reproductive rate of coyotes (BALSER, 1964). This interest was based upon the assumption that reduced reproduction would reduce population levels and that fewer coyotes would result in fewer depredations on livestock. Trials with diethylstilbesterol indicated that reproduction among coyotes could be curtailed (BALSER, 1964; LINHART et al., 1968), but depredation rates were not measured, timing was critical, the approach was impractical without effective delivery systems, and research on this substance eventually ceased (KNOWLTON et al., 1999). Currently there is renewed interest in reproductive inhibition using either chemical or immunocontraceptive agents (DeLIBERTO et al., 1998), mainly as a means of changing the predatory behavior of coyotes. Surgical sterilization (tubal ligation and vasectomy) of coyotes was effective in reducing predation rates on domestic lambs without affecting social behavior and territory maintenance (BROMLEY; GESE, 2001a,b). Among wolves, vasectomies of males have been proposed as a method of population control (HAIGHT; MECH, 1997). However, at the present time there are no substances available for fertility control among predators that is species specific. Species specificity may have to be achieved through appropriately designed delivery systems.

*Relocation of problem animals* – Translocation of individual predators that cause problems has been successful with grizzly bears (BRANNON, 1987), but has proven less useful for wolves that depredate livestock (BANGS et al., 1995, CLUFF; MURRAY, 1995). All to often wolves return to the capture site, or move to areas with livestock and start depredating cattle again (BANGS et al., 1995). Those that kill livestock again are removed from the population (BANGS et al. 1995). Relocation is expensive and time consuming (CLUFF; MURRAY, 1995), but is often considered necessary when dealing with recovery or reintroduction of a valuable endangered predator.

*Financial incentives* – Certain financial incentives have been used to mitigate livestock losses and temper resistence to carnivore recovery in the U.S. Compensation for livestock deaths due to wolves is practiced in parts of the U.S. (FRITTS, 1982; FRITTS et al., 1992) and Canada (GUNSON, 1983), either through government funds or private donations (e.g., Defender's of Wildlife's Wolf Compensation Fund). Problems with these programs are that producers feel they do not receive full market value, compensation is only for verified losses (does not include missing animals), and that payment for losses does not encourage producers to correct poor management practices or try non-lethal techniques (FRITTS et al., 1992). A more recent incentive has been the production of "predator friendly" products in which consumers pay more for goods (e.g., wool, meat) that comes from ranches that do not kill predators. Some producers will also allow their public grazing allotments to be bought out by some non-governmental organization as an incentive to move their livestock to another area with less risk of predation. For example, ranchers in western Montana are removing cattle from areas occupied by endangered species (grizzly bears) and placing them elsewhere with financial assistance from an NGO. Another financial incentive gaining a foothold in the private sector is ecotourism. Some ranchers in the U.S. sell trips to the public for viewing of wolves on their ranches and set up lodging and guiding services to recoup financial losses that may incur from livestock depredations. Similar operations are now being established in Brazil, particularly in the Pantanal region for viewing of jaguars and other wildlife species.

In closing, many different techniques exist to reduce or deter depredations by carnivores. Selectivity, efficiency, and compatibility of the technique should be carefully evaluated prior to implementation. Surveys indicate that non-lethal techniques are readily accepted by the general public (ARTHUR, 1981; REITER et al., 1999). Surprisingly, compensation programs to ranchers are less acceptable to the public than other non-lethal techniques (ARTHUR, 1981; REITER et al., 1999). Among lethal techniques, those methods that are considered cruel and inhumane, or are not selective to the target species, are generally unacceptable to the public (STUBY et al., 1979, ARTHUR 1981, REITER et al., 1999). It cannot be stressed enough that no one technique will solve all depredation problems in all situations. Using various techniques in combination will allow one to be able to adjust to the

behavior of the target animal and environmental conditions. In areas where carnivore conservation is an issue or endangered/threatened species occur, non-lethal techniques should be considered first, with lethal control only if non-lethal methods fail or are impractical in that current situation. There is the perception that as long as you respond, listen, and are doing "something" to solve their depredation problem, livestock producers will appreciate your attempts to help and can lead to acceptance of carnivores in their area (FRITTS et al., 1992). Doing nothing or not responding to their requests for assistance generally leads to the 3 S's: "shoot, shovel, and shut-up." Being out in the field, responding quickly (usually within 24 hours); (FRITTS et al., 1992), and showing that you care about their problem will lead to increased tolerance of carnivores among livestock producers and local communities.

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Table 1 – Percent of depredated lambs lost to specific predators for six states in the Rocky Mountain region during 1999 (Source: U.S. Department of Agriculture 2000).

| Predator | Arizona | Colorado | Idaho | Montana | Utah | Wyoming |
|---|---|---|---|---|---|---|
| Coyote | 60.0 | 71.1 | 82.4 | 79.4 | 64.2 | 77.3 |
| Bobcat | – | – | – | – | 2.7 | – |
| Eagles | – | – | – | 7.1 | 1.6 | 10.0 |
| Dogs | 26.7 | 12.2 | 5.4 | 1.6 | 6.4 | 1.8 |
| Foxes | – | 2.2 | – | 4.8 | 1.1 | 4.5 |
| Cougar | – | 3.3 | 5.4 | 1.6 | 15.5 | 4.1 |
| Bears | – | 7.8 | 4.1 | 1.6 | 8.0 | 2.3 |
| Other[a] | – | – | – | 3.2 | 0.5 | – |

[a] Other predators include wolves, ravens, vultures and other animals.

Table 2 – Species, common name, and body size of various Brazilian carnivores for which depredation management techniques developed in North America may have application. Source: Ginsberg e Macdonald (1990), Eisenberg e Redford (1999).

| Species | Commmon name | Body size (kg) |
|---|---|---|
| Panthera onca | Jaguar | 61-120 |
| Puma concolor | Puma | 24-50 |
| Chrysocyon brachyurus | Maned wolf | 23-25 |
| Felis pardalis | Ocelot | 7-9 |
| Atelocynus microtis | Short-eared dog | 6.5-7.5 |
| Cerdodyon thous | Crab-eating fox | 5-6 |
| Pseudalopex gymnocercus | Pampas fox | 4-6 |

Table 3 – Percent of non-lethal methods used by livestock producers to reduce predator losses of sheep and lambs for six states in the Rocky Mountain region during 1999 (Source: U.S. Department of Agriculture, 2000).

| Method | Arizona | Colorado | Idaho | Montana | Utah | Wyoming |
|---|---|---|---|---|---|---|
| Fencing | 21.7 | 31.3 | 46.4 | 36.0 | 53.6 | 27.0 |
| Guard dogs | 23.2 | 23.0 | 55.2 | 27.5 | 28.5 | 36.0 |
| Llamas | 60.9 | 9.1 | 9.9 | 22.7 | 7.4 | 20.0 |
| Donkeys | 6.0 | 3.4 | 2.5 | 15.1 | 2.3 | 7.9 |
| Shed lambing | 23.8 | 66.6 | 45.5 | 65.6 | 46.5 | 55.7 |
| Herding | 8.7 | 7.1 | 11.3 | 12.9 | 11.9 | 13.4 |
| Night penning | 20.4 | 79.4 | 50.2 | 44.4 | 34.4 | 53.5 |
| Fright devices | 6.3 | 5.6 | 7.3 | 3.3 | 5.8 | 9.2 |

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Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis
Centro Nacional de Pesquisas para a Conservação dos Predadores Naturais

# Manejo e Conservação de Carnívoros Neotropicais

## I Workshop de Pesquisa para a Conservação de Carnívoros Neotropicais

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