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Abstract: The average reported sheep and goat loss to coyotes (*Canis latrans*) in 1992 on those properties worked by the cooperative animal damage control program were relatively low. Sheep and goat losses were not evenly distributed among the producers. Geographical distribution of the losses reflected a positive relationship between relative coyote density and livestock losses. The sheep and goat industry is adversely affected by the cumulative losses of those producers suffering high levels of predation.

The Texas Animal Damage Control Program (ADC) is a cooperative wildlife damage management agency comprised of the Animal Damage Control Program of USDA's Animal and Plant Health Inspection Service, the Texas Animal Damage Control Service of the Texas A&M University System, and the Texas Animal Damage Control Association One of the functions of the cooperative program is to conduct direct control operations for the protection of sheep and goats from depredation by coyotes and other predators Historically, the program's primary control strategy has been to attempt to prevent the infiltration of coyotes into the major sheep and goat production areas (Nunley 1995)

Through its management information system, the Texas ADC program collects livestock loss information from the individual producers who receive direct control assistance from Texas ADC. The program also documents the number of coyotes and other predators taken from each property worked This paper describes the analysis of the interrelationships of producer- and industry-level livestock loss data, relative coyote densities, and coyote damage management efforts for the year 1992.

Coyote predatory behavior

Coyotes are predators that are equipped physically and behaviorally to locate, pursue, and kill small- and medium-sized prey (Knowlton 1980, 1989) Rodents and lagomorphs generally make up the bulk of the coyote diet, but they are capable of killing prey 6-8 times their own size under appropriate circumstances, which includes sheep and goats While they are innately programmed to kill, the recognition of suitable prey and the ability to capture it at least partially reflects skills derived from experience and practice. Like many predators, coyotes frequently kill more than required for their immediate needs This may be partially due to innate responses to specific stimuli, but also because there are survival values in practicing capture techniques and caching their prey.

Wade (1981) described four conditions that further characterize the limits within which coyote predation occurs: (1) anything that is palatable, available, and of a suitable size is "natural" food to coyotes, (2) if only wild prey, fruits, and berries were available these would comprise the entire coyote diet, (3) if only domestic prey, fruits, and berries were available these would comprise the entire coyote diet, and (4) in the absence of coyotes there cannot be coyote predation.

In studies of the sheep killing behavior of captive coyotes, 8 of 11 pen reared coyotes individually killed 35 to 70 pound lambs (Connolly et al. 1976). These pen-reared, and thus naive, coyotes possessed the inherent inclination and ability to kill sheep. In this study, food deprivation had no discernible effect on the killing behavior of coyotes but did influence feeding activity on kills. These observations suggested that hunger is not always the primary motivation for predatory behavior. In a similar study, 18 of 19 pen-raised coyotes, and 38 of 54 wild-caught adult coyotes, killed sheep when placed in a 2.5-acre pen with sheep (U.S. Fish and

Wildl Serv. 1978).

These studies indicate that not all coyotes kill sheep, but most will learn to kill sheep, particularly lambs, if regularly given the opportunity (U.S. Fish and Wildl. Serv 1978). We can assume that the same applies for goats, especially kids.

Livestock loss survey

In early 1993, Texas sheep and goat producers provided the program with estimates of their 1992 livestock losses to specific predators as well as all other causes. These livestock losses were reported only from properties where coyotes or other predators where being taken by ADC at various levels of intensity for the protection of sheep and goats. These producers indicated that there were:

885,000 adult sheep,
628,000 lambs,
721,000 adult mohair goats,
282,000 mohair kid goats,
93,000 adult spanish goats, and
66,000 spanish kid goats

being protected by ADC on their properties Coyotes were responsible for 64% of the sheep losses and 56% of the lamb losses caused by predators (Fig. 1) Coyotes were also responsible for 63% of the goat losses and 42% of the kid losses attributed to predators (Fig. 2). Note also the differential vulnerability among livestock from predation. Lambs were more apt to be killed by coyotes than adult sheep. However, the differential was less of a factor between adult goats and kids.

The best overall estimates available for sheep losses to coyotes on properties without damage control are 4.5% for sheep and 17% for lambs (USDA 1994). On properties with damage control, losses to coyotes are estimated at 1.2% for sheep and 4% for lambs (USDA 1994). Figure 3 indicates the percent of Texas sheep and goats protected by the program in 1992 that were lost to coyotes, other predators, and causes other than predation This data reflects that a relatively small 0.4% of the sheep, 1.7% of the lambs, 0.9% of the goats, and 2.4% of the kids were lost to coyotes.

Frequency distribution of loss rates

To understand the relevance of this average loss data, the frequency distribution of the losses at varying loss rates was analyzed. One of the disadvantages of "average" loss data is that losses are not equally distributed (Wade 1982) Some producers suffer losses which jeopardize economic survival, some suffer losses that they can survive, and some sustain no losses Figure 4 illustrates this point in that 12% of the lamb producers reported losses in excess of 10% while 54% reported no losses to coyotes Similarly, 19% of the kid goat producers reported losses in excess of 10% while 57% reported no losses to coyotes (Fig 5)

Geographical distribution of losses

The geographical distribution, by county, of the reported losses throughout the major sheep and goat production area was examined next Rather distinct regional areas of "low", "moderate", and "high" lamb and kid losses were delineated from this analysis (Figs 6,7) When comparing the distribution of these regions to the suspected relative abundance of coyotes within each region, a positive correlation exists (Fig 8). This positive correlation between sheep and goat losses and coyote numbers in the area of the Edwards Plateau has also been documented by other authors (Shelton and Klindt 1974, Pearson and Caroline 1981).

Predator-prey ratios and loss rates

The correlation between predator numbers and livestock losses reflects the impact of the predator-prey ratio which prescribes that a population of predators will kill at some rough per-predator rate times the number of predators in the population (Wagner 1988). A more dense coyote population will impose a higher kill rate on a specific sheep and goat population

On the other side of the equation, we can see that even with a constant coyote population, the percent of animals lost will be higher on a small sheep and goat operation than a large one. Thus, the concentration of sheep and goats, and/or sheep and goat producers in a given area, is an important factor in explaining some of the differences in losses

(Nielsen 1977, Pearson and Caroline 1981). The counties with the highest percentage losses to coyotes are those with medium- and low-density sheep and goat populations located on the edges and adjacent to the Edwards Plateau. These are also the areas of higher coyote densities.

Impact of sheep and goat losses to coyotes

Economic survival is improbable for those producers suffering the higher level of losses to coyotes, and especially in those cases compounded by additional livestock losses to other predators. Producers who fail to survive are replaced in the high-loss category by others whose operations then bear the brunt of predator populations Utilizing the previous data (Fig 4), if lamb producers with at least a 10% loss to coyotes went out of business, then 221 or 19% of the producers would cease operation. In the case of lamb producers with at least a 25% loss, 72 or 6% of the producers would terminate production Consequently, the average coyote loss statistics of 1.7% for lambs and 2.4% for kids means little to those producers leaving the industry because of high predation losses.

The cumulative impact of the loss of these producers is not adequately recognized since they are not reflected in future loss surveys Loss surveys usually do not measure the effects of a producer's inability, due to predation or the threat of predation, to graze appropriate rangelands with sheep and goats

Industry or state average survey data of livestock losses is important. However, it is also necessary to examine the frequency and geographical distribution of the magnitude of loss among the individual producers In this way we can better understand the interrelationships of coyotes, coyote predation, coyote damage management, individual producers, and the sheep and goat industry as a whole.

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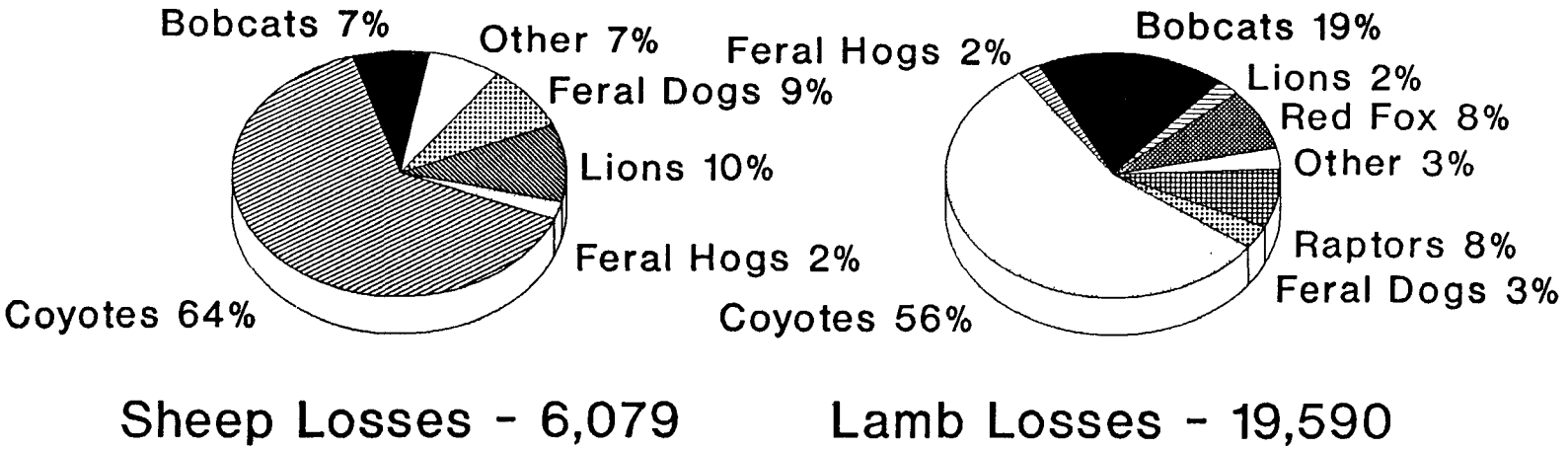

Fig. 1. Sheep and lamb losses to predators in 1992 on properties protected by the cooperative animal damage control program.

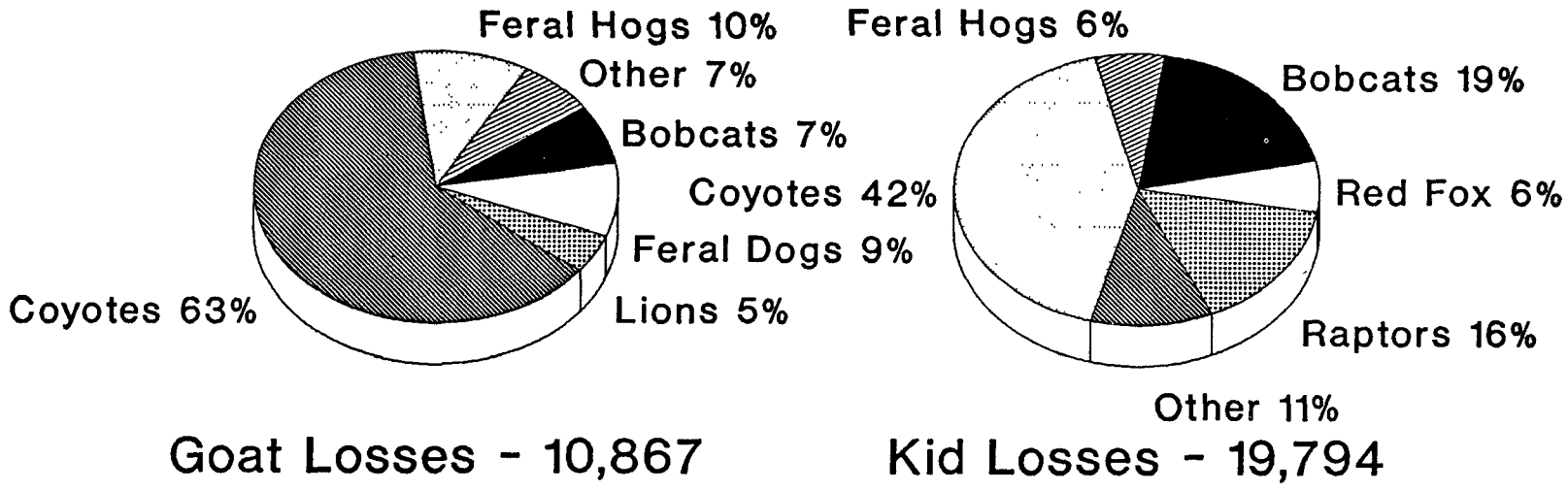

Fig. 2. Goat and kid losses to predators in 1992 on properties protected by the cooperative animal damage control program.

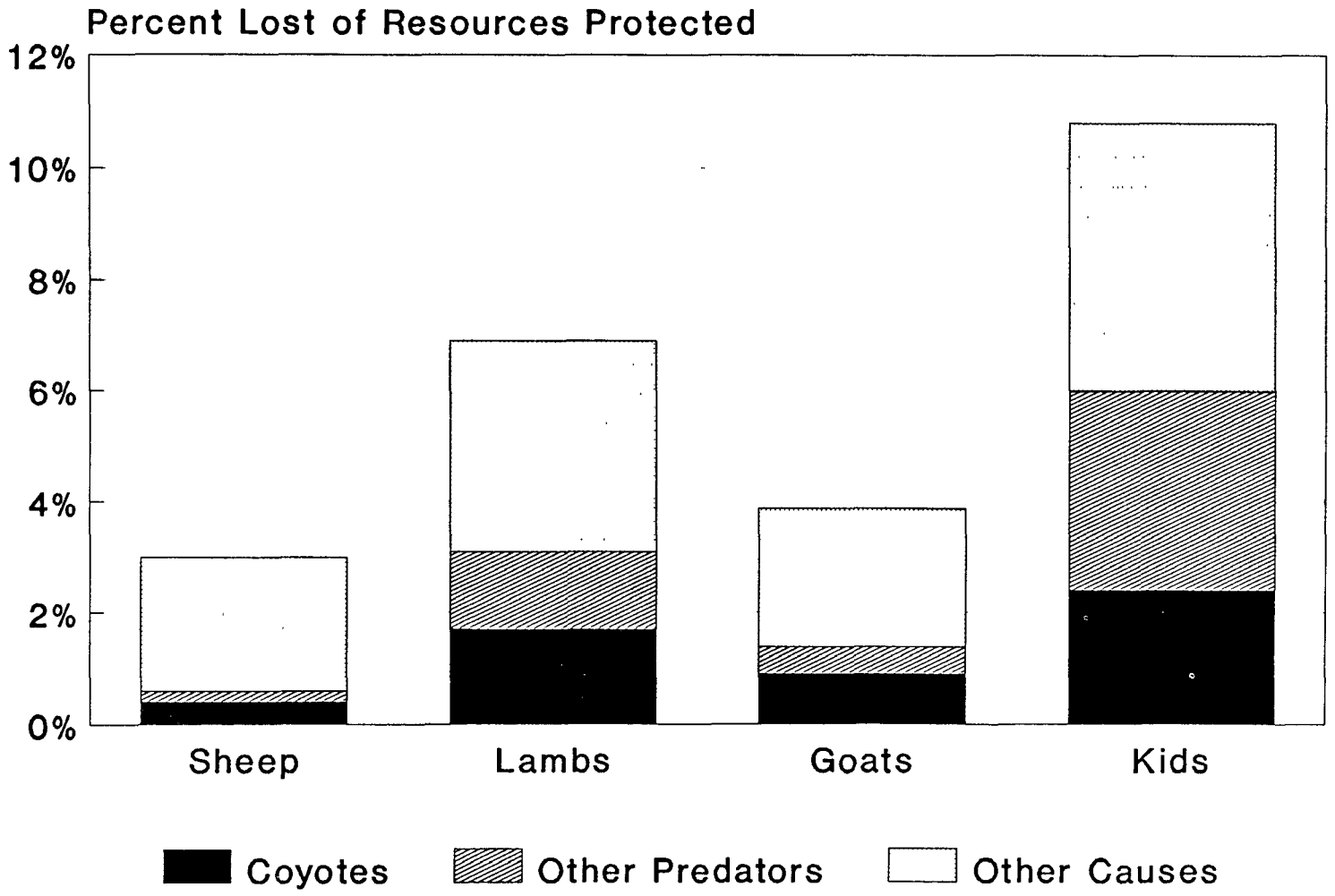

Fig. 3. Percent loss of the total livestock protected in 1992 by the cooperative animal damage control program.

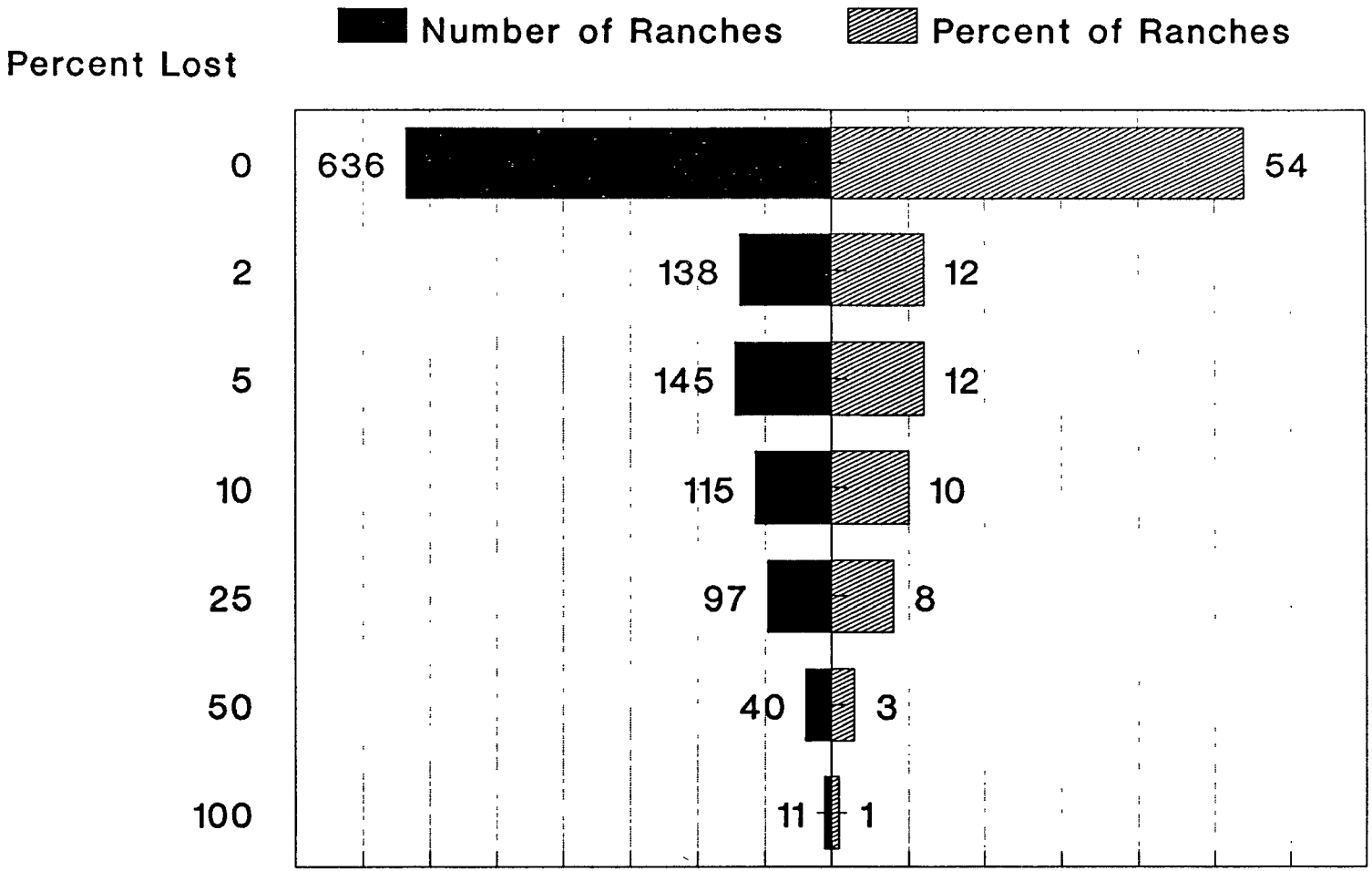

Fig. 4. Percent lamb loss to coyotes in 1992 on 1,182 ranches protected by the cooperative animal damage control program.

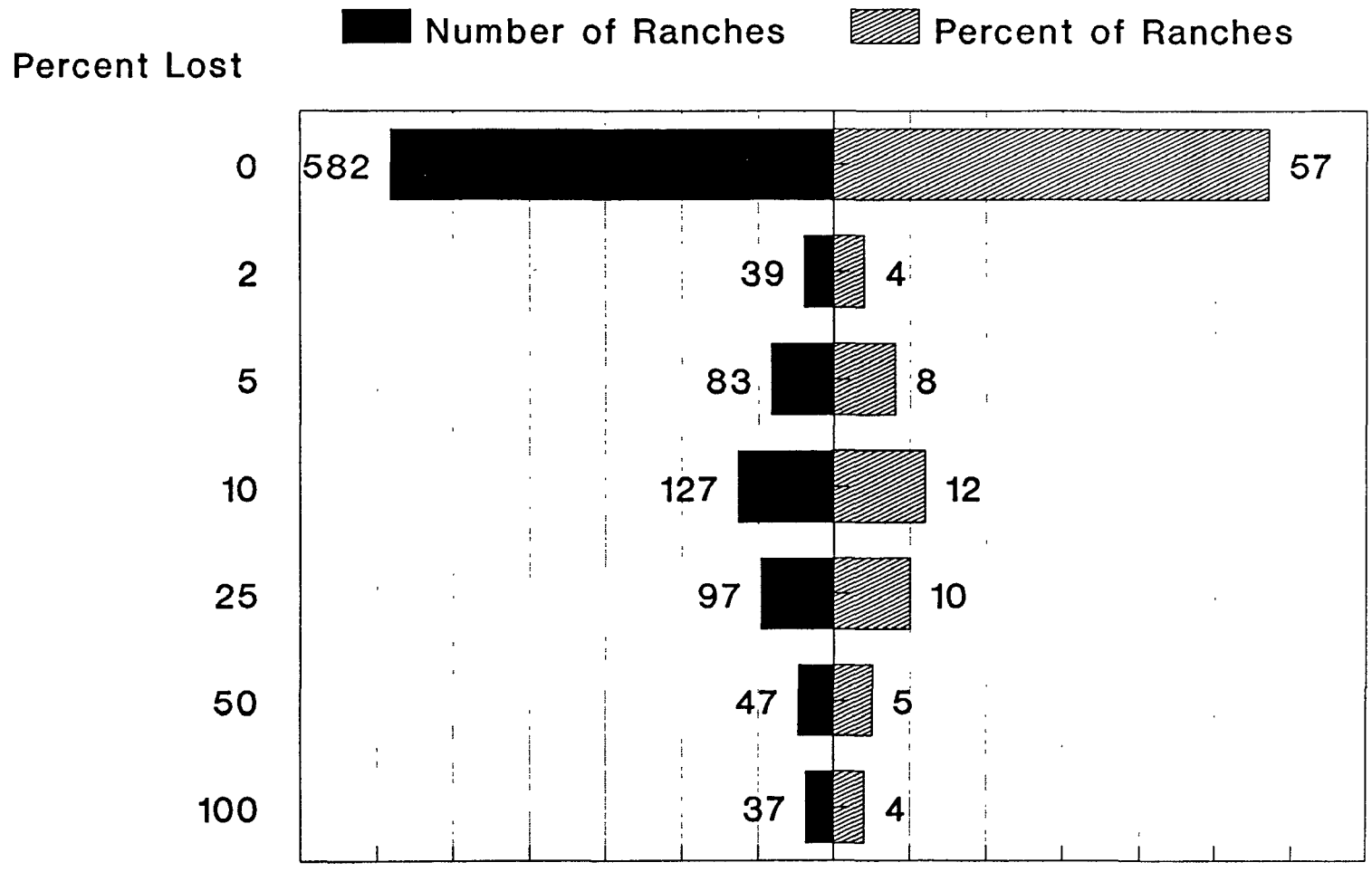

Fig. 5. Percent kid goat loss to coyotes in 1992 on 1,012 ranches protected by the cooperative animal damage control program.

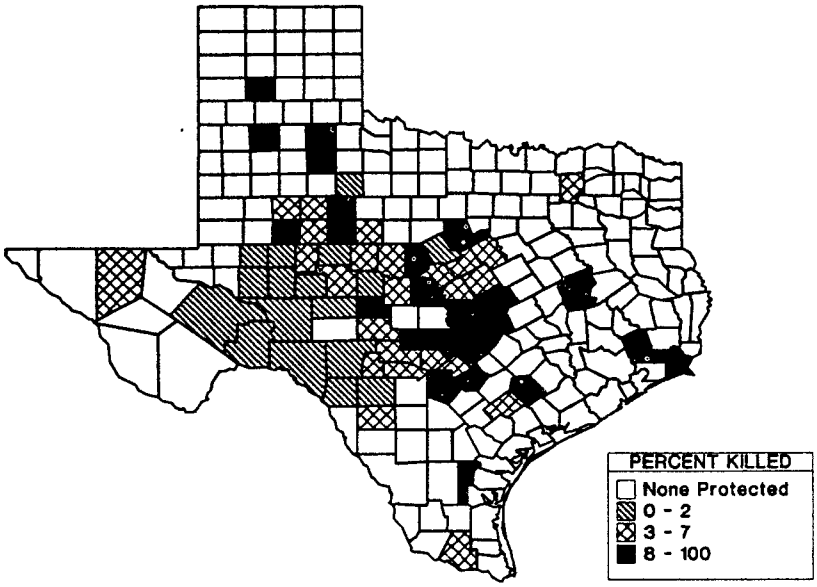

Figure 6. Geographical distribution of lams lost to coyotes in 1992 on 1,182 ranches protected by the cooperative animal damage control program.

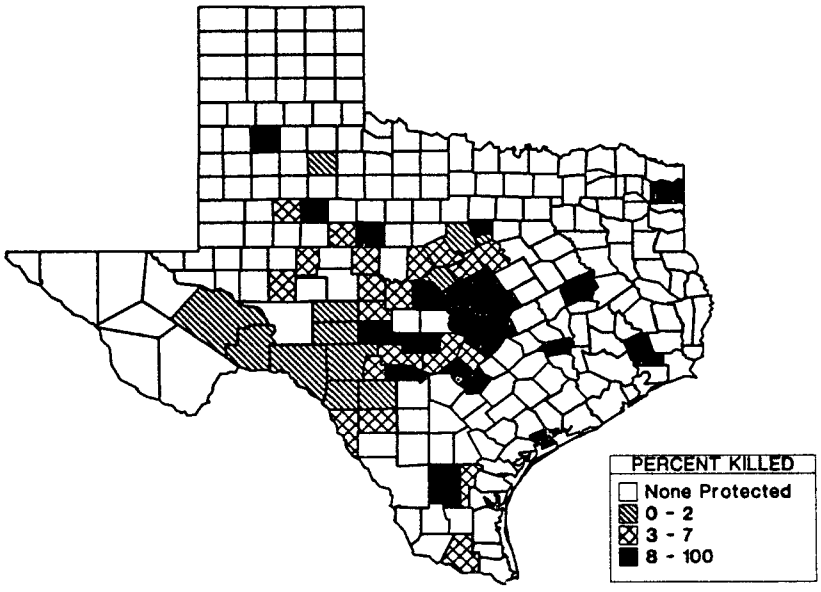

Figure 7. Geographical distribution of kid goats lost to coyotes in 1992 on 1,012 ranches protected by the animal damage control program.

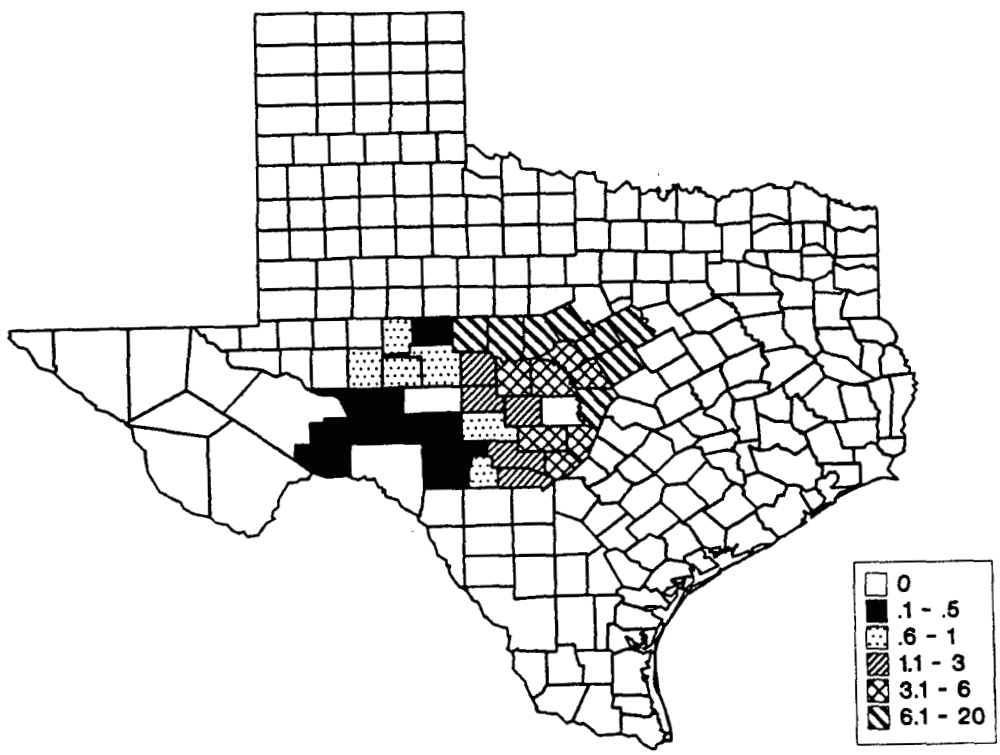

Figure 8. Coyotes taken in 1994 by the cooperative animal damage control program per 10 square miles of area worked