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POPULATION REDUCTION AS A FACTOR IN THE CONTROL OF SKUNK RABIES IN ALBERTA¹

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ABSTRACT: Population reduction is being used currently to combat skunk rabies in Alberta. A total of 2,398 striped skunks (*Mephitis mephitis*) were removed from three counties of southern Alberta during 1980-1983 in an effort to combat rabies outbreaks in those areas. The methods employed included trapping, poisoning, and shooting. Skunks in Forty Mile County have been rabies-free for 4 yr and the outbreaks in Newell and Warner counties appear to be under control. The data suggest that population reduction has been effective in controlling rabies in those areas.

INTRODUCTION

Alberta has experienced a low prevalence of rabies in wild and domestic animals. The first reported epizootic began in 1952 as an invasion of fox rabies from the Northwest Territories (Ballantyne, 1958). Rabies swept through the province and reached the vicinity of Lethbridge by February 1953. The rapid spread (1,100 km in 8 mo) apparently was due to the involvement of coyotes (*Canis latrans*) (Ballantyne and O'Donoghue, 1954). During 1952 to 1956 an extensive control program aimed at reducing the wildlife population was initiated. About 180,000 foxes and coyotes were destroyed by trapping, poisoning, gassing, and shooting (Ballantyne and O'Donoghue, 1954). Subsequently, Alberta remained virtually free of rabies for the next 13 yr with only two positive cases reported between 1957 and 1969 (Gurba, 1974).

Rabies was first reported in the striped skunk (*Mephitis mephitis*) in Alberta during January 1971 within 1.6 km of the Saskatchewan border (Gunson et al., 1978). Efforts to reduce the number of skunks during 1971-1979 apparently were effective in the parkland habitat and along the

Alberta-Saskatchewan border area (BPRZ) (Fig. 1) as no cases of skunk rabies have been reported in either of these two areas since 1979. Since then, two major outbreaks of rabies in striped skunks have occurred in: (1) the southern Alberta area (Forty Mile and Warner counties) (Rosatte and Gunson, 1984a, b) and (2) Newell County (Figs. 2, 3).

The use of population reduction for rabies control has been controversial. Several instances of successful control have been reported (Schnurrenberger et al., 1964; Muller, 1969; Gunson et al., 1978; Macdonald, 1980). However, some authors believe it to be an ineffective method (National Academy of Sciences, 1973; Wandeler et al., 1974; Stubbe and Stubbe, 1977). This paper reports the effects of population reduction and other factors, such as self-limiting characteristics of rabies virus, geography, and denning habits on outbreaks of rabies in skunks in three counties in southern Alberta.

MATERIALS AND METHODS

From January 1980 to September 1983, control of rabies by population reduction was attempted in the southern population reduction zone (SPRZ) consisting of Warner and Forty Mile counties (Fig. 1). The SPRZ is bounded by the Chin Coulee and Chin lakes to the north; the St. Mary River and Reservoir to the west; the Milk River Ridge, Reservoir and River to the south; and Pakowki Lake to the east (Fig. 2). The Newell County population reduction zone (NPRZ) is about 150 km north of the SPRZ (Figs. 1, 3) and control has been in effect there

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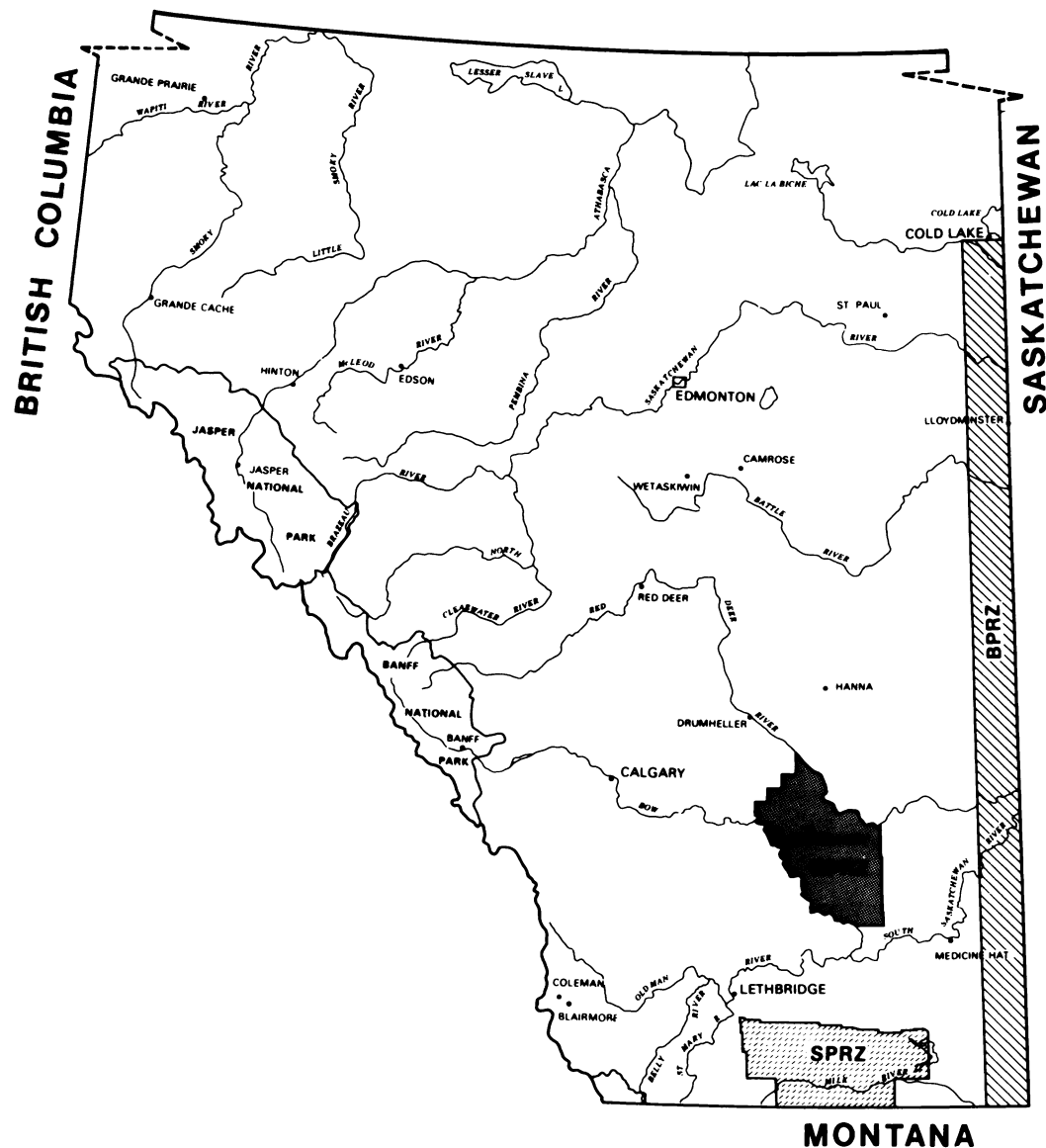


FIGURE 1. Location of striped skunk population reduction areas in Alberta, 1970–1983. ▨ BPRZ in the Saskatchewan-Alberta border area during 1970–; ■ SPRZ in southern Alberta during 1980–; ▤ NPRZ in Newell County during 1982–.

since January 1982. The SPRZ and NPRZ are within the short grass and mixed grass prairie ecoregions (Webb et al., 1967). Additional sampling of skunks was carried out in the area directly north of the SPRZ.

Alberta Agriculture, Alberta Fish and Wildlife, and county personnel were involved in control efforts. Although most skunks were taken with live-traps, some were removed by poi-

soning, and shooting. National live-traps (Tomahawk), baited with sardines, were set at skunk sign and examined daily. Toxicant was administered in the form of strychnine-impregnated (alkaloid) bait cubes (beef fat and parawax) or chicken eggs at a dosage of 30 mg strychnine/bait or egg (1–1.5 cc of 3% strychnine injected). Glacial acetic acid was injected into the eggs as a deterrent to non-target species through taste

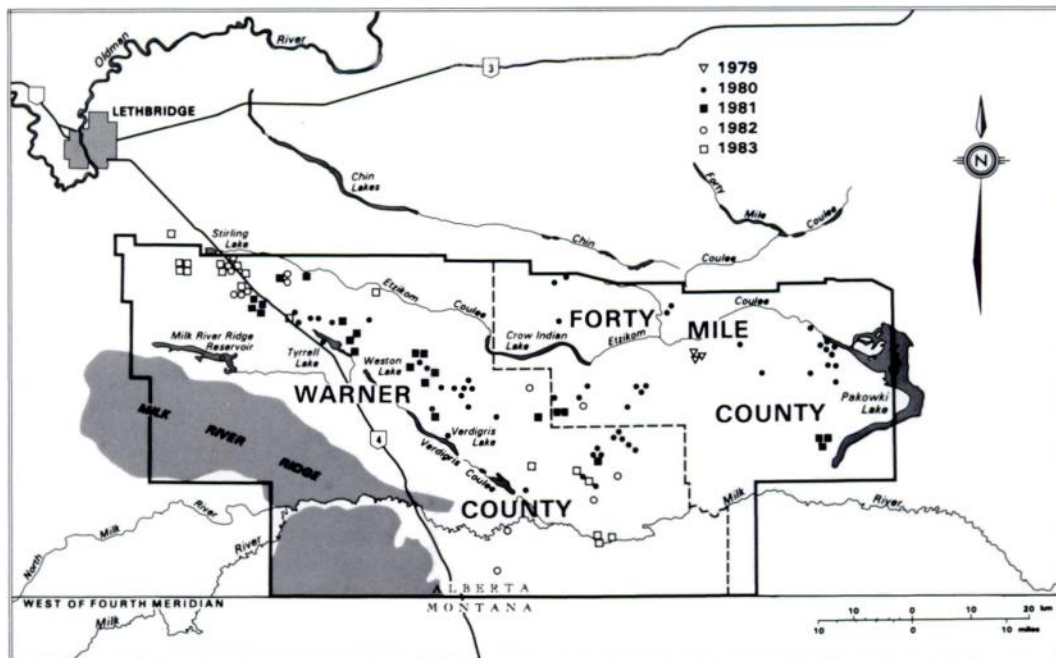


FIGURE 2. SPRZ showing locations of rabid striped skunks during 1979–1983 and major biogeographic landforms.

aversion. The baits or eggs (one to five) were placed in culverts, rock piles, burrows, or under buildings and were accompanied by a conspicuous warning sign. Toxicants were not placed within 0.4 km of human residences unless specifically requested by the landowner. After 10–14 days, the remaining baits or eggs were retrieved and destroyed. Control was concentrated in areas within 5 km of the location of a known rabid animal.

Extensive trapping was done during 1980–1983 in 5-km radial zones around locations where animals were found previously and diagnosed as rabid in Warner County (SPRZ). Trapping effort decreased during the summer months, but otherwise, was consistent between years except during January to March and October and November 1982, when the effort was concentrated in the NPRZ. Skunks were trapped also in an approximate 1,200-km² area north of Warner County between August 1980 and June 1982 to determine if the boundaries of the outbreak had increased. Rabies in skunks had not been diagnosed previously in that area.

Toxicant was used in 13 townships in Warner County from 1980 to 1982. After the dosage was increased from 1.0 to 1.5 cc of 3% strychnine in each egg during 1981, carcasses were

found usually within 5–10 m of the site where the egg was placed.

Control in Forty Mile County involved a combination of live-trapping and the use of toxicants within an area of 2,104 km² during 1980–1983. Poisoned eggs were distributed during the spring and fall. Trapping was restricted largely to winter; toxicants were usually used after trapping was completed. In Newell County (NPRZ) most of the trapping effort was in 14 adjacent townships (1,300 km²) during 1982–1983. Toxicants were used from December 1982 to February 1983.

The trapping effort was quantified as to the number of trap-nights (TN) in each area (1 trap set for 1 night = 1 TN) and the number of skunks collected/TN. Control efforts relating to the use of toxicant were quantified by the number of poison-sites and the number of townships where poison was placed. Differences in prevalence of rabies in skunks and trapping efforts were determined using chi-square analysis (Zar, 1974). Most skunks collected were submitted to Agriculture Canada, Animal Diseases Research Institute (W) in Lethbridge, Alberta, for the detection of rabies virus in the brain by the fluorescent antibody test (Beauregard et al., 1965).

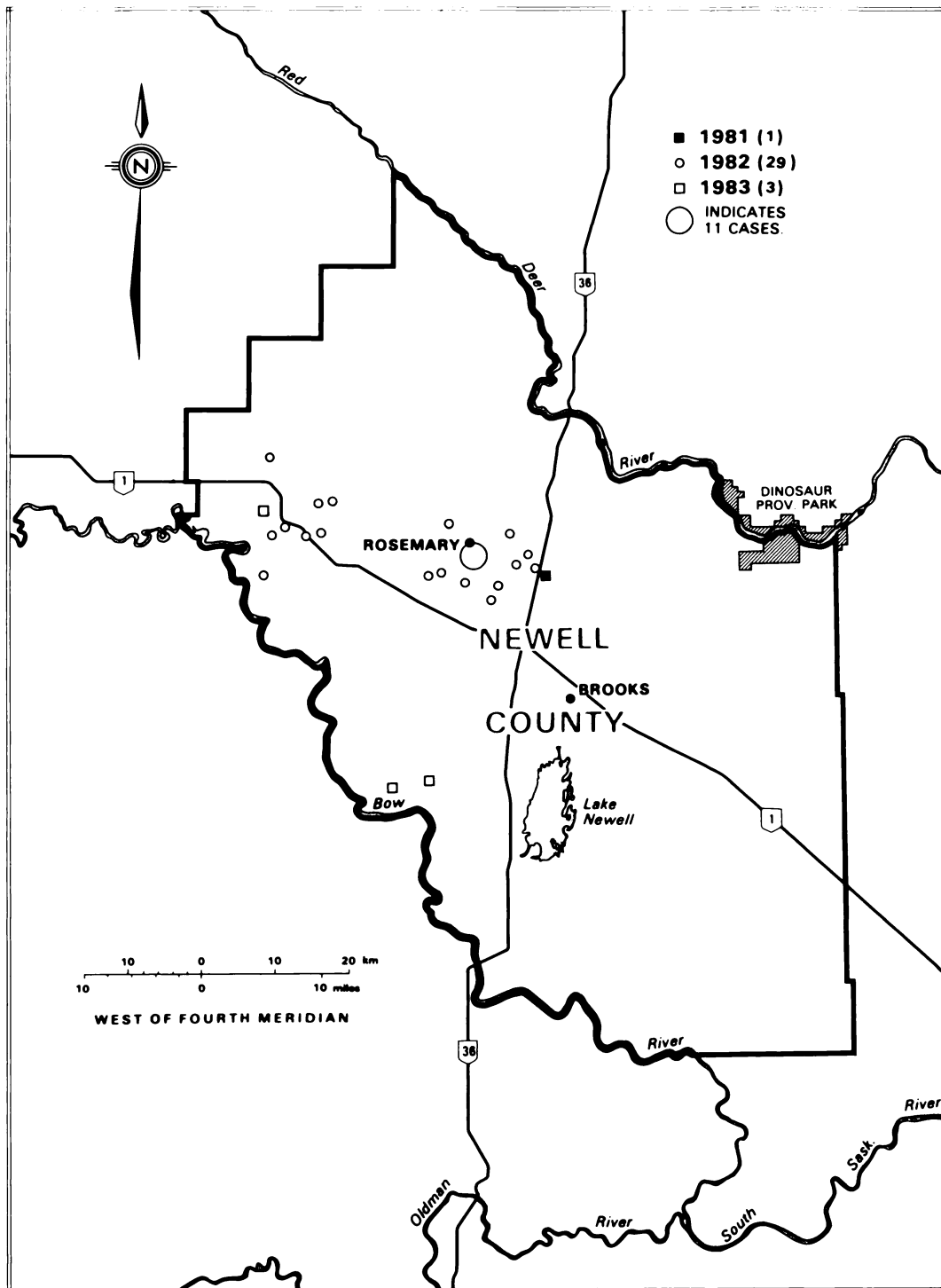


FIGURE 3. County of Newell showing locations of rabid striped skunks during 1981–1983 and major landforms.

TABLE 1. Summary of control effort to reduce the numbers of striped skunks in southern Alberta (Jan. 1980–Sept. 1983).

	Warner (SPRZ)				Forty Mile (SPRZ)				Newell (NPRZ)	
	1980	1981	1982	1983	1980	1981	1982	1983	1982	1983
Trap-nights (TN)	3,790*	4,100*	3,256	5,304	1,600*	455	390	298	3,274	4,510
Skunks trapped	148	239	84	270	192	49	45	33	386	263
Skunk/TN	0.04	0.06	0.03	0.06	0.12	0.11	0.12	0.11	0.12	0.06
Total no. skunks collected	254	403	158	341	204	71	67	62	567	271
Rabid skunks	17	17	2	18	17	5	1	0	30	3
Prevalence ^b	6.7	4.2	1.3	5.3	8.3	7.0	1.5	0	5.3	1.1
Poison sites	29	25	10	>150	40	29	11	37	35	
Townships	12	11	6	16	18	19	17	11	8	

* Estimated.

^b (No. rabid/no. collected) × 100.

RESULTS

Most rabid animals diagnosed in Alberta since December 1979 were striped skunks, accounting for 144 (80%) cases up to 1 September 1983; 110 (76%) of those skunks were diagnosed from the SPRZ and 33 (23%) from the NPRZ. Bats (32) and domestic species (five) accounted for the remaining diagnosed rabies cases.

Southern population reduction zone

Warner County: Totals of 16,450 TN and 214 poison sites were accumulated between January 1980 and September 1983 (Table 1). A total of 1,156 skunks was collected and tested for rabies infection (Table 1); 741 (64%) were live-trapped. The remaining animals were shot. Between June and October 1983, at least 131 skunks died after consuming poisoned eggs but were not tested for rabies. Comparison of the trapping data between years was not possible in Warner County because the trapping effort occurred in different months and at different locations. However, fewer skunks were taken in 1982 than in 1980–1981 (Table 1). Prevalence of rabies in the total sample was 4.7%. The annual prevalence was greatest in 1980 and decreased in 1981 ($P < 0.1$) and 1982 ($P < 0.025$). However, the prevalence in 1983 was greater than in 1982 ($P < 0.05$,

Table 1) but only four cases have been diagnosed in the control area during 1984–1985. Total cost of the control program in Warner County was \$213,800 Canadian (\$15.00/km²/yr) for the period 1980–1983 (Table 2).

Forty Mile County: Totals of 2,743 TN and 117 poison sites were accumulated between January 1980 and September 1983 (Table 1). An estimated 325 skunks were killed with toxicants. From December 1980 to September 1983, 404 skunks were tested for rabies. Eighty percent (319) were captured in live-traps. Prevalence of rabies in the total sample of skunks

TABLE 2. Annual costs in Canadian dollars for control of rabies in striped skunks in Alberta.*

	Warner County (SPRZ) (\$)	Forty Mile County (SPRZ) (\$)	Newell County (NPRZ) (\$)	Total cost
1979–1980 ^b		3,000		3,000
1980–1981	68,800	16,700		85,500
1981–1982	72,500	6,500	17,500	96,500
1982–1983	52,700	9,400	34,300	96,400
1983 ^c	19,800	6,000	13,100	38,900
Total cost	213,800	41,600	64,900	\$320,300

* Includes Alberta Agriculture, Alberta Fish and Wildlife Division, and county costs for control of skunk rabies.

^b Fiscal year 1 April to 31 March.^c Costs as of September 1983.

TABLE 3. Comparison of trapping effort inside and outside of the Southern Population Reduction Zone, 1980–1982.

County	Area	Year	TN ^a	SK ^b	SK/TN ^c
Inside population reduction zone					
Warner	Magrath	Mar., Apr. 1981	204	10	0.049
Warner	Stirling	May 1981	93	2	0.022
Warner	Wilson	June 1981	160	6	0.038
Warner	Raymond	Aug. 1981	237	8	0.034
Warner	Stirling	Mar. 1982	342	14	0.041
Warner	Raymond	Apr. 1982	1,144	53	0.046
Warner	Raymond	June 1982	68	3	0.044
Total			2,248	96	0.043
Outside population reduction zone					
Taber	Bow Island	Aug. 1980	174	15	0.086
Lethbridge	Lethbridge	Mar. 1981	145	23	0.160
Taber	Vauxhall	June 1982	173	19	0.110
Taber	Rolling Hills	June 1982	108	19	0.176
Total			600	76	0.127

^a TN = trapping night.^b SK = skunk.^c SK/TN = skunk/trap night.

was 5.8%. The annual prevalence was greatest in 1980 and decreased significantly in 1982 ($P < 0.05$) and 1983 ($P < 0.025$, Table 1). The number of skunks/TN was consistent between years (0.12 ± 0.01). The county has been free of skunk rabies since July 1982 (December 1985). Total costs of the control program in Forty Mile County were \$41,600 Canadian (\$5.00/km²/yr) for the period 1979–1983 (Table 2).

Outside SPRZ: During 1980–1982 skunks within 50 km outside of the SPRZ northern border were collected by live-trapping to determine if the boundaries of the SPRZ outbreak had expanded. Significantly more skunks/TN were taken outside of the control zone than in Warner County during 1980–1982 ($P < 0.001$, Table 3).

Newell population reduction zone

A total of 7,784 TN and 35 poison sites was accumulated between February 1982 and September 1983 in the 1,300 km² control area of Newell County (Table 1). The

number of skunks/TN during February to April decreased in 1983 over 1982 ($P < 0.001$, Table 1).

From February 1982 to September 1983, 838 skunks collected in Newell County were tested for rabies infection of which 12 were killed with toxicants. Prevalence of rabies in the total sample of skunks was 3.9%, but was significantly lower in 1983 than in 1982 ($P < 0.005$, Table 1). Rabies was not diagnosed in 169 skunks tested between March and September 1983 and only four skunks have been diagnosed rabid in the control area up to December 1985. Total cost of the control program in Newell County during 1981–1983 was \$64,900 Canadian (\$20.00/km²/yr) (Table 2).

DISCUSSION

The prevalence of rabies in striped skunks decreased each year in all three counties except Warner County during 1983. Also, our data indicate that the overall distribution of rabid skunks has not expanded greatly since 1980 and recently

has been limited to isolated areas of Warner County. No rabid skunks have been diagnosed in Forty Mile County since July 1982, and only four diagnoses have been made in Newell County since February 1983 (as of December 1985). The prevalence is well below 1% for 1984–1985. This situation is in contrast to the spread of rabies in other skunk populations in Canada and the United States where rabies has remained enzootic with and without control (Hayles and Dryden, 1970; McLean, 1970; Tabel et al., 1974).

The epizootiology of rabies may be affected by topography of the habitat, the behavior and ecology of the vector, and the effects of control efforts (Irvin, 1970; Rosatte, 1984). Carey et al. (1978) suggested physiographic features may serve as barriers to the spread of rabies in Virginia. In southern Alberta (west of Warner County), the Milk River Ridge provides an upland area of habitat unsuitable for skunks. The Milk River, Etzikom Coulee, and Chin Coulee may provide major deterrents to migrating skunks in the SPRZ on a north–south axis and Pakowki Lake may have a similar effect to the east. As well, the barriers would prevent a vacuum from being created which would draw skunks into the area after population reduction. To further substantiate this claim, home ranges and movements of radio-collared skunks in the SPRZ were not extensive. None of the 28 collared skunks crossed any of the geographical features encompassing the SPRZ (Rosatte and Gunson, 1984a). Verts (1967) also suggested outbreak areas remained more or less discrete due to the restricted movements of skunks.

Striped skunks in a northern prairie habitat may spend 4–5 mo in communal winter dens (Gunson and Bjorge, 1979; Andersen, 1981), thus restricting intraspecific interactions to small segments of the population. Houseknecht (1969) noted contact between skunks was greatest dur-

ing the winter denning period in Minnesota. The virus may become latent in skunks during hibernation (Parker and Wilsnack, 1966) and is self-limiting in many situations (Irvin, 1970). As well, there is no evidence to suggest the reproductive rate or litter sizes of skunks in an area of population reduction increase to compensate for the removal of skunks from the population (Schowalter and Gunson, 1982). These factors could all play a role in limiting the spread of rabies in southern Alberta.

The potential effects of the control program must also be considered as a factor. In Forty Mile County, the infection was initially widespread, as evidenced by the survey trapping and the number of suspect rabid skunks reported by the public. Subsequent control efforts were widespread. Although extensive use of toxicant resulted in relatively few skunks being tested for rabies infection, no rabid skunks have been submitted since June 1982 by the public, or by personnel in the control program up to December 1985. The trapping and poisoning program could have contributed to the limitation of active rabies in the skunk population by lowering the density of potential vectors.

The epizootic situation in Newell County appeared distinct from that in Warner and Forty Mile counties. In Newell County, the outbreak was intense, i.e., short-termed and concentrated. Control efforts were initiated immediately and concentrated in a small area resulting in the removal of >800 skunks (0.62/km²) in 18 mo and an associated decrease in trapping success. Abundance of skunks in the area may have decreased as a result of the population reduction effort, or the disease itself, or both. Few carcasses were found during field investigations prior to poisoning, suggesting that few skunks succumbed to the virus or that they died in cover and were not found. The removal of so many individuals in a short time may

have affected the rate of transmission of the virus. Currently (December 1985), rabies is not considered a problem in Newell County.

Warner County remains the major problem area. The apparent increase in the prevalence of rabies in 1983 may relate to a reduction in control effort in Warner County during 1982 when effort was concentrated in Newell County. The skunk population was allowed to increase during the spring of 1982, which probably contributed to an increase in prevalence during 1983. However, the effects of the control program can, perhaps, be measured by fewer skunks being taken inside the control zone than outside between 1980 and 1982. This may indicate that the combined effects of the control program and the self-limiting nature of rabies lowered the density of skunks in the SPRZ. It must be noted that different areas of the SPRZ were trapped each year so a decrease in skunks/TN will not be as obvious as in the NPRZ where the same areas were trapped. Only four skunks were diagnosed rabid in Warner County during 1984 suggesting the outbreak may be under control.

The effects of the natural epizootiology of rabies in skunks cannot be separated from the control program. The cyclic nature of rabies infections in a free-ranging population has been demonstrated repeatedly (Johnston and Beauregard, 1969). In Saskatchewan, the habitat and density of skunks are similar to those in Alberta (Andersen, 1981), and skunk rabies has been endemic, with a 4- to 5-yr cycle, since 1970. However, the cyclic pattern has not been observed in Alberta, despite continued sampling of skunks since 1971 (Gunson et al., 1978).

We feel that the removal of large numbers of skunks from a limited geographic area has been effective in contributing to a lower prevalence of rabies. An experimental rabies infected area to act as an

untreated control was not possible since the SPRZ and the NPRZ are the only areas in the province where skunk rabies is presently noted. However, in adjacent Saskatchewan, 564 cases of rabies in skunks have been diagnosed between 1980 and 1983. That province currently does not employ population reduction as a method for rabies control and rabies has been enzootic in skunks since the early 1960's (Hayles and Dryden, 1970; Tabel et al., 1974). Rabies infection prevalences of 51% have been reported for skunks submitted by the public in Saskatchewan (Gunson et al., 1978) while comparable data show the prevalence of skunk rabies in Alberta is less than 10%.

The apparent success of the population reduction programs in Alberta may relate to the previous lack of endemic rabies in skunks, the biology of the vector in a northern habitat, the geographical features of the area, and the presence of an organized control effort which was mobilized once the disease was identified.

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