An Evaluation of Anti-Coyote Electric Fencing

MICHAEL J. DORRANCE AND JOHN BOURNE

Abstract

Electric fences with alternating charged and grounded wires were evaluated throughout 1½-2½ grazing seasons on five farms under conditions typical of most domestic sheep operations in the forested areas of Alberta. These fences eliminated or sharply reduced predation and appear to be an economical, effective, nonlethal method for preventing coyote predation of domestic livestock.

Electric fences have been used for years in the prevention of black bear *(Ursus americanus)* damage in beeyards (Storer et al. 1938), but have not been tested extensively as a device for excluding other carnivores. Initial attempts to develop an electric fence for the exclusion of coyotes *(Canis latrans)* were not successful. Shelton (n.d.) concluded that inadequate grounding and the insulating effect of the coyote's fur reduced the electric shock to the extent that electric fences were ineffective for deterring coyotes from sheep pastures. Thompson (1976) evaluated 18 configurations of electric fences in tests with penned coyotes and also concluded that electric fences were ineffective for deterring coyotes. On the other hand Patterson (1977) successfully used an electric fence to reduce fox *(Vulpes vulpes)* predation on a ground-nesting bird colony in England, and Gates et al. (1978) concluded that a properly designed electric fence can effectively prevent coyote predation of domestic sheep. Gates et al. constructed two 1.8-ha enclosures within a 64-ha coyote-proof test pasture. One enclosure was constructed to approximate a conventional sheep fence. The other was an electric fence of 12 wires alternating charged and grounded with an additional charged trip wire 20 cm from the fence around the outside perimeter. Eight lambs were placed in each enclosure and two coyotes were placed within the 65-ha pasture; during two-week tests, all lambs within the conventional fence were killed within nine days, but no losses occurred within the electric fence.

This paper describes and evaluates the use of electric fences for the prevention of coyote predation of domestic sheep on five farmsteads in northern Alberta. Our fence design was somewhat simpler than that described by Gates et al. (1978). In addition, our tests ran throughout 1½-2½ grazing seasons under conditions typical of most domestic sheep operations in northern Alberta, and are probably applicable to most of the forested areas of Canada.

Authors are zoologist, Alberta Agriculture Plant Industry Laboratory, 6909-116 Street, Edmonton, Alberta, T6H 4P2; and biologist, Alberta Agriculture Crop Protection and Pest Control Branch, 9718-107 Street, Edmonton, Alberta, T5K 2C8.
Alberta Government Telephones kindly donated the wire for the electric fences. Acknowledgment for assistance with this study is made to Alberta Agriculture predator specialists L. Bekkerus and E.T. Gould, and farmers B. Beadman, G. Fischer, K. Klein, D. Meniece, and S. Rowe. We also thank J. Baker, Baker Engineering Enterprises, Limited, and A. Todd, Alberta Fish and Wildlife Division, for critical advice.
Manuscript received April 9, 1979.

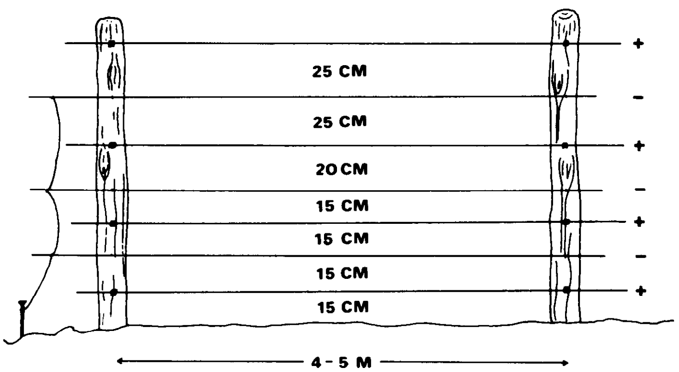

Fig. 1. *Electric fence configuration.*

Study Areas and Methods

Electric fences were constructed around sheep pastures on five farms in the Peace River region in northwestern Alberta during 1976 and 1977. Sheep pastures enclosed by electric fences varied between 6 and 65 ha; total length of fence varied between 0.8 and 3.2 km (Table 1). With the exception of farm B, all farms were on the fringe of settlement, where agricultural land was on the edge or just within vast, unbroken forest. Farm B was in an area of predominantly agricultural land, with small, scattered woodlots. All farms were within the Boreal Mixedwood Forest Region (Rowe 1972).

We used two different fence designs. Pastures on farms B and C were partially enclosed with previously constructed conventional sheep fence (one or two strands of barbed wire spaced 15 cm apart above 81 cm woven wire). A charged wire was placed 15 cm from the ground and 12 cm from the fence around the outside perimeter. Three wires were spaced 15 cm apart above the woven wire, with the first and third wires charged and the second wire grounded. Insulators were used on all charged wires.

Where conventional woven-wire fences did not exist, we constructed an electric fence of seven wires alternating charged and grounded (Fig. 1). Grounded wires were connected to steel rods driven 2-3 m into the ground at the power source and 1 m into the ground on each side of the pasture. Soil within 0.6 m of the fence was sterilized with a mixture of bromacil and paraquat at rates of 13.5 and 2.2 kg active ingredient per ha, respectively. Wooden fence posts were set 4-5 m apart. Wire was 2.7 mm diameter, used telephone wire. Insulators were used on charged wires. Conventional wood gates were used, except that openings within gates were not larger than 10 cm. Unlike Gates et al. (1978), we did not bury a wooden sill under gates, but instead filled in existing holes so that the surface was relatively even.

Fences on farms A, B, and E were powered by one 110-volt charger[1] and on farm C by two 110-volt chargers with one connected to the bottom wire and the other connected to the third,

[1]Model 7721, Baker Engineering Enterprises, Limited, Edmonton, Alberta, Canada.

Table 1. Pasture description and numbers of domestic sheep lost from predation before, and after, electric fences were completed on A,B,C, and D in 1976 and E in 1977.

Producer	Pasture enclosed by electric fence: Area (ha)	Pasture enclosed by electric fence: Perimeter[1] length (km)	Mean annual flock size (SD)	Predation losses: Prior to construction of electric fences: 1974	1975	1976	Predation losses: Within electric fences: 1976	1977	1978
A	33	1.6	296(70)	35	28	0	9	0	0
B	65	3.2	301(70)	22	12	6	0	0	0
C	65	3.2	550(15)	0	17	12	3	0	0
D	6	0.8	44(2)	3	12	0	0	0	6
E	40	2.2	161(19)	—	—	0	—	8	0

[1]Fences were of 7-wire design, except for 0.8 and 1.6 km of modified conventional fence on farms B and C, respectively.

fifth, and seventh wires. The fence on farm D was powered by a 12-volt charger.[2]

Voltage was measured at random points along the charged bottom wire of fences C, D, and E during two days in May 1978. Our voltmeter had a response time of 10 microsec and a selector switch for loaded and unloaded voltage measurements; resistance of the voltmeter was 7,500 ohms and 1 megaohm for loaded and unloaded voltage, respectively. The voltmeter was connected to a charged wire and a "simulated coyote" ground probe. We attempted to simulate the minimum grounding effect of a coyote with a 4.5 kg steel weight that had three legs with a total surface area of 24 cm^2 in contact with the ground.

Sheep were grazed from approximately May-October. Predation losses were reported by farmers. Many losses were confirmed by government personnel since the Alberta Government has paid compensation for verified predation losses of domestic livestock since 1974. Confirmed predation losses of sheep on other farms in the Peace River region were used as an index of year-to-year changes in coyote predation during 1974-78.

Results and Discussion

Predation losses during 1974-78 on farms with electric fences are shown in Table 1. Predation losses on these farms declined dramatically after electric fences were completed (Table 1). Other than the construction of electric fences, we know of no major changes in management on these farms that could account for a decline in predation losses. Flock size varied between years on each farmstead (Table 1), but the total number of sheep on the five farms remained above the same each year. Numbers of sheep confirmed as having been killed by coyotes on 35 other farms in the Peace River region were 105, 73, 22, 98, 61 and during 1974-78, respectively. Thus, losses from coyote predation on these farms varied widely between years, but did not decline dramatically during 1977 and 1978, as was the case on farms with electric fences (Table 1). From the data presented above, we concluded that the electric fences used in this study prevented or reduced predation of domestic sheep by coyotes.

Producers A and B pastured their sheep almost exclusively within electric fences and have had no predation losses since the fences became operational in 1976.

Three lambs were killed by a coyote within fence C shortly after construction in 1976. This coyote probably entered the pasture by crawling under the bottom wire. One coyote was killed and the low spots in the fence were blocked with stones and tree limbs; no losses within the electric fence have occurred since that time. This producer continued to graze adult sheep outside the electric fence, but only one ewe was killed during 1977-78. Overall losses have probably declined because adult sheep were less susceptible to predation than lambs.

Producer D grazed his sheep exclusively within the electric fence. However, on November 30, 1977, a gate was left open, the sheep strayed, and two lambs were killed by coyotes outside the fence that night. Producer D also lost four ewes and two lambs within the fence during 1978; coyotes probably penetrated the fence due to insufficient grounding and low voltage output. This was the only fence powered by a 12-volt charger and, as discussed later, voltage output may be borderline for effective control.

A coyote killed eight lambs within fence E during one night in 1977. After initially penetrating the fence, the coyote attempted to dig out under the fence in at least four places without success. The coyote was still within the fence in the morning and was shot by the producer. This observation suggests that excessive killing may occur when a coyote does penetrate a fence and can not get out.

In 1976, a coyote also penetrated fence B, but killed no sheep. Again, this coyote dug along the fence in at least four places before getting out. We have found no evidence to suggest that a coyote will attempt to dig under an electric fence to get into a pasture, and the above observations suggest that a coyote can dig out only with some difficulty. These coyotes probably penetrated electric fences where the soil was covered by an exceptionally heavy layer of dead grass, manure, or other debris which prevented adequate grounding.

Demand for lethal control has declined markedly since electric fences became operational and consequently, number of predators taken in control operations have also declined. At least 46 coyotes were killed in 1975, and 30 coyotes and 2 black bears were killed in 1976, prior to completion of electric fences. In contrast, only four coyotes were killed during 1976-78, after fences were completed.

Unloaded voltage is a measure of the distance that electricity will jump through air. Hence, a high unloaded voltage will reduce the insulating effect of the coyote's fur. Loaded voltage is a measure of the intensity of a shock received by an animal (J. Baker, personal communications). Unloaded voltage on the bottom wires of fences C and E, powered by 110-volt chargers, varied between 2,800 and 4,000 ($\bar{X}$ = 3,300), while the bottom wire of fence D, powered by a 12-volt charger, varied between 2,200 and 2,400. Loaded voltage varied between 1,200 and 3,500 ($\bar{X}$ = 2,400) on fences C and E, and between 1,100 and 1,500 ($\bar{X}$ = 1,300) on fence D. Our observations suggest that fences C and E were

[2]Parmak Fieldmaster model, Parker-McCrory Manufacturing, Kansas City, Kansas, U.S.A.

adequately powered, while fence D was inadequately powered at times. Thus, to insure effective coyote control, unloaded voltage should probably exceed 2,400; loaded voltage should exceed 1,500 with a current of 0.2 amps (+ 1,500 volts ÷ 7,500 ohms =+0.2 amps).

Large amounts of vegetation in contact with charged wires will sharply reduce voltage, particularly during wet weather. Thus, removal of vegetation beneath fence lines was essential on our study areas, where rainfall and heavy dew were frequent. One application of bromacil effectively controlled vegetation for at least three growing seasons. Removal of vegetation with herbicides had the additional advantage of reducing vegetative litter which can also cause inadequate grounding.

Estimated cost of materials in Canada for a seven-wire electric fence was $1,125 per km, as compared with $1,450 per km for a modified (electrified) conventional sheep fence, and $1,250 per km for a conventional sheep fence. Thus, electric fences provide an economically feasible alternative to conventional fences, although electric fences do require regular inspections and periodic maintenance to ensure that they are operable.

The average cost of materials for the fences constructed for the study was about $2,500 in 1979. In contrast, the average savings per producer in marketable lambs and ewes was probably about $900 per year. In addition, the Alberta Government probably saved $250-350 per producer per year that would otherwise have been spent on predator control. Thus, these data suggest that electric fences can be an effective, economical, nonlethal method for preventing coyote predation on small farmsteads.

Our fence design can probably be improved. It seems probable that a coyote will attempt to penetrate the bottom wires, rather than jump through the middle or over the top of a fence. Consequently, we suspect that only the first and third wires above ground level need be charged; i.e. wires spaced 15 and 45 cm above ground level (Fig. 1). This would reduce by one-half the required length of charged wire and number of insulators. Our fence design might also be improved by an additional grounded wire, 2-3 cm above ground level, which would increase the chances of adequate grounding when a coyote attempted to crawl under the bottom charged wire. The bottom charged wire should also be barbed rather than smooth; the barbs should penetrate the coyote's fur and reduce its insulating effect.

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