KANSAS SMALL MAMMAL CENSUS: A FIVE YEAR STUDY, WITH ATTEMPTS TO DETERMINE FACTORS IN POPULATION FLUCTUATIONS

by

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B. S., Central Missouri State College, 1953

A THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Zoology

KANSAS STATE COLLEGE
OF AGRICULTURE AND APPLIED SCIENCE

1956

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INTRODUCTION

Fluctuations of small mammal populations has received considerable attention, particularly in North America, England, the Scandanavian countries, and Germany. The early work on population mechanics was throughly reviewed by Elton (1927). He showed that in most mammal, and bird, populations there was a fairly regular cyclic increase and decrease in animal numbers. The population built up over a number of years then was reduced drastically in a short period of time after a peak population had been reached. Elton tried to explain the decrease by predator-parasite relationships, considering that a high population would be reduced when the predators became too numerous, or helminth, protozoan, or bacterial parasites reached epidemic proportions. Recovery, then, was possible only after the predator-parasite combination responsible for the decrease had been reduced enough to permit another build-up in numbers.

Failure of other workers to establish definite predator, or parasite, causes of population reduction, in specific cases, led to detailed re-examination of Elton's explanation of population mechanics.

Cole (1954) proposed an explanation by using pure statistics. By drawing random numbers from a table he produced curves that resembled the population fluctuations of certain species. From this he concluded that with completely random fluctuations, and completely adequate data of the population, the basic cycle would be three years in length.

Rowan (1954) suggests that the cycles are due to environmental factors to which some species are susceptible, and others are immune. He points out that animals of the same species may or may not cycle in different parts of the northern hemisphere. He points out, also that not all animals have

cycles, which they should have if randomness is the controlling factor.

Errington (1954) cited examples of synchronous decreases and increases in populations of hares and grouse of northern Minnesota and Wisconsin, and the decreases or increases in litter sizes of central Iowa muskrats. He postulated that environmental or climatic changes could not explain these wide spread fluctuations. He could not show what the controlling phenomenon was, but postulated that it must be something affecting life processes of many species on at least a regional scale.

Selye's "General Adaptation Syndrone" (1946) has been used as the basis for research by two workers. Christian (1956) working with a population of wild Mus musculus, under controlled conditions, found that high populations caused stresses producing an increase of ACTH, which led to delayed onset of puberty, decreased the litter size and increased infant mortality through lactation failure of the mother. All of these factors tended to reduce the total population over a period of time. Frank (1953) reported his experiments on work with a high population of Microtus arvalis in its native habitat. He concluded that the conditions concomitant with a large population set up stresses which kept the adrenalin at a high level over a long period of time. This eventually resulted in a depletion of glycogen supply, and finally death of the mammal due to hypoglycemia. This type of reaction was proposed as an explanation for the "crashes" of peak populations.

Regardless of the direct effect of ACTH and the stress mechanism on population reductions, supplementary or even independent effects of bacterial or virus epidemics cannot be ignored.

The role of paratyphoids and their possible effects on population fluctuations has been studied by several workers. Dalmat (1944) reported

Salmonella typhosa from 19 Deer Mice caught in central Iowa. Myer and Matsumura (1927) isolated 58 cultures of Salmonella from 775 wild rats in San Francisco. Other references to Salmonella derby in a fawn (Gauger and Gordon, 1944), and S. typhimurium in 400 out of 500 baby wood ducks (Levine and Graham, 1942), indicate that the possibilities for infection may be greater than realized, and Salmonella may at times be the causal agent for extensive population reductions.

Tularemia has also been studied as a possible cause of population reduction by various workers. Burroughs, et. al. (1945) determined aerogenic transmission of a latent strain of Pasteurella tularense. Berry (1928) found several dead and dying field mice in California, and the results of two cultures were positive for P. tularense. Jellison, et. al. (1942) studied an epizootic of tularemia in beaver, and the subsequent contamination of stream water with P. tularense. Philip, et. al. (1955) isolated tularemia organisms from three of 14 lots of ticks removed from jack rabbits, and Moillet (1936) observed that the wood tick that could transmit tularemia fed on the blood of rodents and game birds. At the present time, more work has probably been done to prove, or disprove, this factor than any other, but there is no conclusive evidence that tularemia has more than local effect on mammal populations.

Population densities of small mammals must be determined by some trapping method, because of the impossibility of direct counting. The quadrat method of arranging snap traps has been described by several workers (Aldrich, 1943; Stickel, 1946; Williams, 1936). This method can be used to determine the number of mammals per acre as a population index. Stickel indicated that two sources of error could influence the derived population

number in an upward fashion. (1) The overlap of ranges on the margin of the quadrat would increase the number actually living in the circumscribed area. A buffer line of traps around the quadrat would help to keep down infiltration into the test area. (2) The invasion into the vacuum left by the removal of the past residents would also increase the catch. Live trapping with, marking and release of captured animals, has been used by many workers to offset this error (Dice, 1938; Stickel, 1946; Cockrum, 1947), but is not applicable in large scale census work because of the technical problems involved with the traps, and the difficulties encountered in keeping the mammals alive in the traps. The simplest, and hence, the most commonly used method of small mammal trapping, consists of setting snap traps across the field to be studied, either in a straight line, or in clusters of two or three, with the stations far enough apart that they do not seriously affect the neighboring station. From a snap-trap line, comparative numbers can be established, but these numbers cannot be converted to actual population numbers without direct comparison with a trapped grid, or with results from a live-trap line.

If the data are to be gathered from several places by independent workers, a consistancy in the trapping methods, or a system of reducing the data to comparable units is mandatory. To establish a common basis for comparing data, Grinnel (1914) multiplied the number of traps set by the number of nights that the traps functioned and divided by the number of mammals caught establishing a ratio of animals per trap night. If the traps are left in an area for too long a period, or if a study of life span and habits is wanted, this method leaves much to be desired. It is now considered that the first two or three nights trapping normally removes the mammals ranging in that

area, and subsequent catches are largely a result of infiltration from adjacent areas.

In an effort to establish more factual data on extensive mammal populations, a North American Small Mammal Census was set up by John Calhoun, sponsored by John Hopkins University in 1948. With a period of relative inactivity from 1951 through 1955, this census is still functioning with approximately 200 stations over the United States and Canada.

The Kansas Small Mammal Census was organized independently in 1949 to study fluctuations in populations, using relative numbers, and possibly to determine factors involved. A modification of Calhoun's plan was adopted. Calhoun's plan for the North American Census of Small Mammals involved construction of a trapline of 20 stations in a straight line, three traps at each station, each station separated by 25 foot intervals, and all stations trapped for three consecutive days at each sampling period. The Kansas Small Mammal Census was set up on the basis of 30 stations in a line with the stations separated by 40-50 feet. Each station consisted of three traps in a triangle, with no trap more than five feet from the center, placed in a position most likely to catch a specimen. Regularly two mouse traps and one museum special were used at each station. Traps were baited with a mixture of peanut butter and rolled oats, with a small amount of DDT added if ants or other insects were bothersome. All cooperators were instructed to select areas representing typical native grass situations. The cooperators agreed to set their trap line in March or April, and again in October or November, and to maintain the line for three nights at each census run. The modifications were deemed necessary for two reasons. In a typical prairie situation the distance of 25 feet between stations is too close, allowing overlap of

two or more stations within any one home range, and the larger number of stations increases the validity of the data.

The trapping program was initiated in 1950, sponsored by the Kansas Agriculture Experiment Station. The original cooperators were: H. T. Gier, Manhattan, Riley Co.; Beta Beta Beta fraternity sponsored by Ted Andrews at Kansas State Teachers College, Emporia, Lyon Co.; Theodore M. Sperry, Pittsburg, Crawford Co.; Harold D. Swanson, Wichita, Sedgwick Co.; and G. W. Tomanek, Hays, Ellis Co. Plate I shows the counties that have had a station, with dates of opening of the station, and closure date, if the station is not now operating. The following cooperators have been added to the census work since the program was initiated: Harry Duncan, Concordia, Cloud Co.; Rev. Eugene Dehner, Atchison, Atchison Co.; James Maupin, Wellington, Sumner Co.; Virgil Boatwright operated the station at Smith Center, in Smith Co., from 1952 to 1954, and then started a station with Dwight Spencer at Merriam in Johnson Co.; Ron Clothier established the Salina station in Saline Co. in 1953, which William Houston took over in 1955; G. W. Tomanek started the station at Hays in Ellis Co., then Edwin Martin took charge in 1951; Bill Porter started the Garden City station in Finney Co. in 1951, Mickey Penny took it over in 1953, and then Donald Penny took charge in 1955; Dolf Jennings started a station at Burlingame, Osage Co. in 1951, then opened a station at Oberlin, Decatur Co. in 1954.

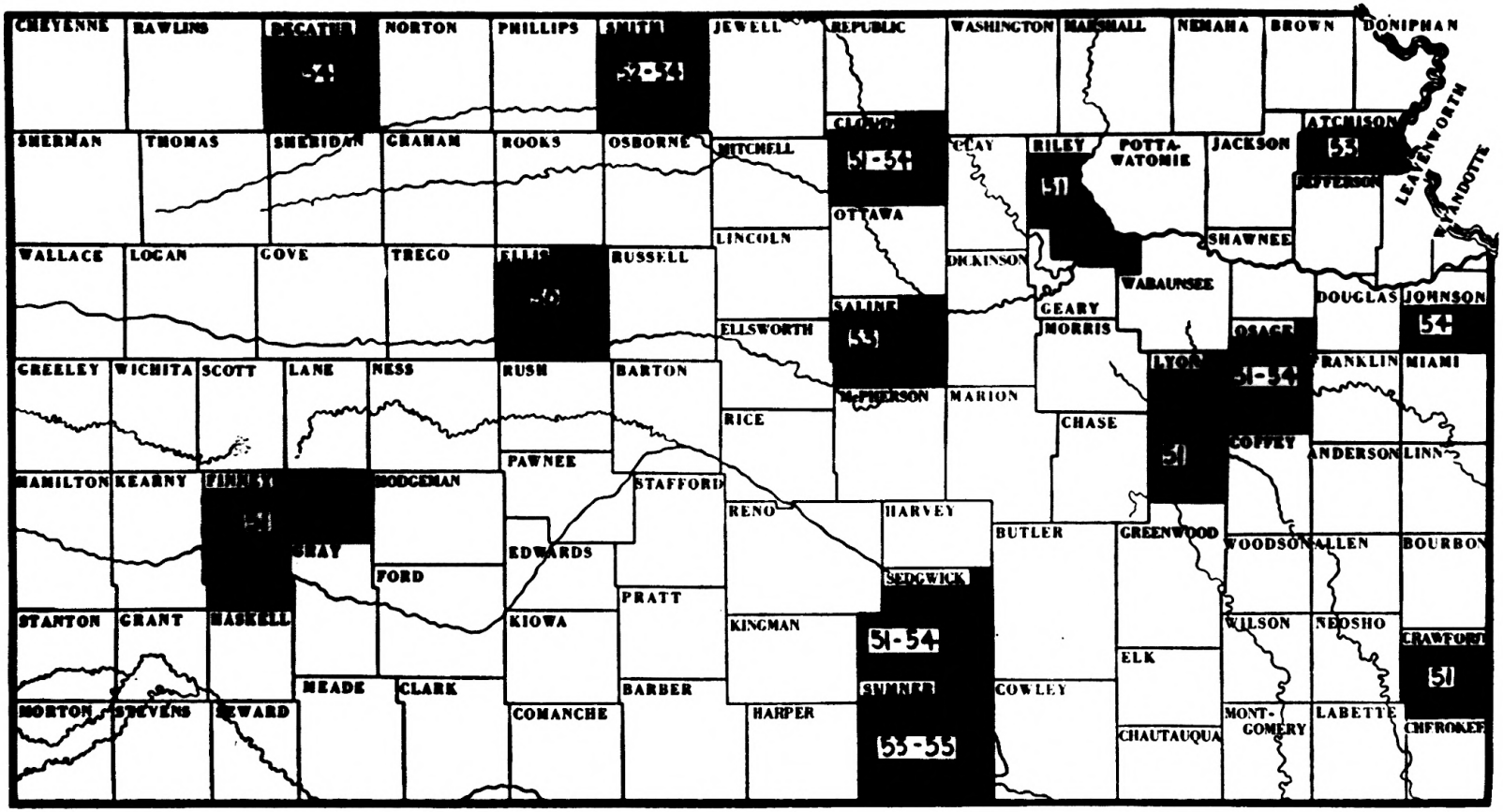
The cooperators have been college professors, high school teachers and interested individuals, most of whom have had special training in mammalogy or ecology or both.

The Kansas Agriculture Experiment Station, through H. T. Gier, provided each cooperator with the necessary traps, data sheets (Form 1.) and informa-

EXPLANATION OF PLATE I

The counties that have had a trapping station located within them, are shown in black. The numbers indicate the year that the trapping station was established, and the closure dates are given if the station is not now operating.

PLATE I


CHEYENNE
RAWLINS
DECATUR
NORTON
PHILLIPS
SMITH
JEWELL
REPUBLIC
WASHINGTON
MARSHALL
NEMAHA
BROWN
DONIPHAN
ATCHISON
LEAVENWORTH
WYANDOTTE
JEFFERSON
SHERMAN
THOMAS
SHERIDAN
GRAHAM
ROOKS
OSBORNE
MITCHELL
CLOUD
CLAY
RILEY
POTTA-WATOMIE
JACKSON
OTTAWA
LINCOLN
DICKINSON
SHAWNEE
WABAUNSEE
WALLACE
LOGAN
GOVE
TREGO
ELLIS
RUSSELL
SALINE
GEARY
DOUGLAS
JOHNSON
ELLSWORTH
MORRIS
OSAGE
GREELEY
WICHITA
SCOTT
LANE
NESS
RUSH
BARTON
LYON
FRANKLIN
MIAMI
MCPHERSON
MARION
CHASE
RICE
COFFEY
ANDERSON
LINN
HAMILTON
KEARNY
FINNEY
HODGEMAN
PAWNEE
STAFFORD
RENO
HARVEY
BUTLER
GREENWOOD
WOODSON
ALLEN
BOURBON
GRAY
EDWARDS
FORD
SEDGWICK
PRATT
STANTON
GRANT
HASKELL
KIOWA
KINGMAN
WILSON
NEOSHO
CRAWFORD
ELK
MEADE
CLARK
BARBER
COWLEY
MORTON
STEVENS
SEWARD
COMANCHE
HARPER
CHAUTAUQUA
MONT-GOMERY
LABETTE
CHEROKEE

tion as needed. The cooperators returned the tabulations after each census run, and in many cases sent the entire catch to Kansas State College for identification check and study. Numerous supplementary traplines were run, particularly at Emporia, Hays, Manhattan, and Pittsburg, to provide additional or supporting data to the regular census runs, and that data was made available to the coordinator.

The taxonomy and identification of subspecies has been according to Hall's Handbook of Mammals of Kansas.

CENSUS AREA DESCRIPTIONS

Atchison County

The trapping area operated by Rev. Eugene Dehner is located four miles south of Atchison, immediately west of highway 73. It is on a north slope of Walnut Creek Valley designated as Corpstein's Prairie. The line is in the shape of a "U" with the open end pointing up hill to the north. The area is bounded on the north by an oak woods, on the east by a corn field, on the south by a stand of elms, and on the west edge by a continuing tall grass area.

Native prairie grass with well interspersed New Jersey tea, prairie willow and a small amount of Baptisia sp. was the predominating cover for trapline. It had not been mowed during the prededing year, nor did it appear to have been burned for several years.

Reithrodontomys was caught in the tall grass area near the end of the line both seasons. The numbers caught in the fall of 1953 show a decrease of over one half, and are a deviation from the expected increase. As can be seen in Table 1. a similar decline occurred in other species. Peromyscus leucopus,

however, was caught for the first time in this reduced catch. Microtus was caught everywhere that sufficient cover prevailed during the fall trapping, but not at all in the spring.

Table 1. Trapping and weather data during the census runs at Atchison.[1]

	Apr 1953			Nov 1953		
Dates	10	11	12	26	27	28
Max temp[2]	53	45	48	55	54	51
Min temp[3]	33	36	31	26	26	23
Precipitation			.37			
P. maniculatus[4]	2				1	
P. leucopus[5]				2	1	
Microtus	2	2	1			
Reithrodontomys	8	7	9	3	5	2
Blarina			1			
Daily totals	12	9	11	5	7	2

1. Weather data taken from Climatological Data for Kansas, published by the U.S. Department of Commerce, Asheville, N.C.
2. Designates daily maximum temperatures, and abbreviation will be used throughout all tables.
3. Designates daily minimum temperatures, and abbreviation will be used throughout all tables.
4. Abbreviated form of Peromyscus maniculatus will be used throughout all tables.
5. Abbreviated form of Peromyscus leucopus will be used throughout all tables.

Osage County

Dolf Jennings trapped different areas for each of the two census runs. The first area, trapped in April 1951, was located three miles northwest of Burlingame, Kansas. The trapping site was a level bottomland pasture, adjoining a bluestem pasture, bordered on the east and south by a creek. The area had been pastured, and had only a sparse to moderate cover of brome and alfalfa. Results of the trapping are given in Table 2. A similar auxiliary trapline was set 50 yards west one week later, resulting in a catch of 16 Reithrodontomys and seven Peromyscus. A third trapline set in a similar situation caught 12 Peromyscus maniculatus and one Reithrodontomys.

The second area, used in April 1952 was 1 1/2 miles northwest of Quenemo, Kansas, on the south side of a public road. The first four traps were in a bluestem meadow, and the next seven traps were in heavy slough grass. The last traps were set in an overgrazed, brushy pasture containing some bluestem, sumac, dogwood, and scattered trees. Peromyscus maniculatus was caught in the bluestem meadow. P. leucopus was caught throughout the length of the line, Microtus in the pasture, and Sigmodon in the slough grass. See Table 2 for detailed trapping information.

Table 2. Trapping and weather data during the census runs at Burlingame.[1]

	Apr 1951			Apr 1952		
Dates	4	5	6	5	6	7
Max temp	66	58	51	52	56	73
Min temp	31	43	45	27	25	33
Precipitation		.21	.50	T		
P. maniculatus	3	4		1		
P. leucopus				4	3	3
Microtus		2	3	1		1
Sigmodon	1	1				1
Reithrodontomys	5		3	2		2
Daily totals	9	7	6	8	3	7

1. The nearest weather station to Burlingame was Osage City, Kansas.

Cloud County

The area trapped by Harry Duncan is 6 3/4 miles west of Concordia on highway 9. The cover is predominately sideoats grama and big bluestem. The line was laid in a southwest to northeast direction, and ended at a grove of Russian olive trees. Approximately 100 feet east and slightly downhill from the last 12 stations is a small farm pond. During the first part of December 1954, the area was accidentally burned off, and in the following spring 45-50 head of cattle grazed on the area. This drastic reduction of cover and disturbance of habitat probably accounted for the low catch in April 1955.

The large catch, shown in Table 3., on the third trapping day in 1951 might be accounted for by the "mild, warm, ideal" weather as described by the cooperator. The preceeding day had a maximum temperature of 63°F., and the night minimum was 51°F.

Table 3. Trapping and weather data for the census runs at Concordia.

	Dec 1951			Mar 1952			Dec 1952			Apr 1953		
Dates	1	2	3	27	28	29	11	12	13	10	11	12
Max temp	52	63	57	55	67	72	50	40	29	49	41	48
Min temp	35	51	36	28	37	45	32	26	18	32	35	30
Precipitation											.11	
P. Maniculatus	6	3	10							3	1	2
P. leucopus												
Reithrodontomys												
Microtus			4		3	2						
Blarina		1										
Daily totals	6	4	14		3	2	0	0	0	3	1	2

Table 3. (Concl'd)

	Nov 1953			Apr 1954			Apr 1955		
Dates	28	29	30	17	18	19	15	16	17
Max temp	58	48	52	71	89	80	82	78	83
Min temp	33	35	32	37	45	47	45	55	51
Precipitation						T			
P. maniculatus	9	2		4	9	1	3	1	
P. leucopus									
Reithrodontomys				1		1			
Microtus						1			
Blarina									
Daily totals	9	2		5	9	3	3	1	

Lyon County

The Delta Kappa chapter of Beta Beta Beta fraternity of Kansas State Teachers College at Emporia, compiled complete data over the five years of census work which is tabulated in Table 4. All eleven trapping seasons were represented, and supporting data included in all cases.

The trapline was established in a north-south direction across a 60 acre

plot located 2.9 miles northwest of Emporia. The area is bounded on the east by the City of Emporia water filtration tanks, on the north by continuing prairie land, on the west by pasture that was formerly cultivated, and on the south by a portion of a city park. The immediate area contained no residences, and no cultivated land within 1/2 mile.

This site was a typical unbroken native bluestem area with few rocks or little subsoil showing. It had not been pastured or burned for several years. Predominately big and little bluestem grew on the hillsides with some sunflowers and rosinweeds present on the flat upland portion, while wild strawberries and sedges prevailed at the north end of the line. On the average station big bluestem and sedges formed the upper story, and bluegrass and little bluestem provided a dense ground cover. This site was totally undisturbed at any time, and the cover remained good for the whole period, except for some cactus appearing in open areas, as noted in April 1955.

The following quote from the Tri Beta report indicates that adverse weather does not always deter small mammal movements. The three day catch in March of 1951 was 48 mice and shrews, with each days catch increasing by one.

> The area showed signs of large rodent populations, as evidenced by numerous runways and holes. Fresh deposits of feces were apparent in many places. The first night that the traps were set, there was 0.58 inches of steady rain from midnight on, with a temperature of 37°F. The second day there was sleet covering the ground, with a temperature of 26°F. The third night, and following day there was snow covering the ground, with light snow falling. Temperatures ranged from 16-30°F.

Table 4. Trapping and weather data for Census runs at Emporia.

Dates	Mar 1951			Nov 1951			Mar 1952			Nov 1952		
	9	10	11	17	18	19	21	22	23	15	16	17
Max temp	32	44	43	34	42	53	51	33	37	76	78	73
Min temp	18	30	24	19	11	19	32	23	15	26	57	54
Precipitation		.58	.22				.12	.03				T
P. maniculatus	9	10	11	5	2	1			1	1	5	3
P. leucopus			1									
Reithrodontomys		2										
Microtus	4		3	3		3	8	3			1	
Sigmodon	1	4	1	9	2	4	1			3	1	1
Blarina	1			3	1	3	6	2				
Cryptotis			1					2				
Daily totals	15	16	17	20	5	11	15	7	1	4	7	4

Table 4. (Cont'd)

Dates	Mar 1953			Nov 1953			Apr 1954			Nov 1954		
	21	22	23	21	22	23	10	11	12	20	21	22
Max temp	78	59	63	41	50	60	72	66	69	62	59	69
Min temp	52	40	29	27	28	37	56	43	39	27	36	39
Precipitation			.07									
P. maniculatus	3			1			1	1				1
P. leucopus												
Reithrodontomys												
Microtus	1											
Sigmodon	1									1	1	
Blarina	3											
Cryptotis												3
Daily totals	8			1			1	1		1	1	4

Table 4. (Concl'd)

Dates	Apr 1955			Nov 1955			Apr 1956		
	16	17	18	19	20	21	21	22	23
Max temp	82	83	85	58	72	71	80	60	53
Min temp	56	54	64	56	54	64	46	35	32
Precipitation									
P. maniculatus			1	1		1			
P. leucopus									
Reithrodontomys						1			
Microtus									
Sigmodon				3	17	6	2	1	
Blarina									
Cryptotis		6			2	2			
Daily totals		6	1	4	19	10	2	1	

Finney County

The Garden City trapping site selected by Bill Porter is in a flood plain immediately south of the Arkansas River and west of highway 83. This area is in a state game preserve with the trapline running east-west between the river and a paralleling dirt road. Since 1951 several "junk piles" have accumulated in the area.

In 1951 scrub brush and sunflowers dominated the first 1/3 of the line, tumbleweed the middle 1/3, and buffalo grass the last part. Over the years the tumbleweed increased its area along the dirt road, but grasses and scrub brush still thrived near the river.

The trapline has always been placed in the same area, but not always in the same way. In November 1951 the line was straight, and paralleled the river and the road, in November 1951 it was layed down as a double arc (~), and in December 1955 the setting was essentially a circle. The changing of line configuration apparently did not change the population figures, however.

Peromyscus maniculatus and P. leucopus have been caught at all stations in the different lines. Reithrodontomys have been caught sparingly at stations all along the line. Three Sigmodon were caught in 1951, and one Onochomys was caught in 1955. Mus musculus is not tabulated, but have increased in numbers since the census began.

The tabulation of results are in Table 5.

Table 5. Trapping and weather data for census runs at Garden City.

Dates	Nov '51-Dec '51			Apr 1952			Nov 1952			April[1] 1953
	30	1	2	11	12	13	19	20	21	
Max temp	66	66	71	42	41	55	47	60	62	
Min temp	25	30	29	32	35	32	25	22	31	
Precipitation					.02	.10				
P. maniculatus	18	14	19	28	26	20	3	24	10	
P. leucopus	7	3	1	2	1	1	2	12	2	
Reithrodontomys				1	3	1			1	
Sigmodon		1	2							
Onochomys										
Daily totals	25	18	22	31	30	22	5	36	13	-31-

Table 5. (Concl'd)

	Nov 1953			Dec 1955			1956[2]		
	28	29	30	7	8	9			
Max temp	60	57	58	50	40	31			
Min temp	35	30	30	20	15	9			
Precipitation						T			
P. maniculatus	8	7	7	9	10	5	27	3	18
P. leucopus					1	1	9	4	6
Reithrodontomys	1		1			1		1	1
Sigmodon									
Onochomys				1					
Daily totals	9	7	8	10	11	7	36	8	25

1. Only the month and total catch was reported.
2. Only the daily catches were reported.

Ellis County

The Hays trapping site is in a relic area within the college pasture located 1 1/2 miles southwest of the city. The area has good cover that has not deteriorated, and is not pastured in some places at all.

The traps were set in a straight line running from west to east. The line ran down a southeast facing slope, through a draw, up a northwest facing slope, and then down a long gentle sough facing slope.

G. W. Tomanek of the Botany Department at Fort Hays Kansas State College gave the following description of the trapping area in 1951.

The mixed prairie near Hays, Kansas has three main natural habitats or sites. They are found on the level uplands with deep, mature, loam soils, on the hillsides and narrow ridges with shallow rocky soils, and on the lowlands which are characterized by a deep, immature soil that has resulted from natural deposition. The upland site is dominated by the two short grasses, buffalo (Buchloe dactyloides) and blue grama grass (Bouteloua gracilis). A few midgrasses such as western wheat grass (Agropyron smithii), three-awn grasses, (Aristida purpurea and A. longiseta), side-oats grama (Bouteloua curtipendula) are found in limited amounts under climax conditions. On the rocky hillsides and ridge lines the two bluestems (Andropogon gerardi and A. scoparius) and side-oats grama make up most of the vegetation. Some species of minor importance are hairy grama (B. hirsuta), blue grama, switch grass (Panicum virgatum), three-awn grasses, hairy dropseed (Sporobolus pilosus) and others. The lowlands are dominated by big bluestem, western wheatgrass, side-oats grama, switch grass, Indian grass (Sorghastrum nutans), and numerous weeds and forbs. The forbs play a minor role in most areas. Some of the more common ones found here are lead plant (Amorpha canescens), wild alfalfa (Psoralea teniuflora), prairie coneflower (Ratibida columnaris), salmon colored mallow (Malvestrum coiuneum), broomweed (Gutierrezra sarothrae), slender tetraneuris (Tetraneuris stenophylla) and western ragweed (Ambrosia psilostachya).

These three sites were included in the trapline. Also included was a revegetated area which had been seeded with a bluestem mixture in 1945. It is now covered by a rather solid cover of big bluestem, switch grass and side-oats grama growing on a shallow, rocky soil. The hillside and lowland sites are part of a relic area which has not been disturbed since the days of the buffalo. The upland, short grass site is part of a moderately grazed pasture. There was a heavy layer of mulch in all sites, but especially in the relic area where it varied from 2-12 inches in depth.

The prairie deer mouse was always well represented in the census runs, (Table 6), with the harvest mouse caught in large numbers in 1952, 1953 and 1954. In 1952 the cotton rat was plentiful, and then disappeared after December 1952. Two violent hail storms in July and October 1954, damaged the prairie to a marked degree. Vegetation, especially forbs, was stripped, and the relic area was completely beaten down. Strangely enough, the grasshopper mouse made its first appearance in November 1954. The sudden reappearance of Microtus is noted in November 1955. The last record of this species was on another census area in April 1950, when one specimen was caught.

Table 6. Trapping and weather data for census runs at Hays.

	Apr 1952			Nov 1952			Mar 1953			Nov 1953		
Dates	2	3	4	5	6	7	20	21	22	26	27	28
Max temp	66	62	61	76	70	53	70	85	60	43	65	55
Min temp	23	31	31	27	29	22	39	46	37	23	31	34
Precipitation									.10			
P. maniculatus	4	5	2	3	1		13	1		11	10	12
Reithrodontomys				2		2	10	4	3	1	1	2
Microtus												
Sigmodon	1	1	1	1	1	1						
Onochomys												
Daily totals	5	6	3	6	2	3	23	5	3	12	11	14

Table 6. (Cont'd)

	Mar 1954			Nov 1954			Apr 1955			Nov 1955		
Dates	26	27	28	19	20	21	7	8	9	24	25	26
Max temp	54	55	69	59	63	64	55	61	70	45	55	59
Min temp	24	28	34	26	28	31	25	37	38	25	18	21
Precipitation												
P. maniculatus	11	6	3	5		7	2	4	2	9	2	
Reithrodontomys	1		1	1		1				1		
Microtus										1	1	
Sigmodon												
Onochomys						2				2	1	
Daily totals	12	6	4	6		10	2	4	2	13	4	

Table 6. (Concl'd)

	Mar 1956		
Dates	22	23	24
Max temp	57	65	78
Min temp	27	31	27
Precipitation			
P. maniculatus	1	2	
Reithrodontomys	1		
Microtus		1	
Sigmodon			
Onochomys	1		
Daily totals	3	3	

Johnson County

The station established by Virgil Boatwright and Dwight Spencer is arbitrarily placed at Merriam, although three different trapping sites have been used in Johnson County. The first area was burned off, and later became building lots. No small mammals were caught in the second area, but the third area has proved sucessful.

Area 1 was located 2 1/2 miles southwest of Overland Park, Kansas. It was an abandoned street car right-of-way covered with brush, grass and many small trees. The trapping line paralleled the right-of-way, which ran a straight west by southwest course. The line started near a hedge row in a wild plum thicket, ran 400 feet through dense sumac and bluegrass, then 450 feet through an open area of bluestem down into a dry wash through heavy slough grass, and then back up into an open area of bluestem grass. This area burned over on the second trapping day in March 1954, and ruined the census.

Area 2 was trapped only in November of 1954, and was located 1 1/2 miles northeast of Merriam at the southeast corner of highway 50 and Antioch road. This area was used as pasture for three horses, was unburned and had an abundance of cover. Annual grasses and bluegrass predominated, with osage orange, buckbrush, sumac and locust scattered throughout.

The present trapping site is designated as area 3, and is located one mile west and 2 1/2 miles south of Zarah, Kansas. The trapline is roughly in the shape of three sides of a rectangle, with the following cover description V. E. Boatwright.

> The plot is bounded on the south by the grounds of a private gun club, which is relatively undisturbed. To the east is an overgrazed pasture. The north side of the plot has been cultivated in the past,

and has a cover of lespedeza and weeds on thin rocky ground, just north of this is winter wheat. On the west is a graded dirt road, with a cultivated field near the north side of the plot, and pasture across the road from the south side of the trapping site.

Stations 1 to 5 are in extremely dense tall native grasses, 6 and 7 in a wash with sumac and tall sunflowers having thin annual grasses underneath, 8 to 15 on the side of a hill with little bluestem the dominant grass, the deep wash between stations 16 and 17 has scattered grasses. Stations 19 to 21 have scattered clumps of tall grasses with some weeds, brush and annual grasses underneath, stations 21 to 24 are in the edge of brush with the understory consisting of annual grasses, stations 25 to 30 run through a wooded area with undergrowth of shrubs, with bluegrass and annual grasses on the floor.

The trapping area itself is unburned and ungrazed, and is seldom disturbed.

An interesting succession is noted during the last three census runs. Sigmodon was caught at station 18 in April 1955, in November 1955 Sigmodon was caught at stations 1, 2, 3, 4, 5, 9, 13, 15, 16, 17, 20, 31 and 32, then decreasing to stations 1, 2, 3, 5, 7, 18, 20, 21, 23, and 24 in March 1956. Cryptotis put in its appearance in November 1955 for one season.

Table 7 tabulates the trapping and weather data.

Table 7. Trapping and weather data for census runs at Merriam.[1]

	Nov 1953			Mar 1954			Nov 1954			Apr 1955		
Dates	14	15	16	6	7	8	19	20	21	2	3	4
Max temp	71	71	72	57	64	55	55	56	48	70	73	72
Min temp	47	44	46	22	36	28	34	30	35	40	47	55
Precipitation												
P. maniculatus												
P. leucopus	5	6	3		1	1				4	2	4
Reithrodontomys										1	3	1
Microtus			1									1
Sigmodon										2	1	
Cryptotis												
Daily totals	5	6	4		1	1	0	0	0	7	6	6

Table 7. (Concl'd)

Dates	Nov 1955			Mar 1956		
	12	13	14	24	25	26
Max temp	60	53	47	60	77	75
Min temp	39	34	26	31	32	47
Precipitation						
P. maniculatus	1					
P. leucopus	1	1		2		2
Reithrodontomys						
Microtus				1		1
Sigmodon	7	6	13	5	5	6
Cryptotis	2		3			
Daily totals	11	7	16	8	5	9

1. The nearest weather station to Merriam was Olathe, Kansas

Riley County

The Manhattan trapping site is four miles northwest of Kansas State College in an area designated as the Marlatt Tract. The regular census runs are made on a line circumscribing an oval shaped knob. The trapline is set about 10 feet in from a mowing line around the west, south and east facing slopes, with the north portion extending up and over the knob from east to west.

The area had not been burned, mowed or pastured five years before the census began. The area had bluestem grass predominating, with wild plum, dogwood and sumac scattered in clumps over the entire area, but thicker on the north side and the west slope. Immediately north is a fenced, badly overgrazed pasture, while the area around the other 3 sides is mowed each August for hay. All other areas around the Marlatt Tract are pastures.

Vegetation during the spring and fall of 1951 was particularly dense due to the heavy rains of that year. During July 1952 part of the northwest slope was accidentally burned, and at this writing has not completely recovered. In the fall of 1952, sumac was noticeable heavier on the west end

of the north line, and in parts of the east line. By the fall of 1953 the burned area had ragweed, rosinweed and some Indian grass. In the spring of 1955 the cover was fairly thin over most of the area, with the burned area showing more grass, but still weedy. In the fall of 1955 and spring of 1956, the area had good bluestem cover, except in the sumac areas. On top of the knob, cars and picnickers have worn the grass cover down to the rocky soil, but only 2 stations are included in the traveled car worn path.

Table 8. Trapping and weather data for the census runs at Manhattan.

	Feb 1951			Nov 1951			Mar 1952			Nov 1952		
Dates	26	27	28	15	16	17	25	26	27	22	23	24
Max temp	62	63	61	41	37	29	48	49	58	48	44	40
Min temp	34	27	38	29	21	17	18	29	21	24	33	30
Precipitation	.65		T				.01	.23				.22
P. maniculatus	3		2	10	6	4				3	6	2
P. leucopus	5	1		2	2	3	4	4	4	3		
Reithrodontomys	1		1	1	2	2					1	1
Synaptomys	6		1	1	4	3	4	2	3			
Microtus	12	1	4	12	14	15	3	2	2	2		
Sigmodon					1							
Perognatus											1	
Blarina		1	1	16	4	2	2					
Cryptotis												
Daily totals	27	3	9	42	33	29	13	8	9	8	8	3

Table 8. (Cont'd)

	Apr 1953			Nov 1953			Apr 1955			Nov 1955		
Dates	2	3	4	5	6	7	20	21	22	9	10	11
Max temp	65	57	67	49	37	35	75	83	84	62	64	60
Min temp	35	30	26	30	31	30	43	45	49	28	29	37
Precipitation		.17		T		.35	.47					T
P. maniculatus	2	2		15	7	2	8	2	2	17	2	2
P. leucopus				2		2	2	1	1			
Reithrodontomys	1			3	2	1		1				
Synaptomys												
Microtus					1	1				3	2	2
Sigmodon												
Perognathus				1			1			1		
Blarina				3						2		1
Cryptotis										3	1	
Daily totals	3	2		24	10	6	11	4	3	26	5	5

Table 8. (Concl'd)

	Mar 1956		
Dates	20	21	22
Max temp	52	50	55
Min temp	29	37	29
Precipitation		.08	
P. maniculatus	6		
P. leucopus			
Reithrodontomys			
Synaptomys			
Microtus	4	4	1
Sigmodon			
Perognathus			
Blarina			
Cryptotis	2		
Daily totals	12	4	1

Decatur County

The trapping site at Oberlin, Kansas, is located six miles northeast of town on the Yonker farm. The area is bounded on the north by a private road, on the west by a highway, on the east by a draw, and on the south by continuing pasture land. The trapping line is roughly divided in half by a fence, and the areas are here spoken of as the south or north pasture. All along the east side, the land sloped eastward toward the draw, and the north side slopes gently toward the north and east. The draw was originally seeded to brome grass, but was grown up with considerable buckbrush. This draw area was plowed in the summer of 1955. East of the draw, and north of the private road lay alfalfa fields. The south pasture was covered mostly with bunch grass that was spotted with some alfalfa, while the north pasture had buffalo and bunch grass. In the spring of 1955 cattle were put to graze in the south pasture. The drouth in 1955, plus the overgrazing, left little cover on the area, but the fall rains brought some growth of crested wheat and June grass. By the spring of 1956 the area showed "mixed native grass, some buffalo grass,

brome grass and some crested wheat grass", but the cover was poor. Where the old cover remained on the draw slopes, Microtus runs were numerous.

Table 9. Trapping and weather data for the census runs at Oberlin.

	Nov 1954			Apr 1955			Nov 1955			Apr 1956		
Dates	25	26	27	15	16	17	24	25	26	14	15	16
Max temp	50	56	58	84	82	80	53	58	66	82	72	64
Min temp	26	26	26	38	42	42	30	18	18	42	31	27
Precipitation												
P. maniculatus	5	4	7	15	11	11	6	3	5	5	3	
Reithrodontomys	1				1	2		2				
Microtus			1			1	1			2		1
Onochomys		1			1	1						
Perognathus												1
Dipodomys										1		
Daily totals	6	5	8	15	13	15	7	5	5	8	3	2

Crawford County

The cooperators at Pittsburg used several sites for their trapping runs. The Ecology class at Kansas State Teachers College ran several lines a semester when that course was given. Areas most frequently trapped and the areas most closely approximating a prairie area were tabulated in the Kansas Small Mammal Census. These 4 areas will be designated as I, II, III, and IV.

Area I was trapped in the following seasons: fall of 1950, fall of 1951, spring of 1952 and fall of 1952. The area was on the eastern border of the college campus, and was a narrow strip that had retained its original prairie cover. This strip measured 1100 feet north and south, and 100 feet east and west. This site is bordered on the southern end by abandoned tracks of the Joplin and Pittsburg Railroad, on the north end by a cemetery that is well taken care of, on the west by a low area that was being filled by trash and dirt from the college, and on the east by a pasture that had in the past been cultivated.

The dominant cover for area I was Indian grass, while big and little bluestem, switch grass, wild alfalfa and other prairie forbs were well represented. In 1950 and 1951 the cover was dense and 6-8 inches in height, but the area was completely burned off in January 1952. By May 1952 the area had a thin new growth of vegetation which supported a rather decent mammal population. Due to drouth conditions from June to November 1952, the prairie grasses produced only a moderate growth in the fall of 1952. However, the ground cover was good, and little soil surface was visible.

Area II was trapped only in May 1951. This site lay "3/4 mile west of Highland Park Cemetery, Pittsburg, Kansas, and 1/2 mile north of Chicopee". This site was a level pastured prairie where the dominant tall grass was broom sedge, and the short grass was dominantly bluegrass. Haw and pin oak were scattered over the area, with several clumps of blackberry briars scattered throughout. The trapline ran through three of these clumps. The area was bounded on the south by railroad tracks with a burned over pasture south of the tracks, the east was bounded by another set of railroad tracks with a prairie in an open woods beyond the tracks; the west side was bounded by a thick hedge row with a plowed field to its west, and the north edge was bounded by Cow Creek, which had a heavy growth of trees along its bank.

Area III was used for three census runs, in the spring of 1953, fall of 1953 and the fall of 1954. The location was 1 1/2 miles southeast of the college campus on the Joplin and Pittsburg Railroad right-of-way, where the tracks crossed Rouse Road. The trapline lay in the right-of-way in a straight line from southeast to northwest. The north 1/3 of the line was covered by bluestem, broom sedge and other short grasses, the middle 1/3 was dominated by Aster sp., and the final 1/3 was most heavily covered by Poa sp. Inter-

spersed with the grasses and forbs were a large number of varieties of weeds and shrubs. All along the northern border of the right-of-way was a wheat field, and on the south was a kaffir field.

Area IV was trapped once, in the fall of 1955, and was located five miles southwest of Pittsburg. The line was straight, and ran a west to east direction. The area sloped gently toward the southwest into an intermittent stream that roughly paralleled the line running 300 feet to the north. Stations 9 through 21 were in poverty grass, but the other stations were in big and little bluestem and Indian grass mixed with weeds, sedge, blackberry bushes, wild rose, coral berry, elm tree saplings and osage orange trees. The whole area was only slightly "browsed". The trapping area was bounded on the north by a plowed field, on the east and south by roads, and on the west by continuing pasture.

Table 10. Trapping and weather data for the census runs at Pittsburg.

	May 1951			Dec 1951			May 1952			Dec 1952		
Dates	1	2	3	17	28	29	7	7	8	12	13	14
Max temp	77	82	85	39	35	44	90	89	90	50	41	37
Min temp	60	50	57	19	12	18	61	62	59	30	22	18
Precipitation		.82			T							
P. maniculatus	1				2	1	2	2	1	1	1	3
Reithrodontomys					3							
Microtus												
Sigmodon	2	2		2	2	3		1		1		
Blarina	2	1										
Cryptotis					3	3						
Daily totals	5	3		2	10	7	2	3	1	2	1	3

Table 10. (Concl'd)

Dates	Apr 1953			Nov 1953			Dec 1954			Nov 1955		
	11	12	13	5	6	7	7	8	9	19	20	21
Max temp	52	49	55	54	42	42	41	45	47	58	66	72
Min temp	41	36	28	33	28	38	26	32	29	31	34	45
Precipitation		.20			.02	.03				T		
P. maniculatus	3	1			4	2	1	2	2		1	
Reithrodontomys												
Microtus							1					
Sigmodon					1		1					
Blarina												
Cryptotis												
Daily totals	3	1			5	2	3	2	2		1	

Saline County

The Salina trapping area was established by Ronald Clothier at a site 3 1/2 miles southwest of Bavaria, Kansas. This area was adjacent to the bombing and gunnery range of the Smoky Hill Air Force Base, outside of the impact range. The traps were set in a straight west to east line down a west facing slope, across a draw and over the crest of a low hill. Stations 1 through 20 were in western beard grass, and the remaining 10 stations in little bluestem grass. This area had an excellent stand of grass, and was surrounded by several miles of grassland on all sides. The cover grasses on the area were noticeably reduced in the fall of 1955 due to drouth conditions and cattle grazing.

Table 11. Trapping data and weather for the census runs at Salina.

Dates	Dec 1953			Apr 1954			Sep 1955		
	11	12	13	23	24	25	26	27	28
Max temp	43	48	45	78	90	89	61	78	79
Min temp	23	18	31	53	63	64	50	53	49
Precipitation			T			.08	.42	T	
P. maniculatus	9	2	3	7	6		4	6	
Reithrodontomys	2		1	1	1	1			
P. leucopus				1					
Onochomys									1
Perognatus						1			
Daily totals	11	2	4	9	7	2	4	6	1

Smith County

The trapping site at Smith Center, Kansas, was 2 miles northeast of town. The area was an unburned, ungrazed wasteland that had largely reverted to native grasses. The line ran a rather straight south to north path. Stations 1 to 8 were on a flat upland, covered by scattered prickly pear and milkweed, station 9 was on a steep slope running into a flat, dry, stream bed, stations 10 to 15 lay in the bottom proper in sedges and native grasses, stations 16 to 20 were on the up slope covered with shale and limestone, then stations 20 to the end of the line were on alternate knolls of native grasses and weedy draws.

Dry weather conditions had prevailed for some time in the whole county, and this area was extremely dry. Almost no runways, or any other indications of small mammal activity were noticed at either census run. There was no known source of water in a radius of 1/2 mile.

Table 12. Trapping and weather data for the census runs at Smith Center.

	Nov 1953				Apr 1953		
Dates	11	12	13		16	17	18
Max temp	39	40	54		69	46	45
Mix temp	14	26	26		19	25	11
Precipitation							
P. maniculatus	3	1			4	12	5
Microtus						1	
Daily totals	3	1			4	13	5

Sumner County

James Maupin used three separate trapping sites at Wellington. The first area was on L. W. Gaskill's farm located four miles northwest of town. This site was trapped in the spring of 1953, and the spring of 1954. An intermittant stream in an "S" shape coursed through the trapping area, with a few

shrubs and trees located in the curve of the stream. Other cover consisted of buffalo grass, native short grasses and clumps of native weeds. The first census run had traps in a "Z" shape cutting across the dry stream bed once, and the second census run for the area had the traps in an inverted "U" position in the lower curve of the stream.

The area trapped in the fall of 1953 was a waste strip on the Fred Allen farm located three miles south of Wellington on Highway 81. The cover consisted mainly of broom sedge, native prairie grass and sunflowers. This line ran easterly, then north along the edge of a wheat field, and finally east between a cultivated field and a hay meadow.

The area trapped in the spring of 1955 was 1 1/2 miles south of town on Highway 81 on M. H. Shore's farm. The area was fenced on the south, bounded by a road on the west, bordered by a dry stream bed on the north, and on the east by a continuous pasture. Along the stream were numerous trees, and the grass cover ranged from 6-8 inches in height near the stream, to 2-4 inches out in the pasture.

Table 13. Trapping and weather data for the census runs at Wellington.

	Apr 1953			Nov 1953			Apr 1954			Apr 1955		
Dates	14	15	16	17	18	19	21	22	23	18	19	20
Max temp	70	68	65	73	70	64	75	58	79	87	84	78
Min temp	49	41	24	45	51	52	56	46	54	65	68	48
Precipitation						1.11		.79				.25
P. maniculatus	3	4	2	17	10	5				1		
P. leucopus									2			
Microtus												1
Sigmodon				5	6	3				1		2
Daily totals	3	4	2	22	16	8			2	2		3

Sedgwick County

The Wichita trapping site was established by Harold Swanson about 4 1/2

miles west of town on Swanson's farm. This plot had not been plowed for several years and was undisturbed, except to spot treat the bind weed with 2-4-D. The area was 500 feet long with the northern 150 feet only 72 feet wide, while the southern 350 feet was 135 feet wide. The eastern border lay next to a county gravel road, the northern 150 feet was bounded by a wheat field, and the remainder bounded by forage sorghum. The topsoil was thin, but supported fairly thick cover of annual grasses mixed with weeds, mares tail, sunflower and bluestem. In the spring of 1952 the fence row next to the road was burned off, which removed considerable cover, and in March 1953 the cover was described as poor.

The trapline started at the north end along the fence row, and extended five stations into the sorghum field. The last ten traps were then placed along the west edge of the plot. In April 1951 some "rodent trails" were apparent, especially in the fence row.

Table 14. Trapping and weather data for the census runs at Wichita.

	Apr 1951			Oct 1951			Apr 1952			Nov 1952		
Dates	4	5	6	29	30	31	17	18	19	6	7	8
Max temp	70	53	52	58	58	38	65	71	71	55	64	62
Min temp	41	49	46	47	38	30	50	53	51	38	37	44
Precipitation	.17	.68	.01	.62		.14	.02	T	T			T
P. maniculatus	2	2	4		1	2	1	2	2	3	2	2
Sigmodon	2			11	9	4					1	
Microtus		1								1		
Reithrodontomys												
Daily totals	4	3	4	11	10	6	1	2	2	4	3	2

Table 14. (Concl'd)

	Mar 1953		
Dates	9	10	11
Max temp	58	48	52
Min temp	42	43	46
Precipitation	.08	.01	.05
P. maniculatus	2	4	4
Sigmodon			
Microtus			
Reithrodontomys		1	1
Daily totals	2	5	5

SUMMARY OF TRAPPING DATA

Plate II shows the total catch for all of the stations participating in the standard census runs. Each station can be identified by its own pattern, and its fluctuations thereby followed. Two general types of fluctuations are demonstrated: (1) a peak in 1951 or 1952, decreasing until 1953, then returning to another peak in 1955 or 1956, as occurred at Emporia and Garden city; (2) peaks in 1951 and 1955, as in (1), but another peak added in 1953 or 1954, as occurred at Concordia, Hays, Manhattan, Wellington and Wichita. The other stations did not have sufficient data to indicate specific population trends.

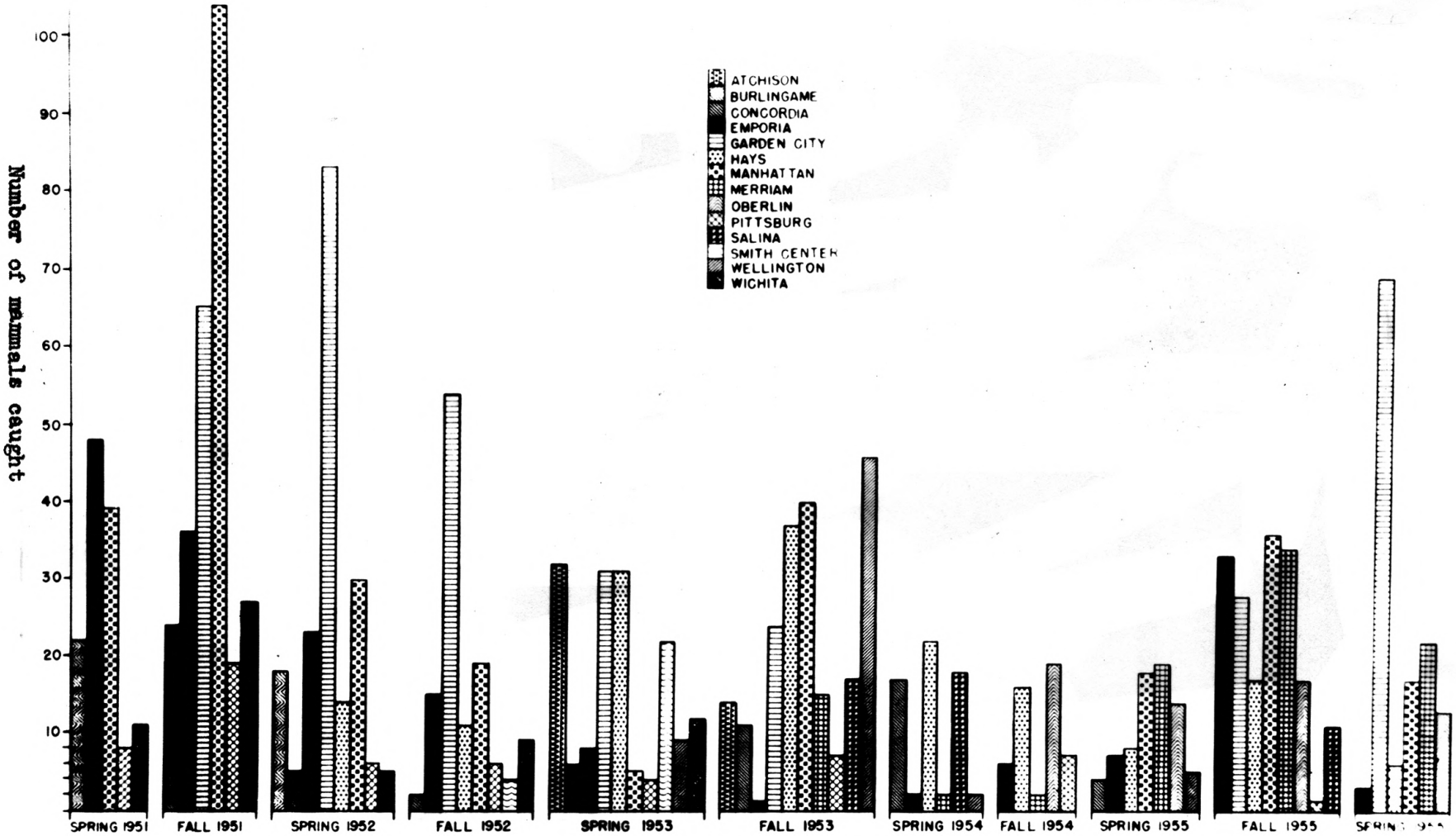
The total number of Peromyscus caught at each station is shown in Plate III. Both P. maniculatus and P. leucopus are included in the total. The striking feature shown in this figure is that the fluctuations of the total population are determined by these mice. Except for a few instances, Peromyscus is the mainstay of the rodent population. Other species add to the peaks, but in years of low numbers do not influence the total picture one way or another.

P. maniculatus bairdii have been caught at Atchison, Burlingame, Emporia Merriam, Manhattan, Pittsburg, Salina and Wichita. P. m. nebrascensis was

EXPLANATION OF PLATE II

Each bar represents the total catch during that season for a trapping station. The key, in upper center, shows the pattern for all 14 census stations. The number of mammals caught is designated at the left of the graph, and the season is shown at the bottom.

PLATE II

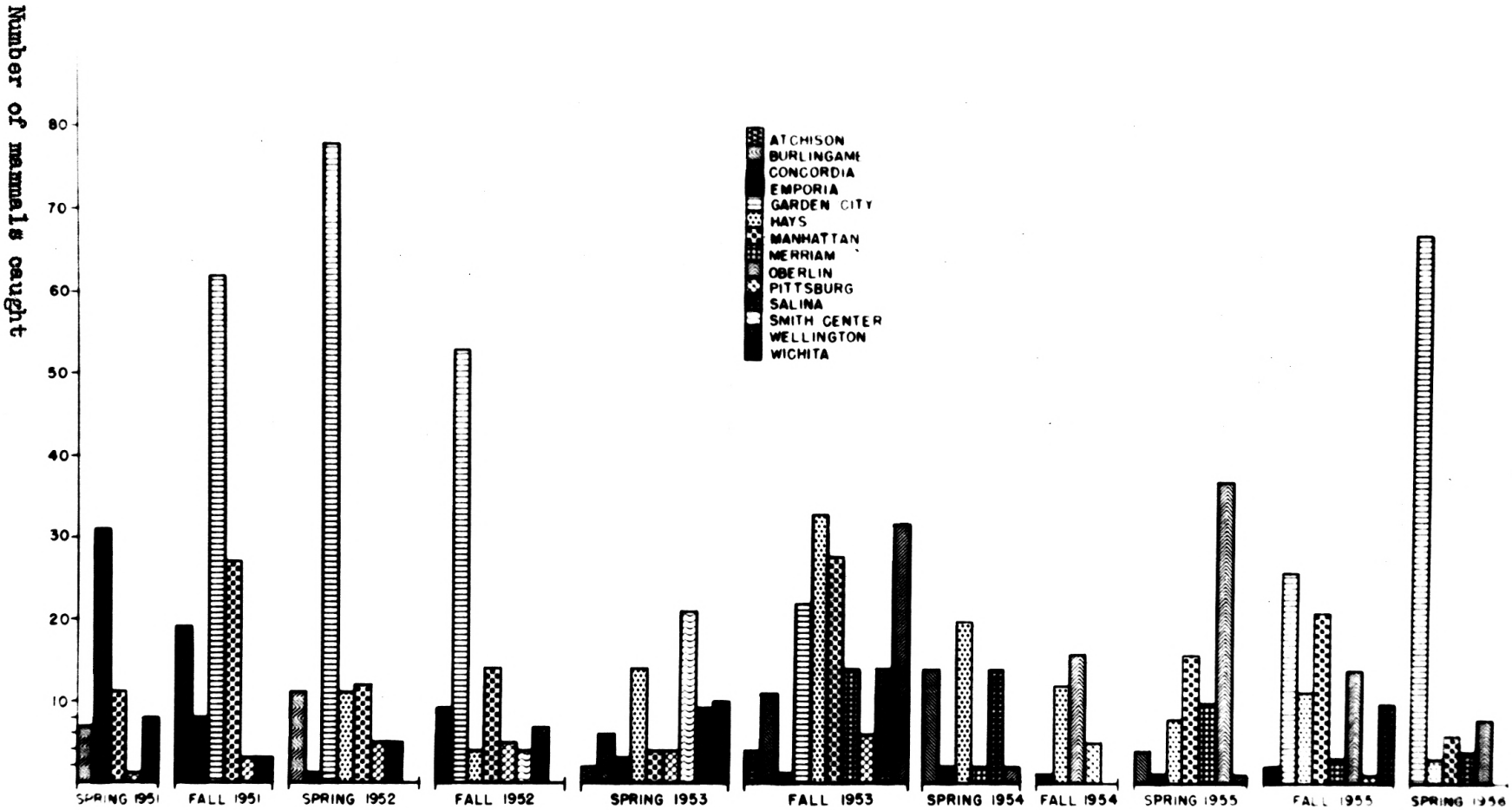


Seasonal trapping from 1951 to 1956

EXPLANATION OF PLATE III

Each bar represents the season total *Peromyscus* catch for a trapping station. The pattern for each station is shown in the key at upper center. The number of mammals caught is designated at the left of the graph, and the season is shown at the bottom.

PLATE III



Seasonal trapping from 1951 to 1956

caught at Concordia, Garden City, Hays, Smith Center and Oberlin. Both species were reported in the Wellington catch. P. leucopus was not consistently caught at all stations because of the stress on trapping typical prairie areas. P. l. tornillo was caught at Garden City, and P. l. auridulus was caught at Oberlin. P. l. noveboracensis was caught at most of the other stations.

The Reithrodontomys catch is shown in Plate IV, Fig. 1. R. megalotis dychei, R. m. aztecus, R. montanus albescens and R. m. griseus are all included in the total. The occurrance of Reithrodontomys has been spasmodic, except at Hays, but there appears to have been a peak in 1953. Mice of this genus have been caught at 12 out of the 14 stations, but only at Atchison and Hays have they been numerous.

R. megalotis dychei has been caught at Atchison, Emporia, Manhattan and Merriam. R. montanus griseus was caught at Burlingame, Concordia, Pittsburg, and Wichita. R. m. albescens was caught at Oberlin, R. m. griseus and R. megalotis dychei at Salina. R. m. dychei and R. montanus albescens were caught at Hays, while R. m. griseus, R. m. albescens and R. megalotis aztecus were caught at Garden City.

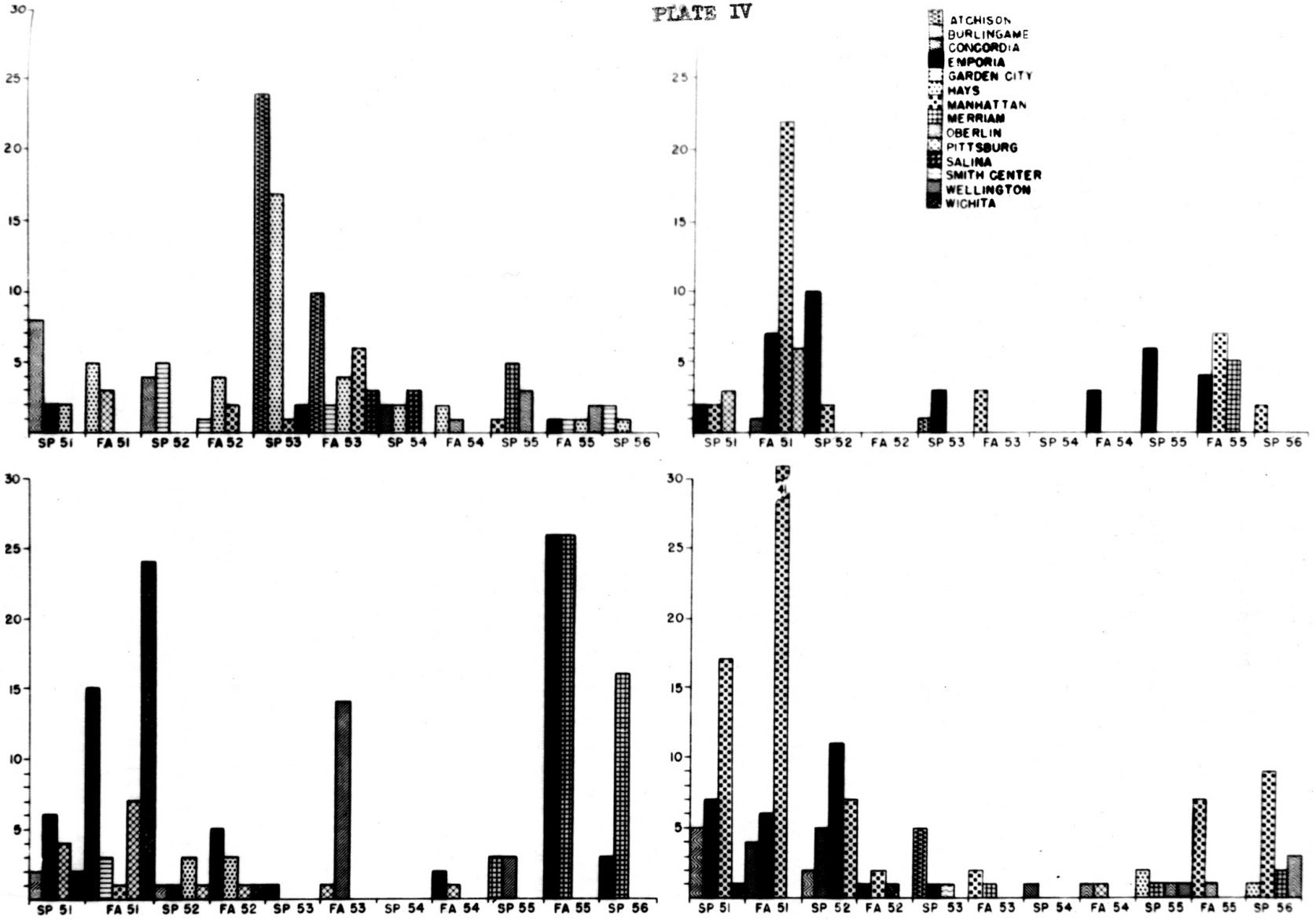
Sigmodon hispidus texianus is the only species of this genus caught in the state of Kansas. The catch of this species is shown in Plate IV, Fig. 2. The cooperators at Burlingame, Emporia, Garden City, Hays, Manhattan, Pittsburg, Wellington and Wichita reported catches of this mammal in 1951 and/or 1952. Sigmodon was caught in large numbers at Emporia in the fall of 1951 and again in the fall of 1955. Many Sigmodon were caught at Merriam in 1955 and spring of 1956. Wellington was the only station to report significant numbers in 1953, while Emporia and Pittsburg each caught one. Wichita, which

EXPLANATION OF PLATE IV

The number of mammals caught is designated at the left of each graph, the season is shown at the bottom, and the pattern characterizing each station is shown in the upper right. Each bar represents the total catch of the species for the stated season at the indicated station.

Fig. 1. Reithrodontomys
Fig. 2. Sigmodon
Fig. 3. Shrew catch, inclused Blarina and Cryptotis
Fig. 4. Microtus

PLATE IV



Numbers indicate total number of mammals caught

Seasons and years of trapping from 1951 to 1956

is only 45 miles north of Wellington, had its peak in the fall of 1951, and then reported only 1 Sigmodon after the fall of 1951. The trapping data thus shows two population peaks of Sigmodon, one in 1951 and another in 1955, with practically no catches of this species between the two peaks.

Two subspecies of Microtus ochrogaster have been caught during the census runs at different stations. M. o. ochrogaster has been caught at Atchison, Burlingame, Concordia, Emporia, Manhattan, Merriam and Pittsburg. M. o. haydenii has been caught at Hays, Oberlin, Smith Center, Wellington and Wichita. The general trend of the population, as seen in Plate IV, Fig. 4, is for one peak in 1951 or 1952, and another peak in the spring of 1956. The apparent peak in Microtus population in the fall of 1951 was due to high catches at Manhattan, Emporia, Concordia and Burlingame, with Hays added in the spring of 1952. This species was caught in small numbers from the fall of 1952 through the fall of 1955, at which time an increase was indicated. In the spring of 1954 the season total Microtus catch, at all stations, was one. During the second peak, in the spring of 1956, a total of 15 Microtus was caught at Manhattan, Oberlin, Hays and Merriam. At no time, in any one season, has this species been caught at more than four stations. The high peak in 1951 accompanied, and was possibly accentuated, by the lush vegetation resulting from the excessive rainfall during that growing season.

The shrew catch for all stations is represented in Plate IV, Fig. 3. Both Blarina brevicauda carolinensis and Cryptotis parva parva are included in this graph. One of the shrew species was caught at each of three stations: one Blarina in December 1951 at Concordia; one Blarina at Atchison in April 1953; and five Cryptotis at Merriam in November 1955. At Pittsburg, five Blarina were caught in May 1951, and six Cryptotis in December 1951. Blarina

was caught at Manhattan in four out of the first six census runs, Blarina was caught with Cryptotis in November 1955, and two Cryptotis were caught in March 1956. Blarina was caught at Emporia in March 1951, November 1951, March 1952 and March 1953, while Cryptotis was caught in March 1951, March 1952, November 1953 and April and November of 1955.

A consideration of Plate IV, Figs. 2, 3, and 4, reveals two interesting, if not significant, facts. The shrews making up a population seem to follow the trend of Sigmodon and/or Microtus. At Emporia in 1951 and 1952 Cryptotis and Blarina were caught when Sigmodon and Microtus were present. In 1954 and 1955 Sigmodon was prevalent and Cryptotis was caught. At Manhattan the Microtus population was high in 1951 with a large number of Blarina present. Blarina and Microtus appeared together again in 1955, but Cryptotis was also present. Although Sigmodon was not caught on this census, this genus was taken on two other trap lines within 1/4 mile of the census area, thus maintaining the co-existence noted elsewhere. At the height of the Sigmodon population at Merriam in 1955, Cryptotis was caught. Thus it is seen in this study that if Sigmodon or Microtus maintained a good population, it seems as if the appropriate shrew occurred. Further trapping should reveal if such a relationship actually exists, or if the correlations seen here are accidental.

One Onochomys leucogaster breviauritus was caught at Salina in 1955. One O. l. arcticens was caught at Oberlin in November 1954, and two were caught in April 1955. One O. l. arcticeps was caught at Garden City in December 1955. Hays has reported the largest number of O. l. arcticeps with two caught in November 1954, three caught in November 1955 and one caught in March 1956.

One specimen of Dipodomys ordii richardsoni was caught at Oberlin in April 1956.

One specimen of Perognathus hispidus paradoxus was caught at Oberlin in April 1956, and one P. h. spilotus at Salina in April 1954. One P. h. spilotus was caught at Manhattan in November 1954, one in November 1953, one in April 1955 and one in November 1955. P. h. spilotus was caught on the Kansas State College pasture in the number and dates indicated; one in September 1950, one in June 1952, three in October 1953, three in June 1955, one in September 1955 and two in November 1955. Nineteen specimens were taken in 8,220 trapnights of supplementary trapping in the Manhattan area.

Synaptomys cooperi gossii was caught at Manhattan during the regular census runs in February 1951, November 1951 and March 1952, and on the college pasture in March 1951 and October 1951. None have been taken in the area since.

Spermophilus tridecemlineatus was caught at three stations, but were not tabulated with the other results. S. t. tridecemlineatus was caught at Salina in April 1954. S. t. arenicola was caught at Hays in March 1956, and at Oberlin in April 1955 and April 1956.

AUXILIARY CENSUS AREA DESCRIPTIONS AND RESULTS OF TRAPPING

During the fall and winter of 1955, and the spring of 1956, extensive random trapping was done in the Manhattan area. Seven traplines, and one quadrat were set in four separate areas, each area representing some type of prairie situation. These lines differed from the standard census lines in that 150 or 300 traps were set in a line, with traps 10-12 feet apart. Supplementary trapping during the season consisted of 8,220 trapnights.

Three traplines were placed in or near the Marlatt tract located four miles northwest of Kansas State College. The first line of 150 traps was run September 28 and 29, in the pasture immediately north of the tract. The line was in overgrazed pasture on a west facing slope that had only a thin grass cover with many small flinty rocks at the surface. The second line, consisting of 300 traps was in the southeast corner of the tract from October 18 to October 27. This line was set in bluestem grass three feet in from the mowing line that followed the contours of the rolling land. The third line, comprised of 150 traps was maintained around the east knob of the Marlatt Tract November 9, 10, 11, 1955.

Another area five miles northeast of Manhattan was trapped four separate times. The trapping area is in a state game preserve, bounded on the west and north by dirt roads, on the south by a pasture, and on the east partly by a road and partly by a woods. This area was naturally divided into a western upper level, and an eastern lower level, with a sharp break of about 25 feet between them. Both areas were similar in that they were covered by heavy bluestem, and that the land was of the rolling type. Two lines of 150 traps each, were established in October 1955, one on each level. In December 1955 and May 1956, 150 traps were set along the same line as that used on the lower level in October. This area was selected because it had better cover, and more type habitats were represented. This line had 90 traps in heavy bluestem, 30 traps in an area of light grass cover and limestone outcroppings, and the last 30 traps in an oak woods. In April 1956, a 208 foot square quadrat comprising 220 traps was set in the upper level of this area by the Wyandotte High School Science Field Club from Kansas City. One side of the square was along the north-south road, and a buffer

line of traps at 10 foot intervals was placed around the other three sides to prevent mice from infiltrating into the quadrat.

The fourth area trapped, November 2-6, was 10 miles southeast of Manhattan on the O'Neil cattle ranch in Deep Creek Valley. The bluestem meadow that was trapped had been mowed earlier in the fall, and had not been pastured since the winter of 1954. The meadow was "U" shaped, and was surrounded by a young oak woods. A line of 150 traps was run outside of the mow-line in the grass under the trees, and another line of 150 traps in the meadow approximately 50 feet inside of the first line. Poor weather conditions were encountered on four out of the five days.

In 1948 H. T. Gier and O. W. Tiemeier started a separate census in the Grass Utilization Pasture of Kansas State College. In earlier days the pasture was well known as one of the best bluestem pastures in the territory. When the land was acquired by Kansas State College it was subdivided into a series of pastures for experimental work. The trapline, consisting of two parallel lines 30 feet apart, ran across four pastures; from a hill top, down a north slope, across a small stream, over a flat ridge to another stream. Each line consisted of 150 traps set at 10 foot intervals. These lines are left in the field two nights and are in general set out in March, June, September and December. Since the start of the census to present, the line has been set a total of 24 times, and represents 14,400 trap nights.

Table 15 lists the trapping data for the college pasture, and the auxiliary trapping of the Manhattan area. The adjusted total catch is the actual total catch reduced to 270 trap nights so that correlation could be made with the standard census runs for Manhattan.

Table 15. Trapping data for the college pasture, and the auxiliary traplines.

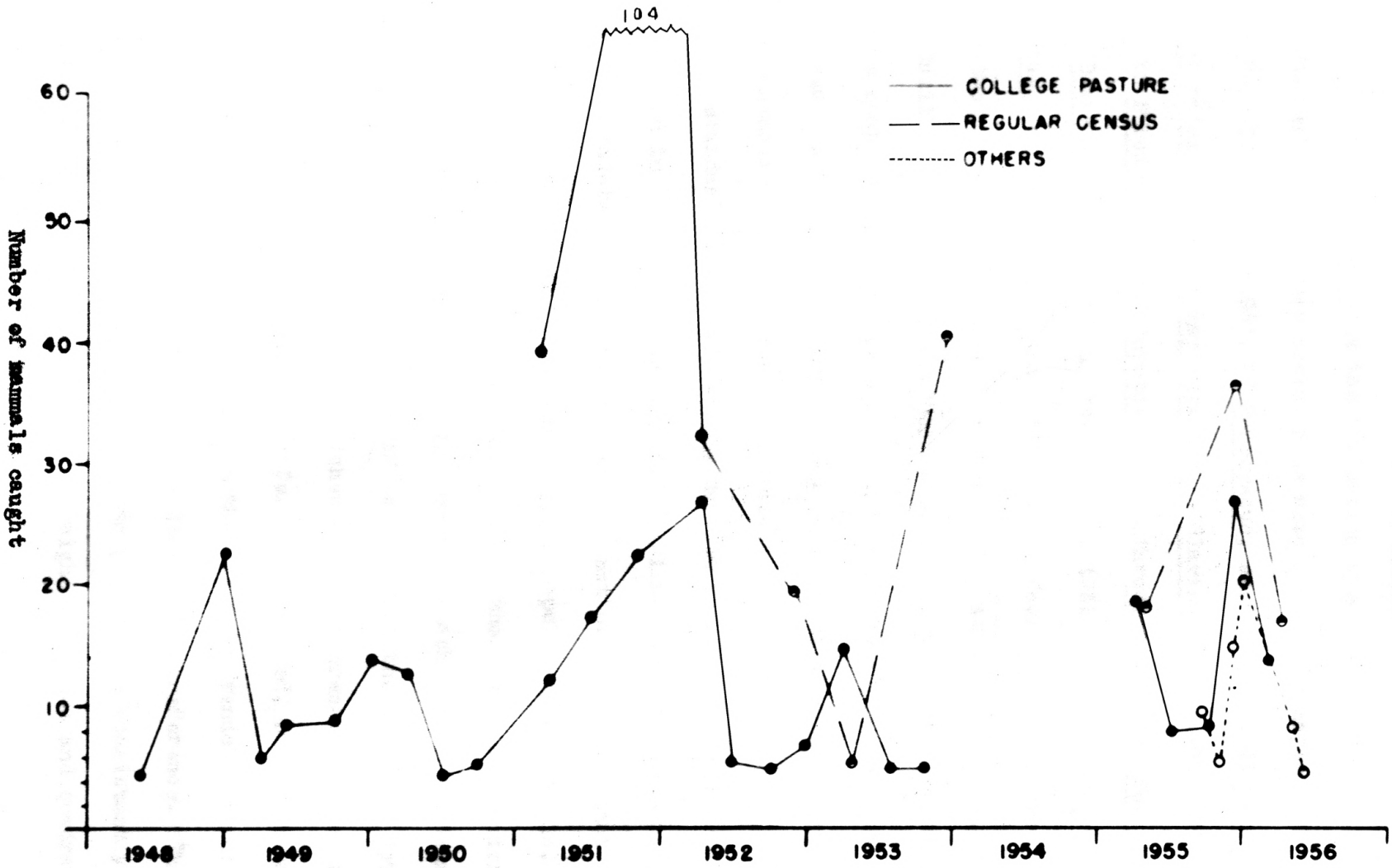
COLLEGE PASTURE			AUXILIARY TRAPLINES		
Dates	Total Catch	Adjusted Total Catch	Dates	Total Catch	Adjusted Total Catch
May 1948	10	4.5	Sep 28, 29, 1955	9	8.2
Dec 1948	51	22.9	Oct 9-15, 1955	39	6.4
Mar 1949	13	5.9	Oct 18-27, 1955	57	5.1
May 1949	19	8.6	Nov 2-6, 1955	17	3.0
Sep 1949	20	9.0	Nov 9-11, 1955	25	15.1
Dec 1949	31	13.9	Dec 28-30, 1955	34	20.4
Mar 1950	28	12.6	Apr 15, 16, 1956	9	3.7
Jun 1950	10	4.5	May 15-17, 1956	8	4.8
Sep 1950	12	5.4			
Mar 1951	27	12.2			
Jun 1951	38	17.1			
Oct 1951	49	22.1			
Mar 1952	59	26.6			
Jun 1952	12	5.4			
Sep 1952	11	4.9			
Dec 1952	15	6.8			
Mar 1953	33	14.9			
Jul 1953	11	4.9			
Oct 1953	10	4.5			
Mar 1955	41	18.5			
Jun 1955	17	7.7			
Sep 1955	18	8.1			
Nov 1955	59	26.6			
Feb 1956	30	13.5			
Jun 1956	16	7.2			

Major and minor peaks are seen to occur, in all lines, in either the late fall or early spring (Plate V). The college pasture trapping showed major peaks in December 1948, March 1952 and November 1955, and minor peaks in December 1949, and March 1953. The major peak in December 1948 was composed of 26 Peromyscus, 21 Microtus, one Reithrodontomys and three Blarina. In the peak of March 1952 there were 34 Peromyscus, 22 Microtus, one Sigmodon and two Blarina. The November 1955 peak had 46 Peromyscus, eight Reithrodontomys and two Perognathus. The minor peaks were composed of the following numbers: December 1949, 23 Peromyscus, one Microtus, three Reithrodontomys and three

EXPLANATION OF PLATE V

The total catch for the Kansas State College pasture, and the auxiliary traplines in the Manhattan area, have been reduced to 270 trap nights to correspond with the regular census trapping. The line key is shown in upper right. The number of mammals caught is designated at the left of the graph, and the years are designated at the bottom of the graph.

PLATE V



Seasonal trapping from 1948 to 1956

Blarina; March 1953, 32 Peromyscus and one Reithrodontomys. During periods of low numbers Peromyscus is the dominating species.

The regular Manhattan census runs also show three major peaks. (Table 8, Plate V). In November 1951, 27 Peromyscus, one Sigmodon, 41 Microtus, five Reithrodontomys, eight Synaptomys and 22 Blarina were caught. In November 1953, 28 Peromyscus, two Microtus, six Reithrodontomys, one Perognathus and three Blarina were caught. In the November 1955 census, 21 Peromyscus, seven Microtus, one Perognathus, three Blarina and four Cryptotis were caught. Again the years of low numbers show Peromyscus as predominating.

Auxiliary trapping in the Manhattan area in the fall of 1955 showed that a large number of small mammals were present, thus supporting the evidence for a peak as found by trapping in the census runs at the college pasture and the standard census runs on the Marlatt Tract.

The standard census line on the Marlatt Tract consistently gave a larger total catch in the peak years than did the line on the college pasture. This might be accounted for in that the area is not pastured, and that the growth is more luxuriant, thus supporting a higher population of mammals. When the decrease in population occurred in late 1951, the higher population was hit harder, reducing it to a level far below that reached in the originally less populated area. In 1955 and 1956 it is seen that the different types of census-taking gave proportional catches. The difference in total number is understandable by the ecological differences involved, but the trend is well established. From this it would seem that if only trends in populations are desired, the type of sampling would be dictated by preference. The only rule to follow would be to repeat the sampling performance consistently.

Duncan (1951) in comparisons of straight traplines and quadrats found that

a straight trapline, with the traps located 10 feet apart, sucessfully removed the small mammal population from an area of about one acre in three nights. The acre quadrat set at the State Lake on April 19, 1956, caught nine mice. One Month later the line of 150 traps at the State Lake caught eight mice. The close correlation between the two catches indicated that a good random sample had been taken in the straight line census work.

ATTEMPTS TO ASCERTAIN ETIOLOGICAL AGENTS IN POPULATION FLUCTUATIONS

Under the direct supervision of Dr. L. E. Erwin of the Bacteriology Department at Kansas State College, 260 field mice were cultured for Salmonella sp. During the summer and fall of 1955, Don Mitchell did the culturing, and the writer continued the work through the spring of 1956. The traplines were run early in the morning to remove the nights catch before undue spoilage took place. To remove the tissue for culture, the following instruments were required: one rounded edge scalpel, one pair of forceps and one pair of small scissors. The instruments were placed in a small beaker of 70 per cent isopropyl alcohol, and each instrument was flamed before using. After the specimens had been removed from each mouse, the instruments were rinsed with tap water and placed back into the alcohol. A small portion of the liver, and 1-1 1/2 inches of small intestine immediately posterior to the pyloric portion of the stomach, were removed in the following manner. The scalpel was used to make an incision one inch long, below the rib cage, to the left of the mid ventral line. A small piece of the liver was pinched off with the forceps and was placed in selenite broth (Difco). The first loop of the intestine was then lifted up with the forceps, an appropriate length cut off with the scissors, and placed in the broth with the liver

specimen. After 16-24 hours incubation, the culture from the selenite broth was streaked on SS agar (Difco), bismuth sulfite agar and EMB (Difco) agar plates. These plates were then incubated for 24 hours, at which time suspected colonies were transferred to Kligler's iron agar. If no colonies had appeared on the agar plates in 48 hours incubation, they were considered negative, and discarded. After the Kligler's iron agar culture had been incubated 18-24 hours, they were examined for formation of a red slant and a yellow butt, with or without gas, and the formation of H_2S. If the reaction was other than these, they were assumed not to be Salmonella. If the above reactions occurred, a transfer was made to urea broth, and allowed to incubate for 24 hours. If the urea broth had turned pink or light red the culture was presumed to be a Proteus sp. If no reaction took place in the urea broth, transfers from the Kligler's iron agar culture into dextrose, ducitol, sucrose, maltose and lactose broth tubes were made. Acid and gas formation in the dextrose, ducitol and maltose tubes, with no reaction in the sucrose or lactose tube was a presumptive positive test for a paratyphoid. Sub-cultures were then sent to the Kansas Public Health Laboratories at Topeka, Kansas, for serological identification.

No results were obtained from these cultures that could be construed to be influential in population fluctuations.

To study the influence of tularemia on small mammal population fluctuations, a heat stable tissue extract (Ascoli) was removed from the liver and spleen of the mammals caught in the regular census runs over the state, including specimens from Emporia, Garden City, Merriam, Oberlin and Salina, and particularly from the mammals caught during the supplementary trapping in the Manhattan area.

After culturing the mammals for paratyphoid, the liver and spleen were entirely removed. Early in the study the tissue from each mouse was kept separate and processed separately. Each specimen was placed in a 15 ml conical centrifuge tube and macerated with a glass rod ground to fit the bottom of the tube. The macerated tissue was suspended in 10 ml of Locke's physiological saline, then was treated in one of two ways. The tissue could be heated in a steam sterilizer for 30 minutes, or the tube placed in a boiling water bath for 30 minutes. The cooked tissue was then centrifuged, and 2 ml. of the supernatant fluid was transferred to a vial and was kept frozen until testing could be accomplished. In later work, tissues from several mice were pooled with four volumes of saline, and macerated with a Waring blender. After the heat process the supernatant was recovered by filtration through filter paper.

The indicator system for the hemagglutination test for tularemia is a suspension of sheep or chicken red blood cells previously sensitized with a 1:4 dilution of a diethyl ether extract of Pasteurella tularense organisms.[1] This extract was called "Erythrocyte Sensitizing Substance", and hereafter will be referred to as ESS. All dilutions are made in saline buffered to pH. 7.0 with 14.2 gms Na_2HPO_4 and 13.8 gms NaH_2PO_4 per liter. Optimum pH. is 7.0, but a pH. of 6.8 to 7.4 may be tolerated. To 2 ml of a 1:4 dilution of ESS, 0.05 ml of packed, triple washed, sheep RBC's are added, and incubated for one hour at 37°C. The RBC's were washed twice with 10 ml of buffered saline, and resuspended in 5 ml of buffered saline to give a final concentration of 1 per cent.

The immune sera, recovered from rabbits innoculated with live P. tularense

1 Dr. Cora M. Downs of the University of Kansas supplied the ESS for these tests.

organisms, needs only to be titered one time.[2] If the sera is refrigerated, and precautions taken to prevent bacterial or fungus contaminations, it will remain stable for months. The agglutinating units are determined as follows. Serial dilutions are made, in buffered saline, of the immune sera from 1:10 to 1:1000. To 0.2 ml of each dilution, 0.2 ml of 1 per cent suspension of previously sensitized cells are added, and incubated for 16-22 hours at 30°C. Positive agglutination is read as a fine layer of cells covering the bottom of the tube, and negative agglutination is shown as a smooth button of cells which gives an even suspension of shaking. If the last dilution showing agglutination is 1:400, then 2 agglutinating units would be a dilution of immune sera of 1:200.

The final part of the test requires that 0.2 ml of a 1:200 dilution of immune sera be added to 0.2 ml of tissue extract, and then incubated for 30 minutes at 37°C. At the end of this period, 0.2 ml of sensitized sheep RBC's are added to the mixture. This is incubated for 16-22 hours at 30°C, and then examined for agglutination as above.

If agglutination is positive then the antigen of tularemia was not present, and indicates that the animal had never been infected with tularemia. The absence of agglutination reveals that the antigen was present, and the animal(s) was, or had been, infected with tularemia.

Approximately 200 extractions have been made from 500 trapped field mice since the fall of 1955. Hemagglutination inhibition tests of 185 specimens revealed that all were negative.

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2. Dr. Cora M. Downs of the University of Kansas supplied the immune sera for these tests. The testing procedure is per personal conversation with Dr. Downs.

WEATHER CONDITIONS AFFECTING POPULATION FLUCTUATIONS

An attempt was made to correlate precipitation with population fluctuations, as is shown in Plate VI. Three month averages of total precipitation were plotted for Manhattan (Fig. 1.), and Emporia (Fig. 2.), beginning with January 1951, and ending with March 1956. Total population as determined by the standard census runs, was then superimposed on the precipitation curve.

An examination of Fig. 1, Plate VI, reveals that the population peak in 1951, 1953, and 1955 follow closely the peaks in the precipitation curves. But an examination of Fig. 2, Plate VI, reveals no correlation between the population curve, the precipitation, nor with the population curve at Manhattan. Another attempt (not graphed) to correlate precipitation with the total catch at Hays revealed a curve unlike either that of Manhattan or at Emporia in that population peaks preceded precipitation peaks. Precipitation may influence populations by determining the nature of the vegetation in the area, but from the data here presented, it is obvious that the mammal populations do not always respond to increased rainfall, or vegetation.

DISCUSSION

In this endeavor to establish a Kansas Small Mammal Census, a continuous five year study of population numbers over a large area has led to an accumulation of statistically significant data possibly unmatched, except by Calhoun, by any other such study. The study began with an apparent peak population, continued through a three year low, and into another apparent peak. The fluctuations seen in the total population are determined by Peromyscus, and accentuated by the other species during the peak years.

EXPLANATION OF PLATE VI

Fig. 1. Three month averages of total precipitation are plotted with solid lines, while the total catches of the Manhattan census runs are shown in broken lines. Precipitation is plotted in inches.

Fig. 2. Three month averages of total precipitation are plotted with solid lines, while the total catches of the Emporia census runs are shown in broken lines. Precipitation is plotted in inches.

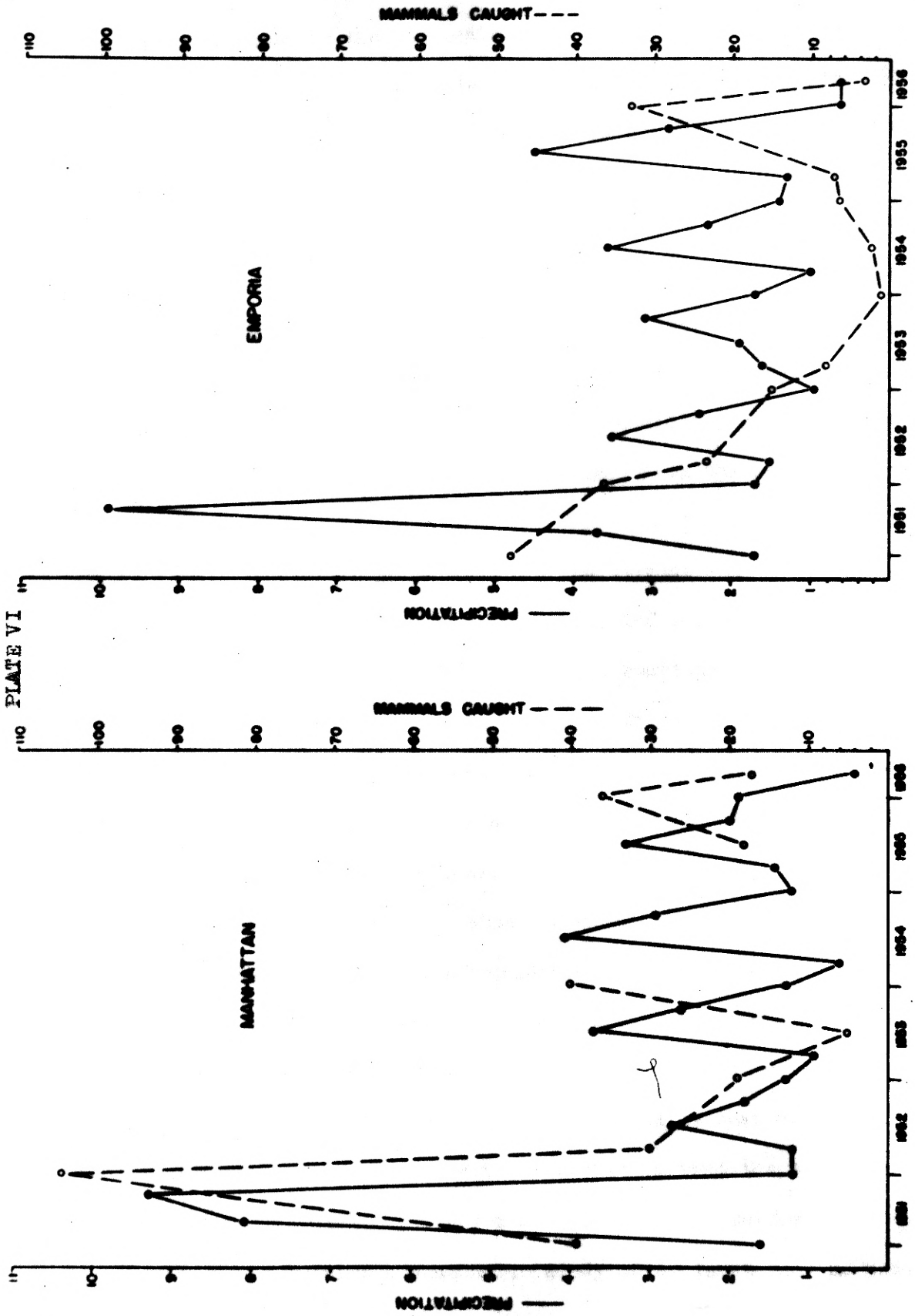
MAMMALS CAUGHT
EMPORIA
PRECIPITATION
MAMMALS CAUGHT
MANHATTAN
PRECIPITATION

PLATE VI

The areas selected by the cooperators, with one exception, have been representative of native grass area in their districts. These representative areas have been as undisturbed as was practically possible. Because unmolested areas were selected, the catches reported are not typical of the entire area, as was shown in the comparison between the closely grazed college pasture at Manhattan, and the undisturbed Marlatt Tract census area. The unmolested areas were selected for the census because of the possibilities of a catch of significant numbers of mammals on such areas as contrasted with the regular low catch in cultivated or pastured areas, and the probability that periodic reinfestations of cultivated or burned areas comes from the overflow from such unmolested areas.

The good coorelation found between the census runs and supplementary traplines in Manhattan, Pittsburg and Hays area, indicate that representative samples of the total population were taken. Few stations experienced bad weather during the census runs, and in the majority of cases the weather had no observable influence on the general trend. Even when undesirable weather conditions prevailed, the total catches were in step with the trends as indicated by catches at other stations.

In a preliminary study to determine the causes of the population fluctuations, extensive testing was done for paratyphoid infections, and tularemia antigen response, indicating past or present infection. The negative results do not preclude the possibility that these diseases have no effect on populations; rather the evidence from other workers indicates that more work should be done along this line. The timing is important in that the studies should begin on a building population, and continue through the peak and eventual decline, which would require a continuous study of at least two and possibly

three years.

If the effect of diseases on mammal populations is ignored, and attention turned to other possibilities, the fluctuations might be explained in two ways. It is necessary to have two explanations in that 2 kinds of fluctuations were observed. Peromyscus and Reithrodontomys have exhibited fluctuations with generally a good basic population before and after a peak. The work of Christian supports this type, in that after a population reaches a liveable level, no further reduction occurs. On the other hand, Microtus and Sigmodon have had high peaks, then suffer a drastic reduction in numbers. This is more in keeping with the work of Frank, and his principle of hypoglycemic shock.

No positive coorelation could be determined between precipitation and population fluctuations as determined by standard census runs.

SUMMARY

A discussion concerning the possible causes of population fluctuations is made with emphasis placed on reduced reproduction and hypoglycemic shock, due to stress of numbers, as a possible cause. The role of diseases, with emphasis on paratyphoid and tularemia, are reviewed.

Methods for determining densities of small mammal populations, and organization and operation of the Kansas Small Census with its modifications from the North American Small Mammal Census are discussed.

Descriptions of the 14 census area with tables giving weather data and trapping results are discussed and listed.

Total population peaks of Kansas small mammals are shown in 1951, 1953, and 1955, with Peromyscus shown as the population mainstay. Reithrodontomys were determined to have a year of peak numbers in 1953. Sigmodon and Microtus

appeared to have their peaks in 1951 and 1955, and the possibility of the occurrance of Microtus-Blarina and Sigmodon-Cryptotis combinations are postulated. All species caught during the regular census runs have been discussed from the standpoint of distribution and relative numbers.

Data from the supplementary traplines in the Manhattan area are listed and tabulated. Good coorelation between straight traplines, station traplines and quadrats is shown. Population trends may then be determined by any of these methods, as long as they are consistently used.

The removal of liver and intestine from field mice, and the culturing methods for determining paratyphoid infections is explained. No results were obtained from the cultures that could be construed to be influential in population fluctuations.

The method for extracting the antigen of tularemia from liver and spleen, and the determination of its presence or absence is described. Negative reactions of 185 extractions, does not indicate that this organism has no relation to the problem, but that further testing is necessary to establish or disprove the role of Pasteurella tularense in population fluctuations.

No influence of precipitation on population fluctuations could be shown from this study.

ACKNOWLEDGMENT

The writer most gratefully acknowledges the suggestions, advice and time freely given by his major advisor, Dr. H. T. Gier. Appreciation is expressed to Dr. L. E. Erwin for his guidance in the paratyphoid determinations, and to Dr. Cora M. Downs and V. D. Foltz for the time and advice given on the tularemia study. Acknowledgment is given to the cooperators who have given freely of their time and efforts during the past five years. Lastly, but not least, appreciation is expressed to a most able assistant and proofreader, my wife, Betty Ann.

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APPENDIX

Form 1

6x9

PEERLESS CLASP

FEDERAL ENVELOPE CO.

KANSAS CENSUS OF SMALL MAMMALS

Cooperator_____

Adress_____

Location of trapping site_____

Description of area, including type of cover (Please include a diagram indicating important features and position of the trap line. A photograph of the area is also desirable)_____

Date traps were set_____

Number of traps_____ Number of stations_____

Weather: First day_____

Second day_____

Third day_____

Disposition of catch_____

Notes and remarks_____

Day's Records Date_____

Species	Capture Location (1)	Sex	Wt. gr.	Length in mm. Total	Tail :	Remarks (2)

(1) Number of trapping station (1 to 30)
(2) Include here pelage indication of age: Juvenile, sub-adult, or adult if recognized as well as number of placental scars or embryos.

Day's Records Date

Species	Capture Location (1)	Sex	Wt. gr.	Length in MM. Total	Tail :	Remarks (2)

(1) Number of trapping station (1 to 30)
(2) Include here pelage indication of age: Juvenile, sub-adult, or adult if recognized as well as number of placental scars or embryos.

KANSAS SMALL MAMMAL CENSUS: A FIVE YEAR STUDY, WITH ATTEMPTS TO DETERMINE FACTORS IN POPULATION FLUCTUATIONS

by

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B. S., Central Missouri State College, 1953

AN ABSTRACT OF

A THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Zoology

KANSAS STATE COLLEGE
OF AGRICULTURE AND APPLIED SCIENCE

1956

through the decline of the present peak, it may be possible to assign a population reducing role to one these organisms.

It was the purpose of the Kansas Small Mammal Census, coordinated by H. T. Gier, to study the fluctuations of rodent numbers, and to attempt to determine the causative agent responsible for the rise and fall of numbers. Cooperators located at Atchison, Burlingame, Concordia, Emporia, Hays, Garden City, Manhattan, Merriam, Oberlin, Pittsburg, Salina, Smith Center, Wellington and Wichita, set out traplines in March-April and October-November. Modifications of Calhoun's North American Census of Small Mammals (1948) plan were used. Trapping stations were set 40-50 feet apart instead of 25 feet, and 30 stations were used instead of 20 stations.

Results of the census indicated three peaks (in 1951, 1953 and 1955) in the rodent populations over the state. Peromyscus make up the basic population, while the other species added to the peaks in 1951 and 1955. Microtus and Sigmodon had peak populations in 1951 and 1955, while Reithrodontomys had its peak in 1953. A correlation between the species of shrews, Blarina or Cryptotis, and populations of Microtus and Sigmodon was indicated. Blarina was prevalent with Microtus, and Cryptotis with Sigmodon.

Correlation between the Kansas State College pasture census, with two straight lines of 150 traps each, the Manhattan standard census runs, and the auxiliary trapping in the fall of 1955 and spring of 1956, indicated that the random sampling techniques were accomplishing the desired end, e.g., trends in population numbers.

Three attempts to correlate precipitation with population fluctuations revealed three patterns. Manhattan had population peaks following precipitation peaks, at Emporia the rodent population steadily decreased in the face of

good precipitation, and at Hays the population peak in 1953 preceded the precipitation peak. The obvious conclusions is that field rodent populations do not always respond to increased precipitation and/or vegetation.