

WINTER DEN STUDIES OF THE COTTONTAIL IN SOUTHERN MICHIGAN

The Game Division of the Michigan Conservation Department established the Rose Lake Wildlife Experiment Station in Clinton County, Michigan, for studies of small game on farmland. Research on the cottontail rabbit has figured prominently in the station's program which was initiated in 1939, and particular attention has been given to the development of new study procedures which would facilitate census operations and the accumulation of other biological data. During the winters of 1941-42 and 1942-43 considerable exploratory work was done with ferrets to determine their possible value in obtaining winter counts of rabbits. In connection with this and related studies, considerable information on denning habits, winter movements, and cover requirements of the cottontail were obtained, and will be presented here.

This study was part of the Federal Aid in Wildlife Restoration Project 2-R, Michigan Conservation Department. D. L. Allen, then biologist in charge of the Rose Lake station, gave many helpful suggestions during the work.

The Area and Methods. A description of the region of this study, particularly from the standpoint of suitability for burrow-inhabiting mammals, has been reported by Allen and Shapton (1942). The area is productive of rabbits (Sylvilagus floridanus mearnsii Allen) and woodchucks (Marmota monax Linnaeus). Heavy hunting (300 gun-hours per 100 acres during the small game season October 15 - December 31) on the area produced a harvest of 24 and 22 rabbits per 100 acres on approximately 1500 acres in the fall and winter of the years (1941-43) of this study. Winter populations following hunting were estimated to be about one rabbit per 5 acres each year. Spring and summer trapping of woodchucks over the same periods showed an average population for the entire area of about 3 animals of all ages per 100 acres. However, much of the total acreage was in crops and pasture, and the woodchuck population was concentrated in idle ground and swale areas. The population density in some situations was probably as high as 25-30 individuals per 100 acres. Dens on the 1500-acre area averaged in frequency about one per 10 acres, and a few

choice denning sites had burrows present to the extent of about 3 to 5 per acre.

For a description of procedures used in the work refer to Linduska (in press).

RESULTS

The winter activity of rabbits has been observed to be highly variable depending on weather conditions, and the tendency for cottontails to seek shelter of dens under some conditions is generally known. A "holing up" response was found by Leopold (1931) to occur within reasonably distinct geographical limits, although the conditions which prompted such activity was not entirely apparent. A general use of underground cover at a temperature of $+10^{\circ}$ F. was noted in Wisconsin, but some evidence was found by Leopold that the animals used surface cover at temperatures as low as -10° F. in parts of Iowa and South Dakota. Trautman (Trippensee, 1934), working in Ohio, found a marked increase in burrow use by cottontails when temperatures fell below $+20^{\circ}$ F. and snow was on the ground. The present study has provided further information on the temperature-burrow use relationships of the cottontail.

Air Temperature and Den Use. An exclusive use of den cover by cottontails was not observed under any of the variety of conditions experienced in the course of this work. Limited winter use of burrows was noted when the minimum daily temperature was as high as $+32^{\circ}$ F., and some rabbits continued to use the surface cover of brushpiles and outbuildings at the low temperature of -8° F. even though burrows were available in the immediate locality. While the movement from surface to den cover did not appear to be dependent upon any critical temperature, it was obvious that den use increased with lowering temperatures (Table I). At air temperatures colder than $+12^{\circ}$ F., burrow occupancy by rabbits was found to be three times as great as it was at temperatures above $+12^{\circ}$ F. The greatest use of dens was found on days having minimum temperatures of $+2^{\circ}$ to -8° F. When under these conditions half of 56 dens examined contained rabbits.

Winter population shifts. Workers in Michigan (Trippensee 1934, Allen 1939, and Haugen 1942) have noted marked movements of rabbits coincident with seasonal changes

in cover conditions, snow depth, and temperature. In Ohio, Trautman (In Trippensee 1934) worked den sites on one thousand acres of agricultural land which included about two acres of brushy creek bottoms and ravines, and of 83 rabbits captured on the entire area, 97 percent were taken in the 2 acres of heavy cover. A similar abandonment of open field situations and movement to heavy cover was readily apparent from tracking studies made in connection with the present work. While these winter movements are quite likely a response to several ecological changes, lowering temperatures alone correlate with the demands for more substantial cover. Table II summarizes ferreting success at various temperature ranges and in several types of weather-protective cover (dens, brushpiles, buildings, etc.). It will be seen that use of such heavy cover increased materially as air temperatures decreased. From the standpoint of ferreting success, a reasonable return was obtained working at temperatures as high as $+32^{\circ}$ F. although near zero conditions were considerably more profitable.

Cover Utilization in Various Habitats. Obviously enough, winter cottontail populations in cropland and other cover deficient areas were far lower than in swale or woodlot situations. Examination of comparable cover types (dens and brushpiles) showed, however, that such cover in the open uplands was far more intensively used than similar types in swales and woods. It appeared that competition during the winter for weather-protective cover in the open uplands was acute, and the abandonment of these areas by a large segment of the rabbit population occurred only after most of the dens and brushpiles were occupied. Table III, which summarized ferreting success in various types of situations, illustrates this relationship of quantity of cover to degree of utilization.

From a rabbit management standpoint a logical speculation might be made regarding the possibility of increasing the winter carrying capacity of such intensively farmed areas by providing artificial cover. In this connection, Haugen (1942) found that where sufficient food items were available, artificial holes and brushpiles did help to maintain rabbits in areas formerly deserted in the winter. In our own work nine brushpiles, placed along a cover-deficient farm lane, have been observed to harbor

TABLE I

Den Occupancy by Rabbits at Various Temperature Ranges

<u>Minimum daily temperature (°F.)</u>	<u>No. days worked in this temper- ature range</u>	<u>Number of dens explored</u>	<u>Number of dens occupied</u>	<u>Percent of dens occupied</u>
-8 to +2	9	56	28	50
+2 to +12	7	61	21	34
+12 to +22	5	31	4	13
+22 to +32	5	33	5	15

TABLE II

Ferreting Success as an Index to Winter Use of Dens
and Heavy Ground Cover under Various Minimum Temperature Ranges

<u>Minimum daily temperature (°F.)</u>	<u>Number of days represented in each temp. range</u>	<u>Number of sites* ferreted</u>	<u>Number of rabbits started</u>	<u>Percent success</u>
-8 to +2	9	66	54	82
+2 to +12	7	73	41	56
+12 to +22	5	46	21	46
+22 to +32	6	66	22	33

* Includes dens, brushpiles, culverts, foundations of out-buildings, etc.

10-12 rabbits in an area where only an occasional winter track could be found before supplying the cover. These brush heaps, built in 1939, also proved attractive to woodchucks and within two years' time practically all of the piles had been selected as denning sites, thereby adding further to their permanence and effectiveness.

Use of various cover types. Table IV shows the frequency with which rabbits were driven from several of the principal winter cover types. While some order of preference might be indicated for the coverts listed, the differences in ferreting success shown are probably more indicative of the location and abundance of each type with respect to other cover. All of 19 farm buildings located in open upland situations had rabbits in the open foundation. Most of the brushpiles studied likewise were in over-deficient upland areas and over half of these were found to be occupied. Most of the burrows, however, were in swales where other brush cover was available and also were present in sufficient numbers to relieve the acute competition for cover which existed in the open uplands. It is questionable that the more consistent use of buildings and brushpiles shows a preference for such cover over den sites, and more likely that the general lack of other cover is reflected in greater use of such above-ground cover.

Protective value of Brushpiles. While the present study showed that lowering temperatures encouraged a marked increase in burrow use by rabbits, it was also apparent that brushpiles continued to be used even during sub-zero weather. Since proper brush disposal offers one of the simplest methods of providing cover, a further consideration of brushpiles from the standpoint of winter protection against weather is worthwhile.

In order to determine temperature differentials between brushpiles and outside air temperatures, 6-foot couples from a Taylor recording thermometer were placed at the ground surface near the center of a brushpile approximately 12 feet in diameter. Temperatures recorded during January, February, and March were compared with readings from a conventional hygrothermograph shelter located within a few feet of the brushpile. Although brush heaps obviously have no inherent heating ability, it is of interest that the mean brushpile temperatures over the 3-month period were 3.6 degrees above those in the adjacent shelter. Brushpiles also showed a meantime lag

TABLE III

Extent of Winter Use of Dens and Close Ground Cover by Rabbits
in Various Habitats

<u>Habitat</u>	<u>No. Sites Ferreted</u>	<u>No. Occupied by Rabbits</u>	<u>Percent Occupied</u>
Open fields	52	42	81
Fencerows	42	23	55
Swales	53	12	23
Woodlots	10	2	20

TABLE IV

Ferretting Success in Various Cover Types

<u>Cover Type</u>	<u>No. Sites Ferreted</u>	<u>No. Sites Occupied</u>	<u>Per Cent of Sites Occupied</u>
Buildings	19	19	100
Brushpiles	60	32	53
Burrows	189	62	33

of 25 minutes for descending temperatures. On one day of sub-zero temperatures and minimum air movement a maximum time lag of $3\frac{1}{2}$ hours between the brushpile minimum and those in the instrument shelter was observed. While it is questionable that such temperature differences are significant in themselves, a good insulating affect is shown which probably provides effective protection against temperature extremes. As would be expected, above-ground shelters did not compare with woodchuck burrows for buffer effect against air temperatures. Several den temperatures, taken by means of a Leeds-Northrop potentiometer and inserting a thermocouple four feet in from the den entrance, fell within limits of 31.5° F. to 35.5° F. Air temperatures in all cases was 0° F. or colder. Gerstell (1939) in Pennsylvania found temperatures from 22° to 37° F. in one den studied while air temperatures ranged from 1° to 47° F. over the same two-week period, the den temperatures "representing on most days an almost constant temperature of approximately 33° F."

Differential denning activity of the sexes. Various studies have indicated that under certain conditions, female cottontails are more inclined to hole up than are the males. Trautman (Trippensee, 1934) found in Ohio that temperatures below 20° F. encouraged an increased use of dens by rabbits and among 391 individuals taken in the winter with ferrets there was a slight preponderance (59 per cent) of females. In our studies under a wide range of temperatures and weather conditions, the total catch was made up of approximately equal numbers of each sex. However, on February 3, 1942, following two successive nights when minimum temperatures of -2° F. were recorded, a total of 13 rabbits were ferreted out of which two (both males) were driven from a brushpile and of the remaining 11 taken from dens, 10 were females and only one male.

Sexes in hunting kill. Hunting returns reported by Gerstell (1937) in Pennsylvania and Allen (1939) in Michigan showed a selectivity for males that both authors felt was explainable by assuming a more general use of dens by females. Allen's hunting season observations were followed up with intensive live-trapping in which an excess of females were taken. His combined hunting and trapping figures indicated the sex ratio before hunting to have been about even. In this connection, a series of sex

ratios based on an accumulated hunting season kill of 1409 rabbits taken over a six-year period at the Rose Lake Station is of interest. These data are summarized in Table V.

For each of the years included in Table V, Michigan's small game season began on October 15 and continued through December 31. From the opening date to November 5, pheasants, fox squirrels and rabbits are legal game, but from November 6 through December 31, of the three, only rabbits can be hunted. Reference to Table V will show that rabbit hunting during the "pheasant" season produced a preponderance of females in three years of hunting and an excess of males in the other three years. The six-year total kill of 751 rabbits during this October 15-November 5 period showed an essentially even sex ratio of 101 males : 100 females. During the November 6-December 31 portion of the small game season the sex ratio ran high to males in each of the six years, and the accumulated total kill of 658 rabbits in this period gave a sex ratio of 119 males : 100 females.

At Rose Lake, 80 percent of the total season hunting pressure occurs during the first three-week period when pheasants are legal game, and only 20 percent is in the last eight weeks of hunting. If hunting pressure affected the sexes differently it would be expected that the six-year averages for the early part of the season would reflect the fact in an unbalanced ratio of the sexes. Since a predominance of males in the kill was noted only during the colder weather of the latter part of the season it would appear that lower temperature was the factor which encouraged a greater use of dens by females and a relative increase in the take of males. The normal mean temperatures given by the East Lansing Weather Bureau, eight miles from the Rose Lake Station are: For October 50.3, November 37.5, and December 27.2.

In Table VI, which summarizes the total hunting season kill of rabbits for the years 1940-1945, and data for years 1943 and 1945 are of interest for the marked preponderance of males which was taken. While the differential activity of the sexes already discussed could account for such differences, we suspect that in these particular years something additional may have been involved. Without attempting a full explanation of

TABLE V

Sex Ratios of Rabbits Shot at the Rose Lake Wildlife Experiment Station
in the years 1940-1945

Year	"Pheasant" Season (Oct. 15 - Nov. 5)			"Rabbit" Season (Nov. 6 - Dec. 31)		
	♂	♀	♂:100 ♀	♂	♀	♂:100 ♀
1940	66	63	105	52	51	102
1941	83	117	71	73	62	118
1942	110	114	97	94	82	115
1943	67	32	209	33	24	138
1944	28	32	88	51	46	111
1945	24	15	160	54	36	150
TOTALS	378	373	101	357	301	119

TABLE VI

Total Season Kill (Oct. 15 - Dec. 31) and Sex Ratios of Rabbits Taken
at the Rose Lake Wildlife Exp. Sta. for the Years 1940 - 1945

Year	Total Kill	Kill per 100 Acres	Sex Ratio ♂:100♀
1940	233	15.1	103
1941	336	23.8	87
1942	404	22.2	104
1943	167	9.3	179
1944	162	8.6	101
1945	139	7.6	153

the relationship, Allen (1943) called attention to sex-ratios and population trends of fox squirrels in Michigan. In periods of population increases a larger proportion of female squirrels was taken at two widely separated experiment stations (the Rose Lake Station, Clinton County, and the Swan Creek Station, Allegan County). With a waning population a reversal in sex ratios was noted with males being taken in greater relative numbers. In the sex ratio records for rabbits shown in Table V it may not be entirely accidental that during two of the three years of low population levels a conspicuous excess of male animals was taken. Similarly, the record high kills of 1941 and 1942 occurred either in or following, a year when females were in excess. Added to this 1941-42 picture of record high kills and anomalous sex ratio were observations at Rose Lake in 1942 of theretofore unknown instances of animals breeding in the same year of their birth (Gooley, 1946).

Other species using dens. Allen (1938) took opossums in his den excavations in Allegan and Kalamazoo counties, but he recovered none in similar work at Rose Lake (Allen and Shapton 1942). Although signs at den openings showed skunks and opossums occupied or had used a few of the burrows, neither of these species was driven forth by ferrets. What the reactions of these species would be when confronted by a ferret was not observed in this study. However, G. W. Bradt, who had considerable experience with ferrets during the time when they constituted legal means for taking rabbits in Michigan, has informed me that skunks will betray their presence in dens before ferrets by tapping their fore feet in the manner usually seen when they are cornered above ground. The action generally observed by Bradt was a sparring, bloodless battle in which the skunk forced the ferret to retreat slowly from the den. In view of this report it appears unlikely that any of the dens worked with a ferret, and selected primarily for signs of rabbits, were occupied by skunks. In these studies the only animal aside from rabbits taken from dens was the prairie deer mouse (Peromyscus maniculatus bairdii), two individuals having emerged from two different dens.

CONCLUSIONS AND SUMMARY

1. Under a wide range of air temperatures 181 ground dens were explored with ferrets. "Holing up" by rabbits was not found to be dependent upon any critical temperature, but rather increased gradually with lowering temperatures. Under minimum daily temperatures of -5° to $+12^{\circ}$ F., den occupancy by rabbits was about three times that found on days when low daily temperatures were $+13^{\circ}$ to $+32^{\circ}$ F.
2. Dens and brushpiles in open field habitats were much more intensively used by rabbits than similar cover in other situations, and an observed winter movement to swales and woodlots was believed to reflect the acute competition for weather-protective cover in open areas. Evidence was obtained of the acceptability of brushpiles for winter cover, and possibilities for increasing the winter carrying capacity of cover-deficient areas through proper brush disposal were suggested.
3. Ferret work on several of the coldest days during the study, and analysis of hunting returns, show that females are more inclined to the use of dens than are males. Late season hunting (November 6-December 31) gave evidence of having a survival value for females in all of six years for which records are available, and the application of such habit differences in the sexes to management of the species may be worth consideration in some areas.
4. Some evidences of a relationship between changing sex-ratios, abnormal breeding behavior, and population fluctuations appear in the data, but these are little more than suggestive.

J. P. Linduska
Game Division
Conservation Department
Lansing, Michigan

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