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SMALL MAMMAL CATCHES UNDER TWO INTENSITIES OF DEER BROWSING

Thesis for the Degree of M. S.
MICHIGAN STATE COLLEGE
Jack D. Beattie
1955

THESIS

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SMALL MAMMAL CATCHES UNDER TWO INTENSITIES OF DEER BROWSING

by

Jack D. Beattie

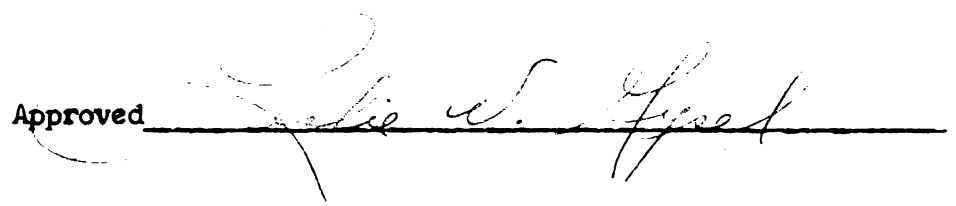
AN ABSTRACT

Submitted to the School of Graduate Studies of Michigan State College of Agriculture and Applied Science in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Department of Fisheries and Wildlife

June 1955

Approved 

THESIS

ABSTRACT

A study was made in The Dead Stream Swamp area during the summer of 1954 in an attempt to determine the effects of deer browsing upon small mammal populations. This was done by measuring compositions and densities of small mammal populations in areas of comparatively unbrowsed and overbrowsed deer yards in each of three cover types.

Vegetation data were gathered by use of nested quadrats located along traplines. Vegetation was classed as trees, shrubs, or herbs and recorded by stem counts and percent cover.

Two sizes of snap traps, placed on traplines, were used to obtain mammal data from each browse condition of each type.

Statistical analysis indicated highly significant differences in numbers of animals between lightly browsed and heavily browsed areas and significant differences among vegetation types when a combined error term was used. More small mammals were found in lightly browsed than heavily browsed areas. The few samples obtained did not provide a very powerful test of differences between areas but the expenditure of man power necessary to detect minor differences could not be justified.

Vegetation samples appeared to be too few to recognize any definite relationship between amount of cover, food, and numbers of small mammals captured. Differences in available browse were not due to previous deer browsing alone but also to the age of the stand and self-pruning.

No correlation was suggested between numbers of small mammals captured and differences in local climate or soil conditions.

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Deep gratitude is due the Peoples of the United States who through the G.I. Bill of Rights, made it possible for the writer to pursue his graduate studies.

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INTRODUCTION

The Problem

The purpose of the problem was to compare small mammal populations in comparatively unbrowsed and overbrowsed deer yards by measuring compositions and densities of small mammal populations in these areas.

Bartlett (1950), reported that overbrowsing is not only detrimental to the deer but that it also deprives other game species, such as snowshoe hares and ruffed grouse of essential low-growing food and cover. It might be assumed that overbrowsing also affects small mammal populations such as shrews, voles, moles, and mice. It was hoped that the sampling of these smaller mammal populations, correlated with samples of vegetation in the same areas, would show whether differences in mammal populations did exist between "good" and "poor" areas of browse conditions. If fairly good quantities of food species were available, the area was called "relatively good". If food species were heavily browsed, the area was called "relatively poor". Evaluations were based on ocular estimates.

Review of Literature

Studies of small mammal populations are both numerous and extensive. Likewise, sample studies of cover types are abundant. Methods and technique in both cases vary greatly and there seems to be no particular answer as to which are the "best". While some studies have compared the effects of larger animals on vegetation, few have attempted to show relationships between vegetation and small mammal populations.

Review of Literature

Dambach (1944) reports that his studies based on three nights trapping showed results to be variable between grazed and ungrazed woodlots. Where leaf litter was of similar depths, the grazed area had a slightly higher population. However, where the amount of leaf litter was greater in one area than the other, small mammals were found to be three and one-third times more abundant in the ungrazed than grazed areas. An apparent increase in abundance of mammals paralleled the development of new woody growth and better distribution of leaf litter in the ungrazed woodlots.

According to Phillip (1936) who based his report on 5010 trap nights in each area. deer mice were found to prefer overgrazed areas while cotton rats preferred areas with more cover. Apparently, each species had individual requirements as to cover. Studies by Allen (1938) of various small mammal species, (including prairie deer mice, while footed mice, and shrews), found in various farm land-use situations, data which agreed with that of Phillip (1936) concerning diferential use of cover by various small mammal species. Blair (1938) found prairie deer mice more abundant in blue grass situations than other types of cover in the same area.

Newbigin (1936), and Dice (1931) agree that the places in which animals live are determined by the nature of the vegetation and its use as food and cover. Dice based his conclusions on some of his previous work with snowshoe rabbits and small mammals and upon a review of work by other investigators.

Description of the Area

Location

The study was made on six plots located in the Dead Strem Swamp area, which occupies an area about nine and one-half miles long and five and one-half miles wide in Roscommon and Missaukee Counties in the north-central part of the Lower Peninsula of Michigan. Roughly, the eastern boundary of the swamp lies between the western edges of Houghton Lake on the south and Higgens Lake to the north. The swamp then expands westward nine and one-half miles to highway M 74.

Physiography

Although most of this "swamp" area is low and wet, it is actually of a very diversified nature; consisting of large areas of wet land, swamp, and bog, interspersed with low sandy ridges and hills in the form of islands and finger estending into and through the swamp. Veatch, Schoenmann, and Moon (1924) state that the relief is a result of glaciation and that the more level areas are part of outwash plains and that the till plains or ridges are mainly land-laid moraines. Several creeks originate in the swamp. Most of them empty into the Dead Stream, from which the swamp gets its name.

Climate

Veatch (1924) reports the chief climatic features for the area studied to be: a mean annual temperature of about 41 degrees Farenheit; a normal precipitation which includes melted snowfall of about 27 inches;

an average snowfall of 56.5 inches; low wind movement, low evaporation, low percentage of possible sunshine; and moderately high humidity. Temperatures below freezing occur from November through March and occasionally in September and May. The frost-free season is about 120 days. The average date of the last killing frost is June 10 and of the earliest is September 10, but killing frosts have been recorded in every month in the year.

Soils

Soils were field checked and identified by reference to the description of Veatch (1924), (1941), and (1953).

Rifle peat is found in cedar-tamarack swamps; these soils have a brown or dark brown, rather coarse and loose crumbly, moderately decayed peat in the surface two or three feet. This surface material usually grades into yellowish brown, fibrous peat which is but slightly decayed. Rifle peat is moderately acid and low in fertility. It occupies wet flats and depressions with a moderately high-water table. The natural water table is less than two feet below the surface for most of the summer.

Saugatuck sand occurs on moist, sandy plains. It occupies positions but slightly higher than the wet lands or swamps which it commonly borders. Subsurface-drainage is slow, due to a shallow water table or layer of clay at or below five feet in depth which prevents free subsoil drainage.

The Newton loamy sands include these soils having dark gray loamy sands rich in organic matter and acid in reaction, underlain by grayish water-logged sands which continue to a depth of three or more feet. They occupy the better drained edges of swamps and still better drained soils occupy adjoining higher ground.

METHODS AND PROCEDURES

Choice of Sites for Study

Study sites were limited to areas within the boundaries of the Dead Stream Swamp. Conditions of browse within this swamp varied from location to location; one part of the swamp was browsed quite heavily and another part only a few miles away had considerable browse left, as shown by field surveys.

To aid in selecting areas to be studied, aerial photos, Game Division cover maps, and maps showing food conditions of deer yards were used. The deer yard maps are prepared yearly, based on ocular evaluations made by District Game Supervisors. Three forest cover types were chosen. Each of these contained both "relatively good" and "relatively poor" available browse according to the current maps. A preliminary survey of the cover types, as recommended by Weaver, (1938), was made to check actual browse conditions (available browse) against those described on the maps.

Three general cover types were used to compare small mammal populations. Within each, subjectively selected sites, as near homogeneous as possible were chosen. In each cover type, areas were selected that were comparable except in degree of browsing. No satisfactory quantitative or quasi-quantitative means have yet been devised by which two people can give independent identical estimates of available browse. Therefore, the areas were selected by a general appraisal of food conditions. If fairly good quantities of food species were available, it was called

"relatively good". If food species were heavily browsed, the area was called "relatively poor". Later it was observed that this condition was due to the stage of succession of the stand as well as to browsing. It is granted that this is a loose classification, but deer browsing activities are so varied, that attempts to define precise limits have been unsatisfactory, since no two people can give independent identical estimates based on ocular values.

Cover Types

The area of cover type "A" was located in a swamp, with a good stocking of cedar-spruce-tamarack, 0-9 inches d.b.h. in the upper story, and with a swamp hardwood understory.

The area of cover type "B" was similar to "A". It was in swamp, with a good stocking of spruce-cedar-tamarack, 3-9 inches d.b.h. in the upper story and also with a swamp hardwood understory.

The area of cover type "C" was near the edge of the swamp, with a medium stocking of poplar, 3-9 inches d.b.h., and a good stocking of spruce-balsam-fir-cedar, 0-3 inches d.b.h. in the upper story while the understory was mostly speckled alder.

In each of the cover types studied, the condition and composition of the forest floor varied. Logs in various stages of decay, stumps, and other characteristics varied considerably from place to place in the same forest type.

The area of cover type "A" was low and level with a water table at the surface in many places. Vegetation was found mostly on slight ground elevations little more than a few inches above the water line. Cover type "B" was similar but had less area covered by standing water. Cover type "C" was the dryest of those studied, with the water table slightly lower than in the other cover types. However, it was still mainly a swamp-bog condition with considerable amounts of standing water. The soils here varied slightly from those of previous areas studied. A little higher content of sand was found in the soil. This area was near the

swamp edge and was partially Newton Sandy loam while the soil associated with previous cover types was found to be Rifle peat.

Measurements of Vegetation

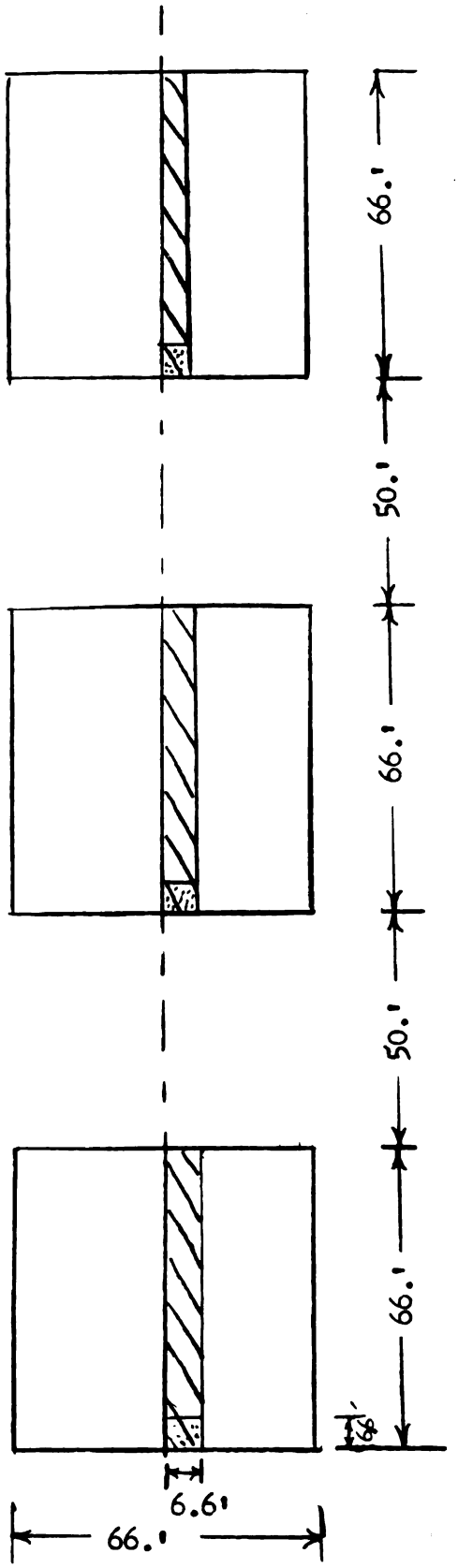
Plot Size and Location

Nested quadrats, located along each trapline (see section on small mammal census) to secure quantitative data for vegetation, although altered in size, were similar to those described by Weaver and Clements (1938), and recommended by Tansley (1920), Hardy (1945), Elliott (1952), Oosting (1953), and Parmelee (1953). Boundaries of quadrats were located by means of a compass and tape. Edges of plots were marked with cotton string. Rectangular quadrats were used because they were considered to be most efficient for sampling.

Different sizes of quadrats were used for trees, shrubs, and herbs. The tree quadrats, first used, (type "A"), were 66 feet square. Inside this, the shrub plot was 66 feet long and 6.6 feet wide. One herb plot six and six-tenths feet square was placed in the nearest end of the shrub quadrat. Four tree quadrats were located on each trapline; each quadrat was spaced 50 feet from the next, (see Fig. No. 1).

Because of the time limitations, quadrat numbers and sizes were changed for cover types "B" and "C". Hauser (1953) reported the use of varied numbers of quadrat plots in different areas of the same study where the size of areas differed. Smaller tree and shrub plots, and smaller but more numerous herb plots were used. The four tree plots used on each trap line were 46.7 feet square. One shrub plot 3.3 feet wide and 13.2

Figure No. 1. - Diagram of Nested Quadrats used in Cover Type "A".



Legend

Trees

Shrubs

Herbs

Note: Four tree plots were used in Cover Type "A".

Figure No. 2.- Diagram of the Nested Quadrats used in Cover Type "B".

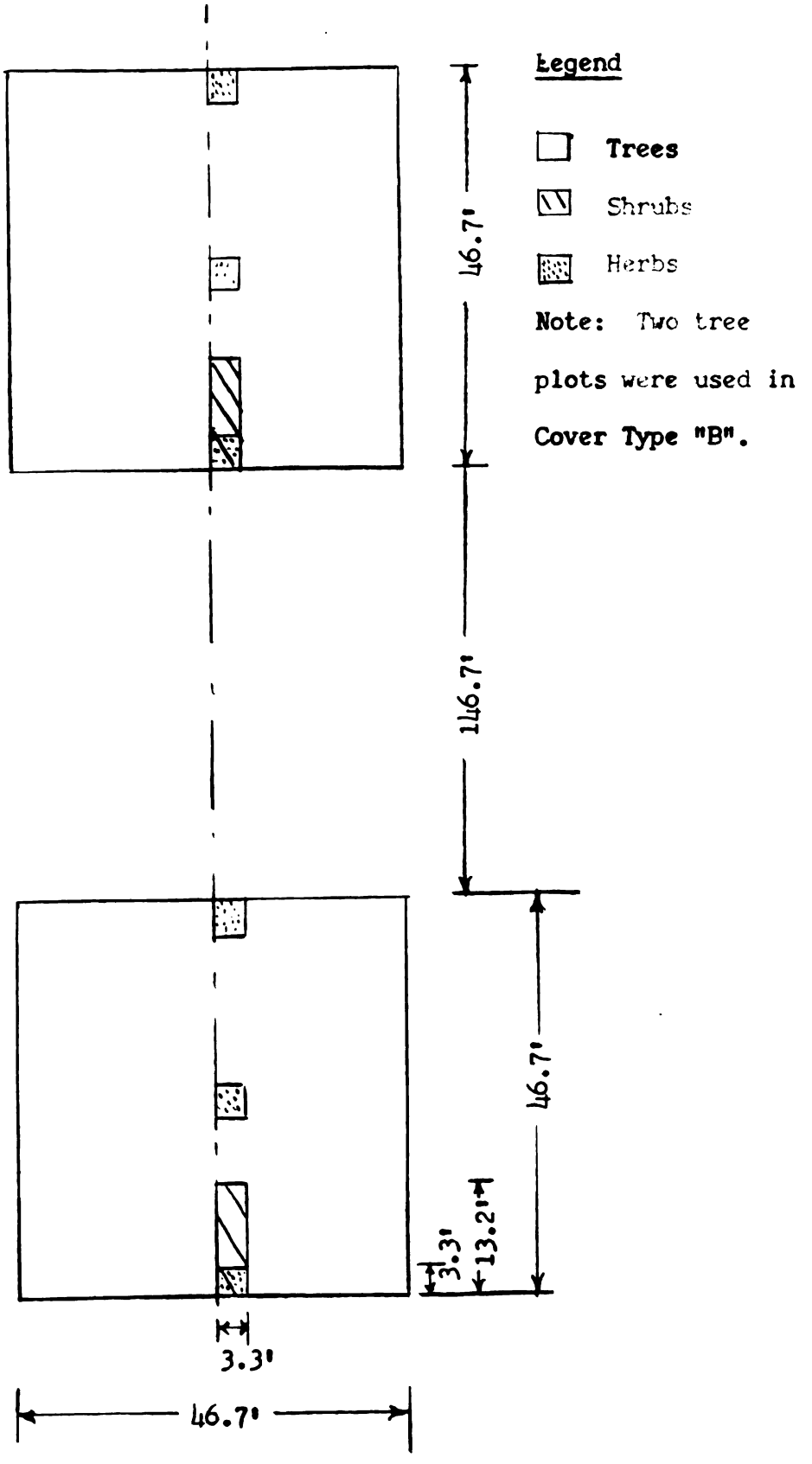
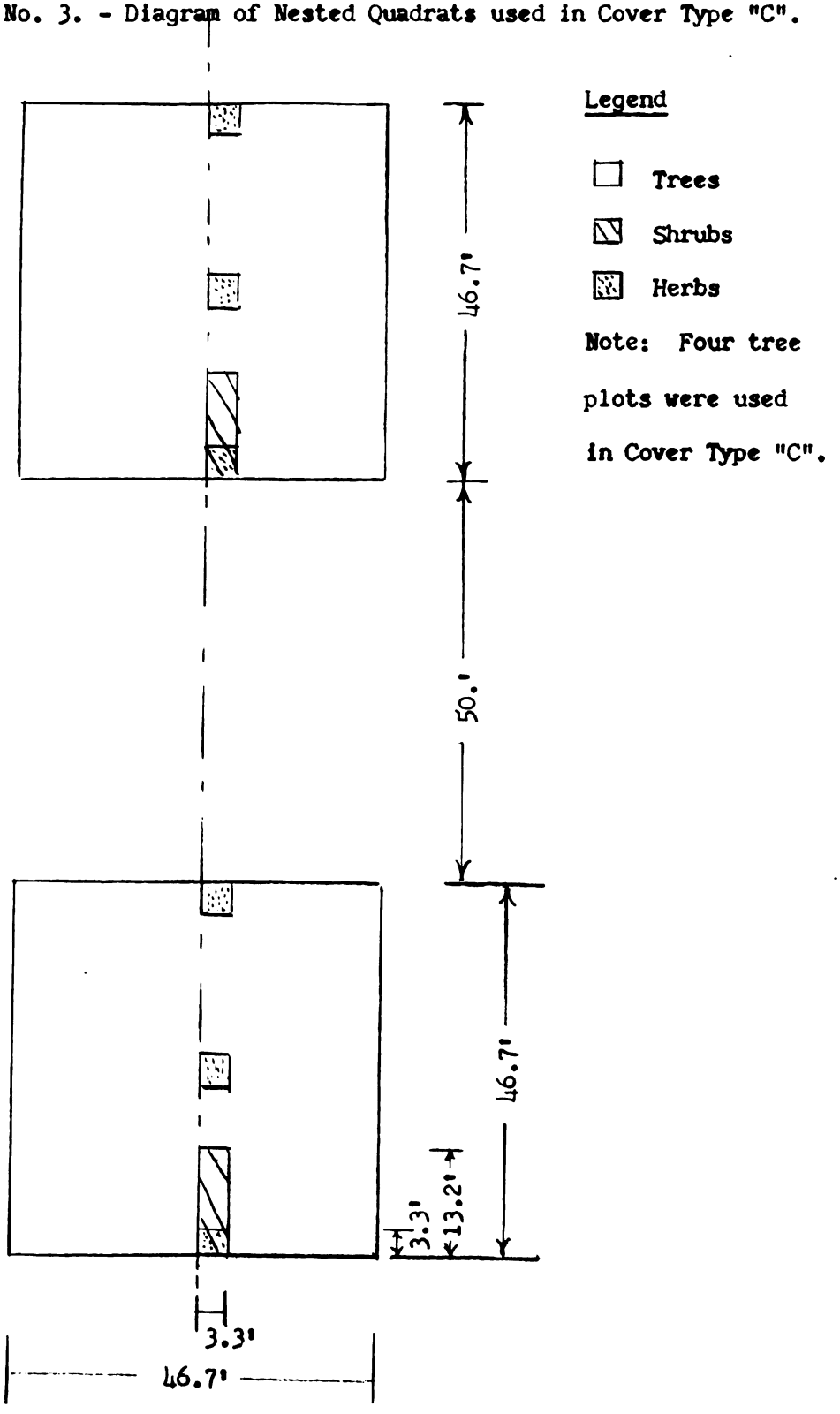


Figure No. 3. - Diagram of Nested Quadrats used in Cover Type "C".



feet long was located in each tree plot. Herb plots were three and three-tenths feet square. Three herb plots were located along the trap line in each tree plot, one on each edge and one in the center, (See Figures 2 and 3).

Tree Measurements

All species one-inch d.b.h. and over were tallied in size classes. Trees under one-inch d.b.h. were tallied with the shrubs. The density of tree species was represented by a tally of numbers present in the quadrat. An ocular estimate of crown class for each species was recorded as judged to be codominant, dominant, or intermediate in type. Five vigor classes based on ocular estimates were used to indicate condition of the species: (1) Vigorous (fast growing); (2) slow growing; (3) stagnant; (4) Dying; (5) Dead, but still standing.

The average height of the "browse line", (partially due to self - pruning caused by shade and the age of the stand), was based on ocular estimates checked occasionally by actual measurement.

Shrub Measurements

All species were tallied by size class, and density. The frequency of species used by animals for browse was noted. Size classes for shrubs in all types were as follows:

Size classes	Height in inches
a	0- 6 inches high
b	7 - 12 inches high
c	13 inches high and over but below 1 inch d.b.h.

Cover classes were used to indicate approximately how much of the area was occupied by a species. Cover classes for shrubs were modified from Barick (1950). For all plot sizes, density classes were:

Cover Class	Percent of Plot covered
T	0 to 10 percent of the plot
1	10 to 33 percent of the plot
2	33 to 66 percent of the plot
3	66 to 100 percent of the plot

Herb Measurements

All species were tallied by stem count; size class; and in some cases, cover class values. Cover classes, in these plots, were used to indicate the percentage of the area occupied by a species where stem counts would be inaccurate and extremely difficult to obtain. Thus cover classes, instead of stem counts were used for grasses, mosses, and ferns. Size classes for herbs were the same as those described for shrubs except that size class c was 13 inches high and over, with no reference to diameter of the stems. Cover classes for herbs in all plots were modified from Barick (1950). Frequency of use by animals according to species, was noted although use in this class was not necessarily considered to be due to deer alone since other species such as rabbits and some of the other small mammals known to utilize herbs were present in the areas studied. Cover classes for herbs were the same as those described for shrub plots.

Mammal Census

Procedures similar to those recommended in the North American Census of Small Mammals Standardized Sampling Procedure, (anonymous, no date), were used.[1]

One set of two parallel lines was used in each location (browsed or unbrowsed) in each cover type. Distance between lines was 400 feet. This distance was supposed to prevent overlaping of trap areas. Each trap line was started, (1st station), 200 feet from the center of the road (or edge of the cover type when roads were not present), to exclude "edge effect". The line extended in a straight line 950 feet long toward the center of the stand, or in such a manner as to pass through vegetation thought representative of the type. In the "heavily-browsed" area of cover type "C", parallel lines could not be used because of shape of the area, but here an engineers compass was placed on an orientated map of the area to determine an azimuth that would bisect the length of the cover type. Then both trap lines were located along the azimuth. Precautions were taken similar to those previously described to exclude "edge effect". Lines in this "browse condition" were located between trails which crossed the azimuth. Starting points for these trap lines were located 200 feet from the center of the trail. It is recognized that the trap lines were not random samples of the general area. There were twenty stations on each trap line with intervals of 50 feet. At each station, three snap

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[1]This is an anonymous, undated, mimeographed release of standardized sampling procedures recommended by the North American Census of Small Mammals organization and is on file at the Michigan Department of Conservation, Houghton Lake Wildlife Experiment Station.

traps were placed within a five foot radius. In three nights, this plan would total 360 trap-nights for each browse condition in each cover type.

Snap traps of two types were used: (1) Museum Special Traps, and (2) Victor "No. 2" 4-ways Traps (mouse size); both manufactured by the Animal Trap Company, Leitz, Pennsylvania. At odd-numbered trapping stations, one Victor trap, (referred to as a small trap), and two Museum Special traps, (referred to as large traps), were used. At even-numbered stations, three Museum Special Traps were used. This arrangement of traps was an attempt, with a limited number of "small" traps, to more adequately sample the smaller species of small mammals. Ryel and Howe (1953), suggested that Museum Special traps are somewhat large for sampling smaller species of Sorex.

The small mammal populations in the three cover types were studied separately. However, the animal populations in both "browse conditions" in each cover type were sampled at the same time. Trap lines were set up and traps placed but not set until all four lines were ready. Traps on all four lines were set the same day. They were visited daily, (every 24 hours), in the same order each time and as near to the same time of day as possible. After three days of trapping, the traps were moved to a new cover type as recommended by Hardy (1945).

For bait, the following ingredients were mixed well together:

2 pounds melted beef fat

2 pounds peanut butter

2 pounds raisins ground with

2 pounds oatmeal

1 pound paraffin (home canning type)

All specimens trapped, were labeled in the field as to trap location and size of trap. Then the animals were placed in individual paper sacks for later study. In the laboratory, the following measurements for all small mammals were made: total length, length of tail, length of hind foot, and length of ear (from notch). Sex and age, as judged by external characteristics were recorded. In general, the specimens were identified from skin characteristics and measurements, but skulls of questionable specimens were saved for later, more positive identification. Skin characteristics did not always permit the separation of the young of some species such as Peromyscus leucopus and Peromyscus maniculatus gracilis, but these species could be identified by skull examination.

Identification and measurements of other specimens trapped were recorded on the same data sheet as those for small mammals.

RESULTS

Vegetation

Treatment of Data

In most species of trees, yield of seed is related to stem size and crown cover. In the present study many mature species were present that never reached the larger diameters and yet produced large quantitie of seed. Thus it seemed that separation of stems on the basis of diameter would not be justified. For this reason, total numbers of stems were used and tree data were converted to a per-acre basis so that the various cover types studied could be compared as well as making comparisons within each cover type.

A list of vegetation used as food by deer was prepared by Atwood (1941), and supported in part by Trippensee (1948) and Duvendeck (1952).Since all species of shrubs in the areas studied were found on the food list, all species were lumped together for comparison by stem counts.

Vegetation on herb plots was seperated into two classes for study of occurance. Vegetation which could be, was counted by stems. That such as mosses, grasses, and ferns, which was not easily tallied by numbers of stems and heights, was recorded only in cover classes. These classes were converted to average per cent coverage for comparisons. The number of plots in which each species occurred was expressed as per cent frequency of individual cover classes.

Vegetation in Area "A"

Chi-Square test for tree data from cover type "A" presented in Table No. III showed "good" and "poor" areas to be similar in so far as stem counts were considered by size classes. Overstory cover was found to be very similar in both conditions for type "A". Shrub cover was found to be greater in the "good" area than in the "poor" area. Although more stems had been "used", in the "good" area more were present there than in the "poor" area. Shrubs were more numerous in size class "A" and less numerous in classes "b" and "c" in the "poor" area where fewer animals were caught. The average cover of grasses, ferns, and mosses (Table VIII) was greater in the "poor" area than in the"good" area, but stem counts of the other herbs (Table VII) showed the "good" area to contain more total stems than the "poor" area.

A total view of the two conditions,not involving statistical tests, showed overhead cover to be about the same but slightly more cover of shrubs and herbs in the good area. Both areas were of types with the "good" area slightly wetter than the "poor" one. Because of the uneven topography,the forest floor was not very homogeneous. Some sample vegetation plots occurred on areas flooded with water. For this reason vegetative values shown by the data were not considered very reliable.

FIGURE 4

GROUND COVER, FOREST FLOOR, AND COMPOSITION OF VEGETATION FOUND IN "HEAVILY BROWSED" CONDITIONS OF COVER TYPES "A" AND "B".

Note the nearly bare forest floor and general lack of deer browse.

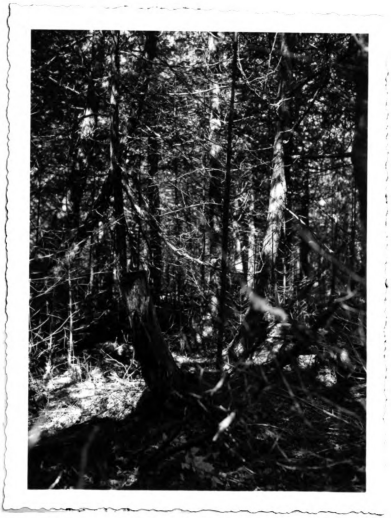

FIGURE 5

GROUND COVER, FOREST FLOOR, AND COMPOSITION OF VEGETATION FOUND IN "LIGHTLY BROWSED" CONDITIONS OF COVER TYPES "A" AND "B".

Note the abundant herbaceous growth on the forest floor and noticeable amounts of Cedar and other available deer browse.

Vegetation in Area "B"

Chi-square tests for tree data from cover type "B" presented in Table IV showed more total trees present in the "poor" area than in the "good" area. Thus if seed production were based on numbers of tree stems, and small mammals related to that alone, it would seem that the "poor" area could support more small mammals than the "good" area. Shrub cover in all size classes was also found to be more numerous in the "poor" areas than in the "good" area but greater numbers of those in the "poor" area were browsed. The average cover of grasses, ferns, and mosses, and also the number of stems of other herbs were greater in the "poor" area than in the "good" area.

This type was similar to type "A" but not quite as wet. Still, many plots were flooded. The "good" area was not as homogeneous as the "poor" area. Part of one of its trap lines passed through a small area in which cover was present but food species for the small mammals studied were sparse. The water level in the "good" area was higher than that found in the "poor" area.

Vegetation in Area "C"

Although stem counts for trees in this area, (Table V), showed more trees over four inches d.b.h. present in the "poor" area than in the "good" area, total stems were nearly the same in both areas. More shrubs of all size classes were present in the "poor" area than in the good area, but at the same time more of the shrubs were "used" in the "poor" area in proportion to those in the "good" area. The average cover of grasses, ferns,

FIGURE 6

GROUND COVER, FOREST FLOOR, AND COMPOSITION OF VEGETATION FOUND IN "HEAVILY BROWSED" CONDITIONS OF COVER TYPE "C"

Note that although ground cover was fairly abundant,(from the summers growth), shrub cover, used by deer during winter months, was quite sparse.

FIGURE 7

GROUND COVER, FOREST FLOOR, AND COMPOSITION OF VEGETATION FOUND IN PART OF THE "LIGHTLY BROWSED" CONDITION OF COVER TYPE "C"

Note that ground cover is fairly sparse in this area. Shrub cover in adjacent areas was greater than that shown here.

and mosses, and the total number of other herb stems was greater in the "good" area than the "poor" area.

This type differed from those previously mentioned in that it was considerably dryer and contained more hardwood species. In general, ground cover was best in the "good" area. There was a difference in general appearance between the "good" and the"Poor" areas of this type. The "good" area consisted of drier soils partly of the Newton Sandy loam type and partly of Rifle Peat. The topography at the "poor" site was very uneven and had many small ridges caused by up-rooted trees. The"good" site did not have as many of these ridges. Sampling indicated that the "poor" site had a greater number of species of trees present although in smaller total numbers than the good site. This variety in species might be thought favorable to small mammals.

Mammal Data

The trap catch by lines shown in Table I is listed only as "small mammals" but the species composition of the total catch is shown in Appendix A. An analysis of variance, (Table II), was carried out for the small mammal trapping data, using a logarithmic transformation, ($X' = \log (X + 1)$), (Snedecor,1950). The results indicated highly significant differences between good and poor areas and differences significant at the five per cent level among types of areas, using a combined error term. A combined error term was used here because the interaction appeared negligible in the analysis.

Actual small mammal populations of each area could not be determined by the sampling procedures. According to Dice (1938), no single statist-

ical sample, unless it be very large could give more than a rough approximation of the size of the population from which it were drawn. Leraas (1938) and Stickel (1946) found that population figures based on a three-day snap trap catch were exaggerated, but Dice (1938) and Jameson (1944) stated that such trap lines gave reliable indications of relative abundance of species in different areas. Hayne, (1949), discussed the estimation of population size from the decrease in rate of capture as animals are removed. This method was not appropriate in the present study because of smallness of catch on most lines.

TABLE I

SMALL MAMMAL CATCH BY LINES ACCORDING TO BROWSE CONDITIONS AND COVER TYPE (Species Composition is shown in Appendix A)

	Browse Conditions					
	Poor			Good		
Cover Type	Line 1	Line 2	Total	Line 3	Line 4	Total
A	1	0	1	4	4	8
B	0	1	1	2	6	8
C	3	6	9	12	4	16
Total for lines	4	7		18	14	
Total for Conditions			11			32

TABLE II

ANALYSIS OF VARIANCE OF LOGARITHMS OF NUMBERS (PLUS ONE) OF SMALL MAMMALS CAUGHT ON 12 TRAPLINES.

Source	Degrees of freedom	Sum of Squares	Mean Square	(Using Interaction Error) F	(Using a Combined Error Term) F
Total	11	1.333			
Type	2	.441	.220	5.7	4.9 *
Good vs Poor	1	.529	.529	13.8	11.7 **
Interaction [Type x (Good vs Poor)]	2	.077	.0383	.8	
Error	6	.287	.048		
(Combined Error)	(8)	.363	.045		

Note:- Computations in the above table were carried out to four decimal places and then rounded off to three decimals under Sum of Squares and Mean Square, and to one decimal under "F".

* indicates significant differences
** indicates highly significant differences (see following discussion)

In reference to Table II showing analysis of variance of the small mammal data, the combined error term yields the best estimate of error of measurement, the mean square for combined error being 0.045 with a standard deviation of 0.21. The approximate 95 per cent confidance limits of average catch in "good" areas are 2.9 to 7.6 animals per line and in the "poor" areas are 0.5 to 2.3 animals. Following the reasoning of Winsor and Clarke (1940),(See also Ball and Hayne, 1952 and Snedecor,1946),

with a standard deviation in logarithms of 0.21, the antilogarithm 1.63 would indicate that the catch has been multiplied (or divided) by 1.63. Thus one standard deviation in the logarithm corresponded to a percentage standard deviation or coefficient of variation of 63 per cent in the catch.

With the information on standard deviation, it is possible to estimate the number of samples (trap lines) needed for confidance limits of a stated size assuming the variability of random samples to be the same as that of the present non-random samples. It would be possible to view the information in still another way. If we desire to know the size of sample necessary to allow us to discriminate between two areas that differ in catch by a stated amount, we must consider the two kinds of errors inherent in any such test for a difference, as discussed by Walker and Lev (1953). Rejecting a hypothesis when it is true is called error of the first kind. The statistical level of significance is the probability of making an error of this kind, alpha error. The probability of accepting a hypothesis when some alternative to the hypothesis is true is called error of the second kind or beta error.

In the present study, the hypothesis tested could be stated thus, "The two kinds of areas are the same with regard to average catch", recalling that we assume catch to be related to, but not identical with, population level. Error of the first kind would be deciding that a difference exists where there is really none, while error of the second kind would be failing to detect real difference in catch.

With error of the first kind set at 0.05 and error of the second kind at 0.20 then computation has been made of the number of traplines necessary to detect population differences at the two levels. If one population were twice the size of the other, then eight trap lines in each sample should be adequate. However, if one were only fifty per cent greater than the other, 23 such lines would be needed in each sample. The greater sample number here reflects the better information.

It is apparent from the data in this study that the few trap lines used did not provide a very powerful test for differences between areas.

There is a real question in such a study as this as to whether one should be satisfied with detecting probable major differences, or whether one should expend many more hours of labor to detect lesser differences. For example from the experience gained in this study, it is judged that to compare two kinds of areas in similar swamp types, using 23 trap lines in each condition, would involve about five and one-half weeks of labor for one individual.

It does seem probable that the small mammal populations studied were greater under the "good" browse conditions than under the "poor". There is less definite evidence that the catches reflect real differences among the cover types chosen for study.

TABLE III

NUMBER OF TREE STEMS IN "GOOD" AND "POOR" AREAS OF TYPE "A", ON A PER-ACRE BASIS

Species	Browse Condition of the Area							
	Good				Poor			
	Diameter in Inches - d.b.h.				Diameter in Inches - d.b.h.			
	1-3	4-6	7-12	13-18	1-3	4-6	7-12	13-18
American Elm	3							
Balsam Fir	148	15	2		594	52	18	
Black Ash	129	9	3		2			
Black Spruce	13	19	9		53	22	4	
Northern White Cedar	744	115	37		632	145	45	
Red Maple	8	9			3			
Service Berry					4	2		
Silver Maple		2	2					
Speckled Alder	652				90			
Tamarack					4		2	
Trembling Aspen						2	3	
White Birch	50	18	3		248	25	2	2
Yellow Birch	2							
Total by size	1749	187	56		1630	248	74	2
Total by condition	1992				1954			

TABLE IV

NUMBER OF TREE STEMS IN "GOOD" AND "POOR" AREAS OF COVER TYPE "B" ON A PER-ACRE BASIS

Species	Browse Condition of the Area							
	Good				Poor			
	Diameter in Inches - d.b.h.				Diameter in Inches - d.b.h.			
	1-3	4-6	7-12	13-18	1-3	4-6	7-12	13-18
Balsam Fir					345	10		
Black Spruce	3	3			5	10	5	
Northern White Cedar	448	80	3		450	150	40	
Red Maple	13	5			-	-	-	
Service Berry					190			
Speckled Alder	415	13			245			
Tamarack	125	73	8			5		
Trembling Aspen	3	3	8					
White Birch	38	10	5		105	15		
Total by size	1045	187	24		1340	190	45	
Total by condition		1256				1575		

TABLE V

NUMBER OF TREE STEMS IN "GOOD" AND "POOR" AREAS OF COVER TYPE "C", ON A PER ACRE-BASIS

Species	Browse Condition of the Area: Good — Diameter in Inches - d.b.h. 1-3	4-6	7-12	13-18	Poor — Diameter in Inches - d.b.h. 1-3	4-6	7-12	13-18
American Elm	29	6						
Balsam Fir	95	29			223	85	5	
Black Ash	12				58	5		
Black Spruce	435	32			3			
Dogwood spp.	3				10			
Eastern Hemlock					10			
Northern Red Oak					5	3		
Northern White Cedar					125	45	5	
Pin Cherry					28			
Red Maple		6	3		33	43	3	3
Red Pine								3
Speckled Alder	300				78			
Trembling Aspen	77	115	58		153	75	28	3
White Birch	43	3			35	23	5	
White Pine								3
Total by size	994	191	61		761	279	46	12
Total by condition		1246				1098		

TABLE VI

STEM COUNTS OF SHRUBS - BASED ON EIGHT PLOTS IN EACH CONDITION

Good Conditions of Browse						Poor Conditions of Browse					
Trapline Number	Number stems showing browse damage	Size Classes a	b	c	Total Number	Trapline Number	Number stems showing browse damage	Size Classes a	b	c	Total Number
A 3 & 4	155	203	250	504	957	A 1 & 2	12	605	5	70	680
B 3 & 4	86	13	35	216	264	B 1 & 2	204	18	126	388	532
C 3 & 4	29	6	25	63	94	C 1 & 2	102	97	47	71	215

TABLE VII

STEM COUNTS OF HERBS - ADJUSTED TO 24 PLOTS

Trapline Number	Total Number of Stems Diameter in inches 0-6	7-12	13" - 1" dbh	Total
A 1 & 2	1491	75	18	1584
A 3 & 4	1656	141	15	1812
B 1 & 2	1022	110	20	1152
B 3 & 4	328	40	73	441
C 1 & 2	375	22	9	406
C 3 & 4	656	25	1	682

Median percentages for cover classes were as follows:

Cover Class	Percent Cover	Median % Cover
T	0-10	5.0%
1	10-33	21.5%
2	33-66	49.5%
3	66-100	83.0%

Average per cent cover in the following three tables was determined by use of the following formula:

$$\text{Average \% Cover} = \frac{\text{Sum of Median Percent}}{\text{Number of quadrats}}$$

TABLE VIII

COMPARISONS OF MOSSES, GRASSES, AND FERNS IN "GOOD" AND "POOR" CONDITIONS OF TYPE "A", USING EIGHT PLOTS, .001 ACRE IN SIZE FOR EACH CONDITION

Species	Frequency Cover Class T	1	2	3-	Average Cover Class Value	Total Average Cover Class
Line Numbers A1 and A2 (poor conditions):						
	percent				percent	percent
Calamagrostis canadensis	13				1.	1.
Dryopteris felix-mas		13			3.	
Onoclea sensibilis			13		6.	9.
Mnium punetatum	13			13	11.	
Ptilum crista castrensis				13	10.	
Sphagnum spp.				38	31.	52.
Total average per cent cover for "poor" conditions:						62.
Line Numbers A3 and A4 (good conditions):						
Osmunda cinnamomea	13				1.	
Osmunda regalis			13		6.	7.
Mnium punetatum		13			3.	
Pleurozium Schreberi		13			3.	
Sphagnum spp.			38	13	29.	35.
Total average per cent cover for "good" conditions:						42.

TABLE IX

COMPARISONS OF MOSSES, GRASSES, AND FERNS IN "GOOD" AND "POOR" CONDITIONS OF TYPE "B", DENSITIES BASED ON 18 PLOTS, .00025 ACRE IN SIZE FOR EACH CONDITION.

Species	Frequency Cover Class*				Average Cover Class Value	Total Average Cover Class
	T	1	2	3		
Line Numbers B1 and B2 (poor conditions):						
	percent				percent	percent
Calamagrostis canadensis	17	08	08	17	21.	21.
Dryopteris felix-mas	25	08			3.	
Onoclea sensibilis	17				1.	
Osmunda cinnamomea	08				0.4	4.4
Lycopodium spp.			17		8.	
Mnium rostratum			08		4.	
Ptilum crista castrensis		17	17	58	60.	72.
Total density for "poor" conditions:						97.4
Line number B3 and B4 (good conditions):						
Calamagrostis canadensis	17	22	06	17	22.	22.
Dyropteris felix-mas	11	06		06	6.	
Onoclea sensibilis	17				1.	
Osmunda regalis		11	06	11	16.	
Pteridium aquilinum		17	06	06	10.	33.
Lycopodium spp.	11				1.	
Ptilum crista castrensis	06	06	11	44	44.	45.
Total density for "good" conditions:						100.

*Per cent frequency cover classes; and Average cover class values in the "poor" areas above were based on 12 plots instead of 18.

TABLE X

COMPARISONS OF MOSSES, GRASSES, AND FERNS IN "GOOD" AND "POOR" CONDITIONS OF TYPE "C", USING 24 PLOTS, .00025 ACRE IN SIZE, IN EACH CONDITION.

Species	Frequency Cover Class				Percent Average Cover Class Value	Total Average % Cover Class
	T	1	2	3		
Line Numbers C1 and C2 (poor condition):						
		percent			percent	percent
Calamagrostis canadensis	25	21	13	04	15.	15.
Dryopteris felix-mas	08	04			1.	
Pteridium aquilinum			08		4.	5.
Heterophyllium Holdanianum		04			1.	
Lycopodium spp.		08	08	08	13.	
Mnium punetatum	08		1		0.4	
Mnium rostratum		04		04	4.	
Pleurozium Schreberi		04		04	4.	
Ptilum crista Castrensis	04	04	04	04	7.	
Total density for "poor" condition:						49.4
Line Numbers C3 and C4 (good conditions):						
Calamagrostis canadensis	13	13	21	25	34.	34.
Dryopteris felix-mas	13	04			2.	
Onoclea sensibilis	04	04			1.	3.
Heterophyllium Holdanianum				04	3.	
Lycopodium spp.	08				0.4	
Mnium punetatum			08		4.	
Mnium rostratum		04			1.	
Pleurozium Schreberi			04	04	6.	
Ptilum crista castrensis			08	21	21.	
Tetraphis pellucidum	04				2.	37.4
Total density for "good" conditions:						74.4

DISCUSSION

The first thing that should be discussed is the terminology used by the investigator. The title of the thesis is "Small Mammal Catches Under Two Intensities of Deer Browsing". Those species of small mammals used in this report included: Clethrionomys gapperi, Blarina brevicauda, Sorex cinereus, Sorex palustris, Peromyscus leucopus, and Peromyscus maniculatus gracilis. Other "larger" small mammals such as Glaucomys sabrinus, Tamiascurius hudsonicus, and Tamias striatus, although caught, were not used for comparisons because of the lack of adequate sampling with the size traps that were used.

Careful field examination of the "browse conditions" of various areas, and examination of data from vegetative quadrats seemed to indicate that the lack of understory browse material was actually due to a combination of the past use of browse material by deer and also the effect of the age of the stand and self-pruning. These observations agree with those of Duvendeck, (1952), who found that self-pruning significantly reduced the amount of available browse on white cedar. This added factor may have had some effect upon the lack of conclusive differences in vegetation of "good" and "poor" browse areas.

In all areas, small mammal captures were greater in "good" areas than in "poor" areas. However, small mammal captures in the cover types observed could not be related directly to the density of any one "layer" of cover. Over-all estimates of cover also showed lack of correlation with

small mammal captures. Two areas studied had more over-all cover in "good" areas while one area had more cover in "poor" areas.

Various foods are used by small mammals. Shull (1907), found that the short-tailed shrew used snails, moles, beetles, and earthworms for food. Hamilton (1941), reported the food of the long-tailed shrew to be mostly insects, earthworms, caterpillars, millipedes, sowbugs, snails, spiders, some vegetable matter, small salamanders, and mice. Townsend (1935), Hatfield (1938) and Hamilton (1941) reported Peromyscus to be mainly vegetarian in habits, although large numbers of insects were used too. Foods used by Peromyscus, based on stomach analysis, cheek pouches, and catches, according to Hamilton are listed in Appendix C. Hamilton further stated that the food of Clethrionomys gapperi consists of seeds of Rubus, Amelanchier, Vaccinium, plus insects, beetles, adult flies, lepidopterous larva, centipedes, spiders, and fungi. From observations in the present study, plentiful amounts of food species of small mammals were present in most areas studied, (see Tables VII-X and Appendix C).

Small mammal populations were judged on total numbers of species. This technique was used because of the very small numbers of individual species captured. However, it would be reasonable to expect species differences among small mammals. For example, total clearing eliminates some and allows others to multiply. Also small mammal catch does not necessarily equal populations present. If, for some reason, areas in the two browse conditions were not comparable except for the amount of available browse, trapping results could be biased.

There may be reasons other than those measured in this study affecting numbers of small mammals found in certain areas. However, small mammals may simply prefer certain areas which the deer avoid, assuming that "good" and "poor" mean "little used" and "much used" by deer. Whatever the reasons, there were differences in small mammal numbers caught between "good" and "poor" browse areas. This would indicate that both the investigator and the small mammals are reacting to certain differences although these differences may not be the same in both cases.

CONCLUSIONS

1. According to an ocular estimate, a difference in the amount of available browse in the areas was present. This difference was due to previous browsing by deer and also to the degree of self-pruning.

2. Catches of small mammals differed significantly between "good" and "poor" browse areas according to results of statistical analysis using a combined error term. More small mammals were caught consistantly in areas classified as containing "good" browse.

3. Features of the vegetation, as analysed, failed to show an obvious correlation with catch of small mammals. This could well have been due to very inadequate sampling of both vegetation and small mammal populations.

4. The variability in catch on various trap lines was large. A large number of trap lines would be necessary to determine anything less than major population differences in various browse conditions.

APPENDIX A

ANIMALS CAUGHT IN TRAPS

Note: Numbers in parenthesis behind common names indicate numbers of each species caught.

Note: Common and scientific names of mammals are listed according to Burt (1946); those of birds are according to Peterson (1947); and those of amphibians according to Pope (1947).

Common Name	Scientific Name
Red-backed vole (6)	Clethrionomys gapperi
Deer mouse (7)	Peromyscus maniculatus
White-footed mouse (4)	Peromyscus leucopus
Short-tailed shrew (12)	Blarina brevicauda
Water shrew (4)	Sorex palustris
Masked shrew (10)	Sorex cinereus
Northern flying squirrel (5)	Glaucomys sabrinus
Red squirrel (1)	Tamiasciurus hudsonicus
Olive-backed thrush (1)	Hylocichla ustulata
Wood frog	Rana sylvatica
Bull frog	Rana catesbeiana
Green frog	Rana clamitans
Leopard frog	Rana pipiens
Pickerel frog	Rana palustris

APPENDIX B

VEGETATION PRESENCE LIST

Note: Common and scientific names of all vegetation are listed according to Robinson and Fernald (1938) unless otherwise noted.

Tree Plots

Common Name	Scientific Name
Ash, black	Fraxinus nigra
Alder, speckled	Alnus incana
Aspen, trembling	Populus tremuloides
Birch, white	Betula alba
Birch, yellow	Betula lutea
Cherry, pin	Prunus pennsylvanica
Cedar, Northern White	Thuja occidentalis
Dogwood	Cornus spp.
Elm, American	Ulnus americana
Fir, balsam	Abies balsamea
Hemlock, Eastern	Tsuga canadensis
Maple, red	Acer rubrum
Maple, silver	Acer saccharinum
Oak, Northern Red	Quercus rubra var. borealis
Pine, red	Pinus resinosa
Pine, white	Pinus strobus

APPENDIX B (continued)

Common Name	Scientific Name
Serviceberry	*Amelanchier canadensis*
Spruce, black	*Picea mariana*
Tamarack	*Larix laricina*

Shrub Plots

Alder, speckeled	*Alnus incana*
Balsam fir	*Abies balsamea*
Black spruce	*Picea mariana*
Black ash	*Fraxinus nigra*
Gray dogwood	*Cornus paniculata*
Leatherleaf	*Chamaedaphne calyculata*
Mountain holly	*Nemopanthus mucronata*
Northern red oak	*Quercus rubra* var. *borealis*
Nine bark	*Physocarpus opulifolius*
Red maple	*Acer rubrum*
Red dogwood	*Cornus stolonifera*
Ribes	*Ribes* spp.
Serviceberry	*Amelanchier canadensis*
Tamarack	*Larix laricina*
Vaccinium	*Vaccinium* spp.
Wild raisin	*Viburnum cassinoides*
White birch	*Betula alba*
Willow	*Salix* spp.

APPENDIX B (continued)

Herb Plots

Scientific Names

Aster spp.

Abies balsamea

Amphicarpa bracteata

Acer rubrum

Aralia udicoides

Calamagrostis canadensis

Chenopodium album

Coptis trifolia

Cornus canadensis

Clintonia borealis

Chamaedaphne calyculata

Cornus paniculata

Caltha palustris

Chiogenes hispidula

Dryopteris felix-mas

Ergeron spp.

Euphorbia spp.

Eupatorium maculatum

Galium trifidum

Heterophyllium Holdanianum (b) (Grev.)

Lycopodium spp.

Ledum groenlandicum

Mnium rostratum Schrad.

Mnium punetatum L.

Mitchella repans

Maianthemum canadense

Menopanthus mucronata

Onoclea sensibilis

Oxalis Acetosella

Osmunda regalis

Osmunda cinnamomea

Ptilum crista castrensis L.

Pteridium aquilinum

Pleurozium Schreberi (Brid.) Mitt.

Populus tremuloides

Polygonum spp. ?

Pyrola minor

Rubus pubescens

Ribes lacustre

Ribes spp. ?

Solidago rugosa

Symphoricarpos alba

APPENDIX B (continued)

Scientific Names

Spirea spp. ?

Spartina Michauxiana

Spiranthes lucida

Sphagnum spp.

Smilacina trifolia

Trientalis americana

Tetraphis pellucida Hedw.

Thuja occidentalis

Thalictrium polygamum

Viola spp.

Viburnum spp.

Viburnum cassinoides

Note: Three species were not identified.

APPENDIX C

FOOD LIST FOR PEROMYSCUS

(Based on stomach analysis, cheek pouches, and catches; compiled by Hamilton, 1941.)

Taxus canadensis

Clintonia borealis

Maianthemum canadense

Polygonum spp.

Corylus americana

Fagus grandifolia

Ribes americanum

Fragaria virginiana

Rosa spp.

Prunus virginiana

Ilex verticillata

Cornus panniculata

Fraxinus americana

Mitchelia repans

Sambucus spp.

Tsuga canadensis

Smilicina racemosa

Medeola virginica

Carya ovata

Ostrya virginiana

Caulophyllum thalictrium

Amelanchier spp.

Rubus spp.

Prunus pennsylvanica

Prunus serotina

Impatiens spp.

Vaccinium canadense

Solanium spp.

Viburnum spp.

Aster spp.

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