A STUDY OF THE WINTER RELATIONSHIPS OF THE SNOWSHOE HARE, *LEPUS AMERICANUS VIRGINIANUS* HARLAN, TO THE HARVARD FOREST

by

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Fig. 1. A form among the pruned branches of a twenty-five-year-old red pine plantation

Fig. 2. Form on the south side of a ten-inch hemlock in a seventy-year pine-hemlock-hardwood stand

INTRODUCTION

There can be little doubt in the minds of those who are familiar with the habits of our wildlife that the environmental factors are so varied over the range of practically any animal as to profoundly change the habits and well-being of the species in question. It is quite evident, then, that a study of a species in one part of its range will not suffice if we are to get a complete picture of the life history and habits throughout its range.

Nearly all of the previous work on the snowshoe hare, Lepus americanus, has been carried on with the sub-species, L. americanus phaenotus Allen, in Wisconsin and the Province of Manitoba, and with the type species L. americanus americanus Erxleben in central and northern Canada.

The State of Massachusetts and adjacent Connecticut represent the southern part of the range of the sub-species, L. americanus virginianus. The many wooded sections with their subordinate cover of shrubby species in these states, especially in Massachusetts, provide ideal local habitats for the snowshoe hare. The cyclic behavior of these animals plus a heavy mortality from hunting have reduced their numbers in this region far below the carrying capacity of the land.

Since the species is classed as one of the important game species in this section, many feel that some form of management is necessary to restore the snowshoe hare in suitable numbers.

Research on the life history and habits of the snowshoe in this region has been lacking. This study, then, seemed particularly desirable as well as timely.

HISTORY AND DESCRIPTION OF THE REGION

The study was conducted during the winter of 1937-38 in the Harvard Forest located in the Town of Petersham, Massachusetts, which is in the northern part of Worcester County. This region is a part of the transition forest zone, a term describing the overlapping of the northern forest as represented by such species as beech, *Fagus grandifolia*, birch, *Betula lutea* and *B. papyrifera*, and hard maple, *Acer saccharum*, and the central hardwood forests to the south in which species of oak, *Quercus* spp., and hickory, *Carya* spp., dominate.

The original climax forest of Petersham consisted largely of hemlock, *Tsuga canadensis*, and hardwood with an interspersion of white pine, *Pinus strobus*. Between the years of 1700 and 1830 this forest was cut and from 65 to 75 percent of the land was cleared for farming. Such a picture, however, was not destined to remain for long. The opening up of the more fertile lands to the west led to abandonment of many of the farms, leaving fields and pastures to seed in and grow up with pure stands of white pine. These stands were logged off upon reaching maturity, thereby giving rise to a flourishing lumber industry the peak of which was reached in 1909.

Following the removal of the white pine there followed a succession of hardwood species, the first crop of which has been largely cut off leaving a few good stands of hardwood sawtimber and many stands of hardwood sprout origin. That is the picture of the forests here today--stands dominated by poor quality hardwoods with a relatively small percentage of white pine and hardwoods

of sawtimber size and value.

Although located in this region, the stands in the Harvard Forest differ from those in the surrounding state and private holdings in that intensive silvicultural practices and plantings have greatly modified the forest that existed at the time of acquisition in 1907. Accordingly we find here, in addition to the natural stands characteristic of the region, numerous softwood and mixed hardwood-softwood plantations varying in age from 1 to 25 years. In addition, the presence of an abundance of shrubby species assists in providing a good environment for several game species, especially white-tailed deer, ruffed grouse, cottontail rabbits, and snowshoe hares.

CLIMATIC CONDITIONS DURING THE STUDY

The winter of 1937-38 was an unusually mild one for central Massachusetts. Although temperatures were below freezing for several weeks in midwinter, they remained above normal for this region. Ordinarily the snowfall from November to March averages around 52 inches in the Town of Petersham. A total depth of 12 inches of snow was recorded at the Forest in January. This was removed by a heavy rain during the later part of the month. Throughout the remainder of the winter only occasional snowfalls occurred, and at no time was there a depth of snow over 6 inches.

Since climatic conditions may affect either directly or indirectly the habits of an animal, it is important that the type of winter encountered during this study be kept in mind when considering this study.

MISCELLANEOUS LIFE HISTORY NOTES

Live Trapping, Traps, and Bait:

The snowshoe hare had previously been found in the Forest only in swampy and laurel-grown areas which were particularly suitable in that they contained in abundance the two principal factors limiting distribution of the species, namely, food and cover. In selecting the study area the largest possible amount of optimum habitat was included.[1] This area, including a good sized spruce swamp, was in compartment II of the Prospect Hill block in the Harvard Forest (see maps).

Fifteen wooden box traps were used to cover the area in order to study the population, movements, weights, etc. (see map No. 1). These traps were designed with a sliding trap door which was released by means of a wire attached to the front end of a flat board pivoted on the floor of the trap. It may be well to state at this point that this type of trap was not found entirely satisfactory, the chief objection being that ice formed on the slide and on the door preventing it from closing. Except in freezing weather they were found to be quite satisfactory.

Preliminary to setting out the traps the hares were baited with apples and carrots to get them accustomed to the bait and to get a general idea of the places at which they were most concentrated. From this preliminary work it was quite evident that apples were definitely preferred to carrots. With the latter it often required several days before they would be eaten at all even when placed with the apples. Even then they were not, as a rule, all taken. On the other hand, the apples were hardly ever

allowed to remain over a day.

As the study progressed and freezing weather arrived, it became evident that apples were no longer satisfactory as a bait for the traps. Having become frozen they seemed to lose all their attraction for the hares. Alfalfa hay was then tried and proved successful as long as the snow was deep enough to cover the low-growing evergreen plants, especially wintergreen, Gaultheria procumbens. However, alfalfa proved worthless after the snow had disappeared, or nearly so. Apples were again used in the spring and the results definitely proved their value in attracting the snowshoes, as well as cottontails and porcupines, to the traps.

Sex Ratio, Weight, Etc.:

Table 1 on page 7 is a trapping record of all the hares caught during the study. The number, identification mark, sex, weight, and condition of each snowshoe on the day it was first trapped are tabulated in this table. The complete trapping record appears in table 2, pages 8 and 9.

In analyzing these results it became evident that no statement could be made regarding sex ratio since the number of snowshoes caught and examined for sex was far too small to be significant. However, it so happened that there was a male: female ratio of 56:44. Leopold (1933) gave the sex ratio of rabbits at birth as 51:49. MacLulich (1937) found the ratio to be 47:53 as based on 269 adult hares examined during his study.

Table I

RECORD OF HARES TRAPPED DURING THE STUDY

Date animal was first trapped	Number	Mark*	Sex	Weight	Condition	Remarks
12/8/37	1	o--R. ear, side	Male		Good	Found dead on 12/7--result of exposure to rain while in trap.
12/10/37	2		Female		Good	Died on 12/11 from injury received in trap.
12/12/37	3	o--R. ear, side o--L. ear, tip	Male	1512 g.	Good	
1/6/38	4	o--L. ear, side	Female	1580 g.	Good	
1/8/38	5		Male		Good	Found dead in trap--cause unknown.
1/11/38	6	o--R. ear, tip	Female	1800 g.	Good	
1/20/38	7	o--L. ear, side o--L. ear, tip	Female	1109 g.	Good	
1/24/38	8	o--R. ear, side o--R. ear, tip	Male	1301 g.	Good	
2/2/38	9	o--R. ear, tip o--L. ear, tip	Female	1442 g.	Good	
2/19/38	10	o--R. ear, side o--L. ear, side	Male	1392 g.	Good	
2/23/38	11	o--L. ear, tip o--R. ear, side o--R. ear, tip	Male	1369 g.	Good	
3/11/38	12	o--R. ear, side	Male	1497 g.	Good	
3/22/38	13	o--R. ear, tip o--R. ear, tip	Male	1475 g.	Good	
4/4/38	14	o--L. ear, tip o--L. ear, tip	Female	1604 g.	Good	

4/5/38	15	o--L. ear, tip o--L. ear, tip o--L. ear, side	Male	1503 g.	Good
4/13/38	16	o--R. ear, tip o--R. ear, tip o--R. ear, side	Female	1849 g.	Good

* o - small hole approximately 1 mm. in diameter made with a punch in the ear.

Table II

TRAPPING RECORD

Date	Trap number 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
11/27/37															
28															
29															
30															
12/1/37															
2		#1													
3															
4							#1								
5					#1										
6					#1										
7						#1									
8															
9															
10					#2										
11															
12		#3													
20															
21															
22															
1/ 1/38															
2															
3															
4															
5					#3										
6										#4					
7															
8						#5									
9				#3											
10															
11									#6						
12															
13															
14				#3											
15															
16									#3						
17	#3														
18								#4							
19			#6												
20						#3					#7				
21															
22										#7					
23															
24											#8				
25															
26															
27			#4												
28															
29			#3												
30															
31															

Table II (Cont.)

Date	Trap number 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
2/ 1/38															
2					#9	#3									
3			#3												
4															
5															
6															
7															
8															
9															
10															
15															
16															
17															
18															
19															#10
20															
21															
22							#3								
23												#11			
24															
25															
26															
27						#3									
28															
3/ 1/38															
2															
3															
4															
5															
6					#3										
7															
8															
9															
10															
11						#12									
12						# 3									
13					#3										
22							#13								
23						#3									
4/4 / 38					#3	#14									
5					#6	# 3					#15				
6					#3	#14									
13													#16		
14					#14				#6						#13
15									#3						
16					#3	#1	#12		#13			#15			
5/24/38						#12									
25											#15				
26					#4	# 6									
27					#3										

The weights recorded in table I are for the date the snowshoes were first trapped. Those retrapped later in the study were weighed at intervals, and the changes in weight are noted in table III.

Table III

SEASONAL CHANGES IN WEIGHT OF HARES

Animal Snowshoe Number	Sex	Weight on day first trapped Weight	Date	Weight for each date hare was retrapped Weight	Date	Change in weight from day the hare was first trapped
3	Male	1512 g.	12/12/37			
3				1412 g.	1/16/38	- 100 g.
3				1559 g.	2/22/38	+ 47 g.
3				1503 g.	3/ 6/38	- 9 g.
3				1575 g.	4/ 4/38	+ 63 g.
3				1583 g.	5/27/38	+ 71 g.
6	Female	1800 g.	1/11/38			
6				1967 g.	4/ 5/38	+ 167 g.*
6				2177 g.	5/26/38	+ 377 g.*
10	Male	1392 g.	2/19/38			
10				1285 g.	3/13/38	- 107 g.
12	Male	1497 g.	3/11/38			
12				1270 g.	4/16/38	- 227 g.
13	Male	1475 g.	3/22/38			
13				1501 g.	4/16/38	+ 26 g.
15	Male	1503 g.	4/ 5/38			
15				1493 g.	5/25/38	- 10 g.

* Due to pregnancy

The number of observations here is too limited to permit more than a brief discussion. The large increase in weight of hare No. 6 was due to its being pregnant. Hare No. 3, from which the best data were obtained, lost weight during the fore part of January when the coldest part of the winter occurred. By April it had gained in weight to surpass that when weighed on December 12.

The reason for the loss of 107 grams of weight in early spring by snowshoe No. 10 and the loss of 22.7 grams by hare No. 12 is not known. Perhaps it was influenced by the breeding season, although hare No. 3, after suffering a slight loss in weight on March 6, gained weight during this same period.

The weights of snowshoes Nos. 13 and 15 were all obtained from late March until the last of May; hence the small variation on the second time they were weighed merely points to their maintaining a fairly constant weight during the spring.

Pelage Changes:

Observations on this particular subject were incidental to the principal objectives. For a treatise on pelage changes the reader is referred to the work of Grange (1932). To describe the coloration of the animals trapped in this study the classification given by Aldous (1937) (brown, brown-white, white-brown, and white) was used. On this basis, and taking into account all observations made during the study, the following table has been prepared.

Table IV

PELAGE CHANGES IN THE SNOWSHOE HARE

Date	Color phase	Number of observations upon which color phase was based
12/2	Brown-white	2
12/12	White-brown	6
1/6	White	2
1/20	White	10
3/10	White	12
3/20	White-brown	3
4/4	Brown-white	4
4/16	Brown-white	14
5/27	Brown*	5

* Belly showed a little white fur

The dates of change given coincide very closely with those noted in the sub-species phaenotus by Aldous (1937) who found that the fall change occurred between mid-October and the last of November, and that the spring change came between mid-March and the first of May. Grange (1932) reported the change from summer pelage to that of snow white in winter to take place in northern Wisconsin from late November until the later part of December.

Breeding Season:

According to Aldous (1937) there was a marked increase in the size of the testes by the last of February, and in March they had reached maximum size. By April they were fully descended into the scrotum and remained so through May and June, starting to decrease in size during July. Criddle (1938) noted the increase in size of the testes to take place by the middle of March, followed by mating two or three weeks later.

In this study the first observation of gonadal enlargement in males was made on February 22. The testes in this animal had descended into the scrotum and had nearly reached maximum size. Observations from this date until the last of May showed all males to have reached the maximum of enlargement by approximately March 15. It seems logical, therefore, that the first mating period in the latitude of central Massachusetts may occur during the last two weeks of March or, in other words, from two to three weeks earlier than with snowshoe hares in the more northern latitudes.

Migration:

The only opportunity to study local migration was during late winter and early spring when it was noted from trapping records (see table II) that three snowshoes, Nos. 12, 13, and 14, had moved into the spruce swamp and immediate vicinity. Judging from the number of times they were retrapped in this area, they settled down here and apparently considered it their home range. This migration took place largely during March, extending possibly into the first week of April.

Criddle (1938) working in Manitoba noted two distinct periods of migration. The first of these took place from mid-February until the first week in April, and the second from October until well into December.

Forms:

From all reports it appears that snowshoes use forms* of one kind or another during inclement weather and in the day time when they are inactive. MacLulich (1937) found that, "In winter tracks showed that hares entered the numerous holes in the snow beside stumps, fallen trees, bent-over alder branches, low balsam or spruce branches, and even, rarely, a hole in bare, smooth snow." Criddle (1938) stated that the hares dig holes in deep snow. Such holes were usually found among tangled scrub which had partly held up the snow. In this study only one similar instance was seen. A snowshoe had dug a hole through the snow matted on low, spreading branches of a small Norway spruce and had used the depression under these branches for shelter. The observations of Grange (1932) and Aldous (1937) are essentially the same as those previously mentioned; that hares use a form which is usually sheltered in some way although it may occasionally be located in fairly open situations.

Figure 1 is a photograph of a form located among pruned branches of a 25-year-old red pine plantation. Figure 2 shows a form found in a 75-year-old pine-hemlock-hardwood stand.

* Here used to designate only the special definitely located resting places repeatedly used by the animals.

From observations made during the winter it was evident that the low-hanging branches of young coniferous trees in the plantations afforded the most desirable sites for the location of the forms. In the spruce swamp fallen logs, up-turned roots of fallen trees, etc. also afforded desirable locations under which a form might be located.

Hares do not use the same form day after day, but seem to have several located about their range which they may use. On the other hand, numerous instances were observed in which they spent a considerable amount of time simply sitting beside tree trunks, on small hummocks, etc.

Water Requirements:

Grange (1932) observed captive hares to drink water freely. Seton (1929) stated that to his knowledge adults never drink anything. From a limited number of observations during the present study it is believed that snow furnishes what water the hares need during winter. This statement is made after having observed several hares take a few mouthfuls of snow upon being released from a trap. Although one spot in the spruce swamp, and inside the daily range of several hares, contained water which remained unfrozen throughout the winter, no tracks were seen around it which would indicate their having come there for water.

Nocturnal Habits:

It is thought by observers that hares are inactive during the day, coming out in the evening for their frolicking and food-getting. MacLulich (1937) noted a decided decrease in activity of the hares after about 11 or 12 o'clock at night followed by a small increase in the early morning.

To observe the time of night activity of the animals it was necessary to make trips through the study area following a snowfall. On February 20 and 21 one trip each night was made around and through the study area on trails and paths located so as to give a good representation of the activity of the hares. These two trips were made from 10:30 to 11:30 p.m. From the number of tracks encountered it was evident that there had been approximately the same amount of activity before this hour as there was from then until morning as shown by the number of new tracks found early the following mornings. This did not, however, give any indication whether or not there were periods of inactivity during early evening and early morning. Therefore, it was decided to make several trips through the study area during the night. Fig. 5 is a presentation of the results of four trips made through the area during the night of March 1-2. This night's investigation in fair weather showed that, with the exception of the short periods of time the snowshoes took for what we may assume to be a rest, the activity was continuous from dusk until dawn.

It may be of interest to mention an incident from tracking observations as noted on December 9. Upon tracking a

hare following a snowfall of 2 inches during the previous night, the animal was suddenly driven from a form beside a log. This occurred at 9:00 a.m. No attempt was made to follow it until 4:00 p.m. The tracks led into the spruce swamp for a distance of approximately 150 yards. Doubling back for some distance the tracks led into the pine-hemlock-hardwood type for a distance of nearly 50 yards. Here the animal was scared from its form after waiting until approached within 20 feet. This incident merely substantiates the observations and conclusions of others that hares are inactive during the day.

General Notes:

In accord with the investigations of previous writers, the hares encountered in this study showed very little inclination, if any, to move about during a storm. There was, though, a restricted movement at times when only a relatively small amount of snow fell or where the snow did not fall very fast, that is, storms characterized by snow flurries. During the heavier snowfalls they appeared to use their forms and the protection afforded by the young, dense coniferous plantations.

Tracking observations revealed that the hares rested for short intervals upon small hummocks, up-turned trees, etc. This was evidenced by the snow being packed down and more or less melted on such spots.

It has been thought that the droppings of the cottontail rabbit could be differentiated from those of the snowshoe in that

p. 18 fig. 5

Relocated to page 16

the former are of a smaller size and, instead of being compressed like those of the snowshoe, are nearly round. During this study there were occasions when a marked similarity was noticed between the two. As a rule the droppings of the snowshoe were quite consistent in size, being rather large and more or less compressed. Those of the cottontail were more variable, and in a good many observations were found to be practically identical with those of the snowshoe. Throughout the winter, droppings from both animals were collected as they were caught in the traps. A representative sample was taken from each collection and photographed (see figs. 3 and 4, page).

It was found that 120 acres comprised the winter range of all the hares trapped during this study. The figure is equal to a population of one snowshoe to 7.5 acres.

FOOD HABITS

Upon examining the various papers on the food habits of the snowshoe hare one finds that a wide variety of foods were taken; in fact, even preferred foods vary a good deal in different localities. Grange (1932), working in Wisconsin, found that hares (L. americanus phaenotus) have a special fondness for various species of aspen, and in addition were found to browse about coniferous trees eating ends of low-hanging branches. From nine stomachs analyzed by the U. S. Biological Survey, Aldous (1936) reported the contents to be composed almost entirely of Salix and Betula twigs, bark, and buds. From southern Manitoba Criddle (1938) has listed as the dominant and preferred species aspen, Populus tremuloides, with Bur oak, Quercus macrocarpa, a close second. Shrubby species which were preferred were hazelnut, Corylus spp., bog birch, Betula glandulosa, wolf willow, Elaeagnus argentea, rose, Rosa spp., all the different kinds of willows, Salix spp., and most of the less common shrubs were eaten to a certain extent.

At first one might well conclude the hardwood species to be of prime importance. Such, however, is not necessarily the case for Criddle (1938) has found that in the mixed forests of northern Canada the white spruce, Picea canadensis, is fed upon nearly as largely as poplar. Notes from the Lake States Forest Experiment Station (1936) state that in addition to the preferred deciduous species--young aspen, willows, and birches--hares have a decided preference for jack pine, white pine, and tamarack.

The study area in the Harvard Forest provided an abundance

of both coniferous and deciduous food species. Thus was provided an ideal set-up for a study of the food preferences of the snowshoe hare.

Data were gathered and compiled under two headings: 1. General food habits; 2. Food habits of individual hares for a 24-hour period. The reason for making such a division was to determine the volume of food normally taken by an adult hare during one day.

In the field the process of collecting data resolved itself into following tracks and runways in the snow and collecting the stub ends of twigs with the petioles of leaves, the missing portions of which had been eaten by the snowshoes. These twig ends were then compared with similar specimens of the same species and diameter which were measured for length. These data appear in table V, pages 22-31. A volume table for cylinders of different diameters and lengths was prepared from which the volume of the twigs was obtained (see table VI, pages 32-40). For the coniferous species 25 twig ends for each 10 mm. length class and 100 leaves for the dicotyledonous evergreens constituted the basis from which the volumes were obtained. The method employed here was to immerse the twigs and leaves in water, noting the amount of displacement in a graduate cylinder. The volumes were then calculated from this displacement figure (see table VII, page 41).

There can be no question that food habits of animals are largely dependent upon what is available. Preferred species may often be far in the minority. Therefore one cannot select from food habits data such as appear in table V, pages 22-31, of

Table V

GENERAL FOOD HABITS *

Compartment: Prospect Hill II
Types: P-1, P-Hm-Hd-3, and Sp-1

Harvard Forest
November 22, 1937

Species	Av. Dia. of Twig	Length of Twig	Volume of Twig
Ive	2.5 mm.	155 mm.	761 cu.mm.
	2.5	220	1080
	2.0	90	283
	2.5	285	1399
	2.0	80	251
	1.5	105	186
	2.0	165	518
	1.5	60	106
	1.5	55	97
Tca	Twig end	105	485
		85	370
		45	180
Aru	2.0	65	204
	1.5	40	70
	2.0	60	188
	2.5	125	393
	1.5	115	203
	1.5	85	150
	2.5	160	785
	2.0	60	188
	2.0	120	377
	2.0	135	424
	1.5	90	159
	1.5	65	115
Gpr	42 leaves	(42 x 170)	7140
	1.0	235 (total)	184
Vca	1.5	45	79
	2.0	60	188
	2.5	75	366
	1.5	60	106
	1.5	50	88
	2.0	55	173
Vco	2.5	245	1203
	1.5	100	177
	2.0	140	440
	2.0	75	236
	1.5	45	79
	1.5	35	61
	2.0	80	251
	1.0	65	51
Dlo	2.0	295	927
	1.5	105	186
Qal	1.5 mm.	30 mm.	52 cu.mm.
	1.0	20	16
	2.5	130	638
	1.5	60	106
Kan	1.0	35	27
	12 leaves	(12 x 115)	1380
Cde	2.5	210	1031
	2.5	190	933
Lli	1.5	65	115
	1.5	110	194
	1.0	40	31
	1.5	95	168

* Food habits of one or several hares over a period of from one to approximately five or six days

Table V (Cont.)

Compartment: Prospect Hill II
Type: Sp-1

Harvard Forest
January 3, 1938

Species	Av. Dia. of Twig	Length of Twig	Volume of Twig
Ive	2.0 mm.	200 mm.	628 cu.mm.
	1.5	145	256
	1.5	110	194
	1.0	15	12
	1.0	20	16
	1.5	150	265
	2.0	290	911
	2.0	190	597
	1.5	135	239
	1.5	115	203
	1.5	60	106
	1.5	155	274
	2.5	440	2160
	1.5	190	336
	1.5	160	283
	1.5	110	194
	2.0	210	660
	2.5	520	2552
	1.5	175	309
	1.5	135	329
	1.0	85	67
Vca	1.0	160	126
	1.5	230	406
	1.0	70	55
	1.0	100	79
Ain	4.5	630	10020
	2.0	60	188
	2.5	320	1571
Nmu	1.5	115	203
Tca	Twig end	15	60
		20	80
		75	315
		40	160
		30	120
		15	60
		15	60
		10	40
		105	485
		45	180
		20	80
		35	140
		40	160

Species	Av. Dia. of Twig	Length of Twig	Volume of Twig
Pru	Twig end	65 mm.	525 cu.mm.
		85	710
		30	240
		15	120
		60	480
		45	360
		50	400
		65	525
		45	360
		60	480
		15	120
		20	160
		30	240
		50	400
		15	120
		20	160
		10	80
		70	570
		40	320
		30	240
		10	80
		20	160
		35	280
		15	120
		10	80
		10	80
		15	120
		15	120
		65	525
		25	200
		15	120

Table V (Cont.)

Harvard Forest
January 4, 1938

Compartment: Prospect Hill II
Types: Mx-Sd-8 and Mx-Sd-9

Species	Av. Dia. of Twig	Length of Twig	Volume of Twig
Pab	Twig end	40 mm.	500 cu.mm.
		35	460
		55	665
		45	555
		60	720
		40	500
		30	420
		55	665
		50	610
		15	300
		60	720
		35	460
		55	665
		35	460
		25	380
		45	555
		20	340
		25	380
		80	1080
		35	460
		40	500
		55	665
		20	340
		40	500
		45	555
		10	170
		15	300
		30	420
		30	420
		45	555
		40	500
		35	460
		50	610
		60	720
		15	300
		50	610
		35	460
		40	500
		35	460
		50	610
		30	420
		45	555
		40	500
		35	460
		25	380
		35	460
		60	720
		90	1290

Species	Av. Dia. of Twig	Length of Twig	Volume of Twig
Pab	Twig end	80 mm.	1080 cu.mm.
		60	720
		40	500
		65	810
		55	665
		20	340
		50	610
		60	720
		55	665
		35	460
		50	610
		70	900
		55	665
		40	500
		30	420
		45	555
		55	665
		75	990
		80	1080
		110	1670
		95	1395
		50	610
		45	555
		20	340
		15	300
		40	500
		30	420
		60	720
		35	460
		40	500
		35	460
		60	720
		90	1290
		30	420
		45	555
		70	900
		40	500
		55	665
		40	500
Aru	2.0 mm.	70	220
	1.5	40	70
	1.5	45	79
	2.0	65	204
	1.5	25	44
	2.5	180	884
	2.5	155	761
	1.5	55	97
	1.5	40	70

Table V (Cont.)

Compartment: Prospect Hill II
Types: Mx-Sd-8 and Mx-Sd-9

Harvard Forest
January 4, 1938

Species	Av. Dia. of Twig	Length of Twig	Volume of Twig	Species	Av. Dia. of Twig	Length of Twig	Volume of Twig
Vpe	1.5 mm.	150 mm.	265 cu.mm.	Vpe	1.0 mm.	25 mm.	20 cu.mm.
	1.0	45	35		1.0	20	16
	1.0	50	39		1.5	45	79
	0.5	15	3		1.0	20	16
	1.0	20	16		1.0	25	20
	1.0	35	27		0.5	20	4
	1.0	25	20		0.5	15	3
	1.0	20	16		1.0	25	20
	1.0	35	27		1.5	60	106
	1.0	25	20		1.0	30	24
	1.0	40	31		1.0	25	20
	1.0	30	24		0.5	20	4
	1.0	35	27		0.5	10	2
	1.0	30	24		1.0	40	31
	0.5	15	3		1.0	30	24
	0.5	25	5		0.5	10	2
	1.0	25	20		2.0	95	299
	1.5	30	52		1.5	60	106
	1.0	30	24		1.5	40	70
	1.0	20	16		1.0	30	24
	0.5	10	2		1.0	40	31
	0.5	15	3		1.0	20	16
	0.5	20	4		1.0	35	27
	1.5	35	61		0.5	15	3
	1.0	30	24		0.5	20	4
	1.0	25	20		0.5	10	2
	1.5	45	79		0.5	15	3
	0.5	10	2		2.0	85	267
	0.5	20	4		1.5	65	115
	0.5	20	4		1.5	50	88
	0.5	15	3		1.0	40	31
	1.0	35	27		1.0	30	24
	1.5	45	79		1.0	30	24
	1.0	35	27		0.5	20	4
	1.0	30	24		0.5	15	3
	0.5	15	3		0.5	15	3
	0.5	10	2	Csp	1.5	80	141
	2.0	65	204		1.0	15	12
	1.5	70	124		1.0	10	8
	1.5	60	106		2.0	280	880
	1.0	30	24		1.5	110	194
	1.0	45	35	Bpo	1.5	210	371
	1.0	35	27		1.5	285	503
	0.5	15	3		1.5	170	300
	0.5	15	3		1.5	110	194
	0.5	10	2		1.0	40	31
	0.5	10	2		1.5	70	124

Table v (Cont.)

Compartment: Prospect Hill II
Types: Mx-Sd-8 and Mx-Sd-9

Harvard Forest
January 4, 1938

Species	Av. Dia. of Twig	Length of Twig	Volume of Twig
Qru	3.5 mm.	330 mm.	3175 cu.mm.
	4.0	390	4901
	3.0	265	1873
	2.5	310	1522
	2.5	215	1065
	2.5	230	1129
	2.0	115	361
	1.5	60	106
Dlo	1.5	45	79
Fpe	2.5	265	1301
	2.5	170	834
	1.5	60	106
	1.5	45	79
	2.5	270	1325
	1.5	55	97
	1.0	30	24
	1.0	25	20
Sla	2.0	235	738
	1.5	115	203
	1.0	70	55
	1.0	55	43
	1.0	45	35
	1.0	40	31
	1.0	30	24
	0.5	15	3
	0.5	20	4
	0.5	20	4
	1.0	35	27
	3.0	410	2898
	1.0	190	149
	1.0	65	51
	1.0	30	24
	0.5	15	3
Pse	1.5	190	336
	1.0	105	82
	1.0	55	43
	1.5	165	292
	1.5	80	141
Ame	1.5	135	239
Bsp	2.5	290	1424
	1.5	95	168
	1.5	70	124
	1.5	40	70
Gpr	265 leaves	(265x170)	45050
	1.0	1300 (total)	1021

Table V (Cont.)

Compartment: Prospect Hill VII
Type: Mx-Sd-2

Harvard Forest
February 1, 1938

Species	Av. Dia. of Twig	Length of Twig	Volume of Twig
Aru	1.5 mm.	100 mm.	177 cu.mm.
	1.5	60	106
	2.0	145	455
	1.5	75	132
	2.0	190	597
	2.5	215	1055
	2.0	20	63
	2.0	25	78
	1.5	95	168
	2.0	170	534
	1.5	65	114
	1.5	90	159
	1.5	70	124
	1.0	30	24
	2.5	275	1340
	2.5	70	344
	1.5	55	97
	2.5	170	834
	1.5	60	106
	1.5	70	124
	1.5	70	124
	2.5	120	589
	1.5	55	97
	1.5	40	70
	1.5	60	106
	1.5	75	133
	2.0	85	267
	1.5	70	124
	1.5	65	115
	1.5	30	53
	2.0	60	189
	1.5	90	159
	1.5	60	106
	1.5	70	124
	1.5	65	115
	1.5	40	70
	1.5	60	106
	1.5	60	106
	2.0	70	220
	1.5	55	97
	2.0	70	220
	1.5	20	36
	2.5	95	466
	2.5	220	1080
	1.5	40	70
	1.5	50	88
	1.5	45	79
	2.0	85	267

Species	Av. Dia. of Twig	Length of Twig	Volume of Twig
Aru	1.5 mm.	40 mm.	70 cu.mm.
	3.0	290	2050
	2.0	110	346
	2.0	90	283
	1.5	70	124
	1.5	55	97
	2.5	170	834
	1.5	40	70
	2.5	180	884
	1.5	30	52
Vca	9.0	55	3495
	2.0	30	94
	2.0	40	126
	4.0	280	3518
	2.0	120	377
	1.5	75	133
	1.5	85	150
	2.0	110	346
	1.0	40	31
	1.0	35	27
	2.0	110	346
	1.5	50	88
	1.5	75	133
	2.0	210	660
	2.5	250	1227
	3.0	330	2333
	1.5	40	70
	2.0	95	299
	1.5	60	106
Cde	2.0	120	377
	2.5	200	982
	2.0	145	455
	1.5	60	106
	1.5	40	70
	2.0	170	534
	2.5	190	933
	1.5	50	88
	2.0	135	424
	2.0	170	534
	2.5	235	1154
	2.0	130	408
	1.5	90	159
	1.5	65	115
	1.5	55	97
	1.5	45	79
Vpe	2.0	70	220
	2.0	80	251
	1.5	60	106

Table V (Cont.)

Compartment: Prospect Hill VII
Type: Mx-Sd-2

Harvard Forest
February 1, 1938

Species	Av. Dia. of Twig	Length of Twig	Volume of Twig
Vpe	1.5 mm.	50 mm.	88 cu.mm.
	1.5	55	97
	1.5	45	79
	1.5	40	70
	2.0	75	236
	1.5	40	70
	1.5	60	106
	1.5	30	52
	1.5	55	97
	2.0	65	204
	2.0	90	283
	1.0	30	24
	1.0	40	31
	1.5	40	70
	1.5	45	79
	1.5	40	70
	1.5	60	106
	2.0	90	283
	1.5	45	79
	2.0	70	220
	2.0	60	188
	2.5	180	884
	1.5	70	124
	1.5	75	133
	1.5	60	106
	1.5	75	133
	1.5	60	106
	1.5	60	88
	1.5	65	115
	2.5	140	687
	1.5	50	88
	2.0	75	236
	1.5	40	70
	1.5	50	88
	1.0	10	8
	1.0	15	12
	1.0	20	16
	1.5	30	52
	1.5	50	88
	2.0	65	204
	2.0	70	220
	1.0	35	27
	1.0	35	27
	1.5	50	88
	1.5	95	168
	1.5	50	88
	1.5	55	97
	2.0	70	220
Vpe	1.0 mm.	30 mm.	24 cu.mm.
	2.0	90	283
	1.5	60	106
	1.5	45	79
	1.0	25	20
	1.0	30	24
	1.0	40	31
	1.5	40	70
	1.5	45	79
	1.5	60	106
	1.0	35	27
	1.5	85	150
	1.5	85	150
	2.0	90	283
	1.5	50	88
	1.5	60	106
	1.5	75	133
	1.5	80	141
	1.5	55	97
	1.5	60	106
	1.0	20	16
	1.0	30	24
	1.0	35	27
	1.5	50	88
	1.5	60	106
	1.5	60	106
	1.5	75	133
Ral	2.0	175	550
	2.0	120	377
	2.0	90	283
	2.5	165	810
	1.5	30	52
	1.5	80	141
	1.5	90	159
	3.5	290	2790
	2.0	115	361
	2.0	115	361
	2.0	185	581
	2.0	155	487
	2.5	190	933
	2.0	150	471
	2.5	175	859
	2.5	180	883
Bpo	1.0	40	31
	1.0	45	35
	1.0	50	39
	1.0	30	24
	1.0	35	27

Table V (Cont.)

Compartment: Prospect Hill VII
Type: Mx-Sd-2

Harvard Forest
February 1, 1938

Species	Av. Dia. of Twig	Length of Twig	Volume of Twig
Bpo	1.5 mm.	120 mm.	212 cu.mm.
	1.5	60	106
	1.5	65	115
	1.5	75	133
	1.0	40	31
	1.0	55	43
	1.5	75	133
Spa	1.0	60	47
	1.0	60	47
	1.5	70	124
	1.5	80	141
	1.5	105	185
	1.0	40	31
	1.5	80	141
	1.5	95	168
	1.5	70	124
	1.5	45	79
	1.5	55	97
	1.5	40	70
	1.5	35	61
	2.0	160	503
	2.0	150	471
	2.5	185	908
	1.5	45	79
	2.5	210	1031
	2.5	235	1153
	1.5	65	115
	1.5	80	141
Ame	2.0	50	157
	2.5	180	884
	2.0	160	503
	2.0	150	471
	1.5	30	52
	1.5	35	61
	2.5	140	687
	1.5	40	70
	1.5	55	97
	2.5	195	957
	2.0	110	346
	1.5	70	124
	1.5	60	106
	1.5	40	70
	2.5	225	1104
Qru	2.0	105	330
	2.0	155	487
	2.0	110	345
	3.0	215	1520
	3.0	190	1342
	2.5	110	540
	2.5	180	883
	2.5	200	982

Species	Av. Dia. of Twig	Length of Twig	Volume of Twig
Qru	2.0 mm.	60 mm.	188 cu.mm.
	2.5	165	810
	2.0	115	361
	2.5	195	957
	2.5	190	933
	2.0	170	534
	2.0	150	471
	1.5	90	159
	2.0	160	503
	2.5	165	810
	1.5	70	124
	2.0	135	424
	1.5	55	97
	2.0	70	220
	3.0	210	1484
	2.5	175	859
	2.0	150	471
	3.0	330	2333
	2.0	70	220
	2.5	145	712
	2.0	90	283
	2.5	135	663
	2.5	165	810
	2.5	230	1129
	2.5	190	933
	3.0	285	2015
	1.5	70	124
	2.5	215	1055
	2.5	180	884
	3.0	240	1696
	2.0	160	503
	2.5	210	1031
	1.5	100	177
	1.5	90	159
	1.5	70	124
	3.0	230	1626
	2.0	165	518
	2.5	200	982
	2.5	180	884
	2.0	115	361
	3.5	325	3127
	1.5	90	159
	2.0	130	408
	2.0	150	471
	2.5	210	1031
	2.0	140	440
	2.5	195	957
	2.0	160	503
	1.5	115	203
	1.5	120	212
	2.5	200	982

Table V (Cont.)

Compartment: Prospect Hill VII
Type: Mx-Sd-2

Harvard Forest
February 1, 1938

Species	Av. Dia. of Twig	Length of Twig	Volume of Twig
Qru	2.0 mm.	190 mm.	597 cu.mm.
	2.0	170	534
	2.0	165	518
	2.0	170	534
	1.5	120	212
	3.5	340	3271
	2.5	210	1031
	1.5	90	159
	1.5	130	230
	3.0	240	1696
	3.0	275	1944
	2.5	190	933
	3.0	210	1484
	2.0	175	550
	2.0	185	581
	2.5	210	1031
	3.5	300	2886
	2.5	190	933
	2.5	215	1055
	2.0	130	408
	2.0	30	94
	2.0	100	314
	2.0	110	346
	2.5	195	957
	2.0	130	408
	3.0	260	1838
	2.0	160	503
	3.0	315	2227
	2.5	260	1276
	3.0	215	1520
	2.5	190	933
	2.0	160	503
	1.5	90	159
	2.0	110	346
	2.5	220	1080
	3.0	210	1484
	2.5	190	933
	2.0	160	503
	2.0	140	440
	2.0	135	424
	1.5	100	177
	1.5	80	141
	2.0	155	487
	1.5	70	124
	2.5	270	1325
	2.5	295	1448
	2.0	175	550
	1.5	125	221
	2.5	240	1178

Species	Av. Dia. of Twig	Length of Twig	Volume of Twig
Qru	1.5 mm.	60 mm.	106 cu.mm.
	2.5	200	982
	2.5	220	1080
	2.0	195	613
	1.5	100	177
	2.0	125	393
	2.0	140	440
	3.0	280	1979
	1.5	115	203
	2.5	200	982
	2.5	190	933
	2.5	200	982
	2.0	165	518
	2.0	150	471
	2.0	165	518
	2.0	140	440
	2.5	195	957
	1.5	80	141
	1.5	60	106
	3.0	270	1909
	2.0	120	377
	2.5	230	1129
	2.0	160	503
	2.0	120	377
	2.5	200	982
	2.0	180	565
Pab	Twig end	190	2790
		80	1080
		90	1290
		30	420
		50	610
		70	900
		40	500
		30	420
		40	500
		90	1290
		50	610
		40	500
		60	720
		30	420
		40	500
		35	460
		40	500
		50	610
		90	1290
		45	555
		60	720
		30	420
		40	500

Table V (Cont.)

Compartment: Prospect Hill VII
Type: Mx-Sd-2

Harvard Forest
February 1, 1938

Species	Av. Dia. of Twig	Length of Twig	Volume of Twig
Pab	Twig end	40 mm.	500 cu.mm.
		20	340
		50	610
		30	420
		50	610
		40	500
		90	1290
		40	500
		60	720
Toa	Twig end	140	660
		50	200
		60	240
		30	120
		45	180
		180	800
		50	240
		65	265
		40	160
		30	120
		145	685
		60	240
		65	265
		50	200
		70	290
		65	265
		30	120
		40	160
		130	610
		30	120
		50	200
		60	240
		65	265
		70	290
		20	80
		40	160
		80	340
		75	315
		60	240
		40	160
		35	140
		65	265
		35	140
Ken	1.5 mm.	50	88
	1.0	30	24
	1.0	25	20
	1.0	20	16
	1.5	40	70
	1.0	20	16
	1.0	25	20

Species	Av. Dia. of Twig	Length of Twig	Volume of Twig
Ken	30 leaves (30x115)		3450
Gpr	1.0 mm.	640 mm. (total)	505 cu.mm.
	375 leaves (375x170)		63750

Table VI

Food of One Animal for a 24-hr. Period

Compartment: Prospect Hill II
Type: P-Hm-Hd-3

Harvard Forest
January 15, 1938

Species	Av. Dia. of Twig	Length of Twig	Volume of Twig
Kla	3.0 mm.	130 mm.	919 cu.mm.
	2.5	65	319
	2.0	100	314
	2.0	55	173
	2.5	40	197
	2.0	70	220
	2.0	50	157
	2.0	45	142
	1.5	20	35
	2.0	45	142
71 leaves (71 x 350)			24,850
Tca	Twig end	55	220
Aru	3.0	560	3,958
Qal	2.0	110	346
	1.5	35	61
	1.5	40	70
	2.0	100	314
	1.5	35	61
	2.0	60	188
	2.0	115	361
	1.5	20	35
	2.0	120	377
	1.5	15	26
	2.0	170	534
	2.0	90	283
	2.5	215	1,055
	2.0	80	251
	2.0	100	314
Pst	Twig end	70	2,040
		95	2,430
		60	1,860
		80	2,220
		120	2,680
		65	1,950
		50	1,650
		35	1,290
Vca	1.5	70	124
	1.5	55	97
	1.5	40	70
	1.0	20	16
	2.0	115	361
	1.0	30	24
	2.5	390	1,914
	3.0	100	707
	1.5	205	362
	1.0	30	24
	1.0	25	20
	1.5	190	336
Vca	2.0 mm.	220 mm.	691 cu.mm.
	1.0	50	39
	1.0	30	24
	1.0	15	12
	1.0	10	8
	1.0	25	20
	1.0	30	24
	1.0	10	8
	1.5	120	212
Cde	2.0	150	471
	1.5	110	194
	2.0	210	660
	1.5	60	106
	1.5	90	159
	1.5	135	239
	1.5	190	336
	1.0	30	24
	1.5	95	168
	1.5	60	106
	1.5	75	133
	1.5	155	274
	2.0	200	628
	2.5	285	1,399
	1.5	90	159
	1.0	15	12
	1.5	110	194
	1.5	80	141
	1.5	130	230
	1.5	90	159
	1.5	80	141
	1.0	25	20
	2.0	180	565
	1.0	20	16
	1.5	65	115
	2.5	270	1,325
	2.0	140	440
	1.5	55	97
	1.5	75	133
	2.0	180	565
	1.0	30	24
	1.5	65	115
	2.5	270	1,325
	2.0	140	440
	1.5	55	97
	2.0	185	581
Rnu	1.5	70	124
	1.5	85	150
	1.0	55	43

Continued

Compartment: Prospect Hill II
Type: P-Hm-Hd-3

Harvard Forest
January 15, 1938

Species	Av. Dia. of Twig	Length of Twig	Volume of Twig
Rnu	1.0 mm.	30 mm.	24 cu.mm.
	2.0	55	173
	1.5	70	124
	1.5	60	106
	1.5	70	124
	2.5	55	270
	1.5	70	124
Lli	1.5	85	150
	1.5	75	133
	1.0	40	31
	1.5	65	115

Table VI (Cont.)

Compartment: Prospect Hill II — Harvard Forest
Types: Mx-Sd-6, Mx-Sd-7, and Sp-2 — January 18, 1938

(A)

Species	Av. Dia. of Twig	Length of Twig	Volume of Twig	Species	Av. Dia. of Twig	Length of Twig	Volume of Twig
Aru	1.5 mm.	170 mm.	300 cu.mm.	Cde	1.5 mm.	60 mm.	106 cu.mm.
	2.0	210	660		1.5	45	79
	1.5	90	159		2.0	70	220
	1.5	130	230		1.0	30	24
	1.5	75	133		1.5	50	88
	1.5	120	212		1.5	90	159
	1.5	146	256		2.0	200	628
	1.0	40	31		1.5	60	106
	1.5	80	141	Dlo	1.5	60	106
	3.0	340	2403		2.0	170	534
	1.5	85	150		1.5	130	230
	2.0	160	503		1.5	160	283
	2.0	200	628		2.0	210	660
	1.5	140	247		2.0	250	785
	2.0	290	911		1.5	70	124
Psy	Twig end	60	1880		1.5	100	177
		75	2180		2.0	220	691
		30	1160		1.5	170	300
		110	2920		1.5	130	230
		75	2180		2.0	205	644
		55	1770	Vca	2.0	45	142
		35	1290		1.5	40	70
		60	1880		1.5	45	79
		25	1020		1.5	60	106
		65	1980		2.0	90	283
		50	1660		1.5	35	61
		40	1420		1.5	40	70
		60	1880		1.5	65	115
		65	1980		2.0	95	299
		30	1160		1.5	70	124
Pat	Twig end	60	1860	Vpe	1.0	40	31
		45	1545		1.0	50	39
		55	1755		1.0	45	35
		50	1650		1.0	30	24
		70	2040		1.5	60	106
		40	1440		1.0	40	31
		45	1545		1.5	55	97
		20	840		1.5	65	115
		35	1290		1.0	30	24
		30	1140		2.0	60	188
Pab	Twig end	60	720		1.0	20	16
		30	420		1.0	30	24
		85	1185		1.5	40	70
		20	340		1.5	50	88
Tca	Twig end	90	400		1.0	30	24
		60	240		1.5	65	115
		40	160		1.5	40	70
		45	180		1.0	20	16
		30	120		1.0	25	20
		20	80		1.0	30	24

Table VI (Cont.)

Compartment: Prospect Hill II
Types: Mx-Sd-6, Mx-Sd-7, and Sp-2

Harvard Forest
January 18, 1938
(A)

Species	Av. Dia. of Twig	Length of Twig	Volume of Twig	Species	Av. Dia. of Twig	Length of Twig	Volume of Twig
Vpe	1.0 mm.	30 mm.	24 cu.mm.	Vpe	1.5 mm.	75 mm.	133 cu.mm.
	1.5	45	79		1.5	60	106
	1.5	60	106		2.0	210	660
	1.5	55	97		1.5	70	124
	1.5	40	70		1.5	60	106
	1.0	25	20		1.0	30	24
	1.5	60	106		1.5	50	88
	1.0	20	16		2.0	70	220
	1.0	25	20		1.0	30	24
	1.0	30	24		1.5	60	106
	1.5	45	79		2.0	105	330
	2.0	70	220		1.0	35	27
	1.0	30	24		1.0	35	27
	1.0	25	20		1.0	30	24
	1.5	50	88		1.5	40	70
	1.5	55	97		1.0	30	24
	1.5	40	70		1.5	65	115
	1.5	60	106		1.5	70	124
	1.0	25	20		1.5	60	106
	1.5	55	97		1.5	80	141
	1.0	25	20		1.5	60	106
	1.5	75	133		1.0	30	24
	1.5	60	106		1.5	50	88
	1.0	30	24		1.5	70	124
	1.0	30	24		1.5	35	61
	1.0	20	16		1.5	60	106
	1.0	30	24		1.5	70	124
	1.0	20	16		1.5	75	133
	1.0	25	20		1.0	15	12
	1.5	70	133		1.0	20	16
	1.5	50	88		1.0	20	16
	2.0	60	188		1.0	30	24
	1.5	45	79		1.0	25	20
	1.0	20	16	Qal	2.0	140	440
	1.0	15	12		1.5	55	97
	1.0	25	20		1.5	70	124
	2.0	55	172		1.5	80	141
	1.5	40	70		2.5	195	957
	1.5	30	52		2.5	205	1006
	1.0	15	12		1.5	45	79
	1.5	55	97		1.5	60	106
	1.0	20	16		2.0	140	440
	1.0	25	20		2.0	175	550
	1.5	45	79		2.0	110	346
	1.5	65	115		1.5	45	79
	1.0	20	16	Aca	2.5	90	442
	1.5	50	88		1.5	65	115
	1.0	25	20		1.5	45	79

Table VI (Cont.)

Compartment: Prospect Hill II
Types: Mx-Sd-6, Mx-Sd-7, and Sp-2

Harvard Forest
January 18, 1938
(A)

Species	Av. Dia. of Twig	Length of Twig	Volume of Twig	Species	Av. Dia. of Twig	Length of Twig	Volume of Twig
Aca	1.5 mm.	65 mm.	115 cu.mm.	Bpo	1.0 mm.	90 mm.	71 cu.mm.
	1.0	25	20		1.0	70	55
	1.5	105	186		1.5	175	309
	1.5	75	133		1.5	145	256
	1.0	30	24		1.0	70	55
	1.5	55	97		1.5	140	247
	1.5	65	115	Mas	1.5	120	212
	1.0	25	20		1.0	65	51
	1.5	65	115		1.0	60	47
	1.5	40	70		1.0	50	39
Ral	2.5	130	638		1.0	70	55
	1.5	80	141				
	2.5	210	1031				
	1.5	70	124				
	1.5	80	141				
Ptr	2.0	230	723				
Bpo	1.5	230	406				
	1.5	200	353				
	1.5	180	318				
	1.0	70	55				
	1.0	80	63				
	1.5	190	336				
	1.0	70	55				
	1.5	165	292				
	1.0	65	51				
	1.5	175	309				
	1.5	160	283				
	1.5	190	336				
	1.5	200	353				
	1.0	90	71				
	1.5	115	203				
	1.0	60	47				
	1.0	50	39				
	1.0	60	47				
	1.0	90	71				
	1.5	170	300				
	1.0	85	67				
	1.0	80	63				
	1.0	95	75				
	1.5	165	292				
	1.0	90	71				

Table VI (Cont.)

Compartment: Prospect Hill II
Types: Sp-1, Hm-Hd-4 (IV), and P-Hm-Hd-3

Harvard Forest
January 18, 1938
(B)

Species	Av. Dia. of Twig	Length of Twig	Volume of Twig
Tca	Twig end	115 mm.	535 cu.mm.
		70	290
		70	290
		20	80
		15	60
		50	200
		30	120
		140	660
		90	400
		80	340
		65	265
		50	200
		70	290
		65	265
		50	200
		15	60
		110	510
		60	240
		65	265
		40	160
		30	120
		50	200
		15	60
		20	80
		25	100
		90	400
		50	200
		40	160
		65	265
		35	140
		30	120
		135	635
		85	370
		70	290
		40	160
		50	200
		20	80
		90	400
		75	315
		40	160
		20	80
		25	100
		110	510
		95	430
		30	120
		25	100
		60	240
		65	265
Tca	Twig end	40 mm.	160 cu.mm.
		120	560
		130	610
		40	160
		50	200
		20	80
		30	120
		90	400
		75	315
		40	160
		20	80
		60	240
		40	160
Pru	Twig end	160	1840
		120	1060
		40	320
		15	120
		60	480
		90	760
		50	400
		80	660
		45	360
		100	880
		20	160
		50	400
		30	240
		60	480
		65	525
		20	160
		55	440
		25	200
		35	280
Pst	Twig end	45	1545
		30	1140
		25	990
		30	1140
		55	1765
		20	840
		25	990
		35	1290
		70	2040
		35	1290
Aru	2.5 mm.	290	1424
	2.0	130	408
	2.5	260	1276
	2.0	190	597
	2.0	200	628
	2.0	180	565

Table VI (Cont.)

Compartment: Prospect Hill
Types: Sp-1, Hm-Hd-4 (IV), and P-Hm-Hd-3

Harvard Forest
January 18, 1938
(B)

Species	Av. Dia. of Twig	Length of Twig	Volume of Twig
Aru	2.0 mm.	180 mm.	565 cu.mm.
	2.0	140	440
	2.0	170	534
	2.0	175	550
	2.0	165	518
	2.5	245	1203
	2.5	330	1620
	2.0	130	408
	3.0	360	2545
Cde	2.0	105	330
	1.5	45	79
	1.5	90	159
	2.0	190	597
	1.5	125	221
	2.0	175	550
Ive	1.5	105	186
	2.0	145	455
	3.0	90	636
	1.5	70	124
	2.0	110	346
	2.0	80	251
	2.0	65	204
Vca	2.0	230	723
	3.0	510	3605
Rnu	1.5	40	70
	1.5	60	106
	1.5	55	97
	2.0	75	236
	1.5	35	61
	1.5	60	106
	1.5	55	97
	1.5	80	141
	1.5	65	115
	1.0	20	16
	1.5	70	124
	1.5	50	88
	2.0	90	283
	1.0	30	24
	1.0	25	20
	1.5	60	106
	1.0	15	12
	1.5	45	79
	1.0	35	27

Species	Av. Dia. of Twig	Length of Twig	Volume of Twig
Rnu	1.5 mm.	45 mm.	79 cu.mm.
	1.0	30	24
	1.0	35	27
	1.5	50	88
Vco	2.5	240	1178
	2.0	80	251
	1.5	45	79
	1.5	30	52
	1.5	35	61
	1.5	45	79
Bpo	1.5	220	389
	1.0	50	39
	1.5	120	212
	1.5	160	283
	1.5	185	327
	1.5	140	247
	1.5	175	309
	1.0	45	35
	2.5	300	1473
	1.0	110	86
	1.0	90	71
	1.0	75	59
	1.5	90	159
	1.5	125	221
	1.0	80	63
Pse	1.5	50	88
	1.0	35	27
	1.5	45	79
	1.5	45	79
	2.0	115	361
	1.5	55	97
Bsp	1.5	110	194

Table VI (Cont.)

Compartment: Prospect Hill II
Types: P-Hm-Hd-3 and Mx-Sd-8

Harvard Forest
February 21, 1938
(A)

Species	Av. Dia. of Twig	Length of Twig	Volume of Twig	Species	Av. Dia. of Twig	Length of Twig	Volume of Twig
Vpe	1.0 mm.	70 mm.	55 cu.mm.	Pab	Twig end	65 mm.	810 cu.mm.
	1.0	60	47			50	610
	1.0	65	51			85	1185
	1.0	70	55			40	500
	1.0	65	51			35	460
	1.0	50	39			40	500
	1.0	40	31			30	420
	1.5	75	132			75	990
	1.0	30	24			65	810
	1.5	75	132			70	900
	1.5	80	141	Tca	Twig end	40	160
Cde	1.5	80	141			50	200
	1.5	60	106			60	240
Aru	2.0	110	346			30	120
	2.0	90	283			70	290
	1.0	40	31			40	160
	1.0	50	39			30	120
	1.0	55	43			20	80
	2.0	100	314			130	610
	2.0	65	204			80	340
	2.5	120	588			75	315
	1.0	45	35			75	315
	3.0	310	2191			80	340
	2.0	120	377			60	240
	2.0	95	299			40	160
	1.5	80	141			40	160
	1.5	65	115			40	160
	1.0	60	47			30	120
	1.0	50	39			40	160
	3.5	420	4041			35	140
	2.5	130	638			40	160
	2.5	110	540			35	140
	2.0	90	283			115	535
	2.0	80	251			105	485
	1.5	60	106			95	430
	1.5	75	133			80	340
	1.5	70	124			80	340
	1.5	55	97			60	240
	1.0	40	31			55	220
	1.0	50	39			50	200
	1.0	35	27			65	365
	1.0	45	35			35	140
Nmu	3.0	370	2615	Gpr	1.0 mm.	400	309
Pab	Twig end	30	420			(total)	[illegible]
		25	380	235 leaves (235 x 170)			39950
		60	720				

Table VI (Cont.)

Compartment: Prospect Hill II
Types: Mx-Sd-6 and Sp-1

Harvard Forest
February 21, 1938
(B)

Species	Av. Dia. of Twig	Length of Twig	Volume of Twig
Dlo	2.0 mm.	150 mm.	471 cu.mm.
	2.5	175	859
	2.0	120	377
	2.5	165	810
	2.0	130	408
	2.5	220	1080
	2.5	190	933
	2.0	115	361
	2.0	140	440
	2.0	145	465
	2.0	150	471
	1.5	65	115
	2.0	105	330
	2.5	160	785
	1.0	30	24
	1.5	90	149
	2.0	155	487
Ive	3.5	290	2790
	1.5	90	159
	1.5	105	185
	1.0	70	55
	2.5	220	1080
Cde	1.5	130	230
	1.5	100	177
	2.0	165	518
Bpa	2.0	135	424
	2.0	120	377
Aru	1.0	20	16
	1.5	130	230
	1.0	40	31
	1.0	50	39
	2.0	160	503
	2.0	145	455
Tca	Twig end	70	290
		40	160
		30	120
		110	510
		70	290
		65	265
		40	160
		30	120
		35	140
		30	120
Rhi	3 leaves (3 x 360)		1080

In addition an undetermined amount of alfalfa hay from a trap was eaten by this animal during the 24-hour period.

Table VII

VOLUME TABLE FOR CYLINDERS OF DIFFERENT DIAMETERS AND LENGTHS*

Dia. in mm.	Length in mm.	Volume in cu.mm.	Dia. in mm.	Length in mm.	Volume in cu.mm.	Dia. in mm.	Length in mm.	Volume in cu.mm.
0.5	5	1	1.5	55	97	2.0	160	503
	10	2		60	106		165	518
	15	3		65	115		170	534
	20	4		70	124		175	550
	25	5		75	133		180	565
	30	6		80	141		185	581
	35	7		85	150		190	597
	40	8		90	159		195	613
	45	9		95	168		200	628
	50	10		100	177		205	644
	55	11		105	186		210	660
	60	12		110	194		215	675
	65	13		115	203		220	691
	70	14		120	212		225	707
	75	15		125	221		230	723
1.0	5	4		130	230		235	738
	10	8		135	239		240	754
	15	12		140	247		245	770
	20	16		145	256		250	785
	25	20		150	265	2.5	110	540
	30	24		155	274		115	565
	35	27		160	283		120	589
	40	31		165	292		125	614
	45	35		170	300		130	638
	50	39		175	309		135	663
	55	43		180	318		140	687
	60	47		185	327		145	712
	65	51		190	336		150	736
	70	55		195	345		155	761
	75	59		200	353		160	785
	80	63	2.0	60	188		165	810
	85	67		65	204		170	834
	90	71		70	220		175	859
	95	75		75	236		180	884
	100	79		80	251		185	908
	105	82		85	267		190	933
	110	86		90	283		195	957
	115	90		95	299		200	982
	120	94		100	314		205	1006
	125	98		105	330		210	1031
	130	102		110	346		215	1055
	135	106		115	361		220	1080
	140	110		120	377		225	1104
	145	114		125	393		230	1129
	150	118		130	408		235	1154
1.5	30	52		135	424		240	1178
	35	61		140	440		245	1203
	40	70		145	456		250	1227
	45	79		150	471		255	1252
	50	88		155	487		260	1276

* Volume for any given diameter and length is rounded off to the nearest whole number.

Table VII (Cont.)

Dia. in mm.	Length in mm.	Volume in cu.mm.	Dia.in mm.	Length in mm.	Volume in cu.mm.	Dia.in mm.	Length in mm.	Volume in cu.mm.
2.5	265	1301	3.5	280	2694	4.0	340	4273
	270	1325		285	2742		345	4336
	275	1350		290	2790		350	4398
	280	1374		295	2838		355	4461
	285	1399		300	2886		360	4524
	290	1424		305	2934		365	4587
	295	1448		310	2983		370	4650
	300	1473		315	3031		375	4712
3.0	190	1342		320	3079		380	4775
	195	1377		325	3127		385	4838
	200	1414		330	3175		390	4901
	205	1449		335	3223		395	4964
	210	1484		340	3271		400	5027
	215	1520		345	3319		405	5089
	220	1555		350	3367		410	5152
	225	1590		355	3416		415	5215
	230	1626		360	3464		420	5278
	235	1661		365	3512		425	5341
	240	1696		370	3560		430	5404
	245	1732		375	3608		435	5466
	250	1767		380	3656		440	5529
	255	1802		385	3704		445	5592
	260	1838		390	3752		450	5655
	265	1873		395	3800	4.5	5	80
	270	1909		400	3848		10	159
	275	1944		405	3897		100	1590
	280	1979		410	3945	5.0	5	98
	285	2015		415	3993		10	196
	290	2050		420	4041		100	1963
	295	2085		425	4089			
	300	2121		430	4137			
	305	2156		435	4185			
	310	2191		440	4233			
	315	2227		445	4281			
	320	2262		450	4330			
	325	2297	4.0	280	3518			
	330	2333		285	3581			
	335	2368		290	3644			
	340	2403		295	3707			
	345	2439		300	3770			
	350	2474		305	3833			
3.5	250	2405		310	3896			
	255	2453		315	3958			
	260	2501		320	4021			
	265	2550		325	4084			
	270	2598		330	4147			
	275	2646		335	4210			

Table VIII

Volume table for twigs of coniferous species* and leaves of dicotyledonous species

Species	Length in mm.	Volume in cu.mm.	Species	Length in mm.	Volume in cu.mm.	Species	Length in mm.	Volume in cu.mm.
Tca	20	80	Psy	100	2700	Pst	65	1950
	25	100		105	2810		70	2040
	30	120		110	2920		75	2130
	35	140		115	3030		80	2220
	40	160		120	3140		85	2290
	45	180		125	3280		90	2360
	50	200		130	3420		95	2430
	55	220	Pab	20	340		100	2500
	60	240		25	380		105	2545
	65	265		30	420		110	2590
	70	290		35	460		115	2635
	75	315		40	500		120	2680
	80	340		45	555		125	2720
	85	370		50	610		130	2760
	90	400		55	665		135	2800
	95	430		60	720		140	2840
	100	460		65	810	Pru	10	80
	105	485		70	900		15	120
	110	510		75	990		20	160
	115	535		80	1080		25	200
	120	560		85	1185		30	240
	125	585		90	1290		35	280
	130	610		95	1395		40	320
Psy	30	1160		100	1500		45	360
	35	1290		105	1585		50	400
	40	1420		110	1670		55	440
	45	1540		115	1755		60	480
	50	1660		120	1840		65	525
	55	1770	Pst	20	840		70	570
	60	1880		25	990		75	615
	65	1980		30	1140		80	660
	70	2080		35	1290		85	710
	75	2180		40	1440		90	760
	80	2280		45	1545		95	810
	85	2385		50	1650		100	860
	90	2490		55	1755		105	910
	95	2595		60	1860		110	960

Species	Number of Leaves	Volume in cu.mm.
Rhi	1	360
Kan	1	115
Kla	1	350
Gpr	1	170

* Volume for any given length includes needles and that length measured from tip of the twig.

this paper species or groups of species and list them as food preferences when they are based solely upon what was eaten. These data must be correlated with the relative proportions in which these food species were available if they are to be of greatest value. Such was the procedure followed in this study. Referring again to table V, it can be seen that for each day data were gathered, whether it be for one or several hares, they were obtained from one to three forest types. It was found that five different areas comprised all the forest types in which food data were obtained. A separate reconnaissance of each area was made to determine the relative proportion in which each plant was available as food for the snowshoes. This reconnaissance was based on the method used by the U. S. Forest Service in making a range survey. Briefly, this is an ocular method in which all species occurring in a range type are noted, each being given a percent figure representing the portion of the total ground cover it constitutes. A density figure is also given each range type. With the field data just referred to and a palatability list, the carrying capacity of the range is determined. For a more complete treatise on this method, the reader is referred to the U. S. Forest Service publication entitled "Instructions for Making Range Surveys on National Forests."

In this study it was necessary to modify the method just explained to obtain the relative availability of the food species found. First, the carrying capacity of the range was not desired; therefore, no density figure was taken. Secondly, in addition to twig ends of coniferous species and leaves of

evergreen dicotyledonous species, only twigs under 5 mm. in diameter were considered since none larger than this were eaten by the snowshoes observed in this study. Only plant material under three feet in height was considered, as this was the maximum height to which the hares fed during this winter. Mention must be made of the fact that at no time during the study were there observed instances in which the snowshoes had eaten only the bark from any shrub or tree.

Each of the five areas was examined by walking through it several times, noting each species present and the percent of the total ground cover it made up as based upon the growth form and relative number of each. This does not give equal representation to species which are far greater in volume even though their percent of the total ground cover be the same as other species. For example, when looked at from directly above at a height of three feet the area under a small Norway spruce, Picea abies, would be completely covered. Likewise a dense patch of wintergreen, Gaultheria procumbens, of the same dimensions would completely cover the ground. Each would then be given the same percent composition. It is at once apparent that the volume of available food in this particular case is not the same for both. Consequently, adjustments were made in the percentages to compensate for such cases. The resulting percentage-volume composition figures of each of the five areas are recorded in table IX pages 46-47. The arrangement in this table is such that for each day food data were collected the relative availability of each food species present in the area on which the hare (or

Table IX

PERCENTAGE-VOLUME COMPOSITION OF EACH OF THE FIVE AREAS FROM WHICH FOOD HABITS DATA WERE GATHERED

Symbol	Scientific name	Common name	Dates on which food habits data were gathered in each area: Nov.22; Jan.3 Jan.18(B);Feb.21(B)	Jan.4 Feb.21(A)	Jan.15	Jan.18(A)	Feb.1
Aca	Amelanchier canadensis	Shad bush				-*	
Ain	Alnus incana	Speckled alder	2.0%				
Ame	Aronia melanocarpa	Chokeberry		-			-
Aru	Acer rubrum	Red maple	1.0	5.0%	7.5%	2.0%	6.5%
Ble	Betula lenta	Black birch	0.5				
Blu	Betula lutea	Yellow birch	0.5		0.5		
Bpa	Betula papyrifera	Paper birch	-				-
Bpo	Betula populifolia	Gray birch	1.0	4.5	1.0	5.0	5.5
Bsp	Betula species	Birch	-	1.5			
Cde	Castanea dentata	Chestnut	0.5	2.5	4.5	0.5	3.0
Csp	Crataegus species	Hawthorn		0.5			
Dlo	Diervilla lonicera	Diervilla	-	-		0.5	
Fgr	Fagus grandifolia	Beech					
Gpr	Gaultheria procumbens	Wintergreen	9.0	24.0	7.5	18.0	23.0
Ive	Ilex verticillata	Winterberry	15.0				
Kan	Kalmia angustifolia	Sheep laurel	4.5	0.5	9.0	5.0	-
Kla	Kalmia latifolia	Mountain laurel	8.0		33.0		
Lli	Lyonia ligustrina	Male berry	0.5		-		
Mas	Myrica asplenifolia	Sweet fern				4.5	

* Dash (-) indicates the species was present but was not common enough to be given a rating.

Table IX (Cont.)

Symbol	Scientific name	Common name	Dates on which food habits data were gathered in each area: Nov.22; Jan.3 Jan.16(B);Feb.21(B)	Jan.4 Feb.21(A)	Jan.15	Jan.18(A)	Feb.1
Mmu	Nemopanthus mucronata	Mountain holly	11.0	-			
Pab	Picea abies	Norway spruce		6.5		5.0	25.0
Pal	Picea alba	White spruce		3.5		19.0	
Ppe	Prunus pennsylvanica	Fire cherry		-			0.5
Pre	Pinus resinosa	Red pine		34.0			
Pru	Picea rubra	Red spruce	10.0		2.5		
Pse	Prunus serotina	Black cherry	0.5	0.5			
Pst	Pinus strobus	Northern white pine	-		0.5	3.0	20.0
Psy	Pinus sylvestris	Scotch pine				22.0	
Ptr	Populus tremuloides	Aspen				-	
Qal	Quercus alba	White oak	-		2.5	-	
Qru	Quercus rubra	Red oak		3.5	7.0	2.0	4.0
Ral	Rubus alleghenicnsis	Blackberry					0.5
Rhi	Rubus hispidus	Dwarf raspberry	-	2.0	0.5	3.0	
Rnu	Rhododendron nudiflorum	Purple azalea	4.0	0.5	1.5	0.5	
Sla	Spiraea latifolia	Meadow-sweet		-			
Tca	Tsuga canadensis	Hemlock	9.0	1.0	4.5	2.0	0.5
Val	Viburnum alnifolium	Witch hobble	1.0		1.5		
Vca	Viburnum cassinoides	Wild raisin	12.0	2.0	10.5	2.5	3.0
Vco	Vaccinium corymbosum	Highbush blueberry	4.0	1.0			
Vpe	Vaccinium pennsylvanicum	Lowbush blueberry	1.5	5.0	2.0	3.0	6.0
	Miscellaneous species		4.5	2.0	4.0	2.5	2.5
		%otal	100.0%	100.0%	100.0%	100.0%	100.0%

hares) fed is tabulated in the column directly below. Attention must be called to the fact that this is a comparative method and expresses in percent only the relative abundance of one species over another as based on the volume and frequency of occurrence of each.

In analyzing the food habits data it was found desirable to first determine the frequency and volume indices for the species eaten on each day data were collected. These indices were obtained from data in table V, pages 22-31, and are recorded in table X, pages 49-52.

The next step was to correlate the average percent of the frequency and volume indices for each species (see table X) with the corresponding availability factor. This factor was arrived at for each of the five areas by using the highest percentage volume composition figure as a base and comparing the figures for the other species with it. The base figure was divided by ten and any species whose percent composition was low enough to fall at 1/10 or below that of the base figure was given an availability factor of ten. Species whose percent composition occurred between 1/10 and 2/10 of the highest figure were given a factor of nine, and so on.

The average of the frequency and volume indices for each species was then multiplied by the corresponding availability factor. These products are recorded in table X , pages 49-52, and express for any given day data were collected the relative palatability or food preferences of the species taken. The final palatability table compiled from the data as a whole was arrived at in the following way. For each species the sum of the products

Table X

DEVELOPMENT OF PALATABILITY RATING

Date	Species	Frequency Indices Percent	Volume Indices Percent	Average of Frequency and Volume Indices Percent	Availability Factor	Product of availability Factor and Average of Frequency and Volume Indices
Nov. 22	Cpr	20.3	27.5	23.9	5	1195
	Ive	13.0	17.6	15.3	1	153
	Aru	17.4	12.2	14.8	10	1480
	Vac	11.6	9.4	10.5	8	840
	Kan	7.3	9.1	8.2	8	656
	Cde	2.9	7.4	5.2	10	520
	Dle	2.9	4.2	3.5	10	350
	Tca	4.3	3.9	4.1	5	205
	Vca	8.7	3.8	6.3	3	189
	Gal	5.8	3.1	4.5	10	450
	Lli	5.8	1.9	3.9	10	390
Jan. 3	Ain	4.1	35.1	19.6	9	1764
	Ive	28.8	31.3	30.1	1	301
	Pru	42.5	25.3	33.9	4	1356
	Tca	17.8	5.8	11.8	5	590
	Vca	5.5	2.0	3.7	3	111
	Rmu	1.4	0.6	1.0	3	30

Table X (Cont.)

Date	Species	Frequency Indices Percent	Volume Indices Percent	Average of Frequency and Volume Indices Percent	Availability Factor	Product of Availability Factor and Average of Frequency and Volume Indices
Jan. 4	Pab	27.1	39.4	33.2	9	2988
	Qpr	27.4	35.1	31.2	4	1248
	Gru	2.5	10.7	6.6	10	660
	Sla	5.0	3.3	4.2	10	420
	Fpe	2.5	2.9	2.7	10	270
	Vpe	25.9	2.4	14.2	9	1278
	Aru	2.8	1.8	2.3	9	207
	Bsp	1.3	1.4	1.3	10	130
	Bpe	1.9	1.2	1.5	9	135
	Csp	1.6	0.9	1.3	10	130
	Pse	1.6	0.7	1.1	10	110
	Ame	0.3	0.2	0.3	10	30
	Dle	0.3	0.1	0.2	10	20
Jan. 15	Kla	26.1	38.9	32.5	1	325
	Pat	6.1	22.8	14.5	10	1450
	Cde	27.7	16.7	22.2	9	1998
	Vca	16.1	7.2	11.7	8	936
	Cal	11.5	6.1	8.8	10	880
	Aru	0.8	5.6	3.2	8	256
	Sau	7.7	1.8	4.7	10	470

Table X (Cont.)

Date	Species	Frequency Indices Percent	Volume Indices Percent	Average of Frequency and Volume Indices Percent	Availability Factor	Product of Availability Factor and Average of Frequency and Volume Indices
Jan. 15 cont.	Lli	3.1	0.6	1.9	10	190
	Tca	0.8	0.3	0.5	9	45
Jan. 16 (A)	Psy	6.1	32.1	19.1	1	191
	Pat	4.0	18.4	11.2	9	1008
	Vpe	40.7	9.3	25.0	9	2250
	Aru	6.1	8.4	7.3	10	730
	Bpo	12.5	6.8	9.7	8	776
	Dlo	4.8	5.8	5.3	10	530
	Qal	4.8	5.3	5.1	10	510
	Pab	1.6	3.3	2.5	8	200
	Bal	2.0	2.5	2.3	10	230
	Vca	4.0	1.7	2.9	9	261
	Cdo	3.2	1.7	2.5	10	250
	Aca	5.2	1.9	3.5	10	350
	Tca	2.4	1.4	1.9	10	190
	Ptr	0.4	0.9	0.7	10	70
	Mas	2.0	0.5	1.3	8	104
Jan. 16 (B)	Tca	35.7	22.2	28.9	5	1445
	Aru	8.8	19.4	14.1	10	1410
	Pat	5.9	19.1	12.5	10	1250
	Pru	11.1	14.3	12.7	4	508

Table X (Cont.)

Date	Species	Frequency Indices Percent	Volume Indices Percent	Average of Frequency and Volume Indices Percent	Availability Factor	Product of Availability Factor and Average of Frequency and Volume Indices
Jan. 18 cont.	Vca	1.2	6.3	3.7	3	111
	Bpo	8.8	5.8	7.3	10	730
	Ive	4.1	3.2	3.7	1	37
	Rmu	13.5	3.0	8.3	8	664
	Cde	3.5	2.8	3.1	10	310
	Vco	3.5	2.5	3.0	8	240
	Pse	3.5	1.1	2.3	10	230
	Bsp	0.6	0.3	0.5	10	50
Feb. 1	Gru	23.3	38.1	30.7	9	2763
	Opr	21.7	23.5	22.2	1	222
	Pab	5.6	8.5	7.3	1	73
	Aru	10.1	6.1	8.2	8	656
	Vca	3.3	5.0	4.1	9	369
	Ral	2.8	3.7	3.3	10	330
	Vpe	13.5	3.6	8.5	8	680
	Tca	5.7	3.2	4.5	10	450
	Cde	2.8	2.4	2.7	9	243
	Bpa	3.7	2.1	2.9	10	290
	Ame	2.6	2.1	2.4	10	240
	Kan	2.9	1.4	2.1	10	210

Table X (Cont.)

Date	Species	Frequency Indices Percent	Volume Indices Percent	Average of Frequency and Volume Indices Percent	Availability Factor	Product of Availability Factor and Average of Frequency and Volume Indices
Feb. 1 cont.	Bpa	2.1	0.3	1.2	8	96
Feb. 21 (A)	Cpr	47.0	55.7	51.3	4	2052
	Aru	17.5	15.8	16.7	9	1503
	Pab	7.8	12.1	9.9	9	891
	Tca	19.3	11.4	15.3	10	1530
	Mnu	0.6	3.6	2.1	10	210
	Vpe	6.6	1.1	3.9	9	351
	Cde	1.2	0.4	0.8	10	80
Feb. 21 (B)	Dlo	38.6	44.9	41.7	10	4170
	Ive	11.4	22.4	16.9	1	169
	Tca	22.7	11.4	17.0	5	850
	Aru	13.6	6.7	10.2	10	1020
	Mal	2.3	5.6	3.9	10	390
	Cde	6.8	4.9	5.8	10	580
	Bpa	4.5	4.2	4.4	10	440

of the availability factor and the average of the frequency and volume indices was obtained. This figure was divided by a number representing its frequency of occurrence for the nine different times field data were gathered. That is, if a species was present in the area each time data were gathered, it would be given a figure of nine. Should any given species be absent from the area on which data were collected for any one day, it would be given a figure of 8, and so on. After obtaining these figures for all the species, they were multiplied by a factor which would reduce the highest one to 100. In table XI page 55, are recorded these results which express the relative palatability of all the species from the composite field data.

As a check on the final palatability table another method was devised of evaluating the food species. From the field data as a whole the average of the frequency and volume indices for each species was calculated. A palatability figure was arbitrarily given to each. This figure was arrived at by personal judgment of the relative value of each species. After multiplying the average of the frequency and volume indices by the palatability figure for all species, the ones found to have the highest ratings by this method were (in order of importance); wintergreen, red oak, lowbush blueberry, red maple, Norway spruce, hemlock, chestnut, and diervilla. From table XI it can be seen that these eight species are also the preferred ones obtained by the first method of arriving at palatabilities of the various species.

In listing food preferences one must not be guided entirely by what statistics may show. It is at once apparent

Table XI

PALATABILITY RATING OF SPECIES

Species	Palatability Rating
Picea abies	100
Acer rubrum	78
Diervilla lonicera	70
Quercus rubra	66
Tsuga canadensis	57
Gaultheria procumbens	51
Pinus strobus	51
Vaccinium pennsylvanicum	49
Castanea dentata	43
Alnus incana	42
Picea rubra	36
Amelanchier canadensis	34
Rubus allegheniensis	27
Spiraea latifolia	20
Viburnum cassinoides	20
Betula populifolia	19
Pinus sylvestris	18
Betula sp.	17
Vaccinium corymbosum	17
Ilex verticillata	16
Betula papyrifera	14
Rhododendron nudiflorum	14
Lyonia ligustrina	11
Myrica asplenifolia	10
Aronia melanocarpa	9
Kalmia angustifolia	9
Prunus pennsylvanica	9
Populus tremuloides	7
Kalmia latifolia	6
Prunus serotina	6
Rubus hispidus	5
Nemopanthos mucronata	4
Quercus alba	4
Crataegus sp.	2
Betula lenta	-*
Betula lutea	-
Fagus grandifolia	-
Picea alba	0
Pinus resinosa	0
Viburnum alnifolium	0

* A dash (-) indicates that as available food for snowshoes these species occurred in too little quantity to be considered.

there are so many contributing factors in wildlife research that the investigator must use judgment in interpreting the data. To mention a few factors, the fairness in sampling, the covering of such plants as wintergreen by deep snow, etc. all have their effect. Taking into account these variations and the palatability ratings arrived at by calculation of 2535 observations, wintergreen was found to be the preferred species. Following it were red oak, red maple, Norway spruce, and diervilla. Closely approaching these in importance were lowbush blueberry, hemlock, and chestnut. Red pine and witch hobble were not eaten at all. Although white spruce has been given no palatability rating, there is reason for some question here. This may be explained partially at least by the fact that no data were gathered in those parts of the plantations where white spruce was particularly abundant. It was noted also during the study that many twigs of gray birch had been cut by the snowshoes but were not eaten.

Previous investigations have given little if any information on the amount of food normally taken by one animal during a 24-hour period. Referring to table V, it is found that on four different days the food habits data were gathered for individual animals during a 24-hour period. The volume for each was calculated and recorded in the following table.

Table XII

VOLUME OF FOOD TAKEN BY INDIVIDUAL SNOWSHOES DURING A 24-HOUR PERIOD

Date on which food habits data were gathered	Volume of food taken by an individual during 24-hour period
Jan. 15	70.6 cc
Jan. 18 (A)	81.9
Jan. 18 (B)	68.3
Feb. 2	72.3

Average - 73.3 cc

It is recognized that the number of observations here is quite small. However, considering the degree of accuracy with which these data were obtained it is believed the average figure of 73.3 cc is quite significant.

DAILY AND SEASONAL RANGES

It was found in this study that the hares preferred and, in fact, only inhabited ranges with ample cover. This is in accord with Aldous (1937) who reported hares to be more numerous in the brushy areas. Likewise, Grange (1932) found that the amount of underbrush largely determines the desirability of any particular range, and the lack of a goodly proportion of either aspen or balsam fir, or both, seems to be a limiting factor in many cases.

From a study of the types in this study area it is apparent that cover was not a limiting factor except in the cut-over areas. In such places not a single track was seen throughout the winter, indicating the undesirability of such open areas even though food species were present in abundance.

Formerly there were no snowshoes in the plantations on the Forest. Now it has been proved that they have extended their range to these and spend a great deal of their time in them. One group of plantations with an area of twelve and one-half acres on Compartments II and VIII of the Prospect Hill Block comprised the home range for at least two or three hares throughout the winter season. These coniferous plantations in which the snowshoes were found are on cutover lands where hardwood sprouts and other woody species of the ground cover provide an ample supply of food.

Daily ranges have apparently not been noted by previous investigators, although Grange (1932) reported having followed a snowshoe for one hour and fifteen minutes, during which time it could not be driven from an area of perhaps ten acres in extent.

The daily ranges noted in this study were obtained by

tracking the animals following snowfalls. In all cases it was found that in a restricted area which we may call the home range it became impossible to follow a separate track even though there had been but one hare in the area during the 24-hour period. Accordingly, such areas were encircled to enclose all tracks inside and the exterior boundaries of the ranges were indicated by color and line schemes on the maps which accompany this paper. Whenever side trips were taken from the home range, they were usually for the purpose of obtaining food. This was especially true in the spruce swamp where the amount of available food was relatively low.

From the trapping record and close association with conditions in the study area throughout the winter it is believed that the ranges shown here are reasonably accurate. The two hares (Nos. 3 and 6) were the ones from which most of the data were gathered. Since these two were the only ones which spent the winter in the spruce swamp, it is quite certain that the daily ranges found here were those of individual hares except, of course, when one range overlapped another. Tracks of snowshoes entering from outside areas were carefully accounted for in mapping the daily and seasonal ranges.

On the accompanying maps appear all the daily ranges it was possible to obtain for each 24-hour period following a snowfall. As a rule, on the third day following a fresh snow it became virtually impossible to distinguish a range because of the great number and confusion of tracks. The seasonal ranges of the two hares were determined from the trapping record and the daily

ranges. The areas were obtained by the use of a planimeter and are recorded in table XIII, page 60. Any range noted here may be located on the proper map by referring to the legend.

Upon examining the ranges in table XIII it is apparent that for the first 24-hour period following a snowfall the range was comparatively small. Especially was this true when the snow was deep. On the second successive day there was an extension in the daily range. The same may be true for the third successive day. From the average figures in table XIII and field notes taken during the study, the increase in range during the second and third day following a fresh snow has been found to be from one and one-half to two and one-half times as great as the average area of 7.2 acres for the first day; in other words, the average daily range on the second and third day may be from 10.8 to 18.0 acres.

While statements may be made concerning the area of ranges and the relative increase in size on successive days following a storm, it must be remembered that both are largely dependent upon climatic conditions, especially depth of snow. Throughout the study a record of the depth of snow was kept. The snow depth each time a daily range was noted may be found by referring to table XIII. In general it may be said that the greater the snowfall the smaller will be the daily range for the successive days and a longer time will be required for the hares to extend their daily range to the limit. On several occasions it was observed that, following a light snowfall, the range for the next day was essentially that of the maximum daily winter range.

Table XIII

DAILY AND SEASONAL RANGES OF INDIVIDUAL HARES

Date	Snow Depth Inches	Hare Number	Area of Range for 1st 24-hr. period*	Area of Range for 2d 24-hr. period	Area or Range for 3d 24-hr. period	Area of Seasonal Range	Number of Map from which Areas Were Obtained
1/3/38	8.0	3(?)	8.2 acres				1
1/3/38	8.0	6(?)	9.2				1
1/14/38	8.5	3	15.8				1
1/19/38	11.5	3	.6				2
1/19/38	11.5	6	4.4				2
1/20/38	10.0	6		1.9 acres			2
1/20/38	10.0	3		8.3			2
1/22/38	11.5	3(?)	.8				2
1/23/38	12.0	3(?)		5.1			2
2/21/38	5.5	3	11.8				3
2/21/38	5.5	6(?)	7.5				3
2/21/38	5.5		3.5				3
2/22/38	4.0	3		10.7			3
2/22/38	4.0	6(?)		9.0			3
2/23/38	4.5	3			12.0 acres		3
3/1/38	5.0	3	10.6				4
3/1/38	5.0	6	10.6				4
3/1/38	5.0		2.9				4
3/2/38	1.5	3		13.9			4
3/2/38	1.5	6		10.2			4
	AVERAGE		7.2	8.4	12.0		
		No.3				34.0 acres	5
		No.6				30.2	5

* Areas obtained by use of a planimeter.

In conclusion it is certain that the depth of snow and whether or not it has a crust on the top are two determinants of the area a snowshoe will cover during a night. Although in this study the food supply was not found to be a limiting factor, a scarcity of it would undoubtedly also be instrumental among the forces which determine the range, whether it be daily or seasonal.

SUGGESTIONS FOR MANAGEMENT

Two of the most important factors, namely, food and cover, which determine the desirability of a range for snowshoes may be greatly affected by forest management practices.

One outstanding point brought out by this study was the need of low, dense cover on an area to make it habitable for the hares. This need was particularly well met by young, coniferous or conifer-hardwood plantations and, in addition, such areas provided ample food if the stands were established on cutover lands. Upon reaching an age of about 25 years most of the plantations become less desirable although they may be used for cover if material from prunings or thinnings is left on the ground. The food supply at this age is also diminished and remains so until the age of about 40 years is reached when the crown canopy begins to open up, thereby encouraging the growth of an understory.

Areas which had been recently clearcut were never inhabited by hares even though food species were present in abundance. Thus is demonstrated the need for the protection afforded by advance growth and trees from the seedling stage on up. The most desirable ranges are those with a good interspersion of types so that the hares may find food, cover, etc. in their relatively short cruising radius. Large unbroken types would for the most part be either uninhabitable or would become so at some stage in their development.

Stands from the immature to mature stage are used if the canopy is broken enough to allow the growth of an understory. This is greatly aided by establishing mixed hardwood-softwood stands. Instances were noticed where forms were located in such stands.

Thinnings are favorable to the snowshoes when the material is left on the ground. The result, in addition to providing cover, is favorable to letting in more light, and encouraging the growth of the understory. Weeding operations provide an abundance of material for cover and promote hardwood sprout growth.

Small refuges containing dense cover and within reach of an ample food supply would be particularly favorable to the population of hares in this region where the hunting pressure is too great.

In central Massachusetts the control of hunting and the provision for areas containing suitable cover should receive first attention in attempting to initiate a plan of management for these animals, since food is not limiting in this region.

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CONCLUSIONS

1. Apples proved to be very satisfactory bait for taking the hares in live traps until the arrival of freezing weather when alfalfa hay was successfully substituted.

2. The animal on which the best data were obtained lost weight up to 100 grams upon the arrival of cold, snowy weather. By April and May this loss had been made up.

3. The fall change in the color phase of the hares occurred between mid-November and the last of December. The spring change took place between mid-March and the last of April.

4. There was a marked increase in size of the testes by the middle of February, and by March 15 they had reached maximum size. Therefore, the breeding season may commence in the latitude of central Massachusetts during the last two weeks of March.

5. A local spring migration took place during March and the fore part of April.

6. The low-hanging branches of young coniferous trees provided the most desirable location for forms, for shelter during storms, and for cover in the daytime when the hares are largely inactive. Numerous instances were observed where short rest periods were taken during the night activity. At such times the animals sat beside tree trunks, on small hummocks, etc.

7. Although an unfrozen puddle of water was available throughout the winter, no tracks were seen around it which would indicate that

the hares had come there for water. Several were observed to take a few mouthfuls of snow upon being released from a trap.

8. The night activity of the snowshoes was found to be practically continuous from dusk until dawn in favorable weather. They are largely inactive during moderate and heavy snowstorms.

9. The droppings of the snowshoe are quite consistent in size, being rather large and more or less compressed, while some individual droppings of the cottontail were found to be practically identical with those of the snowshoe.

10. The population density on the study area was found to be one hare to approximately seven and one-half acres.

11. Palatability ratings of the food species were obtained by correlating feeding data with the relative availability of the species. This was arrived at by a modification of the method used by the U. S. Forest Service in making a range survey. Using two different methods of calculation in arriving at the final palatability ratings and exercising personal judgment in interpreting the data it was found that wintergreen was the preferred species. Following it were red oak, red maple, Norway spruce, and diervilla. Closely approaching these in importance were lowbush blueberry, hemlock, and chestnut. Red pine and witch hobble were not eaten at all. These conclusions are based on 2535 observations of forty species.

12. Hares were found to only inhabitat ranges with ample evergreen cover. Food was not a limiting factor for the snowshoes observed during the present study. One group of coniferous plantations with

an undergrowth of hardwood sprouts and shrubs provided a home range for at least two or three hares during the winter.

13. The average daily range following a snowfall was 7.2 acres and for the second and third successive days was found to be from 10.8 to 18.0 acres.

14. The depth of snow, whether or not it has a frozen crust on top, and the food supply are some of the factors which determine the area of the daily range. The average winter range as based on the movements of two snowshoes was found to be 32.1 acres.

15. It was found that weedings, thinnings, and some other forest management practices were favorable to the hares. Coniferous or conifer-hardwood plantations were especially well liked. Clear-cutting or any practice which destroys the cover is detrimental to the snowshoe. Control of hunting and provision for cover are the factors which should receive first attention in managing the snowshoe hare in central Massachusetts.

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