

THE RELATION OF THE SKUNK  
TO GAME AND BURROW-USING ANIMALS IN VIRGINIA

by

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Thesis submitted to the Graduate Faculty of the  
Virginia Polytechnic Institute  
in candidacy for the degree of  
MASTER OF SCIENCE  
in  
WILDLIFE MANAGEMENT

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June, 1953

Blacksburg, Virginia

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## ACKNOWLEDGMENTS

As in all cooperative ventures, the assistance of a great many individuals was essential to the completion of this project. Particular thanks are due the following persons and organizations:

To the Commission of Game and Inland Fisheries of the Commonwealth of Virginia for financial assistance and use of equipment, without which this investigation could not have been undertaken.

To Dr. Henry S. Mosby, the late Dr. Cecil F. DeLaBarre, Professor A. S. Massey, Professor J. J. Aulbach, and Professor J. D. Smith for the technical assistance, advice, and supervision, and, above all, for time so generously donated.

To District Game Technicians and Game Wardens of Virginia for the amount of help which they so readily supplied upon request.

To the Parasitology Department of the Virginia Polytechnic Institute for identifying parasites collected during the investigation; with special thanks to \_\_\_\_\_ for her fine cooperation.

To \_\_\_\_\_ for interest shown in this project, and use of equipment and personnel while work was being done on the Bedford County Study Area.

To the following fellow graduate students who contributed many field observations, offered many suggestions, and above all for their fellowship and humor: \_\_\_\_\_

\_\_\_\_\_ , and \_\_\_\_\_ . I wish to extend special thanks to graduate students

and                    for their assistance and continued interest during this investigation, and for their constructive criticism of field work.

To                    , a graduate of V. P. I., I wish to extend my special thanks for companionship, advice, and many hours spent in the field assisting in field work and observations.

And finally, to my wife, for her patience and assistance in making this investigation possible.

## INTRODUCTION

According to Seton (1929, 2:312-313), the earliest known account of the skunk (Mephitis mephitis spp.) is by F. Gabriel Sagard-Theodat in his "Historie du Canada" published in 1636. The animal was called "Babougi Manitou," "Scangaress," or "Quinesque" by the Indians of that time. Theodat described the animal (Seton, 1929:312) as: "a very strong-smelling beast of the size of a Cat or of a young Fox, but it has the head a little less pointed, and the skin covered with a thick fur, rough and smoky, and its big tail turned back over itself; it hides itself in winter under snow, and does not come out until the beginning of the moon of the month of March. This animal, besides being of very bad odour, is very malicious, and of ugly appearance; they drop also (so it is said) among their excrements, little serpents, long and slender, which, nevertheless, do not live very long."

The skunk has been known in Virginia since early colonial times. The animal has increased in numbers and range in the state for the last several decades. Apparently, the increase has been gradual and has been little affected by trapping, even in years in which there was a great demand for skunk fur.

From the years 1848 to 1905, the Hudson Bay Company collected 302,564 skins of this species (Seton, 1929: 2). A list of sales in London from 1900 to 1915 shows an average annual catch in America of 1,204,723 animals, with a high of 2,009,465 in 1911, and a low of 615,000 animals in 1915 (ibid). According to Ashbrook (1951), from states reporting, there were 3,001,943 striped skunks (Mephitis spp.)



sold for fur in the United States from 1945 to 1950. Also, during this period, there were 271,189 spotted skunks (Spilogale spp.) sold for fur. From 1944 to 1950, there were 288,663 striped skunk pelts taken in Virginia, with a high of 99,705 in 1944 and a low of 32,781 in 1950. Variation of the annual fur catch for the various years depended primarily upon the skunk population and demand for long-haired furs. The demand in turn depended upon the style of women's clothing for that particular period of time. Thus, it is not to be inferred that the number of skunk pelts sold reflects the actual population of skunk in Virginia or elsewhere.

## REASONS FOR THIS INVESTIGATION

According to field reports, there has been a notable increase in the striped skunk (Mephitis mephitis spp.) throughout Virginia within recent years. In addition to this increase, there has been an eastward extension of the range of this animal (Handley and Patton, 1947, p. 136), until in 1952 it was found in all but nine counties of Virginia (Figure 5). Evidence available indicates that the increase in numbers and range has been gradual rather than eruptive. On the other hand, according to field reports, abrupt declines in numbers have occurred in localized areas (Figure 8). These decreases appear to be the result of some type of epidemic within the population. In general, it may be said that the population of skunk in Virginia has markedly increased throughout most sections of the State. This increase in numbers has been of such magnitude as to cause upland game hunters to become concerned as to the effect of skunk on nesting success of gallinaceous birds such as bobwhite quail, wild turkey and ruffed grouse. In addition, there have been increased reports of damage done by skunk to poultry and crops. It is also possible that skunk may affect other segments of animal populations, both wild and domestic, by transmission of disease and parasites. Thus, this investigation was undertaken to assemble all available information on these relationships, especially attempting to evaluate the relationship of the skunk to other animals.

A rather detailed study of these relationships was made on three areas. One study area, the V. P. I. College Farms, which is intensely developed for agricultural purposes, is located in Montgomery County near Blacksburg. The College Farms of some 2,300 acres was the major

study area for several reasons. In 1952-53, a high skunk population was present and a considerable amount of information regarding the quail, rabbit, squirrel, woodchuck, and red fox was available from other studies on the Farms. The availability of this area had a great deal of influence upon its being chosen as a study area.

The second study area was the farm of Mr. H. O. Meriwether which is located in Bedford County near Lynchburg. A program for the control of the skunk and woodchuck had already been planned for use on this area; thus the primary work accomplished on this area was that of assembling data on the results of this control program. The agricultural practices on this farm are devoted almost entirely to pasture and hay crops for cattle. This area, in the Piedmont region of the State, is in a different physiographic region from the other two, which are west of the Blue Ridge Mountains.

The third study area was near Newcastle in the Barbour's Creek region of Craig County. This area was selected primarily in an effort to determine the variation in skunk populations in an agricultural region and a forested mountainous region. An attempt was also made to compare the type of den sites selected by skunks and other animal species in forested terrain as compared with burrows used on the V. P. I. College Farms.

It is hoped that this investigation will point out some ecological factors to be considered in determining a sound management program for skunk based on its relationship to other game species and to agricultural practices.

## THE STATUS OF SKUNK AND WOODCHUCK IN VIRGINIA

State-wide Population.

Skunk populations in Virginia vary markedly in the several physiographic divisions of the State. Time allotted to this project did not permit a detailed investigation of the population of skunk present in various sections of the Commonwealth, but general information regarding relative abundance of skunk and other burrow-using animals was assembled.

The distribution and abundance of woodchuck were taken into consideration because of their possible correlation with the population abundance of the striped skunk. The skunk is a burrow-using animal which prefers to use dens constructed by other animals rather than to dig its own. General information indicates that the eastward extension of the range of the skunk in Virginia was preceded by a similar range extension of the woodchuck.

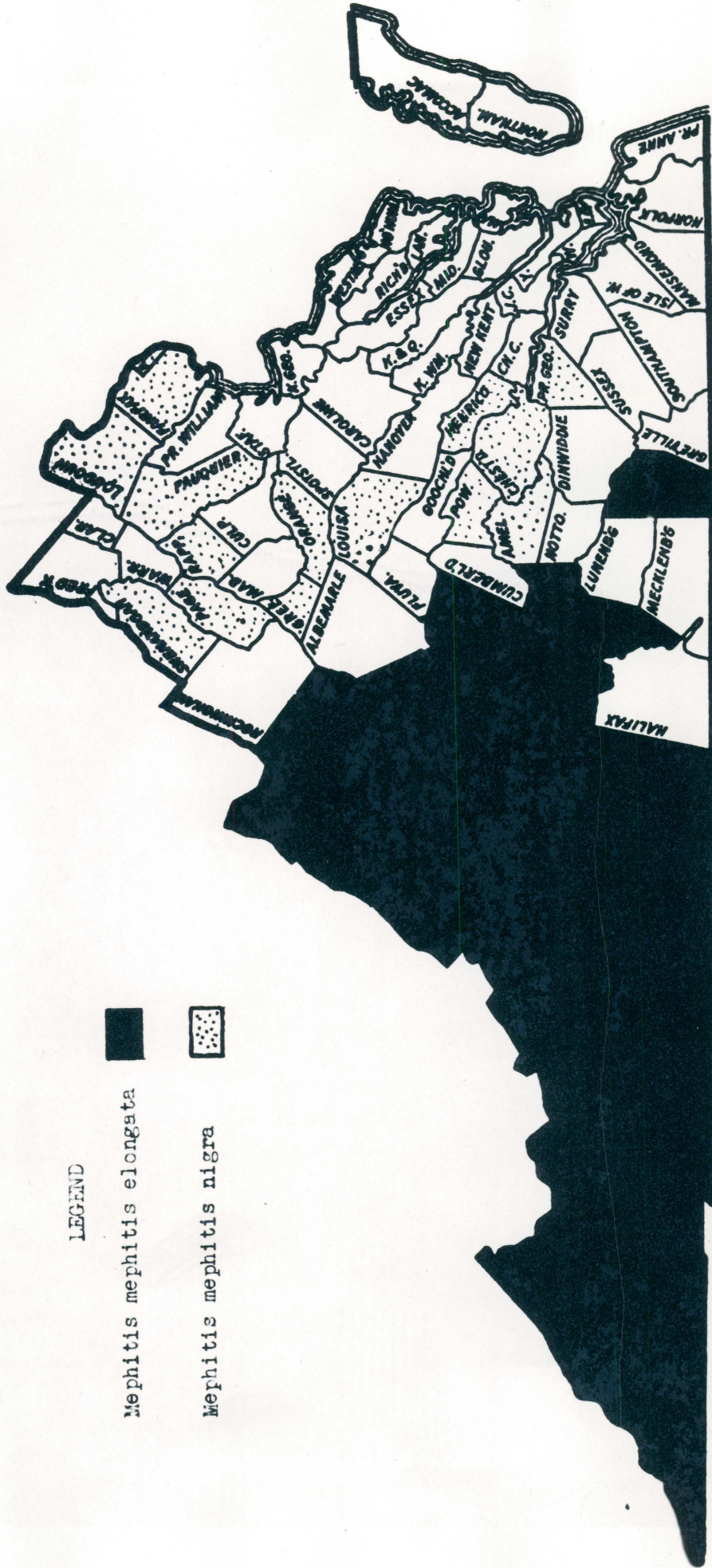
The distribution of the skunk and woodchuck in Virginia as shown by Handley and Patton (1947: p. 136, 148) are not intended to be complete, but only to show definitely the counties from which these animals have been recorded (Figures 1, 2 and 3). Currently, the eastward spread of these animals into areas in which the animals were not previously recorded has greatly increased the ranges as recorded by these workers.

Information on distribution and abundance of these animals and population fluctuations was collected by interviewing all Virginia game wardens while the wardens were attending the Virginia Game Wardens' School at V. P. I. in August, 1952. As determined from information

collected during the interviews, the distribution and relative abundance of skunk are shown in Figure 4, while that of woodchuck is shown in Figure 5. No attempt was made to differentiate between the genus Spilogale and Mephitis, or the subspecies M. m. elongata and M. m. nigra.

It may be seen by a comparison of Figures 4 and 5 that there is a close correlation both in distribution and abundance of skunk and woodchuck populations. This correlation could be due to the utilization of woodchuck burrows by skunk (den utilization, pp. 29-34). This apparent relationship is particularly evident in the eastern section of the State where both animals are absent or scarce. All available data indicate that the densest population of both animals is in the Piedmont and Appalachian regions of the State. In the mountainous region, the largest concentrations are in valleys situated between mountain ranges. Animals are reported to have county-wide distribution in all counties west of the Blue Ridge Mountains, with the smallest populations at higher elevations.

All of the Virginia Game Wardens were personally interviewed while they were in Blacksburg in August, 1952. Each warden was requested to supply information concerning the relative abundance and current fluctuations of both the skunk and woodchuck within his county. Table 1 contains the number of counties in which skunk and woodchuck were reported as increasing, decreasing, or remaining static. The trends of the skunk in the several regions of Virginia are shown in Figure 6, and similar data on the woodchuck are presented in Figure 7.



LEGEND

*Mephitis mephitis elongata*

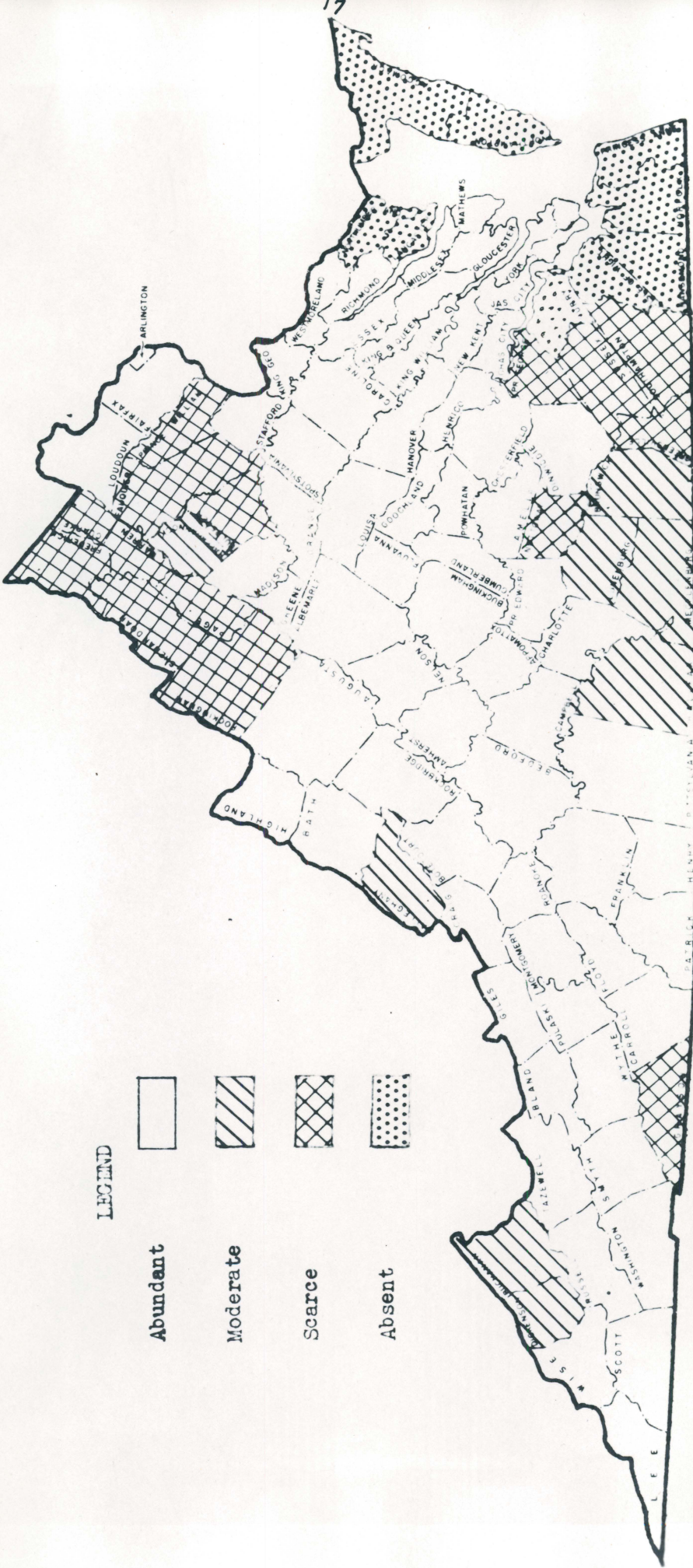
*Mephitis mephitis nigra*

Figure 1. Distribution of striped skunk in Virginia as described by Handley and Patton (1947).









**LEGEND**

**Abundant**



**Moderate**



**Scarce**



**Absent**



**Figure 4. Distribution and relative abundance of skunk in Virginia in 1952 as reported by state game wardens.**

*no help*



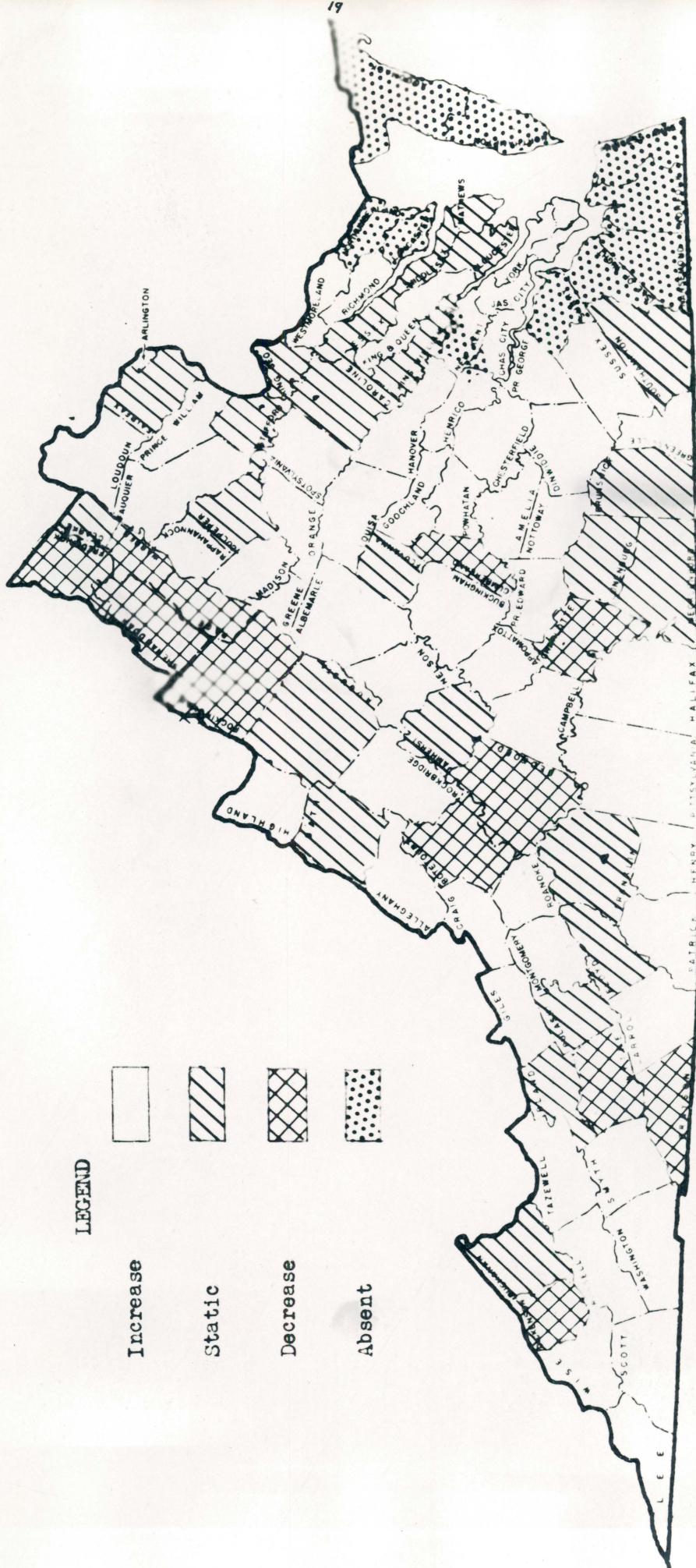


Figure 6. Trends in the skunk population in Virginia in 1952 as reported by state game wardens.



TABLE 1.

## TRENDS OF SKUNK AND WOODCHUCK POPULATIONS AS REPORTED BY STATE GAME WARDENS

|              | Skunk                        |                               | Woodchuck                    |                               |
|--------------|------------------------------|-------------------------------|------------------------------|-------------------------------|
|              | Number of counties reporting | Percent of counties reporting | Number of counties reporting | Percent of counties reporting |
| Increase     | 32                           | 53                            | 64                           | 65                            |
| Static       | 24                           | 24                            | 27                           | 27                            |
| Decrease     | 14                           | 14                            | 2                            | 2                             |
| Absent       | 9                            | 9                             | 6                            | 6                             |
| <b>Total</b> | <b>99</b>                    | <b>100%</b>                   | <b>99</b>                    | <b>100%</b>                   |

The state game wardens stated in the interview that a severe die-off of skunk occurred in Frederick, Clark, Loudoun, Shenandoah, Warren, Page, Rappahannock, Culpeper, Fauquier, Prince William, Rockingham and Wythe Counties within the past three years (Figure 8). The die-off occurred from two to three years ago (approximately 1949) in northern counties, and in 1951 in Wythe County. In Rockingham County, the population decreased an estimated 70 per cent within two years. From reports which have been received, animals go blind, stagger and starve to death. A similar decline in the skunk population in Pennsylvania several years ago was believed to have been caused by a form of encephalitis (McDowell, 1952). Since diseased skunks in Pennsylvania showed the same symptoms as those in Virginia, the die-off in Virginia apparently was caused by the same disease. This die-off may also have been caused by the parasite Filaroides mustelorum which attacks the frontal bone of the skull (Page 52). No diseased animals from the stricken region were obtainable to determine the exact cause of death. From all of the evidence available, it appears as though the disease is working its way southward as a high skunk population builds up. This disease seems to serve as a natural check on the numbers of this animal within specific regions.



## COLLEGE FARM STUDY AREA

General Description of College Farms.

The V. P. I. College Farms consist of approximately 2,300 acres located in Montgomery County, Virginia. This area, with the exception of woodlots, is under intense cultivation throughout the year (Figure 9). The topography of the area is generally rolling with differences in elevation of less than 100 feet. There is a seasonal abundance of surface water present widely dispersed throughout the area in the form of streams. The average precipitation is 41.46 inches per year, and a mean temperature of 52.7 degrees, with a high of 100 degrees and a low of 9 degrees (Virginia Agricultural Experiment Station).

A cover map of the V. P. I. College Farms was made by use of a system described by Graham (1945) and adapted to this region by Mosby (1951). This system was based on ecological succession and cover type symbols were established. Vegetative cover was divided into three major categories: (1) overstory, (2) understory, and (3) ground cover. Where overstory, understory, and ground cover are indicated, they are presented as a fraction with overstory as the numerator and understory and ground cover as the denominator. (Figure 9, Cover Map of College Farms.)

Wild Mammals Present on Area. There are 18 species of mammals, other than skunk, present on the V. P. I. College Farms. This information (Table 2) was compiled from field observations, files of the Virginia Cooperative Wildlife Research Unit, and Handley and Patton (1947).





**LEGEND**

- P Porous soil
- M Marsh
- C Row crops
- CH Pasture and hay
- 10 Polerant trees
- 6 Mixed herbaceous
- 0 Orchard
- 10-40 d.b.h.
- bg Bluegrass
- cn Corn
- cl Clover
- gr Crazed
- m Mixed
- s Shrubs
- t Trees
- wh Wheat
- " Degree of stocking or grazing intensity
- Degree of stocking (understory)

Figure 9. Cover map of the V. P. I. College Farms.

TABLE 2.

## LIST OF MAMMALS FOUND ON THE V. P. I. COLLEGE FARMS

| Order       | Scientific name                           | Common name        |
|-------------|---|--------------------|
| Marsupialia | <u>Didelphis v. virginiana</u>            | Opossum            |
| Insectivora | <u>Scalopus a. aquaticus</u>              | Common mole        |
|             | <u>Cryptotis p. parva</u>                 | Least shrew        |
|             | <u>Blarina brevicauda kirtlandi</u>       | Short-tailed shrew |
| Carnivora   | <u>Procyon l. lotor</u>                   | Raccoon            |
|             | <u>Mustela rixosa allegheniensis</u>      | Least weasel       |
|             | <u>Mustela frenata noveboracensis</u>     | New York weasel    |
|             | <u>Mephitis mephitis elongata</u>         | Striped skunk      |
|             | <u>Vulpes fulva</u>                       | Red fox            |
| Rodentia    | <u>Marmota m. monax</u>                   | Woodchuck          |
|             | <u>Tamias striatus fisheri</u>            | Eastern chipmunk   |
|             | <u>Sciurus carolinensis leucotis</u>      | Gray squirrel      |
|             | <u>Reithrodontomys h. humilis</u>         | Harvest mouse      |
|             | <u>Peromyscus leucopus noveboracensis</u> | White-footed mouse |
|             | <u>Microtus p. pennsylvanicus</u>         | Meadow mouse       |
|             | <u>Ondatra z. zibethica</u>               | Muskrat            |
|             | <u>Rattus n. norvegicus</u>               | House rat          |
|             | <u>Mus m. musculus</u>                    | House mouse        |
| Lagomorpha  | <u>Sylvilagus floridanus mallurus</u>     | Cottontail rabbit  |

Ground Nesting Birds Present on Area. The bobwhite quail (Colinus v. virginianus) is the only ground nesting game bird present on the study area. As of November 1, 1952 there were 20 coveys present with a total of 221 birds. For the range and size of individual coveys, see Figure 10.

Some of the more common ground nesting non-game birds which are present on the college farms are: the meadowlark (Sturnella magna), red-winged blackbird (Agelaius phoeniceus), vesper sparrow (Coturniculus savannarum passerinus), field sparrow (Spizella pusilla), chipping sparrow (Spizella socialis), and towhee (Pipilo erythrophthalmus). This information was compiled from Smyth (1951), Peterson (1947), and Reed (1904).

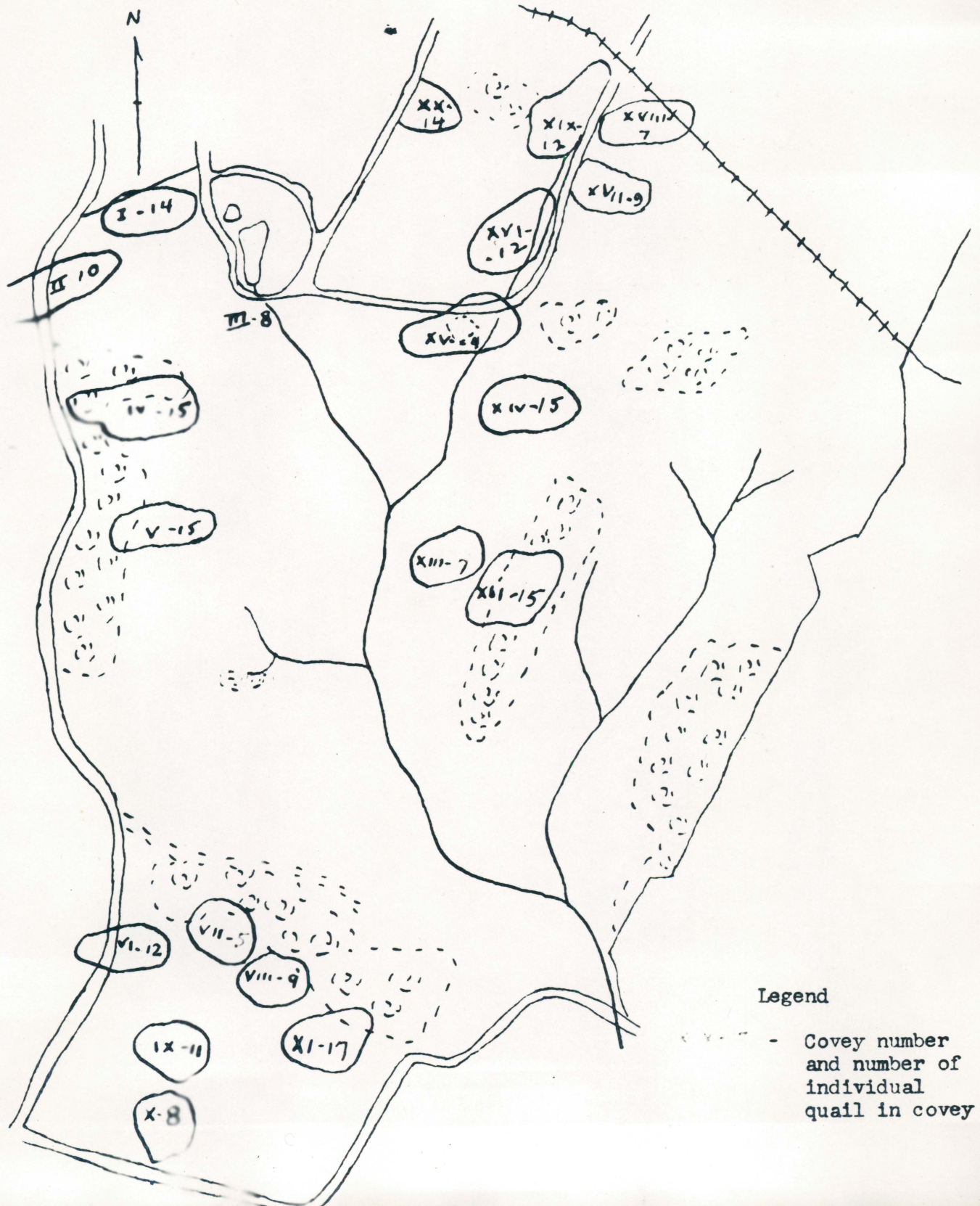
Location of Ground Burrows.

Ground burrows on the College Farms were located and plotted on a base map of the area. These burrows were located by making a systematic coverage of the area on foot. All fence rows were traversed, while only isolated trees, stumps and rock outcrops were closely examined in open fields. Burrows were located in an effort to determine their use by species, frequency and purpose of utilization and density of burrows on the area.

At the close of the investigation, 138 ground burrows had been located on the area (Figure 10). This is an average of one burrow per 16 acres.

According to the method of coverage, 71 (or 54 percent) of the burrows were located in fence rows; 23 (or 17 percent), in open fields away from any ground cover with exception of grasses or clover; 21 (or

Figure 10. Range and size of bobwhite quail coveys on V. P. I. College Farms, Nov. 1, 1952 (Mosby and Byrd, 1952, p. 14).



16 percent) in wooded areas; 15 burrows (or 11 percent) under trees of various sizes; and three (or two percent) under buildings.

All of the ground burrows are located near open areas, usually land containing agricultural crops (Figures 9 and 11). As indicated by field observations, woodchucks originally constructed the majority of the burrows. These animals utilized heavily the crops, particularly corn and clover, adjacent to their dens.

#### Utilization of Ground Burrows.

In Michigan, it is common for rabbits, skunks and opossums to enter ground burrows in the course of a night's wanderings (Allen and Shapton, 1942). They state, (ibid, p. 59) "The fact that such common animals as the woodchuck, weasel, skunk and cottontail rabbit may often find themselves confronting one another within the narrow confines of a subterranean tunnel suggests that relationships in burrows during winter may be instrumental in deciding what will survive to spring." Skunks often use burrows dug by other animals such as the fox, badger and woodchuck (Lantz, 1923). The overwinter survival of cottontail rabbits in some areas depends upon the presence of ground burrows (Linduska, 1947). As these studies were made in northern states, the findings may not be applicable to Virginia.

Utilization of ground dens in the study area was determined partly by use of 75 hair-catching devices. These devices were constructed from nine-gauge wire as described by Hartesveldt (1951). They were inserted into the wall or top of 45 burrow entrances with the "teeth" facing exteriorly. Burrows were visited every day to collect hair from the devices.

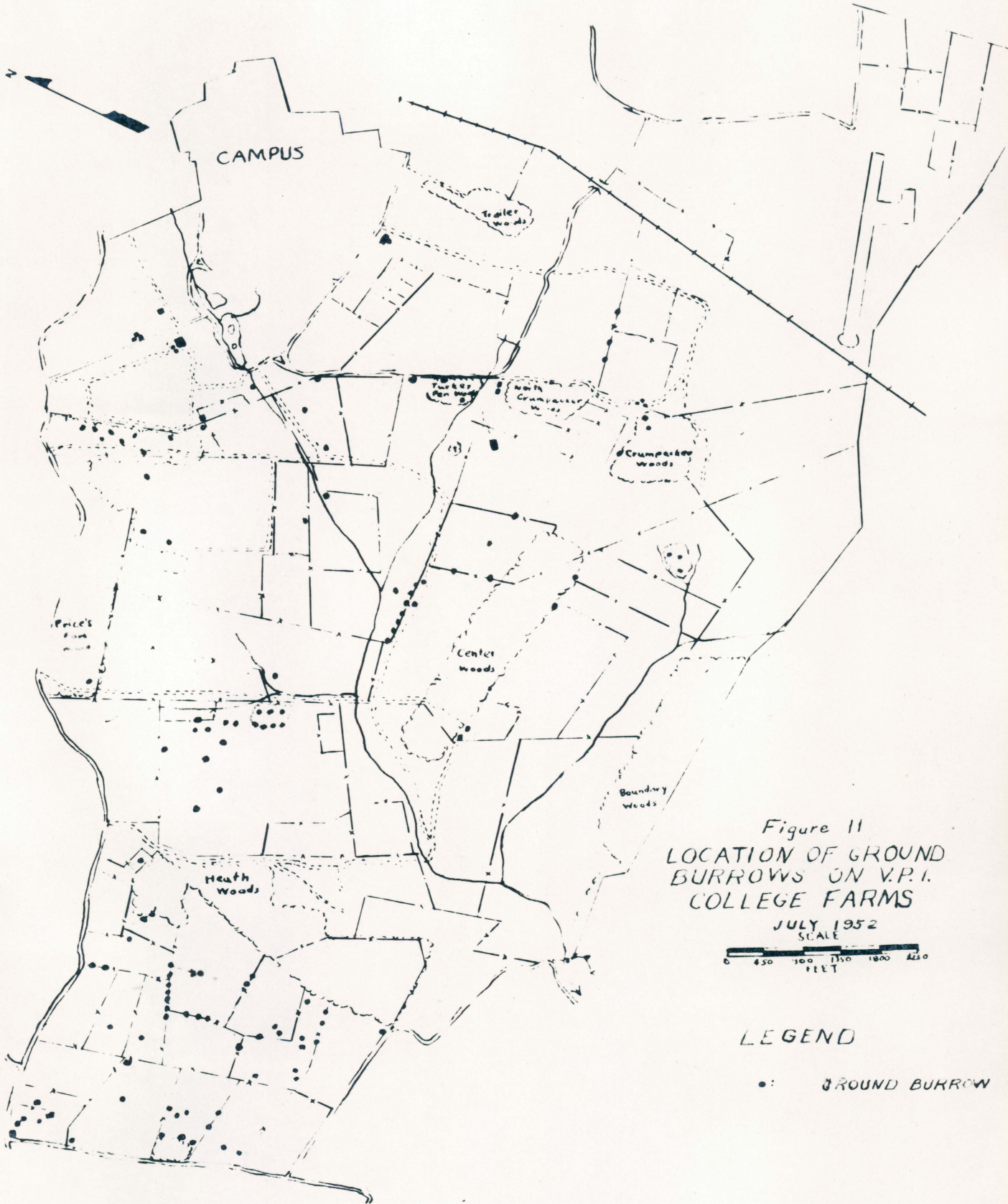


Figure 11  
LOCATION OF GROUND  
BURROWS ON V.P.I.  
COLLEGE FARMS

JULY 1952  
SCALE



LEGEND

• GROUND BURROW

Hairs collected were cross-sectioned by a method described by Mathiak (1938). An attempt was made to identify the cross-sectioned hairs by use of keys constructed by Mathiak (1938) and Muncy (1951). Later, upon advice received from Dr. Wm. H. Stickel (1952), a key was not used in final identification and cross-sectioning was used only when separating hairs of the rabbit and woodchuck. Using Dr. Stickel's advice, the gross physical characteristics of hair, such as length, color, and diameter were used in identification. Animals which utilized the 45 dens studied by this method are listed in Table 3.

There are several limitations to this method of determining burrow utilization, the most important being the difficulty in identification of hair specimens collected. If hair-catching devices are set far enough into the entrance of the burrow to come in contact with small mammals such as the weasel, they will be bent out of shape by passage of larger animals; if they are adjusted for large animals, they will not come in contact with smaller ones. It is seldom possible to determine exactly what use is made of a den, whether for escape cover, home burrow, or in search of food.

On the mornings of December 1 and 3, 1952, and January 9, 1953, when two inches of snow covered the ground, 72 ground burrows were inspected for tracks. No burrow was visited more than once. Tracks left by animals visiting the burrows were clear enough to be identified. Illustrations in Bradt and Shafer (1947) and Burt and Grossenheider (1952) were used to aid in identification of tracks. (Table 4.)

TABLE 3.

ANIMALS UTILIZING 45 GROUND BURROWS AS DETERMINED BY IDENTIFICATION OF  
HAIR COLLECTED AT BURROW ENTRANCES, V.P.I. COLLEGE FARMS,  
1952

|   | Rabbit | Wood-<br>chuck | Skunk | Skunk &<br>Woodchuck | Uniden-<br>tified | No hair<br>collected |
|---|--------|----------------|-------|----------------------|-------------------|----------------------|
| No. individual<br>dens utilized<br>by species | 3      | 6              | 21    | 4                    | 2                 | 9                    |

TABLE 4.

UTILIZATION OF GROUND BURROWS BY ANIMALS ON THE V.P.I. COLLEGE FARMS,  
AS DETERMINED BY TRACKS IN SNOW ON MORNINGS OF DECEMBER 1 and 3, and  
FEBRUARY 9, 1953

| Tracks observed         | Number of times burrows were utilized<br>by animals or combinations of animals |
|-------------------------|--|
| Rabbit                  | 3  |
| Skunk                   | 24   |
| Red Fox                 | 20   |
| Opossum, Skunk          | 1  |
| Rabbit, Skunk           | 4  |
| Red Fox, Skunk          | 3  |
| Red Fox, Skunk, Rabbit  | 3  |
| Red Fox, Skunk, Opossum | 1  |
| Empty                   | 10   |
| Unidentified            | 1  |



This method of investigation was greatly hindered by lack of snow. The three mornings in which tracking was done were the only mornings in which there was sufficient snow to use this procedure. For this reason, only concentrations of burrows were visited in an attempt to study as many as possible in this short period of time. Only five burrows were isolated and these were visited while enroute to concentrated areas.

This method of study is also limited by the combinations of animal species which may occur within the same burrow. Where combinations of animals, such as the red fox, skunk and rabbit, were known to have used the same burrow in one night, it was impossible to ascertain whether they were present at the same time or different times.

It is interesting to note that 11 dens were visited by one red fox on the morning of December 3 and seven on the morning of February 9. No sign of a fresh kill was present at any dens visited by the fox.

A rabbit and a red fox were known to have entered a den during the same night and only tracks of the fox were observed leaving the den. Whether the fox killed the rabbit within the burrow, the rabbit entered after the fox had departed, or the fox went only part of the way into the burrow is not known.

A mechanical ferret was used in determining den utilization by McDowell (1952). The ferret consisted of a section of nine-gauge wire with an oval-shaped block of wood attached to one end. When this block of wood was inserted into the burrow, it could be forced around the bends in the tunnel by twisting the wire. The noise caused by the

block against the sides of the burrow was supposed to scare the animals into leaving the burrow.

A ferret similar to the one described above was constructed and tested in the field. The wire was too limber to push the wooden block into the burrow. A second attempt was made using E-X Cable, obtained from the V. P. I. Electric Department. This also was too limber.

Another attempt was made by using a commercial plumbers "snake" used to clean out stopped-up pipes. This entered the burrow with only a little twisting and turning; however, it did not cause animals to leave the burrow. It was easy to tell whether the "snake" came in contact with a skunk because these animals would invariably release their musk. Many hairs and much nest material were pulled from the burrow when the "snake" was removed. This operation was hampered by divisions of burrows and short length of the "snake." Since it was only 15 feet long, it did not reach to the end of many of the burrows.

A commercial smoke torpedo was obtained from the F. C. Taylor Fur House in St. Louis, Missouri, which was unsuccessful in causing animals to leave any of the ten burrows in which it was tested. Upon completion of the test on several burrows, entrances were closed in an effort to see whether the burrows had been occupied during testing. In four cases burrows were reopened from the interior. The cable attached to the torpedo was too stiff and short to enable insertion into the burrow of more than five feet.

#### Effect of Skunk on Ground Nesting Birds.

Stoddard (1950:189) found that 65 nests of bobwhite quail (Colinus

v. virginianus), or nearly 11 percent of the total number studied, were destroyed by skunks. Thirty of these nests were destroyed by spotted skunk, six by striped skunk, and 29 were not identified as to which skunk was the predator. No evidence was found of an adult bird having been caught by a skunk.

Bump, et al. (1947:334, 337) found in their study of ruffed grouse (Bonasa u. umbellus) in New York that skunk destroyed 61, or 13.2 percent, of the nests destroyed by predators during the study. Skunks killed only one adult grouse and no chicks.

Hamilton (1936:241, 243) found in New York that birds occurred in 24 of 1,067 scats and stomachs examined and consisted of 1.9 percent of the food found during fall and winter months. Birds occurred in 11 of 570 scats and stomachs and consisted of 1.46 percent of the volume during spring and summer months. The birds were not identified as to species in this report.

Selko (1937:70-76), in Iowa, found that birds occurred in 13 out of 149 striped skunk scats and in 27 of 59 spotted skunk scats. Blue-winged teal occurred most frequently in spotted skunk; chickens, in the striped skunk. Numerous chickens had been scattered in the fields with barnyard manure and it was impossible for the writer to determine whether the chicken remains found in the scats of the striped skunks were from this source. Game birds identified were believed to have been hunting season cripples. The spotted skunk consumed approximately four times as much bird matter, by volume, as the striped skunk.

Crabb (1941:336) found eggs of bobwhite quail in only two out of 844 scats of the spotted skunk in Iowa. At no time of the year did bird material appear in more than 11 percent of the number of scats examined by Crabb.

Birds on V. P. I. College Farms. Only one quail nest was found on the V. P. I. College Farms during the past nesting season. This nest, located 175 feet from the nearest skunk burrow, contained 11 hatched eggs. Locating quail nests was greatly hindered by the late date at which the project was begun as the nesting season was nearly over.

A portion of an egg of an unidentified sparrow was found at the entrance to one ground burrow.

Several feathers from an adult quail were found in the entrance to a skunk burrow. As a result of the amount of feathers found, it is believed that this bird was eaten by a skunk. These feathers were found at the time of the annual quail harvest conducted by members of the Virginia Cooperative Wildlife Research Unit; therefore, the bird may have been a cripple or dead bird found by the skunk.

No other evidence was found to indicate predation upon birds or birds' nests by skunks.

#### Effect of Skunk on Game Animals.

Hamilton (1936:240-246) found in his fall and winter study of the skunk in New York that cottontail rabbits had been eaten by 44 out of 1,067 skunks or 4.1 percent of the total. Over 80 percent of the animal remains found in the spring and summer months was meadow mice (Microtus spp.), but remains of rabbit and squirrel were also found.

Selke (1937:73), in Iowa, collected 210 skunk scats in the fall of 1936. Cottontail rabbit remains were found in seven scats (1.37 percent of total volume) of the striped skunk and in three scats of the spotted skunk (1.37 percent of total volume). Muskrat was identified in three striped skunk scats, but constituted only 0.73 percent of total scats by volume. Fox squirrel (Sciurus niger rufiventer) remains appeared in three scats of the spotted skunk, constituting 5.18 percent of the total volume.

Crabb (1941:353-362) reports that rabbits were the most important single item on the winter diet of the spotted skunk in Iowa. Their remains occurred in 38 of 75 scats examined and represented 54.26 percent by volume of all animals found. In the spring, rabbits appeared in 59 of 330 scats collected, in 27 of 254 scats collected in the summer, and in 22 of 185 scats collected in the fall. No other game animals were reported as having been found by the author. Mice constituted the bulk of the animal diet at all seasons except winter when the rabbit was the highest.

Game Animals on V. P. I. College Farms. Little evidence of predation upon game animals was obtained on the V. P. I. College Farms. The only evidence was one rabbit which presumably had been killed by a weasel and carried to a den by a skunk. Approximately 150 skunk scats were examined in the field. This examination consisted only of a cursory inspection of the food remains and identifying them as insects, fruits and berries, and animal matter. In order of occurrence these items were insects, fruits and berries, and mice. No detailed scat analysis

was made, the food remains being classified only as above.

Based on the literature reviewed and field observations, the writer believes that skunks have little effect on the over-all population of game animals. On the V. P. I. College Farms, all evidence indicates that insects, mice, and fruits and berries are the staple diet of this animal.

#### Census of V. P. I. College Farms.

An effort was made to obtain an estimate of the skunk population present on the V. P. I. College Farms by means of the take-retake method of estimation. The objective of this phase of the study was to derive the population estimation by use of the Lincoln Index and Krumholz Formula. In the trapping operation, 30 No. 1 steel traps were placed in entrances of 15 burrows. The burrows were randomly selected using tables of random sample numbers and representing approximately a ten percent sample of the known burrows present. The precensus period extended over 14 days and was followed immediately by an eight-day census period. Thus, the trapping extended over a 22-day period and represented 660 trap nights. The trapping period was from March 15 through April 5, 1953.

During the precensus period, seven skunks and three opossum were captured. One of the seven skunks escaped before it could be marked, but the remaining skunk and opossum were placed in a wire holding funnel and sexed, weighed, and tagged with No. 1 Monel fish tags. All captured animals were released immediately after the above data were taken. It is of interest to note that five of the six skunks and all opossums

taken during precensus period were males. Also, during the same evening a Norway rat and a male skunk were captured in the same burrow.

During the census period, one each of the following was captured: opossum, skunk, woodchuck, and bobwhite quail, which was eaten by an unknown animal. The skunk and woodchuck were males and the opossum was a female carrying nine young in the pouch.

There were no marked animals recaptured at any time during the census periods; therefore, the Lincoln Index and Krumholz Formula could not be utilized. However, if it is assumed that approximately the same number of animals could have been taken at all burrows, the ten percent of the burrows sampled would indicate that an estimated population of 70 skunks and 40 opossums existed on the entire study area.

One skunk which was captured during the census period was followed when released. This animal ran in a small circle to get its bearings, then headed down a road for a distance of 0.5 miles. This animal, having passed five others, stopped only once at one burrow, and then continued its journey to enter a barn and disappear. This observation would indicate that most of the skunks had a "home" burrow and might add credence to the process used in arriving at the population estimate given above.

## BEDFORD COUNTY STUDY AREA

The author was interested in determining the effectiveness of gas cartridges as a method of woodchuck control and to determine the influence of such a control program on other burrow-using animals such as the skunk.

The woodchuck-skunk control program was initiated by the Boonsboro Ruritan Club in the spring of 1952. A total of 2,000 gas cartridges were purchased through the county agent from the Rodent Control Section of the U. S. Fish and Wildlife Service. This control program was carried on by individual farmers on their property. The author assisted on this program only on the farm of Mr. H. O. Meriwether. Visits to two neighboring farms were made for the purpose of studying the effect of previous poisoning.

The study area was approximately 30 acres in size, being equally divided between pasture and alfalfa (Figure 12). Fifty-two ground burrows were present on the area at the beginning of the control program (Table 5). All burrows were gassed and sealed shut with sod or stones between the 8th and 16th of July, 1952.

Five burrows which had been gassed were excavated. Only one burrow contained animals which had been killed by gas, the other four being empty. The animals recovered by excavation were two juvenile woodchucks, one male and one female.

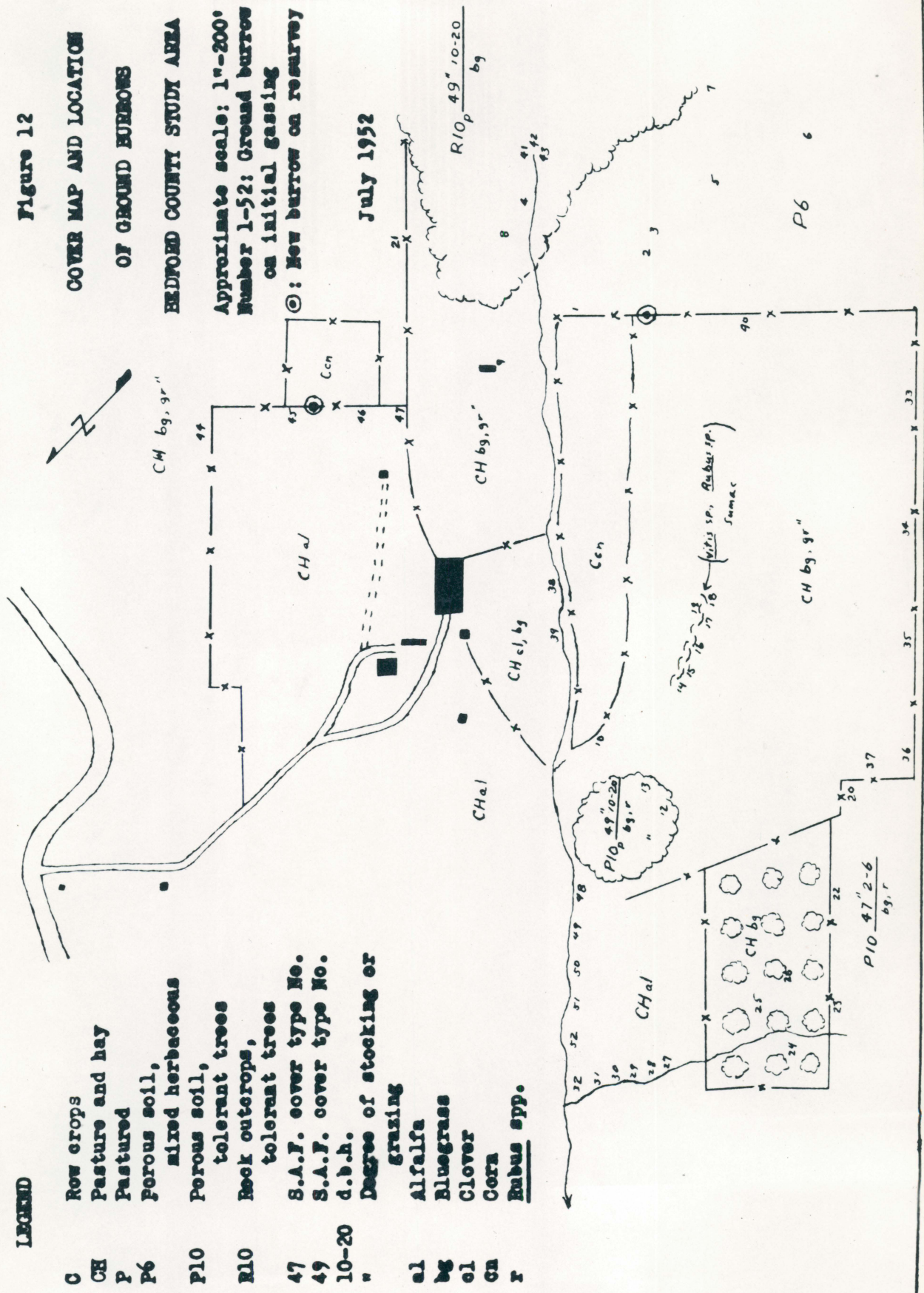
The population estimate of woodchuck based upon the above data was 21 animals for the beginning of the control program. At the 95 percent confidence limit, the population estimate was  $20.8 \pm 46.9$  animals.



**Figure 12**  
**COVER MAP AND LOCATION**  
**OF GROUND BURROWS**

**BEDFORD COUNTY STUDY AREA**  
 Approximate scale: 1"-200'  
 Number 1-52: Ground burrow  
 on initial gassing  
 ©: New burrow on resurvey

July 1952



**LEGEND**

- C Row crops
- CH Pasture and hay
- P Pastured
- P6 Perous soil, mixed herbaceous
- P10 Perous soil, tolerant trees
- R10 Rock outcrops, tolerant trees
- 47 S.A.F. cover type No.
- 49 S.A.F. cover type No.
- 10-20 d.b.h.
- " Degree of stocking or grazing
- al Alfalfa
- bg Bluegrass
- cl Clover
- cn Corn
- x Rubus spp.

TABLE 5.

GROUND BURROWS SURVEYED AND GASSED ON THE FARM OF MR. H. O. MERIWETHER,  
BEDFORD COUNTY, VIRGINIA, JULY, 1952

| Burrow number | Date of gassing | Number of entrances | Number of gas cartridges used in initial gassing | Burrow excavated | Remarks                | Burrow reopened August 21, 1952 |
|---------------|-----------------|---------------------|--|------------------|------------------------|---------------------------------|
| 1.            | 7-8-52          | 1                   | 1  | no               |                        | yes                             |
| 2.            | 7-8-52          | 1                   | 1  | yes              | empty                  | no                              |
| 3.            | 7-8-52          | 1                   | 1  | no               |                        | yes                             |
| 4.            | 7-8-52          | 2                   | 2  | no               |                        | no                              |
| 5.            | 7-9-52          | 2                   | 1  | no               |                        | yes                             |
| 6.            | 7-9-52          | 1                   | 1  | no               |                        | no                              |
| 7.            | 7-9-52          | 2                   | 2  | no               |                        | yes                             |
| 8.            | 7-9-52          | 1                   | 1  | no               |                        | no                              |
| 9.            | 7-9-52          | 3                   | 2  | no               | re-gassed 7-15         | yes                             |
| 10.           | 7-9-52          | 1                   | 1  | no               |                        | no                              |
| 11.           | 7-9-52          | 2                   | 1  | yes              | empty                  | yes                             |
| 12.           | 7-9-52          | 3                   | 2  | no               |                        | yes                             |
| 13.           | 7-9-52          | 2                   | 1  | yes              | empty                  | yes                             |
| 14.           | 7-9-52          | 1                   | 1  | no               |                        | yes                             |
| 15.           | 7-9-52          | 2                   | 1  | no               |                        | no                              |
| 16.           | 7-9-52          | 2                   | 1  | no               |                        | yes                             |
| 17.           | 7-9-52          | 2                   | 1  | no               | re-gassed 7-15, 16     | yes                             |
| 18.           | 7-9-52          | 1                   | 1  | no               | skunk scat in entrance | yes                             |
| 19.           | 7-9-52          | 1                   | 1  | no               |                        | no                              |
| 20.           | 7-9-52          | 4                   | 2  | yes              | gassed 7-15, 16; empty | yes                             |
| 21.           | 7-9-52          | 1                   | 1  | no               |                        | yes                             |
| 22.           | 7-11-52         | 2                   | 1  | no               |                        | yes                             |
| 23.           | 7-11-52         | 4                   | 1  | no               | reopened 7-15          | yes                             |
| 24.           | 7-11-52         | 1                   | 1  | no               |                        | no                              |
| 25.           | 7-11-52         | 1                   | 1  | no               |                        | no                              |
| 26.           | 7-11-52         | 1                   | 1  | no               |                        | no                              |
| 27.           | 7-11-52         | 3                   | 1  | no               |                        | no                              |
| 28.           | 7-11-52         | 2                   | 1  | no               |                        | yes                             |
| 29.           | 7-11-52         | 3                   | 1  | no               |                        | yes                             |
| 30.           | 7-11-52         | 2                   | 1  | no               |                        | no                              |
| 31.           | 7-11-52         | 2                   | 1  | no               |                        | yes                             |
| 32.           | 7-11-52         | 2                   | 1  | no               |                        | yes                             |
| 33.           | 7-11-52         | 1                   | 1  | no               |                        | yes                             |
| 34.           | 7-11-52         | 1                   | 1  | no               | blacksnake in burrow   | yes                             |
| 35.           | 7-11-52         | 1                   | 1  | no               | re-gassed 7-14         | yes                             |

Table 5, continued.

| Burrow number                    | Date of gassing | Number of entrances | Number of gas cartridges used in initial gassing | Burrow excavated | Remarks                                   | Burrow reopened August 21, 1952 |
|----------------------------------|-----------------|---------------------|--|------------------|---|---------------------------------|
| 36.                              | 7-11-52         | 2                   | 1  | no               | re-gassed 7-14                            | yes                             |
| 37.                              | 7-11-52         | 1                   | 1  | no               | re-gassed 7-14                            | yes                             |
| 38.                              | 7-11-52         | 1                   | 1  | no               |   | yes                             |
| 39.                              | 7-11-52         | 4                   | 2  | yes              | two woodchucks recovered                  | yes                             |
| 40.                              | 7-11-52         | 1                   | 1  | no               | re-gassed 7-14                            | yes                             |
| 41.                              | 7-15-52         | 1                   | 1  | no               | opossum tracks in entrance, skull near-by | yes                             |
| 42.                              | 7-15-52         | 2                   | 1  | no               |   | no                              |
| 43.                              | 7-15-52         | 1                   | 1  | no               |   | no                              |
| 44.                              | 7-15-52         | 2                   | 1  | no               |   | yes                             |
| 45.                              | 7-15-52         | 1                   | 1  | no               |   | no                              |
| 46.                              | 7-15-52         | 1                   | 1  | no               |   | yes                             |
| 47.                              | 7-15-52         | 1                   | 1  | no               |   | yes                             |
| 48.                              | 7-15-52         | 2                   | 1  | no               |   | yes                             |
| 49.                              | 7-16-52         | 1                   | 1  | no               |   | yes                             |
| 50.                              | 7-16-52         | 1                   | 1  | no               |   | yes                             |
| 51.                              | 7-16-52         | 3                   | 1  | no               |   | yes                             |
| 52.                              | 7-16-52         | 1                   | 1  | no               |   | yes                             |
| Ave. no. of entrances per burrow |                 | 1.6                 |  |                  |   |                                 |

A resurvey of the area on August 26, 1952, showed that 38 of the ground burrows which had been gassed, or 73 percent, had been reopened and were again in active use. As nearly as could be determined, all had been reopened from the exterior. Four of the completely excavated burrows, including the one from which the two woodchucks had been recovered, were again in active use (Table 5). Two new burrows had been constructed on the area between the time of initial gassing and resurvey. On the other two farms examined, an estimated 90 percent of the gassed burrows had been reopened and were in active use.

From observations and signs present on the farm of Mr. Meriwether, it was found that ground burrows were being utilized by the following animals: woodchuck, from observations and animals recovered by excavation; skunk, from scats found in burrow entrance; opossum, from tracks found in burrow entrance; and pilot black snake (Elaphe o. obsoleta), from observation.

All three of the farms were isolated from one another and were surrounded by areas which contained high populations of skunk and woodchuck. It is believed by the author that the burrows which had been reopened were opened by animals moving into the farms from surrounding areas. The results of this experiment indicated that it is not feasible to attempt a complete control project for these animals on isolated areas surrounded by areas of relatively high woodchuck and skunk populations.

## BARBOURS CREEK STUDY AREA

This area is in the Jefferson National Forest in Craig County, Virginia. The area consists of approximately 320 acres on the upper portion of Camp Branch, a stream originating near the crest of Potts Mountain and terminating at the point where the branch enters Barbours Creek. The cover on the area is composed of four major Society of American Forester types: (1) bear oak, number 35; (2) chestnut oak, number 36; (3) Virginia pine, bear oak, and red oak, number 43; and (4) yellow poplar, hickory, and red oak, number 55. The hills on both sides of Camp Branch were covered with various sized boulders and cliffs which made ideal den sites for animals (Figure 13).

The area was chosen primarily to compare the skunk population, den sites, and other animals present with those of an agricultural region.

The den sites on this area are of an entirely different type from those studied on the previous two areas. The known dens on this area were all located under boulders or in ledges along cliffs. There is an estimated 5.3 acres per rock den for the entire area (McLaughlin, 1953).

There are 15 species of land mammals present on the Barbours Creek study area. This figure (Table 6) was derived from field observations, files of the Virginia Cooperative Wildlife Research Unit, and Handley and Patton (1947).

Ruffed grouse is the only known ground nesting game bird found on the area.

Traps were selectively placed along the stream bank from August 10 through 15, 1953. The trapping involved 132 trap nights. Three female



Figure 13. Typical Site of Rock Dens on Barbours Creek Study Area,  
April, 1953.

TABLE 6.

## MAMMALS PRESENT ON BARBOURS CREEK STUDY AREA

| Order        | Scientific name                           | Common name             |
|--------------|---|-------------------------|
| Marsupialia  | <u>Didelphis v. virginiana</u>            | Opossum                 |
| Carnivora    | <u>Ursa a. americanus</u>                 | Black bear              |
|              | <u>Procyon l. lotor</u>                   | Raccoon                 |
|              | <u>Mustela frenata noveboracensis</u>     | New York weasel         |
|              | <u>Mustela vison mink</u>                 | Mink                    |
|              | <u>Spilogale putorius</u>                 | Allegheny spotted skunk |
|              | <u>Mephitis mephitis elongata</u>         | Striped skunk           |
|              | <u>Urocyon c. cinereoargenteus</u>        | Gray fox                |
|              | <u>Lynx r. rufus</u>                      | Bobcat                  |
| Rodentia     | <u>Tamias striatus fisheri</u>            | Chipmunk                |
|              | <u>Sciurus carolinensis leucotis</u>      | Gray squirrel           |
|              | <u>Peromyscus leucopus noveboracensis</u> | White-footed mouse      |
|              | <u>Neotoma magister</u>                   | Wood rat                |
| Lagomorpha   | <u>Sylvilagus floridanus mallurus</u>     | Cottontail rabbit       |
| Artiodactyla | <u>Odocoileus v. virginianus</u>          | White-tailed deer       |

spotted skunks and one white-footed mouse were trapped. Two of the skunks were captured in traps located on banks of Camp Branch, the other being captured approximately 20 yards from the stream in a trap located at the base of a cliff. From the above data, it is impossible to derive a population estimation for the area.



## CONTROL OF POPULATION

Many times skunk and woodchuck populations reach such numbers as to damage farm crops and, therefore, need to be controlled. One such method of control is gassing ground burrows.

According to Silver (1928:2), ground burrows should be gassed only in the spring, for at that season the woodchuck is active in keeping its burrow cleaned out, thereby facilitating recognition of active burrows. Also, the animals remain near the burrow during the breeding season to feed and protect the young, thus also assuring a higher degree of success. Gassing at this time minimizes the possibility of destroying valuable fur bearing and game animals. Later in the year a woodchuck family will have more than one burrow and if all of the burrows are gassed, the cost of the project is greatly increased.

The Bedford County study area (p. 40-43) was gassed in July, 1952. Only one of the five excavated burrows contained dead animals, the other four being empty. Of the many burrows which had been reopened overnight on this area, all had been reopened from the outside by animals which had been elsewhere during the day. One burrow had been gassed three times during the two-week period and was reopened after each gassing.

#### Methods of Control.

Gas Cartridge. A gas cartridge for the control of burrowing rodents is manufactured at the Fish and Wildlife Service Supply Depot at Pocatello, Idaho. These cartridges may be purchased from local county agents in Virginia at cost. They are shipped in case lots of 200 cartridges and cost approximately eight cents a cartridge.

The cartridges have a fuse attached to the outside when they are shipped. A place is marked on the side of the cartridge where a hole must be punched to insert the fuse. Several holes the size of a pencil must be made in the end near the fuse to allow the gas to escape after the fuse has been lighted. Upon lighting the fuse, the cartridge is inserted as far into the burrow as possible and the burrow entrance covered with sed, rocks, or any other available material which will prevent the escape of the gas. If the burrow has more than one entrance, the other entrances may be closed before the cartridge is inserted into the burrow. If there is any doubt as to whether all of the entrances connect into one burrow, they may not be closed until smoke from the burning cartridge can be seen at these entrances.

All of the animals recovered from burrows gassed by this method were in nests and appeared to have been killed almost instantly. None of the burrows gassed had been reopened from the interior. However, many had been reopened from the exterior, presumably by animals which were outside of the burrow at the time of gassing.

The lethal gas produced by the cartridges is carbon monoxide which is poisonous to all burrow-using animals. Therefore, it is assumed that any animal in the burrow, whether desirable or undesirable, is killed when the burrow is gassed in this manner. This economical and safe method is easy to use and a cartridge may be carried in the pocket while a person is in the field working.

Cyanide Compounds. When used in the field, cyanide powder is placed in the entrance to the burrow and the burrow sealed shut. About one

round tablespoon of calcium cyanide dust is sufficient to treat one burrow. This powder may also be applied with a commercial dust gun. Make sure the powder is placed in a pile and not spread over the floor of sides of the burrow.

Caution. The gas given off by calcium cyanide (Hydrocyanic acid) acts very rapidly when obtained in a lethal concentration (Silver, 1928). However, there is little danger if this gas is used outdoors by an intelligent person.

Antidotes. "If anyone is poisoned by calcium cyanide, have him inhale ammonia; apply cold water to his head and spine; give stimulant of 1 teaspoon of aromatic spirits of ammonia; administer artificial respiration." (Silver, 1928, p. 5)

Experiments were made using sodium cyanide and water in an effort to gas a juvenile woodchuck which had been captured. The animal was sealed in a cardboard box which was about one and one half feet long, one foot wide and one foot high. Approximately 1.5 tablespoons of sodium cyanide and an equal amount of water were placed in an open bottle in the box. The box was opened 24 hours later and the animal emerged alive and in apparently good condition. The same experiment was again tried, the dosage being doubled. The second attempt ended with similar results. The animal was then placed in a glass container of about the same volume as the box. Paper excelsior, saturated with water was placed in the bottom, the animal placed in the jar, and about one tablespoon of calcium cyanide added. The animal died in less than one minute.

Shooting. Shooting is the only selective control method known. Shooting insures that the undesirable animal is destroyed and desirable species are left unmolested. This method is less costly, and if carefully used, is less dangerous than the use of calcium cyanide. This method, however, is time consuming and impracticable for a farmer to attempt to use during certain seasons. This method is ideally suited for use by sportsmen, giving them some shooting during closed hunting season. Many sportsmen take to the fields annually to shoot woodchucks.

A method of selective control is more desirable than a wholesale slaughter method as that obtained by gassing all of the ground burrows on an area. Shooting seems to be the only selective method yet devised which is at all practicable, providing that sportsmen cooperation can be obtained.

## PARASITES

No detailed study of skunk parasites was attempted. However, all endoparasites collected were referred to the Parasitology Section of the V. P. I. Biology Department for identification.

Two ticks which were collected from a striped skunk on the V. P. I. College Farms were identified as Ixodes cookei Pack by Dr. Grayson at the Entomology Section of the V. P. I. Department of Biology. Both ticks were females which were 1/5 to 1/3 engorged.

The only other parasite which was identified was Filaroides mustelorum which was collected from a spotted skunk captured on the Barbours Creek study area. This parasite is a viviparous nematode (Figure 14). From information obtained from the Parasitology Section, very little is known of the life history of this nematode. Slugs and snails are intermediate hosts for other parasites of the genus Filaroides and presumably are for F. mustelorum. The parasite attacks the frontal bone of the skull (Figure 15), but its effect on the host animal is not known. It may, however, cause the symptoms characteristic of dying animals in the area of severe die-off of the striped skunk (p. 22).



Figure 14. Filaroides mustelarum from Skull of Spotted Skunk Collected on Barbours Creek Study Area, April, 1953 (15x).

(Photo by W. B. Gross)

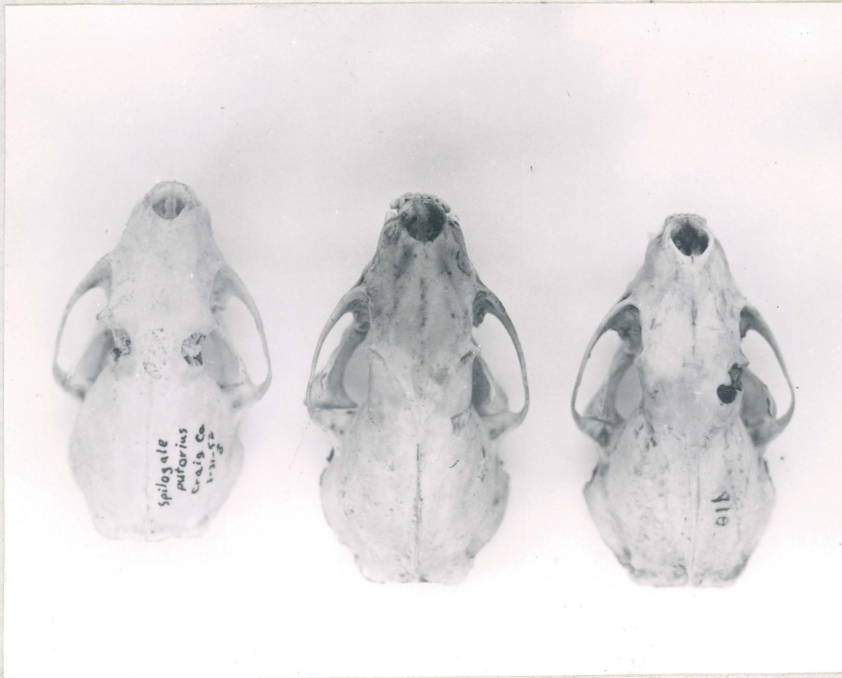


Figure 15. Skulls of Spotted Skunk Showing Damage by Filaroides mustelorum. Left to right: Heavy infection on both sides, no infection, heavy infection on one side only.

(Photo by L. R. Hundley)

## SUMMARY AND CONCLUSIONS

1. A study of the skunk (Mephitis m. elongata Bangs, M. m. nigra Peale and Beauvois and Spilogale putorius Linnaeus) was carried on in an attempt to determine the relationship of this animal to game and burrow-using animals in Virginia. This investigation included work on distribution, abundance, food habits, burrow utilization, census and control.
2. The skunk is an unprotected wildlife species in Virginia and few are hunted for sport and trapped for fur.
3. The skunk is found in all but nine counties in Virginia and is increasing throughout most of its range.
4. The increase in range and numbers is correlated with similar increases of woodchuck, with exceptions in areas of high skunk mortality within the past five years.
5. Skunks are abundant on the V. P. I. College Farm study area and utilize many of the ground burrows present. On the Barbours Creek study area skunks utilized rock dens.
6. No appreciable predation upon game animals or ground nesting game birds was noted on the V. P. I. College Farm study area. The staple diet was insects, fruits, berries, and mice.
7. From literature reviewed, game animals and birds taken by skunk for food include cottontail rabbit, fox squirrel, bobwhite quail, blue-winged teal, and ruffed grouse. Domestic fowl taken includes chickens and chicken eggs.



8. It is impracticable to attempt any method of woodchuck-skunk control program by gassing ground burrows unless done in the spring. Gas cartridges are the easiest and safest means of control of ground burrow-using animals, but shooting is most desirable.
9. Diseases and parasites seem to have little effect on skunk populations with possible exception of rabies and Filaroides mustelorum.

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