BURROWING HABITS OF THE PLAINS POCKET GOPHER IN NORTHCENTRAL AND NORTH-WESTERN OKLAHOMA DURING THE FALL AND WINTER OF 1969-70

By

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CHAPTER I

INTRODUCTION

Plains pocket gophers (*Geomys bursarius* Shaw) are solitary fossorial mammals that inhabit vast regions of the central and southwestern United States. Gophers seldom come to the ground surface, and are well adapted to an underground existence. The forelimbs are muscular, and the spatulate hands are armed with huge claws. The mouth is unusual in that the skin of the upper lips is joined behind the upper incisors, creating the impression of a sealed mouth with large teeth protruding. The mouth actually is a small opening just above the lower incisors (Sanderson 1967). It is possible that the semi-enclosed oral cavity permits the gopher to dig rapidly and cut roots with the incisors without getting soil in the mouth.

The cheek pouches on either side of the head are used in transporting rootstocks to food-storage chambers located along the tunnel system (Downhower and Hall 1966). The average weight of the plains pocket gopher is about eight ounces; average total length is about nine inches. Breeding is in the spring, and the one annual litter averages four young. The young disperse in the summer, and territories again are rigorously defended by fall.

The plains pocket gopher is capable of exerting a pronounced effect on its environment. Prior to the arrival of settlers, the gopher was an asset to the ecology of the Great Plains, deepening and fertilizing the soil in rocky areas and increasing soil aeration (Grinnell 1923, 1933, Taylor 1935, Ellison 1946). Populations of gophers were probably not extensive, since little activity has been observed under natural stands of native vegetation (Trowbridge 1941, Phillips 1936, Buechner 1942). However, man's agricultural, industrial, and residential activities have altered the usual sequence of plant succession, and the habitat is maintained at a sub-climax stage. Populations of pocket gophers have greatly increased under these conditions, since certain agricultural crops and invading forbs characteristically develop fleshy root systems attractive to gophers (Anon. 1960, Trowbridge 1941).

The tillage of the soil has not only altered vegetation, but the soil itself. Soil profiles are destroyed, and wind-blown deposits accumulate. Pocket gophers typically thrive in these looser, sandies soils.

The pocket gopher has thus become a pest in wide areas of its range. In these areas large numbers of mounds are cast onto the surface during foraging activities, which cover and destroy many plants. The mounds interfere with spring emergence of desirable smaller plants and seedlings, while exposing mineral soil which favors weedy invaders. The casts then harden and partially seal the soil against water infiltration, increasing sheet erosion (Julander et al. 1959, Day 1931, Gabrielson 1938, Peck 1941). In addition, the mounds are unsightly and may result in frequent maintenance of mowing machinery in lawns, golf courses, along highway rights-of-way, and in hay or alfalfa fields.

Another problem which is directly related to site disturbance and resulting increases in gopher activity is that of damage to buried cables, wires, and pipes. Some difficulties have arisen in areas where plastic water pipes are used (McIlvain, Personal Communication, 1970).

In view of the preceding discussion, research into the behavior, habitat preference, abundance, distribution, and control of pocket gophers should continue. Short-term eradication programs will not furnish answers to many of these ecological questions.

Although three descriptions of burrowing activities of the plains pocket gopher in Kansas have been published (Scheffer 1910, 1931, Downhower and Hall 1966) little is known about such activity in Oklahoma. Miller (1957) excavated and diagrammed nine tunnel systems of the valley pocket gopher (*Thomomys bottae*) in California. Other members of *Thomomys* have also been studied. Crouch (1942) described generalized tunnels of pocket gophers as a group.

The primary objective of this study was to excavate and describe selected tunnel systems in northcentral and northwestern Oklahoma. A brief evaluation of the mound-count population estimation technique was also conducted. Field work began September 1, 1969, and terminated May 1, 1970.

CHAPTER II

THE STUDY AREAS

Two principal areas were chosen for this study. The area in northcentral Oklahoma consisted of three sites in the vicinity of Stillwater in Payne County. The area in northwestern Oklahoma was represented by several sites on the Southern Plains Experimental Range, 10 miles south of Buffalo in Harper County. A map depicting the location of these study sites in relation to the species range is presented in Figure 1. A discussion of each principal area follows.

Northcentral Oklahoma

Research in northcentral Oklahoma was conducted on three sites in Payne County (Fig. 2). The area is situated in the transition zone between the forests of the east and the prairie of the west (Coryell 1952). The three study sites can be generally included in a brief discussion of Payne County.

Regional Land-use

Payne County is in an agricultural area. Approximately 85 per cent of the land in the county is under some type of

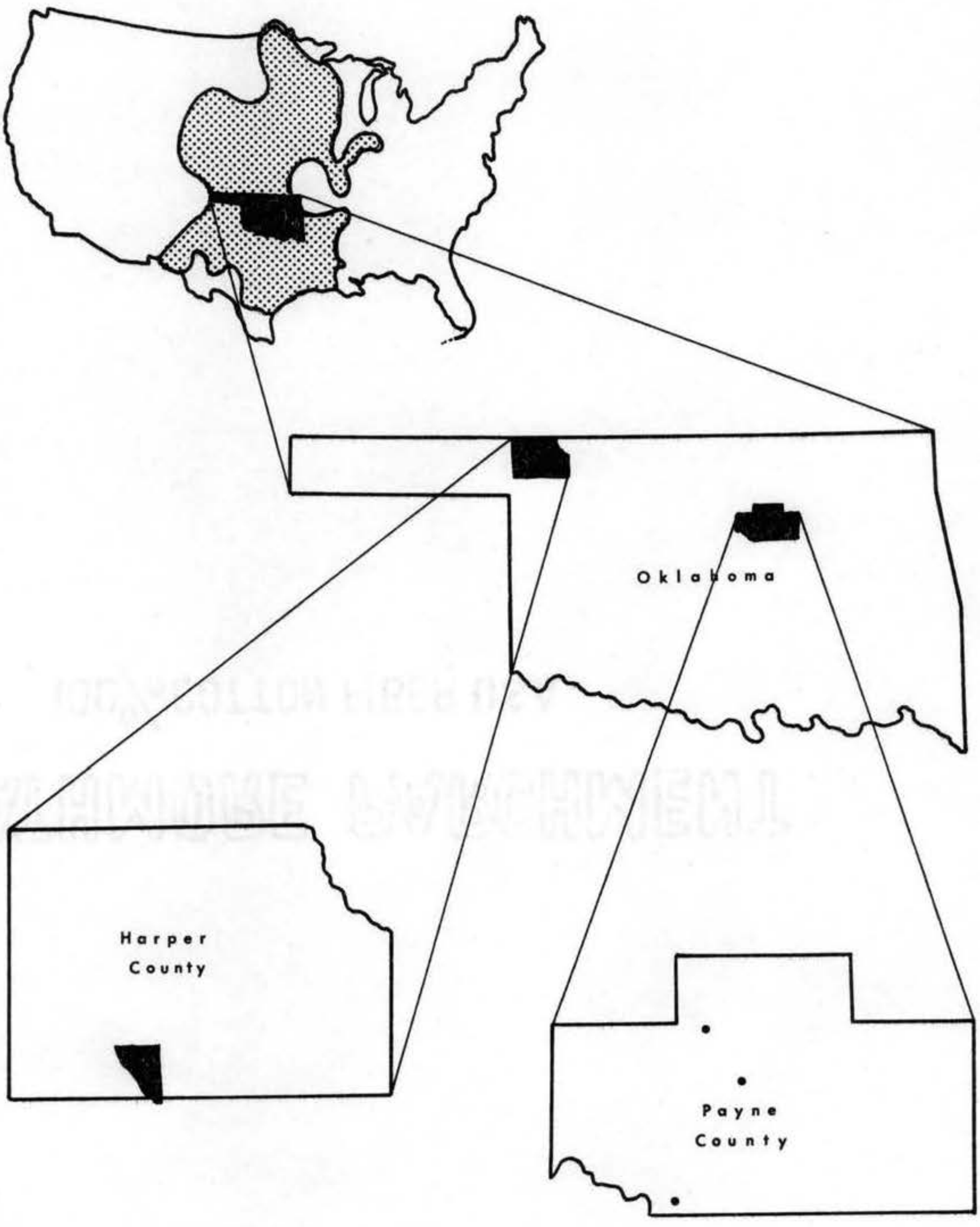

Figure 1. Location of the principal areas of study in relation to the geographical range of <u>Geomys bursarius</u> (Burt and Grossenheider 1964)

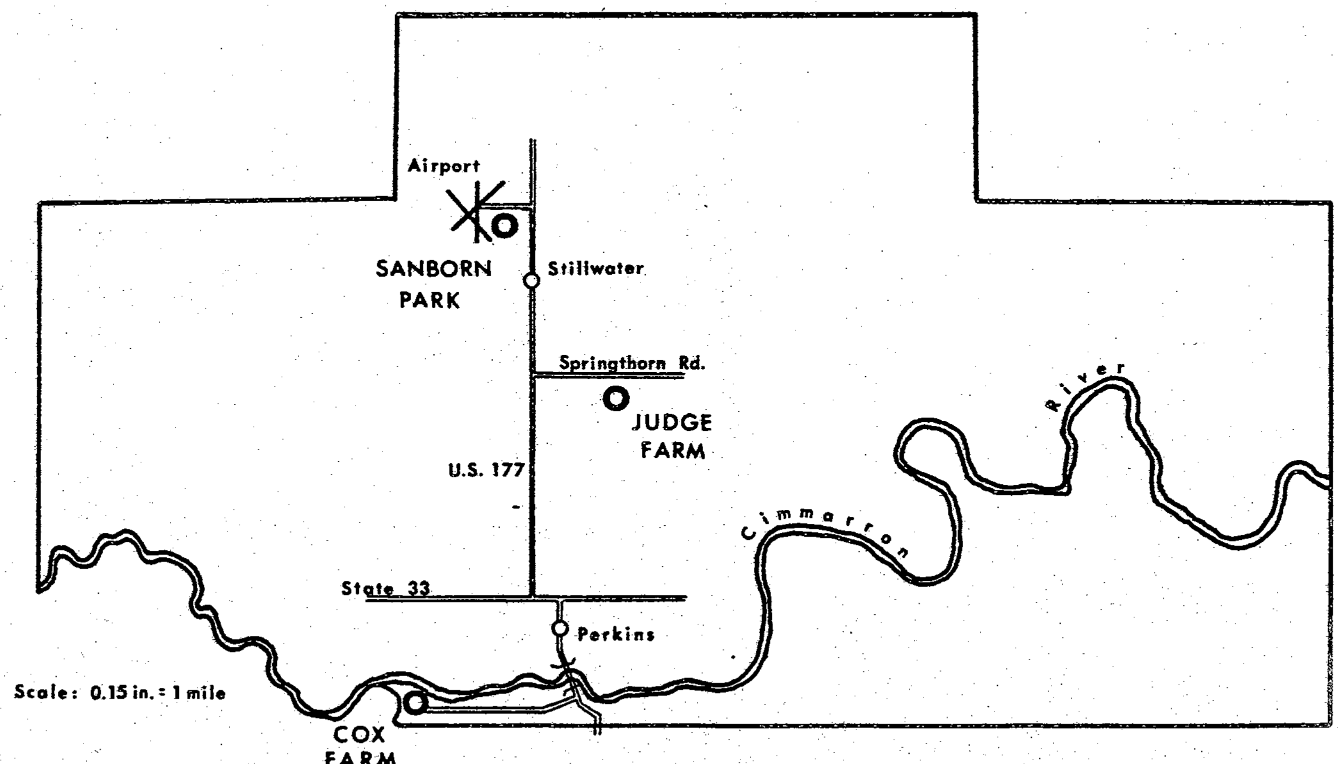

Figure 2. Map of Payne County, Oklahoma, showing excavation sites

agricultural practice. Pasture for beef cattle is of greatest extent, occupying over 65 per cent of the land, while cropland (principally wheat and barley) occupies only about 20 per cent. In recent years pastureland has increased (Buikstra 1968).

Climate

Payne County has a typical temperate continental climate with frequently unstable weather conditions. The growing season averages 213 days per year, with the last killing frost on March 31, and the first killing frost on October 20. The average annual temperature is 60.7 F (Buikstra 1968). There are no regular occurrences of long cold spells in winter, but extended periods of temperature near 100 F are not unusual during the summer. Rainfall is seasonal with approximately 75 per cent of the annual average (33.31 inches) falling in the spring and early summer. Prevailing winds are southerly during spring, summer, and fall, and northerly during the winter (Coryell 1952).

Topography

Payne County lies in the gently to moderately rolling prairie-woodland ecotone or "cross-timbers." Many ravines dissect the area and erosion is particularly evident in abused pasture situations. Elevation varies from 800 feet above sea level in the eastern portion to 1,150 feet in the western portion (Coryell 1952). Stillwater, the closest major city to all study sites, is 886 feet above sea level.

Soils

The hilly eastern portion of the county lies on shallow soils of the Hanceville-Conway Group of the Red and Yellow Podzolic soils with parent material of sandstone and shales. Soils of the undulating prairie regions of the central and western portions of the county, including the study sites, are classified in the Zaneis-Renfrow fine sandy loam and silt loam association of the Reddish Prairie soils. Parent materials are in the Red Beds formation. Soils generally are of red calcareous clay or sandy clay containing local strata of gypsum, limestone, and sandstone (Coryell 1952).

Recent soils data for the specific locations of pocket gopher excavations have been compiled (Soil Conservation Service 1970). Specifically, the Judge Farm, two miles south of Stillwater, is classified in the Renfrow-Kirkland soils group. These soils are deep and lie on gently to moderately sloping, eroded uplands with clay subsoils. Water erosion is a severe problem. On the Cox Farm, southwest of Perkins, Yahola fine sandy loam prevails. These soils are deep, reddish-colored, and well-drained. Wind erosion is more severe than water erosion. On the Sanborn Lake property, two miles north of Stillwater, Renfrow silt loam prevails. The lack of slope, coupled with the clay subsoil result in a tightly packed soil that takes water very slowly. Erosion is not severe on upland sites.

Vegetation

The upland forest is composed almost entirely of post oak (*Quercus stellata*) and blackjack oak (*Q. velutina*). Eastern red cedar (*Juniperus virginiana*) is common along field borders and in woodland clearings. Bottomland timber includes pecan (*Carya* sp.), elm (*Ulmus americana*), and cottonwood (*Populus deltoides*) (Coryell 1952).

In the prairie regions of Payne County, the single most dominant species is little bluestem (*Andropogon scoparius*). Other prominent prairie grasses include big bluestem (*A. gerardii*), switchgrass (*Panicum virgatum*), Indiangrass (*Sorghastrum nutans*), buffalo grass (*Buchloe dactyloides*), purpletop (*Tridens flavus*), and gramas (*Bouteloua* spp.). Weed species include sunflower (*Helianthus petiolaris*), yarrow (*Melilotus officianalis*), and nightshades (*Solanum* spp.) (Coryell 1952, Buikstra 1968).

Northwestern Oklahoma

All research in northwestern Oklahoma was conducted on the 3600-acre Southern Plains Experimental Range, three miles north of Fort Supply, Woodward County, Oklahoma. The study area itself lies principally in Harper County, Oklahoma. The North Canadian River forms the southern border of the area, and U.S. Highway 183 forms the western border. A map of the study area is shown in Figure 3.

History of the Area

The Southern Plains Experimental Range is a research unit of the U.S. Southern Great Plains Experiment Station, Woodward, Oklahoma. The range was acquired by the Experiment Station in 1941 for use in the investigation of different systems and intensities of grazing with beef cattle in the sagebrush range type (Trowbridge 1941). The land has since been fenced into a variety of replication study units.

Regional Land-use

Agriculture is the basis for the economy of the region. Grain farming, principally wheat, and beef cattle ranching are the main sources of income (Nance 1960).

Climate

The climate of Harper County is continental. Temperatures vary greatly and are likely to change rapidly. Summer temperatures often rise to between 100 F and 105 F. Humidity is low, and nights are cool. In winter the temperature occasionally drops to -15 F, but extended periods of extreme cold are rare. Average rainfall is 22.20 inches per year, with records of 11.11 inches (1954) and 35.81 inches (1941). The frost-free season lasts for approximately

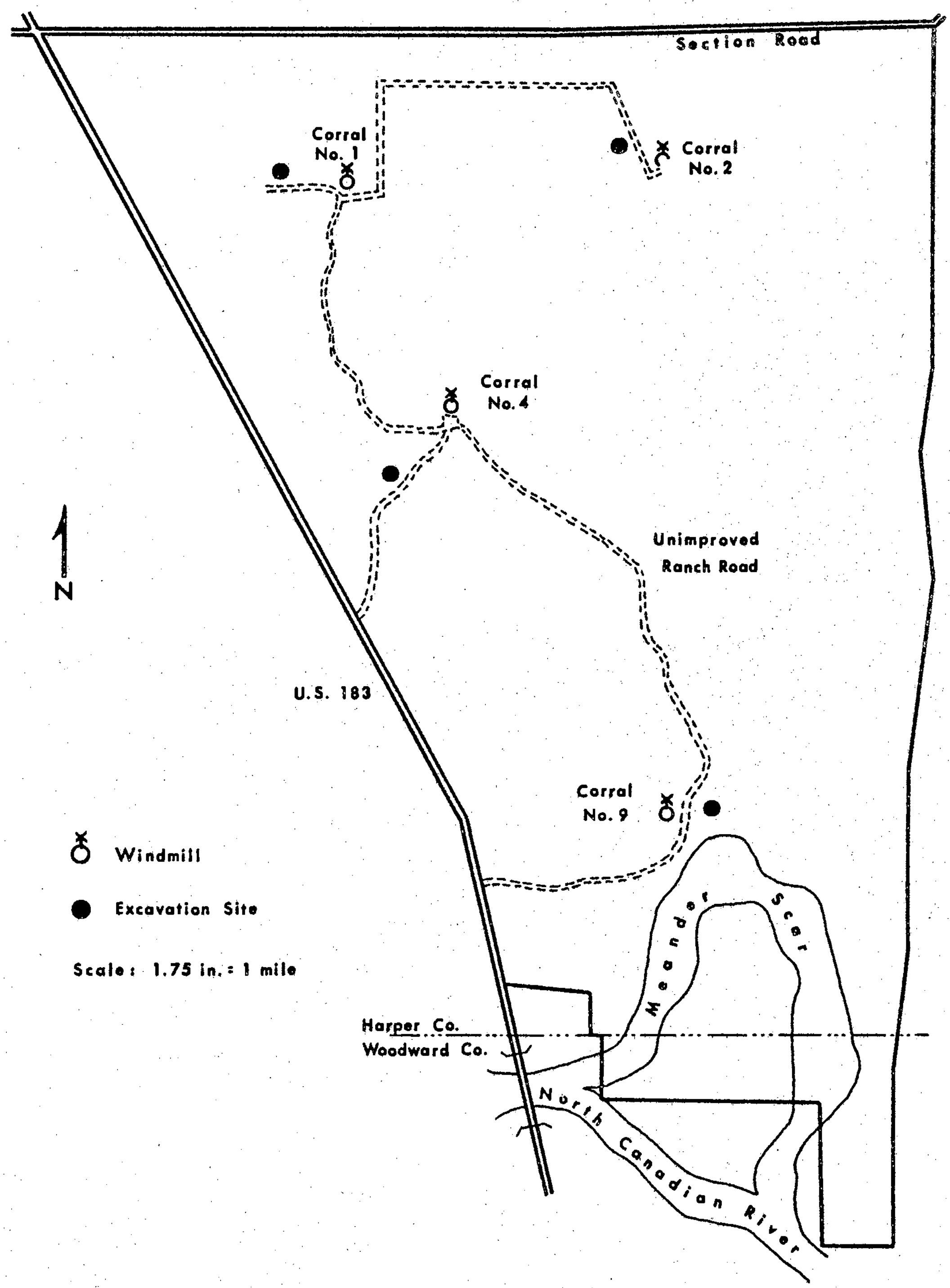

Figure 3. Map of the Southern Plains Experimental Range, showing excavation sites

190 days, with the average date of the last killing frost April 13, and the average date of the first killing frost October 20 (Nance 1960). Prevailing winds are southerly and consistently quite strong.

Topography

Harper County lies on a dissected plain of rolling prairie, with stabilized dunes paralleling the north bank of the North Canadian River. Elevation at nearby Buffalo, Oklahoma is 1791 feet above sea level (Nance 1960).

Soils

Most of Harper County is underlain by redbeds of soft, weakly consolidated, reddish sandstone and silty or loamy rock (Nance 1960). Broad areas of the North Canadian, including the study area, have an overlying mantle of sand.

The Southern Plains Experimental Range lies predominantly on windblown sands and alluvial beds of the Pratt and Tivoli-Pratt-Otero soil associations. Pratt soils are characterized by a deep surface soil of brown or light-brown sandy-loam or loamy sand, and a subsoil of brown to reddish-brown sandy loam or loam. The Tivoli-Pratt-Otero association is generally very light-colored loamy fine sand or sand to a considerable depth (Nance 1960). These sandy soils are rapidly permeable, quick to dry, and subject to wind erosion. Water erosion is of much less consequence. Pratt soils are suitable for cultivation on level or gentle slopes, while the sandier Tivoli-Pratt-Otero soils are generally suitable only for grazing (Nancé 1960).

Within the Pratt associations, divisions are based upon slope. Designations include: (1) level and riverwash (slope 0-1 per cent), undulating (slope 0-4 per cent), hummocky (4-8 per cent), and duny (slope 8-30 per cent) (Nance 1960). Generally, the steeper slopes are less densely vegetated.

Vegetation

Sandsage (*Artemesia filifolia*) is the dominant vegetation type for the study area. Native shortgrass prairie species that are common include little bluestem (*Andropogon scoparius*), sand dropseed (*Sporobolus cryptandrus*), blue grama (*Bouteloua gracilis*), buffalo grass (*Buchloe dactyloides*), and mat sandbur (*Cenchrus pauciflorus*). Bottomland woody vegetation is principally sandbar willow (*Salix interior*), cottonwood (*Populus deltoides*), and tamarack (*Tamarix gallica*) (Nance 1960).

CHAPTER III

METHODS AND MATERIALS

The burrowing habits of pocket gophers were studied chiefly by excavation. Animals were collected at each dig site. Population estimation was limited to the mound-count method. A more-detailed discussion of the methods is included below.

Selection of Study Sites

It is well-known that pocket gophers typically inhabit sandy soils where acceptable vegetation is present (Davis et al. 1938, Downhower and Hall 1966). The vastness of such areas in Oklahoma prohibited detailed randomization-selection of study areas. Therefore, excavation sites were established arbitrarily, based primarily on: (1) presence of gophers as indicated by fresh mounds, (2) accessibility and cooperation of land-owners, and (3) difference from other selected areas.

Location of specific sites for mound-count study within broader areas was mechanical. A grid was sketched over aerial photographs, and numbers were assigned to graticular intersections. A table of random digits (Snedecor and Cochran 1967) was used in the selection process.

Vegetation Analysis

An extensive analysis of vegetation in the selected study areas was not possible in this study. However, basic information necessary for adequate description of the local habitat was obtained. At each location, the principal species were identified and visual abundance ratings were recorded. The number of plots varied, depending upon observable diversity of vegetation. Selection of quadrats was random, using a table of random digits on a four-foot grid. Quadrats were taken until the representative species were listed.

Soil Analysis

Soil samples were taken at each excavation site and analyzed for percentage sand, silt, and clay. Soil samples were not taken in areas where mound-counts were conducted. Samples were taken at the average tunnel depth for each location. Soil samples were analyzed by the staff of the Department of Agronomy Soils Laboratory, Oklahoma State University, Stillwater.

Excavation of Tunnels

Scheffer (1910) stated that it is practically impossible to determine the limits of gopher burrows except where an invader has recently established in new territory. The apparent validity of this theory led to the personal selection of tunnels that were excavated in the present study. Therefore, tunnel systems (as evidenced by earth mounds) that appeared isolated from other gopher activity were excavated. One exception was made in a heavy mound-accumulation area on the Southern Plains Experimental Range in northwestern Oklahoma.

Prior to actual digging, all signs of surface activity, including mounds and earth plugs, were mapped and staked with one-fourth-inch diameter welding rods. Flagging material was attached to each stake. Different colors of flagging represented mounds, earth plugs, and the approximate path of the main tunnel. A similar method was used by Downhower and Hall (1966).

Macabee gopher traps were then set in the tunnel (Fig. 4) and maintained until no new mounds appeared. Frequently the animal was taken the first night, but traps were left at least one additional night to assure that no gophers remained. Hansen and Remmenga (1961) and Reid et al. (1966) reported that 2 or 3 days was sufficient to remove all gophers in a tunnel system. It was necessary to remove the gophers from the burrow systems prior to excavation, since the animals persistently plug passages to escape intruders (Miller 1957).

Excavation was begun at one of the mounds, and exploration then proceeded in both directions to termination. Breckenridge's (1929) observation that tunnels were sealed so tightly at the mounds that direction could not be found

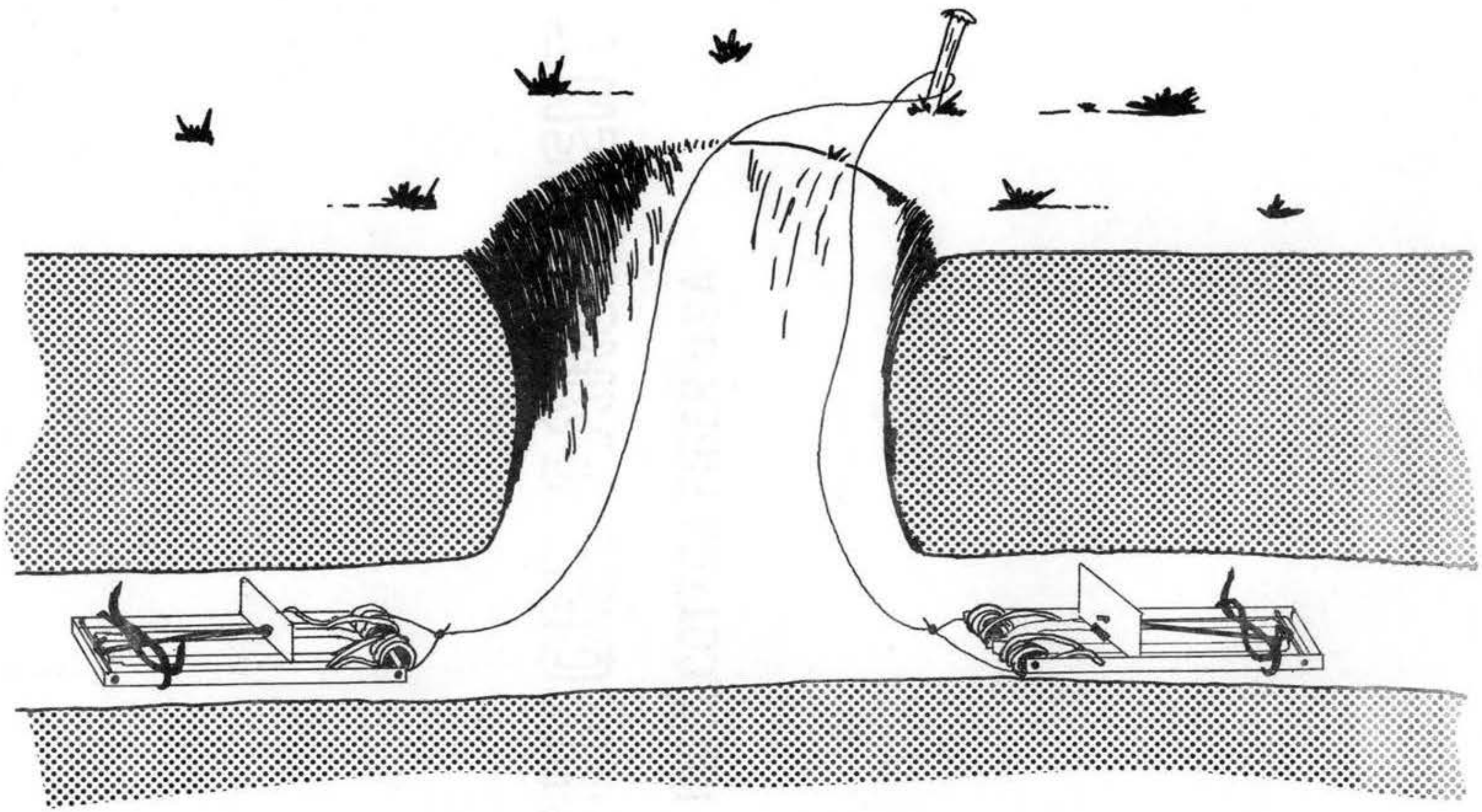

Figure 4. Technique for trapping pocket gophers (Crouch 1942)

was not applicable in this study. Some authors have reported the use of a stiff probe to locate the tunnel directly from the surface without actually exposing the passages (Howard and Childs 1959, Hansen and Remmenga 1961). This method was found unreliable in the present study. By beginning at a mound, the exit tunnel, although loosely plugged, was easily located. Subsequently, the main tunnel was found. Tunnels can also be easily located by digging a one-foot-deep hole between two closely-spaced mounds.

The entire length of the passage-ways was exposed. The method of horizontal probing with a light wire, as described by Arlton (1936) in a study of the eastern mole (Scalopus aquaticus), has limited value in exploring pocket gopher tunnels. It is possible that many side branches would be overlooked between the holes that were dug. More importantly, the downward branches that could possibly lead to nest sites would also be neglected.

The most effective method found for exposing the tunnels begins with the digging of a large, bushel-basket-sized hole across the passageway. The investigator then straddles this hole and begins cutting along the tunnel pathway with a four-pound cutter mattock, pulling the soil behind him. This method allows the investigator to observe all sections of the network, while filling the unsightly ditch as he works. This procedure results in a minimum amount of site disturbance, and no doubt would have arrested some apprehension among landowners if it had been utilized at the beginning of the study.

Data were recorded during excavation, and details were added to the mound map prepared on gridded chart paper prior to digging. Tunnel direction, diameter, and depth were recorded whenever a change was noticed. In accordance with the methods described by Davis et al. (1938) and Downhower and Hall (1966), tunnel diameter was measured vertically, and tunnel depth was measured from the ground surface to the bottom of the tunnel.

Mound-Count Census Method

Various authors have expressed interest in the estimation of pocket gopher populations by observing patterns of surface activity (Reid 1962, Richens 1965, Reid et al. 1966). Some of the methods involved transect counts of fresh diggings (Phillips 1936, Ingles et al. 1949, Howard 1961). Julander et al. (1959) determined the relative abundance of gophers by counting fresh mounds on 0.1-acre mechanically-located plots. Davis et al. (1938) counted lines or groups of gopher mounds, using one gopher per line or group as a census factor.

All methods of population estimation by observation of surface sign are based on the assumption that pocket gophers, regardless of species, are generally solitary except during the spring reproductive effort. This assumption is, in effect, fully accepted by investigators in the field (Davis et al. 1938, Crouch 1942, Ingles 1952, Downhower and Hall 1966). Scheffer (1910) cited plural occupancy in a number of tunnels, even in the fall, but he conceded that this was not the general rule.

Mound-count census evaluation was attempted on three study plots in the Stillwater area during this study. Four short-term mound-count censuses were conducted on the Southern Plains Experimental Range. The method employed consisted of a modification of that described by Reid (1962) and Reid et al. (1966).

The one-fourth acre plots selected for mound-counts were gridded into four-foot squares. Flagging of old mounds was impractical, since cattle persistently ate all flagging material. Therefore, all mounds within the plot were destroyed by scattering the cast soil. At 48-hour intervals, the plots were revisited, and new mounds were recorded on a gridded field map. All fresh gopher signs were then destroyed by scattering the soil after determining mound volume.

CHAPTER IV

RESULTS AND DISCUSSION

Vegetation and Land-use

Forty-three square-meter quadrats were surveyed during the study. The number of quadrats per study site varied from three to ten, depending on the observable degree of uniformity of the vegetation. A listing of the principal species and their respective abundance at each excavation site is presented in Table I. Nomenclature follows Britton and Brown (1913).

Vegetation supplies food to the pocket gopher. Although food habit analysis was not a part of this study, some notable observations were made. In Payne County, the Cox Farm study site was completely devoid of perennial forbs which might supply fleshy rootstocks to gophers. The area was cleanly farmed, and densely covered by wheat-bermuda grass pasture. In spite of this, gopher activity was pronounced even at considerable distances from weedy fencerows. Evidently, the gophers were either consuming roots of these grasses or surface-feeding on the leaves. The latter is possible, since the wheat was green and succulent during much of the winter. However, surface

TABLE I

REPRESENTATIVE PLANT SPECIES, PER CENT FREQUENCY, AND RELATIVE ABUNDANCE ON EACH ONE-FOURTH ACRE STUDY SITE

Location	Species	No. m^2 Quadrats	Per Cent Frequency	Relative Abundance
N. C. Okla.				
Judge Farm		10		
	Bluestem (*Andropogon scoparius*)		40	Common
	Fescue (*Festuca octoflora*)		30	Common
	Brome Grass (*Bromus* sp.)		40	Occasional
	Johnsongrass (*Sorghum halepense*)		30	Common
	Sunflower (*Helianthus petiolaris*)		20	Occasional
	Psoralea (*Psoralea linearifolia*)		10	Occasional
	Mugwort (*Artemesia ludoviciana*)		30	Common
	Nightshade (*Solanum torreyi*)		30	Occasional
	Yucca (*Yucca glauca*)		10	Local
	Alfalfa (*Medicago sativa*)		10	Rare
Cox Farm		5		
	Wheat (*Triticum aestivus*)		100	Abundant
	Bermuda Grass (*Capriola dactylon*)		100	Abundant
	Sandbur (*Cenchrus pauciflorus*)		80	Common
Sanborn Lake		10		
	Bluestem (*Andropogon scoparius*)		80	Abundant
	Bluestem (*Andropogon saccharroides*)		50	Common
	Three-awn (*Aristida oligantha*)		60	Common
	Switchgrass (*Panicum virgatum*)		30	Occasional
	Bristle grass (*Setaria geniculata*)		30	Occasional

TABLE I (continued)

Location	Species	No. m^2 Quadrats	Per Cent Frequency	Relative Abundance
N. C. Okla.				
Sanborn Lake (continued)	Brome grass (*Bromus catharticus*)		10	Rare
	Purple-top (*Echinochloa crusgalla*)		30	Occasional
	Love-grass (*Eragrostis curvula*)		20	Occasional
	Johnsongrass (*Sorghum halepense*)		10	Locally-Com.
	Fescue (*Festuca octoflora*)		20	Rare
	Yarrow (*Achillea lanulosa*)		10	Rare
	Melilot (*Melilotus officianalis*)		40	Common
	Psoralea (*Psoralea tenuiflora*)		20	Rare
	Barley (*Hordeum pusillum*)		40	Common
	Multiflora Rose (*Rosa multiflora*)		10	Fencerow
Northwestern Oklahoma				
Entrance		5		
	Bluestem (*Andropogon scoparius*)		80	Abundant
	Grama (*Bouteloua gracilis*)		60	Common
	Buffalograss (*Buchloe dactyloides*)		80	Abundant
	Sandsage (*Artemesia filifolia*)		60	Common
	Queen-root (*Stillingia sylvatica*)		20	Occasional
	Thistle (*Cirsium* sp.)		20	Occasional
Corral No. 1		3		
	Sandsage (*Artemesia filifolia*)		100	Abundant
	Buffalograss (*Buchloe dactyloides*)		100	Abundant
	Prickly Pear (*Opuntia humifusa*)		33	Occasional
	Nightshade (*Solanum* sp.)		33	Occasional

TABLE I (continued)

Location	Species	No. m^2 Quadrats	Per Cent Frequency	Relative Abundance
Northwestern Oklahoma				
Corral No. 2		5		
	Sandsage (*Artemesia filifolia*)		80	Common
	Buffalograss (*Buchloe dactyloides*)		100	Abundant
	Grama (*Bouteloua gracilis*)		80	Abundant
	Plantain (*Plantago purshii*)		20	Occasional
Corral No. 9		5		
	Sandsage (*Artemesia filifolia*)		100	Abundant
	Bluestem (*Andropogen scoparius*)		60	Common
	Buffalograss (*Buchloe dactyloides*)		80	Abundant
	Evolvulus (*Evolvulus pilosus*)		20	Rare
	Sand Dropseed (*Sporobolus cryptandrus*)		20	Occasional
	Plantain (*Plantago purshii*)		40	Occasional
	Prickly Pear (*Opuntia humifusa*)		20	Occasional
	Thistle (*Cirsium* sp.)		20	Occasional

feeding has not been recorded as a significant activity of the plains pocket gopher (Downhower and Hall 1966). Diggings of the coyote (Canis latrans) were repeatedly found in this area, suggesting that gophers may have been attractive to these predators.

On the Judge Farm and at Sanborn Lake, grasses were common, but large-rooted forbs were also present. Species that definitely were utilized at these two sites included Johnsongrass, alfalfa, multiflora rose, and yucca. Gopher-damaged rootstocks of these plants were found in the tunnels themselves, either in situ or detached and stored in the tunnel. The yucca appeared to provide an exceptionally desirable food supply. On the Judge Farm, approximately 100 feet of connecting tunnels and a maze of intersections was traced in a 50-foot-square area where numerous yucca plants were located. These tunnels were within one inch of the ground surface and were easily traceable by surface ridges much like those raised by the eastern mole (Scalopus aquaticus). This is also significant in that Scheffer (1910) stated that the feeding tunnels of the plains pocket gopher "never show in surface ridges."

In the study area in Harper County, the vegetation is chiefly sandsage-grassland. Sandsage evidently supplies the bulk of the food for gophers in this area. Numerous cuttings on the large taproots were observed. Near Corral No. 2, two pieces of sandsage root, each exceeding one foot in length, were found completely severed and lying horizontally in the tunnel.

Surface activity was confirmed in the Harper County area. In the burrows at Corrals No. 1 and 2, small caches of buffalo grass leaves were found. The chambers were much too small for nests, so it is assumed that this plant constituted an undetermined portion of the diet of the gophers. In addition, three small pellets of cattle dung were found in the tunnel near Corral No. 9.

The relationship of vegetation and land-use to gopher abundance is interesting. By observation and by literature review, it is apparent that gophers do well in grazed or mowed situations. The constant cropping of the aerial portions of certain plants may trigger physiological reactions in the plant, resulting in larger rootstocks which would be more attractive to gophers. Reduction of competition for light and space might also allow perennials characteristic of intermediate successional stages to thrive. These plants often develop large rootstocks and would provide considerable food for gophers.

Intensive cropland cultivation usually results in a reduction of gopher activity, probably due to the elimination of desirable foods and the mechanical interference with burrowing (Crouch 1942, Anon. 1960). Replacement of the sandsage-grassland type with high-yield lovegrass pasture on the Southern Plains Experimental Range (Fig. 5) has resulted in a reduction of gopher activity. Gopher

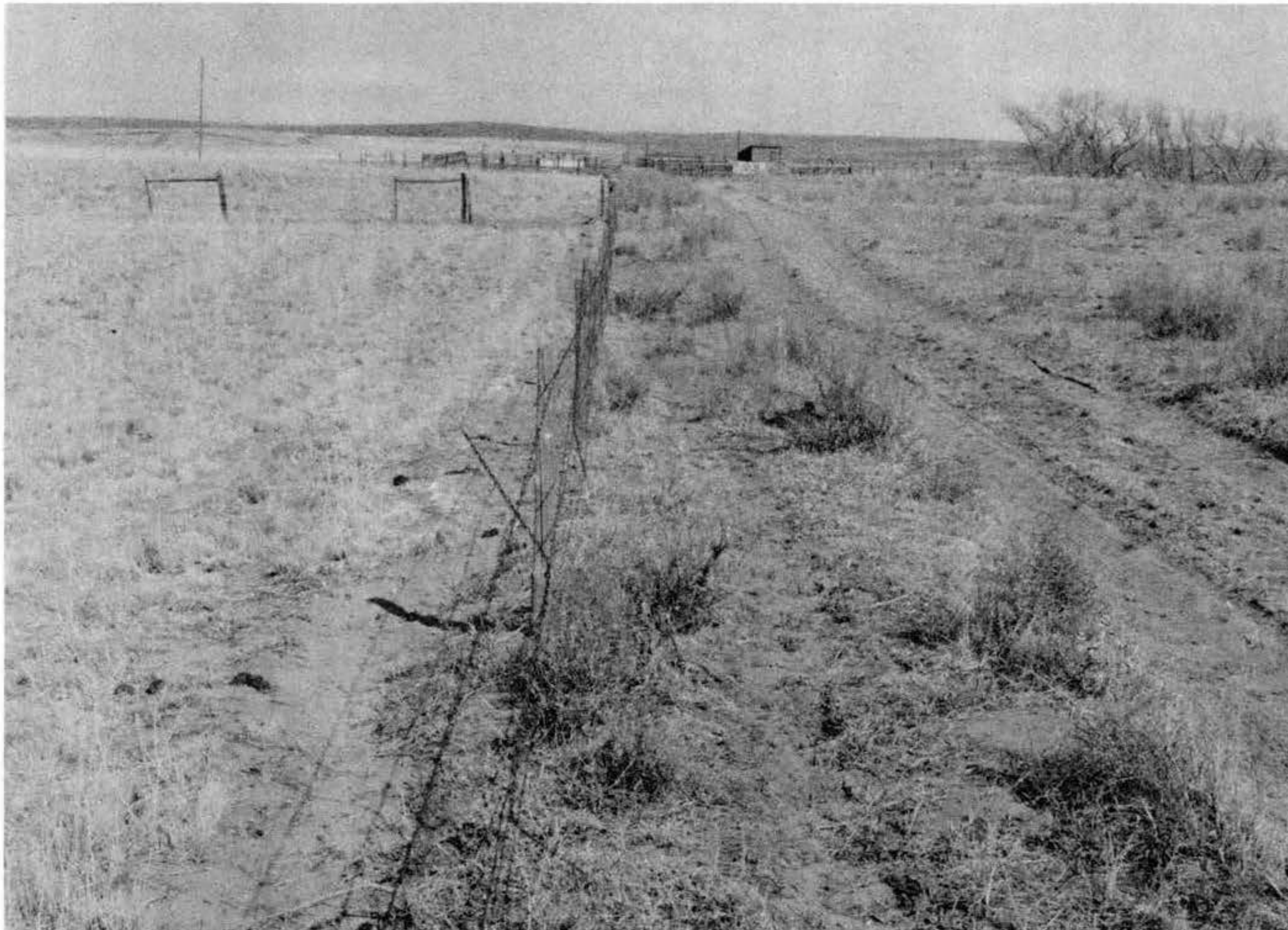

Figure 5. Land-use practices that affect gopher activity - Lovegrass pasture (Left) and moderately-grazed sandsage-grassland (Right)

mounds numbered in excess of 500 per acre in the sandsage type, while no mounds were found in the lovegrass pasture except along field borders. McMurry (1943) reported that the mowing of sandsage reduced gopher activity, but observations during this study did not verify this. If this practice resulted in a significant reduction in the amount of sandsage, gophers probably would move, since sandsage seems to be the largest single contributor of food.

On the Cox Farm in Payne County, high-yield pasture culture did not inhibit gopher activity. The explanation for this is unknown. Other study sites in Payne County presented predictable results. The Judge Farm was moderately grazed, and gophers were common. The Sanborn Lake property was not grazed, nor recently mowed, and gophers were found only near disturbed areas along fencerows. Interaction of vegetation with other components of the environment, such as land use and soil composition, obscures true causal agents of gopher activity.

Soil Analysis

The mechanical composition of soil is an important determinant of gopher activity. Crouch (1942) stated that tight sticky soils high in clay content are unattractive to gophers. Loose sandy soils provide excellent gopher habitat (Davis et al. 1938, Glass 1952). Data were collected in this study for comparison (Table II).

TABLE II

MECHANICAL SOILS DATA FOR POCKET GOPHER STUDY SITES IN OKLAHOMA, 1969-70

	Soil Composition Per Cent		
Location	Clay	Silt	Sand
Northcentral Oklahoma			
Judge Farm	13.75	43.73	42.52
Cox Farm	5.00	23.30	71.70
Sanborn Lake	12.50	66.58	20.92
Northwestern Oklahoma			
Entrance	3.75	4.30	91.95
Corral No. 1	3.75	3.63	92.62
Corral No. 2	5.00	8.28	86.72
Corral No. 9	3.75	7.90	88.35

Downhower and Hall (1966) determined that the plains pocket gopher in Kansas occurs only in soils composed of less than 30 per cent clay and more than 40 per cent sand. In Oklahoma, none of the study sites contained soil composed of more than 13.75 per cent clay, although the Sanborn Park study site contained only 20.92 per cent sand. The mere presence of pocket gophers at Sanborn Park is evidence that the findings of Downhower and Hall (1966) do not universally apply. However, the very slight level of activity, plus the observation that gophers seldom worked away from field borders at this site, indicate that the food supply (rootstocks of multiflora rose) explained their presence. It is opined that gophers would otherwise not be present on this particular site at all, and that the figures reported by Downhower and Hall (1966) are generally quite acceptable for Oklahoma. It should be noted, however, that pocket gophers are occasionally found in clay soil (Glass 1952). More research is needed to establish limiting factors of distribution.

The destruction of soil profiles and the alteration of soil structure by human activity was suspected of having an effect on the level of pocket gopher activity. Observations during the present study could neither confirm nor deny this. Probes of tunnels near buildings and fence posts on the Southern Plains Experimental Range revealed no strikingly different depth nor extent of burrows. Pronounced gopher activity on graded areas such as highway rights-of-way are thought to be as much a function of mowing practices and altered flora as of disturbed soil, since it has been shown that gophers will invade less desirable soils, regardless of structure, to obtain a select food supply.

Excavation of Selected Tunnels

The burrow system of the pocket gopher has been described as consisting of two types of tunnels. The foraging tunnels lie within a few inches of the ground surface and cover a vast area. Lateral branches from these subsurface runways lead to surface mounds. The deep tunnels are much less extensive, localized, and characteristically have nest chambers, food caches, and several connecting passageways (Miller and Bond 1960, Downhower and Hall 1966). In the present study, this distinction between two types of tunnels in one burrow system was not evident. Much of the tunnel was within a few inches of the ground surface, but there were deeper sections of tunnel. However, these deeper areas were not singular in occurrence, nor abrupt in design. A discussion of the findings follows.

Burrow System Diagram

Six tunnel systems were excavated during the fall and winter of 1969-70 in northcentral and northwestern Oklahoma. Complete diagrams of these tunnels are presented in the Appendix.

All of the tunnels studied had some common characteristics. A diagram has thus been prepared which incorporates these features into a "typical" burrow system of the plains pocket gopher in the study areas (Figure 6).

Tunnel Dimensions

Data were collected during excavations to determine the locus of activity, the size of tunnels, and the depths to which gophers work. These data are summarized in Table III. Data for the Cox Farm site were collected by probes rather than complete excavation.

The deepest tunnel section recorded in the study (36 inches) occurred at Sanborn Lake, the site of the lowest level of gopher activity of all tunnels excavated.

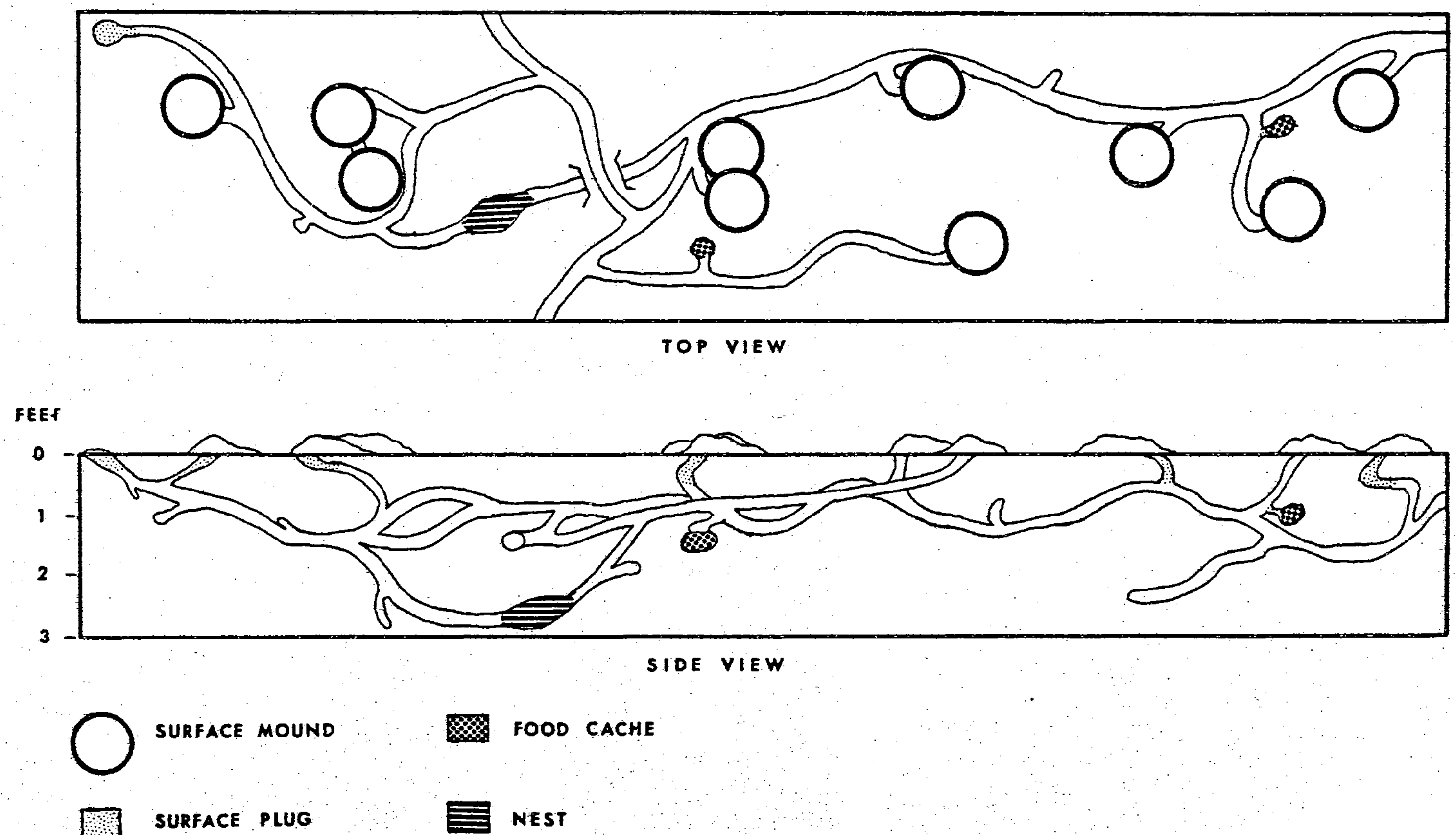

Figure 6. Author's conception of a typical pocket gopher burrow system in established mound areas of northcentral and northwestern Oklahoma during the winter of 1969-70

TABLE III

DIMENSIONS OF POCKET GOPHER TUNNEL SYSTEMS EXCAVATED IN NORTHCENTRAL AND NORTHWESTERN OKLAHOMA DURING FALL AND WINTER, 1969-70

Location	Depth (in.) $\bar{X}$	Depth (in.) range	Diameter (in.) $\bar{X}$	Diameter (in.) range	Dist. between mounds (ft.) $\bar{X}$	Dist. between mounds (ft.) range	Total length of tunnel (ft.)	Approximate area covered by system (sq. ft.)
Northcentral								
Judge Farm	7.8	0-15.4	2.8	2.0-4.0	9.7	1-28	383	20,000
Cox Farm	9.5	1.6-16.1	2.8	2.2-3.7	5.3	1-16	---[1]	---[1]
Sanborn Park	18.7	0-36.2	2.9	2.2-3.7	7.1	1-17	97	1,500
Northwestern								
Entrance	8.6	5.5-10.2	2.8	2.4-3.3	4.6	1-12	75	800
Corral No. 1	15.0	12.6-18.1	2.9	2.6-3.7	3.6	1-7	25[2]	200[2]
Corral No. 2	16.2	0-28.3	3.1	2.0-5.1	7.7	2-15	68	1,200
Corral No. 9	14.3	7.1-30.7	2.8	2.2-4.5	5.2	1-11	237	2,500

[1]Unable to obtain permission for unlimited excavation.
[2]Incomplete excavation. Tunnel lost beneath road.

However, the average depth of tunnels in the northwestern study area (13.5 inches) was slightly greater than the average of those in the northcentral area (12 inches). The soil on the Harper County area was much sandier than the soil in Payne County. It is thought that looseness associated with high sand content is the best explanation for the greater average depth in Harper County.

Average depths at both areas are greater than those reported for the plains pocket gopher in Kansas. Downhower and Hall (1966) reported the mean tunnel depth to be approximately nine inches. Howard and Childs (1959) suggested that in warmer climates, gophers may work deeper than in cooler regions. Average annual temperatures in Oklahoma are slightly higher than in Kansas. Also the fact that deep sections of tunnel occurred frequently rather than locally as reported by Downhower and Hall (1966), could explain the greater average depth noted in Oklahoma. Scheffer (1931) also noted that tunnels of Kansas pocket gophers average less than one foot beneath the surface.

The maximum tunnel depth recorded during this study (36 inches) is considerably less than the 65-inch depth recorded for the plains pocket gopher in Kansas (Downhower and Hall 1966). However, there was some indication that gophers tunneled in excess of the recorded 36-inch maximum depth on the Southern Plains Experimental Range in northwestern Oklahoma. At the entrance to the area, a

55-foot-long tunnel was excavated. This tunnel had been totally plugged by gophers, and it was traceable only by the striking color difference between the two soils (Figure 7). The light-colored soil must have come from the "C" horizon in this particular location. The "C" horizon begins at approximately 45 inches depth, and may continue downward for several feet (Nance 1960). If a deeper tunnel existed, it was not located. Miller and Bond (1960) recorded instances of deep burrowing of Thomomys during summer, with the soil being deposited in unused foraging tunnels rather than on the ground surface.

The maximum length recorded for a single burrow system, including all side branches, was 383 feet. This particular tunnel was unusual in that about 100 feet of this length meandered about in a small area, marked by conspicuous surface ridges.

The average length of all tunnels was 176 feet. Downhower and Hall (1966) described five complete burrow systems of Geomys ranging from 14 feet to 510 feet in length, averaging 250 feet. Miller (1957) excavated nine burrow systems of Thomomys, the longest of which was 275 feet. Crouch (1942) stated that individual systems of pocket gophers as a group often exceed 800 feet. Ingles (1952) found no tunnel system of Thomomys exceeding 120 feet in length.

The area covered by burrow systems was also estimated. The Judge Farm burrow system was quite extensive

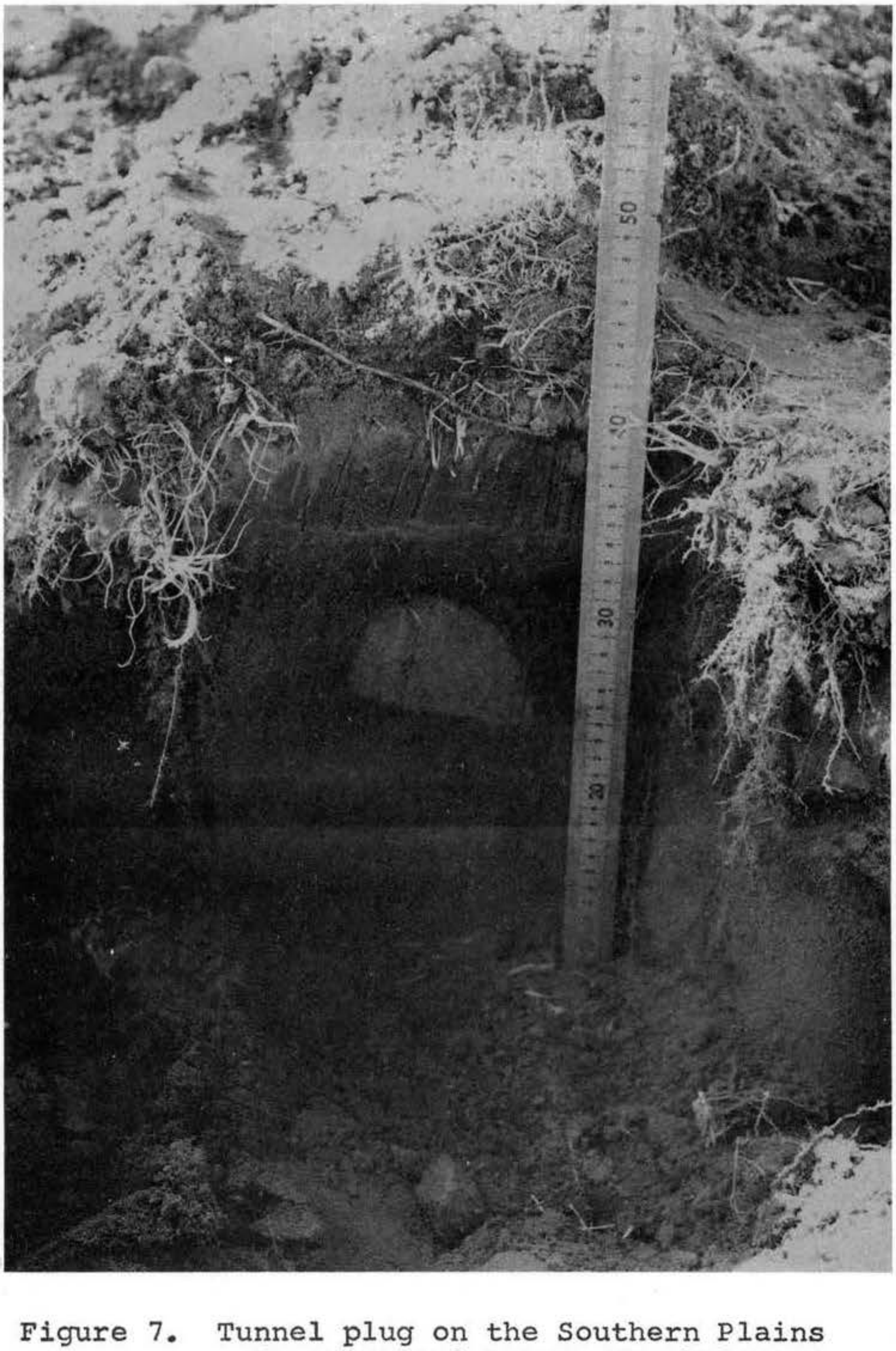

Figure 7. Tunnel plug on the Southern Plains Experimental Range, Northwestern Oklahoma, March 25, 1970

(approximately one-half acre) due to its great length and its meandering course. The average land area estimated for a single gopher was 5,500 square feet, or about one-eighth acre. Ingles (1952) found that the area worked by one gopher (Thomomys) ranged 80-2,016 square feet.

It appeared that in areas where the food supply was good, the burrows were less extensive. That is, if many choice food plants were present on a small area, that area would be worked thoroughly by a foraging gopher. Conversely, on areas where choice food plants were sparse, gophers would be forced to continue burrowing toward other desirable plants. Both of these situations are illustrated in the diagram of the burrow system at Judge Farm (Appendix). The long, uni-directional portion of the tunnel occurred beneath mixed pasture grasses and occasional forbs. When the tunnel reached the small concentration of yucca plants, it became a maze of connecting runways among the roots of the yucca. Further, the Corral No. 9 burrow system in Harper County showed a similar pattern among sandsage plants.

Nests

Nest construction in a deep, localized network of runways within the vaster foraging network has been described by a number of investigators (Criddle 1930, Crouch 1942, Downhower and Hall 1966). Invariably, these descriptions indicate that nests are well-formed, ovoid chambers lined with grasses. In the present work, no such distinct chamber was found. However, four-burrows (Corrals No. 1, 2, 9, and Sanborn Park) each contained one enlarged section of tunnel about 15 inches long and four inches in diameter. Only small amounts of material suitable for nest-lining were found in these enlarged areas, and it is questionable that they were indeed nests. Miller (1957) observed that nests of Thomomys occasionally have very little nest material. Downhower and Hall (1966) reported one tunnel system that had no nest, and noted that it was the home of a male gopher. They proposed that males may not construct nests. The peculiar expanded sections of tunnel described in the present study were found in the tunnels of one male and three females. Further study is needed to prove nest construction by both sexes.

Food Caches

Food storage is a well-documented behavioral pattern for most pocket gophers (Wade 1927, English 1932, Ward 1942, Ingles 1952, Downhower and Hall 1966). The type of food cached is as varied as the plant life in the particular habitat. Food caches were found in all burrow systems except on Cox Farm and the site near the entrance to the Southern Plains Experimental Range. Caches found were small, spherical chambers about three inches in diameter and placed in short dead-end lateral spurs from the main tunnel. Often the caches were near mounds.

A small concealed cache of fresh Johnsongrass roots was accidentally exposed during excavation at Sanborn Park. The fact that this cache had been sealed from the main tunnel by a well-packed plug of earth indicates that other caches may not have been found. A considerable amount of food must be present in the tunnel system if the occupants are to cease surface activity for extended periods in the spring and early summer.

Tunnel Plugs

The pocket gopher frequently fills certain passageways in its underground burrow system with soil (Fig. 7). A number of these earthen plugs were found in the present study. Mention has been made of the sealing of food caches, but plugs were also noted beneath surface mounds, at surface termination of runways, and in the main tunnel itself.

Miller (1957) stated that the precise reasons for sealing portions of the burrow system are unknown. He suggested that gophers may be sensitive to light, drafts, and temperature changes, or that the plug functions as a predator-proofing mechanism. Howard and Ingles (1951) observed plugs in main runways and suggested that the extremely solitary nature of gophers requires isolation from neighboring gophers. In areas of high-level gopher activity, with several animals per acre, the isolation mechanism could well take the form of plugged passageways.

Mohr and Mohr (1936) noted that gophers probably can hear their neighbors at considerable distances through the soil, and that territories may extend beyond the confines of the tunnel. This may not be applicable when a single main tunnel is very long, for the occupant could be far from where a neighbor would accidentally intercept its burrow. Crouch (1942) suggested that tunnels may frequently intercept other tunnels in high-use areas. It seems reasonable to suppose that encounters between two gophers would result in one animal being chased away with the escape passage then being plugged.

Near Corral No. 9, on the Southern Plains Experimental Range in northwestern Oklahoma, a high-use area was excavated to determine the mechanism by which individuals maintain their isolation. Traps were spaced around fresh mounds and three animals were removed. Exploration of one of the tunnel systems revealed a tightly-packed earthen plug about one foot from the surface at either end of the burrow. One of these plugs was traced eight feet, where it joined an open tunnel, presumably occupied by another animal. The plug on the opposite end of the excavated tunnel was lost after five feet, but it led toward the site where another gopher was captured. Apparently, pocket gophers do frequently plug passageways to escape intraspecific hostility.

Surface plugs were found beneath most mounds and at surface termination of main tunnels. No gopher tunnel that opened directly to the surface was found during the entire study. Surface plugs averaged about ten inches in length.

Study of Surface Mounds

Due to the high costs encountered in excavating gopher tunnels, other methods of assessing gopher activity are desirable. The mound-count is a commonly used criterion for such activity.

The estimation of populations of gophers by observing surface mounds has been recorded in a number of publications. Reid et al. (1966) expressed the necessity of conducting such analyses in the fall and winter, since the young would not be occupying parental burrows.

Several authors have correlated mound activity with numbers of gophers per unit area, obtaining fairly high coefficients (Mohr and Mohr 1936, Richens 1965, Reid et al. 1966). No regression was used in the present study, but the author would not disclaim similar outcomes. However, the applicability of these findings beyond the study sites, as suggested by other studies, is questionable. The endless array of ecological components of superficially similar habitats would limit such extensions of data.

Ellison (1946) estimated the populations of gophers per acre by dividing the number of square feet in an acre by the square of the average distance between mounds on a transect. This method is confusing, and it also is based on questionable assumptions. One of these states that the average distance between mounds represents the average diameter of the territory occupied by a single gopher. In the present study, this distance is approximately six feet. Excavations in the areas revealed territories of 0.1-0.5 acres, far exceeding the six feet necessary to meet the assumption. Therefore, such a method would result in substantial over-estimation of gopher numbers in these study areas.

Population Estimation

Population estimates modified from the 48-hour interval method described by Reid et al. (1966), were conducted near each excavation site. Data are summarized in Table IV. Since equal study time was not possible for each major area, these results are inconclusive. However, certain trends appear. Non-sandy soils (e.g., Sanborn Park) do not seem to support as many gophers as the sandier soils (e.g., Corral No. 9). It is also evident that as the density of mounds increases, the reliability of the estimate decreases. This variability of population size is indicated by the fluctuation of the range (Table IV), which in one case runs from zero to four animals. Clearly, these data support hypotheses by other investigators (Ingles et al. 1949, Miller and Bond 1960, Hansen and Remmenga 1961, Howard 1961) that mound rows simply are not conspicuous in areas of pronounced gopher activity.

TABLE IV

MOUND-BUILDING ACTIVITIES OF POCKET GOPHERS ON ¼-ACRE STUDY PLOTS IN NORTHCENTRAL AND NORTHWESTERN OKLAHOMA DURING FALL AND WINTER, 1969-70

Location	Dates	Number 48-hrs. estimates	Est. No. of gophers on ¼-acre plot $\bar{X}$	range	Number mounds present initially	Number mounds added in 48-hr. $\bar{X}$	range	Volume of soil cast in 48-hrs. (gal.) $\bar{X}$	range	Surface area covered in 48-hr.[1] (sq. ft.) $\bar{X}$	range
Northcentral Oklahoma											
Judge Farm	Dec.3-Mar.1	8	2	0-3	78	3	0-10	4	0-9	3	0-11
Cox Farm	Nov.7-Mar.1	11	3	0-4	142	12	0-25	6	0-10	14	0-28
Sanborn Park	Nov.4-Mar.1	6	1	0-2	47	1	0-11	1	0-5	1	0-12
Northwestern Oklahoma											
Entrance	Mar.18-Mar.24	2	2	0	137	3	2-4	3	2-4	3	2-4
Corral No. 1	Mar.18-Mar.24	2	4	3-5	177	14	10-18	8	6-11	16	11-20
Corral No. 2	Mar.18-Mar.24	2	2	0	26	1	0	1	0	1	0
Corral No. 9	Mar.18-Mar.24	2	5	3-7	248	19	15-23	15	9-20	21	17-26

[1]Average number new mounds in 48-hrs. x 0.6^2 ft. (average mound radius) x 3.14 (π).

Statements such as that by Mohr and Stumpf (1966) that "the course of the burrows usually is conspicuous by earth mounds" apply only in areas of recent, low-level gopher activity.

Projections of Data

The extent of gopher activity was quantified by determining the average volume and the average area covered by mounds (Table IV). Relative activity among the study sites is shown by the number of mounds present initially. The Sanborn Park property had the fewest mounds. Conversely, the undisturbed sandy sandsage sites in northwestern Oklahoma had great numbers of mounds per unit area. In fact, the figures presented for the northwestern area can only be estimates, since the entire ground surface appeared to have been recently worked by gophers. Trowbridge (1941) noted that areas of high-level gopher activity on the Southern Plains Experimental Range were as much as 80 per cent covered by mounds.

Projections based on mound data obtained in north-central and northwestern Oklahoma are presented in Table V. These figures are based on the assumption that gophers are equally active throughout the year. However, observations support the findings of recent studies (Downhower and Hall 1966) that gophers burrow actively only in the fall and spring. Thus, a more realistic estimate may be obtained by dividing the tabular calculations by two. Using this correction factor, the maximum soil quantity cast by one gopher per acre in one year is 1.3 tons (northwestern Oklahoma, Corral No. 9). This is far below the estimated 2.25 tons of soil reported by Downhower and Hall (1966). The limited sampling effort possible in obtaining data of this nature may explain this difference. Studies of western pocket gophers (Thomomys) consistently yield higher estimates (Ellison 1946, Miller 1957, Miller and Bond 1960). In both cases, the amount of soil redeposited is significant from an ecological standpoint. Downhower and Hall (1966) calculated that seven gophers on one acre of land could completely cover the ground surface with a loose layer of soil one inch deep in ten years.

TABLE V

ANNUAL ESTIMATES OF SOIL TRANSPORT BY POCKET GOPHERS, BASED ON DATA COLLECTED FROM OKLAHOMA, 1969-70

Location	Avg. No. gophers per acre	Average ground surface area covered by mounds of one gopher in one year (sq. ft.)	Average amount of soil cast per gopher per year (tons)
Northcentral Oklahoma			
Judge Farm	8	308.5	1.6
Cox Farm	12	822.6	1.7
Sanborn Park	4	205.7	0.9
Northwestern Oklahoma			
Entrance	8	308.5	0.9
Corral No. 1	16	720.3	1.8
Corral No. 2	8	102.8	0.5
Corral No. 9	20	781.9	2.6

McCullough (1962) reported in a study of 13 gophers on the Southern Plains Experimental Range, site of the present study, that each gopher turned an average of 182 mounds each winter. This datum is not directly comparable with the present findings. However, based on a 90-day winter and upon the average number of gophers per site studied, it was determined that each gopher turned 146 mounds in 1969-70 on the same area.

Temporal Activity Patterns

Gophers were active throughout the study. Winter inactivity periods (December 20-February 13) reported by Downhower and Hall (1966) in Kansas were not evident in Oklahoma, although a reduction in activity was apparent during brief periods of cool temperatures. Crouch (1942) reported that gophers in the Southwest (including Oklahoma) maintain longer seasonal activity periods than gophers in the more northern areas of the species range. Figure 8 illustrates the progression of mound construction on the study areas. The infrequency of visits to the northwestern area, and the inability of the investigator to identify sign marked on previous visits, forced elimination of this area from the figure. Pocket gophers in each location were more active from November to February than from February to May. Mound construction virtually ceased in late spring. This reduction of activity is probably

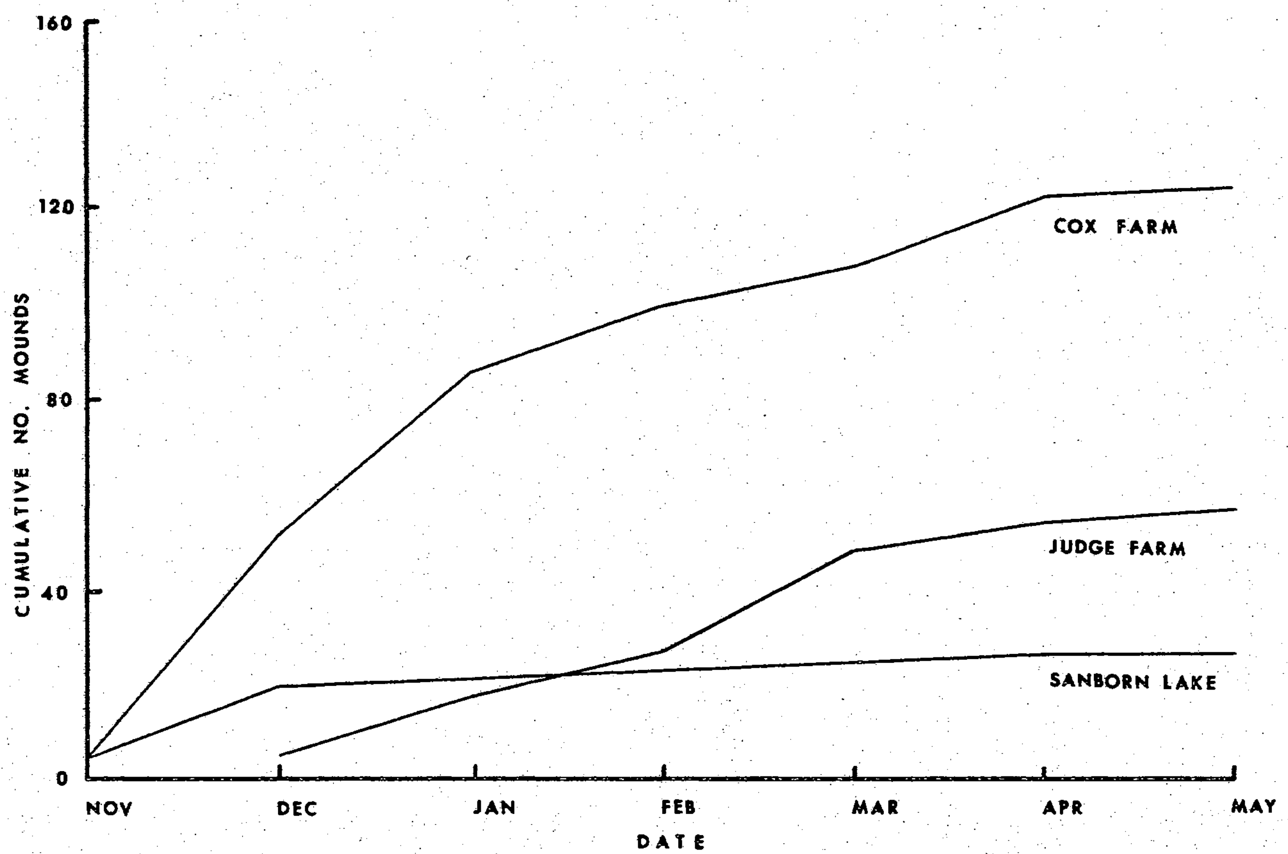

Figure 8. Cumulative numbers of mounds cast by gophers in northcentral Oklahoma, 1969-70

attributable to behavioral changes associated with the reproductive effort. Presumably this inactivity would continue until the young began dispersing from the parental burrow in late summer (Reid et al. 1966). Downhower and Hall (1966) reported that the lowest level of activity of the plains pocket gopher occurred during warmer periods of summer.

CHAPTER V

CONCLUSIONS

The following conclusions are based upon analysis of data and numerous observations by the author. For conciseness, these conclusions are listed.

1. Pocket gophers are significant members of the grassland ecosystem, effecting a substantial vertical transport of soil.

2. The plains pocket gopher frequently works at depths up to three feet in Oklahoma, but the majority of activity occurs within one foot of the ground surface.

3. High sand content of soil is associated with high populations of pocket gophers.

4. Vegetation is important in the distribution and abundance of gophers. Apparently gopher tunnels are more extensive in areas which have few large-rooted plants.

5. Depth of tunnels is probably a function of soil more than of vegetation. The average tunnel depth is greatest in sandy soils.

6. Cultivation substantially reduces gopher activity, except in certain cases where the crop develops large rootstocks (e.g., alfalfa).

7. Undisturbed tall-grass prairie does not typically support pocket gophers.

8. Pocket gophers populations are related to sub-climax vegetation except in sandsage-grassland, where the climax vegetation supports large numbers of gophers.

9. Moderately grazed or overgrazed pastureland supports more gophers than ungrazed land, assuming that other environmental factors are uniform.

10. Mowing of vegetation may increase gopher activity. Possible explanations that merit further study include: (a) physiological response of plant roots to the periodic removal of aerial plant parts, and (b) reduced competition among plants for light and space.

11. Disturbance of soil profile and structure by machinery does not appear to stimulate gophers to invade nor to work at greater depths.

12. Increased activity of pocket gophers along highway rights-of-way probably is attributable to mowing practices and altered flora. Perhaps the only methods of controlling pocket gophers along highway rights-of-way are (a) removal of the animals, and (b) cessation of mowing. Both methods are impractical under present technology and policy.

13. The mound-count method is not a reliable technique of estimating pocket gopher abundance.

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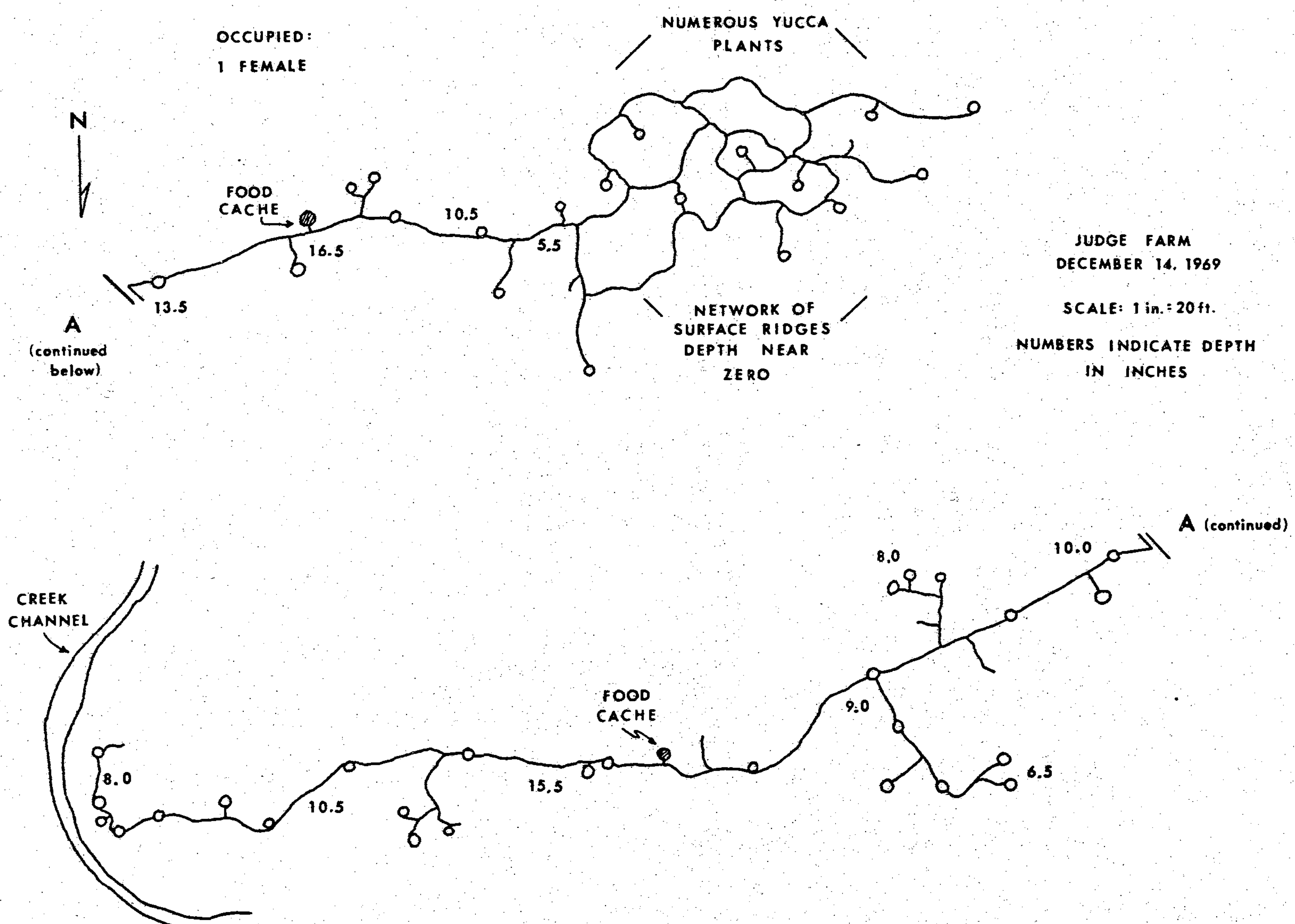
APPENDIX

BURROW SYSTEM DIAGRAMS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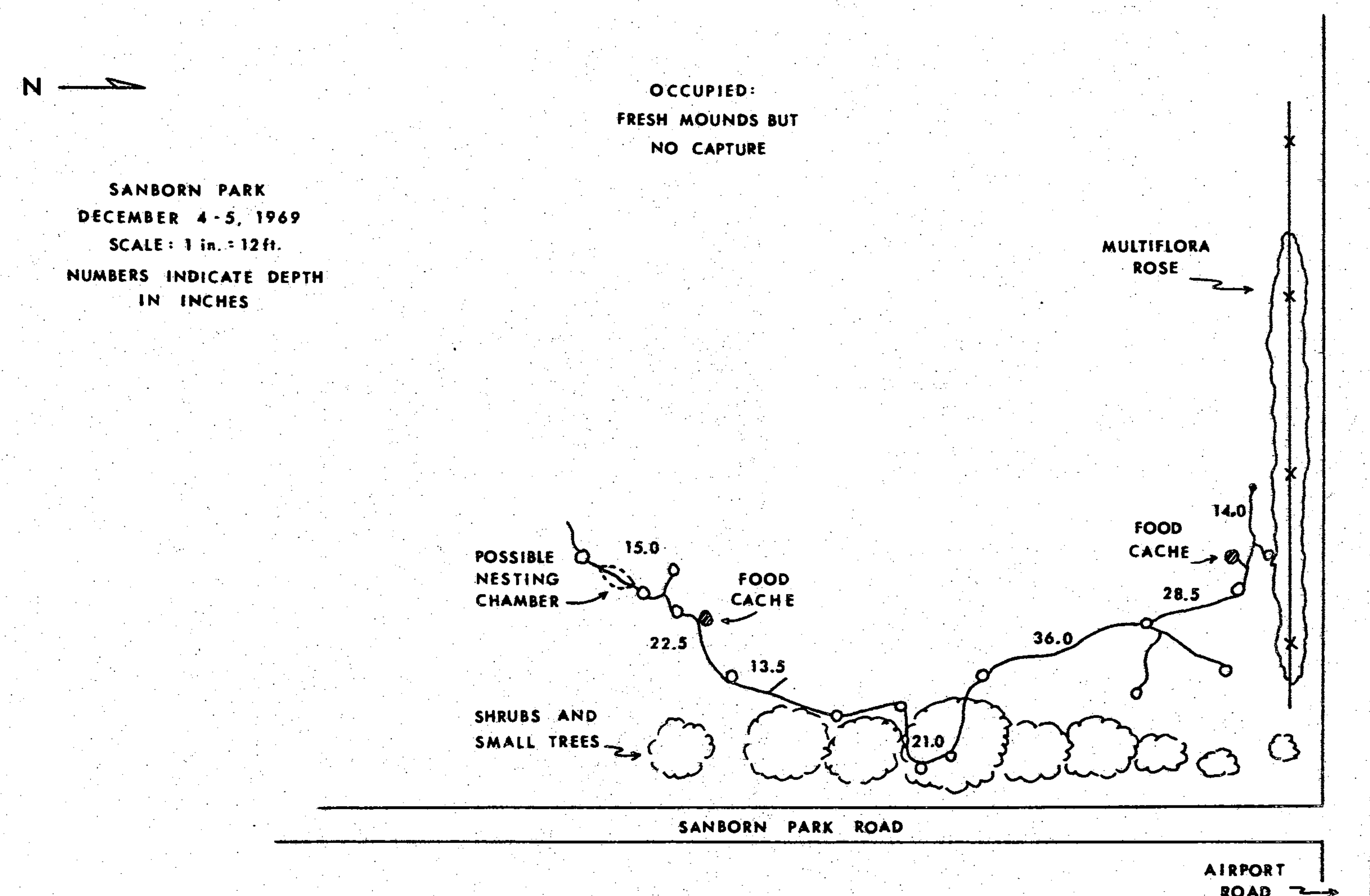
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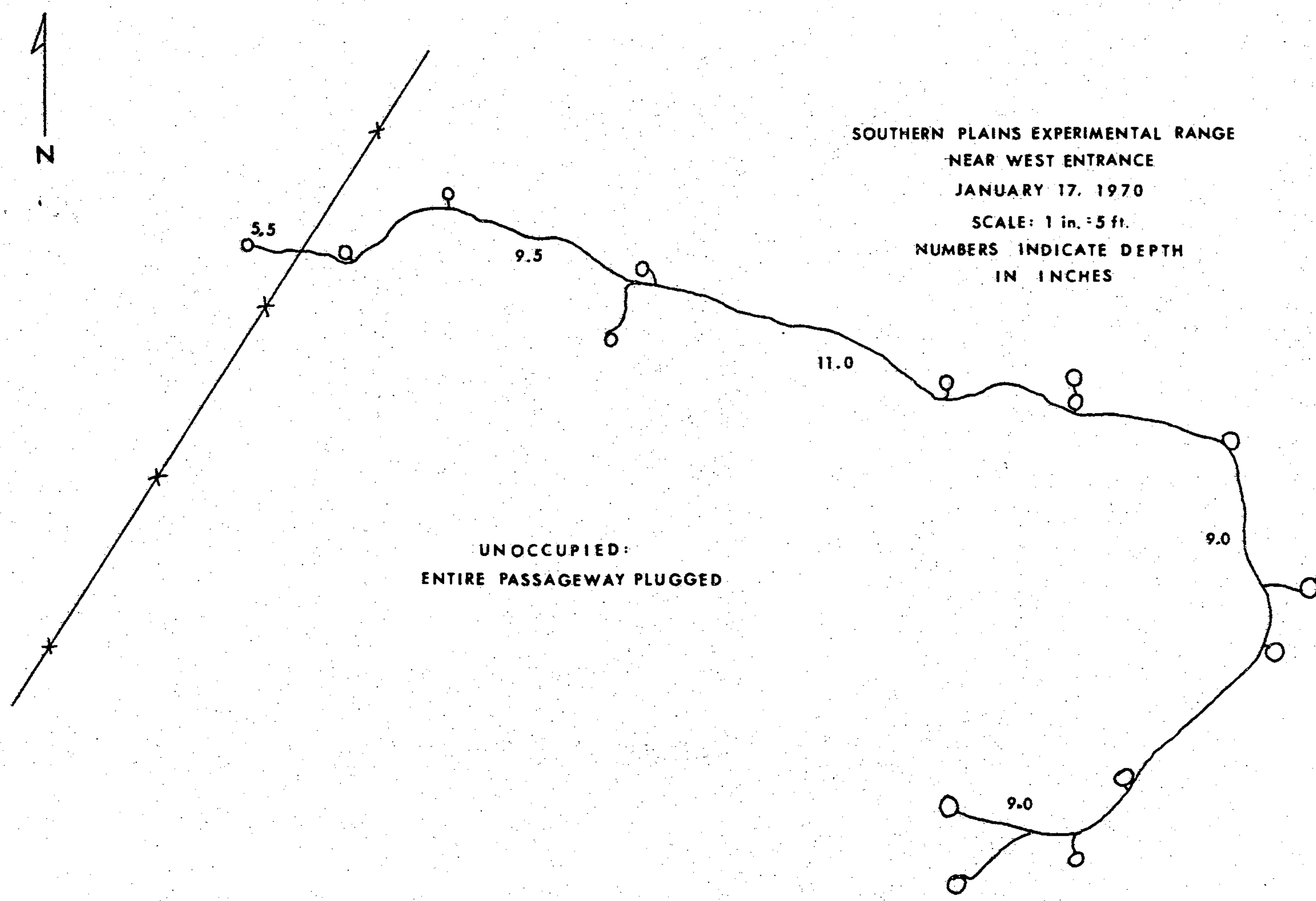
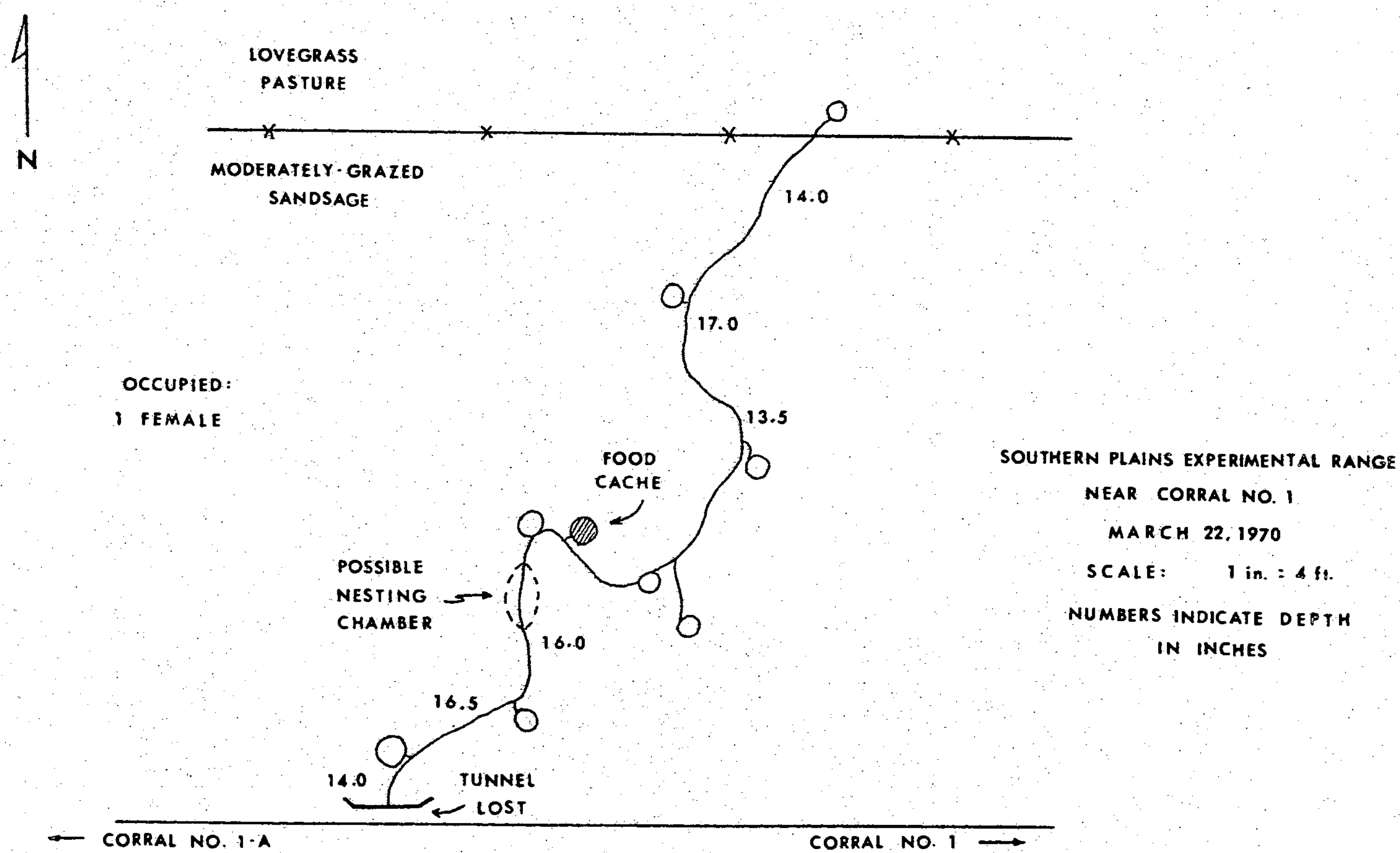
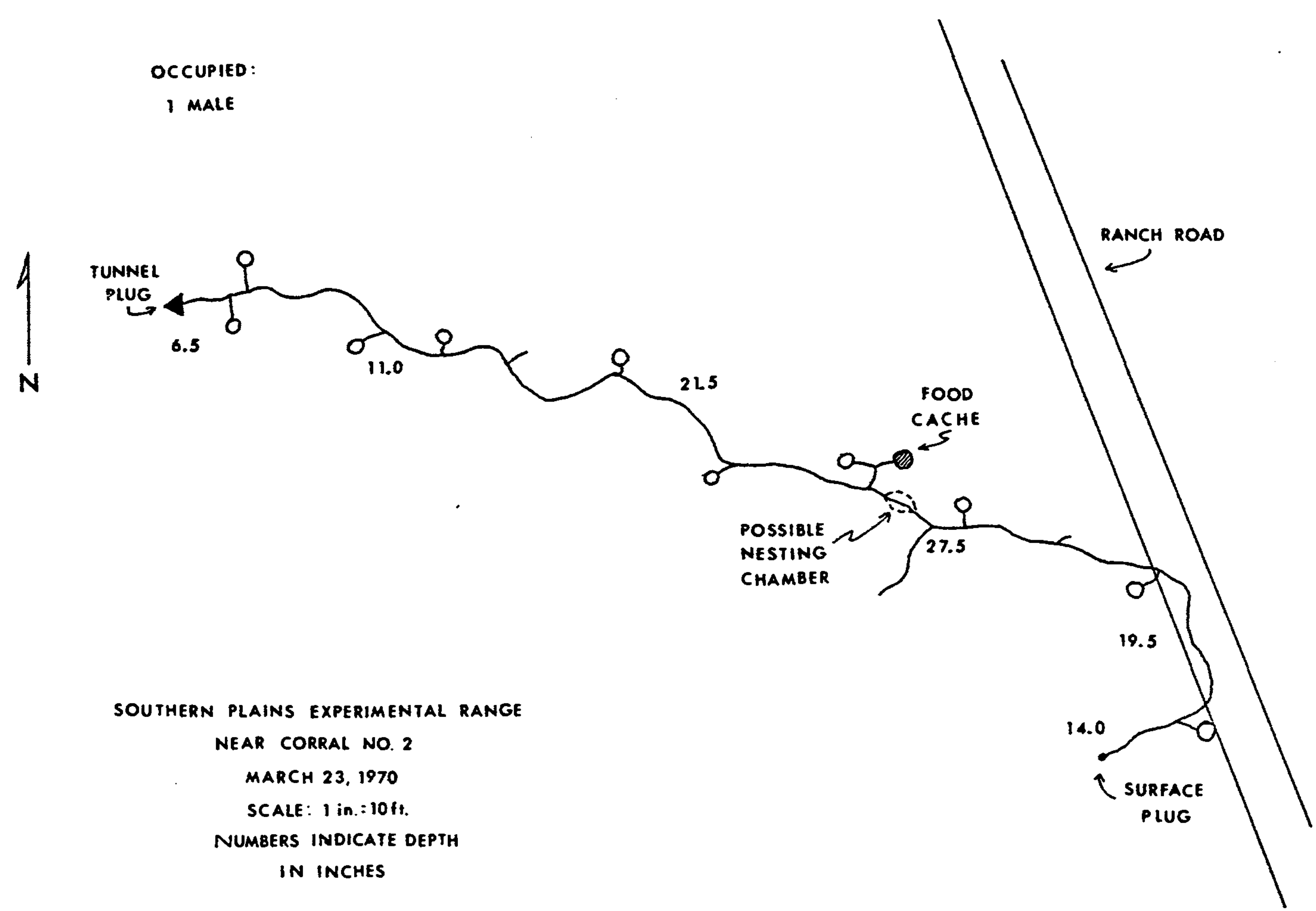
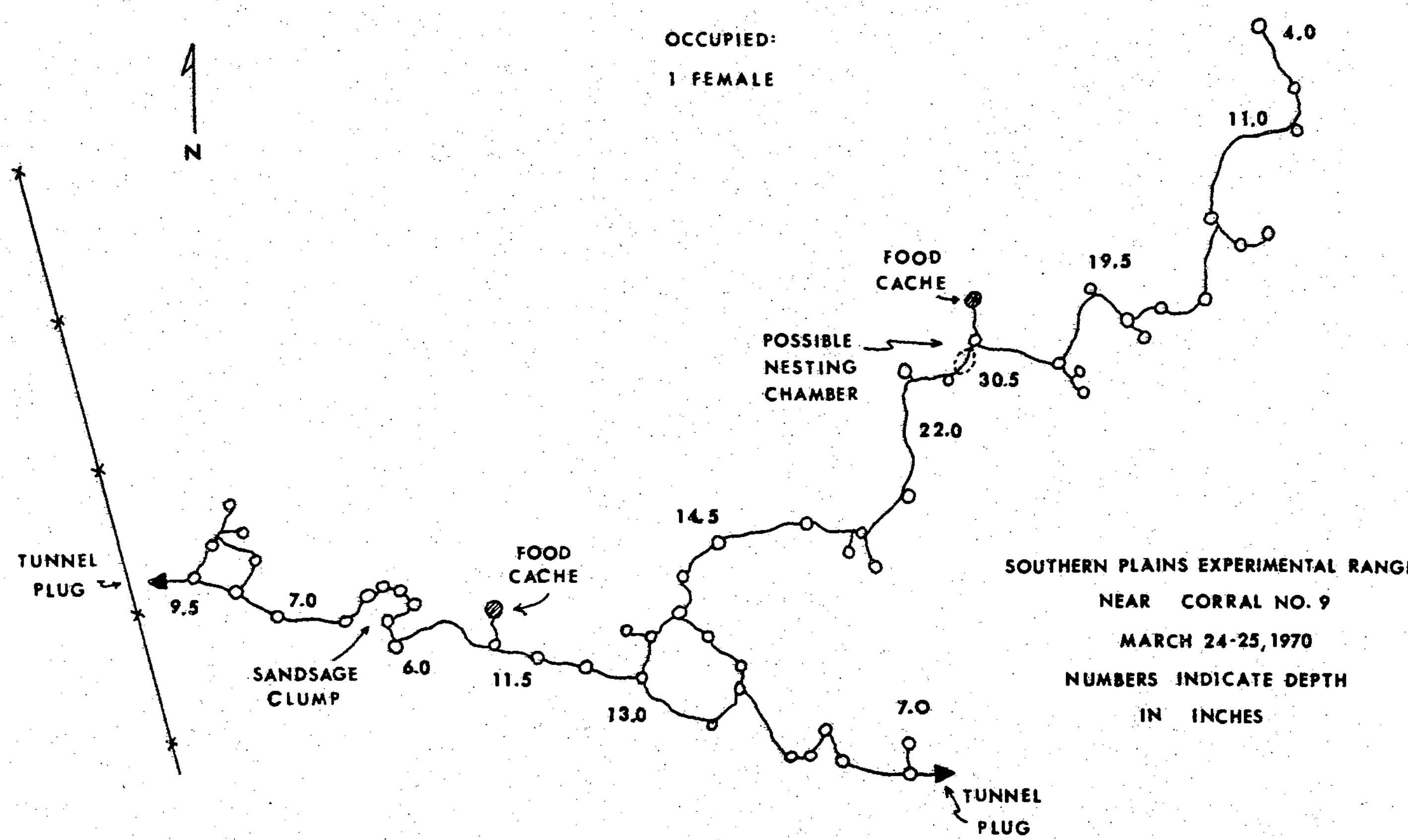
NO CAPTURE
SANBORN PARK
DECEMBER 4-5, 1969
SCALE: 1 in. = 12 ft.
NUMBERS INDICATE DEPTH
IN INCHES
MULTIFLORA
ROSE
14.0
FOOD
CACHE
POSSIBLE
NESTING
CHAMBER
15.0
FOOD
CACHE
28.5
22.5
36.0
13.5
SHRUBS AND
SMALL TREES
21.0
SANBORN PARK ROAD
AIRPORT
ROAD


N
SOUTHERN PLAINS EXPERIMENTAL RANGE
NEAR WEST ENTRANCE
JANUARY 17, 1970
SCALE: 1 in. = 5 ft.
NUMBERS INDICATE DEPTH
IN INCHES
5.5
9.5
11.0
9.0
9.0
UNOCCUPIED:
ENTIRE PASSAGEWAY PLUGGED


N
LOVEGRASS PASTURE
MODERATELY-GRAZED SANDSAGE
14.0
17.0
13.5
OCCUPIED:
1 FEMALE
FOOD CACHE
POSSIBLE NESTING CHAMBER
16.0
16.5
14.0
TUNNEL LOST
CORRAL NO. 1-A
CORRAL NO. 1
SOUTHERN PLAINS EXPERIMENTAL RANGE
NEAR CORRAL NO. 1
MARCH 22, 1970
SCALE: 1 in. : 4 ft.
NUMBERS INDICATE DEPTH IN INCHES


OCCUPIED:
1 MALE
TUNNEL
PLUG
6.5
N
11.0
21.5
FOOD
CACHE
POSSIBLE
NESTING
CHAMBER
27.5
RANCH ROAD
19.5
14.0
SURFACE
PLUG
SOUTHERN PLAINS EXPERIMENTAL RANGE
NEAR CORRAL NO. 2
MARCH 23, 1970
SCALE: 1 in.:10 ft.
NUMBERS INDICATE DEPTH
IN INCHES


OCCUPIED:
1 FEMALE
N
4.0
11.0
19.5
FOOD
CACHE
POSSIBLE
NESTING
CHAMBER
30.5
22.0
14.5
TUNNEL
PLUG
9.5
7.0
FOOD
CACHE
SANDSAGE
CLUMP
6.0
11.5
13.0
7.0
TUNNEL
PLUG
SOUTHERN PLAINS EXPERIMENTAL RANGE
NEAR CORRAL NO. 9
MARCH 24-25, 1970
NUMBERS INDICATE DEPTH
IN INCHES

VITA

David Estes Watts

Candidate for the Degree of

Doctor of Education

Thesis: BURROWING HABITS OF THE PLAINS POCKET GOPHER IN NORTHCENTRAL AND NORTHWESTERN OKLAHOMA DURING THE FALL AND WINTER OF 1969-70

Major Field: Higher Education Minor Field: Zoology

Biographical:

Personal Data: Born in Madison, Tennessee, August 2, 1943, the son of Charles E. and Lorena Watts.

Education: Graduated from DuPont High School, Old Hickory, Tennessee, in May, 1961; received the Bachelor of Science degree from Tennessee Technological University in 1965, with a major in Biology; received the Master of Science degree from the University of Tennessee in 1968, with a major in Forestry; completed requirements for the Doctor of Education degree at Oklahoma State University in July, 1970.

Professional Experience: Senior Laboratory Assistant in Biology, Tennessee Technological University, Cookeville, Tennessee, 1964-65; Supervisor in Manufacturing, E. I. DuPont Company, Old Hickory, Tennessee, 1965-66; Graduate Research Assistant, the University of Tennessee, Knoxville, Tennessee, 1966-68; National Science Foundation Teacher Trainee, Oklahoma State University, 1968-69; Graduate Teaching Assistant in Zoology, Oklahoma State University, 1969-70.

Honorary and Professional Societies: Associate Member of the Society of the Sigma Xi; Gamma Sigma Delta; The Wildlife Society; American Society of Mammalogists; Southwestern Association of Naturalists.

Name: David Estes Watts Date of Degree: July 31, 1970

Institution: Oklahoma State University

Location: Stillwater, Oklahoma

Title of Study: BURROWING HABITS OF THE PLAINS POCKET GOPHER IN NORTHCENTRAL AND NORTHWESTERN OKLAHOMA DURING THE FALL AND WINTER OF 1969-70

Pages in Study: 69 Candidate for Degree of Doctor of Education

Major Field: Higher Education Minor Field: Zoology

Scope of Study: The plains pocket gopher exerts a pronounced influence on the ecology of grassland ecosystems. The habits of the gopher are difficult to ascertain due to the fossorial mode of existence. This research was conducted to describe selected burrow systems of the gopher in two widely-separated areas of Oklahoma. Tunnel dimensions and surface activity were recorded. In addition some assessment was made of the value of the mound-count census technique. Seven sites were studied; six of these were excavated.

Findings and Conclusions: Burrow systems were similar in all areas studied. Excavation of burrow systems revealed that gophers typically work at depths of approximately one foot, although depth occasionally extends to two or three feet. Burrow systems occupied an average of one-tenth of an acre of ground surface. Food caches were found in most burrows, but nests were almost indistinguishable. Apparently pocket gophers in the areas of study use very little nest-lining material.

Soil texture and vegetation were considered important determinants of gopher activity. Sand content of the soil in the northwestern area was greater than sand content of soil in the northcentral area. Apparently gophers are more abundant in the northwestern area due to sand soil and the abundance of desirable food plants. Land-use practices influenced gopher activity to a considerable extent.

Gophers cannot be readily censused by mound-counts in areas where gopher activity is pronounced. It was

estimated that there was an average of eight gophers per acre on the less-sandy soils of the northcentral area, and twelve gophers per acre on the sandy northwestern area.

ADVISER'S APPROVAL: ____________________