LIFE HISTORY NOTES ON *SIGMODON HISPIDUS TEXIANUS* WITH SPECIAL EMPHASIS ON POPULATIONS AND NESTING HABITS

LIFE HISTORY NOTES ON SIGMODON HISPIDUS TEXIANUS WITH SPECIAL EMPHASIS ON POPULATIONS AND NESTING HABITS

By

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Bachelor of Science

Ottawa University

Ottawa, Kansas

1936

Submitted to Department of Zoology

Oklahoma Agricultural and Mechanical College

In Partial Fulfillment of the Requirements

For the degree of

MASTER OF SCIENCE

1940

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PREFACE

The cotton rat has received relatively little attention, because its economic importance is not striking under normal circumstances. The animals usually inhabit waste tall grass and low shrub areas; they forage in the late afternoon and night. Accordingly, their presence is not very evident to the casual observer.

The purpose of this paper is to bring together some of the pertinent facts concerning the life history of the cotton rat. Special emphasis is given to population study and nesting habits. Most of the field work was done on the Lake Carl Blackwell Area, Payne County, Oklahoma. These observations were made during the period of time from November 1, 1939 to July 20, 1940. The trap-night method was used in determining the numbers of rats present. Nests and burrows were dug out to allow close observation of their construction. Careful cruising was another method of study employed.

I am much indebted to several people who have helped me in many ways in preparing this thesis. First, I wish to acknowledge the work of Dr. F. M. Baumgartner, Associate Professor of Entomology, in directing this study. Thanks are also due Prof. R. O. Whitenton, Head of the Zoology Department, for his kind assistance. Information in the form of letters from Claude W. Hibbard, Assistant Curator of

Vertebrate Paleontology, University of Kansas, Lawrence; Gale Monson, Assistant Biologist, Soil Conservation Service, Tucson, Arizona; Homer G. Towns, Chief, Regional Biology Division, Soil Conservation Service, Fort Worth, Texas; H. L. Whitaker, Area Biologist, Soil Conservation Service, Muskogee, Oklahoma; Charles H. Rouse, Associate Biologist, Bureau of Biological Survey, Cache, Oklahoma; Dr. G. C. Rinker, Hamilton, Kansas; William H. Kellogg, Jr. Biologist, Soil Conservation Service, Elk City, Oklahoma; R. B. Hickerson, District Field Assistant, Rodent Control Service, College Station, Texas; and E. V. Komarek, Assistant Director, Cooperative Quail Study Association, Sherwood Plantation, Thomasville, Georgia, have been of great help to me. I wish also, to thank the county agricultural agents of Oklahoma who gave me information on the cotton rat in their particular counties. I sincerely thank all others who helped in any way with the preparation of this thesis.

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LIFE HISTORY NOTES ON *SIGMODON HISPIDUS TEXIANUS* WITH SPECIAL EMPHASIS ON POPULATIONS AND NESTING HABITS

Introduction

Synonomy

Miller (1923) gives the synonomy of the Texas cotton rat in his "List of North American Recent Mammals", thus:

"*Sigmodon hispidus texianus* (Audubon and Bachman)

1853 *Arvicola texiana* Audubon and Bachman, Quadr. N. America, Vol. 3, p. 229

1891 *Sigmodon hispidus texianus* Allen, Bull. Amer. Mus. Nat. Hist., Vol. 3, p. 267, June 30, 1891"

Mr. E. A. Goldman (corres.) gives the following explanation of the above changes in nomenclature:

> "The change is due to the fact that when *Arvicola texiana* was described by Audubon and Bachman, they evidently associated the animal with the voles, the generic name for which at that time was *Arvicola*, and were not familiar with the genus *Sigmodon*, which had been described by Say and Ord in 1825. Allen in 1891 discovered that *texiana* had been referred to the wrong genus and transferred it to the genus *Sigmodon*, to which it properly belongs."

Diagnostic Characters

The cotton rat is a native American Muridae, so it belongs to the subfamily, Cricetinae. The tubercles of the upper molars form flattened S-shaped loops, therefore, this rodent belongs to the genus Sigmodon. As only one species is found in this part of the United States, the rodent belongs to the species Sigmodon hispidus. This rat is somewhat smaller than S. h. hispidus (Table 1.), whose average measurements are: length, 252 mm.; tail, 102 mm.; hindfoot, 32 mm. They differ also in that S. h. texianus has a more reddish rump (Pratt, 1935).

Table 1.

Comparison of Measurements

Subspecies	length	tail	foot
[1] S.h. hispidus	252 mm.	102 mm.	32 mm.
[2] S.h. texianus	254 mm.	104 mm.	30 mm.
[3] S.h. texianus	238 mm.	97 mm.	31 mm.

Anthony's measurements were originally given in inches. This may account for the fact that his figures for measurements of S. h. texianus are larger than the ones given by Pratt (1935) for S. h. hispidus.

General Description

The Texas cotton rat is intermediate between the field

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1. Pratt (1935) 2. Anthony (1928)
3. Average of measurements in Table 2.

mouse, Microtus sp., and the Norway rat in size. Its body shape more closely resembles that of the field mouse, however, the tail is comparatively long. The head is rather broad, tapering to a pointed nose. It is attached by a short neck to a stocky body. The ears are easily seen but do not extend beyond the hair. The tail, shorter than the head and body, is scaly and thinly haired. The top of the tail and feet are a dark greyish color. The sexes do not vary noticably in size.

The pelage of both sexes is identical and the seasonal variation is very slight. The grizzled, hispid appearance of this rat is characteristic. The upper parts range from a rich brown to buffy blackish grey. This color shades off to a dull whitish grey on the belly. The young are similar to the adults but lack the grizzled, hispid appearance (Anthony, 1917).

Anthony (1928) gives the length of the Texas cotton rat as 10 inches (254 mm.) ; tail vertebrae 4.1 inches (104 mm.) and the hind foot 1.2 inches (30 mm.) . During the course of these investigations a series of measurements were taken (Table 2). The average measurements for these animals were: total length, 238.3 mm.; tail length, 97 mm.; hind-foot, 31 mm. It is evident that these figures are somewhat smaller (Table 1.) than those given by Anthony (1918), with the exception of the hind foot. This may be due to the fact that the animals were not fully

grown, however, they were not noticably immature.

Table 2.

Sex, weight, and measurements of rats taken in November, 1939.

Date	Total length in mm.	Tail length in mm.	Hind-foot length in mm.	Weight in grams	Sex
Nov. 4.	211	83	29	69	Female
Nov. 8.	204	85	30	69	"
Nov. 8.	235	102	32	87	"
Nov. 8.	237	106	34	96	"
Nov. 11-12	239	94	31	72.6	"
Nov. 11-12	259	100	30	98	"
Nov. 11-12	252	102	31	101.5	Male
Nov. 11-12	264	104	32	104.1	"
Nov. 11-12	292	103	31	129	Female
Nov. 17.	227	97	31	77.2	"
Nov. 17.	223	86	32	77	"
Nov. 17.	247	109	34	112	Male
Nov. 20.	207	91	30	90.5	Female

The predominance of females taken may be a significant factor, although the total number of individuals trapped is not enough to determine a true predominance in a large area.

Range

Subspecies of S. hispidus extend over all of the

southern part of the North American Continent. Cotton rats have been reported from Raleigh, North Carolina, to Southern California and from Panama, as far north as Harper County, Kansas (Hibbard, 1933).

Allen (1940) gives the range of Sigmodon hispidus texianus as,

> "Approximate eastern half of Texas, westward to Vernon and San Antonio, northward to southwest Missouri and south eastern one-fourth of Kansas."

Mr. Claude W. Hibbard (corres.) has found evidences of Texas cotton rats from as far west as Meade County, Kansas. Figure 2 shows approximate distribution of this form in Oklahoma.

Type Locality

The Brazos River, Texas, is given as the type locality of this subspecies.

Habitat

The cotton rat is principally a field rodent, however, during periods of abundance, it is often found near home sights on farms. At times it is seen in cities. In October, 1939, in a residential part of Stillwater, a cat was observed playing with a cotton rat which it had crippled. The remnants of two cotton rats and their nests were found beneath a board walk on the Oklahoma A. and M. College campus.

The cotton rat does best in areas which provide sufficient low cover to hide them. Sedge marsh and broom sedge associations seem to harbor the greatest concentrations of

rats (Stoddard, 1936). Our findings agree with Lay and Baker (1938) who have reported that the cotton rat rarely lives in woodland.

Populations

Blair (1938) found 88 cotton rats to the acre in a sedge marsh association in the summer of 1936. Stoddard (1936) reports approximately 40 rats to the acre in a carefully planned rat-population study in a typical broom sedge area in 1926. Hamilton (1939) writes of five hundred rats having been killed by poison on a single acre of sweet potatoes. The region near San Antonio, Texas, suffered a great "plague" of rats in 1889(Anthony, 1917).

Field Studies

Trapping

Dr. F. M. Baumgartner first noticed a heavy infestation of cotton rats on the Lake Carl Blackwell Area in Payne County, Oklahoma, when he began his work there in the spring of 1938. He has kindly allowed the use of field notes on the cotton rat population studies which he made in April of 1939. They are as follows:

Station 1. (Figure 1)

Location: N.W. corner, S.4,19N...1E. Lake Carl Blackwell Area.

Habitat: Solid stand of bluestem grass, (Andropogon scoparius), 75 ft. S. of abandoned church.

Area: 50 ft. by 50 ft.

Traps: 100 snap-back mouse traps set about 5 ft. apart over whole area.

Bait: Mixture of rolled oats, peanut butter and raisins (Standard mix).

Trap-nights: 300; 100 on April 20, 21 and 22, 1939.

Results: April 20,- 6 cotton rats, 19 deer mice (Peromyscus leucopus), 4 house mice (Mus musculus).

April 21,- 11 cotton rats, 9 deer mice.

April 22,- 12 cotton rats, 4 deer mice, 1 mouse sp.?

Total- 39 cotton rats, 32 deer mice, 4 house mice and 1 mouse sp.?

Station 2. (Figure 1.)

Location: N. E. Corner, S.5,19N..1E. Same general area as Station 1.

Habitat: Area recently terraced (1937?). Vegetation consisting chiefly of miscellaneous weeds such as daisy fleabane (Erigeron ramerosus), broom weed (Gutierrezia Sorothrae), and sun flower (Helianthus annuus). Terrace ridges practically bare or covered with a sparse growth of grasses.

Area: Approximately 100 ft. by 100 ft, traps set about 11 ft. apart.

Traps: 75 snap-back rat traps.

Bait: Same as above.

Trap-nights: 225; 75 on April 23, 24, and 25, 1939.

Results: April 23,- 56 cotton rats, 3 deer mice.

April 24,- 27 cotton rats, 1 deer mouse, 1 mouse sp.?

April 25,- 21 cotton rats.

Total- 104 cotton rats, 4 deer mice, 1 mouse sp.?

During the fall of 1939 cotton rats were still noticed to be quite numerous short distances north-east and west of Stillwater. In attempting to get some idea of numbers, the following data was gathered:

Station 3. (Figure 1.)

Location: N. E. corner of S.5,19N..1E. Same area as Station 2, 100 ft. W. and 150 ft. S. of section corner.

Habitat: Typical upland which has been out of cultivation for about 5 years. The land is gently sloped to the south-east. It has been recently terraced (1937?), the ridges being about 35 ft. apart. The vegetation is made up of daisy fleabane, broom weed, and a few sun flowers, fox tail and tickle grasses.

Area: 60 ft. by 60 ft.

Traps: Snap-back rat traps were used. On Nov. 1, 15 traps were set; 10 were added one week later.

Bait: Same as above.

Trap-nights: The traps were set intermittently over a 3-weeks period in such a way as to add up to 330 trap nights.

Results: Table 2 accounts for 13 rats; 10 others were not included in this table because they were partially eaten, bob-tailed, or decomposed. Total of animals taken: 23 cotton rats, 1 house mouse, 2 deer mice, 1 cottontail rabbit (Sylvilagus floridanus), and 1 crow (Corvus brachyrhynchos).

Trap-nights per rat for the 3 stations mentioned above were:

Table 3.

Trap-nights per rat

Station 1	1 rat in 7.69 trap-nights
Station 2	1 rat in 2.16 trap-nights
Station 3	1 rat in 14.35 trap-nights

Stations 2 and 3 partially over-lap so the same rats would roam over both areas as the cover is practically the same. One rat in 2.16 trap-nights at Station 2 in April would indicate that the rats were more plentiful than they were in November when one rat was taken in 14.35 trap-

nights at Station 3. This may indicate a gradual decrease in population which culminated early in January 1940.

Dr. F. M. Baumgartner's studies on the abundance of hawks and owls in this area were indicative of heavy rodent populations. The sharp decline in the hawk and owl population which occurred during the early part of January was indirect evidence of a greatly decimated population of cotton rats as pellets from these birds indicated that this rodent formed a large part of their diets.

Marked cotton rat activity was noticed about December 15. However, no rats were taken in traps. From January 9 to 31, a few traps were kept set and baited along a roadside 1 mile west of the Oklahoma A. and M. Campus. In the 150 trap nights that these traps accumulated, one live rat was taken on January 12. The warmer weather of January 16 seemed to cause some activity around 3 rat holes of this area. The grass around two of them was quite muddy. The third had been cleaned out and a lot of cut stems of Bermuda grass (Cynodon dactylon), rat pellets and fresh dirt was piled out on the snow just below the hole.

Traps were reset on the Lake Carl Blackwell Area, January 17, 1940, at Station 4. Rat signs showed Station 4 to have been heavily infested previously with cotton rats.

Station 4. (Figure 1.)

Location: N. E. corner of S.6,19...1E.

Habitat: Terraced bluestem sod. The terrace ridges

were covered with low weeds and summer grasses.

Area: 16 rods by 12 rods. The traps were placed in 4 parallel rows, each one chain (66ft.) from the other. The traps were placed about 17 ft. apart in the rows (Blair, 1938).

Traps: 50 snap-back rat traps and 15 live traps.

Bait: Standard rodent mix of peanut butter, rolled oats and raisins. At times only peanut butter, or peanut butter and one other ingredient were used.

Trap-nights:

Jan. 17-26	60 traps	600 trap-nights
Jan.27- Feb. 26	65 traps	1950 trap-nights
Feb.27-Mar. 15	50 traps	850 trap-nights
	Total---	3400 trap-nights

Results:

No rats were taken in 3400 trap nights.

Traps were maintained at Station 4 for a sufficient length of time to indicate that no rats were present in this area. When no rats were taken at this station and careful cruising of other areas failed to show fresh cotton rat sign, it was decided to sample, periodically, the following stations which represent the different habitats found on the Lake Carl Blackwell Area.

As the trapping at the following stations was done for the purpose of determining the presence or absence of

rats it was decided to set the traps in one long line, thus sampling the largest possible area with a minimum number of traps. The traps were kept set for 4 consecutive days in each habitat during each period.

Station 5. (Figure 1)

Location: In N. E. ¼ of S.5,19N..1E., ½ mi. W. of church sight.

Habitat: Second bottom. Division line between bluestem sod and fallow cultivated land. The cover is made up of sun flower, lettuce (Lactuca canadensis), rag weed (Ambrosia sp.?), daisy fleabane, prinopsis (Prinopsis ciliata), partridge pea (Cassia chamoecrista), horse nettle (Solanum carolinense), and milk weed (Asclepias sp.?).

Traps: 50 snap-back rat traps placed about 17 feet apart in one line.

Bait: Same as in Station 4.

Trap-nights: Period 1.

200; 50 each on April 25, 26, 27, and 28, 1940.

Results:		
	April 25	no catch
	April 26	no catch
	April 27	1 Peromyscus sp.?
	April 28	1 Peromyscus sp.?
	Total	2 Peromyscus sp.?

Mouse sign was very evident during this period of trapping (April 25-28) at Station 5. Bait was removed, presumably by mice, from at least half of the traps each night.

Trap-nights: Period 2.

200, 50 each on July 13, 14, 15, and 16, 1940.

Results:	July 13	no catch
	July 14	1 Terrapene ornata
	July 15	no catch
	July 16	no catch
	Total	1 Terrapene ornata

Station 5 showed very little, if any sign of the presence of mice during this period of trapping. Ten mouse traps were kept set along with the rat traps to try to recover some of the mice noticed here during Period 1, but no mice were taken.

Station 6. (Figure 1.)

Location: In N. W. ¼ of S.4,19N..1E., 250 yds. E. of church sight.

Habitat: Terraced upland out of cultivation for 5 years or more. The cover contained sunflower, prinopsis, ragweed, little bluestem, partridge, horse nettle, side oats grama (Boutelcua curtipendula), and love grass (Eragrostis sp.?). The growth between terrace ridges is rather sparse. Most of the weed growth is confined to the dit-

ches and sides of the terraces.

Traps: Same as Station 5.

Bait: Same as Station 4.

Trap-nights: Period 1.

200; 50 each on May 21, 22, 23, and 24, 1940.

Results:

May 21	no catch
May 22	2 Terrapene ornata
May 23	no catch
May 24	no catch
Total	2 Terrapene ornata

Trap-nights Period 2.

200; 50 each on July 9, 10, 11, and 12, 1940.

Results:

July 9	no catch
July 10	no catch
July 11	no catch
July 12	no catch

Station 7. (Figure 1.)

Location: N. W. ¼ of S.5,19N..1E. and S. W. ¼ of S. 32,20N..1E.

Habitat: This station was a small ravine containing fringe forest cover. Half of the traps were placed in the fringe forest which was about 50 feet wide. The other half of the traps were placed along the division line

between a fallowed field and the fringe forest. The fringe forest was made up principally of hack berry (Celtis occidentalis), elm (Ulmus americana), buck brush (Symphoricarpos Symphoricarpos), wild grape (vitis sp.?), dogwood (Cornus sp.?), cottonwood (Populus deltoides), coffee bean (Gymnocladus dioica), and green briar (Smilax sp.?).

The fallowed field bordering this fringe forest contained prinopsis, sunflower, horse-weed (Leptilon canadense), daisy fleabane, and lamb's quarter (Chenopodium alba).

Traps: Same as Station 5.

Bait: Same as Station 4.

Trap-nights: Period 1.

200; 50 each on May 26, 27, 28, and 29, 1940.

Results: May 26 no catch

May 27 no catch

May 28 no catch

May 29 no catch

Trap-nights: Period 2.

200; 50 each on July 4, 5, 6, and 7, 1940.

Results: July 4 no catch

July 5 2 Neotoma floridana

July 6 no catch

July 7 1 Neotoma floridana

Total 3 Neotoma floridana

On July 11, 20 snap-back rat traps were set on the west side of Boomer Lake, 1½ miles north of Stillwater in an area known to have been heavily infested with cotton rats during the fall of 1939. In the following 4 days that these traps were set (80 trap-nights), the only animal taken was a ground squirrel, Citellus tridecemlineatus.

Station 8. (Figure 1.)

Location: N. W. ¼ of S.9,19N..E.

Habitat: Lake side, not true marsh because water level has only reached this point in the last year. The dominant plants which made quite a low dense growth were sedges (Carex sp.?), willow sprouts (Salix sp.?), and knot weed (Polygonom sp.?).

Traps: 70 snap-back rat traps placed about 17 feet apart in one line, about 20 feet back from the water's edge.

Bait: Mixture of peanut butter, rolled oats, raisins and bacon grease.

Trap-nights: 280; 70 each on July 16, 17, 18 and 19, 1940.

Results: July 16 no catch

July 17 no catch

July 18	1 Terrapene ornata
July 19	no catch
Total	1 Terrapene ornata

The following summary of trapping activities will help the reader to get a more compact view of just was has been done in the way of trapping during the course of these investigations.

Table 4.

Summary of Trapping (Figure 1)

Nov. 1-21	330	trap nights	Station 3
Jan. 9-31	150	" "	1 mi. W. of A. & M. Campus
Jan. 17-Mar.15	3400	" "	Station 4
April 25-28	200	" "	Station 5
May 21-24	200	" "	Station 6
May 26-29	200	" "	Station 7
July 4-7	200	" "	Station 7
July 9-12	200	" "	Station 6
July 13-16	200	" "	Station 5
July 11-14	80	" "	1½ mi. N. of Stillwater; west side of Boomer Lake.
July 16-19	280	" "	Station 8

This accumulation of nearly 5000 trap-nights in habitats that were previously infested with cotton rats cer-

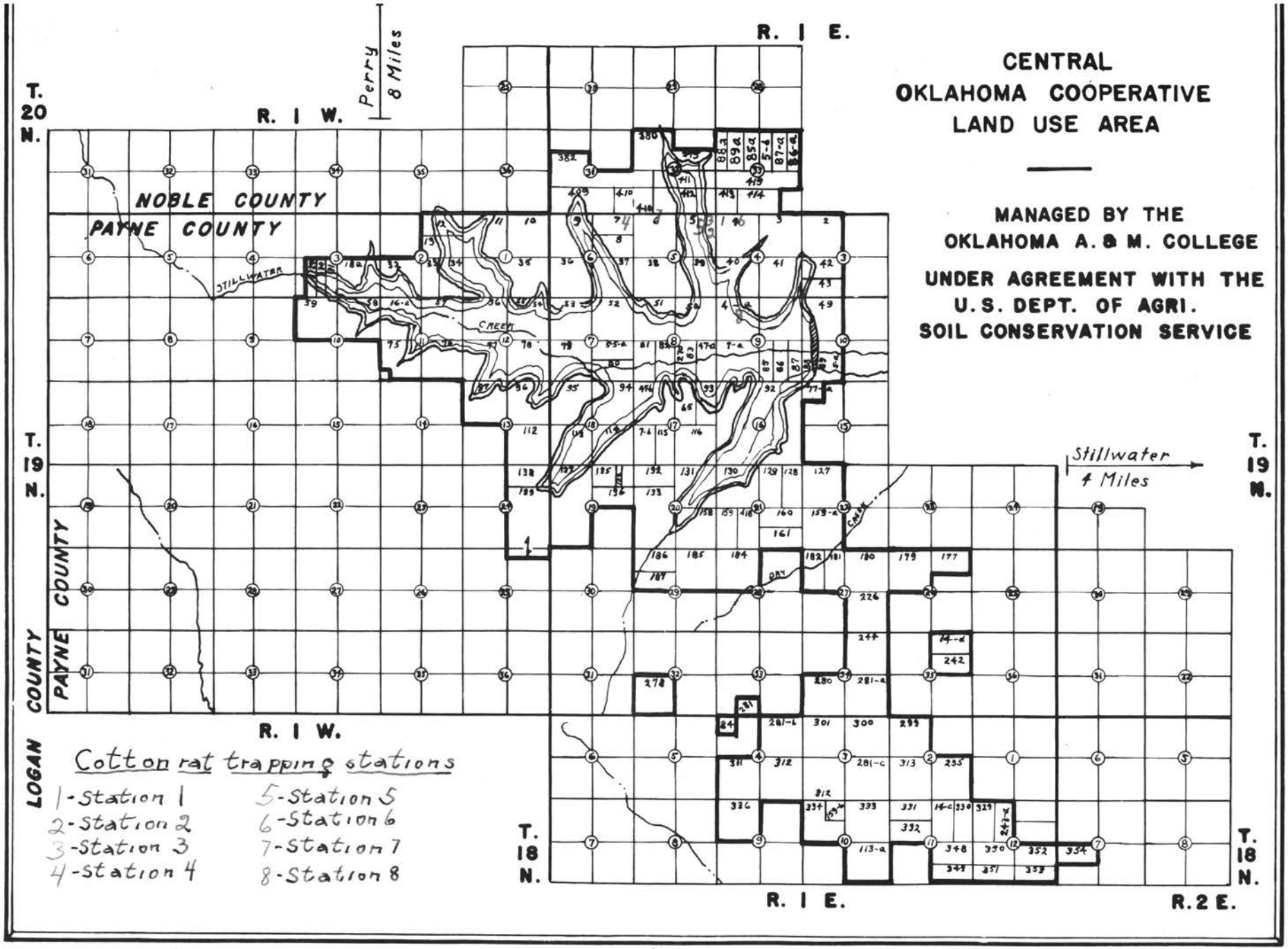

CENTRAL
OKLAHOMA COOPERATIVE
LAND USE AREA
MANAGED BY THE
OKLAHOMA A. & M. COLLEGE
UNDER AGREEMENT WITH THE
U.S. DEPT. OF AGRI.
SOIL CONSERVATION SERVICE
R. 1 E.
R. 1 W.
T. 20 N.
T. 19 N.
T. 18 N.
R. 2 E.
Perry
8 Miles
Stillwater
4 Miles
NOBLE COUNTY
PAYNE COUNTY
LOGAN COUNTY
PAYNE COUNTY
STILLWATER CREEK
Cotton rat trapping stations
1-Station 1
2-Station 2
3-Station 3
4-Station 4
5-Station 5
6-Station 6
7-Station 7
8-Station 8

Figure 1.

tainly proves that there was a very severe decimation of cotton rats in the region of Stillwater.

Decimation

It is a generally known fact that this animal undergoes a yearly die-off in early spring or late winter (Komarek, 1937). It is also suggested that cotton rats have more or less definite cycles of numbers over a period of a few years. Komarek (1937) observed severe die-off's following periods of maximum abundance in the first few months of 1926, 1930, 1934, and 1936.

Extent of Decimation. Soon after the decimation was noticed near Stillwater, plans were made to find the extent of the die-off. Only a limited amount of information has been obtained as few workers are interested in this form. However, information received has come from widely separated points of known cotton rat range.

It is of particular interest that the population of Sigmodon hispidus in regions both east and west of the range of texianus have apparently not undergone marked reduction during the early part of 1940 (corres., Gale Monson, Tucson, Arizona and E. V. Komarek, Thomasville, Georgia).

Dr. C. C. Rinker, Hamilton, Kansas, (corres.) states that S. h. texianus were so numerous during 1938 and 1939 that they "fairly swarmed". Since December 26, 1939, in extensive trapping, he has taken one and seen one. He

states that he has seen no dead and does not know whether they died or migrated. What ever the cause, they have almost completely disappeared.

H. L. Whitaker, Muskogee, Oklahoma, reports (corres.) a die-off of similar proportions at about the same time of the decimation noted here. He also reports decimations during the first part of 1934 and 1936.

A letter from W. H. Kellogg, Elk City, Oklahoma, (corres.) also indicates a decimation of cotton rats in that area which presumably came about during the early part of 1940.

A very apparent decrease in cotton rats is evident at College Station, Texas, (R. B. Hickerson, corres.). He states that the decrease has come about in the last year (1939-1940), and that "they are scarcely to be found" at the present time.

These 4 locations would seem to give one a fair sample of the range of S. h. texianus. However, it is entirely possible that there are local islands of cotton rats through-out the range of this species that have not been decimated. The fact that cotton rat populations are more conspicuous in optimum habitat makes their presence seem very spotted when large areas are considered (Figure 2.).

More detailed information on the status of the cotton rat has been sought for Oklahoma. This information was gained in various ways. Personal letters were exchang-

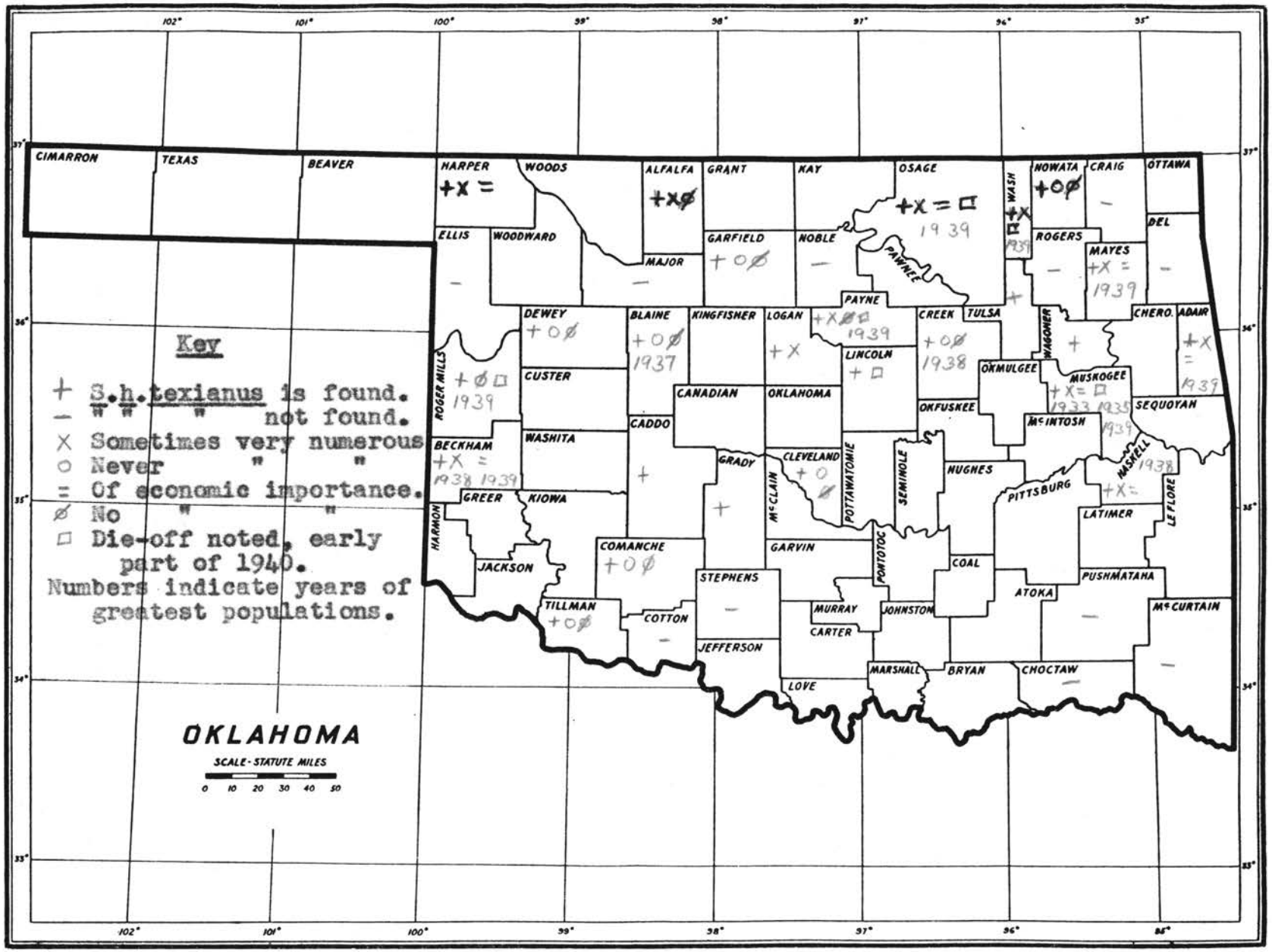


Figure 2. Status of S. h. texianus in Oklahoma

ed with individuals who were in a position to have considerable information on this form, some information was gained by talking with people from various parts of the state, and a questionnaire was sent out to each county agricultural agent. In some cases the reliability of this information is open to question since some of the people have indicated that they were not familiar with the cotton rat. The results of this quest for information on the status of the cotton rat in Oklahoma are shown in Figure 2.

The data obtained, although not conclusive, suggests that cotton rats are generally more plentiful and of greater economic importance in the eastern part of the state. W. H. Kellogg, Elk City, Oklahoma, (corres.) suggests that over-grazing may have destroyed cotton rat habitats in many areas throughout the western part of the state.

Probable Causes of Decimation. The four most plausible factors in the decimation in this immediate area seem to be a shortage of food, low temperatures, a blanket of snow, and disease. It is also possible that the cotton rat greatly lessened its own numbers through cannibalism or that other predators were responsible for a large part of the decimation.

1. Shortage of food. General observations by Dr. F.M. Baumgartner (field notes) indicate approximately 1/3 of the stalks of seed bearing plants were cut by rodents in

the spring of 1939. In late August rat damage again became conspicuous and by the middle of October most of the seed bearing plants had been cut off. Plot counts in November indicated that 60 to 95% of the stalks were cut by rodents and most of the seeds had been consumed. The barking of shrubs and shoots and eating of grass crowns was also of conspicuous damage. These observations strongly suggest that the basic winter food supply of cotton rats was definitely limited.

2. Low temperature (See Figure 3). This graph shows two periods of low daily minimum temperatures. From January 5 to 8, the minimum temperature stayed below 10°F., and went down to -5°F. one day. During the ten day period from January 18 through January 27, the daily minimum was from 14 to 26 degrees lower than the average minimum for January. From January 18 through January 26, the daily maximum was 20 to 32 degrees less than the average maximum. As the range of the cotton rat is confined to areas where moderate temperatures prevail, these periods of unusually low temperatures may have caused heavy mortality.

3. Lack of food due to a blanket of snow. The following table shows the amount of snowfall during the latter part of December and January, 1940.

Since the cotton rat is not known to store winter food, this species must depend upon foraging for food at fairly regular intervals. The snow blanket which stayed on the

This graph shows minimum and maximum temperatures each day from Dec. 26, 1939, through Jan. 31, 1940, plotted against minimum and maximum temperatures averaged over a period of 38 years. The minimum and maximum mean temperatures for Dec., 1939 and Jan., 1940 are also shown. This data was taken at the Stillwater weather station.

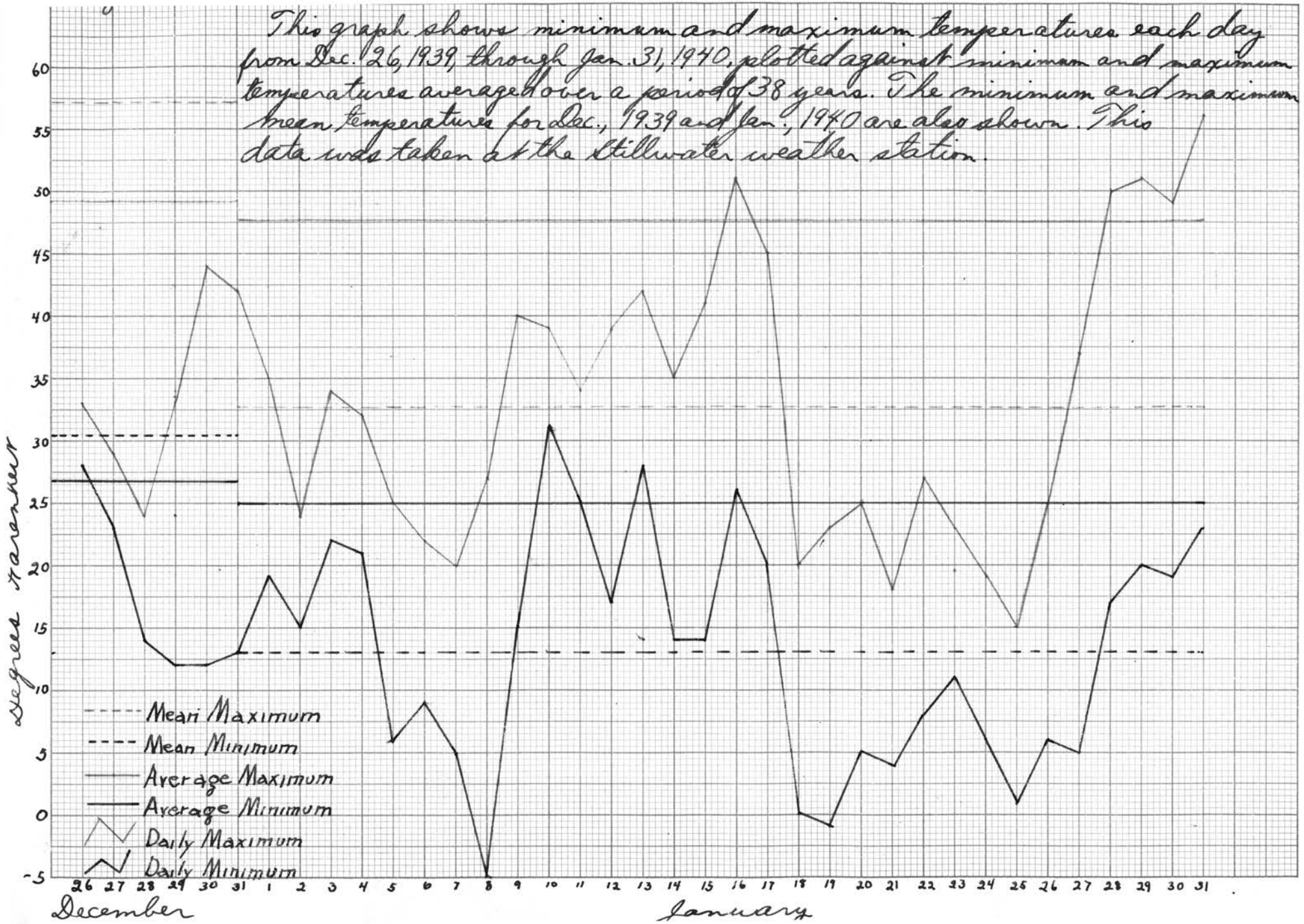


Table 5.

Precipation in the Form of Snow

Dec.	23	.19 in.	Jan.	6	.07 in
"	24	.63 "	"	7	.29 "
"	25	.10 "	"	14	.01 "
"	26	.40 "	"	19	Trace
Jan.	1	.03 "	"	23	.02 "
"	4	.27 "			

ground in places for nearly six weeks must have been a decided hindrance in gathering food if it did not entirely prevent the rat from leaving its burrows. Field observations bore this out.

4. Disease. The thoroughness and the comparatively short time involved in the decimation here suggest the possibility that a very contageous and deadly epizootic was present.

Dr. Edward Francis, Surgeon of the U. S. Public Health Service, examined a specimen of the 1926 die-off for tularemia, a common rodent disease, and found no evidence of the disease present (Stoddard, 1931). Dr. Lewis H. Moe, Associate Professor of Bacteriology and Veterinary Medicine, Oklahoma A. and M. College, examined a male rat which died February 25, 1940, after having been in captivity since January 12. He reported no lesions of tularemia evident. Komarek (1937) found 3 cases of severe coccidiosis after a small population of banded rats disappeared,

but he had no evidence that this was the cause of the die-off.

After severe die-off was noted here, a number of nests were examined to try to find out just what happened to the rats. Table 4 shows the number and types of nests examined and the complete carcasses and carcass remnants found in each type.

Table 6.

Results of Examinations of Nests

Nest Types	No. of Nests Examined	Complete Carcasses	Skin and Bones
Above ground	47	0	3
In burrows	30	5	7
Under objects	33	0	6

The complete carcasses were decomposed beyond a point where they could be used in the laboratory to determine the possibility of disease causing the animal's death. All 5 of these rats were in sleeping position with the head lying against the side and the tail lying on the bottom of the nest, curled around the front part of the body. Two of these rats were found in one nest.

In several cases the fragmentary remains seemed to represent two rats that lived in the same nest. The skin and bones were always disarranged in the nest or partially pulled out of it. These remnants may have been due to depredations of other cotton rats or other mammals that

would not have to destroy the burrow to get to the rats. On the other hand it is possible that these rats died and were then eaten by other cotton rats. The facts that the remnants were found in the nests and the nests and burrows were not disarranged tend to support the latter hypothesis.

Parasitism, predation and cannibalism that accompanied the large populations of the cotton rats may have also been factors in their decline in numbers. In final analysis it is plausible to assume that a combination of two or more of the above factors resulted in the almost complete decimation.

Estimated Populations

The above mentioned indications of severe die-off prompted other methods of determining the numbers of cotton rats that were present before this severe decimation. Accordingly, the home or nest locations in burned-over areas were counted. Four one-acre areas were selected and the following nest counts were made:

Table 7.

Number of nest locations found in 4 different habitats.

1. Terraced grassland hillside	33
2. Terraced cultivated hillside (fallowed 5 years or more)	29
3. Roadside (gently sloping to west)	24
4. Roadside (includes ravine and banks sloping to it)	72

The areas surrounding the nests and the nests themselves showed varying amounts of rat activity. Some had several entrances with a lot of material such as soil, cut stems, rat pellets, etc., scattered along the runs in such a way as to build them up an inch or two above the surrounding ground level.

From the work done around the nests, it would seem that at least half of them were the work of more than one rat. By applying this assumption, it seems that one could arrive at a very conservative estimate of the population which had been present, by multiplying the number of nests by 1½. The use of this formula would give one an estimate of about 45 rats per acre in field areas and 72 per acre in road-side areas. It should be noted that this formula is used only to arrive at an estimate in this area.

The greater population along the roadside could probably be explained by the fact that the rats could make their nests easier and they would be better protected near the road-side bank due to the dense grass and weed growth which is usually found here. In shallow ditches the grass and roots of the overhanging sod usually cover a very good run and often many nests.

Nest Sights and Preferences

Figure 4 indicates approximately the location and number of nests found along a roadside area (south side). The west half-mile (No. 3 of Table 7) is gently sloped to-

ward the west. The east half-mile (NO. 4 of Table 7) slopes from both sides toward the ravine in the center of

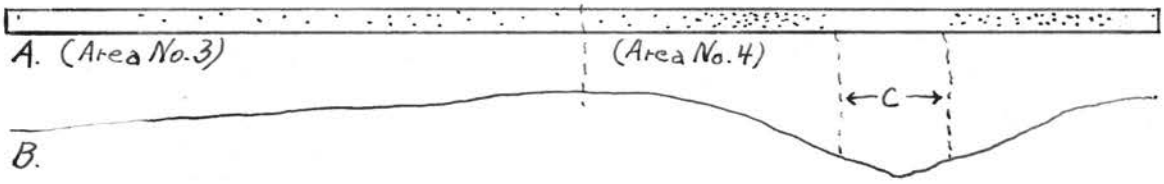


Figure 4. Nest sites and preferences along one mile of roadside a rod wide (Nos. 3 and 4 of Table 7.) A. Dots represent nests. B. Contour of A. C. Ravine containing trees and shrubs. (Not drawn to scale.)

it. It is interesting that the heaviest concentrations of nests are on each side of the ravine. There were no nests in the tree and shrub area. The greater number of nests on the west side of the ravine may be due to the fact that a small gulley, parallel with the road, facilitated nest building.

Careful cruising of areas No. 1 and 2 of Table 7, indicated that out in the field, the rats prefer to build their more or less permanent nests in the banks of terraces. Only a few underground nests were found away from the terraces.

Great concentrations of cotton rat nests were also noticed along the margins of some cultivated fields. In

these fields the rats usually make fence rows, weedy terraces and gullies or other waste places, their headquarters, with well worn runs extending out into the field. This is in agreement with the observations of Anthony (1917). If these refuges have been worked by moles, the rats usually have some underground runs, however, most of the nests will be above ground, protected by a clump of grass or other shelter.

A great deal of cotton rat activity has been noticed near rock piles. One community seemed to center about a rock outcropping and large rocks which lay below it along the hillside.

Cotton Rat Sign

Cotton rat runs are perhaps the most evident "sign" to the casual observer. If these runs are used much they will be strewn with pieces of grass and rat pellets. The above-ground nests are usually quite evident signs of cotton rat activity. Rat pellets are often the first sign noticed. Quantities of cut grass in thick grass areas are usually the work of cotton rats. At times, cotton rats cut areas of several acres of weeds so completely that they give the appearance of having been mowed. Cotton rat hair and bones in hawk and owl pellets and mammal feces are also signs of the presence of rats.

Cotton Rat Nests

Nests of this region can be divided into three differ-

ent types according to location: those made on top of the ground; those made in burrows; and those made in or under piles of wood, rock, or other materials.

Nests Above Ground. Nests on top of the ground are often built under a clump of grass or along a slight bank with a heavy growth of grass lopped over them. Where clumps of bluestem are several feet apart and little cover between, occassionally two nests will be located under the same clump. The nests above ground may serve only as temporary or summer shelters, however, one area was noticed where no other type of nest seemed to be present. These nests are usually spherical balls of cut grass with finer softer parts on the inside and coarser materials on the outside. They are from 6 to 10 inches in diameter and usually have 2 openings which are merely open pockets in the side of the nest. The runs to these nests are well beaten, but are not cluttered with cut stems, earth, rat pellets, etc., as is characteristic. Above-ground nests were quite predominant along the fence rows of a plowed field which had grown up in sunflowers. A very efficient network of runs joined these nests with all parts of the field.

Burrow Nests. The burrow type of nest is usually found in a roadside bank, along terrace ridges, and in the banks of gullies, however, some are found in level ground. Figure 5 shows a very simple type of underground

nest. The tunnel was about 3 feet in length and seemed to

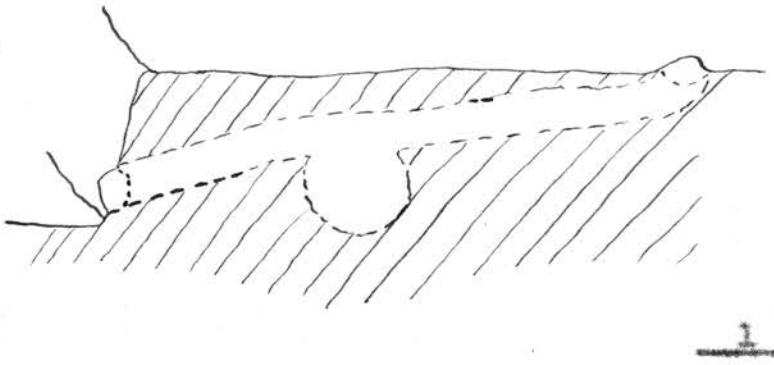


Figure 5.- Diagram of a simple underground nest.

be part of an abandoned mole tunnel. The nest was in a hollowed-out space, 8 or 10 inches across, about half way between the two ends.

Figure 6 shows a little more elaborate system of burrows and some are much more complicated than the one rep-

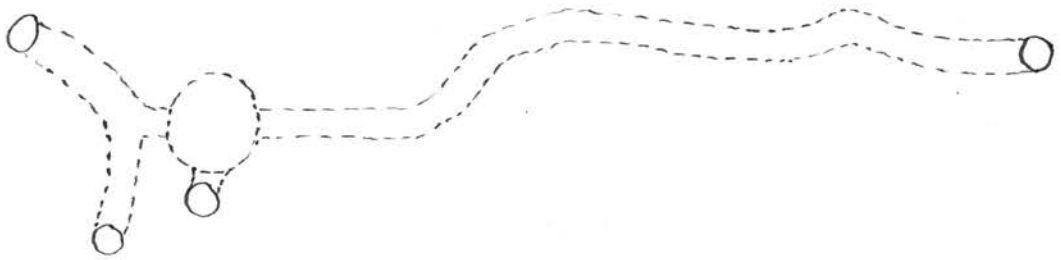


Figure 6.- Diagram of an underground nest with a more complicated system of burrows.

resented in Figure 6. Large nest locations with 5 to 7

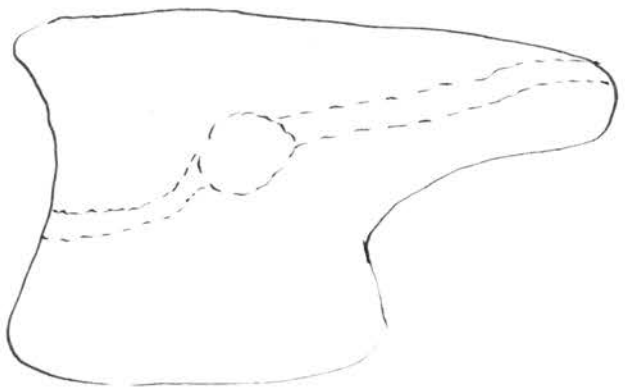
openings which led through burrows of varying lengths are often found in terraces. The burrows are rarely more than 8 or 10 inches below the surface of the ground.

The tops of most of the nests are within 4 inches of the surface. However, in some cases a second nest is found which is usually below and at one side of the top one. The tops of these lower nests are usually within 8 or 10 inches of the ground level. The grass of the lower nest always seems newer and thicker than the top one, which might indicate that it was made as a special winter nest. Where dead rats were found in nest regions with two nests, they were always in the lower.

A definite period of cleaning out of cotton rat burrows was noticed about the middle of December, 1939. Old pieces of rat fur, bones, pellets, fresh dirt and some old nest straw were piled near the holes or scattered along the runs for a short distance. This may have been the time of building the lower or winter nest.

Nests Under Objects. The nests made under materials were of varying degrees of elaborateness. Those under pieces of building paper, single boards, pieces of metal, etc., were usually just temporary shelters with only a small nest. Some of the more permanent nest sights were also equipped with the deeper winter nest arrangement described in the discussion of burrow nests. Figure 7 diagrams the nest and tunnel arrangement under a large

rock.



1 foot

Figure 7.- Nest and burrows under a large rock.

The cotton rat does not show very good sense in choosing a site for its nest from the point of view of flooding. More than half the rock pile baffles in the roadside ditches in this part of the Lake Carl Blackwell Area contain quite elaborate rat nests. The very dry fall of 1939 may have made these seem suitable places for nesting.

One area of especially great cotton rat activity centered about a pile of large rocks in a bluestem sod region.

Life History and Economic Status

Reproduction

Data on the breeding habits of S. h. texianus are very limited, so other subspecies will be considered.

Varying numbers of young have been reported for the different subspecies. Burt (1933) reported a female, S. h. cienegae, which echtained 17 fetuses. Gravid females of S. h. pallidus are reported by Bailey (1931) to contain

from 4 to 11 fetuses. Brimley (1923) found from 3 to 9 cotton rats to the litter with an average of 6, in North Carolina. The mammae are normally 8 to 12 in number. Svihla (1929) states that the young of S. h. hispidus are able to run about at birth, their eyes open in 24 hours, and they are weaned at about 10 days of age.

Temperature seems to be the factor which controls the length of the breeding season. In warm climates the animals breed the year around. Gravid females have been taken at Raleigh, North Carolina, in January, May, July, and October (Brimley, 1923). Stoddard(1931) gives the following on the breeding season and young of S. h. hispidus in Georgia:

> "A few young are born in spring but the greater number come after June and the breeding season extends into the winter. From 6 to 9 are produced at a time. The weight of 6 born in captivity on Oct. 27, averaged 6 grams each on the fourth day... As they are born in a very advanced state of development, they quickly become active and self reliant."

Bailey (1931) suggests that S. h. pallidus in New Mexico has 2 or 3 litters a year. The size of the rats taken near Stillwater in November of 1939, might indicate only one or two litters during that particular season as none of the rats taken were noticably immature. However, no careful study of them was made.

Food Habits

Stoddard(1931) sums up the feeding habits of the cotton rat quite well in the following:

"In the wild state they apparently subsist largely upon various seeds, roots, green sprouts on bases of broomsedge, grasses and possibly larger insects, for beetle-wing cases are numerous in their run-ways. Captive cotton rats usually eat meat readily and fondness of certain individuals for quail eggs makes them obnoxious upon the quail preserve. When caught in "live traps" they frequently kill and partly devour weaker individuals of their own kind.

"Experiments carried on by the Investigation demonstrated that the cotton rats are fond of seeds of sumac, partridge pea, and especially the seeds of various pines, although they do not appear to care for or be able to handle the smaller weed seeds. They dig up and eat the roots of perennial legumes, especially bush clovers (Lespedeza), doing considerable damage to quail-breeding areas in this way at times."

In heavily populated cotton rat habitat, a large percentage of the weeds such as daisy fleabane, broom weed, rag weed, and some sun flowers were found to be cut at about 3 to 5 inches above the ground. In some cases this was uniform enough to give the appearance of having been mowed. Some of these areas were 10 to 15 acres in size. A somewhat similar cutting of Bermuda grass was noticed in a few areas, however, the grass was cut close to the ground.

The cotton rat is not known to store food to any great extent, however, a few small temporary depots of food are occasionally found. Blair (1938) found nuts of black hickory (Carya buckleyi), pecan (Carya pecan), and acorns of black jack-oak (Quercus marilandica) under a rock where he also found a male cotton rat. Twenty to thirty horse nettle seeds were found during this investigation under some old building paper and boards which also covered a cotton rat nest. In another place several sunflower heads

and a large amount of cotton rat pellets were noticed under an old lard can lid which was leaning against a bank.

The above quotation from Stoddard (1931) sums up very well the observations made here on the cotton rat. A male cotton rat kept in the laboratory from January 12 to February 25, was quite fond of soda crackers, lettuce, cabbage, carrots and sunflower seeds as well as meat scraps, sumac seed and partridge pea mentioned above.

Economic Status

Hamilton (1939) gives the following on the destructiveness of Sigmodon hispidus in the South:

> "Cotton rat damage to sugar cane is severe, 36 per cent of the crop sometimes being destroyed and in some instances as much as 78 per cent. In southern Florida truck farming is an important industry, and every type of produce here raised is subject to damage by the cotton rat. In 1924 the damage amounted to $45,000 to the 12,000-acre tomato crop, while in 1931 it was estimated that the loss to all truck crops amounted to $150,000 in spite of control measures by the farmer. Three or four plantings of squash are frequently necessary before even a partial crop may be raised, sweet potatoes are often so badly damaged that they have no market value, and the best of the winter tomatoes are often ruined by the rodents."

Bailey (1931) says,

> "Grain at any stage from green blades to ripening heads is a favorite food."

Alfalfa is also very acceptable. The animal probably gets its name from the fact that it is so fond of cotton seed.

> "Cotton rats are very destructive to ripening tomatoes. In one truck garden (in Texas) practically every third ripe tomato was a mere shell. As these rats feed in the daytime, they are often caught at their misde-

meanors" (Strecker, 1929).

On the other side of the picture, the cotton rat probably is of some value as a "buffer" food for predatory forms that might otherwise feed on game species. Mr. Charles H. Rouse, Cache, Oklahoma, writes (corres.):

> "The importance of the cotton rat in this area rests on the availability to raptors and predators, who might otherwise prey on species considered of greater importance. For example, in examining slightly over 100 coyote droppings, remains of cotton rats were found on 8 occasions."

Control

These animals are usually controlled by natural means such as unsuitable habitat and predatory reptiles, birds, and mammals. At times these forces get out of balance and definite control measures must be applied.

Komarek (1939) believes that fire is a great help in keeping land from becoming optimum cotton rat habitat. He believes fire to be the key to a balanced normal population between quail, rodents and larger mammals.

Second to systematic burning would come poisoning. Mr. James Silver, rodent specialist in the Bureau of Biological Survey, gives the following on preparation and placing of poison (Stoddard, 1931).

> "Preparation of bait. Mix 1 tablespoon of gloss starch in 1/4 cup of cold water and stir into 3/4 pint of boiling water to make a clear starch paste. Mix one ounce of powdered strychnine (alkaloid) with 1 ounce of baking soda and stir into starch paste to a smooth creamy mass free of lumps. Stir in 1/4 pint of heavy corn syrup and 1 tablespoon of glycerine. Pour this mixture over 20 quarts of good quality, clean whole barley and stir thoroughly to coat each kernel. Spread

out on a newspaper to dry.

"Placing of poisoned baits. Locate cotton rat runs and place a medium-sized handful of poisoned barley at any point along them. Scatter the bait for a foot or more along the trail to avoid the danger of live stock picking up a toxic dose. Place a bait every 10 to 12 paces along a continuous system of runs and closer where the infection is unusually heavy. Twenty quarts of poisoned barley should make approximately 1,000 baits.

"Poisoning may be done at any season, but preferably between the conclusion of the burning season and April 15, in order to afford maximum protection from rat depredations to ground nesting birds."

Summary

1. Nearly 5500 trap-nights plus intensive field observations demonstrated that the Texas cotton rat, S. h. texianus, was very abundant in the fall of 1939, but practically disappeared in January of 1940.

2. This decimation was found to extend over most of the range of S. h. texianus, but apparently did not occur in the adjoining ~~ranges of other~~ subspecies.

3. Lack of food, low temperatures, a blanket of snow, and disease probably caused the decimation.

4. Timbered areas, both upland and low land, were not inhabited by cotton rats.

5. Three types of nests were found, nests above ground, in burrows, and under objects.

6. Many nest locations consisted of two nests. The lower nest appeared to have been built for winter occupation.

7. Terrace ridges were preferred nesting sites.

8. Nests located in field areas averaged 32 per acre. Nests located in roadside areas averaged 48 per acre.

9. Due to their abundance, cotton rats are probably of greater economic significance in the eastern and central part of the state.

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