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Aerial Hunting Takes Sheep-Killing Coyotes in Western Montana

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Abstract.--This paper reports limited data to document that depredating coyotes were shot from a helicopter in western Montana in 1976. Coyotes marked themselves by puncturing diphacinone-filled collars on the necks of sheep they attacked. Subsequently, 11 coyotes were shot from a helicopter on 3 ranches where collared sheep had been attacked. Six coyotes contained diphacinone and thus were confirmed as having recently attacked or fed on collared sheep.

INTRODUCTION

The Federal-Cooperative Animal Damage Control program (hereafter called ADC program)[3] uses a variety of lethal methods to protect livestock from predators. During 1971-76 the ADC program in 13 western states killed 429,437 coyotes, of which 28.5% were shot from aircraft. Aerial hunting expanded significantly after the 1972 ban on predacidal uses of chemical toxicants (Executive Order 11643 and related EPA actions). The numbers of coyotes shot from aircraft increased from approximately 6,100 in Fiscal Year 1971 to 33,600 in FY 1976 (Evans and Pearson 1980; USDI 1979:29). The 1976 figure includes some 9,700 coyotes taken from fixed-wing airplanes, and 23,900 from helicopters. Since 1976, aerial hunting has continued to be important for protecting livestock, but rising costs of helicopter operation have led the program to rely more on fixed-wing planes and less on helicopters. In FY 1985 the ADC program in 15 western states took approximately 15,900 coyotes from fixed-wing aircraft and 13,400 from helicopters.[4]

The ADC program directs control as selectively as possible to the depredating individual or local depredating population (USDI 1979). However, there are few data to quantify the effectiveness of commonly used methods in taking particular individual coyotes that may be killing livestock at a particular place and time. This paper provides data to establish that aerial hunting on selected ranches in western Montana took coyotes known to have recently killed sheep, or fed on coyote-killed sheep, on these ranches. The data were produced in conjunction with studies of sheep neck collars containing diphacinone, a slow-acting toxicant that served as a chemical marker between time of dosing and time of death for coyotes that punctured collars during attacks on sheep.

METHODS

The toxic collar, or livestock protection collar, is a novel method to kill coyotes that prey on sheep and goats (fig. 1). When coyotes attack collared livestock and puncture the collars, they receive an oral dose of toxic liquid (McBride 1974). Several toxicants have been used experimentally. The present study with diphacinone collars has been reported in detail elsewhere (Connolly 1976, 1979; Connolly et al., 1976, 1978). It is summarized here to establish that the slow-acting toxicant served to mark coyotes that attacked or fed on collared sheep, so that these individuals could be identified later if taken by other control methods.

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[3]The ADC program, formerly managed by the U.S. Department of Interior, Fish and Wildlife Service, was transferred on December 19, 1985 to the U.S. Department of Agriculture, Animal and Plant Health Inspection Service.

[4]Unpublished ADC program records.

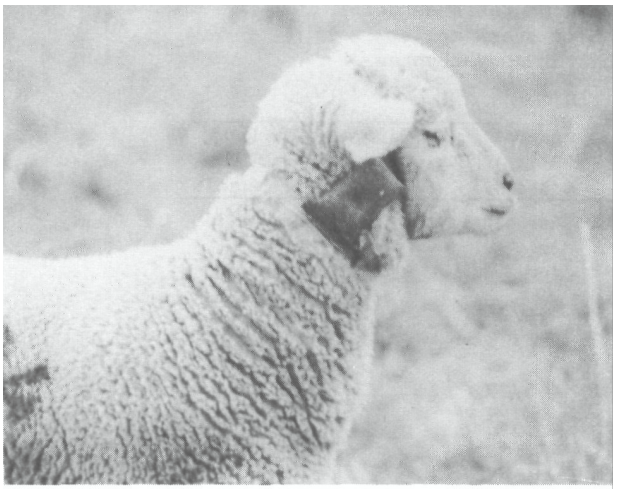

Figure 1.--A 35-pound lamb with diphacinone-filled collar. Only 1 of the 2 collar packets is visible.

Diphacinone, 2-(diphenylacetyl)-1H-indene-1,3(2H)-dione, is an anticoagulant rodenticide used since the 1950s. It acts by blocking the formation of prothrombin in the liver by competitive inhibition of vitamin K. When formulated in propylene glycol and administered to nonfasted, captive coyotes with a syringe in a single oral dose to the back of the mouth, the LD_{50} with 95 percent confidence limits was 0.6 (0.3 to 1.2) mg/kg. Times to death ranged from 6 to 17 days for 16 captive or wild coyotes (Savarie et al., 1979).

Sheep neck collars made of polyvinylchloride were filled with 5% aqueous suspension of diphacinone (50 mg active ingredient/ml). This commercial formulation, "Suspension Vampiricida Difenadiona", was purchased from Motomco, Inc., Clark, NJ. Three different collar configurations were used. Each collar had either 2 or 4 toxicant packets of various sizes. Depending on the number and size of packets, each collar contained 50 to 200 ml of toxic liquid, or 2.5 to 10 grams of active ingredient.

Diphacinone collars were pen-tested by releasing captive coyotes into 1-hectare (2.5-acre) enclosures with collared sheep. Four collars containing 5% diphacinone were punctured by captive coyotes; all 4 coyotes died. Three other coyotes present in the pens during these tests also died after participating in attacks or feeding on dead, collared lambs. Four more coyotes died after they punctured collars containing lower concentrations of diphacinone. For all 11 coyotes that died in pen tests of diphacinone collars, times to death averaged 8 days (range 4-13 days). Each coyote exhibited normal behavior until 1-2 days before it died.

Body tissues from 11 coyotes dosed by collars and 13 other coyotes dosed by researchers were analyzed after death for diphacinone residues. All livers and most muscle samples contained measurable amounts of diphacinone (Connolly 1979; Savarie et al., 1979).

Following pen tests that showed diphacinone collars to be lethal to attacking coyotes, field tests were conducted on 14 western Montana ranches in 1976. The Eight Mile Ranch (O'Gara et al., 1983) near Florence, Montana was the main study area. Collared lambs were placed in fenced pastures where coyote predation had recently occurred or was expected. Average pasture size was 209 acres (n = 23 pastures, range 5 to 816 acres). The number of collared lambs per pasture varied from 1 to 29 but was usually 4 to 10. Some pastures also contained uncollared ewes or wethers, since larger groups of sheep seemed more attractive to coyotes. Adult sheep were not collared because coyotes usually selected lambs. While collared sheep were in the field, other sheep on each ranch were moved away or penned at night to protect them from coyotes.

Collared and uncollared sheep were checked daily for evidence of predation. Each dead or injured sheep was examined for characteristic wounds inflicted by predators and for other evidence relating to cause of death. Sheep carcasses were removed each morning.

Other methods of coyote control were used concurrently with collars on some ranches. The principal technique used by the ADC program was aerial hunting from a turbocharged Bell 47 helicopter. An ADC employee used a 12-gauge semi-automatic shotgun with BB shot to shoot all coyotes seen during flights over ranches where predation had occurred. Coyote carcasses were recovered so that liver and hip muscle samples could be preserved for diphacinone residue analysis. Sampling was limited to coyotes taken on or near ranches where collars had been punctured by coyotes within the previous 20 days. Based on recorded times to death, as reported earlier, it was assumed that all coyotes puncturing diphacinone collars would disappear from the population within 20 days. We also assumed that all coyotes puncturing collars would exhibit measurable diphacinone residues until they died.

In addition to coyotes taken by helicopter, 1 coyote was caught in a snare and another was shot from the ground. The latter animal was taken by a rancher near the carcass of a freshly killed, collared lamb.

Diphacinone in coyote tissues was analyzed by the methods of Bullard et al., (1976) as modified (Connolly et al., 1976). Presence of diphacinone was interpreted as evidence that the coyote was a depredating individual. Pen studies had shown that coyotes could be poisoned either by attacking collared lambs and puncturing collars or by scavenging contaminated lambs killed

Table 1.--Background data and diphacinone residues for 13 coyotes removed from ranches where sheep collars containing diphacinone were punctured by coyotes in 1976.

Number of collars punctured & Dates	Uncollared[1] sheep killed	Coyotes taken[2] Sample number	Date of death	Diphacinone (ppm) Liver	Hip Muscle
Eight Mile Ranch					
3 (3/24, 3/25, 3/25)	13	CR-C1[2]	est. 3/26	ND[3]	ND[3]
1 (5/8)	81	CR-C3	5/28	0.9	ND
		CR-C4	5/28	ND	ND
1 (5/29)	82	CR-C5	5/29	ND	ND
		CR-C6	5/29	2.3	ND
		CR-C7	5/29	ND	ND
1 (5/29)	64	CR-C8	6/1	ND	ND
		CR-C9	6/1	ND	ND
1 (5/29)	53	GEC 2, 3	6/13	7.3	0.7
DP ranch					
1 (9/24)	0	GEC 4, 5	9/28	1.3	2.6
		GEC 6, 7	9/28	1.9	1.6
GB ranch					
2 (9/29, 9/29)[4]	NR[5]	GEC 8, 9	10/3	1.4	0.9
RL ranch					
1 (9/5)	1	GEC 10, 11[2]	9/5	6.0	NS[6]

[1]Total for 20 days before coyote was taken.

[2]Coyote #CR-C1 was found in a snare on 4/3; estimated date of death was 3/24-3/28. GEC 10, 11 was shot by a rancher. Others were shot from ADC program helicopter.

[3]ND = not detected; less than 0.1 ppm.

[4]Three more collared lambs were missing and presumed killed. Collars were not available to check for punctures.

[5]NR = not recorded. Approximately 40 lambs were killed from late June to late September.

[6]NS = muscle not sampled. Stomach contained 114.2 ppm.

by other coyotes, but coyote-killed sheep rarely were scavenged on the Eight Mile Ranch. Of 105 carcasses left in the field and checked daily for feeding, only 4 instances of coyote feeding on 1-day-old carcasses were recorded (O'Gara et al., 1983). Prompt cleanup of collared lamb carcasses minimized their availability to scavenging coyotes and there was no other known source of diphacinone on the study areas. For these reasons, we think the diphacinone-positive coyotes recovered in this study dosed themselves by attacking rather than scavenging collared lambs.

RESULTS AND DISCUSSION

Thirteen coyotes were taken within 20 days after diphacinone collars had been punctured (Table 1). Six of 11 coyotes shot from a helicopter contained diphacinone and thereby were confirmed as having attacked or fed upon collared lambs in the previous 20 days. As described above, there is ample reason to regard the diphacinone-positive animals as depredating individuals.

All of the diphacinone-negative coyotes came from the Eight Mile Ranch where only a few

of the sheep killed by coyotes had collars (Table 1). Coyotes could have attacked many sheep on this ranch without encountering collared sheep, which were pastured separately from the main ranch flocks. In addition, helicopter collections were biased against animals that punctured collars because some of them would have died before aerial hunting took place. Coyotes may have been collected for 20 days after collars had been punctured, but the average time to death was undoubtedly much shorter. Therefore, the documented proportion of depredating individuals (6/11 or 55%) among coyotes taken by helicopter is regarded as a minimum estimate. The true proportion of sheep killers probably was higher.

The coyote taken by snare (CR-C1) was negative, but the animal shot near a freshly-killed collared lamb (GEC 10, 11) contained diphacinone. The concentration found in its stomach (114 ppm, Table 1) was the highest level ever recorded in our laboratory from a coyote. We speculate that this animal punctured the collar within 1 hour before it was shot.

Ranchers and ADC specialists ordinarily cannot identify depredating individual coyotes. Except on rare occasions when coyotes are observed and shot while attacking livestock, the removal of depredating individuals can only be inferred if predation stops after a particular coyote or group of coyotes has been taken. Such inferences are uncertain at best. The approach illustrated in this paper offers a more rigorous way to document the removal of depredating individuals.

The practical solution to coyote depredation is removal or exclusion of all coyotes from immediate localities where depredation is occurring or expected to occur. The limited results reported here support this concept, as they show that coyotes taken by helicopter near sheep flocks included individuals preying on those flocks.

As noted previously, these data were produced during efficacy tests of diphacinone sheep collars. If the study had been conducted specifically to measure the selectivity of aerial shooting for depredating individual coyotes, larger numbers of sheep would have been collared and the collars would have contained a nontoxic marker rather than a toxicant. The approach developed in this paper also could be used to study other methods of coyote removal, alone or in combination.

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