SUCCESSFULLY raising goats is a challenging enough endeavor in the absence of problems caused by predators. When predators are added to the mix it can become overwhelming and costly. Predators such as coyotes, bobcats, mountain lions, red foxes, feral hogs, and domestic or feral dogs are among the suspects when mortalities occur. The National Agricultural Statistical Service reported that in Texas in 2003, 110,000 sheep and goats, with a value of $10.9 million, were lost to predation. These estimates are conservative since: 1) they are derived only from reported losses made at initial counts of lambs and kids; 2) losses have been shown to be 2 to 3 times higher in the absence of control programs which are already in place, like USDA/APHIS Wildlife Services (see http://www.aphis.usda.gov/ws/); and 3) they only take into account direct losses to producers, not future value of animals and animal products, nor the multiplier effect on local economies.

This article will concentrate on instilling in the student the practice of objectively evaluating the physical evidence of predation in order to: 1) accurately assign responsibility; 2) chose the proper tool(s); and 3) proceed with an integrated pest management approach.

The Problem

Predation on small livestock such as goats is a serious problem in many areas. As previously mentioned millions of dollars in losses are reported to USDA/APHIS Wildlife Services each year, a considerable portion being that experienced by goat producers. Some predators such as coyotes are becoming increasingly a matter of concern because of their remarkable ability to adapt to the presence of humans—even to the point of entering back yards to kill pet dogs and cats. Other predators are relatively unlikely in the minds of some. Dogs, both feral and domestic, are a major source of loss especially in goat producing areas which are on the edges of cities and suburbs. In fact, even in rural areas un-restrained dogs can be a major threat.

In years past goat production was centered in regions such as the Edwards Plateau of Texas in which ranchers shared the burden of predator management and were successful on a large scale, practically ridding the region of livestock killing predators. When predation occurred, the reaction on the part of ranchers was swift and effective. Though never fully removed, except for wolves, goat-threatening predator populations were maintained at a level which allowed survival of livestock operations in the face of the relatively few predators that remained.

The trend in the past few decades has been less large-scale goat production in these and other areas, and a corresponding lessening of effort to control predators has ensued. The producers that remain find themselves with basically no community-wide support in the battle against livestock losses to predators. The situation warrants increased awareness of all aspects of predator management.
management so that the struggle to maintain meat goat production enterprise viability can be successful.

Though challenging, predator management can be successful if adequate awareness, knowledge, and some essential skills are acquired. Of utmost importance is a thorough understanding of Integrated Pest Management which will be detailed later.

The Approach

The intent in this article is to utilize some of the same instructional material which Texas Cooperative Extension wildlife specialists have used in Predator Awareness Workshops throughout Texas since 1994. The meetings begin with the topic "Predator Appreciation", meaning- a) to be cautiously or sensitively aware of, b) to judge with heightened awareness, and c) to comprehend with knowledge. Getting a handle on each of these definitions is helpful in analyzing situations that may require corrective action, developing a strategy for predator management, and then implementing it wisely, economically, and humanely.

Evolution of Expectation and Terminology

In at least one way, the evolution of thought regarding how we approach the reduction of losses by predators to livestock, in this case goats, has mirrored the treatment of invasive brush on rangelands. As with efforts to address brush encroachment, there was a time when "predator eradication" was the terminology associated with dealing with livestock losses to predators. With the passage of time, it was realized that "eradication" might have been a rather overly ambitious objective. Individual predators were being removed, population levels were being reduced, but efforts were not successful in annihilating populations. Though much lessened at times, predation continued at some level even under the most motivated strategies.

Next, "predator control" became the order of the day. At least, it was thought, we can "control" predators. Again, a level of predation remained in many instances, even after concerted control efforts, which was unacceptable. And it seemed, unavoidable.

"Predator management" has become a more accurate portrayal of current efforts at reducing predation. In fact, the concept of "coping with" predators has emerged as an even more suitable moniker for the situation in which producers often find themselves today. Embodied in the idea is acknowledgement that a variety of practices might be implemented including lethal and non-lethal means to accomplish the objective of reducing predator-related losses. The ideal aim would be the selective removal of only the offending animal(s) when feasible. Texas Cooperative Extension has utilized the idea in the production of several educational products dealing with predation: Coping with Bobcats, Coping with Coyotes, and Coping with Feral Hogs (visit http://tcebookstore.org for details). Heretofore in this module the term predator management will be utilized with the intention that it includes the spirit of "coping".

Development of Effectiveness and Acceptability of Tools and Strategies

Much like the changes in the way we refer to livestock loss-causing predator removal activities the methods that have been used have changed through the relatively recent past. Early on,
toxicant-laced baits were utilized to effectively remove problem predators. However, collateral damage was extensive. Non-target wildlife was killed inadvertently. Public disfavor of the practice generated efforts to remove the practice, culminated in a ban on the use of the chemical in such practices by Executive Order of President Nixon in 1972. Today there are only two toxicants available for predator management, none for indiscriminate placement. The use of these will be discussed later.

Available to predator managers today is an array of tools and techniques, some non-lethal, some lethal, from which the proper one(s) for a given situation can be selected. Non-target mortalities have been greatly reduced, practically to the point of non-existence in some instances. One particular technique has the ability to remove only the offending individual animal.

**APPROACH**

**Integrated Pest Management**

In order for farmers to effectively wage war on insect threats Integrated Pest Management (IPM) was implemented some years ago. It utilizes five basic components which provide for a systematic approach to the formulation of strategies for addressing pest concerns of various kinds, including the predators confronted by meat goat producers.

1. Pests versus Beneficials
2. Scouting
3. Economic Thresholds
4. Management Alternatives
5. Environmental Concerns

**Pests versus Beneficials**

Being able to recognize when a predator is detrimental (Pest) or beneficial in a particular situation, is an important skill for predator managers to possess. Obviously, when a predator is killing goats it has earned the name Pest. However, some animals which may be of little concern to you day-to-day, yet provide a food source (prey) for predators, can be performing a valuable service to your operation as they provide a buffer for the effect that would be realized in their absence. Predators are generally opportunistic in their feeding habits. A density of rabbits and/or rodents providing a ready food source for predators which would otherwise be homing in on your goats is a beneficial situation, lessening to some degree the amount of predation that would otherwise take place if rabbit numbers were low.

Likewise, situations can exist in which one potentially threatening predator population in effect can control or limit the population density of a known killing predator. If raccoons are the predator of concern (killing or maiming young kid goats, e.g.) coyotes can actually be beneficial to a degree because they are considered by many to limit raccoon numbers since raccoons are a food source for coyotes. Far-fetched, certainly, since coyotes themselves are usually a threat to goat production.
But, you get the point. Be sure that by lowering one population you do not inadvertently enhance another which could be just as damaging to your operation. The interrelationships of predator and prey species are fascinating. An understanding of them is crucial to the realization of the desired results from your predator management efforts.

Scouting

First, the presence of predators must be ascertained. Roads and sandy draws can be monitored for droppings (scats) and tracks, largely identifiable by species. Look for scrapes where animals mark their territory. Net-wire fences provide the opportunity to check for hair left behind as animals cross over or under. Digs or slides under fences can be indicative of certain species. Scent stations made by clearing all of the vegetation off a piece of ground about 1 yard in diameter along a roadside, with some sort of track bearing surface like flour or slacked lime generously dusted over it and a scent source like bobcat urine (available from trapping suppliers) in the center, can provide a means of seeing which predators are present in an area. Monitor the stations daily for at least three consecutive days.

Next, the trend of the population density of potential predators is important. If population density information is gathered the same way every season or year, e.g. using the same roads, the same methods, i.e. objectively gathered, it will be useful for planning your predator management strategy. By keeping track (no pun intended) of the information gathered-number of scats and/or tracks on a given route which is monitored the same way every season or year, the number of sets of tracks, and scent station nights in which various species occur, and accumulating the information over several years and across areas-you can begin to see what trend might be apparent in various predator populations and adjust your predator management accordingly.

Trouble spots might become apparent as you monitor predator numbers. Whether by virtue of goat losses having occurred there or the presence of an unusually high density of predators you may choose to initially aim your management efforts there.

Economic Thresholds

Economic feasibility understandably drives much of what is done in agricultural operations, just as it does in other business ventures. With regard to predator management feasibility can be determined by identifying the economic threshold, that point at which the level of damage incurred is sufficient to justify the cost of the control practice. Before undertaking any predator management activities, many of which can be rather expensive, be sure that the end justifies the means. It makes no sense to expend thousands of dollars to reduce losses amounting to hundreds. At least attempt to utilize economically appropriate measures. Balance the "control" expense with the value of the loss. A relatively minor loss (monetarily) to predation will warrant a different response than a more extensive loss. Let the degree of loss dictate the response.

Management Alternatives

A key element of IPM is the development of an array of management alternatives-a toolbox, so to speak-from which to select the appropriate approach to a particular situation. Both non-lethal and
lethal techniques are available. Non-lethal means might be considered first, then lethal ones if necessary.

Often a predation problem can be effectively thwarted by non-lethal measures such as:

1) Shed kidding or night penning year-round
2) Guard animals such as donkeys (jennies, usually), llamas, or dogs can be effective.
3) Fencing type and configuration can limit predation, or at least provide for more effective application of some types of lethal techniques such as snares which can be placed in digs under net-wire fences. Electrified offset (~8 inches) wires can be placed on fences at about 8 inches off the ground and again at about 30 inches to deter fence climbing by cats. Overhanging top portions of fences can also deter fence climbing. A buried lateral apron of net wire can deter digging under fences.
4) Noise-making devices, especially around pens where animals are kept overnight can help ward off predators, though eventually the predators will likely grow accustomed to the noise and ignore it.
5) Aversive taste conditioning of predators has met with only limited success so far, but remains a possibility in the future.

If non-lethal practices are not feasible or effective, lethal measures might then be necessary. The toolbox most commonly includes:

1) Foothold or leghold traps- generally buried alongside travel-ways and baited with an attractant or visual lure like an over-hanging feather or tuft of hair, or blind-set in known paths; can be fairly selective depending on placement, bait, and overall operator skill.
2) Live traps or cage traps- fairly selective depending on size, bait, and trigger mechanism
3) Snares- suspended loops of cable with a one-way slide that tightens on the animal and restrains or kills it as it passes through a dig under a fence; selectivity depends on skillful placement in known passage-ways of offending animals and frequent monitoring.
4) M-44s (sodium cyanide delivery devices), and Livestock Protection Collars (LPCs) (containing sodium monofluoroacetate- or Compound 1080)- available in some states; selectivity is canine specific for M-44s and offending individual animal specific for LPCs; strict compliance with governmental regulations regarding their use and licensing for applicators is required. Contact your state wildlife officials and agriculture officials for more information. For licensing in Texas contact the Texas Department of Agriculture.
5) Aerial gunning- effective and selective; approval and/or permit(s) required. Check with your state wildlife officials for pertinent regulations and permits. For further assistance contact USDA/APHIS Wildlife Services office in your state.

Environmental Effects

An IPM approach always includes evaluation of potential environmental impacts. The manipulation of wildlife populations can involve numerous ramifications. Be aware of the effect
that reducing the population density of one species may have on population levels of others. If lowering the numbers of coyotes, for example, will likely enhance white-tailed deer survival and therefore their population density, be prepared to harvest added numbers of deer in order to keep the population from exceeding the level which can be supported by the existing habitat without degradation. If M-44s or LPCs are used make sure that all label requirements are followed in order to protect non-target animals from being affected and to safeguard against environmental contamination. When used properly these tools are safe and pose minimal threat to the environment.

INTERPRETING EVIDENCE

Tools Needed

The basic skills needed to address suspected predation incidents are similar to those required for a crime scene investigator. Among these are: an inquiring mind, critical thinking skills, knowledge of the habits of potential culprits, objectivity, and of course a strong stomach. Often a kill site is discovered well after decomposition has begun.

Various "sign" can be sought out as evidence. The presence of tracks, scats, and hair left nearby (on fences, e.g.) are tell-tale signs of visitation by a particular animal. However, generally more conclusive evidence is required to rule out whether that animal was just passing through or was indeed the perpetrator.

The mode of attack can be indicative of certain predators. Also the damage suffered can point to one predator or another. For example puncture spacing (canine teeth, talons), number of bites, location of damage (throat area vs. back of head or back), presence or absence of sub-dermal hemorrhage, and the location of the carcass and its general condition. If the carcass of a kid goat is found bearing soft hooves which appear never to have been walked on, there is a chance that the animal was still-born or died of neglect and subsequent exposure. Look for milk in the stomach to see if it ever nursed, and signs of dehydration such as sunken eyes. Also look for bites by skinning the throat area and the back of the neck. If there is an absence of hemorrhage under the skin, even if bite punctures are present the animal was almost surely dead before being bitten. On the other hand if hemorrhage is present the animal was still alive when bitten, pointing toward predation.

SPECIES PROFILES

Rather than presenting extensive information about the biology of various species habits, factors relevant to the objective scrutiny of goat losses or damage will be presented for several of the more common predators. More detailed information about the life history of each can be found in The Mammals of Texas, by Schmidly, and Predator Control as a Tool in Wildlife Management, by Rollins, et al. See the Reference Material section.

Coyotes

Typically, and there are some exceptions of course, a coyote will kill goats by attacking the throat region, biting and collapsing the trachea. Death occurs by suffocation after (sometimes) a rather prolonged struggle, leaving considerable sub-dermal hemorrhage. Sometimes a coyote will bite the side of the head or even the back of the head. A young, inexperienced coyote may bite
wherever it can catch the animal. Eventually, with maturity, the throat attack seems to be the mode most often adopted.

Coyote tracks are rather slender and elongated. Their travel is usually deliberate, resulting in a straight path with hind feet often falling in the track of the front feet. Particularly distinguishing characteristics include visible nail marks (often the middle two toes only) and bi-lobed heal pad.

Scats are usually cylindrical and cigar-shaped with minor strictures apparent and blunt or pointed ends. The texture varies according to the current diet, whether primarily vegetation (seeds from fruits) or animal (hair and bone).

An integrated approach using a variety of control measures is most effective. Non-lethal means include net-wire fencing and guard animals. Also consider trapping (No. 4 with chain and drag hook), snaring, hunting from the air and from the ground, M-44s, LPCs, or calling with prey-mimicking audio devices (calls).

**Bobcats**

Bobcats with few exceptions attack goats by biting the back of the neck at the base of the skull or on the side of the head, or by biting the back of the jaw and lower part of the skull while restraining them by embedding their claws in the goat's side or flank. Death is usually caused by crushing the spine and/or skull. After the kill the carcass may be fed upon immediately or it may be cached-dragged to another location and partially covered with debris-to be fed upon later. If the meat spoils before consumption it may be abandoned for another fresher kill. Often hair will be plucked from the carcass giving it a scruffy appearance.

Tracks are more rounded in appearance than those of a coyote, and are larger. Nail marks are usually not apparent since cats typically keep claws retracted until needed for defense or capture of prey. The heel pad is tri-lobed. On especially soft surfaces the track may appear to be "tented" or "peaked" between the toes owing to the shorter hair between them compared to coyotes.

Bobcat scats are cylindrical and are segmented with prominent strictures and usually have elongated pointed ends, often with protruding hair.

Non-lethal methods include electrified offset wires on fences, over-hang on top of fence, both to deter climbing. Previously mentioned lethal means are effective for bobcats also.

**Mountain Lions**

Though rare compared to other predators which threaten goat operations, mountain lions can cause extensive loss. Their diet is mostly deer in many areas, but includes livestock at times. They are known to kill a deer every 3-14 days, depending on how quickly the meat spoils and the number of deer available. Like bobcats they drag and then cache their dead prey, sometimes urinating and defecating on top of the debris that has been kicked upon it. Scapes created by pushing and kicking debris up on to the carcass will sometimes point to the eventual direction of travel.

Lion tracks and scat are similar to those of a bobcat, only larger.
The most effective and selective means of lion capture is by trained dogs. Foothold traps (No. 4½ with chain and drag hook) and foothold snares can be effective, also. Considerable skill is required to minimize non-target captures.

**Red Foxes**

The red fox is an introduced species which is often confused with the smaller gray fox, and is responsible for goat losses in some locales. They can be distinguished by their white-tipped tail.

Tracks are coyote-like, though smaller, but in contrast all marks from all four claws on each foot are likely to be visible. Scats are generally non-segmented, bearing pointed ends with protruding hair.

Predation by red foxes is typically characterized by multiple bites on the back. Due to their size, relatively small animals such as kid goats are most at risk to red foxes.

For control consider trapping, snaring, and hunting. Red foxes can often be called up with the use of prey-mimicking audio devices (calls).

**Feral Hogs**

At least 30 states have reported the presence of feral hogs-hogs which are either domestic hogs gone wild or descendants of free-roaming hogs brought to North America by explorers in the 1600's. Livestock predation, including goats, is one of the many negative impacts that they have caused. Young animals are particularly vulnerable.

Often no evidence of predation is found when feral hogs are the culprit because the entire prey animal is consumed. A bloody patch of ground, a hoof or two, or an inverted skin with hooves and maybe the skull attached, is likely to be all that remains, if anything. Sometimes the only indication may be circumstantial-missing young, dams with distended udders, and the known presence of feral hogs in the area.

Signs of their presence include: rubs on trees and utility poles, wallows in mud, and rooted-up soil, rocks, and debris where they have searched for food items.

Being a cloven-footed animal their tracks are similar to deer and even goats, but with more blunt tips and obvious dew claw marks. Scats are large and resemble a pile more often than a cylindrical mass, especially when fruits and other plant items are being consumed.

Aerial hunting is the most efficient and effective control means for feral hogs. Also use portable cage traps or funnel traps built on-site with t-posts and welded wire hog panels. With either setup use a one-way gate and pre-bait the trap with the gate open for several days until hogs grow accustomed to entry, then set for capture.
**Domestic and Feral Dogs**

Though "wildlife predators" claim more of the immediate attention when predation of goats is known or suspected, free-roaming domestic dogs, some of which are more accurately described as wild or feral, are serious contenders for the top spot on the list of suspects. Since breeds vary extensively in size and conformation track evidence often resembles wild canines or cats. Typical characteristics of tracks include bi-lobed rear of heel pads and a more sloppily-placed print, i.e. less deliberate, straight-line travel.

Kills by dogs are often characterized by multiple bites on the hind quarters and flaps of skin pulled away from the animal due to the dog's attempts to restrain the fleeing. Several animals might be attacked at once by a single dog or a pack of dogs, sometimes with little if any feeding on the carcasses.

Non-lethal measures include guard animals and net wire fencing. Otherwise use foothold traps, cage traps, snares, aerial and ground hunting, and M-44s (only if dogs are known to be killing livestock - Check local laws and regulations)
RECOMMENDED REFERENCES


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