Between 1992 and 1998, UC Berkeley and USDA scientists undertook a series of studies at the UC Hopland Research and Extension Center to learn about how lethal coyote controls can be used more effectively and selectively. Coyotes were captured in padded leg-hold traps or snares, radio-collared and released. Each collar had its own distinct frequency, so that the locations of individuals could be determined by tracking with a directional antenna.

Targeting alphas can make coyote control more effective and socially acceptable

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The decline of the sheep industry in California is due in part to depredation by coyotes, which forced many operations with narrow profit margins out of business. Coyote control has a long and contentious history in the West. Present-day control strategies include nonselective removal of coyotes in the vicinity of depredation, use of guard animals, electric fencing and improved sheep husbandry practices (Knowlton et al. 1999). Losses can remain unacceptably high despite the use of any of these strategies or combinations of them. The problem is complicated by growing public opposition to the use of lethal methods. In 1998, California voters passed Proposition 4, which banned the use of bodygripping devices such as leg-hold traps; M-44 cyanide ejectors, which eject sodium cyanide into the nasal cavity of a coyote when it bites a device; and sodium fluoroacetate (Compound 1080), the toxicant used in livestock protection collars. Proponents of the ballot measure argued that nonlethal alternatives such as electric fences and guard animals are as effective as lethal removal in reducing losses and should be used because they are more humane. However, the reality is more complex.

Types of control

Guard animals have been effective in some situations and ineffective in others, particularly in rough country with dense vegetation that coyotes (Canis latrans) use for cover. Electric fences can be effective, but they are not practical for large pastures because they are too costly to install and maintain. Certain husbandry practices, such as synchronizing lamb birthing to reduce the period of maximum vulnerability, have been suggested as potentially useful for reducing depredation, but they have not been systematically evaluated. We must learn more about...
the situations in which nonlethal methods should be the first choice. In general, nonlethal methods are most likely to be effective in smaller open areas where there is an abundance of alternative foods for coyotes. Furthermore, nonlethal methods are probably less effective where sheep are present year-round and become a regular part of the coyote’s prey base (Blejwas et al. in press; Sacks and Neale in press).

We also need to learn more about how lethal controls can be used more effectively and selectively. In 1992, a cooperative research project was established between UC Berkeley and the U.S. Department of Agriculture’s (USDA) Wildlife Services/National Wildlife Research Center. A series of four studies was undertaken between 1992 and 1998 on the on 5,358-acre UC Hopland Research and Extension Center (HREC), where a large flock of sheep (600 to 1,500 ewes plus lambs) is maintained year-round. Coyote depredation is a chronic problem at HREC (Scrivner et al. 1985), and losses are typical of other sheep ranches in California’s North Coast (fig. 1).

A variety of nonlethal control methods and husbandry practices have been tried at HREC over the years, including guard animals (dogs and llamas), lambing in the protection of a barn, electric fences, frightening devices and chemical repellents. Sheep losses remained high despite their use. Sheep operations that are not subsidized cannot sustain this rate of predation and remain economically viable. This level of loss has an even greater impact on research because it can disrupt the experimental design by reducing the number of sheep in a test group.

The primary control strategy at HREC from the 1950s through the mid-1990s was to remove coyotes in response to depredation. This strategy of corrective control, which is non-selective in terms of the age, sex and social status of the coyotes targeted, is typical of much of the western United States. Usually, specialists from USDA Wildlife Services removed the coyotes using a combination of leg-hold traps, snares and M-44 cyanide ejectors. These devices were commonly placed along trails used by coyotes or in places where coyotes had excavated a crawl-way under a fence. Most of the removal was done during the lambing season when predation was the highest.

The trappers, as best as they were able, used available tools to remove sheep-killing animals; however, such efforts were imperfect. It was not always practical to interrupt control whenever a coyote was captured to see if the killing stopped. Once traps, snares and M-44s were set out, they usually remained in place as long as they were successful. During this period, a number of studies were conducted to test alternative coyote-control methods and protect research sheep (see p. 26). From 1995 to 1998, HREC attempted selective removal through testing and use of the livestock protection collar.

Local population reduction, prior to the lambing season, is another common lethal control strategy. This approach is preventative and it assumes that all coyotes in an area are equally likely to kill sheep. Furthermore, it is widely believed that coyotes concentrate at rich food sources such as sheep...
ranches and that regular culling is needed to keep their numbers in check. Our research evaluated these assumptions. In this paper we synthesize our findings, which have been published as separate papers in the technical literature.

Is nonselective removal effective?

The first step was to determine whether the nonselective control practiced on the HREC was effective in reducing depredation losses. We analyzed HREC records from 1981 through 1994 using the numbers of coyote-killed sheep together with the numbers of coyotes removed for control (Comer et al. 1998). If nonselective control was effective, then removing more coyotes should have resulted in fewer sheep being killed by coyotes (that is, a negative correlation). Three different time scales were used for this analysis: yearly, seasonally and monthly. Because predation of lambs was greater than that of ewes, this was analyzed separately. The results showed that over this 14-year period there were no correlations between the numbers of coyotes removed in any of the three time scales and the numbers of sheep kills during corresponding intervals for the next 2 years.

These results suggest that nonselective removal was not effective in reducing depredation at HREC. There are two possible explanations. First, not all coyotes were preying on sheep and those that were doing so were not being removed consistently. Analysis of coyote space-use patterns in relation to sheep kills supported this explanation (fig. 2). Alternatively, coyotes may not have been the only important predators of sheep at HREC. Bobcats were also common, and we thought that they might be responsible for the large number of lambs missing each year. However, there was no evidence of predation on lambs by any of 12 radio-collared bobcats during the 1995 lambing season, whereas radio-collared coyotes were responsible for all lamb kills in several intensively monitored pastures (Neale et al. 1998).

Not all coyotes kill sheep

The next step addressed the question of which coyotes were killing sheep at HREC and whether they could be characterized in terms of age, sex or social status. To answer this question we captured coyotes, examined them for evidence of breeding and radio-collared them to determine their space-use patterns and association with sheep kills. We demonstrated that coyotes at HREC are territorial and that their social structure is similar to those found elsewhere (Knowlton et al. 1999; Sacks, Jaeger et al. 1999). This means that coyotes divided up the area into separate nonoverlapping territories, which at HREC averaged about 1.74 square miles each. Territories were contiguous and fit together like pieces of a puzzle. Each territory was controlled by a breeding “alpha” pair, and often contained nonbreeding offspring from previous years (“betas”) as well as pups from the current year. In addi-
tion, there were nonterritorial tran-
sients — dispersing coyotes looking
for opportunities to acquire their own
territories and become alphas. Territo-
ries were defended by the alpha pairs,
which tried to exclude all but the
members of their own packs.

Our research showed that it was the
alphas whose territories overlap sheep
pastures, particularly pastures with
lambs, that were the principal killers
of sheep (Sacks, Jaeger et al. 1999). Evi-
dence suggests that sheep become part
of the coyote prey base especially
when sheep are available year-round,
as they are at HREC (Sacks and Neale
in press).

Unlike domestic dogs, coyotes do
not kill sheep for sport; generally, a
single sheep was killed within a coy-
ote territory each day. Either alpha in
a pair will kill the sheep, usually by
biting down on the sheep’s trachea
and holding until it suffocated. Alphas
feed first on the kill and may cache
parts of it for later consumption. At
HREC, sheep carcasses were rapidly
eaten by scavengers including betas
and transients.

During the 1994 lambing season
(December to May), radiotelemetry in-
dicated that one alpha pair was re-
sponsible for 46 kills at HREC. Killing
stopped only when the male of this
pair was removed. In 1995, alphas
from four territories were associated
with 89% of the 74 coyote-killed
lambs. Betas and transients were not
associated with any of these kills.

Removing betas and transients

Coyote depredation was high dur-
during the 1995 lambing season at HREC
despite the removal of 23 coyotes be-
Only one of these coyotes was an al-
pha. The nonselective targeting of coy-
otes with traps, snares and M-44s was
more likely to remove young, less ex-
perienced animals than alphas, except
when the alphas had pups (Sacks,
Blejwas et al. 1999). Evidently alphas,
which were more cautious prior to
whelping, were forced to take more
risks once they had pups to feed (April
to September). At HREC, the lambing
season (December to May), when
losses were highest, coincides with the
time before whelping when alphas
were hard to capture. The reason that
no relationship was found between
numbers of coyotes removed and sub-
sequent depredation losses was that
coyote removals were highest during
the lambing season (Conner et al.
1998). Throughout most of the rest of
the western United States the lambing
season is in the spring and early sum-
mer, coinciding with pup rearing. This
suggests that nonselective removal
may be more effective at reducing
losses where this overlap occurs. Nev-
evertheless, alphas have been found to
be the problem coyotes on California’s
North Coast and the intermountain
West, implying that in either situation
control is most effective when it selec-
tively targets the alphas whose territo-
ries overlap with sheep.

In contrast to our findings at HREC,
an earlier study undertaken in South
Texas found no difference in the rela-
tive vulnerability of younger versus
older coyotes to traps and M-44s
(Windberg and Knowlton 1990). That
study, however, was done in an area
where there had been no prior coyote
control. Older coyotes at HREC may

Fig. 3. Map of HREC showing the locations
of coyote-killed sheep in relation to the
boundary of a single coyote territory.
Following the removal of the breeding
female from that territory, no additional
sheep were killed within the territory
during the next 3 months.
have been more wary of control devices because of previous exposure to them. This interpretation is supported by the findings of a study in sheep-producing areas of southern Africa with black-backed jackals (Brand et al. 1995), which are closely related to coyotes. All age classes of jackal were vulnerable to an M-44-like device when it was first introduced. However, by the second year of use only young jackals were vulnerable.

Another factor that may influence a coyote’s vulnerability to control devices is its familiarity with an area. A number of studies have indicated that resident coyotes are harder to trap within versus outside their territories (Windberg and Knowlton 1990; Sacks, Blejwas et al. 1999). Alphas may be hardest to capture because they are likely to have the most prior experience with control devices (associating them with human activity and/or removal of pack members) and be most familiar with the area.

Selective removal of alphas

The question of whether selective removal of alphas stops depredation was important to address because it was not known how quickly the alphas removed by control would be replaced, how quickly the replacement alphas would begin killing, and whether neighboring alphas or transients would take advantage of an undefended territory and begin killing sheep. In the last of our studies undertaken at HREC, selective removal typically stopped or reduced depredation in the removal territories for the subsequent 3 months (fig. 3) and was more efficient at reducing depredation losses than nonselective removal (Blejwas et al. in press). This control strategy is an effective alternative to population reduction and is likely to be applicable throughout the western United States.

But how are alpha coyotes selectively removed? One way is with the livestock protection collar, which kills only coyotes that have attacked collared sheep by the throat and punctured packets containing sodium fluoroacetate poison (Connolly 1993). This method was used at HREC from 1995 until 1998, when California voters passed Proposition 4 to ban its further use, as well as other animal control methods.

Alternative methods, such as calling and shooting, are now being explored to selectively target control to the alpha coyotes. We are evaluating whether particular types of broadcasted calls can be used to selectively target the alphas. One idea is to imitate an intruder in a territory — this would attract the alpha to drive it away. The use of domestic dogs to attract alphas is being investigated, and we are also interested in nonlethal approaches. As a first step, we are trying to understand why alphas are especially wary and difficult to capture within their own territories.

References


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