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ABSTRACT: With U.S. Environmental Protection Agency's approval of certification and training of sodium monofluoroacetate (Compound 1080) Livestock Protection Collar applicators by the Texas Department of Agriculture in April 1988, use of collars by ranchers was made possible. This paper presents data from 1988 and 1989 on use of Livestock Protection Collars to protect domestic sheep and goats subject to coyote (Canis latrans) predation. Information concerning coyote puncture of collars, loss of collars to other factors, and targeting strategies used by ranchers are discussed. Success of collar use is compared to other predator control methods used by ranchers.

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INTRODUCTION

The Livestock Protection Collar (LPC) is a rubber bladder containing a toxicant and is attached to the neck of sheep or goats with straps (Rancher's Supply, Inc. n.d.). Coyotes attacking sheep or goats at the throat are poisoned when collars are punctured. The outstanding advantage of the collar is its selectivity for individual coyotes actually causing damage (Connolly 1980).

Mr. Roy McBride of Alpine, Texas, developed a successful collar using Compound 1080 in the early 1970s, and the U.S. Fish and Wildlife Service, Denver Wildlife Research Center, performed field tests of collars using three toxicants-sodium cyanide in 1975, diphacinone in 1976, and Compound 1080 in 1978-1980, including sites in Texas (Connolly 1980). Additional field tests of Compound 1080 collars in Texas were performed during 1980-1983 by the Texas Agricultural Experiment Station, Texas A&M University, under contract to the Denver Wildlife Research Center. The U.S. Department of Agriculture subsequently obtained a registration for use of the LPC by Animal Damage Control Service personnel.

In December 1987, the U.S. Environmental Protection Agency (EPA) granted a conditional registration for Compound 1080 Livestock Protection Collars to Rancher's Supply, Inc., for use of small collars containing 30 ml of 1% Compound 1080 solution in Texas, and in April 1988 approved the Texas Department of Agriculture's program for training and certification of collar applicators. Walton (1989) describes the Department's program, which includes training on identification of predation, alternate methods of predator management, and proper use of M-44 sodium cyanide, as well as LPC use and safety.

Approximately 11,000 Texas ranchers raise sheep or goats or both. Texas leads the nation in number of sheep and angora goats, with 1.9 and 1.5 million head respectively (Texas Agricultural Statistics Service 1989). Texas also has approximately 400,000 Spanish goats and smaller but significant numbers of dairy and cashmere goats. Much of the range utilized for sheep and goat production is gently rolling to rugged limestone hills with moderate-to-dense brush that provide good habitat to a variety of avian and mammalian predators. Annual predation losses are about $9 million (Mulder 1988), with coyotes accounting for more than half of the damages.

LPCs offer ranchers another tool to use in protecting livestock from predation. Due to the mode of action, collars can be especially useful in taking coyotes that have learned to evade conventional control methods such as traps, snares, calling and shooting, and M-44 sodium cyanide devices. Only a few ranchers are currently using LPCs at this time. The small LPC that fits lambs or kids from 15 to 50 pounds is now registered for use by specially trained and certified applicators in the states of Montana, New Mexico, South Dakota, Texas, and Wyoming. However, since collars became available to applicators starting in 1988, approximately 70% (1,278 collars) of all collars sold in the United States have been to Texas ranchers. This paper provides information on the results of collar use during 1988 and 1989 in Texas.

METHODS

To satisfy a 3-year monitoring plan for collar use filed with the EPA by Rancher's Supply, Inc., and the Texas State Plan for Certification of Pesticide Applicators, the Texas Department of Agriculture must report annually on all LPC use and status of each collar by serial number. All LPC applicators licensed by the Texas Department of Agriculture must report to the Department quarterly on all collar use, the fate of all collars, any punctures by coyotes, collar-induced mortality of nontarget species, and any accidents involving collars. Maximum, minimum, and estimated collar use-days were calculated from quarterly reports. Maximum use-days are determined by counting the number of days from the date of collar attachment until a collar was found to be punctured, ruptured, missing, etc. Minimum use-days are determined by counting the number of days from attachment until the last day on which a collar was found to be in satisfactory condition. An estimate for collar use-days is then calculated by averaging the maximum and minimum numbers.

Applicators must also complete a site review and sales data form before purchase of collars. This form includes questions on predation losses, pasture sizes, methods of predator control being used, and location of ranches where collars are to be placed on livestock.

A survey concerning collar use and predation was sent to 42 applicators purchasing collars in December 1988 to collect additional information on LPC use in that year. Another survey was mailed in December 1989 to the 50 applicators possessing collars at that time. Also, 17 collar applicators were mailed a survey on livestock guard donkey use and husbandry practices in June 1989. Results from the latter are discussed in Walton and Feild (1989). Data gathered during annual applicator inspections and discussions with applicators have provided additional information on collar use.

RESULTS

During 1988 and 1989, 51 licensed LPC applicators obtained collars and 40 applicators actually used collars. Twenty-two (55% of the applicators actually using collars) reported one or more punctures of collars that were attributed to coyote attacks. Four collar users reported they suspected taking coyotes with collars in both 1988 and 1989. Thirty-seven confirmed or suspected LPC-induced coyote kills were reported in 1988, and 23 suspected or confirmed coyote kills were reported in 1989. A minimum of 7 dead poisoned coyotes were located by applicators in 1988, including two coyotes that had punctured the same collar. Only 1 dead poisoned coyote was reported as being found in 1989.

An estimate of 25,694 collar use-days was calculated for 1988, and an estimate of 26,986 collar use-days was calculated for 1989 for a total of 52,680 collar use-days. An average of 1,054 collar use-days was recorded per suspected coyote kill. Kills were recorded with from 2 to 25 collared head of sheep or goats in a pasture and in 1 to 104 days maximum time from application of collars. For 57 collar punctures attributed to coyotes, 17 (29%) occurred within 7 days of collar attachment, 31 (54%) within 14 days, and 43 (75%) within 21 days. Average number of collars deployed in a pasture during suspected punctures by coyotes was 11, but 63% of all reported punctures occurred with 10 or fewer collars in use. To date, punctures have been recorded for all months except January and March. Forty applications of LPCs in pastures have resulted in reporting of one or more coyote punctures of collars while 57 applications have resulted in no reported coyote punctures. Sixty-four collars have been reported as missing or lost along with the collared animals. Forty-three collars have been reported as torn or pierced by vegetation, with cactus (Opuntia spp.) thorns being a leading cause of damage; 11 collars were ruptured by unknown causes; and 1 collar was torn open during removal. All causes of collar loss or destruction combined have resulted in a collar-life of approximately 300 use-days.

The common targeting practice reported by ranchers successful in taking coyotes with LPCs is to place a few collared lambs or kids with their mothers along with a larger number of dry ewes or nannies in a pasture where coyotes are attacking at the throat. If young animals in excess of the number of collars are on hand, they are penned or moved (with their mothers if not weaned) to a pasture some distance from the area of coyote attacks. One collar applicator successfully used night penning and a guard donkey with the livestock in an adjacent pasture to direct coyote attacks to collared kids (Hitzfelder, pers. comm.). An applicator with a guard dog bonded to goats was successful in using collars on lambs in the same pasture with the dog and goats (Hayden, pers. comm.). The dog protected goats from attack on the bedding grounds at night but the sheep were bedding in another area. A few applicators are using collars on small target flocks of adult goats in a prophylactic manner. These collared target animals are placed in pastures with a history of predation to remove predators prior to moving in larger herds to graze. This strategy has been successful for several ranchers but generally has resulted in considerable collar use-days per suspected coyote puncture.

The only incident of suspected nontarget Compound 1080 poisoning reported in the 2 years of collar use involved a lamb with a collar ruptured from an unknown cause. Other mortality to collared animals other than animals killed during attacks that resulted in collar punctures include 1 animal destroyed due to Compound 1080 contamination from a ruptured collar, 1 collared animal that broke a leg after being caught in a leg-hold trap, 6 that died of unknown causes, and 30 that were killed by predators in attacks not resulting in puncture of collars. Twenty of the animals killed by predators without puncturing collars were all in the same pasture.

Site review forms submitted to the Texas Department of Agriculture by applicators indicate that in the 2 years prior to purchase of collars the 51 ranchers collectively lost approximately 3,500 sheep and 2,200 goats. They had slightly in excess of 35,000 sheep and 23,000 goats at the time collars were acquired. More than half of the LPC applicators raise both sheep and goats. Herd size varied from fewer than 100 head to more than 5,000 animals. Pastures where applicators planned to use collars were reported to range from 60 acres to 1,700 acres.

Thirty-four returns (81%) were received from the 1988 survey of LPC applicators and 33 returns (65%) were received from the 1989 survey. More than 70% of the respondents to both surveys reported an increase in predation over the last 5 years. All responses except for 1 in 1989 indicated losses to coyotes. More than 58% of all sheep and goat losses reported in the 1989 returns were attributed to coyotes. Domestic dogs ranked second in frequency of predation on livestock in both years.

All respondents to the surveys used a variety of predator management practices. Responses to a request to evaluate effectiveness of methods used are contained in Table 1. Reported 1989 predator take on the 126,949 acres used for sheep and goat production by the 33 respondents was 496 coyotes, 14 dogs, 54 bobcats (Lynx rufus), 31 red fox (Vulpes vulpes) or gray fox (Urocyon cinereoargenteus), 1 mountain lion (Felis concolor), and 28 other. However, only 21 of the 33 respondents reported taking coyotes by any method and 5 of the respondents reported that no predators of any species were taken. A single respondent with 7% of the acreage indicated taking more than 62% of the total reported predator kill. Table 2 shows the numbers of predators taken by various methods. A majority of the ranchers received assistance from the Texas Animal Damage Control Service, and responses may include predators taken by that agency.

Applicators possessing collars in 1988 and 1989 who did not use collars indicated no use for the following reasons:

1. Did not have predation from coyotes attacking at the throat of sheep or goats.
2. Number of lambs or kids in the pasture precluded targeting with the number of collars available.
3. Livestock was in pasture where collar use would not be feasible.
4. Predation problem was more easily controlled by other means.
5. The cost of using collars and record-keeping requirements would be prohibitive.

Two applicators, including one who was successful on the first night of use, have reported destroying their collars to avoid the reporting and record-keeping chores.

DISCUSSION

Very few Texas ranchers have taken advantage of the opportunity to use LPCs, and only a small number of coyotes have been taken in the 2 years of collar use. An article entitled "EPA, ranchers clash" appearing in the July 26, 1985,

issue of Texas Agriculture Weekly quotes a number of sources correctly predicting little use of collars due to the restrictions on collar use imposed by EPA. Several other factors contribute to the reluctance to use collars. Texas ranchers suffer livestock losses to a wide variety of predators, and in Texas, collars are normally limited in their effectiveness to coyotes attacking at the throat of sheep and goats. With only the small collar registered for use, effectiveness is further limited to use mostly on small lambs and kids. Many ranchers are satisfied with their current methods or the protection afforded by the Texas Animal Damage Control Service. The husbandry and management requirements for effective collar utilization are frequently in excess of the common practices or capabilities on extensive range livestock operations. Large rough pastures and heavy brush make checks on collared animals difficult. Also, cost is a primary consideration of many ranchers as initial investment including testing and license fees, a minimum of 10 collars at $20 each, and incidental equipment costs total about $300 to $350. The Texas Agricultural Experiment Station (1983) using data from LPC use on 12 ranches calculated an average total cost of $1,055 during an average 30-week period and estimated a cost of $1,828 for a 52-week period. Labor accounted for more than half of the total cost even at only $3.65 an hour. Current cost can be expected to be substantially higher.

Table 1. Predator control methods used in 1989 and effectiveness reported by 33 licensed Texas Livestock Protection Collar applicators.[a]

Method	Use	Effective		Most effective
		Yes	No	
Livestock protection collar	21	13	4	4
M-44	21	10	4	3
Traps	19	10	5	3
Snares	25	15	6	4
Calling and shooting	20	9	6	1
Aerial gunning	8	5	3	3
Denning	3	1	2	0
Night penning	8	6	2	2
Exclusion fencing	6	1	4	0
Guard dog	8	5	1	1
Guard donkey	15	7	5	0
Frightening device	1	0	1	0
Other	2	0	1	1

[a]Includes incomplete responses.

Collar use by Texas ranchers has demonstrated some success without any adverse or unexpected nontarget losses. Though only 57 collar punctures have been attributed to coyotes, among the coyotes taken were several that had escaped all other control measures for longer than a year and were believed to be responsible for killing more than 100 head of livestock. This ability to kill problem coyotes during all seasons of the year accounts for the relatively high effectiveness rating of collars by applicators as opposed to other methods responsible for taking much larger numbers of coyotes. Also, the average of 1,054 use-days per puncture attributed to coyotes achieved by ranchers compares favorably with approximately 832 use-days per puncture on an "intensive" site and 1,367 use-days per puncture on a "rancher-use" site recorded in the Texas Agricultural Experiment Station (1983) study.

Table 2. Number of animals reported taken in 1989 with various predator control methods as reported by 28 Texas Livestock Protection Collar Applicators.

Method	Species					
	Coyote	Dog	Bobcat	Fox	Lion	Other
LPC	23	0	0	0	0	0
M-44	64	0	0	0	0	3
Traps	108	2	23	5	0	0
Snares	123	2	9	7	0	0
Calling and shooting	10	9	12	10	0	0
Aerial gunning	136	0	10	0	0	0
Denning	16	0	0	7	0	0
Other	16	1	0	2	1	25
Totals	496	14	54	31	1	28

Actual success in taking coyotes has probably been underestimated by attributing kills primarily on the basis of collar punctures. A significant number of the collared animals reported lost or missing were likely to have involved collar punctures. Compound 1080 typically requires 1 to 2 hours to produce symptoms of intoxication in coyotes, 4 to 8 hours or even longer to cause death, and therefore permits coyotes to travel long distances before succumbing to the toxicant (Wade and Connolly 1980). Before dying, coyotes can easily drag off small kids and lambs. The thick vegetative cover and rough terrain on many Texas sheep and goat ranches further hamper locating kills. An assumption that additional coyotes were taken with collars is also supported by the relatively low incidence of collared animals found dead from unknown causes and the low incidence of collared animals recorded as being killed without collar punctures. Of the latter, a majority (20 of 30) were all killed in a single pasture in an area known to have severe dog predation problems.

Applicators that first correctly identified coyote attacks at the throat of sheep or goats and then collared all kids or lambs placed with a larger number of adult animals, as recommended in the Applicator Manual for Compound 1080 in Livestock Protection Collar (Wade 1985), were usually successful in taking coyotes with collars in less than 3 weeks.

Collar applicators with small pastures in areas of relatively high human activity have been especially successful. It is likely that coyotes in such areas are not disturbed by the added activity associated with collar applications. A minimum of 2 applicators successfully used livestock guard animals to assist in directing coyote attacks to collared animals. Use of collars in a prophylactic manner resulted in a high number of collar use-days per suspected coyote kill. Some failures with collars can probably be attributed to the target coyotes being taken by other means either by the collar applicator or adjacent landowners. Inadequate numbers of collared kids or lambs in the presence of large numbers of "target-size" animals contributed to several failures to take coyotes in instances were predation occurred. Improper identification of the predator causing losses is also suspected to be an important cause of failure to take coyotes with collars.

Utility of LPCs can be greatly increased if large numbers of collars can be made available to ranchers at lower cost. The number of kids or lambs produced on many Texas ranches precludes successful targeting during much of the year with a small number of collars. To address this problem, licensed applicators are now establishing several collar pools patterned after LFC clubs organized in South Africa to combat jackal (Canis aureus) predation (McBride 1990). The Texas collar pools will make up to several hundred collars available to members and operate through transfer of collars via an agent of Rancher's Supply, Inc., the Texas collar registrant. An added benefit to participants will be the reduction of paperwork as reporting will not be required when collars are not being used or in possession by an applicator.

CONCLUSIONS

Livestock Protection Collars can be used effectively and safely by Texas ranchers in conjunction with other predator control methods to protect sheep and goats from coyote predation. Collars are especially valuable in taking coyotes that have learned to avoid other control methods such as traps, M-44s, and calling and shooting. Reduction in cost to applicators such as afforded through collar pools will make collaring large numbers of animals feasible and thereby increase ability to take coyotes when large numbers of lambs and kids are on the range.

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