LOW POPULATION DENSITY AND HABITAT PREFERENCE

OF SIGMODON

By

Daniel Anders Ring

Bachelor of Science

University of Nebraska

Lincoln, Nebraska

1965

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
MASTER OF SCIENCE
July, 1968

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Thesis Approved:

Thesis Adviser

Acting Thesis Adviser

Dean of the Graduate College

ACKNOWLEDGEMENTS

I would like to express my appreciation to Dr. Adolph M. Stebler, former leader of the Oklahoma Cooperative Wildlife Research Unit, who served as my major advisor, who guided this study giving his helpful advice and criticism and who made the unit materials available for this research; to Dr. Roy W. Jones who became my acting adviser in the absence of Dr. Stebler; to Dr. Robert I. Smith who offered his advice and criticism of the thesis; to Dr. Jerry J. Crockett who assisted in plant identification and vegetation sampling techniques; to Dr. Raymond D. Eikenbary who read the thesis and to Dr. H. I. Featherly who assisted in plant identification.

In addition, I would like to thank Bonnie Long for typing the final copy of the manuscript.

Finally, I would like to express appreciation to my wife, Joyce, whose understanding, encouragement and hard work has made this thesis possible.

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CHAPTER I

INTRODUCTION

Animal populations are known to fluctuate through time. As the number of animals in a population increases, the individuals live closer to one another, or they must move to new areas, or both may occur. As the number of animals in a population decreases, does the pattern of distribution change? Do they still cover the same areas which they used during high population, but with a greater spacing between individuals; or do they react to a lower population level by localizing in certain areas, being plentiful in these restricted areas? Therefore the question, what is the habitat in which individuals live during low population density?

The animal studied was the cotton rat, Sigmodon hispidus, which here is referred to simply as sigmodon. Sigmodon is an irruptive animal as noted by Davis (1958), Haines (1963) and Schendel (1940). Goertz (1964) studied sigmodon in an area during a period of high population density, and Green (1964) in the same area, during the period immediately following a population crash. From their data and from personal communication (Stebler, 1966), it was apparent that a low population density had existed for about one year before this study of habitat commenced. What habitat type did the sigmodon prefer after at least one year of low population density? During this period the sigmodon should have had sufficient time to become established in a preferred type because of a lack of population pressure dispersing individuals. A clumped distribution of animals in habitat with similar characteristics suggests that sigmodon are in preferred habitat.

The specific objectives were to: (1) locate population reservoirs, (2) identify the habitat types occupied by the reservoir population, and (3) determine the sex and age ratios of these remnant populations.

The field work upon which this study is based was carried out in western Payne County, Oklahoma, from April to October, 1966.

CHAPTER II

METHODS

Two study areas were used, each serving in part, a different function. One study area, called "the grid", was used to obtain measures of population density, and sex and age ratios. The other study area, a composite of transects, was used to obtain habitat preference information.

The grid is a 20-acre plot located 12 miles west and 3 miles north of Stillwater, Payne County, Oklahoma. This area had been used in previous studies (Goertz, 1962, and Green, 1964), which provided records for comparisons of population density. The primary vegetation on the grid included these species: little bluestem (*Andropogon scoparius*), switchgrass (*Panicum virgatum*), Indiangrass (*Sorghastrum nutans*), and Johnsongrass (*Sorghum halepens*), with interspersed American elm (*Ulmus americana*), and western hackberry (*Celtis occidentalis*). In a draw across one end of the grid, smooth sumac (*Rhus glabra*), American elm, and western hackberry were the principal species.

The study area used principally to obtain habitat preference information and secondarily sex and age ratios is located south of Lake Carl Blackwell, 8 miles west of Stillwater. This area which will be referred to as "the transects," was divided into 31 different transects sampling different habitat types. After a survey of the area, the following habitat types and the approximate number of transects in each type were established:

Grass-plum thicket	4
Grass-buckbrush thicket	3
Grass-sumac	6
Grass-pine	3
Grass-post oak-blackjack oak	2
Grass only	13

Each transect frequently traversed more than one habitat type. Post oak and blackjack oak forests were only lightly sampled, even though they made up at least one-half of the study area. Previous investigators had pointed out that sigmodon preferred unforested areas (Blair, 1938; Erickson, 1949; Goertz, 1962; Hays, 1958).

The grid was live-trapped for a period of 5 days near the first of each month from April, 1966, through September, 1966. The sigmodon were toe-clipped, weighed, checked for sex and released. The population size was calculated by using the simple capture-recapture method of Bailey (1951); $X = \frac{a(N+1)}{r+1}$ where X is the population size, a is the total number of marked individuals in the population, N is the number trapped on a given day, and r is the number of marked individuals trapped on the same day as N. The variance, the standard error and the coefficient of variation were computed for each month, again using Bailey's (1951) method. By using this method a comparison of present population density estimates with previous high and low population density estimates was obtained.

Each transect was snap-trapped for a period of 3 days each month, April, 1966, through September, 1966, except for a period from April 20 to May 13, when live-traps were used to collect sigmodon for another research project. Each transect was 300 feet long and was the route of 25 evenly spaced snap-traps arranged linearly. Each sigmodon was weighed and the sex was determined. The vegetation was analyzed by the following method at each trap site where a sigmodon was trapped.

1. Height was measured in centimeters at the foliar crown.
2. Grass density was determined by the line interception method of Canfield (1941) using a 1-meter transect.
3. Forb density was determined by counting all stalks in a 25-centimeter belt transect, 1-meter long.
4. Shrubs, vines, and trees were counted from meter-square plots on either side of the meter stick.
5. Density of the cover for each plant species was estimated.
6. In August and September ground litter was measured for minimum and maximum depth.

All vegetational analysis were made with concern for a description of the actual sigmodon habitat.

Retrapping every transect each month showed movements of the individuals in the population. Two different types of observation indicated these. One was when one or two sigmodon were trapped on a transect one month and not during preceeding or following months. The other was when sigmodon were trapped for several successive months following a period when none were trapped on that transect. It was assumed that sigmodon removed by snap-trapping would be replaced, provided that the area furnished a favorable habitat. For this to occur the snap-trapping must not remove all individuals in the population and the population must be large enough to have other individuals in "less desirable" habitat who would move in to fill a vacant area. This movement is possible because of the size of the home range of sigmodon, about one acre (Odum, 1955), and the tendency for individuals to wander.

CHAPTER III

RESULTS

Population Size

The monthly grid population estimates show that the sigmodon population increased from a low of 5 in May to a high of 151 in August, then declined to 136 in September as shown in Table I. In April and May so few sigmodon were trapped that an estimation of the numbers by using Bailey's (1951) method was not feasible. The decline in numbers from April to May was, at least in part, due to the death in the traps of 4 of the 10 sigmodon trapped.

TABLE I

MONTHLY GRID POPULATION ESTIMATES

Month	Number Trapped	Population Estimation
April	10	10
May	5	5
June	24	34
July	51	68
August	139	151
September	124	136

The number trapped along the transects fluctuated, but these data were not suited to an estimation of the population. The actual number of sigmodon trapped each month, however, is given in Table II.

TABLE II

NUMBER OF SIGMODON TRAPPED EACH MONTH ON THE TRANSECTS

Month	Number
April	51
May	42
June	34
July	56
August	56
September	76

Sex Ratio

The sex ratios of sigmodon on the grid varied considerably from month to month and is shown in Table III. The difference in the sex ratio from April to May, may have been due to the deaths of 4 sigmodon, of which 3 were males.

The sex ratios on the transects are shown in Table IV. The male sigmodon outnumbered the females on the transects, while the female sigmodon outnumbered the males on the grid. The sigmodon with unknown sex had been partly eaten rendering them useless for sex determination.

TABLE III

MONTHLY SEX RATIO FROM THE GRID

Month	Male Number Trapped	Male Percentage	Female Number Trapped	Female Percentage
April	6	60%	4	40%
May	2	40%	3	60%
June	16	67%	8	33%
July	22	43%	29	57%
August	64	46%	75	54%
September	58	47%	66	53%

TABLE IV

MONTHLY SEX RATIOS FROM THE TRANSECTS

Month	Male Number Trapped	Male Percentage	Female Number Trapped	Female Percentage	Unknown Sex
April	31	66%	16	34%	4
May	20	48%	22	52%	0
June	23	68%	11	32%	0
July	30	61%	19	39%	7
August	34	68%	20	37%	2
September	49	65%	26	35%	1

Age Ratio

The monthly age ratios from the grid are shown in Table V. Immature animals were considered as any under 60 grams (Odum, 1955). As the number of immatures in the population increased, the total number of sigmodon increased.

TABLE V

MONTHLY AGE RATIOS FROM THE GRID

Month	Immature		Mature	
	Number Trapped	Percentage	Number Trapped	Percentage
April	3	30%	7	70%
May	0	00%	5	100%
June	2	8%	22	92%
July	10	20%	41	80%
August	55	40%	84	60%
September	32	26%	92	74%

The monthly age ratios from the transects are shown in Table VI.

TABLE VI

MONTHLY AGE RATIOS FROM THE TRANSECTS

Month	Immature		Mature		
	Number Trapped	Percentage	Number Trapped	Percentage	Unknown Age
April	1	2%	45	98%	5
May	6	14%	36	86%	0
June	5	20%	20	80%	9
July	15	27%	41	73%	0
August	4	7%	52	93%	0
September	8	11%	67	89%	1

The number of sigmodon trapped on each transect is shown in Table VII. It is noted that certain transects consistently yielded more sigmodon each month than did other transects. During 6 months of trapping, or 13,950 trap nights, 315 sigmodon were trapped. Of these, 204 were trapped on 9 of the transects which were considered as preferred sigmodon habitat. Consistent trap success made these transects appear to have some desirable features to the sigmodon. Table VIII gives a description of these 9 transects.

In the Lake Carl Blackwell area, i.e., on the transects, sigmodon were found in vegetation of various heights. The trend though was toward their living in vegetation which provided a good over head cover by being at least 20 cm. tall and usually with a density of cover over 50 per cent. This agrees favorably with the findings of Goertz (1962) who found few sigmodon at trap sites with a cover density of less than 40 to 60 per cent and with a cover height of less than 10-20 cm. Figure 1 shows, by month, the number of sigmodon trapped at each density and height class of vegetation.

During August and September, the depth of the litter was measured where each sigmodon was trapped. In August, 4%, and in September, 7%, of the sigmodon were trapped where there was no litter. The maximum litter depth was at one trap site where the litter was 20 cm. deep. In this case the principal plant species were big bluestem (<u>Andropogon gerardi</u>) and switch grass (<u>Panicum virgatum</u>). The vegetational growth was very dense and the litter was not tightly compressed. Another area which had 16 cm. of litter had Indian grass (<u>Sorghastrum nutans</u>), little bluestem (<u>Andropogon scoparius</u>) and a canopy of winged sumac (<u>Rhus copallina</u>). Aside from these and a few other instances where it was not compacted, the litter was from 0 to 4 cm. deep. The maximum and minimum litter depths around the traps is shown in Figure 2.

TABLE VII

THE NUMBER OF SIGMODON TRAPPED EACH MONTH ON EACH TRANSECT.

Transect Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Monthly Totals
April	0	5	0	0	2	1	0	0	0	1	0	3	0	0	2	0	1	1	7	2	4	2	2	3	1	3	0	2	2	7	0	51
May	1	8	0	0	0	0	0	2	0	3	0	2	1	5	1	0	0	0	3	2	2	1	1	2	0	3	0	2	0	3	0	42
June	1	4	0	0	0	0	0	0	0	7	0	1	0	0	1	0	0	1	1	3	3	1	2	0	4	3	0	0	1	1	0	34
July	1	9	5	0	0	3	0	1	0	9	0	1	1	0	0	0	0	0	5	4	3	3	2	2	1	2	1	2	0	1	0	56
August	0	2	5	0	1	0	1	0	0	4	2	0	2	1	0	0	0	5	4	4	6	6	2	4	3	2	0	1	0	1	0	56
September	1	10	7	0	0	0	0	0	0	6	0	2	1	8	0	0	0	2	10	3	5	8	4	1	1	2	0	0	2	3	0	76
Transect Total	4	38	17	0	3	4	1	3	0	30	2	9	5	14	4	0	1	9	30	18	23	21	13	12	10	15	1	7	5	16	0	315

TABLE VIII

FEATURES OF NINE TRANSECTS WHICH WERE CONSIDERED GOOD HABITAT

Transect Number	Habitat Type	Average Cover Density	Average Height	Physiographic Aspects
2	grass-plum thicket	72.6%	71.0cm.	North slope. Followed two old terraces. 100 yds. to water.
10	Grass-forb	77.5%	62.8cm.	Slight north slope. Crossed moist gully. Numerous trees and shrubs close. 50 yds. to water.
19	grass-forb	78.5%	77.8cm.	North slope. Just below high water line of several years age. Tall grass, forbs and trees near. 100 yds. to water.
20	grass-plum thicket	77.5%	56.6cm.	North slope. Crossed one old terrace. 200 yds. to water.
21	grass	79.3%	57.5cm.	North slope. Followed moist swale. Good shrub growth at each end.
22	grass-pine	77.3%	53.2cm.	North slope slight. Numerous 6 in. deep furrows forming runways.
23	grass-pine	83.0%	49.5cm.	Slight north slope. Numerous 6 in. deep furrows forming runways.
26	grass-sumac thicket	89.0%	52.2cm.	East slope. Crossed terraces. Tall grass.
30	grass-forb	67.5%	61.3cm.	West slope. Rocky soil. 20-30 yds. to water.

Total Density of Cover in Per Cent

Height of Principle Cover in cm.

	0	10	20	30	40	50	60	70	80	90	100
0-19								1	2	1	
20-39							1	6	6	5	
40-59							3	2	4	2	
60-79								1	1		2
80-99								2		2	2
100-119								2			
120-139								2			
140-159										1	
160-179											1
180-199									1		

April

	0	10	20	30	40	50	60	70	80	90	100
0-19											
20-39					1	1		3	6	2	
40-59								3	1	4	
60-79										1	
80-99					1		2				1
100-119						1	2		1		
120-139				1				1			3
140-159						1		3	2		
160-179											
180-199									1		

May

	0	10	20	30	40	50	60	70	80	90	100
0-19											
20-39					1	2	1	3			
40-59				1		3	5	2		3	
60-79							1	1	1	2	
80-99							2	1	1		
100-119											
120-139									1		
140-159											
160-179											
180-199									1		

June

Figure 1. Each graph shows the total number of sigmodon trapped each month on the transects as well as the relation between animals trapped, cover height, and density in per cent.

Figure 1 (Continued)

Total Density of Cover in Per Cent

Height of Principle Cover in cm.	0	10	20	30	40	50	60	70	80	90	100
0-19								1			
20-39					1	3	4	2	3		
40-59					1	1	1	4	4	8	
60-79							2	3	8	7	1
80-99						1	2	2	1	1	
100-119								4	1	1	
120-139									1		
140-159									1	4	
160-179								1		1	
180-199							1		1		

July

Height of Principle Cover in cm.	0	10	20	30	40	50	60	70	80	90	100
0-19											
20-39					1		1	2	2	1	
40-59					1	1	3	3	6	8	2
60-79							2	1		2	3
80-99									2		
100-119								3	1	3	1
120-139									1	1	
140-159						1				1	
160-179											
180-199									1	1	

August

Height of Principle Cover in cm.	0	10	20	30	40	50	60	70	80	90	100
0-19											
20-39					2		2	6		5	
40-59						1	1	1	9	1	
60-79			1			1	1	3	3	4	1
80-99							1	2			1
100-119						1		3	1	1	
120-139										1	1
140-159											1
160-179											
180-199										1	

September

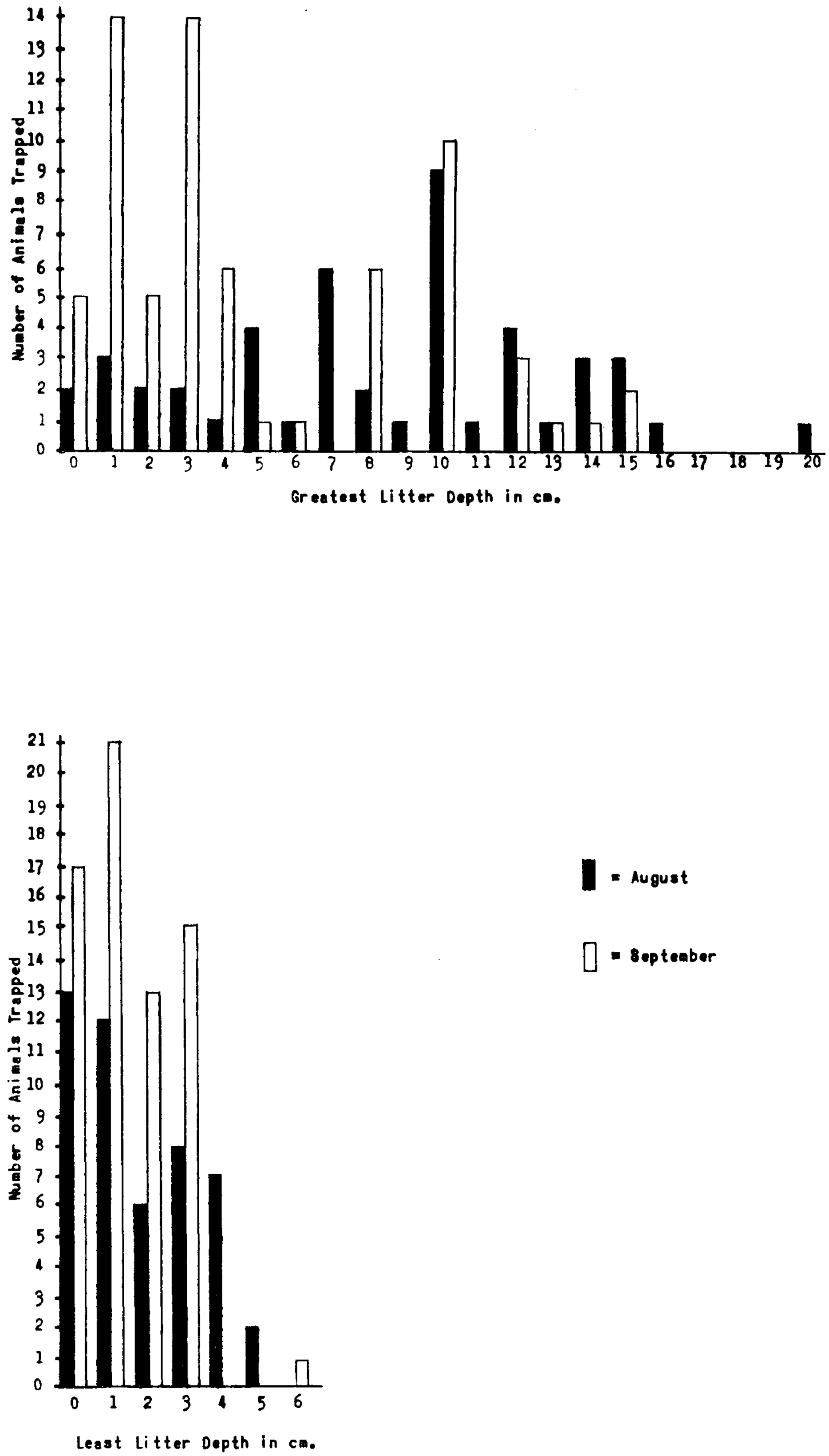

Figure 2. Litter Underfoot on Transects at Sites Where Sigmodon were Trapped

CHAPTER IV

DISCUSSION

Population Density

The sigmodon population on the 20-acre grid increased from a low of 5 in May to a high of 151 in August. Expressed as sigmodon-per-acre, the population density ranged from a low of 0.36 in May to a high of 10.8 in August. High population densities have been reported by Davis (1958) as several hundred sigmodon per acre in Texas, and by Green (1964) as 54 sigmodon per acre near Lake Carl Blackwell, Oklahoma. The population density estimates for the grid were helpful as a clue to the general regional population and as a base against which to compare the transect results.

Due to a continued low population during, and one year previous to the study, it was felt that the sigmodon should be located in their preferred habitat in the particular area under investigation and at that particular time. There should have been a minimum of population pressure dispersing the sigmodon to inferior or marginal habitat. Goertz (1962) found that population pressure became a factor causing sigmodon to move into what, under conditions of low population, would be considered inferior or marginal habitat, when there were 25 sigmodon or more per acre.

Sex Ratio

The sex ratio on the grid indicated that slightly more than 50% of the sigmodon were female except for April and June, when there were more males. This contrasts with the results from the transects, where there were more males than females in all months except May. The live-trapping on the grid should have had little effect on the sex ratio, while snap-trapping on the transects served to cause an imbalance favoring the males. The imbalance began after the first month of trapping. During subsequent months the individuals susceptible to trapping were either those which were not trapped the first month, those born in the monthly trapping interim or those which had immigrated. In sigmodon, males have a larger home range than females, (Blair, 1953), and they have a greater tendency to wander (Stickel and Stickel, 1949). This results in a differential probability of the sexes emigrating and as the sex ratios indicate, more males are trapped after the first month due probably to dispersal movement. This dispersal differential between the sexes makes the sex-ratio data obtained from the snap-trap catch in a single area over an extended time unreliable (Stickel, 1946; Townsend, 1935). That sigmodon move is demonstrated in Table VII, where it may be noted that occasionally 1 or 2 individuals were trapped on a transect one month, none being trapped there on the preceeding or following month. It was assumed that these sigmodon were transient and were only moving through the trap site when trapped. If this is true, repopulation of areas is realized from nearby existing populations (Stickel, 1946).

Age Ratio

The age ratio on the grid indicated a low reproductive rate for the sigmodon. The percentage of immatures ranged from 0 per cent to 40 per cent of the monthly total number trapped. Odum (1955) estimated that in high-density years, three fourths of the population would be immature and less than one half of the population would be immature in low density years. The sigmodon studied here were not reproducing at a rate which would indicate an increasing population. If their reproduction rate is habitat-quality dependent, then better habitat would allow for more reproduction and a higher population. Habitat is only one factor, though, which might affect the rate of increase in animals. Tanner (1966) concluded that in most animal species a population's growth rate is a decreasing function of density. DeLong (1967) found that in the feral house mice breeding populations were controlled by mortality and dispersal of juveniles and subadults increasingly as density increased.

Age ratios derived from sigmodon removed from an area over an extended period of time are not a reliable indication of the natural population in this instance, because of a larger proportion of males in the population due to immigration. More females in the population should allow for a larger number of progeny.

Habitat

Several authors have reported finding sigmodon in a variety of habitats. Dixon (1922) in Imperial Valley, California, found sigmodon living near the newly built canals. Svihla (1929) found the Louisiana sigmodon in "damp, marshy, habitat filling the place that Microtus does in the North". Burt (1933) found sigmodon commonly along Arizona irrigation ditches. Erickson (1949), in the Savannah River Refuge, Georgia, found sigmodon along dikes and island edges, preferring the edge between the marsh and upland. Davis (1958), in Texas, reported finding sigmodon inhabiting tall-grass areas where sedges and grasses offered both freedom of movement under a protective canopy and with an adequate food supply. Bradley (1966), in Nevada, reported sigmodon found in a marsh less than one acre in size with cattails, Bermuda grass and mesquite around the outer edges. In 1961 sigmodon were still present there, but now are absent due to dried up marshes resulting from the flood control exerted by Lake Powell downstream.

The following habitat types have been found to harbor sigmodon in Oklahoma. Phillips (1936) in central Oklahoma, found sigmodon restricted almost wholly to the abundant cover of undisturbed grassland. Large catches were made in areas of moist soil with heavy grasses. Blair (1938) reported few sigmodon in oak-elm associations, many in sedge-marsh associations, and moderate numbers in lowland thickets with some in sumac and plum thickets associated with various grasses. Schendel (1940) found sigmodon plentiful in ditches, terrace ridges and grasslands near Lake Carl Blackwell. Glass and Halloran (1961), in the Wichita Mountains, found sigmodon primarily in intermontane meadows. Hays (1958), in central Oklahoma, found sigmodon almost without exception in tall grass along fence rows and terraces. Goertz (1964), at Lake Carl Blackwell, found the most important component of the sigmodon habitat to be a moderate-to dense stand of mid-to-high perennial grasses.

Because the sigmodon population had been at a low level for about one year before the present study was initiated, it was assumed that the individuals may be persisting in preferred habitat. By snap-trapping in different habitat types, a comparison of the number of sigmodon trapped in these was possible. But more important, features in the habitat which were important to the sigmodon also were revealed.

The plant species, aside from their value as food, are seemingly only important in as much as their form offers certain qualities needed for survival. The quality studied here was the physical character of the vegetation which the sigmodon used. The plants must offer cover close overhead with a greater height above the dense cover being desirable. It must be of a density which conceals the individual. Sigmodon were rarely found where poor vegetational growth was present, or on bare ground. The areas which provided the best vegetational growth in the form of grasses, forbs, and small shrubs provided the favored sigmodon habitat. Due to long, dry periods during summer, the vegetational growth of really good quality was found in low areas near water and north slopes which were protected from the sun and wind. Sigmodon were found, therefore, in the comparatively lush vegetational growth areas which were usually associated with a relative abundance of moisture.

Because of their life-form, the grasses, primarily little bluestem (*Andropogon scoparius*), broomsedge bluestem (*Andropogon virginicus*), Indian grass (*Sorghastrum nutans*), switch grass (*Panicum virgatum*), and big bluestem (*Andropogon gerardi*) furnished adequate density and height to be preferred sigmodon habitat in moist areas. The most common grass found in habitat preferred by sigmodon was little bluestem, which is a bunch grass. The leaves stool-out to leave a small open area under the bowering canopy they form. This foliage character affords concealment, and is favored by sigmodon.

Forbs commonly present were western ragweed (Ambrosia psilostachya), Lousiana sagewort (Artemisia ludoviciana), daisy fleabane (Erigeron strigosus), and annual broomweed (Gutierrezia dracunculoides). Western ragweed and Lousiana sagewort were by far the most common forb species present. Forbs usually played a role secondary to grasses in the habitat in that they provided few plants and less canopy.

Shrubs encountered were buttonbush (Cephalanthus occidentalis), sand plum (Prunus angustifolia), smooth sumac (Rhus glabra), winged sumac (Rhus copallina), and coral berry (Symphoricarpos orbiculatus). Sand plum was the shrub which offered the most to sigmodon, seemingly because it formed a dense stand of stems with twigs from near the ground upward, with fairly good grass growth under the canopy. The other shrubs found in the area had a longer stem with few twigs or branches near the ground except for the coral berry which was usually thick enough to crowd out the grass.

A few traps were set in the post oak (Quercus stellata) and blackjack oak (Quercus marilandica) forests, but no sigmodon were trapped there. This result was expected due to former findings by Goertz (1964) and Blair (1938) which showed that sigmodon were rarely found in wooded areas.

That sigmodon needs to have its environment close to it was expressed by Hepworth (1966) who found that animals of this species were under greater stress away from cover or when trapped in large live-traps than when under cover or when trapped in small live-traps. This explains in part why sigmodon are not found in forested areas or where the vegetational growth is sparse, but are found where stands of dense grass provide a close over head canopy.

As noted previously most of the sigmodon were trapped in areas where cover density was 50% or more and height was 20 cm. or more. Usually associated with this height and density of cover is a litter cover on the ground.

During periods of low population density, sigmodon persist in a rather clumped distribution, which is directly associated with vegetational growth. The more dense and taller grasses provide a sanctuary for the animals during low population periods. Individuals presumably move out from these areas and repopulate other locations as the population density increases.

CHAPTER V

SUMMARY AND CONCLUSIONS

The objective of this investigation was to ascertain the habitat preference of the cotton rat, *Sigmodon hispidus*, under low population conditions. Data were collected in the following manner: by analyzing the vegetation at sites where sigmodon were trapped along transects; and by live-trapping, marking and releasing sigmodon on a grid.

Population density, sex ratio, age ratio and habitat selected by the sigmodon were considered.

Field work was conducted between April 1, 1966 and September 30, 1966, near Lake Carl Blackwell, Payne County, Oklahoma.

The population density on the grid ranged from 0.36 sigmodon per acre in May to 10.8 sigmodon per acre in August. This was considered a low population.

The sex ratio on the grid was slightly over 50% females and slightly less than 50% males during most months. The sex ratio on the transects was about 40% females and about 60% males. This indicated the inaccuracy of sex ratio estimates where the animals are being removed (the transects) and that the male is the first to move into new areas. The male is known to have a larger home range.

The age ratio on both the grid and transects indicated a low population density and a low rate of reproduction during the period of this study.

The habitat in which sigmodon was found was one in which the vegetation furnished it with a close, confining physical structure. The vegetational growth was of a height to provide over head cover and the density was such as to close in around the sigmodon. Sigmodon were found living in a habitat which concealed their activities.

Because of specific habitat requirements sigmodon were found to have a clumped distribution during low population periods. This is associated with vegetational growth which is controlled by weather, soil and topography.

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VITA

Daniel Anders Ring

Candidate for the Degree of

Master of Science

Thesis: LOW POPULATION DENSITY AND HABITAT PREFERENCE OF SIGMODON

Major Field: Zoology

Biographical:

Personal Data: Born in Peoria, Illinois, July 11, 1943, the son of Mr. and Mrs. Phillip N. Ring.

Education: Graduated from Wakefield High School, Wakefield, Nebraska in May, 1961; attended Luther Junior College, Wahoo, Nebraska 1961-1962; received the Bachelor of Science degree from the University of Nebraska in 1965 with a major in Zoology; completed requirements for Master of Science degree in July, 1968.

Professional Experience: Graduate Teaching Assistant, Oklahoma State University, 1966-1968; Summer Research Assistant, Oklahoma State University, 1968.

Professional Organizations: Member of the American Society of Mammalogists, Phi Sigma.