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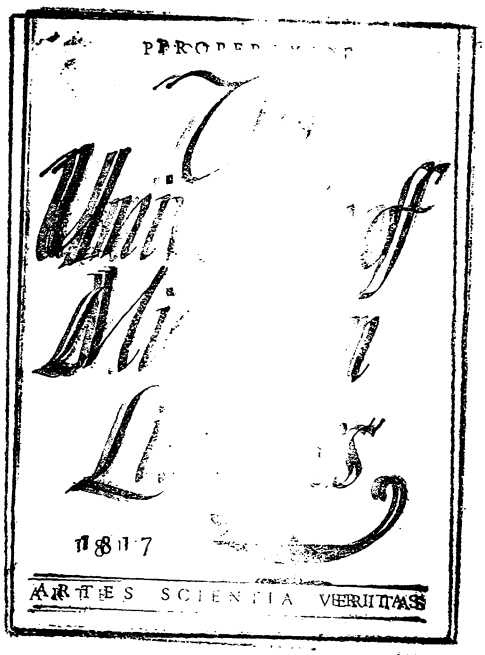


# RELATION OF WOODCHUCK DENS TO SOIL TYPES, TOPOGRAPHY AND OTHER ENVIRONMENTAL FACTORS IN WASHTENAW COUNTY, MICHIGAN

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TABLE OF CONTENTS

# INTRODUCTION

The woodchuck (Marmota monax rufescens. Linnaeus.) is beneficial to many den inhabiting game animals, and especially to those that do not burrow themselves. The dens provide winter shelter and permit species to live in places that otherwise would be unsuitable for them. Therefore the distribution of woodchuck dens in various soil types and under various site conditions becomes an important consideration in wildlife management.

The cottontail (Sylvilagus floridanus mearnsii. Allen.) and skunk (Mephitis mephitis. Schreber.) of Michigan are two valuable species that are often dependent on woodchuck dens for shelter. Fackler (1943) found that the number of woodchuck dens in a locality can be an important factor in cottontail survival during severe winter conditions. The cottontail is the most important game animal in Michigan according to Burt (1946). He states that approximately two million are taken annually, providing sport and food for nearly three hundred and fifty thousand hunters. The skunk is likewise important, both as a valuable fur-bearer and an effective insectivore and mouser. Other fur-bearers, such as the fox (Vulpes fulva. Desmarest.), the weasel (Mustela frenata noveboracensis. Emmons.), and the racoon (Procyon lotor lotor. Linnaeus.) derive some benefits from woodchuck dens. It becomes apparent that the obscure woodchuck is an economic asset that has often been unappreciated.

Technicians have repeatedly neglected the woodchuck in their ecological studies. This is because many valuable game species have

demanded immediate attention and those of lesser or indirect importance have been pushed into the background. Some of these loose ends are now being picked up. The objective of this study is to determine the influences of such factors as soil, topography, vegetation, and water on the location of woodchuck dens.

## STUDIES ON RELATED SUBJECTS

Few formal studies have been conducted concerning the interrelations of woodchucks and the terrestrial environment. R. A. Grizzell of the Patuxent Wildlife Refuge, Laurel Maryland is in the process of determining some of these associations for that area. Moss (1940) obtained information pertaining to the bearing of soils on the distribution of vegetation and wildlife. He concluded that "Woodchuck burrows were apparently located at random throughout the area. They did not check with present or past evidence of cultural features and had no definite relation to topography or aspect. However, when plotted on the completed soil maps from an intensive soil survey, the dens proved to be restricted very closely to what the soil expert classified as sandy loam".

Studies of a similar nature on other animal species have revealed definite correlations. Dice (1939, 1939a) found conformity between soil color and pelage color in the deermouse (Peromyscus maniculatus) in southeastern Washington, Idaho and Oregon. Stuart (1932) found a correlation between soil texture and the distribution of the lizards of west-central Utah; the preference was believed to be from its egg-laying

Soil Symbols Appearing on Photograph 1

(Not all of the listed soil types occur on the study area.)

B . . . . . .Berrien loamy sand

Bm. . . . . .Berrien sandy loam

Bn. . . . . .Bronson loam

Br. . . . . .Bronson sandy loam

Bs. . . . . .Bellefontaine sandy loam

By. . . . . .Brady sandy loam

Bl. . . . . .Brookston loam

Cm. . . . . .Carlisle muck

F . . . . . .Fox sandy loam

Gd. . . . . .Gilford loam

Gl. . . . . .Griffin loam

Km. . . . . .Kerston muck

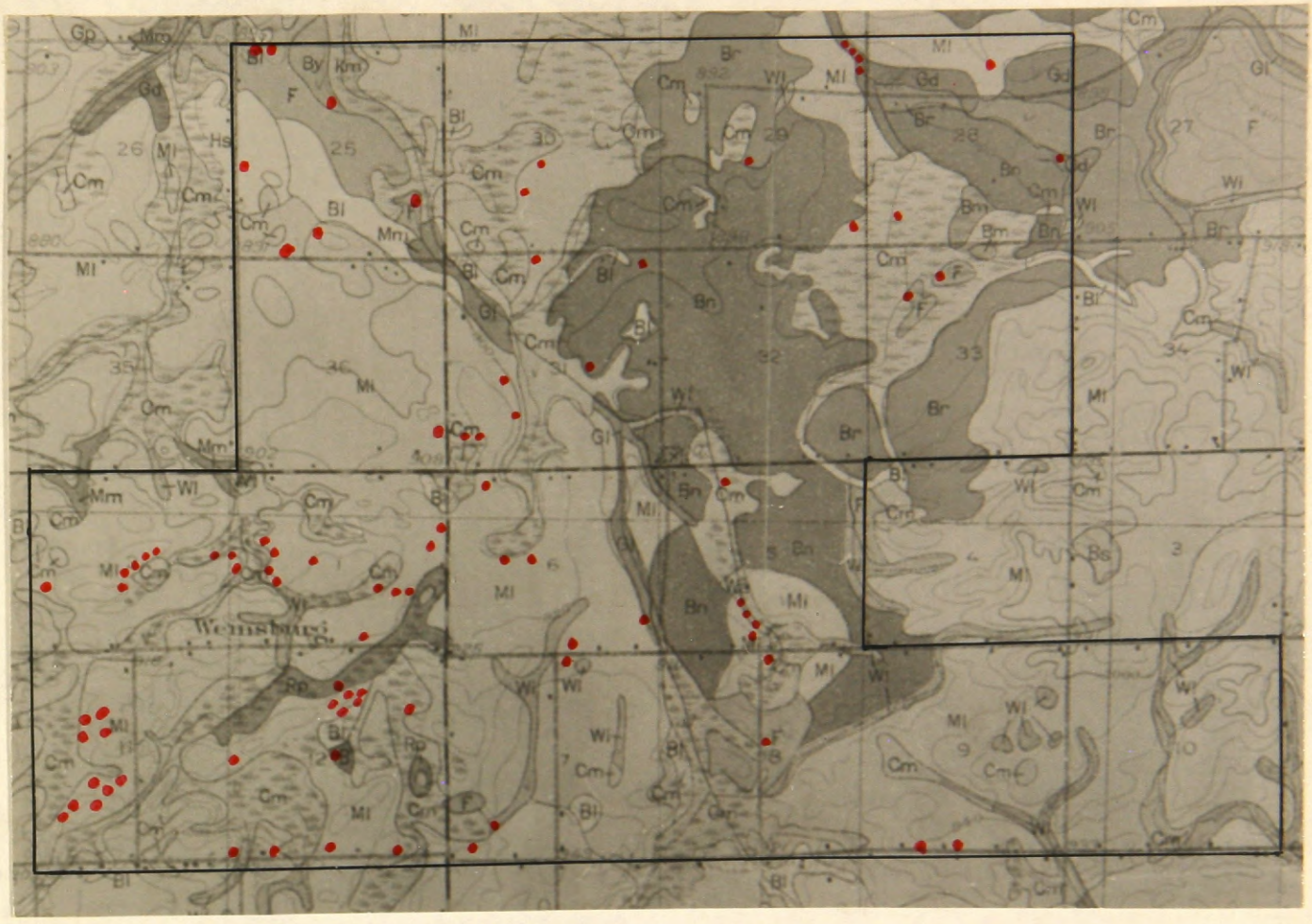
Mn. . . . . .Maumee loam

Ml. . . . . .Miami loam

Wa. . . . . .Wallkill loam

Wl. . . . . .Washtenaw loam

Rp. . . . . .Rifle peat

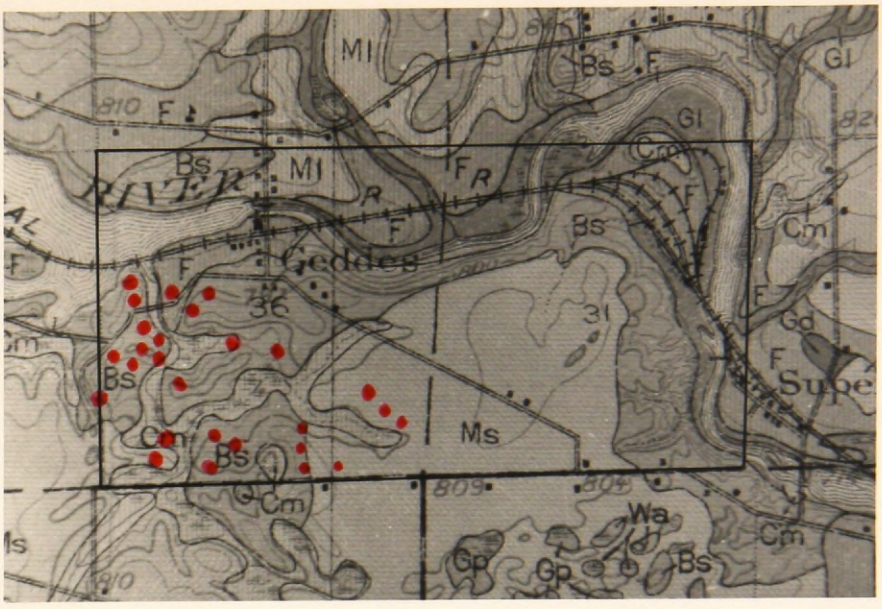


Photograph 1

Study Area*Den Locations** on Sections 1, 2, 11, and 12, Freedom Township; Sections 5, 6, 7, 8, 9, and 10, Lodi Township; Sections 28, 29, 30, 31, 32, and 33, Scio Township; Sections 25 and 36, Lima Township.

*Boundary marked by black line

**Red dots indicate location of dens.




Photograph 2

Study Area*Den Locations**on Section 36, Ann Arbor Township and Section 31, Superior Township

*Boundary marked by black line
**Red dots indicate location of dens

Soil Symbols appearing within the two sections.

Bs. . . . . .Bellefontaine sandy loam

Cm. . . . . .Carlisle muck

F . . . . . .Fox sandy loam

Gl. . . . . .Griffin loam

Ms. . . . . .Miami silt loam

Ml. . . . . .Miami loam

habits. Grinnell (1932) stated that the distribution of kangaroo rats (Dipodomys ingens. Merriam.) seemed correlated with the distribution of Panoche fine sandy loam in interior California. Landwer (Unpublished) reported that the prairie dog (Cynomys ludovicianus) does not occur on sands. These studies indicate definite influences being exerted by the soil or a closely related ecological situation.

## PROBLEM AND STUDY METHODS

The objective of the study has been to determine if any soil type or soil texture selectivity is exercised on the part of the woodchuck in locating his dens. Incidental to this, observations and notations were made to determine the influences of topography, surrounding cover, and water proximity.

The intention was to select an area with an approximately equal acreage of representative soil types. The limitations as to areas and time available have resulted in the study area being representative as to soil types but not equal in soil type acreages.

The twenty land survey sections used in this study are shown in photographs 1 and 2. These pictures were taken of the soils map of Washtenaw County, Michigan. The eighteen sections west of Ann Arbor, Michigan are primarily agricultural land whereas the two sections east of Ann Arbor are forest land and pasture. (See map 1.)

There are thirty-three different soil types in Washtenaw County, as classified by the U. S. Bureau of Chemistry and Soils. Sixteen are represented on the study area. These representative soil types include mineral and organic soils varying from high to low fertility. Various texture classes are represented and are well interspersed throughout the area studied.

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Cover maps of the specified areas were made by advanced students in wildlife management at the University of Michigan. They made den studies of the individual areas and located these dens on the cover maps. Copies of these den maps were used for location and observation of dens in this study. In addition to their area coverage, an attempt was made to make a systematic cruise while checking the dens they had located. After collecting the data on a section of land, the borders were checked by driving slowly around it in a car to locate dens which are sometimes found along road ditches.

The data sheets used for tabulating information on individual dens are shown in Figures 1 and 2. The procedure was very simple in that the numbers opposite the features characteristic of the den were checked with a pencil. In this manner, the information collected at each den site was concise and uniform throughout the study. The soil description gives information that when combined with the den location on the soil map readily identifies the soil type. The ecological description gives a categorical classification of the vegetation within a two hundred foot radius. Topographic information taken in the field consisted of the slope at the den site, entrance exposure, and situation or topographic feature associated with the den location. The data on water was tabulated to determine if there were any restrictions as to proximity, class of water, or elevation of water in location of the den. General information regarding den use and the present inhabitant was collected for purposes of obtaining an indication of the value of the den to other animals.

Fig. 1

FIELD OBSERVATION FORM

Den No.____ Date____ Location T.____ R.____ Sect.____ Forty No.____

Surface drainage: Good____ Med.____ Poor____

Subdrainage: Good____ Med.____ Poor____

Ground surface: Even____ Rough____

Soil Description

| -Top Soil- | -Subsoil at entrance from den diggings- | -Subsoil Color- |
|---|---|---|
| 1 Sandy loam | 1 Clay | 1 Reddish-brown |
| 2 Loamy sand | 2 Sandy clay | 2 Grayish-brown |
| 3 Loam | 3 Silt | 3 Brown |
| 4 Clay loam | 4 Sand | 4 Pale yellow |
| 5 Silt loam | 5 Gravel | 5 Yellowish-brown |
| 6 Loamy fine sand | 6 Rubble | 6 Dark-brown |
| 7 Sand | | 7 Black |
| 8 Clay | | 8 Light-brown |
| 9 Peat | | |
| 10 Muck | | |

Ecological Description

| -Ecol. Series- | -Ecol. Stage- | -Cover Types- (Within 50') (Within 200') |
|---|---|---|
| 1 P series | 1 | 1 |
| 2 A series | 2 | 2 |
| 3 R series | 3 | 3 |
| 4 B series | 4 | 4 |
| 5 BS series | 5 | 5 |
| 6 M series | 6 | 6 |
| 7 MS series | 7 | 7 |
| 8 F series | 8 | 8 |
| 9 E series | 9 | 9 |
| | 10 | 10 |

Topography

| -Slope- | -Entrance Exposure- | -Situation |
|---|---|---|
| 1 0° | 1 North | 1 Hill |
| 2 10° | 2 Northeast | 2 Gravel pit |
| 3 20° | 3 East | 3 Roadside ditch |
| 4 30° | 4 Southeast | 4 Drainage ditch |
| 5 40° | 5 South | 5 Gulley |
| 6 50° | 6 Southwest | 6 Fencerow |
| 7 60° | 7 West | 7 Level |
| 8 70° | 8 Northwest | |
| 9 80° | | |
| 10 90° | | |

Fig. 2

FIELD OBSERVATION FORM

Water

| -Proximity in feet- | | -Class- | | -Den elevation above nearest water (in feet)- | |
|---|---|---|---|---|---|
| 1 | 10 | 1 | Rapid creek | 1 | 5 |
| 2 | 20 | 2 | Sluggish creek | 2 | 10 |
| 3 | 30 | 3 | Rapid river | 3 | 15 |
| 4 | 40 | 4 | Sluggish river | 4 | 20 |
| 5 | 50 | 5 | Pond | 5 | 25 |
| 6 | 100 | 6 | Lake | 6 | 30 |
| 7 | 200 | 7 | Bog | 7 | 40 |
| 8 | 300 | 8 | Marsh | 8 | 50 |
| 9 | 400 | 9 | Rapid drainage ditch | 9 | 75 |
| 10 | 500 | 10 | Sluggish drainage ditch | 10 | 100 |

General Information

| -Use- | | -Present Inhabitant- | | | |
|---|---|---|---|---|---|
| 1 | Active | 1 | Rabbit | 5 | Raccoon |
| 2 | Inactive | 2 | Skunk | 6 | Fox |
| 3 | Unknown | 3 | Weasel | 7 | Opossum |
| | | 4 | Woodchuck | 8 | Unknown |

9 _____

-Remarks-

The field observation forms were extremely valuable in saving time at the den sites; information was uniform, rapidly collected, and easily arranged for various forms of analysis.

The dens tabulated in this study were those identified as active woodchuck dens and all other dens which could be determined as having been originally excavated by woodchucks.

The system used at the den site for identification as to the original excavator was first to look for signs such as tracks, fecal deposits, trails to feeding areas, or possibly the remains of woodchucks as found near several dens. The odor of the dens and the manner in which the soil had been thrown from the entrance during excavation were characteristic; the active woodchuck's den has an odor unlike that of other den inhabiting animals and the manner of excavation leaves the soil thrown straight back two to four feet from the entrance. This manner of digging can be contrasted to the badger's spreading soil around the entrance and the fox's throwing the soil four to six feet straight back from the entrance. The size and number of entrances often aided identification of the dens. The average number of entrances as found by Twichell (1939) was 2.8. Eighty per cent of the 132 dens he studied had from 1 to 3 entrances. The entrance diameter is usually from 6 to 10 inches wide and about 6 inches high; of course, there were variations in these dimensions. The animal's characteristic habit of expelling dirt from the den almost daily and the cropped vegetation near the entrances aided in identification and determining use. Hairs caught on roots or rocks at the entrance were often found. Although there are two color phases of this woodchuck in Washtenaw County, the hair coloration did

aid identification in some cases. The dark phase woodchuck guard hair has a sequence of black, white, black, and white colors starting with the black at the tip. The angle of the entrance tunnel can also be used as an indicator of the animal that made the den. Merriam (1884) states that the burrows of woodchucks are of two principal types, "...the first slopes at a moderate angle from the surface and has a mound of dirt near its entrance; the other is more or less vertical for several feet (often a metre or more) immediately below the surface, and no loose earth can be found in its neighborhood. As a rule they (the galleries) slant abruptly downward from the entrance to a depth of from three to four feet". As a last check as to what had been using the den, the subsoil at the entrance was scraped through for signs of prey eaten or possibly the bones of the original inhabitant.

Hartesveldt (1947) developed a burdock device for catching hairs of animals using specific dens. He had varied degrees of success in identification of hairs, "Some specimens required many comparisons with known hairs to identify them. Others went unidentified after more than an hour of comparisons". This device was not used in the present study because of the large number of dens being observed, the time needed for collection of hairs, and the time required for identification of hairs.

## THE STUDY AREA

The study area consists of twenty sections of land or approximately 13,168 acres; eighteen of these sections are west and two sections are east of Ann Arbor (See map 1). The best route to the western sections would be to follow U. S. Highway 12 until reaching Zeeb Road.

Turn south and drive approximately one mile to Park Road and that location is the northeast corner of the study area. The two sections east of Ann Arbor are best reached by following Geddes Avenue out of town to Huron River Drive. Follow this road until crossing Hogback Road. This intersection is in the approximate center of the western boundary of section 36 of Ann Arbor township.

The topography is diversified and gently rolling. The mineral soils, typical of uplands, make up 82.3 per cent and the organic soils, typical of lowlands, make up 17.7 per cent of the county, Veatch (1930). The highest elevation is 1023 feet M.S.L. and the lowest elevation is 803 feet M.S.L. on the study area. The highest elevations occur in the southern-most sections of the western group.

Drainage is generally northward toward the Huron River. The streams are small and variable in direction of flow as their courses have been governed by the character and trend of glacial features and the irregularities in ice deposition. Swamp and marshland are scattered throughout. Drainage ditches are common and vary considerably in regularity of pattern.

The vegetation of the study area is variable and largely governed by individual farm practices. The area of greatest natural cover, forest land, is approximately 10 to 12 per cent of the land in the study area. "The original forest growth of this county consisted of different associations of hardwoods, in which the principal species were red oak, white oak, black oak, hickory, beech, sugar maple, elm, ash, and basswood", Veatch (1930).

About 65 per cent of the farms in this area are classified as general, livestock, and dairy farms in the 1945 Census, U.S. Dept. Commerce (1945). The major livestock enterprise is the dairy. The minor livestock enterprises, poultry, sheep, and hogs are each about equal in importance concerning income. Most of the crops are grown for feed. The cash crops are wheat, beans, and sugar beets. There is much rolling and non-tillable pasture which favors the sheep enterprise. The average size farm in the region is 109 acres. About 82 per cent of the land area is in farms and 65 per cent of this area is tillable, U.S. Dept. Commerce (1945).

The study area soil types are diversified in age, conditions of moisture under which developed, constituents, and texture. The following paragraphs present these and other pertinent factors associated with this investigation as found by Veatch (1930).

Mineral Soils

Miami silt loam represents soil of the well-drained clay land of the upland part of the county. The content of organic matter is not high, but the supply is durable. The average content of moisture is comparatively high, as both the subsurface layer and substratum are rather impervious and highly retentive of moisture. The land is for the most part smooth or level, although a few areas are moderately rolling, with slopes subject to erosion ranging from 10 to 20 per cent gradient. Natural drainage is sufficient in the more rolling areas, but elsewhere the run-off is not rapid, and excessive quantities of water may be held in the spring because of the retentiveness of the underlying clay. This

is a comparatively old soil having a mature profile. In general, this soil has developed under good drainage conditions.

Miami loam is another representative of the well-drained clay soils. The substratum, or parent material is massive comparatively impervious clay which extends to a depth of several feet. Miami loam as compared with Miami silt loam has a slightly higher percentage of coarse matter in the parent material and throughout the soil. It also has a lower degree of plasticity and imperviousness in the subsoil. Areas of Miami loam range from smooth or nearly level to rolling or moderately rough. The slope in most places is sufficient to carry off the rainfall. Some of the steeper slopes show considerable erosion or gullying taking place. This is a comparatively old soil with a mature profile; it has developed under good drainage conditions.

Hillsdale sandy loam comprises a considerable part of the moderately hilly well-drained land in the northwest part of Washtenaw County; there are only scattered areas of this soil on the study area. The content of humus is medium and is fairly durable in the smoother land. Although the soil contains sufficient fine material to make it moderately retentive of moisture, it is permeable and penetrable to a depth of several feet. The texture is predominantly sandy with a mixture of clay and organic material. The land is in general gently rolling or moderately hilly, most of the slopes having a gradient of less than 10 per cent. This soil is not excessively coherent. It is a comparatively old soil having a mature profile and has developed under good drainage conditions.

The surface soil of Bellefontaine sandy loam, to a depth of 6 or 7 inches, is friable or loosely coherent, sandy loam, or fine sandy loam.

This is underlain by a lighter colored sandy loam and is sometimes mixed with a coarse gravelly or cobbly mixture which contains sufficient clay to render the mass coherent and compact. The substratum, or parent drift material, is a mixed mass of sand, sandy clay, gravel, and boulders. The soil is only moderately retentive but holds sufficient moisture to carry crops through ordinary periods of dry weather. Bellefontaine sandy loam occurs in fairly large areas which are characterized by knobs, hills, and gentle to steep slopes. The gradient of most of the slopes is from 5 to 10 feet to a hundred, but locally is from 25 to 30 feet to a hundred. Slopes exceeding 10 per cent are susceptible to gullying and destructive erosion when put under cultivation; most of this soil type was not under cultivation on the study area. This is an old soil with a mature profile and has developed under good drainage.

The greater part of Fox sandy loam is underlain by sand and gravel and is found on comparatively dry smooth plains of both upland and lowland. The upper surface is a sandy mixture and this is underlain by a layer of sand and gravel held firmly together by the clay. Between two and three feet below the soil surface is found a coarse sand, or sand and gravel, which is pervious and comparatively dry to a depth of several feet. The average content of moisture is low or only moderate; the clay layer may become moderately hard. Fox sandy loam occurs in nearly level areas, although some of the land is pitted with shallow dry depressions or lakes and dotted with swamps. This soil type is old in that it has a mature profile; it has developed under good drainage.

Bronson loam comprises loam soil on level land, underlain by sand and gravel deposits. This soil is very similar to the Fox soils. A

floor of massive impervious clay is present in some places at a depth of less than 10 feet. The land is easily tilled in that the surface relief is favorable. This soil is intermediate in organic content. Bronson loam is an old soil with a mature profile; it has developed under intermediate moisture conditions.

Bronson sandy loam, as a whole, comprises soil which is sandier or predominantly lighter in texture in the plow layer than Bronson loam. This slight difference in texture implies a corresponding difference in tillage requirements and other factors affecting plant growth, but the farm conditions in general and crop adaptations are not greatly different. This soil is old in having a mature profile; it has developed under intermediate moisture conditions.

Berrien sandy loam is loose and loamy in the top 4 to 6 inches and is friable and easily penetrable to a depth of 3 feet or deeper. Most of this soil is naturally drained. The principal deficiency of the land is its low natural fertility. This is an old soil with a mature profile; it has developed under intermediate moisture conditions.

The Gilford soils comprise the dark-colored wet soils underlain by a sandy or gravel clay material. It occurs on level or flat land of the old lake-bed plain in the southeastern part of the county and also on the wet gravelly valley plains in the upland part. This soil is high in organic matter and is underlain by sand and gravel or by friable sandy clay. The soil is of medium or high fertility. Poor natural drainage is the depreciating factor. This is an old soil with a mature profile and has developed under high moisture or swampy conditions.

Brady sandy loam comprises level semi-wet land in valleys or gravelly plains in the upland division of the county. The soil is moderately

gravelly throughout. A deeper substratum of clay may be present in places, at a depth ranging from 4 to 6 feet. Under natural conditions the water table lies at a depth ranging from 3 to 4 feet. The content of organic matter is medium. Brady sandy loam is an old soil with a mature profile; it has developed under high moisture or swampy conditions.

The Brookston soils comprise the soils of the flat clay lands which are, or were originally, wet and swampy. Brookston loam consists of a 6 to 10 inch surface layer of black loam rich in organic matter, grading into a more plastic or sticky sandy clay mottled with yellow or brown. This material, in turn, is underlain by the substratum of clay or alternate thin layers of sand and clay. Brookston loam is relatively high in natural fertility. The content of organic matter is comparatively high and is durable under cultivation. The subsurface clay is hard and resistant when dry, but under natural conditions is penetrable, so that hardness is determined by excessive water and lack of aeration rather than by naturally resistant soil layers. A large part of this soil is still wooded. This is an old soil having a mature profile; it has developed under high moisture or swampy conditions.

Wallkill loam represents a soil condition, where mineral soil has been washed in over peat or muck, this soil type occurs in small basins or potholes. It also occurs at the bases of slopes as narrow bands or deltas on the edges of peat or muck swamps. The soil is generally fine in texture. The depth to the peat or muck ranges from a few inches to 3 feet. The areas of this soil type are all small; much of it remains as waste land or pasture land because of the small size of the separate

bodies or because of the impracticability of artificial drainage. This is a comparatively young soil having incomplete or no soil profile development. It is usually a soil having slight slope in basins and drainage swales.

Griffin loam is poorly drained bottom-land soil, or the alluvium deposited by streams during flood stages. The surface soil is for the most part sandy loam or friable loam containing a comparatively large proportion of organic matter. Poor subsurface drainage and consequent poor aeration and oxidation, occurs just below the surface soil. The alluvial deposits, although for the most part sandy, are variable, consisting of mixtures or alternating layers of sand, sandy clay, silt, and in places thin beds of muck. The soil is high in natural fertility. The total acreage is small and is depreciated by poor drainage and the narrowness of the areas along the winding courses of the valleys and streams. The land is used chiefly for pasture and woodlots. This is a young soil having an incomplete or no soil profile. Its origin lies in recent alluvium deposited by streams.

Washtenaw loam occurs in depressions where the soil has been washed in from adjacent slopes. The soil so accumulated, for the most part, represents the finer materials--clay, silt, and very fine sand--and contains a high percentage of organic matter. The thickness of the accumulated soil ranges from a foot to 10 feet, beneath which are old or fossil soils. This soil occurs in small basins without outlets, and in places the material is deposited in narrow drainage swales. The many separate bodies of this soil are especially numerous in the hilly or more rolling parts of the county. Here they occur in association with the Miami,

Hillsdale, and Bellefontaine soils. Locally, deltas of coarse material occur, which consists of recently washed in material from gullies, and in places peat or muck is present at a slight depth. Washtenaw loam is a young soil having an incomplete or no soil profile. This soil usually has but a slight slope and occurs in basins or drainage swales.

Organic Soils

Carlisle muck is characterized by dark-brown or black surface material of a coarse-granular structure, and a loamy texture. In the typical soil the organic matter becomes finer in texture at a depth of a few inches, is pasty when wet, and is hard when dry. At a depth ranging from 15 to 20 inches, the material, in most places, becomes coarser, more peaty, and less decomposed, and in many places it is not distinguishable from that underlying Rifle peat and Greenwood peat. In Carlisle muck, the parent organic material has been so greatly modified in most places that the original vegetal composition cannot be determined. The water table is very high in this soil type except in areas where it is well drained. Carlisle muck is an older soil in the advanced stages of decomposition.

Rifle peat occupies an intermediate position in mean depth of the water table and state of decomposition of the plant matter between Carlisle muck on the one hand and Greenwood peat on the other. The surface soil is granular, woody, and loamy, and nearly black or dark brown, but it does not show very much decomposition below a depth of a few inches; at this level the material is coarse in texture, either woody or fibrous, and not compact. Rifle peat is widely distributed in irregular areas throughout the county. The land is poorly drained and generally used

Fig. 3

ARRANGEMENT OF SOIL TYPES BY PER CENT OF TOTAL ACREAGE

| | |
|---|---|
| Miami loam | 41.1% |
| Carlisle muck | 16.8 |
| Bronson loam | 13.7 |
| Miami silt loam | 5.7 |
| Fox sandy loam | 4.9 |
| Bronson sandy loam | 4.5 |
| Bellefontaine sandy loam | 3.1 |
| Washtenaw loam | 2.5 |
| Brookston loam | 2.0 |
| Griffin loam | 1.7 |
| Gilford loam | 1.7 |
| Rifle peat | 0.8 |
| Wallkill loam | 0.6 |
| Hillsdale sandy loam | 0.5 |
| Berrien sandy loam | 0.2 |
| Brady sandy loam | 0.2 |

for pasture and wild hay. Rifle peat is an older soil in the advanced stages of decomposition.

The soils found on the study area are considered to be representative of the soil types in Washtenaw County, Michigan. These soil types arranged in order of fertility are as shown in Table 1.

Soil type areas are represented in Fig. 3 as percentages of the total study area acreage. By using a percentage comparison of area, the relative amounts of the represented soil types can be easily compared as to use by woodchucks.

The various texture classes are represented by the following percentages of the total study area acreage: loam 62.9%, silt loam 5.7%, sandy loam 13.7%, muck 16.9%, and peat 0.8%.

Soil type areas were determined by the use of a planimeter on the Washtenaw County Soil Survey map. The planimeter is accurate within one per cent when used with care, Bouchard (1947). During this work the error was two and one-tenth percent when compared with the computed area. The small scale map, 1:62,500, contributed to the additional error.

The acreage values obtained from the county soils map by the planimeter cannot be applied to the exact soil type acreages in the field. The use of this acreage measure is for purposes of comparison. The errors on the map are consistent and compensatory; therefore, a comparison of the relative acreages is considered valid.

## SOIL AND VEGETATION IDENTIFICATION

Soil type identification was obtained through a combination of a hand texture test described by Lyon and Buckman (1937) and enlarged

TABLE 1

FERTILITY RATING*

| Soil Type | Fertility |
|---|---|
| Brookston loam | High |
| Gilford loam | High |
| Griffin loam | High |
| Carlisle muck | High |
| Washtenaw loam | High |
| Miami loam | Medium to high |
| Miami silt loam | Medium to high |
| Wallkill loam | Medium to high |
| Hillsdale sandy loam | Medium |
| Bellefontaine sandy loam | Medium |
| Bronson loam | Medium |
| Brady sandy loam | Medium |
| Berrien sandy loam | Medium |
| Fox sandy loam | Medium to low |
| Bronson sandy loam | Medium to low |
| Rifle peat | Medium to low |

*Arrangement according to Veatch (1930)

photographs from the county soil map of the individual sections being studied. The scale of these photographs was eight inches to the mile. Whenever there was a question as to the identity of the soil type, the soil description as given by Veatch (1930) was carefully compared.

The following key is taken from Lyon and Buckman (1937) and was used in the field for the hand texture test in determining the texture classes of the soil types. These texture classes are: gravel, sands, clays, loam, sandy loam, silt loam, and clay loam.

I. Soils possessing the properties of one size of particle largely:
   1. Particles of soil very large....gravel
   2. Particles apparent to eye; soil feels gritty and is rather non-plastic..sands
   3. Particles very small; soil very plastic when wet, hard when dry.....clays

II. Soils possessing the properties of a number of sizes of particles, i.e., a mixture:
   1. A fairly equal exhibit of sandy and clayey properties.....loam
   2. A mixture but with sand predominating... .....sandy loam
   3. A mixture but with silty characters dominant. The soil has a floury or talc feel and is quite plastic when wet.....silt loam
   4. A mixture but with clayey characters very apparent. Soil is very plastic and approaches a clay in character..clay loam

The use of the county soil map for a survey as this is limited. The extensive method in which the soil survey map was made introduces several sources of error in locating the exact soil type boundaries. For this reason the hand texture test was used with map photographs and the combination proved to be highly satisfactory for the soil work in this study.

Cover types surrounding the den sites were designated by symbols from the system of ecological classification given by Graham (1945). The symbols denote the predominating plant species on a particular soil series.

## RESULTS OF RESEARCH

### Soil Relations

The associations of soils to dens described herein are based on the average number of acres per den for a given soil type. This density factor was obtained by dividing the total acreage of a soil type by the number of dens found on it.

All the soil types are well represented in total acreage with the exception of Wallkill loam, Berrien sandy loam, Brady sandy loam, and Hillsdale sandy loam; these soils are represented by less than 100 acres of area. Excluding these soils for lack of data, the sequence of soil selectivity by the woodchuck is Bellefontaine sandy loam, Gilford loam, Rifle peat (dens only occurred where the soil type had been drained or piled and dried), Miami loam, Fox sandy loam, Brookston loam, Miami silt loam, Bronson sandy loam, Griffin loam, Carlisle muck, Washtenaw loam, and Bronson loam. Of course, this sequence assumes that the woodchuck has had all of the listed soil types accessible to him. One can consider

such a condition as having occurred for this area in that the location and relative composition of the soil types have prevailed since the advent of the woodchuck in large numbers. These animals became abundant in the area when Washtenaw County was first being settled in 1827. Also, the woodchuck frequently travels long distances in search of a new den site. Seton (1929) writing about the individual range of the woodchuck stated, "...a time comes when the woodchuck needs a change; and he sets out to seek his fortune elsewhere, going perhaps a mile or more, before finding a location that suits his taste...". For these reasons it is logical to conclude that 122 years have presented ample time and opportunity to exhibit any preference that does exist.

In most cases, the soil types were widely distributed. However, Bellefontaine sandy loam occurred only on section 36 of Ann Arbor township and section 31 of Superior township. Sixteen and eight-tenths per cent of all dens on the study area occurred on these two sections. The area made up one of the larger tracts composed of a single soil type. Human activity was practically nil. Where the majority of the dens occurred, the land was heavily pastured. The blue-grass (Poa pratensis) was in fair condition and Crataegus was common. Whether the lack of human activity or the soil type was the influencing factor is conjectural; the amount of activity is directly associated with the value of the soil type. An area of approximately 200 acres in section 2 of Freedom township is known to be little used by humans, lightly pastured, and of a different soil type. However, the den density was much lower. An area of similar description occurred in section 12 of Freedom township. It consisted of approximately 400 acres that had a high den density. This

indicates a correlation of den location with human activity (related to soil value), soil type, and size of the area infrequented by human activity.

Soil texture is a basis to the classification of soils. As seen in the texture comparison of the summary of table 2, the same general pattern of den density for a group of soil types is evident. If larger areas of Berrien sandy loam, Brady sandy loam, and Hillsdale sandy loam could have been obtained for study, the soil type and texture classes would have been more strongly emphasized in the data.

Surface and subsurface soil drainage is definitely important although not obvious in the data (See soil drainage data in summary of table 2). The dens located in poorly drained soil types were occasional or uninhabited refuges. The position of Rifle peat in the soil type selectivity rating is an example of how this soil becomes useful for woodchucks when drained. Only where this soil had been dug from the ditches and dried out in ditch banks was it used for woodchuck dens. As shown in the table, surface drainage is not quite so important as subsurface drainage. Twenty-two and six-tenths per cent of the dens had poor surface drainage but only 9.8 per cent of the dens had poor subsurface drainage. All of the dens with poor subsurface drainage were without permanent inhabitants.

Contrary to the research of Denney (1944), this study has shown no correlation of soil fertility and population of woodchucks. The largest den density occurred in the soils of medium and lower fertility ratings, (See table 3). An overall comparison of the data in Table 3 shows little association of soil fertility and den location. In fact, the highest and lowest den densities occur in soil types of the same fertility rating, (See Bellefontaine sandy loam and Bronson loam in table 3).

SUMMARY OF TABLE 2 (APPENDIX), DEN SITE SOIL DESCRIPTION

| Soil type | Number of dens | Per cent of total dens | Acres in soil type | Acres * per den |
|---|---|---|---|---|
| Bellefontaine sandy loam | 19 | 16.8 | 416.0 | 21.89 |
| Wallkill loam | 3 | 2.6 | 76.8 | 25.60 |
| Gilford loam | 5 | 4.4 | 140.8 | 28.60 |
| Berrien sandy loam | 1 | 0.76 | 32.0 | 32.00 |
| Brady sandy loam | 1 | 0.76 | 32.0 | 32.00 |
| Rifle peat | 2 | 1.8 | 108.8 | 54.40 |
| Hillsdale sandy loam | 1 | 0.76 | 70.4 | 70.40 |
| Miami loam | 55 | 48.7 | 5414.4 | 98.44 |
| Fox sandy loam | 5 | 4.4 | 652.8 | 130.56 |
| Brookston loam | 2 | 1.8 | 262.4 | 131.20 |
| Miami silt loam | 4 | 3.5 | 752.0 | 188.00 |
| Bronson sandy loam | 3 | 2.6 | 588.8 | 196.26 |
| Griffin loam | 1 | 0.76 | 224.0 | 224.00 |
| Carlisle muck | 8 | 7.8 | 2220.8 | 277.60 |
| Washtenaw loam | 1 | 0.76 | 358.4 | 358.40 |
| Bronson loam | 2 | 1.8 | 1817.6 | 908.80 |

Average acres per den, all soil types included, for the study area--173.82

*Based on total acreage of the study area

SUMMARY OF TABLE 2, DEN SITE SOIL DESCRIPTION (CON'T)

Texture Comparison

| Soil texture class | Number of dens | Per cent of total | Acres in class | Acres per den |
|---|---|---|---|---|
| Loam | 70 | 61.3 | 8,326.4 | 118.9 |
| Sandy loam | 29 | 25.7 | 1,760.0 | 60.6 |
| Muck | 8 | 7.7 | 2,220.8 | 277.6 |
| Silt loam | 4 | 3.5 | 752.0 | 188.0 |
| Peat | 2 | 1.8 | 108.8 | 54.4 |

Soil Division Comparison

Mineral Soil. . . . . 103 dens or 91.2% of the total

Organic Soil. . . . . 10 dens or 8.8% of the total

Soil Drainage Data

| Quality | Surface Drainage (No. of dens) | Per cent of total dens |
|---|---|---|
| Good | 25 | 22.6 |
| Medium | 62 | 54.8 |
| Poor | 26 | 22.6 |
| **Quality** | **Subsurface Drainage (No. of dens)** | **Per cent of total dens** |
| Good | 40 | 35.4 |
| Medium | 62 | 54.8 |
| Poor | 11 | 9.8 |

TABLE 3

SOIL TYPE FERTILITY AS RELATED TO ACRES PER DEN

| Soil type | Fertility | Acres per den |
|---|---|---|
| Brookston loam | High | 131.20 |
| Gilford loam | High | 28.60 |
| Griffin loam | High | 224.00 |
| Carlisle muck | High | 277.60 |
| Washtenaw loam | High | 358.40 |
| Miami loam | Medium to high | 98.44 |
| Miami silt loam | Medium to high | 188.00 |
| Wallkill loam | Medium to high | 25.60 |
| Hillsdale sandy loam | Medium | 70.40 |
| Bellefontaine sandy loam | Medium | 21.89 |
| Bronson loam | Medium | 908.80 |
| Brady sandy loam | Medium | 32.00* |
| Berrien sandy loam | Medium | 32.00* |
| Fox sandy loam | Medium to low | 130.56 |
| Bronson sandy loam | Medium to low | 196.26 |
| Rifle peat | Medium to low | 54.40 |

*Figure eliminated in calculation of average because of small total acreage giving the value.

Average acres per den for high fertility soils--203.96
Average acres per den for medium high fertility soils--104.01
Average acres per den for medium fertility soils--333.69
Average acres per den for medium to low fertility soils--127.07

It is now obvious that certain soil relationships effect woodchuck den location. These soil factors are (1) soil type and the associated texture and drainage, (2) human activity as governed by land value, and (3) size of area infrequented by humans.

The preferred conditions are a soil in which the woodchuck can dig easily, a texture that allows good surface and subsurface drainage, and a minimum of human activity over a large area. A general law which could be applied for this area regarding soils and woodchuck dens is stated as follows: The number of woodchuck dens in a specific area is directly proportional to soil type and size of tract and inversely proportional to human activity.

Vegetational Relations

The areas of highest den density did not occur near the croplands. As shown by table 4, Appendix, the most common vegetational types were grass and woodland. Where these types were not available, the dens were located in odd areas or in fencerows where trees and shrubbery were abundant. Usually woodland borders were near the den site. As best could be determined by numerous observations, the den site was so located as to be in a position where the surrounding area could be readily observed. The den entrance may be well concealed, but the surrounding area was rarely dense with vegetation. Dens located in roadside vegetation were never found below the level of the road crown.

Seventy-six and four-tenths per cent of all dens occurred on soils of terrestrial origin. The soils of aquatic origin had 21.3 per cent and transitional belt soils had only 2.2 per cent of the dens.

The soils of terrestrial origin were most abundant in area, the aquatic soils next and transitional belts the least. The transition

SUMMARY OF TABLE 4, (APPENDIX) DEN SITE ECOLOGICAL DESCRIPTION

Soil Series Summary

Nonporous soils of terrestrial origin occurred within 200 feet or at the site of 76 dens. (55.8%)

Porous soils of terrestrial origin occurred within 200 feet or at the site of 28 dens. (20.6%)

Marsh soils of aquatic origin occurred within 200 feet or at the site of 20 dens. (14.7%)

Marsh seepage soils of aquatic origin occurred within 200 feet or at the site of 7 dens. (5.1%)

Bog soils of aquatic origin occurred within 200 feet or at the site of 2 dens. (1.5%)

Transition belt soils occurred within 200 feet or at the site of 3 dens. (2.2%)

Note: Occasionally more than one series occurred at one den site.

Further analysis of this table is to be found in Results of Research.

belt soils were very small in area. It is believed that sufficient area of aquatic soils were present to show a preference by the woodchuck if he so desired a den location in such a site. For these reasons it appears that soils of terrestrial origin are preferred for a den site. Certain vegetational groups and ecological soil series therefore are related to woodchuck dens. A combination of grass and woodland on a soil of terrestrial origin is the desired condition.

Topographic Relations

The topographic relations given attention in this study were slope, entrance exposure, and situation at the den site. Slope varied from 0 to 70 degrees. 69.1 per cent of the total dens had a slope within a range of 0 to 15 degrees. Thirty and nine-tenths per cent of the dens occurred in the 15 to 70 degrees range of slope. The degree of slope apparently has no effect in determining where den excavation occurs other than where the slope is precipitous. Normally the woodchuck will seek a point of vantage regarding the surrounding topography and these points generally have a low degree of slope.

Entrance exposure has been a highly conjectural feature in studies of the woodchuck. The prevailing wind direction and southerly exposure to the sun are the two factors concerned. The prevailing winds of this area are westerly. Considering the directions of minimum exposure to wind as being the eastern slopes between due north and due south, 79.7 per cent of the dens occurred in this protected range. The woodchuck hibernates 4 to 6 months a year, Howell (1915). In as much as he spends his winter in such a manner, the woodchuck leaves his summer den to seek a hibernation den site at the onset of cold temperatures. Hamilton (1934)

## SUMMARY OF TABLE 5 (APPENDIX), TOPOGRAPHIC DATA

### Slope Data

| Degree of slope | No. of dens | Per cent of total dens |
|---|---|---|
| 0 | 44 | 39.0 |
| 10 | 34 | 30.1 |
| 20 | 9 | 8.0 |
| 30 | 10 | 8.8 |
| 40 | 7 | 6.2 |
| 50 | 2 | 1.9 |
| 60 | 4 | 3.4 |
| 70 | 3 | 2.6 |

### Entrance Exposure Data

| Direction of exposure | No. of dens | Per cent of total dens |
|---|---|---|
| North | 20 | 17.7 |
| Northeast | 7 | 6.2 |
| East | 28 | 24.8 |
| Southeast | 10 | 8.8 |
| South | 25 | 22.2 |
| Southwest | 3 | 2.6 |
| West | 13 | 11.5 |
| Northwest | 7 | 6.2 |

### Situation at Den Site

| Situation | No. of dens | Per cent of total dens |
|---|---|---|
| Hill | 57 | 41.3 |
| Gravel pit | 0 | |
| Roadside ditch | 14 | 10.1 |
| Drainage ditch | 22 | 16.0 |
| Erosion gulley | 0 | |

SUMMARY OF TABLE 5, (CON'T.)

| | | |
|---|---|---|
| Fencerow | 34 | 24.6 |
| Level | 11 | 8.1 |

More than one feature often occurred at the same den site as shown below: (fencerow combinations)

| | |
|---|---|
| Hill-fencerow | 7 |
| Roadside ditch-fencerow | 13 |
| Drainage ditch-fencerow | 3 |
| Level-fencerow | 1 |

states that, "In choosing a suitable burrow, or site in which to spend the winter, woodchucks usually seek a hedgerow, woods, or a steep incline in stony ground that has a southern exposure". Further corroboration of this seasonal habit is described by Merriam (1886), "...the majority of our woodchucks desert the meadows in autumn and hibernate in burrows in the woods". Thirty-three and six-tenths per cent of the dens studied had southern exposures, between southeast and southwest, in sites such as described by these men.

There was no definite preference for a particular topographic feature near or on which the den was constructed. Hills were used for 41.1 per cent of the dens; however, this is no criteria signifying preference for the feature. Low rolling hills are very common on the study area and would have been available for every den had the woodchuck desired such a feature.

Den-Water Relations

The data gathered on water proximity is extremely variable. It does show that water occurs within 1000 feet of every den studied. 98.3 per cent of the dens were located within 500 feet of water. The question arises as to whether or not a den could be located further than 1000 feet from water on the study area. Parts of all the study area offer localities where the den site could be further than 1000 feet from water. This condition could be interpreted as being a physiological requirement or a habitat requirement. The physiological needs can be eliminated by the supposition that woodchucks satisfy most of their needs for water with the succulent plants that make up their main diet plus the rain or dew on these plants, Seton (1929). Water conditions in the study area provide

SUMMARY OF TABLE 6 (APPENDIX pg. 20), DEN-WATER RELATIONSHIPS

Water Proximity

| Water proximity in feet | No. of dens | Per cent of total dens |
|---|---|---|
| 10 | 17 | 15.0 |
| 20 | 13 | 11.5 |
| 30 | 5 | 4.4 |
| 40 | 8 | 7.1 |
| 50 | 5 | 4.4 |
| 100 | 19 | 16.8 |
| 200 | 19 | 16.8 |
| 300 | 12 | 10.6 |
| 400 | 4 | 3.5 |
| 500 | 9 | 8.0 |
| 1000 | 2 | 1.7 |

98.3% occurred within 500 feet of water
Average distance from water--164.1 feet

Water Class Occurrence

| Class within 500 feet | No. of dens | Per cent of total dens |
|---|---|---|
| Rapid creek | 6 | 5.1 |
| Sluggish creek | 4 | 3.4 |
| Pond | 12 | 10.3 |
| Marsh | 48 | 41.2 |
| Rapid drainage ditch | 15 | 12.8 |
| Sluggish drainage ditch | 31 | 27.2 |

SUMMARY OF TABLE 6, (CON'T.)

Elevation Above Nearest Water

| Elevation in feet | No. of dens | Per cent of total dens |
|---|---|---|
| 5 | 19 | 16.8 |
| 10 | 33 | 29.2 |
| 15 | 23 | 20.3 |
| 20 | 20 | 17.7 |
| 25 | 12 | 10.6 |
| 30 | 6 | 5.4 |

Average height of dens above water--14.6 feet

an abundance of vegetation for food and cover determining the amount of human activity which can occur. Habitat requirements appear to be the basis of the need for water in the vicinity of the den site.

The classes of water within 500 feet were rapid creeks, sluggish creeks, ponds, marshes, rapid drainage ditches, and sluggish drainage ditches. Marshes were most frequently near the den; this would be expected with the large number of marshes in the study area and also in the county. Apparently, no particular source of free water is preferred.

The elevation of the den entrance above the nearest water was variable. 83.2 per cent of the dens were 10 to 50 feet above the nearest water. In many cases where the dens were only 5 feet above the nearest water, the water drainage was comparatively uniform and did not endanger the den during any season; others of this elevation were deserted—probably the result of flooding.

Den Use Observations

The study area had 61 active dens which were originally excavated by woodchucks. These active dens make up 54 per cent of all dens studied. There were 43 inactive dens excavated by woodchucks. Nine other dens excavated by woodchucks could not be positively determined as active or inactive dens.

Dens inhabited by woodchucks made up 26.5 per cent of all, active and inactive, dens studied. Fifty per cent of all active dens were inhabited by woodchucks. At 13 active sites, the inhabitants could not be determined. The 43 inactive dens displayed signs of occasional use; the most frequent species seeking temporary refuge in these dens appeared to be the cottontail. (See summary of table 7).

SUMMARY OF TABLE 7 (APPENDIX, pg. 26), DEN USE DATA

| Use | | No. of dens | Inhabitant |
|---|---|---|---|
| Active | | 3 | Rabbit |
| | | 5 | Skunk |
| | | 30 | Woodchuck |
| | | 3 | Raccoon |
| | | 7 | Fox |
| | | 13 | Unknown |
| | Total | 61 | |
| Inactive | Total | 43 | |
| Unknown | Total | 9 | |
| | Grand Total | 113 | |

## SUMMARY

1. The soil relationships which effect the location of woodchuck dens are: (1) soil type and the associated texture and drainage, (2) human activity as governed by land value, and (3) size of area infrequented by humans.

2. The preferred conditions for woodchuck den sites are: (1) a soil in which he can dig easily, (2) a soil texture that allows good surface and subsurface drainage, and (3) a minimum of human activity over a large area.

3. The number of woodchuck dens in a specific area is directly proportional to soil type and size of tract and inversely proportional to human activity.

4. Soils of a terrestrial origin are preferred for den sites.

5. A combination grass and woodland is the preferred vegetation at the den site.

6. The sequence of soil type selectivity for the study area is Bellefontaine sandy loam, Gilford loam, Rifle peat, Miami loam, Brookston loam, Miami silt loam, Bronson sandy loam, Griffin loam, Carlisle muck, Washtenaw loam, and Bronson loam.

7. Soil type selectivity is exercised by the woodchuck but is done so over a period of many years.

8. Dens located in adjacent roadside vegetation were never found below the level of the road crown.

9. Slope is not a deciding factor in den location, although many dens were located at points of vantage where the gradient was often low.

10. Entrance exposure is generally in a southerly direction for winter dens. Entrance exposure is variable in summer dens, although 79.7 per cent occurred on the slopes sheltered from the prevailing winds of the study area.

11. There is no definite preference for a particular topographic feature near or on which the den is constructed in this study area.

12. Free water is a habitat requirement and not a physiological requirement for the woodchuck. All dens occurred within 1000 feet of water and 98.3 per cent of the dens were located within 500 feet.

13. There was no preference for a particular class of free water in the vicinity of the den site.

14. The elevation of dens above water exhibited little conformity other than to be above flood water levels.

15. The most frequent species seeking temporary refuge in inactive dens appeared to be the cottontail.

16. Woodchucks occupied 50 per cent of the active dens on this area.

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# APPENDIX

TABLE 2

DEN SITE SOIL DESCRIPTION

| Den No. | Soil Type | Surface Drainage | Subsurface Drainage | Top Soil | Subsoil at Den Entrance |
|---|---|---|---|---|---|
| 1 | Miami loam | Good | Medium | Loam | silt, sand |
| 2 | Miami loam | Good | Good | Loam | silt, sand |
| 3 | Miami loam | Medium | Medium | Loam | silt, sand |
| 4 | Miami loam | Medium | Medium | Loam | silt, sand, gravel |
| 5 | Miami loam | Poor | Medium | Loam | gravel, silt sand |
| 6 | Miami loam | Medium | Medium | Loam | silt, sand, gravel |
| 7 | Miami loam | Poor | Medium | Loam | silt, sand, gravel |
| 8 | Miami loam | Medium | Good | Loam | silt, sand, gravel |
| 9 | Miami loam | Medium | Good | Loam | silt, sand, gravel |
| 10 | Miami loam | Medium | Good | Loam | silt, sand, gravel |
| 11 | Miami loam | Poor | Good | Loam | silt, sand, gravel |
| 12 | Miami loam | Medium | Good | Loam | silt, sand, gravel |
| 13 | Miami loam | Medium | Good | Loam | silt, sand, gravel |
| 14 | Miami loam | Poor | Good | Loam | silt, sand |
| 15 | Miami loam | Poor | Medium | Loam | silt, sand, gravel |
| 16 | Miami loam | Medium | Good | Loam | silt, sand, gravel |

TABLE 2 (con't)

DEN SITE SOIL DESCRIPTION

| Den No. | Soil Type | Surface Drainage | Subsurface Drainage | Top Soil | Subsoil at Den Entrance |
|---|---|---|---|---|---|
| 17 | Miami loam | Poor | Medium | Loam | silt, sand, gravel |
| 18 | Miami loam | Medium | Medium | Loam | silt, sand, gravel |
| 19 | Miami loam | Medium | Medium | Loam | silt, sand |
| 20 | Miami loam | Medium | Medium | Loam | silt, sand |
| 21 | Miami loam | Medium | Medium | Loam | silt, sand, gravel |
| 22 | Miami loam | Medium | Medium | Loam | silt, sand, gravel |
| 23 | Miami loam | Medium | Medium | Loam | silt, sand, gravel |
| 24 | Miami loam | Medium | Medium | Loam | silt, sand, gravel |
| 25 | Miami loam | Medium | Good | Loam | silt, sand, gravel |
| 26 | Miami loam | Medium | Medium | Loam | silt, sand |
| 27 | Miami loam | Medium | Medium | Loam | silt, sand, gravel |
| 28 | Miami loam | Medium | Medium | Loam | silt, sand |
| 29 | Miami loam | Medium | Medium | Loam | silt, sand |
| 30 | Miami loam | Medium | Medium | Loam | silt, sand |
| 31 | Miami loam | Medium | Medium | Loam | silt, sand |
| 32 | Miami loam | Medium | Medium | Loam | silt, sand, gravel |
| 33 | Miami loam | Medium | Medium | Loam | silt, sand, gravel |

TABLE 2 (con't)

DEN SITE SOIL DESCRIPTION

| Den No. | Soil Type | Surface Drainage | Subsurface Drainage | Top Soil | Subsoil at Den Entrance |
|---|---|---|---|---|---|
| 34 | Miami loam | Medium | Medium | Loam | silt, sand |
| 35 | Miami loam | Poor | Medium | Loam | sand |
| 36 | Miami loam | Medium | Good | Loam | silt, sand |
| 37 | Miami loam | Medium | Medium | Loam | silt, sand, gravel |
| 38 | Miami loam | Medium | Medium | Loam | silt, sand, gravel |
| 39 | Miami loam | Medium | Medium | Loam | silt, sand, gravel |
| 40 | Miami loam | Medium | Medium | Loam | silt, sand, gravel |
| 41 | Miami loam | Medium | Medium | Loam | silt, sand, gravel |
| 42 | Miami loam | Medium | Medium | Loam | silt, sand, gravel |
| 43 | Miami loam | Medium | Medium | Loam | silt, sand, gravel |
| 44 | Miami loam | Medium | Medium | Loam | silt, sand, gravel |
| 45 | Miami loam | Medium | Medium | Loam | sand, gravel |
| 46 | Miami loam | Medium | Medium | Loam | sand, gravel |
| 47 | Miami loam | Medium | Medium | Loam | sand, gravel |
| 48 | Miami loam | Medium | Medium | Loam | silt, sand |
| 49 | Miami loam | Poor | Medium | Silt Loam | silt, sand, gravel |
| 50 | Miami loam | Medium | Medium | Sandy Loam | silt, sand |

TABLE 2 (con't)

DEN SITE SOIL DESCRIPTION

| Den No. | Soil Type | Surface Drainage | Subsurface Drainage | Top Soil | Subsoil at Den Entrance |
|---|---|---|---|---|---|
| 51 | Miami loam | Medium | Good | Loam | sand, gravel |
| 52 | Miami loam | Medium | Medium | Loam | silt, sand |
| 53 | Miami loam | Medium | Medium | Loam | silt, sand, gravel |
| 54 | Miami loam | Medium | Medium | Loam | silt, sand |
| 55 | Miami loam | Good | Medium | Loam | silt, sand |
| 56 | Bellefontaine sandy loam | Good | Good | Sandy Loam | silt, sand |
| 57 | Bellefontaine sandy loam | Good | Good | Sandy Loam | sand, gravel |
| 58 | Bellefontaine sandy loam | Good | Good | Sandy Loam | silt, sand, gravel |
| 59 | Bellefontaine sandy loam | Good | Good | Sandy Loam | silt, sand, gravel |
| 60 | Bellefontaine sandy loam | Good | Good | Sandy Loam | silt, sand, gravel |
| 61 | Bellefontaine sandy loam | Good | Good | Sandy Loam | silt, sand, gravel |
| 62 | Bellefontaine sandy loam | Good | Good | Sandy Loam | silt, sand |
| 63 | Bellefontaine sandy loam | Good | Good | Sandy Loam | silt, sand, gravel |
| 64 | Bellefontaine sandy loam | Good | Good | Sandy Loam | silt, sand |
| 65 | Bellefontaine sandy loam | Good | Good | Sandy Loam | silt, sand, gravel |
| 66 | Bellefontaine sandy loam | Good | Good | Sandy Loam | sand |

TABLE 2 (con't)

DEN SITE SOIL DESCRIPTION

| Den No. | Soil Type | Surface Drainage | Subsurface Drainage | Top Soil | Subsoil at Den Entrance |
|---|---|---|---|---|---|
| 67 | Bellefontaine sandy loam | Good | Good | Sandy Loam | silt, sand |
| 68 | Bellefontaine sandy loam | Good | Good | Sandy Loam | sand |
| 69 | Bellefontaine sandy loam | Good | Good | Sandy Loam | silt, sand |
| 70 | Bellefontaine sandy loam | Good | Good | Sandy Loam | silt, sand |
| 71 | Bellefontaine sandy loam | Good | Good | Sandy Loam | sand, gravel |
| 72 | Bellefontaine sandy loam | Good | Good | Sandy Loam | silt, sand, gravel |
| 73 | Bellefontaine sandy loam | Good | Good | Sandy Loam | silt, sand, gravel |
| 74 | Bellefontaine sandy loam | Medium | Good | Sandy Loam | silt, sand, gravel |
| 75 | Carlisle Muck | Poor | Poor | Muck | silt, rubble |
| 76 | Carlisle Muck | Poor | Poor | Muck | silt, rubble |
| 77 | Carlisle Muck | Poor | Poor | Muck | silt, rubble |
| 78 | Carlisle Muck | Poor | Medium | Muck | silt, sand, rubble |
| 79 | Carlisle Muck | Poor | Poor | Muck | silt, rubble |
| 80 | Carlisle Muck | Poor | Poor | Muck | silt, sand, rubble |
| 81 | Carlisle Muck | Poor | Poor | Muck | silt, rubble |
| 82 | Carlisle Muck | Poor | Medium | Muck | silt |
| 83 | Fox Sandy Loam | Good | Good | Sandy Loam | sand |

TABLE 2 (con't)

DEN SITE SOIL DESCRIPTION

| Den No. | Soil Type | Surface Drainage | Subsurface Drainage | Top Soil | Subsoil at Den Entrance |
|---|---|---|---|---|---|
| 84 | Fox Sandy Loam | Good | Good | Sandy Loam | sand |
| 85 | Fox Sandy Loam | Medium | Good | Sandy Loam | sand |
| 86 | Fox Sandy Loam | Medium | Good | Sandy Loam | silt, sand, gravel |
| 87 | Fox Sandy Loam | Good | Good | Sandy Loam | silt, sand, gravel |
| 88 | Gilford Loam | Poor | Poor | Loam | silt, sand |
| 89 | Gilford Loam | Poor | Medium | Loam | silt, gravel |
| 90 | Gilford Loam | Medium | Medium | Loam | silt, sand, gravel |
| 91 | Gilford Loam | Medium | Medium | Loam | silt, gravel |
| 92 | Gilford Loam | Medium | Medium | Loam | silt, gravel sand |
| 93 | Miami Silt Loam | Poor | Medium | Silt Loam | silt, clay |
| 94 | Miami Silt Loam | Poor | Medium | Silt Loam | silt, sand, clay |
| 95 | Miami Silt Loam | Poor | Medium | Silt Loam | silt, sand, clay |
| 96 | Miami Silt Loam | Poor | Poor | Silt Loam | silt, sand, gravel |
| 97 | Bronson Sandy Loam | Good | Medium | Sandy Loam | sandy clay |
| 98 | Bronson Sandy Loam | Good | Good | Sandy Loam | sand |
| 99 | Bronson Sandy Loam | Good | Good | Sandy Loam | silt, sand, gravel |

TABLE 2 (con't)

DEN SITE SOIL DESCRIPTION

| Den No. | Soil Type | Surface Drainage | Subsurface Drainage | Top Soil | Subsoil at Den Entrance |
|---|---|---|---|---|---|
| 100 | Wallkill Loam | Medium | Medium | Loam | silt, sand, gravel |
| 101 | Wallkill Loam | Medium | Medium | Loam | silt, sand, gravel |
| 102 | Wallkill Loam | Medium | Medium | Loam | silt, sand, gravel |
| 103 | Bronson Loam | Medium | Medium | Loam | silt, sand |
| 104 | Bronson Loam | Medium | Medium | Loam | silt, sand, rubble |
| 105 | Rifle Peat | Poor | Poor | Peat | silt, sand |
| 106 | Rifle Peat | Poor | Poor | Peat | silt, sand, rubble |
| 107 | Brookston Loam | Medium | Medium | Loam | silt, sand |
| 108 | Brookston Loam | Medium | Medium | Loam | silt, sand, rubble |
| 109 | Washtenaw Loam | Medium | Medium | Loam | silt, sand |
| 110 | Berrien Sandy Loam | Medium | Medium | Loamy Sand | sand |
| 111 | Griffin Loam | Poor | Poor | Loam | silt, sand |
| 112 | Hillsdale Sandy Loam | Medium | Good | Sandy Loam | silt, sand |
| 113 | Brady Sandy Loam | Medium | Good | Sandy Loam | silt, sand |

TABLE 4

DEN SITE ECOLOGICAL DESCRIPTION

Soil series and cover type numbers according to S. A. Graham's, Ecol. Class. of Cover Types, 1945 Journ. Wildl. Mgt., Vol. 9, No. 3. Crop symbols used are at the end of this table.

| Den No. | Soil series | Cover type or crop within 50' | | | | Cover type or crop within 200' | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | N | E | S | W | N | E | S | W |
| 1 | nonporous | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 |
| 2 | nonporous | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 | 5 |
| 3 | nonporous | 5,6 | 5,6 | 5,6 | 5,6 | 5,6,7 | 5,6 | 5,6,7 | 5,6 |
| 4 | nonporous | 5,9 | 5,9 | c | 5,9 | 5,9 | 5,9 | c | 5,9 |
| 5 | nonporous | 5,7 | 5,7 | 0 | 5,7 | 5 | 5,7 | 0 | 5,7 |
| 6 | nonporous | 6,7,9 | c | 6,7,9 | 6,7,9 | 6,7,9 | c | 6,7,9 | 6,7,9 |
| 7 | nonporous | al | 6,7,8 | 0 | 6,7,8 | al | 6,7,8 | 0 | 6,7,8 |
| 8 | nonporous | 5,9 | 5,7 | 5,9 | 5,9 | 5,9 | 5,7 | 5,9 | 5,9 |
| 9 | nonporous | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 |
| 10 | nonporous | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 | 5 |

TABLE 4 (con't)

DEN SITE ECOLOGICAL DESCRIPTION

| Den No. | Soil series | Cover type or crop within 50' | | | | Cover type or crop within 200' | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | N | E | S | W | N | E | S | W |
| 11 | nonporous | 5 | 5 | 5,7 | 5,9 | 5 | | 5,9 | 5,9 |
| | stagnant marsh | | | | | | 5 | | |
| 12 | nonporous | 5,9 | 5 | 5 | 5 | 5,9 | | | 5 |
| | marsh | | | | | | 5 | 5 | |
| 13 | nonporous | 5 | 5,9 | 5.9 | 5,9 | 5 | 5,9 | 5,9 | 5,9 |
| 14 | nonporous | 5 | 5,9 | 5,9 | 5,9 | 5 | 5,8 | 5,8 | 5,8 |
| 15 | nonporous | 5 | 5,8 | 5,9 | 5,9 | 5 | 5,9 | 5,9 | 5,9 |
| 16 | porous | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 | 0 | 5,9 | 5,9 |
| 17 | nonporous | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 | 0 | 5,9 | 5,9 |
| 18 | nonporous | 5 | 5,8 | 5,9 | 5,9 | 5 | 5,9 | 0 | 5,9 |
| | marsh | | | | | 5 | | | |
| 19 | nonporous | w | 7,9 | al | 7,9 | w | 7,9 | al | 7,9 |
| 20 | nonporous | c | 7,9 | al | 7,9 | c | 7,9 | al | 7,9 |

TABLE 4 (con't)

DEN SITE ECOLOGICAL DESCRIPTION

| Den No. | Soil series | Cover type or crop within 50' | | | | Cover type or crop within 200' | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | N | E | S | W | N | E | S | W |
| 21 | nonporous | w | 7 | p | 7 | w | 7 | p,c | 7 |
| 22 | nonporous | | 7 | cl | 7 | | 7 | cl | 7 |
| | marsh | 5 | | | | 5 | | | |
| 23 | nonporous | 5,9 | 5,9 | 5,9 | 5,9 | 5 | 5,9 | 5,9 | 5,9 |
| 24 | nonporous | 5,9 | 5,9 | 5,9 | 5,9 | 5 | 5,9 | 5,9 | 5,9 |
| 25 | nonporous | 5 | 5,9 | 5,9 | 5,9 | 5 | 5,9 | 5,9 | 5,9 |
| 26 | nonporous | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 |
| 27 | nonporous | 7 | st,7 | 7 | 4 | 7 | st,7 | 7 | 5 |
| 28 | nonporous | 5 | st | 5 | 7 | 5 | st | 5 | 5,7 |
| 29 | nonporous | 5 | st | 7 | 7 | 5 | st | 7 | 5,7 |
| 30 | nonporous | 5 | 5,7 | 5,9 | 5,7 | 5 | 5,7 | 5,9 | 5,7 |
| 31 | nonporous | 5 | 9 | 9 | 9 | 5 | 9 | 9 | 9 |
| 32 | nonporous | 7 | st | 7 | st | 7 | st | 7 | st |
| 33 | nonporous | 5 | 5 | 5 | 5 | 5 | 5 | 5 | st,5 |
| | marsh seepage | | | | | | 4 | | |

TABLE 4 (con't)

DEN SITE ECOLOGICAL DESCRIPTION

| Den No. | Soil series | Cover type or crop within 50' | | | | Cover type or crop within 200' | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | N | E | S | W | N | E | S | W |
| 34 | nonporous | 5,9 | 5,8 | 5,9 | 5,9 | 5 | 5,9 | 5 | 5,9 |
| | marsh | | | | | 9 | | 7,9 | |
| 35 | nonporous | 5,9 | 5,9 | 5,9 | w | 5,9 | 5,9 | 9,5 | w |
| | marsh | | | | | | 5 | | |
| 36 | nonporous | al | al | al | al | al | al | al,6,7 | al |
| 37 | nonporous | 5,al | al | 5,7 | 5 | 5,al | al | al,6,7 | al |
| 38 | nonporous | 7,8 | al | 7,8 | c | 7,8 | al | 7,8 | c |
| 39 | nonporous | 6,7,9 | 9 | 6,7,9 | w | 6,7,9 | 9,w | 6,7,9 | w |
| 40 | nonporous | 5,6 | 5 | 5 | al | 5,6,c | 5,c | 5 | al |
| 41 | nonporous | 5,8 | 5,9,c | 5,9 | 5,9 | 5,8 | 5,9,c | 5,9,w | 5,9,w |
| 42 | nonporous | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 |
| 43 | nonporous | w | 7,8 | c | 7,8 | w | 7,8 | c,0 | 0,7,8 |
| 44 | nonporous | 7 | st | 7 | st | 7 | st | 7 | st |
| 45 | nonporous | 5,6 | 5,6 | 5,6 | 5,6 | 5,6 | 5,6 | | 5,6 |
| | marsh seepage | | | | | | | 5,7 | |

TABLE 4 (con't)

DEN SITE ECOLOGICAL DESCRIPTION

| Den No. | Soil series | Cover type or crop within 50' | | | | Cover type or crop within 200' | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | N | E | S | W | N | E | S | W |
| 46 | nonporous | 5,6 | 5,6 | 5,6 | 5,6 | 5,6 | 5,6 | | 5,6 |
| | marsh seepage | | | | | | | 5,7 | |
| 47 | nonporous | 5,6 | 5,6 | 5,6 | 5,6 | 5,6 | 5,6 | | 5,6 |
| | marsh seepage | | | | | | | 5,7 | |
| 48 | nonporous | 5 | 5 | 5 | 5,7 | 5 | 5 | 5 | 5,7 |
| | marsh | 5,7,9 | 5 | | | 5,7,9 | 5 | | |
| 49 | nonporous | cl | 6,7 | 5,p | 6,7 | cl | 6,7 | 5,p | 6,7 |
| 50 | nonporous | 5 | 5,9 | 5,9 | 5,9 | 5 | 5,9 | 5,9 | 5,9 |
| 51 | nonporous | w | 7,8 | p | 7,8 | w | 7,8 | p | 7,8 |
| 52 | nonporous | w | w | w | w | w | w | w | w |
| 53 | nonporous | 5 | 7,9 | 5,7,9 | 7 | 5 | 7,9 | 5,7,0,al | 7 |
| | marsh | | | | 9 | | | | 9 |
| 54 | nonporous | 5 | 5 | 5 | 5 | w | 5 | 5 | 5 |

TABLE 4 (con't)

DEN SITE ECOLOGICAL DESCRIPTION

| Den No. | Soil series | Cover type or crop within 50' | | | | Cover type or crop within 200' | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | N | E | S | W | N | E | S | W |
| 55 | nonporous | 5 | 5 | 5 | 5 | w | 5 | 5 | 5 |
| 56 | porous | 5,9 | 5,9 | 5,9 | 5,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 |
| 57 | porous | 5,8,9 | 5,9 | 5,9 | 5 | 5,8,9 | 5,9 | 5,9 | 5 |
| 58 | porous | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 |
| 59 | porous | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 |
| 60 | porous | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 |
| 61 | porous | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| 62 | porous | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 63 | porous | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 64 | porous | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 65 | porous | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,10 |
| | marsh seepage | | | | | | 5 | | |
| 66 | porous | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 |
| | marsh seepage | | | | | | | 5 | |

TABLE 4 (con't)

DEN SITE ECOLOGICAL DESCRIPTION

| Den No. | Soil series | Cover type or crop within 50' | | | | Cover type or crop within 200' | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | N | E | S | W | N | E | S | W |
| 67 | porous | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 |
| | marsh seepage | | | | | | | 5 | |
| 68 | porous | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7,9 | 5,7 | 5,7 |
| 69 | porous | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7,9 | 5,7 | 5,7 |
| 70 | porous | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 |
| 71 | porous | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 |
| 72 | porous | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 | 5,7 |
| | transition belts | | 5,7 | 5,7,9 | | | 5,7 | 5,7,9 | |
| 73 | porous | 5 | | | 5,7 | 5 | | | 5,7 |
| | transition belt | 7,9 | 5,7,9 | 7,9 | | 7,9 | 5,7,9 | 7,9 | |
| 74 | porous | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 |
| 75 | marsh | 4,5,6 | 4,5,6 | 5,9 | 5,9 | 4,5,6 | 4,5,6 | 5,9 | 5,9 |

TABLE 4 (con't)

DEN SITE ECOLOGICAL DESCRIPTION

| Den No. | Soil series | Cover type or crop within 50' | | | | Cover type or crop within 200' | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | N | E | S | W | N | E | S | W |
| 76 | marsh | w | 6,7 | 5 | 6,7 | w | 6,7 | 5,al | 6,7 |
| 77 | marsh | 5,6,7 | 5,6 | 5,6,7 | 5 | 5,6,7 | 5,6,7 | 5,6,7 | 5 |
| 78 | marsh | 7,c | 7,8 | 7 | 7,8 | 7,c | 7,8 | 7 | 7,8 |
| 79 | marsh | c | c | c | c | w,cl | c,p | c,9 | c |
| 80 | marsh | 6,7 | 6 | 6 | 6 | 6,7 | 6 | 9 | 6 |
| 81 | marsh | 5,7,8,9 | 5,7,8,9 | 5,7,8 | 5,7,8 9 | 5,7,8,9 | 5,7,8,9 | 5,7,8,9 | 5,7,8,9 |
| 82 | nonporous | 5,6 | 5,6 | | 5,6 | 5,6 | 5,6 | | 5,6 |
| | marsh | | | 7,8 | | | | 7,8 | |
| 83 | porous | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 |
| 84 | porous | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 | 5,9 |
| 85 | porous | 5,7 | 5 | 5,7 | 5 | 5,7 | 5 | 5,7 | 5 |
| 86 | nonporous | 5,9 | c | 5,9 | c | 5 | c | 5,9 | c,w |
| 87 | porous | | w | | | | w | | |
| | transition belts | 5,7,9 | 5 | 5,7,9 | 5,7,9 | 5,7,9 | 5 | 5,7,9 | 5,7,9 |

TABLE 4 (con't)

DEN SITE ECOLOGICAL DESCRIPTION

| Den No. | Soil series | Cover type or crop within 50' | | | | Cover type or crop within 200' | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | N | E | S | W | N | E | S | W |
| 88 | nonporous | 9 | 9 | 9 | 9 | 9 | 9 | 9 | 9 |
| 89 | nonporous | 7 | 7 | 7 | al | 7 | 7 | 7 | al |
| 90 | nonporous | 5,7 | 5,7 | 5,7 | al | 5,7 | 5,7 | 5,7 | al |
| 91 | nonporous | 5,9 | 5,9 | 5,9 | 5,9 | 5 | 5,9 | 5,9 | 5,9 |
| 92 | nonporous | 5,7 | 5,8 | 5,8 | al | 5,8 | 5,7 | 5,7 | al |
| 93 | nonporous | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 |
| 94 | nonporous | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 |
| 95 | nonporous | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 |
| 96 | nonporous | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 | 5,7,9 |
| 97 | nonporous | 5 | 9 | 9 | 5 | | 9 | 9 | 5 |
| | marsh | | | | | 7,9 | | | |
| 98 | porous | 5 | 5,6,7 | 5 | 5,6,7 | 5 | 5,6,7 | 5 | 5,6,7 |
| 99 | porous | cl | cl | cl | cl | 5,9 | | cl | 6,7 |
| | marsh | | | | | | 6,9 | | 6,7 |

TABLE 4 (con't)

DEN SITE ECOLOGICAL DESCRIPTION

| Den No. | Soil series | Cover type or crop within 50' | | | | Cover type or crop within 200' | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | N | E | S | W | N | E | S | W |
| 100 | nonporous | w | 5,6,7 | cl | 5,6,7 | w | 5,6,7 | cl | 5,6,7 |
| 101 | nonporous | w | w | cl,7 | w | w | w | cl,7 | w |
| 102 | nonporous | cl | 5 | w | w | cl | 5,w | w | cl,5,w |
| 103 | nonporous | 7,9 | cl | 7,9 | 7,9 | 7,9,cl | cl | 7,9,c | 7,9,c |
| 104 | nonporous | w | 7,10 | c | 7,10 | w | 7,10 | c | 7,10 |
| 105 | bogs | 5,6,7 | 5,7 | 5 | 5,6,7 | 5,6,7 | 5,6,7 | 5 | 5,6,7 |
| 106 | bog | 5,6,7 | c | 5,6,7 | cl | 5,6,7 | c | 5,6,7 | cl |
| 107 | nonporous | | 7,8 | c | 7,8 | | 7,8 | c | 7,8 |
| | marsh | 6 | | | | 6 | | | |
| 108 | nonporous | 5 | 7,8 | c | 7,8 | 5 | 7,8 | c | 7,8 |
| | marsh | | | | | 6 | | | |
| 109 | nonporous | 5 | 5 | 5 | 6,7 | 5 | 5,c | 5 | 6,7 |
| 110 | porous | 5,9 | 5,7,8,9 | 0 | 5,7,8,9 | 5,9 | 5,7,8,9 | 0 | 5,7,8,9 |

TABLE 4 (con't)

DEN SITE ECOLOGICAL DESCRIPTION

| Den No. | Soil series | Cover type or crop within 50' | | | | Cover type or crop within 200' | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | N | E | S | W | N | E | S | W |
| 111 | nonporous | 7,8 | O | 7,8 | p | 7,8 | c,O,orch | 7,8 | p |
| 112 | nonporous | 6,7 | cl | 6,7 | c | 6,7 | cl | 6,7 | c |
| 113 | porous | c | 5,6 | c | 5,6 | c | 5,c | c | 5,6 |

Crop symbols used in table:

O - Oats

al - Alfalfa

orch - Orchard

c - Corn

cl - Clover

p - pasture

w - wheat

st - stubble

TABLE 5

Topographic Data

| Den No. | Slope in degrees | Entrance exposure | Situation at den site |
|---|---|---|---|
| 1 | 70 | east | drainage |
| 2 | 20 | northwest | hill |
| 3 | 20 | southeast | hill |
| 4 | 0 | northwest | fencerow |
| 5 | 60 | south | fencerow |
| 6 | 0 | south | level |
| 7 | 10 | north | fencerow, hill |
| 8 | 20 | north | fencerow, hill |
| 9 | 10 | west | hill |
| 10 | 10 | west | hill |
| 11 | 20 | northeast | hill |
| 12 | 40 | southeast | hill |
| 13 | 10 | south | hill, fencerow |
| 14 | 0 | north | hill |
| 15 | 0 | south | hill |
| 16 | 10 | east | hill |
| 17 | 10 | south | hill |
| 18 | 20 | north | hill |
| 19 | 0 | east | roadside ditch, fencerow |
| 20 | 0 | east | roadside ditch, fencerow |

TABLE 5 (con't)

| Den No. | Slope in degrees | Entrance exposure | Situation at den site |
|---|---|---|---|
| 21 | 0 | north | roadside ditch, fencerow |
| 22 | 0 | northwest | roadside ditch, fencerow |
| 23 | 0 | north | hill |
| 24 | 10 | north | hill |
| 25 | 60 | north | hill |
| 26 | 0 | west | hill |
| 27 | 30 | east | drainage ditch |
| 28 | 20 | west | drainage ditch |
| 29 | 30 | west | drainage ditch |
| 30 | 10 | east | drainage ditch |
| 31 | 10 | north | drainage ditch |
| 32 | 0 | southwest | fencerow |
| 33 | 10 | east | hill |
| 34 | 0 | east | hill |
| 35 | 0 | east | fencerow |
| 36 | 10 | south | hill |
| 37 | 40 | east | hill |
| 38 | 10 | east | hill, fencerow |
| 39 | 10 | east | roadside ditch, fencerow |
| 40 | 20 | east | hill, fencerow |

TABLE 5 (con't)

| Den No. | Slope in degrees | Entrance exposure | Situation at den site |
|---|---|---|---|
| 41 | 20 | northeast | hill |
| 42 | 0 | north | hill |
| 43 | 10 | south | roadside ditch, fencerow |
| 44 | 10 | east | fencerow |
| 45 | 10 | southeast | hill |
| 46 | 0 | northeast | hill |
| 47 | 10 | southeast | hill |
| 48 | 30 | northeast | hill |
| 49 | 0 | northwest | fencerow |
| 50 | 10 | north | hill |
| 51 | 10 | south | roadside ditch, fencerow |
| 52 | 0 | south | level |
| 53 | 0 | north | roadside ditch, fencerow |
| 54 | 30 | south | hill |
| 55 | 30 | south | hill |
| 56 | 10 | north | hill |
| 57 | 0 | south | fencerow |
| 58 | 10 | northeast | hill |
| 59 | 10 | northeast | hill |
| 60 | 10 | south | hill |
| 61 | 0 | west | hill |

TABLE 5 (con't)

| Den No. | Slope in degrees | Entrance exposure | Situation at den site |
|---|---|---|---|
| 62 | 0 | northwest | hill |
| 63 | 10 | north | hill |
| 64 | 0 | south | hill |
| 65 | 30 | east | hill |
| 66 | 30 | southeast | hill |
| 67 | 30 | southeast | hill |
| 68 | 10 | south | hill |
| 69 | 10 | east | hill |
| 70 | 10 | east | hill |
| 71 | 10 | southeast | hill |
| 72 | 40 | southeast | |
| 73 | 10 | southeast | hill |
| 74 | 0 | southwest | level |
| 75 | 10 | south | drainage |
| 76 | 0 | east | fencerow |
| 77 | 0 | east | fencerow |
| 78 | 0 | northwest | drainage ditch |
| 79 | 0 | southwest | level |
| 80 | 0 | southeast | drainage ditch |
| 81 | 0 | south | hill |
| 82 | 0 | south | hill |

TABLE 5 (con't)

| Den No. | Slope in degrees | Entrance exposure | Situation at den site |
|---|---|---|---|
| 83 | 0 | north | drainage ditch |
| 84 | 0 | south | level |
| 85 | 10 | west | drainage ditch |
| 86 | 50 | west | roadside ditch, fencerow |
| 87 | 50 | west | hill |
| 88 | 0 | east | level |
| 89 | 30 | east | drainage ditch, fencerow |
| 90 | 40 | east | drainage ditch, fencerow |
| 91 | 20 | east | drainage ditch |
| 92 | 70 | southeast | drainage ditch, fencerow |
| 93 | 0 | east | level |
| 94 | 0 | south | level |
| 95 | 0 | east | level |
| 96 | 10 | east | hill |
| 97 | 10 | north | hill |
| 98 | 10 | south | hill, fencerow |
| 99 | 0 | northeast | hill |
| 100 | 60 | east | drainage ditch |
| 101 | 60 | south | drainage ditch |
| 102 | 40 | south | drainage ditch |

TABLE 5 (con't)

| Den No. | Slope in degrees | Entrance exposure | Situation at den site |
|---|---|---|---|
| 103 | 0 | south | fencerow, level |
| 104 | 0 | northwest | roadside ditch, fencerow |
| 105 | 0 | south | drainage ditch |
| 106 | 30 | west | drainage ditch, fencerow |
| 107 | 0 | north | roadside ditch, fencerow |
| 108 | 40 | north | roadside ditch, fencerow |
| 109 | 0 | west | hill |
| 110 | 70 | north | hill, fencerow |
| 111 | 40 | west | drainage ditch |
| 112 | 0 | east | fencerow |
| 113 | 0 | north | drainage ditch |

TABLE 6

DEN-WATER RELATIONSHIPS

| Den No. | Proximity of water in feet | Class | Elevation of den above nearest water |
|---|---|---|---|
| 1 | 10 | rapid drainage ditch | 5 |
| 2 | 10 | rapid drainage ditch | 10 |
| 3 | 20 | rapid drainage ditch | 10 |
| 4 | 500 | pond | 10 |
| 5 | 400 | marsh | 30 |
| 6 | 200 | rapid drainage ditch | 5 |
| 7 | 500 | rapid drainage ditch | 30 |
| 8 | 200 | marsh | 20 |
| 9 | 200 | marsh | 25 |
| 10 | 200 | marsh | 25 |
| 11 | 100 | marsh | 5 |
| 12 | 50 | marsh | 5 |
| 13 | 100 | sluggish drainage ditch | 15 |
| 14 | 100 | sluggish drainage ditch | 10 |
| 15 | 100 | sluggish drainage ditch, marsh | 10 |
| 16 | 200 | sluggish drainage ditch, marsh | 10 |
| 17 | 200 | sluggish drainage ditch, marsh | 20 |
| 18 | 100 | marsh | 15 |
| 19 | 1000 | pond | 15 |
| 20 | 300 | sluggish drainage ditch | 20 |

TABLE 6 (con't)

| Den No. | Proximity of water in feet | Class | Elevation of den above nearest water |
|---|---|---|---|
| 21 | 200 | marsh | 10 |
| 22 | 200 | sluggish drainage ditch | 15 |
| 23 | 400 | sluggish drainage ditch | 20 |
| 24 | 300 | sluggish drainage ditch | 20 |
| 25 | 300 | sluggish drainage ditch | 15 |
| 26 | 500 | sluggish drainage ditch | 25 |
| 27 | 10 | rapid drainage ditch | 5 |
| 28 | 20 | rapid drainage ditch | 10 |
| 29 | 20 | rapid drainage ditch | 10 |
| 30 | 10 | rapid drainage ditch | 10 |
| 31 | 50 | rapid drainage ditch | 15 |
| 32 | 500 | marsh | 15 |
| 33 | 100 | pond | 15 |
| 34 | 100 | marsh | 15 |
| 35 | 40 | marsh | 15 |
| 36 | 500 | sluggish drainage ditch | 20 |
| 37 | 500 | sluggish drainage ditch | 25 |
| 38 | 200 | sluggish drainage ditch | 10 |
| 39 | 30 | pond | 10 |
| 40 | 20 | sluggish drainage ditch | 25 |
| 41 | 200 | marsh | 30 |
| 42 | 400 | sluggish drainage ditch | 20 |

TABLE 6 (con't)

| Den No. | Proximity of water in feet | Class | Elevation of den above nearest water |
|---|---|---|---|
| 43 | 300 | marsh | 15 |
| 44 | 300 | marsh | 25 |
| 45 | 100 | marsh | 20 |
| 46 | 100 | marsh | 25 |
| 47 | 100 | marsh | 25 |
| 48 | 40 | marsh | 10 |
| 49 | 200 | marsh | 10 |
| 50 | 200 | marsh | 25 |
| 51 | 200 | marsh | 20 |
| 52 | 300 | marsh | 15 |
| 53 | 20 | marsh | 5 |
| 54 | 40 | marsh | 15 |
| 55 | 40 | marsh | 15 |
| 56 | 50 | pond | 10 |
| 57 | 50 | pond | 20 |
| 58 | 30 | pond | 15 |
| 59 | 200 | rapid drainage ditch | 25 |
| 60 | 200 | marsh | 30 |
| 61 | 50 | pond | 15 |
| 62 | 300 | marsh | 20 |
| 63 | 300 | marsh | 20 |
| 64 | 300 | rapid creek | 20 |

TABLE 6 (con't)

| Den No. | Proximity of water in feet | Class | Elevation of den above nearest water |
|---|---|---|---|
| 65 | 100 | marsh | 20 |
| 66 | 100 | marsh | 15 |
| 67 | 100 | marsh | 10 |
| 68 | 100 | sluggish creek | 25 |
| 69 | 100 | sluggish creek | 30 |
| 70 | 300 | sluggish creek | 20 |
| 71 | 300 | marsh | 30 |
| 72 | 40 | rapid creek | 15 |
| 73 | 40 | rapid creek | 10 |
| 74 | 200 | pond | 15 |
| 75 | 10 | rapid creek | 5 |
| 76 | 500 | marsh | 10 |
| 77 | 10 | sluggish creek | 5 |
| 78 | 100 | marsh | 5 |
| 79 | 200 | marsh | 5 |
| 80 | 10 | rapid drainage ditch | 10 |
| 81 | 20 | pond | 10 |
| 82 | 30 | marsh | 5 |
| 83 | 20 | rapid drainage ditch | 10 |
| 84 | 30 | marsh | 10 |
| 85 | 20 | sluggish drainage ditch | 10 |
| 86 | 200 | sluggish drainage ditch | 10 |
| 87 | 40 | rapid creek | 15 |

TABLE 6 (con't)

| Den No. | Proximity of water in feet | Class | Elevation of den above nearest water |
|---|---|---|---|
| 88 | 20 | marsh | 5 |
| 89 | 10 | sluggish drainage ditch | 5 |
| 90 | 10 | sluggish drainage ditch | 5 |
| 91 | 20 | sluggish drainage ditch | 15 |
| 92 | 10 | sluggish drainage ditch | 10 |
| 93 | 400 | sluggish drainage ditch | 25 |
| 94 | 300 | pond | 20 |
| 95 | 20 | pond | 5 |
| 96 | 20 | rapid creek | 10 |
| 97 | 100 | marsh | 15 |
| 98 | 500 | marsh | 20 |
| 99 | 100 | marsh | 5 |
| 100 | 10 | sluggish drainage ditch | 10 |
| 101 | 10 | sluggish drainage ditch | 10 |
| 102 | 10 | sluggish drainage ditch | 10 |
| 103 | 40 | sluggish drainage ditch | 20 |
| 104 | 200 | marsh | 5 |
| 105 | 10 | sluggish drainage ditch | 5 |
| 106 | 10 | sluggish drainage ditch | 10 |
| 107 | 30 | marsh | 5 |
| 108 | 100 | marsh | 15 |
| 109 | 10 | marsh | 5 |
| 110 | 500 | sluggish drainage ditch | 20 |

TABLE 6 (con't)

| Den No. | Proximity of water in feet | Class | Elevation of den above nearest water |
|---|---|---|---|
| 111 | 10 | rapid drainage ditch | 10 |
| 112 | 1000 | marsh | 20 |
| 113 | 20 | rapid drainage ditch | 10 |

TABLE 7

| Den No. | Active | Inactive | Unknown | Inhabitant |
|---|---|---|---|---|
| 1 | | | x | |
| 2 | x | | | skunk |
| 3 | x | | | skunk |
| 4 | x | | | fox |
| 5 | | x | | |
| 6 | x | | | skunk |
| 7 | x | | | woodchuck |
| 8 | x | | | unknown |
| 9 | x | | | woodchuck |
| 10 | | x | | |
| 11 | x | | | woodchuck |
| 12 | x | | | fox |
| 13 | x | | | woodchuck |
| 14 | | x | | |
| 15 | x | | | unknown |
| 16 | x | | | woodchuck |
| 17 | | x | | |
| 18 | | x | | |
| 19 | x | | | woodchuck |
| 20 | x | | | unknown |
| 21 | | x | | |
| 22 | | x | | |
| 23 | x | | | woodchuck |

TABLE 7 (con't)

| Den No. | Active | Inactive | Unknown | Inhabitant |
|---|---|---|---|---|
| 24 | | x | | |
| 25 | | x | | |
| 26 | | x | | |
| 27 | x | | | unknown |
| 28 | x | | | woodchuck |
| 29 | x | | | woodchuck |
| 30 | | | x | |
| 31 | x | | | woodchuck |
| 32 | x | | | woodchuck |
| 33 | x | | | woodchuck |
| 34 | | x | | |
| 35 | | x | | |
| 36 | | x | | |
| 37 | | x | | |
| 38 | x | | | skunk |
| 39 | x | | | woodchuck |
| 40 | | x | | |
| 41 | | x | | |
| 42 | x | | | fox |
| 43 | x | | | skunk |
| 44 | x | | | rabbit |
| 45 | x | | | woodchuck |
| 46 | x | | | woodchuck |

TABLE 7 (con't)

| Den No. | Active | Inactive | Unknown | Inhabitant |
|---|---|---|---|---|
| 47 | | | x | |
| 48 | | x | | |
| 49 | | x | | |
| 50 | | x | | |
| 51 | x | | | woodchuck |
| 52 | | x | | |
| 53 | | x | | |
| 54 | x | | | fox |
| 55 | x | | | fox |
| 56 | | x | | |
| 57 | x | | | woodchuck |
| 58 | | x | | |
| 59 | | x | | |
| 60 | x | | | woodchuck |
| 61 | | x | | |
| 62 | x | | | rabbit |
| 63 | x | | | unknown |
| 64 | x | | | rabbit |
| 65 | | x | | |
| 66 | | x | | |
| 67 | x | | | woodchuck |
| 68 | | x | | |
| 69 | | x | | |
| 70 | x | | | unknown |

TABLE 7 (con't)

| Den No. | Active | Inactive | Unknown | Inhabitant |
|---|---|---|---|---|
| 71 | | x | | |
| 72 | | x | | |
| 73 | | | x | |
| 74 | x | | | woodchuck |
| 75 | | x | | |
| 76 | | x | | |
| 77 | | x | | |
| 78 | x | | | unknown |
| 79 | x | | | racoon |
| 80 | x | | | unknown |
| 81 | | x | | |
| 82 | | x | | |
| 83 | | | x | |
| 84 | | x | | |
| 85 | | x | | |
| 86 | x | | | racoon |
| 87 | x | | | woodchuck |
| 88 | x | | | racoon |
| 89 | x | | | unknown |
| 90 | x | | | woodchuck |
| 91 | x | | | woodchuck |
| 92 | x | | | unknown |
| 93 | | x | | |

TABLE 7 (con't)

| Den No. | Active | Inactive | Unknown | Inhabitant |
|---|---|---|---|---|
| 94 | | x | | |
| 95 | x | | | |
| 96 | | x | | |
| 97 | x | | | fox |
| 98 | x | | | fox |
| 99 | | x | | |
| 100 | x | | | woodchuck |
| 101 | x | | | woodchuck |
| 102 | x | | | unknown |
| 103 | x | | | woodchuck |
| 104 | | x | | |
| 105 | x | | | woodchuck |
| 106 | x | | | unknown |
| 107 | | | x | |
| 108 | | | x | |
| 109 | x | | | woodchuck |
| 110 | x | | | woodchuck |
| 111 | | | x | |
| 112 | x | | | woodchuck |
| 113 | | | x | |