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A PROFILE OF REPORTED SKUNK RABIES IN ARKANSAS: 1977-1979

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Abstract: Skunk rabies in Arkansas increased from 90 laboratory confirmed cases in 1977 to 140 in 1978 and 297 in 1979. In 1979, the Arkansas Department of Health declared a skunk rabies epizootic in Arkansas. Skunk rabies accounted for 90% of the total rabies cases in 1978 and 1979. March, April and May had the highest incidence in each year. SYMVU computer analysis illustrated the distribution and spread of rabies. In general, rabies was confined to the upland areas of the state. Regression analysis of 16 density-independent variables revealed no correlation with the distribution of rabies, indicating the primary determinants to be biotic.

INTRODUCTION

Since the early 1950's, the major hosts of rabies in the United States have shifted from domestic animals to wildlife, primarily the skunk. In the 1970's the number of rabies cases among skunks reached such levels that some states (e.g., Texas and Oklahoma) were experiencing epizootics. Previously reported studies have described a skunk rabies belt extending from southern Texas and Louisiana north into Canada (Parker, 1975). With 90 laboratory-confirmed cases in 1977, 140 in 1978 and 297 in 1979, Arkansas ranked first in the United States in number of laboratory-confirmed cases reported per square km. This led the Arkansas Department of Health to declare a rabies epizootic among skunks in 1979 (McChesney, pers. comm.).

Arkansas is in the geographic range of two species of skunks, the eastern spotted skunk *(Spilogale putorius)* and the striped skunk *(Mephitis mephitis)*. Both species have been found positive for rabies, however, lower densities and secretive habits of the spotted skunk make the striped skunk the principal vector. Reports on the distribution of rabies in striped skunks have been published for a number of states and provinces of Canada (Friend, 1968; Gunson et al., 1978; Hall, 1978; Hayles and Dryden, 1970; Parker, 1962; Rakowski and Andrews, 1972; Sanderson et al., 1967; Schnurrenberger et al., 1964; Schnurrenberger et al., 1970; Tabel et al., 1974; Trainer, 1967-68; Webster et al., 1974). These studies have usually presented distributional data by county rather than by exact geographical locations, thus an accurate temporal and spatial pattern of the spread of rabies is not apparent. While the above reports have provided information concerning the epizootic aspects of the disease, they have, for the most part, not attempted to correlate skunk density-independent variables with rabies distribution. A few studies have, however, correlated such variables as habitat diversity, human population density, other rabid animals, distance to health laboratories and animal bite investigation activities, to reported rabies in skunks (Carey et al., 1978; Lewis, 1972; Verts and Storm, 1966). This study has attempted to describe the spread of the present epizootic of skunk rabies in Arkansas, as well as correlate a large number of density-independent variables with the reported cases.

MATERIALS AND METHODS

Arkansas Department of Health records were utilized for data on cases, monthly prevalence, numbers of skunks tested for rabies and individuals having contact with rabid skunks. Only laboratory-confirmed cases of rabies reported by the Arkansas Department of Health were utilized.

Persons having contact with rabid skunks were interviewed by questionnaire or telephone to determine the exact location of the rabid animal. The state was divided into 16 sq. km. quadrats and the locality of the rabid skunk was plotted. Distributional patterns were obtained using the SYMVU computer program at Memphis State University.

Sixteen density-independent variables (which would not only influence skunk rabies distribution, but also skunk population density and distribution) were plotted on the above grid map and matched, as closely as possible, with the reported cases of skunk rabies (Arkansas Dept. of Planning, 1973; Mather, 1964; National Oceanic and Atmospheric Administration, 1977-79). In this way, we could compare the variables both spatially and temporally with rabies cases. The variables and rabies cases were tested for correlation, using step-wise multiple regression analysis, a subroutine of the Statistical Package for the Social Sciences (Nie et al., 1975). Computations were conducted using the Xerox Sigma IX computer at Memphis State University.

RESULTS AND DISCUSSION

The total number of cases, since 1955, of the three primary rabies vectors in Arkansas (skunks, [striped and spotted combined], foxes [gray foxes, *Urocyon cinereoargenteus* and red foxes, *Vulpes vulpes*] and domestic dogs) are compared in Fig. 1. Skunk rabies was much less important than domestic dog and fox rabies until a shift was seen in 1963 and 1964. The present epizootic of skunk rabies began in 1976. This general pattern of rabies in Arkansas followed

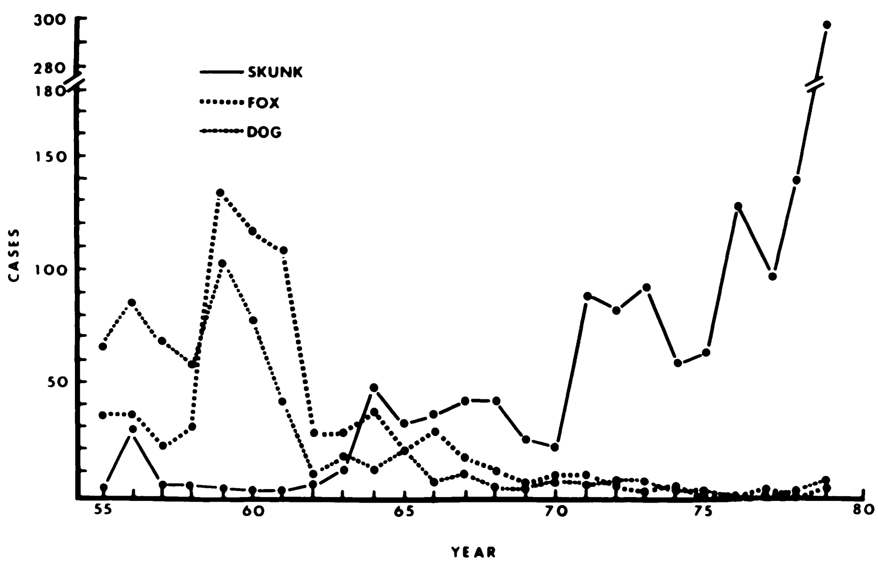


FIGURE 1. Total cases of laboratory-confirmed rabies in skunks (spotted and striped combined), dogs and foxes (gray and red combined) in Arkansas (1955-79).

the national trend (McLean, 1970; Parker, 1975; Winkler, 1972).

Table 1 compares the total number of skunk heads examined, between 1977 and 1979 and those confirmed to be rabid. Although numbers vary among both months and years, total percentage positives were similar for each year (57%, 52%, 52% respectively).

March, April and May constitute the months with the highest percentage of yearly cases of rabies (Fig. 2). A rather consistent percentage of cases is seen during the remainder of the year. There is some variation among years, however, the trend is similar for each year.

SYMVU three-dimensional illustration of geographical distribution of skunk rabies for each year is shown in Fig. 3. The height of the peak represents the number of cases in that locale and the width of the base represents the geographic area. This computer program is predictive as to the number of cases found between known locales, assigning an averaged value to those areas between adjacent data values. Thus, each map is a composite of known and predicted cases.

Over the three-year period, skunk rabies has been restricted almost entirely to the highland areas or to a band roughly 16 km on either side of the escarpment separating the highland from the delta (see inset map on Fig. 3 for reference to the escarpment). Rabies was often concentrated in localized areas, as evidenced by sharp narrow peaks. Furthermore, rabies did not seem to remain concentrated in any one area for more than a year or two.

Results of the stepwise multiple regression analysis of the 16 parameters tested are shown in Table 2. None of the parameters correlated significantly with

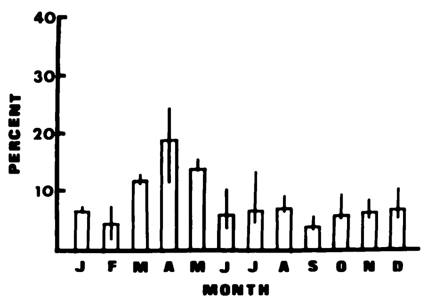
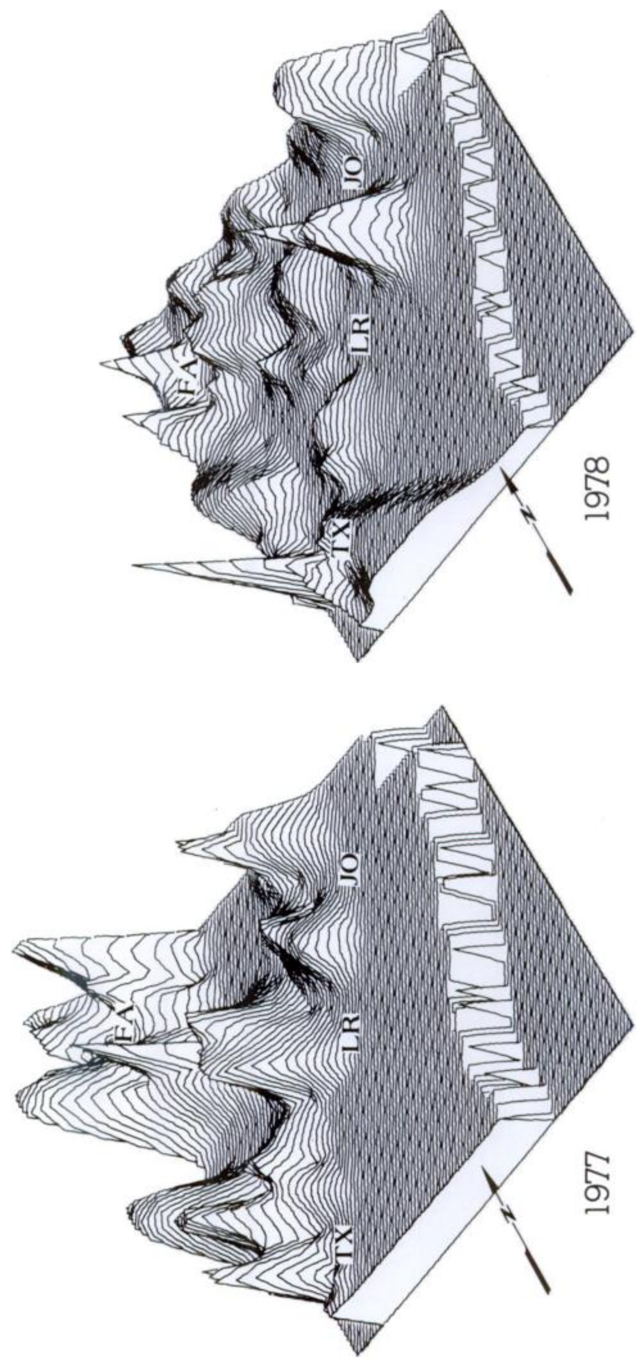


FIGURE 2. Percent of total cases of skunk rabies by month (1977-79). The bar represents the mean for the three years and the vertical line represents the range.

TABLE 1. Skunk heads examined by Arkansas Department of Health, 1977-79.

	1977			1978			1979		
	Total	Rabid	% Rabid	Total	Rabid	% Rabid	Total	Rabid	% Rabid
Jan.	6	6	100	12	9	75	42	20	50
Feb.	10	2	20	7	2	29	43	21	49
March	16	11	69	30	18	60	44	34	77
April	12	11	92	24	17	71	87	72	83
May	16	15	94	20	19	95	59	42	71
June	20	10	50	17	5	29	45	17	38
July	24	13	54	20	10	50	53	13	25
Aug.	21	7	33	40	13	33	50	18	36
Sept.	15	4	27	21	8	38	34	10	29
Oct.	11	6	55	30	12	40	48	16	33
Nov.	9	5	56	22	12	55	30	18	60
Dec.	11	8	73	25	15	60	34	16	47
Total	171	98	57	268	140	52	569	297	52


FA
LR
JO
TX
1978
FA
LR
JO
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1977

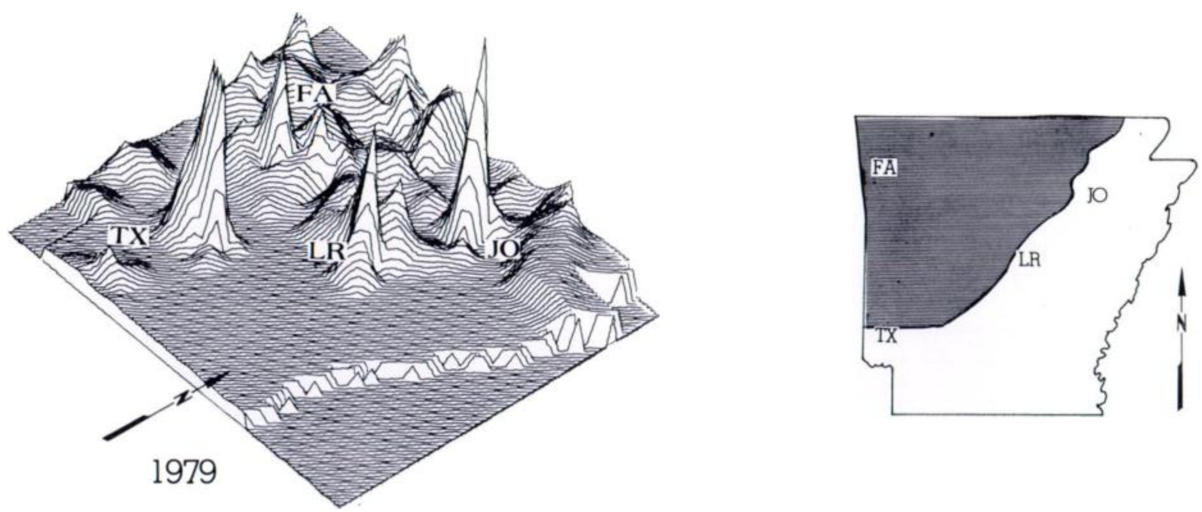

FIGURE 3. SYMVU three-dimensional line-drawing illustrating the incidence of reported cases of skunk rabies in Arkansas for 1977-79. The heights of the peaks represent numbers of cases and the bases represent geographical area. The following cities have been positioned for reference: LR - Little Rock, JO - Jonesboro, TX - Texarkana and FA - Fayetteville. The inset map of the state illustrates the highland areas (shaded portion).

TABLE 2. Step-wise regression correlations of density-independent variables and skunk rabies distribution.

Variable	Correlation coefficient
Human population density	0.127
Farming region	0.168
Mean duration of growing season	-0.015
General forest type	0.104
Soil type	0.027
Annual runoff	0.011
General physiographic region	0.136
Evapotranspiration	-0.034
30 yr. mean precipitation	0.009
High monthly precipitation (yr.)	-0.006
Low monthly precipitation (yr.)	0.139
Total yearly precipitation	0.004
30 yr. mean temperature	-0.009
Jan. temperature (yr. low)	-0.048
July temperature (yr. high)	-0.134
Mean yearly temperature	-0.078

the incidence of reported rabies for the years 1977-79.

Studies in several north-central states have shown the major peak of rabies activity to be in late spring, primarily April-June (Sanderson et al., 1967; Schnurrenberger et al., 1964; Schnurrenberger et al., 1970; Trainer, 1967-68; Verts, 1967). This study showed a similar peak, however, it began a month earlier and extended from March to May. This shift would not be unexpected as skunks in Arkansas begin reproductive and foraging activities at an earlier date due to climatic differences. The spring peak of rabies corresponds to increased activity and subsequent interactions between skunks. Factors which cause the disease to manifest itself at this time are largely speculative (Parker, 1975; Verts, 1967). It could be related to increased exposure in the late fall as animals begin communal denning activities (Houseknecht, 1969) or, as Hall (1978) suggests, the animals may harbor a subclinical infection which may be reactivated due to the increased stresses of rebuilding fat deposits, reproductive activity, and increased aggressiveness. The relatively constant rate of rabies during the remainder of the year is probably a combination of exposure during breeding, mother-young transfer of the virus and increased contact during dispersal of young animals. In Canada researchers found a late year peak in rabies activity, which we did not observe, and attributed it to dispersal of young of the year (Hayles and Dryden, 1970; Tabel et al., 1974; Webster et al., 1974). Other studies which also did not observe this peak, implicated young skunks in most rabies cases occurring late in the year (Gunson et al., 1978; Webster et al., 1974). We did not have age and sex data which might have provided further information in this regard.

Results from Table 1 indicate that there has not been a statewide epizootic; in that while the numbers of rabid skunks has increased, the percentage of positive skunks has not changed appreciably. In Canada, in recent years, researchers have found increasing numbers of rabid skunks without an increase in percentage positive (Casey, pers. comm.). In fact, a public awareness campaign begun in early 1979, by the Arkansas Department of Health, probably influenced the numbers of skunks submitted for testing. An analysis of the SYMVU results graphically demonstrate the presence of localized epizootics. Hall (1978) found much the same type of results in northeastern Tennessee and termed these areas microfoci. It is important that rabies microfoci be ascertained on a continual basis and control measures or monitoring of the disease be instituted. Computer application, using such programs as SYMVU, would be extremely useful in locating these microfoci. The application of these techniques for graphically displaying movements and patterns of other wildlife diseases should also prove useful to researchers.

The lack of correlation between the variables we tested and the incidence of reported rabies indicates that the major factors involved in the incidence and the spread of the disease are probably biotic in nature. Some abiotic factors not tested (e.g. distance to the health laboratory or veterinarian and previous experience with animal rabies), however, might have influenced the reported incidence of rabies in Arkansas, as they have in other states (Carey et al., 1978; Lewis, 1972; Verts and Storm, 1966). Lewis (1972) in Oklahoma, also found that human population density and habitat diversity had no effect on the reported incidence of skunk rabies. However, Carey et al. (1978) have stated that it is not the actual human population density (as was used in this and other studies), but the "effective" population density (the proportion of the population which has potential for contact with rabid animals) that is important for correlation with the reported incidence of rabies. Their data, however, dealt primarily with fox rabies, and the behavioral differences between rabid foxes and skunks might influence what the "effective" population might be.

Studies in the past have also indicated that rabies is primarily density-dependent (Marx and Swink, 1963; Rausch, 1958; McLean, 1970); however, it has been suggested that other factors may be implicated in skunks (Hall, 1978). Hall (1978) pointed out, "such factors as habitat destruction, reduction of food supply, and/or increased parasitism and diseases other than rabies could reduce skunk populations, lower resistance to the rabies virus, and initiate an upsurge in clinical skunk rabies cases". We feel that the stresses these conditions might impose could result in increased skunk rabies if skunk populations were not reduced below the level needed for perpetuation of the disease. While no such threshold level for host populations to support rabies transmission has been determined (Carey et al., 1978; Verts, 1967), it seems reasonable that such a level might exist. Hall (1978) also pointed out that periodicity in skunk rabies could result from changes in the ratio of susceptible and immune skunks and/or the general herd immunity of the population. This points out the need for a thorough understanding of skunk population dynamics, social interactions, and movements in both rabid and non-rabid populations. Furthermore, a comprehensive investigation should be conducted into the dynamics of the disease such as mother-young transfer, latency of viral expression, and immune response.

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