December 1983

Rancher Use of Compound 1080 Toxic Collars in New Mexico

Gary A. Littauer

New Mexico Department of Agriculture, New Mexico State University, Las Cruces, New Mexico

Ranchet Use ref ~~~.:~aE~aar~~ 1080 I-oxic Collats iii NEW Mexico

Gary A. Littauer, New Mexico Department of Agriculture, New Mexico State University, Las Cruces, NM 88003

ABSTRACT: Twenty-three ranchers were trained and certified to use Compound 1080 in toxic collars to control coyote (Cants latrans predation on sheep during a 2-year experimental program conducted by the New Mexico Department of Agriculture. Fifteen ranchers employed a total of 330 collars in field use. Two used collars in preventive control schemes and success was unknown. Thirteen used collars in corrective control (i.e. predation was in progress); 6 had collared lambs attacked and killed by coyotes; 4 had 1 or more collars punctured by coyotes and in 1 case a bobcat; 3 solved specific coyote problems that they were unable to solve by other means. Although punctured collars were not recovered for verification, 2 other ranchers were believed to have stopped killer coyotes based on circumstantial evidence. Two ranchers were found to be in violation of use restrictions during the 2-year program. One was dropped from the program and the other was reprimanded and found in compliance upon subsequent inspection. One nontarget animal, a skunk (Mephitis mephitis), was discovered that my have died from scavenging on a collared lamb carcass. Problems encountered by ranchers in using collars included restrictions against using collars on federal land and lack of suitable areas to keep main flocks of sheep while collared target flocks were in use. Conclusions drawn from the experimental program were: (1) ranchers can be expected to safely use 1080 in toxic collars; (2) some ranchers will not be successful in using collars; however, others will be able to solve certain coyote predation problems they are unable to solve by other means; (3) some violations of use restrictions may occur; however, they likely will be infrequent.

INTRODUCTION

Coyotes cause substantial economic loss to many sheep and goat ranchers particularly in the Western United States. The control of this type of loss is a complex problem requiring the utilization of a broad array of animal damage control techniques. One technique developed in the early 1970's was the livestock protection collar, more commonly referred to as the toxic collar. The collar was developed by Roy McBride, a former U.S. Fish and Wildlife Service (USFWS) employee in Animal Damage Control (ADC).

The toxic collar takes advantage of the coyote's normal habit of attacking the neck areas of sheep and goats (Connolly et al. **1976).** The collar is positioned on the sheep/goat so that an attacking coyote is likely to puncture 1 of 2 toxicant reservoirs with its teeth and receive a lethal oral dose of toxicant.

The toxicant used in the collars in this experimental program was Compound 1080 (sodium monofluoroacetate). Coyotes that ingest lethal **doses** of 1080 often do not experience symptoms for 2 or more hours, so coyotes poisoned by toxic collars may travel a considerable distance before they die (Atzert **1971).** Consequently few coyotes that puncture collars are ever found. **However, 1080** was found to be 100$ effective against coyotes that punctured **collars** in tests conducted by the USFWS-Denver Wildlife Research Center (DWRC) (Connolly **1980).**

The main advantage of the collar is that it is highly selective, removing only those coyotes that actually prey on livestock. In addition, it has been shown to be effective against depredating coyotes that have eluded other means of control.

The USFWS-DWRC has been conducting research on toxic collars since 1974. That research has shown that toxic collars, using Compound 1080, can be used to stop certain problem coyotes from killing sheep and goats. Furthermore, the DWRC concluded that using Compound 1080 in the collars poses an *insignificant hazard* to nontarget species and humans. Due to the amount of labor and livestock management required to successfully use collars, the DWRC concluded that collars would best be used by ranchers rather than government ADC personnel. The DWRC in mid-1980 recommended expanded use of the McBride collar, preferably under experimental programs of rancher use approved by the Environmental Protection Agency (EPA) (Connolly 1980).

The USFWS applied to EPA in September of 1981 for registration of Compound 1080 in toxic collars for use by certified applicators (USDI 1981). Formal hearings were conducted by EPA in 1982 to determine if substantial new information exists to warrant reconsideration of the 1972 order which cancelled registered uses of 1080 for predator control. At the time of this writing the final decision in those hearings had not been rendered. The fate of the USFWS registration application will depend on the final hearing decision.

I extend sincere appreciation to the 23 sheep producers who cooperated in this experimental program. I also gratefully acknowledge the many individuals in the New Mexico Cooperative Animal Damage Control Program for their assistance in identifying suitable ranchers and in field application and monitoring of collars. Special thanks go to G. Connolly, USFWS-DWRC for his invaluable assistance, advice and editorial review of this manuscript, and to R. McBride for his helpful comments and suggestions. Finally, I would like to thank R. J. White, New Mexico Department of Agriculture (NMDA) for his guidance and direction during the 2 years of this experimental program.

METHODS

In June of 1980, at the request of the New Mexico Wool Growers, Inc., the NMDA applied to EPA for an experimental use permit to determine whether ranchers could safely, effectively, and feasibly use 1080 toxic collars under the ranching conditions prevalent in New Mexico (i.e. large fenced rangeland pastures, oftentimes rugged terrain, and intermingled land status). The permit was granted on February 3, 1981.

Collars were purchased from Rancher's Supply of Alpine, Texas (owned by Roy **McBride), and were** loaded with 1080 solution in the State Chemistry Laboratory at NMDA. A fluorescent pink dye called Rhodamine B was added to the toxicant solution to aid in the identification of leaks and spills and was also intended to mark the teeth of coyotes that punctured collars. Collars purchased at the start of the experimental program were small-sized (of the 2 sizes available) and contained 30 ml of toxicant solution.each. The concentration of 1080 (active ingredient) in-the solution was 11 mg/ml as recommended by the USFWS-DWRC.

A training program was developed consisting of 2 taped slide series - 1 on pesticide laws and regulations, and 1 on the safe and effective use of toxic collars. Training also involved point-by-point clarification of label directions
and the 27 use restrictions, instructions on first aid procedures and record keeping. Each participant in the **experimental program was required** to pass a 25-question multiple choice exam on the 27 use restrictions and on safe and effective use of toxic collars.

Fifteen ranchers were initially selected to participate in the program. They were chosen with the help and cooperation of USFWS-ADC personnel in **New Mexico who were** familiar with ranchers having specific coyote predation problems. At the start of the experimental program, President Nixon's Executive Order 11643 as amended was still in effect preventing the use of toxicants (except for use of sodium cyanide in the M-44 device) in predator control on federal lands. Therefore, the 15 ranchers were selected based on land status of **their ranches** (i.e. they had pastures with no federal land) as well as on **their past problems** with coyotes. Other ranchers were added to the program as specific coyote predation problems developed that seemed amenable to collar use. A total of 23 ranchers was trained and certified to use collars in the 2 **years** of the experimental program. Ranchers were provided with assistance in fitting collars when they requested it and were monitored by NMDA personnel for compliance with restrictions. All ranchers except 1 had 10 or more 1080 collars in possession for a period of time subsequent to training and certification.

Toxic collars were usually employed when a particular coyote or pair of coyotes was killing 1 or more lambs per night or was killing several lambs per week in a particular pasture. The main flock was gathered from the pasture and a target flock of from 5 to 30 lambs with their ewes was selected. Collars were fitted on the lambs and the target flock was placed back into the pasture where predation had been occurring while the main flock was moved to another pasture or kept penned at night. Under this type of strategy, the coyote in returning to the pasture finds only collared lambs, hopefully punctures a toxic collar on the next lamb that it kills, and is prevented from killing more lambs.

RESULTS AND DISCUSSION

Use of Collars in Preventive Contro

Two ranchers utilized collars in "preventive" control schemes - i.e. they did not have coyote predation occurring at the time but expected predation to occur. The 2 ranchers had somewhat remote ranches located in the foothills of the Sacramento Mountains in southcentral New Mexico. Their ranches bordered the Mescalero Apache Indian Reservation and consisted of rugged hills and canyons varying in vegetative cover from open, rolling grassland to dense pinyon-juniper (edulis-Juniperus ,,) woodland. The ranchers reported that coyotes usually immigrated from the reservation and caused substantial lamb losses. Controlling predation was difficult since neither the ranchers nor the local USFWS trapper could implement forms of control on the reservation.

Each rancher placed a target flock in a pasture adjacent to the reservation with the hopes that any coyotes coming 'from the reservation would attack and kill collared lambs, puncture collars, and be eliminated before reaching the ranchers' main flocks.

One rancher placed 25 collared lambs in a 5000-acre (2024-ha) pasture for a 4.5 month period. He reported difficulty in monitoring the target flock and that frequently it was impossible to account for all of the collared animals. The restrictions on collar use stated that users of collars must check on collared animals at least twice a week. This proved difficult for the rancher in this preventive control scheme. The collared lambs were gathered 3 times during the 4.5 month period to adjust collars. Unfortunately, the rancher did not record the collar serial numbers nor ear tag numbers of the collared lambs, nor did he obtain an accurate count of the collared lambs when the target flock was gathered for collar adjustment. When the collared lambs were gathered to be sold in the fall, 7 were missing and, to date, have not been recovered. The rancher suspected that at least some were killed by coyotes since his predation problem was reduced from the previous year. However, the cause of disappearance of the 7 lambs remains unknown.

The other rancher placed 8 collared lambs with their ewes in a 2500-acre (1000-ha) pasture of rugged pinyon-juniper woodland. The collared lambs weighed approximately 20-25 pounds (9-11 kg). The target flock was fairly predictable in coming to water at 1 corner of the pasture, and the rancher felt there would be no problem in monitoring the target flock. The collared lambs were left in the pasture for approximately 2 months, and collars were adjusted once during that period. One collared lamb was missing when collars were removed. To date, the missing lamb has not been recovered, nor has the cause of its disappearance been determined.

During the time the target flock was out, the rancher reported losing approximately 100 lambs to coyotes in another pasture. The pasture contained Bureau of Land Management (BLM) land, however, and he did not attempt to use collars there. A coyote was eventually caught in a snare and the rancher reported that no more kills occurred.

The second rancher also placed collars on 7 Angora goats and placed them in a 160-acre (65-ha) pasture for approximately 7.5 months. Three of the collared goats were missing when collars were removed and have not been recovered. No known attacks by coyotes on the collared goats or the flock of sheep occurred during this time.

These limited attempts at using 1080 toxic collars for preventive control illustrate several problems ranchers will likely encounter in using collars in that type of strategy under the ranching conditions prevalent in New Mexico. The use of toxic collars requires intensive management, in that collars must be periodically adjusted on growing lambs and, according to the use restrictions imposed in this experimental program, ranchers must monitor them at least twice a week to check the condition of the collars and to search for lost collared animals. Unless predation is occurring frequently, ranchers will not likely be able to justify the time and expense of frequent monitoring of collared animals in large rugged pastures. Consequently, some collared animals will probably be lost to unknown causes and even if coyotes are responsible, ranchers may be unable to determine the cause.

Use 9f collars in Corrective Control

Thirteen ranchers used collars in corrective control situations (i.e coyote predation was in progress at the time of collar use) in the 2 years of the

experimental program. A narrative description of 4 representative situations of collar use in corrective control situations is presented here to illustrate what might be expected under New Mexico ranching conditions.

Tularosa, Farm Flock. One rancher located near Tularosa, New Mexico had a farm flock of approximately 550 ewes that had begun lambing in December, 1980 and were located in a 200-acre (81-ha) irrigated pasture. Approximately 35 lambs had been lost to coyotes between the start of lambing and the time the rancher was certified to use collars in early April, 1981. The rancher had confirmed 20 of the losses as coyote kills by finding the presence of tooth punctures on the throats of the lambs. The other unconfirmed losses had either been scavenged to the point that determining cause of death was impossible or had been apparently carried away by the attacking coyote(s). NMDA personnel verified 2 dead lambs as coyote kills just prior to the rancher's certification. The rancher had resorted to penning the sheep at night to avoid predation.

The rancher felt that since predation was frequent and predictable, a small target flock of 5 collared lambs would be sufficient in the relatively small pasture. Another target flock of 5 collared lambs was placed about 0.5 mile (0.75 km) away in another irrigated pasture of approximately 80 acre (32 ha) in which he had experienced coyote predation in the previous year and into which he wished to move some of his sheep.

A USFWS-ADC trapper had caught 2 male coyotes the week prior to collar use near the area of depredation. However, 3 lambs were killed in 2 nights after the c-votes were captured. Two more coyotes were caught the morning collars were put out and no more losses were noted.

In this situation, coyote predation was stopped due to the use of other control methods. Although this was not an adequate test of the effectiveness of toxic collars, it illustrates what will likely happen in many instances of rancher use of collars when other predator control methods are used concurrently.

Santa Rosa Rangeland Flock. A rancher located near Santa Rosa, New Mexico had approximately 250 ewes with lambs in a 1500-acre (600-ha) fenced rangeland pasture consisting of flat to gently rolling open grassland with scattered cholla (opuntia fulgida) and yucca (Yucca elata). The lambs ranged from about 50-80 pounds (23-36 kg). The rancher had verified 2 dead lambs as coyote kills during a 1-week period prior to collar use. Collars were fitted on 35 lambs which were placed with their ewes in the pasture where kills had occurred. In addition, 150 rams were placed in the pasture so that there was no substantial change in the number of sheep in the pasture. The coyote(s) returned in the next 12 days and killed 3 collared lambs without puncturing collars. Each collar had 1 or more tooth marks on the velcro straps above the rubber toxicant pouches. The collars used were small-sized and it was determined from the tooth marks that large-sized collars would probably have been effective. A USFWS-ADC trapper captured an adult male coyote in a snare and an adult female in a trap several days after these kills occurred and losses stopped.

It is believed that the small-sized collars would have eventually worked since the coyotes did not appear to be purposefully avoiding them and the USFWS-DWRC had used small collars on lambs of this size with success in the past (G. Connolly, USFWS-DWRC, personal communication). However, the loss of additional lambs while waiting for the coyote(s) to eventually puncture small

collars is not desirable. Therefore, NMDA obtained an additional label to permit the use of large-sized collars (containing 60 ml of toxicant) and used them as needed in future tests.

Hondo Rangeland Flock. A rancher near Hondo, New Mexico had lost a minimum of 10 lambs to coyotes in a 640-acre (260-ha) pasture prior to using toxic collars. NMDA personnel verified 2 coyote killed lambs the morning that collars were placed into field use. The ranch consisted of hilly, rocky terrain and was densely wooded with pinyon-juniper. It was nearly impossible to locate kills without the aid of turkey vultures (Cathartes aura) scavenging in the area.

A target flock of 20 collared lambs with their ewes was placed in the pasture where the kills had occurred. A coyote-killed lamb was discovered the next morning but the coyote had bitten behind the collar and failed to puncture it. The rancher also collared 30 of approximately 37 lambs that were in the adjacent 640-acre (260-ha) pasture. During the next 10 days, 2 collared lambs and 1 uncollared lamb were killed in the second pasture. Both collarswere punctured. A bobcat (Felis rufus) was suspected of being responsible for some of the kills because the uncollared lamb carcass was partially covered with soil and ground litter. Such behavior is typical of bobcat kills (Wade and Bowns 1982). Two days after the last collared lamb was killed, a dead bobcat was discovered about 100 yards (91 m) from the kill site. The punctures on the collar appeared to have been made by the cat's claws. Due to the presence of several areas of vomitus around the kill site, it appeared the bobcat had stayed near the kill long enough to start feeling symptoms of 1080 poisoning. The cat may have ingested a lethal dose by grooming it's paws. The rancher experienced no more losses after the second collared lamb kill.

In this case a USFWS-ADC trapper had employed traps, snares, and M-44s in the area for a month or more and had been unable to stop the predation problem. Therefore, the collars were successful where alternate methods had failed.

Tatum Ranigeland Flock. A rancher near Tatum, New Mexico had lost 15 lambs to a coyote in approximately 5 weeks prior to collar use. The lambs were lost in 2 adjacent pastures but had mostly occurred in 1 of approximately 1500 acres (600 ha). This ranch consists of flat open grassland with virtually no brush or other tall cover. A USFWS-ADC trapper had set traps and snares in the area since the killing had begun but was unsuccessful.

The rancher placed a target flock of 37 collared lambs with their ewes in the pasture where most kills had occurred. The next night, a collared lamb was killed and the collar was punctured. In addition, coyotes attacked 4 lambs, killing 2, in 2 other pastures in another part of the ranch. These latest kills were believed to be due to a different coyote or coyotes. The USFWS-ADC trapper captured 2 coyotes about 6 miles (9.6 km) from these last 2 pastures within several days after the kills took place. Fifteen days after the collared lamb kill, a dead coyote that had pink dye on the fur around its mouth was discovered about 1 mile (1.6 km) from the site where the collared lamb was killed. No further losses occurred.

In this case, collars were successful in stopping a killer coyote that had eluded other means of capture. The rancher's use of collars in combination with the trapper removing 2 coyotes was apparently responsible for the curtailment of lamb losses on this ranch.

Table 1 contains summary statistics for rancher use of toxic collars in the 2 years of the experimental program. Twenty separate tests of collar use were reported. Sixteen tests were conducted in situations considered to be ideal for collar use - i.e. coyote predation was in progress in a specific area and seemed to be predictable. Sixteen tests were on fenced rangeland and 3 were in farm flocks. The total number of collars used was 330. The number of collars used per test ranged from 3 to 50. The number of days collars were in use in each test ranged from 9 to 110 in corrective control situations and from 28 to 155 in preventive control situations. The total number of collared lambs attacked and killed was 12, or 4% of collars used, and 5 or 38% of these were known to have resulted in punctured collars. In tests conducted by the DWRC, 13% of collared animals were attacked by coyotes, and 71% of the coyote attacks resulted in punctured collars (Connolly 1980).

In 2 instances, a collar was believed to have been punctured by a coyote due to circumstantial evidence. In 1 case, a collared lamb had been missing for about 3 weeks; a coyote that had been dead for several weeks was discovered in the pasture but no trace of the missing collared lamb has been located. In another case, a coyote killed a collared lamb and carried it away. The collar was not found but was believed to have been punctured since the almost nightly predation ceased.

Four ranchers were successful in getting coyotes to puncture 1 or more collars Three were able to attribute use of collars to curtailment of a predation problem they were unable to solve by other means. In addition, circumstantial evidence indicated 2 other ranchers were successful in using collars to stop depredating coyotes even though punctured collars were not recovered for verification.

The number of accidentally punctured collars was 18 (5.5% of collars used) and ranged from 1 to 5 per test in which accidental punctures occurred. Connolly (1980) reported that 3.5% of collars used in DWRC tests were accidentally punctured. The number of collars lost to unknown causes in NMDA's experimental program totaled 21 (6% of collars used). Similarly, 18 or 5.8% of 313 collars were lost in tests conducted by the DWRC.

Economic Feasibility ,iiitv

The livestock protection collar currently costs from $16.50 (small-size) to $17.50 (large-size) (Roy McBride, personal communication). On first impression, this cost seems somewhat high and raises questions of cost efficiency. However, a simple analysis of the results from the test near Tatum, New Mexico suggests that collars may be considered cost efficient to a rancher experiencing a frequent predation problem.

In that test, lambs were being lost at a rate of about 3 per week. There were approximately 10 weeks left before the lambs were to be gathered and sold in the fall which means the rancher could have expected to lose another 30 lambs. At the then current market price of $47.00 cwt. (New Mexico Crop and Livestock Reporting Service 1982) and an average market weight of 110 pounds (50 kg) per lamb, the rancher would probably have lost an additional $1,550 worth of lambs if the coyote(s) had not been stopped.

1. Summary of rancher use of Compound 1080 in toxic collars to control coyote predation on sheep in New from February 3, 1981-February 3, 1983.

r	Type of Control-Corrective or Preventive (C or P)	Fenced Rangeland or Farm Flock (R or F)	N Collars Used	N Days of Use	N Collared Lambs Attacked	N Collars Punctured by Predators	N Accidental Punctures	N Collars Lost to Unknown Causes	N Dead Predators Found
	C	F	10	17	0	0	0	0	
	C	F	10	19	0	0	0	0	
	C	F	15	92	0	0	1	0-1-/	
	C	R	35	23	3	0	0	0	
	C	R	15	17	3	1	1	1	
	C	R	19	65	1	1	5	2	
	C	R	10	9	0	0	0	0	
		R	10	17	0	0	0	0	
	C	R	41	29-453/	0	0	0	0	
	C	R	32	41-45a/	0	0	0	2	
	C	R	50	86	3	2	5	2	11/
	C	R	5	110	0-4/	0A/	0	2-k/	1
	C	R	3	83	0	0	0	0	
	C	R	5	17	1	0-5./	0	15-/	
	C	R	37	16	1	1	1	0	1
	P	R	25	136	0	0	4	7	
	P	R	8	28	0	0	0	1	
	P	R	7?-/	15 5	0	0	1	3	
	C	R	10	20	0	0	0	0	
	C	R	3	6	0	Q	0		
LS			330	980-1000	12	5	18	21	

„/ Three collars were reportedly lost when a group of 107 sheep was stolen from this rancher.

2/ These collars were placed on Angora goats.

3/ Approximately half of the collars were removed after number of days on left; rest of collars were removed after number of days on right.

Collared lamb was missing; collar was believed to have been punctured by a coyote due to presence of dead coyote in pasture.

5,/ Collar not recovered, but was believed punctured due to curtailment of predation. One of these was the same collar presumed to be punctured by a coyote.

Z/ Predator discovered was a bobcat.

The initial investment in the 37 collars this rancher used would have cost about $650 at a cost per collar of $17.50. Therefore, had he been required to purchase the collars used on his ranch, the rancher would have realized a savings of lost lambs equal to more than double his initial investment in collars in just 1 successful episode of collar use. The collars are reusable as long as they are not punctured and can, therefore, be depreciated over several years. Consequently, 1 investment in 30 or 40 collars could solve many instances of coyote predation and the actual return on the initial investment would be much higher. Two collars were rendered unusable in the Tatum test C1 punctured by a coyote and 1 punctured accidentally). The cost of replacing those collars would have been about $35. Based on the summaries contained in Table 1 it is reasonable to assume that, on the average, ranchers will lose about 10% of the collars they use to accidental punctures and disappearance of collared livestock. Therefore, a more reasonable estimate of the number of collars a rancher could expect to lose during a period of field use of 37 collars would be 3-4 at a cost of $62.50 to $70 .

The costs discussed above do not include the costs of labor, collared animals killed or missing, or of other items such as supplemental feed if animals are penned at night. In most cases, these costs are already being incurred by the rancher prior to collar use. When coyote predation is occurring, most ranchers check their flocks frequently, often daily; therefore, monitoring collars when frequent predation is in progress would not generally result in additional labor cost. The amount of time required to gather and collar a target flock may be considered an additional labor requirement of collar use as well as record keeping When coyotes are killing, however, ranchers are generally more than willing to incur these costs. The loss of collared animals is similarly not an additional cost since, with predation in progress, animals are lost regardless if collars are being used. Therefore, to a rancher who is trying to decide whether collars are worth an investment, the cash outlay for purchasing collars will likely be the primary concern. In addition, the time and inconvenience of becoming certified will be a major concern to some ranchers.

Collars seem to deteriorate somewhat after periods of use. This is apparently due to exposure of the nylon straps and the rubber pouches to sunlight and to wear and tear during use. Collars, therefore, may "wear out" and become unusuable even if never punctured. However, at the end of the 2 years of this experimental program, all unpunctured collars were still serviceable even after periods of field use of up to 155 days. I speculate the average life of collars put into field use for 1 or 2 months each year to be at least 4 years. Consequently, an initial investment in collars could probably be depreciated over at least 4 years. If 1080 collars are not used and are kept enclosed in lightproof containers, their shelf life would be must longer.

Nontarget Hazar s

One skunk was found dead near the carcass of a collared lamb that had been killed by a coyote and had its collar punctured. The skunk was dried and decomposed when it was discovered and had been scavenged. Although it is unknown whether the skunk died from 1080 poisoning, its close proximity to the dead collared lamb suggests 1080 was the most likely cause of death.

believed to have died from 1080 poisoning during field use of 1080 in toxic collars, including the field tests conducted by the USFWS-DWRC and by Texas A&M University (Connolly 1980; Texas A&M University and DWRC 1981). Due to the slow action of 1080 it is possible that most poisoned nontarget animals would not be discovered. However, significant poisoning of nontargets would likely have been noticed.

In scavenging tests conducted by the DWRC it was found that domestic dogs and magpies ignored contaminated neck areas on dead collared lambs and goats to feed on exposed tissues (Connolly 1980). One of the use restrictions requires that contaminated animals be disposed of by burning or burial. Consequently, the inherent feeding behavior of scavengers combined with disposal requirements should greatly reduce potential hazards to nontarget species.

compliance with Use Restrictions

Ranchers for the most part were able to comply with restrictions on use imposed in this experimental program. One restriction proved to be burdensome and unnecessary. It required that each collared animal be marked with a colored ear tag to facilitate identification during monitoring. In practice, ear tag numbers were not visible in the field and field identification of individual collared animals was not practical. Each collar was serially numbered so that collared animals could be individually identified. The major useful function of ear tagging was, therefore, to identify animals that had lost their collars. However, although 21 collars were lost during the experimental program, no live ear tagged animals lost collars; lambs and collars disappeared together. Several ranchers marked collared animals with branding paint which also could serve to identify animals that lose collars. A daub of branding paint on the back of a lamb's head remains visible for several months and is easier and less costly to apply than ear tags.

Some ranchers had difficulty in complying with the twice-weekly monitoring requirement, particularly when target flocks were placed in large rugged or brushy pastures and when collars were used in preventive control. One rancher even expressed the belief that the presence of people twice a week in pastures where coyotes were killing caused some coyotes to leave the area for a time or else caused them to begin killing elsewhere. Twice-weekly monitoring may, therefore, be detrimental to collar effectiveness in some situations. Connolly (1980) reported that daily monitoring of collared animals apparently had a repelling effect on coyotes. Therefore, frequency of monitoring can be critical to collar effectiveness in some instances. Monitoring once a week would be a more reasonable requirement and would allow more flexibility to the rancher.

Two ranchers were found to be in violation of use restrictions during the experimental program. One rancher did not have collars stored under lock and key and had failed to keep records .on use. A second rancher had an employee who withdrew the 1080 solution from 3 collars and stored the solution in an unlabeled contained. The first rancher was issued a reprimand and was checked at a later date for compliance with restrictions. At that time, he had the collars stored under lock and key. Collars and the withdrawn 1080 solution were confiscated from the second rancher and he was dropped from the experimental program.

Human Safety

No human illnesses or accidental poisonings occurred during this experimental program. Two employees of 1 rancher had 1080 solution come in contact with their hands when they accidentally tore 4 collars while removing them from lambs. The employees washed the solution from their hands and suffered no ill effects. Compound 1080 does not absorb readily through intact skin (Atzert 1971). Therefore, hazard of exposure from handling collars is small. Rubber gloves were supplied with every 5 toxic collars assigned to ranchers and some ranchers chose to use them even when handling intact collars.

The major potential hazard of using 1080 in toxic collars would result from oral ingestion of the toxicant. However, probability of oral ingestion is extremely low. At the LD50 0 values of 0.7 to 2.1 mg/kg estimated-for man in Atzert ('.971), a 150-pound (68-kg) person would have to consume from 4.3 to 13.0 ml of collar solution (containing 11 mg/ml of sodium monofluoracetate) to obtain a median lethal dose. A few drops accidentally ingested would, therefore, have a small chance of being hazardous. Ranchers in this experimental program seemed to exhibit a healthy respect for the collars and the toxicant solution, which greatly lessens the chance of exposure to 1080.

Management Problems in Using Collars

A problem encountered by some ranchers in using collars was lack of a suitable area to keep a main flock while a target flock was isolated in the area of predation. One rancher was forced to collar only half of the lambs in a target flock because he felt he could not mix ewes and lambs from that flock with sheep in any of his other pastures. Another rancher had a number of **irrigated circular** pastures as alternate areas to keep a main flock during collar use. However, these areas were either already being grazed at their carrying capacity or were in a stage of production (e.g. wheat in early stages of growth) that could not withstand grazing at that time. Problems of this nature must be taken into consideration by a livestock producer in deciding whether he or she can use collars effectively.

As mentioned previously, ranchers could not use toxic collars on federal land during this experimental program. Three ranchers had small parcels of Bureau of Land Management land in 1 or more pastures where they desired to use collars. In addition, several nonparticipating ranchers expressed interest in participating but could not because they had few or no pastures without federal land. Executive Order 11643 was revoked by President Reagan's Executive Order 12342 on January 27, 1982 removing the impediment that the presence of federal land exerts in using 1080 collars. Should 1080 toxic collars be registered by EPA, any future problem would result from federal agency policy.

CONCLUSIONS

This experimental program has demonstrated that ranchers can safely use Compound 1080 in toxic collars. No accidental poisonings or health problems resulted from use or handling of toxic collars in this experimental program. Only 2 of 22 ranchers and their employees that possessed and handled collars came into contact with 1080 solution and neither suffered any ill effects. Although overall

success in the experimental program seemed low in that only 4 of 15 ranchers using collars were able to sustain 1 or more verified punctured collars by attacking predators, it was apparent that some ranchers will be successful in stopping certain hard-to-solve predation problems with the use of collars.

As in the use of other predator control methods, individual skill and luck varies. As ranchers gain experience in using collars and become more familiar with targeting strategies, it is likely that success will be greater.

The fact that about 1/3 of the participants in the program did not use collars suggests that a substantial proportion of ranchers who become certified will not use collars. The collar technique is specialized and appears to be suited for use under limited circumstances. Therefore, use would largely be limited to those situations where they are most likely to work, and it is doubtful that extremely large numbers of collars would be in use in New Mexico at any point in time should 1080 toxic collars be registered by EPA.

In every case where collars were used in this experimental program, other control methods were also in use. Collars were never used as a replacement for existing predator control programs but were used supplementally to them. Toxic collars appear to be another tool to be added to the array of existing control methodologies.

The results of NMDA's experimental program have shown that 1080 in toxic collars can be used safely and effectively by trained and certified ranchers in New Mexico. The results of DWARF research have demonstrated that environmental hazards in using 1080 collars are minimal and NMDA's experimental program has offered no evidence to the contrary. Although this program indicated that some violations of use restrictions may occur, it is probable that existing pesticide enforcement mechanisms in New Mexico are sufficient to prevent significant misuse.

LITERATURE CITED

ATZERT, S. P. 1971. A review of sodium monofluoroacetate (Compound 1080): its properties, toxicology, and use in predator and rodent control. Spec. Sci. Rep.--Wildl. 146, U.S. Fish Wildl. Serv., Washington, DC.

CONNOLLY, G. E. 1980. Use of Compound 1080 in livestock neck collars to kill depredating coyotes, a report on field and laboratory research. November 1979-March 1980, U.S. Dep. Int., Denver Wildl. Res. Center, Denver, Colo., 125pP.

R. M. TIMM, W. E. HOWARD, and W. M. LONGHURST. 1976. Sheep killing behavior of captive coyotes.J. Wildl. Manage. 40:400-407.

NEW MEXICO CROP AND LIVESTOCK REPORTING SERVICE. Agricultural Prices October, 1982. Agri. Info. 6:4 pp.

TEXAS A&M UNIVERSITY SYSTEM, AND THE DENVER WILDLIFE RESEARCH CENTER. 1981. Efficacy of the 1080 toxic collar as a predator damage control method. Progress report, 1 Dee, 1980--31 Dee. 1981. 97pp.

U. S. DEPARTMENT OF INTERTOR - FISH AND WILDLIFE SERVICE. 1981. Application for registration of Compound 1080, Sodium Monofluoracetate for use in the livestock protection collar for the protection of sheep and goats from depredating coyotes. Submitted to the U.S. Environmental Protection Agency, Sept. 1981.

WADE, D. A. and J. E. GOWNS. 1982. Procedures for evaluating predation on livestock and wildlife. Bull. B-1429. The Texas A&M Univ. Sys. College Station. 42pp.