SMALL MAMMAL CENSUSES NEAR PRAIRIE DU SAC, WISCONSIN

HAROLD C. HANSON

Research Assistant, Department of Wildlife Management*
University of Wisconsin

INTRODUCTION

Each winter since 1930 the gamebirds and predators on a seven square mile area in Westpoint Township, Columbia County near Prairie du Sac have been censused. The results of these censuses will be summarized in a forthcoming paper by Errington. In order to fill the gaps in our knowledge concerning the populations of animals not heretofore censused, the writer, during the years 1941 and 1942, made censuses of mice and shrews, cottontail rabbits, fox and gray squirrels, winter birds, and nesting songbirds. This paper summarizes the data obtained on populations of mice, shrews, and cottontail rabbits. It also includes notes on four little-known Wisconsin mammals: pygmy short-tailed shrew (*Cryptotis parva parva*), least weasel (*Mustella rixosa allegheniensis*), harvest mouse (*Reithrodontomys megalotis pectoralis*), and the pine mouse (*Pitymys pinetorum scalopsoides*).

Fifteen quadrats in 12 cover types were censused between September 21 and October 29, 1941: Grain stubble (two fields); Alfalfa (two fields); Bluegrass—sweet clover two fields); *Carex stricta bog*; Smartweed—foxtail; Short-grass prairie relic; Sandy field (primarily panic grass); Juniper bluff; Red oak and red cedar pasture; Whitebirch—prickly ash; Red and white oak woodlot (severely grazed); Red and white oak woodlot (moderately grazed).

MATERIALS AND METHOD

Quadrats employing snap traps have been used by a number of authors (Bole 1939, Townsend 1935, Williams 1936). Live trapping and banding have been used with notable success by

* Now Assistant Game Technician, Illinois Natural History Survey, Urbana, Illinois.

Burt (1940) and Blair (1940 a, b, c) while censuses by means of nest boxes have yielded much information not obtainable by either of the other two methods (Nicholson 1941).

Because of the large number of cover types that had to be sampled in a brief period, it was decided that quadrat trapping with snap traps would be most suitable. That snap traps when properly employed can obtain adequate estimates of small mammal populations has been shown by Goodnight and Koestner (1942), who made a field comparison between live traps and snap traps, and found that the two techniques were of about equal value. They found that snap traps gave the approximate total population in three days, while live traps took two or three days longer.

Previous investigators (see Burt 1940, 36-39) have estimated small mammal populations on the basis of the catches they obtained from quadrats only a fraction of the size of the home range of any one individual.

In this work, unless otherwise specified, quadrats 300 feet square containing 121 traps spaced ten yards apart were used. Each quadrat was trapped for four nights. This is a modification of the method used by Burt (*op. cit.* 12-14). He found that quadrats from two to five acres, containing live traps similarly spaced, usually caught most of the shrews and mice in four successive nights of trapping.

Before cool weather set in, crickets proved to be very troublesome in eating the bait, which consisted at first of a mixture of rolled oats and peanut butter. By experimentation it was found that a moist crumbly mixture of millet, rolled oats, and peanut butter was better because the millet withstood the depredations of the crickets, and thus remained available to the mice.

Regardless of the size of quadrat used, small mammals whose home ranges border the quadrat area are likely to be taken (Dice 1941). Some adjustment must be made for catches of these bordering individuals when calculating density. The author believes the most equitable method of determining the coverage of snap trap quadrats is that suggested by Dice (1938); that is, to consider the area censused to be the area of the quadrat itself, plus an additional distance beyond its periphery equal to the radius of the home range of the species in question. In

this paper each quadrat is assumed to have drawn upon peripheral zones as follows:

Blarina brevicauda	75 ft.	(after Burt)
Reithrodontomys megalotis	50 ft.	(arbitrary)
Peromyscus maniculatus	75 ft.	(after Blair 1940a)
Peromyscus leucopus	50 ft.	(after Burt)
Microtus pennsylvanicus	60 ft.	(after Blair 1940c)
Microtus ochrogaster	60 ft.	(arbitrary)
Pitymys pinetorum	60 ft.	(after Burt)
Mus musculus	75 ft.	(arbitrary)

These censuses are first discussed quadrat by quadrat. A later discussion deduces habitat preferences for each species. Additional notes on individual species are included in the latter section.

A few quadrats were inhabited by both species of *Peromyscus*. Because these mice are difficult to separate before adulthood, the identifications are doubtful for a few of the immatures taken.

Calculations of the number of mice per acre usually produced decimal figures. When these involved only a fraction of a mouse per acre, they can not be rounded off without distorting the species ratio. Hence, all densities have been left in decimals, but it should be understood that this does not imply accuracy to one decimal.

Status of the Rodent Cycle in 1941

Mice were generally abundant in all habitats censused in the fall of 1941. During the fall of 1942, according to a farmer on the Prairie du Sac area, mice were far more numerous in his fields than during the previous year. Field experience by the author and other Wisconsin workers leaves little doubt that the small rodent population "crashed" some time between late in the winter of 1942-43 and early spring. Repeated trapping during that spring and summer in hayfields, bluegrass areas, sand prairies, and waste places yielded but a few specimens. However, *Peromyscus leucopus* was found in fair numbers in a wooded ravine in the Baraboo hills. This leads the author to suspect that this species may not be cyclic, or if it is cyclic, that its numbers do not fluctuate as violently as field-inhabiting species.

Cover Types and Populations

Grain Stubble

Two grain stubble-fields were censused. The catch taken from the two fields reflected the character and density of the cover; Field I having sparse stubble and a poor growth of weeds, had a population of only 1.7 mice per acre, while Field II, having a fertile black soil which supported a dense growth of weeds, yielded 5.2 mice per acre. Table I suggests that as grain stubble-fields became increasingly weedy, there is a corresponding increase in the rodent population, particularly of the genus, *Microtus*. Thus besides reducing crop yields through competition, weeds may also be the indirect cause of crop losses because of the high rodent populations they seem to encourage.

Table I. Number of mammals caught, calculated density per acre, and composition of population of two grain stubble-fields, September 21-28, 1941.

Species	No. mammals caught		Calculated density per acre		Composition by per cent of population	
	Field I	Field II	Field I	Field II	Field I	Field II
Reithrodontomys megalotis	2	2	0.5	0.5	30	10
Peromyscus maniculatus	2	7	0.4	1.5	23	29
Microtus ochrogaster	1	6	0.2	1.5	13	29
Mus musculus	3	8	0.6	1.7	34	32
Total	8	23	1.7	5.2	100	100

Bluegrass—Sweet Clover

The quadrat used in Field I was 300 feet square, while Field II with an area of 4.25 acres was trapped in its entirety. Since the latter field was bordered by woods on three and one-half sides, it was possible to trap it to exhaustion before an influx of mice through the one opening to an adjoining field could seriously affect the catch. During the four census nights, eighty mice were caught and in the following three nights only an additional fifteen mice were secured. However, to make the census figures for all cover types comparable, the population figures

given in Table II are based on the standard four-night trapping period.

There was a greater proportion of bluegrass and a more luxurious growth of weeds in Field II, thus accounting for the proportionately greater catch of field voles, *Microtus ochrogaster*, which reach their highest populations in dense cover. A correspondingly lower population of prairie deer mice (*Peromyscus maniculatus*) also reflects this cover difference, as they are known to prefer habitats having a more open ground surface.

Woodland deer mice are computed as a part of the total field inhabiting population, since it was evident that portions of the fields bordering the woods were important parts of their home ranges.

TABLE II. Number of mammals caught, calculated density per acre, and composition of population of two fields of bluegrass and sweet clover, Oct. 2-11, 1941.

Species	No. mammals caught		Calculated density per acre		Composition by per cent of population	
	Field I	Field II	Field I	Field II	Field I	Field II
Blarina brevicauda	3	5	1.0	1.1	12	6
Reithrodontomys megalotis	1	4	0.3	0.9	4	5
Peromyscus maniculatus	7	7	2.3	1.6	27	9
Peromyscus leucopus	5	4	1.7	0.9	21	5
Microtus ochrogaster	6	60	2.0	14.1	24	75
Mus musculus	3		1.0		12	
Total	25	80	8.3	18.6	100	100

Alfalfa

Field I was censused with a quadrat 300 by 300 feet and Field II with a quadrat 300 by 240 feet. The census figures for these two fields in Table III suggest that an average alfalfa field supported seven to eight mice per acre in the fall of 1941. Again it is evident from a comparison of the rodent populations for Fields I and II (Table III) that a field supporting a fairly high *Microtus* population is generally inhabited by a correspondingly lower prairie deer mouse (*Peromyscus maniculatus bairdi*) population.

TABLE III. Number of mammals caught, calculated density per acre, and composition of population of two alfalfa fields, September 23—Oct. 5, 1941.

Species	No. mammals caught		Calculated density per acre		Composition by per cent of population	
	Field I	Field II	Field I	Field II	Field I	Field II
Reithrodontomys megalotis	4	5	1.2	1.7	17	23
Peromyscus maniculatus	6	4	1.8	1.1	25	15
Microtus ochrogaster	2	8	0.6	2.5	8	34
Microtus pennsylvanicus		2		0.6		9
Mus musculus	12	5	3.6	1.4	50	19
Total	24	24	7.2	7.3	100	100

Carex stricta Bog

The total small mammal population of this bog (Table IV) compares very closely with that obtained for alfalfa fields. Its population was characterized by relatively low populations of non-microtine species and the presence of a shrew, which species, like voles, were found to be most abundant in dense cover.

The entire bog of 1.5 acres was trapped.

TABLE IV. Number of mammals caught, calculated density per acre, and composition of population of a *Carex stricta* bog, October 16-19, 1941.

Species	No. mammals caught	Calculated density per acre	Composition by per cent of population
Blarina brevicauda	1	0.6	8
Reithrodontomys megalotis	1	0.6	8
Peromyscus maniculatus	3	2.0	28
Microtus ochrogaster	3	2.0	28
Microtus pennsylvanicus	3	2.0	28
Total	11	7.2	100

Smartweed—Foxtail

This habitat occupied a small basin at the foot of a steep dry hill (populations on this hill are discussed under *Prairie Relic*) and was censused in its entirety as it had an area of only 2.1 acres. Due to the fact that this site was inadequately tiled,

drainage from the surrounding fields often made it too wet to cultivate in the spring. The central portion had been ploughed the previous spring, but had to be abandoned, and a dense growth of yellow foxtail and ragweed marked this sector at the time of the census. Beggar's tick (Bidens) and smartweed (Polygonum) were the most abundant plants. Newly planted timothy, a mature stand of alfalfa, and a cornfield adjoined three sides of the basin while on the fourth side northeast it merged with the *Carex stricta* bog previously discussed.

During the census period, October 16-19, the nearby cornfield was cut and shocked, which may have increased the catch. The catch of house mice was so spectacular (see Table V) that I believe it to be unlikely that this disturbance affected the results to any great degree.

House mice were so abundant in this 2.1 acre plot it seemed improbable that four nights of trapping could have completely exhausted the resident population. To test this possibility a fifth night of trapping was carried out and eleven more house mice, three voles, two prairie deer mice, and a harvest mouse were caught.

The top-heavy population of house mice in this habitat is a striking illustration of how "animal weeds" may overrun the land side by side with plant weeds. Undoubtedly the magnet which attracted the high rodent population was the abundant food supply, the ground being thickly strewn with seeds of foxtail grass, ragweed, and smartweed. In contrast to this situation was the "hostility" of the relatively undisturbed adjoining *Carex stricta* bog. In spite of the extreme density of house mice on this quadrat none were taken in the central portion of the bog (Table IV).

TABLE V. Number of mammals caught, calculated density per acre, and composition of population of a smartweed—foxtail habitat, October 16-19, 1941.

Species	No. mammals caught	Calculated density per acre	Composition by per cent of population
Reithrodontomys megalotis	5	2.4	5
Peromyscus maniculatus	12	5.7	12
Microtus ochrogaster	4	1.9	4
Microtus pennsylvanicus	1	4.7	9
Mus musculus	73	34.0	70
Total	95	48.7	100

Short-grass Prairie Relic

Many areas like this one are found in southwestern Wisconsin on steep westerly-facing hillsides. The five domiant plants composing this relic were: *Andropogon scoparius Sporobolus heterolepis, Aristida basiramea, Amorpha canescens,* and *Aster sericeus.* Because of the topography, it was necessary to lay out the traps in the form of a triangle that spread down fanwise from the peak of the hill. Consequently there was a relatively large amount of edge across which mice from the different surrounding cover types might have drifted. For this reason the census figures in Table VI are not strictly comparable with those given for the other types. The area covered by the traps was 0.8 acre but the actual coverage was assumed to be one acre.

As might be expected the prairie deer mouse (*Peromyscus maniculatus*) was the dominant species in this relic. The woodland deer mice (*Peromyscus leucopus*) were taken from amongst a thicket of wild grape and bittersweet on an outcropping of limestone in the center of the census area. The genus *Microtus* was conspicuously absent, possibly because the cover was neither dense nor succulent enough for their requirements. The great bulk of this large catch of deer mice were immatures and young adults.

In spite of my limited data, I believe the original prairie was capable of supporting a fairly high small rodent population. This belief is supported by the findings of Smith (1940) working in Oklahoma. He says that: "Although somewhat less food is available in climax prairie, excellent cover is present and a large population of rodents is found."

TABLE VI. Number of mammals caught, calculated density per acre, and composition of population of a short-grass prairie relic, October 17-20, 1941.

Species	No. mammals caught	Calculated density per acre	Composition by per cent of population
Reithrodontomys megalotis	1	1.0	2
Peromyscus maniculatus	24	24.0	56
Peromyscus leucopus	13	13.0	30
Mus musculus	5	5.0	12
Total	43	43.0	100

Sandy Field

Continuous farming of an inadequate topsoil had reduced this field to shifting sands. It is now slowly returning to a modified prairie. At the time of the census, scattered clumps of panic grass (*Panicum Scribnerianum*) were the dominant cover. Prairie lespedeza (*Lespedeza capitata*), a species of puccoon (*Lithospermum croceum*), and spiderwort (*Tradescantia reflexa*) also occurred. The field is planted to pines, but only ten per cent of the quadrat supported trees over three years of age. The eight- to ten-year-old trees have not yet modified the surrounding ground cover.

Though cover was at a minimum, prairie deer mice proved to be surprisingly abundant (Table VII).

TABLE VII. Number of mammals caught, calculated density per acre, and composition of population of a sandy field, October 7-10, 1941.

Species	No. mammals caught	Calculated density per acre	Composition by per cent of population
Reithrodontomys megalotis	1	0.3	8
Peromyscus maniculatus	8	2.3	62
Mus musculus	4	1.1	30
Total	13	3.7	100

Juniper Bluff

Depressed juniper (*Juniperus communis depressa*), arranged in a somewhat checker-board fashion, together with prairie relics form one of the unique plant associations on the Prairie du Sac area. This type is found on the extremely dry and westerly-facing slopes overlooking the Wisconsin River. Though cattle-grazing had caused the invasion of such weeds as evening primrose, mullen, and hoary vervain, a number of prairie species still flourished. Among the latter were: little bluestem grass (*Andropogon scoparius*), St. John's wort (*Hypernicum*), prairie bluebell (*Campanula*), and lead plant (*Amorpha canescens*). This habitat was the only one censused in which both species of *Peromyscus* were distributed rather evenly throughout the quadrat (Table VIII). The author has not encountered a reference in the literature to any other habitat freely populated by both species of deer mice.

The census plot was only 240 by 240 feet due to the configuration of the available area.

TABLE VIII. Number of mammals caught, calculated density per acre, and composition of population on a juniper bluff, October 15-18, 1941.

Species	No. mammals caught	Calculated density per acre	Composition by per cent of population
Reithrodontomys megalotis	2	0.7	6
Peromyscus maniculatus	14	4.0	31
Peromyscus leucopus	20	7.7	58
Mus musculus	2	0.7	5
Total	38	13.1	100

Red Cedar—Red Oak Pasture

This woodlot was composed of an open stand of red cedar and red oak occurring in about equal numbers, with a few scattered depressed junipers. The ground cover was sparse, made up chiefly of an intermixture of bluegrass, a panic grass and an occasional clump of little bluestem grass. A few small scattered patches of prickly ash and black raspberry were all that remained of the shrubs. Among other herbs and weeds present were wild bergamot, prairie clover (*Petalostemum*), prairie lespedeza, St. John's wort, hoary vervain and mullen.

The drastic effect of long continued grazing of woodlots on small mammal populations is evident in Table IX below. The only apparent reason for the woodmouse population holding up was the excellent places of retreat afforded by the litter of needles under the cedars and amongst the depressed junipers.

TABLE IX. Number of mammals caught, calculated density per acre, and composition of population of red cedar—red oak pasture, October 2-5, 1941.

Species	No. mammals caught	Calculated density per acre	Composition by per cent of population
Peromyscus leucopus	11	3.4	92
Mus musculus	1	0.3	8
Total	12	3.7	100

White Birch-Prickly Ash

White birch and prickly ash were the two chief woody species growing on a north-facing slope that was censused in late October. At one time an even-aged stand of red oak timber had occupied the site, but had been cut over some years previous to the time of the census. After the cutting occurred the slope had evidently been pastured by cattle. Under their selective browsing these two species, unpalatable to cattle, gradually assumed dominance.

Since the leaves of neither the birch or ash tend to build up a heavy layer of leaf mold, this cover type offered little attraction to small mammals. Thus the small mammal population of this woodland was unusually low (Table X). The three shrews were taken near old rotten stumps of oak trees.

Table X. Number of mammals caught, calculated density per acre, and composition of population of a white birch—prickly ash woodlot, October 24-27, 1941.

Species	No. mammals caught	Calculated density per acre	Composition by per cent of population
Blarina brevicauda	3	0.8	31
Peromyscus leucopus	5	1.8	69
Total	8	2.6	100

Red and White Oak Woodlot
(severely grazed)

The low mammal density found in this woodlot (Table XI) indicates that constant grazing by cattle may be disastrous to small mammal populations. Cattle had eradicated almost every shrub in this woods and the resultant packing of the topsoil had probably excluded the locally rare pine mouse (*Pitymys pinetorum*). Even the woodland deer mouse population was markedly low. Fox squirrels still remained abundant in this woods, and probably benefitted by the lack of cover.

TABLE XI. Number of mammals caught, calculated density per acre, and composition of population of a red and white oak woodlot (severely grazed), Oct. 24-27, 1941.

Species	No. mammals caught	Calculated density per acre	Composition by per cent of population
Blarina brevicauda	1	.2	4
Glaucomys volans	1	..	..
Peromyscus leucopus	18	5.3	96
Total	20	5.5	100

Red and White Oak Woodlot

(moderately grazed)

This woodlot differed from the one discussed above mainly as to the degree of grazing to which it had been subjected. Prickly ash and a species of *Rubus* were the only remaining shrubs of any abundance. A thick layer of leaf mold was believed to explain the survival of pine mice in this woodlot, since this species in Wisconsin has been recorded only from woods in which litter remained. The woodland deer mouse population (Table XII) was similar in density to that which Burt found in an oak-hickory woodlot (11 per acre in November) in Michigan. Flying squirrel populations are not calculated on an acreage basis, as little is known of their mobility, but the presence of a greater number of den trees is thought to account for their greater abundance in this woods.

HABITAT PREFERENCES

Pygmy Short-tailed Shrew—*Cryptotis parva parva* (Say)

The author is aware of only one previously published record reporting this species from Wisconsin. This record consists of the remains of an individual found in an owl pellet collected at Prairie du Sac. (Errington, Hamerstrom, and Hamerstrom, 1940). Intensive fieldwork may reveal that it is more widely distributed and common in Wisconsin than the lack of records would indicate.

The single specimen in the author's collection was found dead on the Sauk Prairie on December 15, 1942, by Albert Gastrow of Prairie du Sac. It had been killed by a red fox, as the trail sign clearly indicated, and then had been tossed aside. The finding of

this specimen on prairie is in agreement with its preference for dry habitats.

TABLE XII. Number of mammals caught, calculated density per acre, and composition of population of a red and white oak woodlot (moderately grazed), Oct. 25-28, 1941.

Species	No. mammals caught	Calculated density per acre	Composition by per cent of population
Blraina brevicauda	2	0.4	4
**Glaucomys volans*	2		
Peromyscus leucopus	30	8.8	89
Pitymys pinetorum	2	0.5	5
Mus musculus	1	0.2	2
Total	37	9.9	100

* A third flying squirrel was caught on the fifth night.

Short-tailed Shrew—*Blarina brevicauda brevicauda* (Say)

Short-tailed shrews on the Prairie du Sac area are apparently chiefly limited in their distribution to areas of bluegrass and woodlands having numerous fallen logs and a thick layer of leaf mold (Table XIII). In these situations they inhabit the runways made by themselves and by the resident mouse population, and in all likelihood are dependent on them for protection, as well as for insect food or an occasional mouse. Hence, shrew populations are probably relatively secure from horned owl predation. ("Represented in 2.7% of the total pellets and stomachs [examined]"—Errington, Hamerstrom, and Hamerstrom, 1940). Predation likely occurs when they make short excursions away from these sheltered trails.

TABLE XIII. Populations and relative abundance of short-tailed shrews in five cover types, October 2-28, 1941.

Cover Type	Calculated density per acre		Composition by per cent of population	
	Field I	Field II	Field I	Field II
Bluegrass-Sweet Clover	1.0	1.1	12	6
Carex stricta	0.6		8	
White Birch-Prickly Ash	0.8		31	
Severely grazed woods	0.2		4	
Moderately grazed woods	0.4		4	

Least Weasel—*Mustela rixosa allegheniensis* (Rhoads)

Records of the least weasel in southern Wisconsin are too few to enable one to deduce the pattern of its distribution in this portion of the State. Swenk (1926), in the most recent review of the species, lists the following Wisconsin records: Pierce Co., Prescot 1; Racine Co., Burlington 1; Sauk Co., Sumpter township, 2; Merrimac 1. After his paper was published, remains of another specimen was reported in an owl pellet from Stoughton, Dane Co., by Errington, Hamerstrom and Hamerstrom (1940). Phillip Wright of the University of Wisconsin is known to have secured two in the University Arboretum. During the winter of 1943-44 a third specimen was taken in the arboretum by Robert A. McCabe, biologist in charge. I am indebted to him for furnishing his data on this specimen.

The data on five more least weasels recently taken in Sauk Co. are given in Table XIV. These specimens were obtained from farmers by Mr. Ed Ochsner of Prairie du Sac, and at least four of the five were killed by the farmers when removing corn shocks from the fields.

TABLE XIV. Data on six additional least weasels taken in Wisconsin.

Collector's Number	Locality	Date	Sex	Weight	Total Length	Tail	Hind Foot
638	Eastern Sauk Co.	About Mar. 20 '43	♂	60 gms	198	34	24
652	Eastern Sauk Co.	About Apr. 3 '43	♂	45* gms	182	29	22
686	Eastern Sauk Co. Honey Creek	Nov. 10-14 '43	♂		193	26	23
651	Eastern Sauk Co.	About Mar. 25 '43	♀	48.3 gms	184	27	22
653	Eastern Sauk Co.	About Apr. 3 '43	♀	36* gms	165	23	19.5
1	Dane Co. University Arboretum	Apr. 9, '43	♀			23	20

* These weights are low as the specimens were eviscerated when received.

Descriptions of the pelage of these six specimens are given below:

Individual (Collector's Number)	
638	Entirely white except for brown hairs on the distal half of tail.
652	Entire back and sides brown; ventral portion of the body white, the white extending slightly higher on the head and neck region and present on the dorsol side of the toes of the fore legs.
686	Pelage entirely white including the tip of the tail.
651	Pelage midway between the white of winter and the brown of summer. The brown limited to the dorsal ⅝ of the body and extending down the dorsal sides of the fore and hind legs and tail. A white patch above the nose and extending around the eyes as a circumorbital ring; a larger white patch in front of each ear. Ears brown, slightly tipped with white. Sides of neck white and numerous white hairs intermixed with the brown of the back where it joins the white sides.
653	Similar to No. 652.
1	Similar to No. 652.

Harvest Mouse—*Reithrodontomys megalotis pectoralis** Hanson

A local reconnaissance was made on the Sauk prairie, in addition to the censuses in Columbia County, to gather further information regarding the habitat preferences of the harvest mouse. One of the cover types trapped in Sauk County was a tall stand of ragweed in a sandy fallow field. On entering this field two harvest mice were observed running about. One of these mice was captured by hand, while subsequent trapping yielded an additional three. As no other species of mice were caught in that field, it would appear that the harvest mice like a partial over-head canopy and a relatively herb-free, hard-packed ground surface that permits freedom of movement. Their apparent preference for the cultivated counterpart of this ecological niche, alfalfa fields, is evident from Table XV. They were also more abundant in this habitat relative to the total population than in any of the other cover types.

This mouse is fairly common about Prairie du Sac. Hence, it is surprising that specimens had not been reported from Wisconsin prior to 1941. Errington (1932) and Errington, Hamerstrom, and Hamerstrom (1940) did not report it in owl pellets collected from the Prairie du Sac region. This species was, however, frequently recorded in owl pellets that they studied from

* A paper by the author relating to the discovery of this species in Wisconsin and its distribution and taxonomy has been published by the Chicago Museum of Natural History. See *Literature Cited.*

Des Moines and Ames, Iowa—localities that lie well within the previously known range of the harvest mouse.

The author examined roughly 100 owl pellets collected on April 1, 1942, from a Scotch pine plantation on the Sauk prairie, Sauk County, in which five long-eared owls had wintered. In these pellets were found skulls of 77 *Microtus*, 25 *Peromyscus*, and 17 *Reithrodontomys*, thus indicating that the harvest mouse was freely taken by long-eared owls.

TABLE XV. Population and relative abundance of harvest mice in eight cover types, September 21-October 20, 1941.

Cover Type	Calculated density per acre		Composition by per cent of population	
	Field I	Field II	Field I	Field II
Stubble	0.5	0.5	30	10
Alfalfa	1.2	1.7	17	23
Bluegrass-Sweet Clover	0.3	0.9	4	5
Foxtail-Smartweed	2.4		5	
Carex stricta bog	0.6		8	
Sandy field	0.3		8	
Prairie relic	1.0		2	
Juniper bluff	0.7		6	

Prairie Deer Mouse—*Peromyscus maniculatus bairdi* (Hoy and Kennicott)

The prairie deer mouse was probably the most abundant native mouse on the Prairie du Sac area in the fall of 1941. Like the harvest mouse, this species seemed to prefer situations where the immediate ground cover varied from light to moderate densities. This is shown by the fact that they attained a fairly high density in a sandy field having as its chief cover scattered plants of panic grass. Other species of mice seem to be unable to populate, at least in any densities, such xeric and exposed habitats. As pointed out by Johnson (1926), the prairie deer mouse has probably increased in abundance and extended its range as a result of cultivating the land; and investigations will probably show that prairie deer mice are confined to early stages of the prairie succession on uncultivated lands. The distribution of this species on the Prairie du Sac area supports these contentions (See Table XVI).

TABLE XVI. Population and relative abundance of prairie deer mice in eight cover types, September 21—October 20, 1941.

Cover Type	Calculated density per acre		Composition by per cent of population	
	Field I	Field II	Field I	Field II
Stubble	0.4	1.5	23	29
Alfalfa	1.8	1.1	25	15
Bluegrass—Sweet Clover	2.3	1.6	27	9
Foxtail—Smartweed	5.7		12	
Carex stricta bog	2.0		28	
Sandy field	2.3		62	
Prairie relic	24.0		56	
Juniper bluff	4.0		31	

Woodland Deer Mouse—*Peromyscus leucopus noveboracensis* Fischer

Woodland deer mice were trapped in every census area that supported a few trees or shrubs. One female had made her nest for five new-born young in a paper wasp nest hanging in a clump of hazel-bush. At least a portion of the habitat in cover of a woody nature seemed requisite to satisfy some demand in this mouse.

A female, which had her young in a nest of corn silk inside of a corn-shock, was the only individual encountered a considerable distance from timber or brush. Johnson (*op. cit.*) also reports capturing a wood mouse in a cornfield a quarter of a mile from the nearest woodland. However, some individuals which have home ranges along the borders of woods range out into

TABLE XVII. Population and relative abundance of the woodland deer mouse in seven cover types, October 2-28, 1941.

Cover Type	Calculated density per acre		Composition by per cent of population	
	Field I	Field I	Field II	Field II
Bluegrass—Sweet Clover	1.7	0.9	21	5
Short grass prairie relic	13.0		30	
Juniper bluff	7.7		58	
Red-oak—Red cedar pasture	3.4		92	
White birch—Prickly ash	1.8		69	
Red and White Oak Woodlot (Severely grazed)	5.3		96	
Red and White Oak Woodlot (Moderately grazed)	8.8		89	

adjoining fields (Blair). While trapping the bluegrass-sweet clover fields a number of wood mice were taken (Table XVII), but these were generally caught in traps less than 35-40 feet from the forest edge.

Field Vole—*Microtus ochrogaster* Wagner

The northern and western limits of the range of this species in the midwest is still in need of careful exploration. Field investigations by the author in central and western Wisconsin and in southeastern Minnesota have suggested the possibility that the range of *Microtus ochrogaster* is coincident with that of the harvest mouse, *Reithrodontomys megalotis pectoralis*, in this region.

It was observed that *Microtus ochrogaster* was the common vole at the localities where harvest mice occurred, while localities that did not yield harvest mice also failed to yield *M. ochrogaster*; replacing this vole in the same ecological niche was the meadow vole, *Microtus pennsylvanicus*.

Microtus ochrogaster may be the most abundant vole over the uplands and sand prairies of the driftless region. It proved to be the only vole common to the upland fields in Westpoint Township, Columbia County, and on the Sauk prairie, Sauk County, both on the eastern border of the driftless area. In western Clark County, Schmidt (1931) found *Microtus ochrogaster* only on sandy plains and slopes of sandstone mounds where there was no heavy covering of grass; *Microtus pennsylvanicus* was taken in hayfields, pastures, and other well-watered habitats.

Records of the field vole from western Wisconsin are limited, but they indicate that this species occurs there freely. Allen (1936) mentions obtaining specimens of the field vole in Vernon County. In the fall of 1942 the writer trapped a number of these voles, as well as three harvest mice, from an upland alfalfa field east of La Crosse in La Crosse County during one night of trapping.

According to Thwaites (unpublished map 1944) the western limits of the driftless area are now recognized as extending not beyond the tops of the Mississippi River bluffs on the Minnesota side. Since data available suggests that the harvest mouse, *R. m. pectoralis*, is found only in or on the periphery of the driftless

region (Hanson 1944), it was of especial interest to find a grain stubble-field in a valley near Hokah, Houston County, Minnesota, which was inhabited by both species of voles as well as harvest mice. Allen (1936) also reports finding both species of *Microtus* in a similar valley near Caledonia, Houston County. However, at three localities a few miles west of Hokah and well beyond the edge of the driftless area, the writer was unable to trap either the harvest mouse or the field vole. At these localities (two near Spring Grove, Minnesota, and one 14 miles southwest of Preston, Minnesota) *Microtus pennsylvanicus* and *Peromyscus maniculatus* were the only species of mice obtained.

The field vole and harvest mouse are apparently absent from northeast Iowa (Allamakee and Winnesheik Counties) where *Microtus pennsylvanicus* is abundant as Dr. Sherman Hoslett of Luther College, Decorah, Iowa, was unable to secure an example of this species during an intensive five-year study of the mammals of these two counties. Thus, judging from the evidence available, it seems that the ecological or geological factors determining the distribution of the harvest mouse in the southeast Minnesota-northeast Iowa region may also be operative in the case of *Microtus ochrogaster.*

Cory (1912) notes that prairie voles are commonly found in clover and alfalfa fields, a preference the Prairie du Sac census supports. Stubble-fields become increasingly inhabitable to this species as quackgrass and other weeds gain a foothold, but maximum densities are attained in bluegrass areas (Table XVIII).

TABLE XVIII. Population and relative abundance of the field vole in five cover types, September 21-October 19, 1941.

Cover Type	Calculated density per acre		Composition by per cent of population	
	Field I	Field II	Field I	Field II
Grain stubble	0.2	1.5	13	29
Bluegrass—Sweet clover	2.0	14.1	24	75
Alfalfa	0.6	2.5	8	34
Carex stricta bog	2.0	0.0	28	0
Smartweed—Foxtail	1.9	0.0	4	0

Meadow vole—*Microtus pennsylvanicus pennsylvanicus* (Ord)

The only habitat to yield more than two stray meadow voles was a *Carex stricta* bog. Several other specimens were obtained

from a another bog a few miles east of the Prairie du Sac area. Since this species was found commonly only in *Carex stricta*, it seems possible that it could become *locally* extinct through draining and the gradual drying up of these bogs.

TABLE XIX. Population and relative abundance of the meadow vole in three cover types, October 2-19, 1941.

Cover Type	Calculated density per acre	Composition by per cent of population
Alfalfa	0.6	9
Carex stricta bog	2.0	28
Smartweed—Foxtail	4.7	9

Pine Mouse—*Pitymys pinetorum scalopsoides* (Audubon & Bachman)

Pine mice collected in northern Clark County, Wisconsin, by Franklin Schmidt were recently recognized as a new subspecies by Hartley H. T. Jackson (1941). Since the two individuals collected by the author are not in a pelage comparable with the type series from Clark County, the Columbia County specimens are assumed to belong to the race *scalopsoides*. Additional specimens of pine mice have been taken in western Dane County (Blue Mounds) by Phillip Wright (University of Wisconsin collections). Excepting mention of a specimen from Lynxville, Crawford County, (Jackson *op. cit.*) no other published records are available to reveal the distribution of this species elsewhere in the state.

The habitat requirements of the pine mouse in Wisconsin are apparently very specific as all records of this species to date are from oak forests having a heavy carpet of litter and leaf mold. Elsewhere in its range, according to Hamilton (1938), it has been found in such diverse situations as sphagnum bogs and rocky hills about caves. Hamilton (*op. cit.*) quotes Poole as having found pine mice in Pennsylvania on an area having "light sandy alluvial soils supporting scattered trees and shrubs."

One of the two specimens taken on the Prairie du Sac area was trapped above ground at the base of an oak tree, while the other was caught in a trap set in an opened runway in the leaf mold.

TABLE XX. Population and relative abundance of the pine mouse in a red and white oak woodlot, October 25-28, 1941

Cover Type	Calculated density per acre	Composition by per cent of population
Red and White Oak Woodlot (moderately grazed)	0.5	5

House Mouse—*Mus musculus musculus Linnaeus*

House mice attained their greatest densities in cultivated fields where they often were the most abundant species. When their numbers about farm buildings were taken into consideration, there can be little doubt that they were the most numerous mammal on the Prairie du Sac area. Because of their general abundance in fields far from any farm buildings, it is difficult to understand their comparative absence in owl pellets. One reason may be that owl pellet studies usually represent the late winter and early spring months, a period when house mice particularly seek buildings for refuge; another may be that the first spell of severe cold weather greatly reduces the field inhabiting populations.

The high density of this species found in the prairie relic was probably due to an influx of individuals from the nearby area of smartweed and foxtail which had an extremely high house mouse population (Table XXI). However, it should be noted that they were *relatively* uncommon in this undisturbed area.

TABLE XXI. Population and relative abundance of the house mouse in nine cover types, September 21-October 20, 1941.

Cover Type	Calculated density per acre		Composition by per cent of population	
	Field I	Field II	Field I	Field II
Grain stubble	0.6	1.7	34	32
Alfalfa	3.6	1.4	50	19
Bluegrass—Sweet Clover	1.0		12	
Smartweed—Foxtail	34.0		70	
Sandy field	1.1		30	
Short grass prairie relic	5.0		12	
Juniper bluff	0.7		5.3	
Red Oak—Red Cedar pasture	0.3		8.0	
Red and White Oak woodlot (moderately grazed)	0.2		2.0	

Cottontail—*Sylvilagus floridanus mearnsi* (Allen)

Method and Materials.—The method used to census cottontail rabbits was first employed by Durward Allen (1938-1939) in Michigan. It consists of trapping and banding the largest number of rabbits possible and securing a shot sample of the population on the census area. From the ratio of banded to unbanded rabbits in the sample to the total number banded, the actual population is determined. This technique has been used by Lincoln as an adjunct to estimating continental waterfowl populations.

Forty "Pennsylvania type" box traps, as described by Gerstell (1937), were used for the census. All rabbits caught were banded with ear tags which proved to be very satisfactory. Carrots were found to be the best bait as they did not spoil quickly in mild weather and were not as attractive to mice as ear or shell corn.

Census Area.—The census area consisted of approximately 65 acres of woods and brushy cover on the south slopes of Blackhawk ridge, and an area of second growth timber and brushlands adjoining its western base. The observed tendency of wintering cottontails in southern Wisconsin to avoid cold windy slopes made it unnecessary to extend the trap lines on to the north slopes of the ridge. This latter area was not considered a part of the winter range when computing the population. A brief description of the cover types on the census plot and their acreages are summarized below:

Cover Types	Acreage
Ungrazed woods with an abundant understory of shrubs	14
Grazed woods containing scattered thickets of prickly ash, blackberry and red cedar	21
Second-growth oak woods with a poor understory of shrubs	13
Heavy bluegrass, with scattered shrubs, young oaks and stump sprouts (5 small areas)	16
Short grass prairie relic	1.5
Total	65.5

Trapping Operations.—Due to the diversity of the cover types, weather conditions, and the irregular distribution of the rabbit populations in the various coverts, trap movement proceeded in no orderly fashion; instead, the traps were shifted from place to place whenever their efficiency in catching un-

banded rabbits suffered a marked drop. In addition to these variables in the procedure, one sector of the census area was trapped continuously during most of the census period. The number of traps used varied, and their efficiency was never 100% as mice sometimes ate the bait or sprung the traps. A summary of the trapping operations is given in the table below:

Trapping Periods	Traps in Use	Trap nights
Nov. 23-Dec. 7	30	420
Dec. 7-Dec. 22	38	532
Jan. 9-Jan. 13	13	52
Jan. 13-Feb. 13	37 (av.)	1148
	Total	2100

A total of 71 rabbits were caught and of these four died in the traps. The number of repeats was small because of the frequency of trap movement. Of the 22 rabbits that repeated, a few were caught as many as three times, making the total number of repeats twenty-nine.

Sampling.—Shooting was believed to be the most efficient means by which an adequate sample of the rabbit population could be secured in the shortest period of time, thereby reducing any error resulting from movements of rabbits into or out of the census area during the sampling period. It was also thought that shooting would obtain a more representative sample than live trapping which might be more apt to take an undue number of rabbits having the trap habit. The latter point, however, still requires further testing. Other sources of error that are present in this technique of censusing have already been discussed by Allen (*op. cit.*) and Dice (1941).

During the first shoot on February 14, a crew of eight secured only three rabbits. The sampling was continued until March 22, but it was with the greatest difficulty that a sample of twenty-one was secured.

Populations.—Twelve of the twenty-one rabbits shot carried bands. As the total number of rabbits banded was known (71, minus three that died in traps), the solution of a simple ratio gave the approximate total population on the census area.

$$\frac{(71-4)}{x} \cdot \frac{12}{21} \qquad 12\,x = 1407 \,. \qquad x = 117$$

In the course of the fieldwork, remains or indications of old kills of 11 rabbits were found. This number added to the 117 implies a peak fall population of at least 128 rabbits on the 65 acres of brushlands and woods, or a density of 2 rabbits per acre. However, the average density for the entire winter would be somewhat less.

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