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Mammal Damage and Movements of Deer Mice in South Dakota Shelterbelts

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MAMMAL DAMAGE AND MOVEMENTS OF DEER MICE IN SOUTH DAKOTA SHELTERBELTS

BY

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This thesis is approved as a creditable and independent investigation by a candidate for the degree, Master of Science, and is acceptable for meeting the thesis requirements for this degree. Acceptance of this thesis does not imply that the conclusions reached by the candidate are necessarily the conclusions of the major department.

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MAMMAL DAMAGE AND MOVEMENTS OF DEER MICE IN SOUTH DAKOTA SHELTERBELTS

Abstract

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A study was initiated to examine animal damage to new shelterbelts in Brookings County, South Dakota. Feeding preferences of deer mice (Peromyscus maniculatus), prairie voles (Microtus ochragaster), and cottontail rabbits (Sylvilagus floridanus) was conducted on 5 woody species that commonly occur in South Dakota shelterbelts. Movements of deer mice were studied in a mature shelterbelt using a smoked kymograph tracking technique.

Green ash (Fraxinus pennsylvanica Marsh.), tatarian honeysuckle (Lonicera tatarica L.), and common lilac (Syringa vulgaris L.) were the most common tree species encountered in this study. Of the trees examined, 398 (8.9%) sustained animal damage over the winter. Dogwood (Cornus stolonifera Michx.) received significantly more damage than the other species. Conifer trees received significantly less damage than deciduous trees. Branch damage occurred on 170 of the damaged trees. Rabbits fed on 77.8% of the trees that received damage.

There was a significant difference in the amount of feeding between deer mice and prairie voles in laboratory studies. The rodents preferred honeysuckle and avoided ponderosa pine (Pinus ponderosa Laws.). Rabbits preferred Siberian elm (Ulmus pumila L.) and honeysuckle and avoided ponderosa pine.

Average home range size was 0.06 hectares. Movement occurred more on the ground and lower elevations in trees compared to levels at higher elevations. At higher elevations deer mice moved significantly more in green ash and hackberry (Celtis occidentalis L.) than other tree species.

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INTRODUCTION

Planting of shelterbelts in South Dakota began in 1873 with passage of the Timber Culture Act (Griffith 1976). Many trees were planted during the Prairie States Forestry Project which was initiated in 1935 and terminated in 1942 (Griffith 1976). Approximately 32,180 kilometers of shelterbelts were planted during that time representing < 3% of the total land area (Griffith 1976). Shelterbelts comprise 1.1% of the land area within the eastern portion of South Dakota (Walker and Suedkamp 1977).

Acreage of shelterbelts is decreasing in the Great Plains due to intensification of agriculture (Griffith 1976). Walker and Suedkamp (1977) reported that over 7,200 hectares of shelterbelts in South Dakota changed from good condition to poor condition over the last 22 years. They estimated that in the next decade another 16,529 hectares of shelterbelts will deteriorate. Howard (1979) thought that hectares of shelterbelts might increase because of more and larger shelterbelts planted.

Protection from animals is important in establishing tree plantings (Bagley 1976). Information on effects of animal damage will be valuable if shelterbelt planting in the Great Plains increases in the future. Sartz (1970) found that damage varied among tree species and among types of plantings in Wisconsin. He also observed that 90% of trees planted in some areas received damage from animals and 64% of the damaged trees died. Black et al. (1979) reported that 30% of unprotected trees in Washington and Oregon received damage and 14% of

newly planted trees died from injuries sustained from animals. Baer (1980) reported that up to 100% of trees of certain species were damaged by rabbits in 1 shelterbelt in eastern South Dakota.

Shelterbelts are important habitat for wildlife. They supply elevated song and display perches for breeding birds and resting and feeding stations for transient birds (Martin 1978). Pheasants (Phasianus colchicus) utilize shelterbelts for winter cover (Kimball et al. 1956) and for nesting cover (Vandel 1980). Whitetailed deer (Odocoileus virginianus) use shelterbelts throughout the year (Richardson and Peterson 1974, Popowski 1976). Fox squirrels (Sciurus niger) find nesting cover, food, and winter cover in shelterbelts and woodlots (Trippensee 1948). Cottontail rabbits (Sylvilagus floridanus) thrive on agricultural lands where cropland, grassland, and woodlots are well distributed (Haugen 1942).

Shelterbelts are important to man because they increase crop production and reduce soil erosion (Goldsmith 1976). Shelterbelts result in better distribution of soil moisture (Frank et al. 1976) and they modify the microclimate (Rosenberg 1976). Because of the importance of shelterbelts to wildlife and man, it is important to understand relationships between small mammals and shelterbelts. The hypotheses tested in this study were: 1) rabbits and prairie voles (Microtus ochragaster) damage and feed upon deciduous trees more than coniferous trees, 2) prairie voles feed upon woody species more than deer mice (Peromyscus maniculatus) feed on woody species and both species feed upon deciduous trees more than coniferous trees under controlled

laboratory conditions, and 3) deer mice exhibit more arboreal movements than prairie voles and short tailed shrews (Blarina brevicauda).

STUDY AREA

The shelterbelts studied were located in Brookings County, South Dakota. Brookings County (T112N-T109N; R52W-R47W) is in the Coteau des Prairies region of eastern South Dakota. The topography varies from flat to undulating hills. Brookings County has one of the highest shelterbelt densities in eastern South Dakota with 2.9 shelterbelts planted per 259 hectares (Walker and Suedkamp 1977). Agriculture is the predominant industry throughout the study area.

Climate is continental, influenced by air masses from northern regions and from the Gulf of Mexico. Seasonal and daily temperatures fluctuate greatly and range from a mean of -10 C in January to 23 C in July (Westin 1959). Average precipitation is 54.9 cm per year and average snowfall is 62.53 cm per year (Westin 1959).

Soils vary from level medium to fine textured in the bottomlands to gently sloping medium textured in the central upland. Soil types in the county are Regasol, Humic Gley, Soloth, and Chernozem (Westin 1959). Tree species planted in shelterbelts vary according to soil type.

Shelterbelts vary in size and composition and are comprised of a variety of tree and shrub species. Green ash (Fraxinus pennsylvanica Marsh.), Siberian elm (Ulmus pumila L.), and tartarian honeysuckle (Lonicera tatarica L.) are dominant species (Walker and Suedkamp 1977).

METHODS

Animal Damage Survey

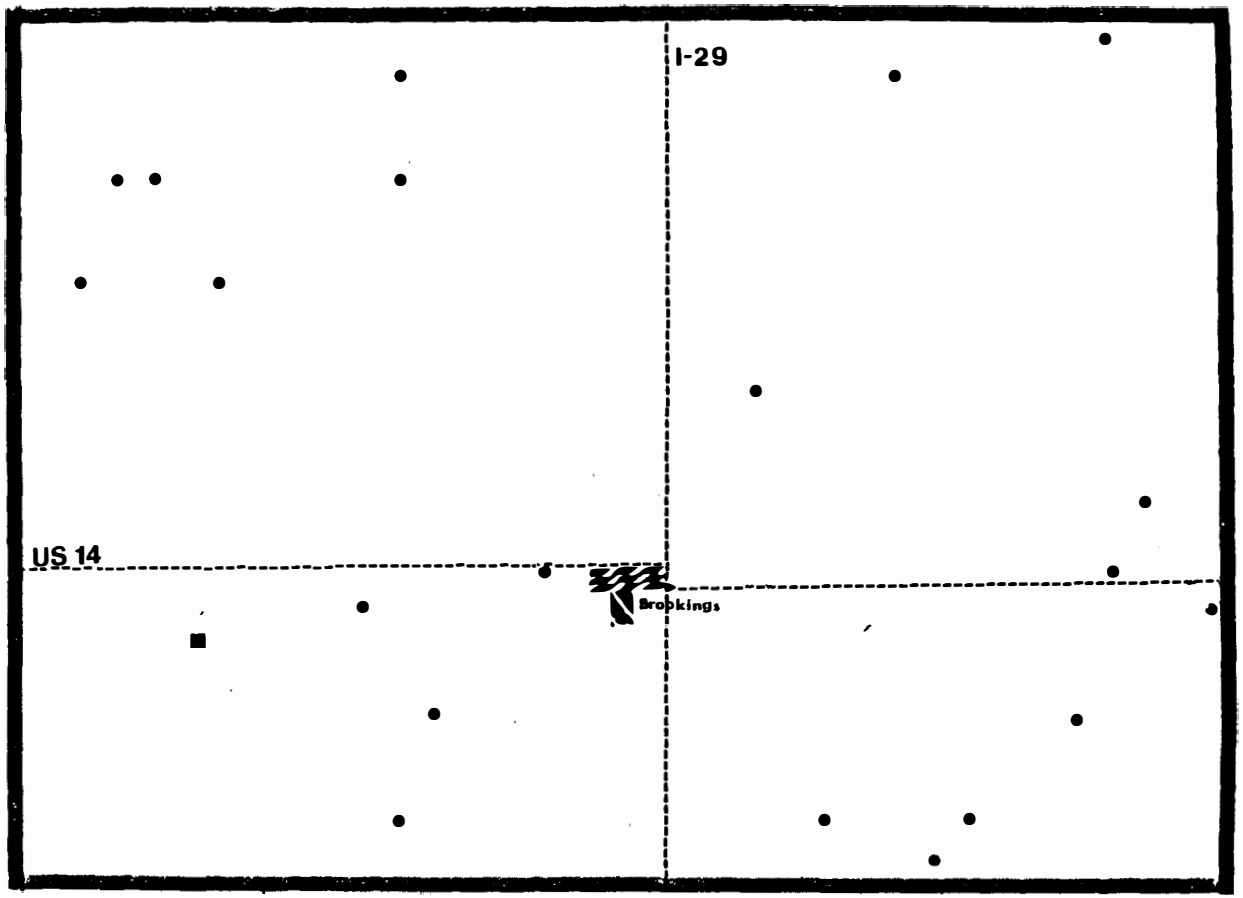
Animal damage surveys were conducted in fall 1980 and spring 1981 on 19 shelterbelts planted in 1980 (Figure 1). If shelterbelts were less than 61 meters long, each tree in that shelterbelt was examined. Shelterbelts longer than 61 meters were divided into 15.25 meter quadrats and trees in 4 random quadrats were examined.

Identification of types and causes of damage followed characteristics as described by Pearce (1947) and Lawrence et al. (1961). Feeding by voles has a finely gnawed appearance lacking distinct tooth marks. Rabbits leave clean knife-like oblique cuts on stems and branches. Deer and livestock, lacking upper incisors, leave a splintered break on stems and buds. Livestock damage was identified by wool, hair, tracks, and feces. Deer also damage trees by destroying the bark when they polish their antlers.

When recording types of damage, individual trees were divided into 3 equal sections: base, lower stem, and upper stem. The type of damage was recorded as girdled (bark completely stripped around the tree) or scarred (bark not stripped completely around the tree). Branch damage (branches stripped of bark or clipped) and crown damage (tip or terminal bud damaged or clipped) were also recorded.

Slight damage was recorded if 0 to 33% of branches were damaged or if damage to the stem did not exceed more than a 33% girdle. Moderate damage was recorded if 34 to 66% of branches were damaged or if damage to the stem did not exceed 34 to 66% girdled. Severe damage was

Figure 1. Location of shelterbelts examined for damage to trees, Brookings County, South Dakota.



• location of first year shelterbelt plantings
■ location of mature shelterbelt

8 km

recorded if 67 to 100% of the branches were damaged or if the stem was girdled more than 67%.

Chi square goodness of fit test (Steel and Torrie 1980) was used to detect differences between tree species which were damaged.

Laboratory Feeding Preferences

Twelve deer mice, 12 prairie voles, and 12 cottontail rabbits were live trapped from shelterbelts and placed in individual cages with food (lab chow and rabbit bits) and water available at all times. The animals were acclimated to their surroundings for 5 days before feeding trials began.

One woody sample of ponderosa pine (Pinus ponderosa Laws.), eastern red cedar (Juniperus virginianus L.), green ash, Siberian elm, and tatarian honeysuckle was placed in each cage for 5 days. Samples were live twigs not larger than 1.5 cm in diameter and cut into 10 cm lengths for rodents and 50 cm lengths for rabbits as recommended by Timm (1979). After 5 days, the twigs were removed and the amount of gnawing was measured and recorded as percentage of bark removed: none, 25% or less, 26 to 50%, 51 to 75%, or 76 to 100%. The trials were repeated twice.

Analysis of variance was used to indicate differences in gnawing between rodent species and gnawing by rodents between tree species. Student-Newman-Keuls' (SNK) test was used to detect differences between mean gnawing values if analysis of variance indicated significant differences.

Movements of Rodents

Live trapping was conducted the first 10 nights of each month in a mature shelterbelt from April through October at each intersection of a 10 x 10 grid with 7.5 meter spacing (Otis et al. 1978) to capture animals for marking. Six columns of traps were placed inside the shelterbelt and 2 columns in each cornfield adjacent to the shelterbelt. Captured animals were toe clipped to identify the tracks of individual animals following procedures developed by Justice (1961). No more than 2 toes were clipped on the left rear foot from each animal.

Movements of deer mice were monitored by recording tracks of marked animals on smoked paper at tracking stations (Justice 1961, Sheppe and Carnes 1965). Tracking stations were open-ended milk cartons with sheets of 8.9 cm x 17.8 cm kymograph paper. The kymograph paper was covered with residue from benzene and natural gas smoke.

Tracking stations were placed in 5 tree species (tatarian honeysuckle, green ash, Siberian elm, ponderosa pine, and hackberry (Celtis occidentalis L.) at 61, 122, 183, and 244 cm above ground and at ground tracking stations. Papers were collected every other day during a 10 day tracking period 5 days after the study had been live trapped.

Three-dimensional home ranges were determined for a period May through September. A minimum of 3 capture points was necessary to calculate home range size.

Most workers using trapping do not measure 3-dimensional area within an animal's normal range and movements (Blair 1942, Storer et al. 1944). According to Sheppe and Carnes (1965) and Metzgar

(1973) the tracking method is superior to trapping because it reduces biases and home range estimates tend to be larger and more accurate.

The method of delineating home range size from recapture data varies (Stickel 1968). Methods used are: 1) drawing the smallest convex polygon containing all capture points, 2) using a minimum polygon connecting outside points of capture, 3) measuring recapture radii, and 4) determining the covariance matrix of capture points (Jennerich and Turner 1969). I used the fourth method because of its lack of bias and high statistical stability.

Chi square goodness of fit test (Steel and Torrie 1980) was used to determine differences in movement by deer mice between the 5 tree species and at the different height levels in each tree species.

RESULTS AND DISCUSSION

Composition of Shelterbelts

Seventeen species of trees occurred in the 19 new shelterbelts examined (Table 1). Green ash was found in 90% of the shelterbelts and comprised 21% of the trees in the quadrats (Table 1). Occurrence of common shrubs in shelterbelts was tatarian honeysuckle (65%) and common lilac (Syringa vulgaris L.) (35%). Common conifers were blue spruce (Picea pungens Englem.) (40%), Rocky Mountain juniper (Juniperus scopulorum Sarg.) (40%), and ponderosa pine (30%). Siberian elm and northwest poplar (Populus spp.) each occurred in only 5% of the shelterbelts and comprised < 1% of the trees examined.

Walker and Suedkamp (1977) reported that Siberian elm and American elm (Ulmus americana L.) occurred in 52 and 38% of shelterbelts, respectively, in the Sioux Falls district. I found no American elm and ≤ 1% Siberian elm. I found 3 species (dogwood--Cornus stolonifera Michx., robusta poplar, Populus spp., and northwest poplar) that they did not report. Compared to Walker and Suedkamp (1977) occurrence of the conifers blue spruce and Rocky Mountain juniper increased from 8 to 40% and ponderosa pine from 8 to 30%. Eastern red cedar, however, occurred in 18% of shelterbelts they examined and in 5% of the shelterbelts planted in 1980-1981.

Tree Survival

Tree survival varied from 30 to 100% over the first winter (Table 2). Trees with best survival were siberian elm (100%), northwest

Table 1. Occurrence of 3,541 trees and shrubs examined in 19 new shelterbelts in Brookings County, South Dakota, 1980.

Tree species	Number of trees	Percent of total trees	Percent occurrence
Green ash (*Fraxinus pennsylvanica*)	736	20.7	90.0
Honeysuckle (*Lonicera tatarica*)	722	20.4	65.0
Lilac (*Syringa vulgaris*)	420	11.9	35.0
Blue spruce (*Picea pungens*)	297	8.4	40.0
Hackberry (*Celtis occidentalis*)	261	7.4	55.0
Rocky Mountain juniper (*Juniperus scopulorum*)	246	6.9	40.0
Ponderosa pine (*Pinus ponderosa*)	208	5.9	30.0
Amur maple (*Acer ginnala*)	206	5.8	30.0
Dogwood (*Cornus stolonifera*)	138	3.9	15.0
Cottonwood (*Populus deltoides*)	59	1.7	20.0
Robusta poplar (*P. angulata* X *P. nigra*)	53	1.5	20.0
Caragana (*Caragana arborescens*)	51	1.4	5.0
Chinese elm (*Ulmus parvifolia*)	32	0.9	5.0

Table 1. Continued

Tree species	Number of trees	Percent of total trees	Percent occurrence
Red cedar (Juniperus virginianus)	31	0.9	5.0
White willow (Salix alba)	31	0.9	5.0
Northwest poplar (P. deltoides X P. balsamifra)	25	0.9	5.0
Siberian elm (Ulmus pumila)	25	0.9	5.0
TOTAL	3,541	100.0	

Table 2. Number of trees and shrubs dying from causes other than animal damage and survival of trees throughout the first winter in 19 shelterbelts in Brookings County, South Dakota.

Species	Number trees examined	Number dead in fall	Number dead in spring	Overall survival (%)
Green ash	736	60	60	91.8
Honeysuckle	722	43	93	87.1
Lilac	420	53	96	77.1
Blue spruce	297	56	93	68.7
Hackberry	261	8	19	92.7
Rocky Mountain juniper	246	45	77	68.7
Ponderosa pine	208	119	131	37.0
Amur maple	206	12	15	92.7
Dogwood	138	72	97	29.7
Cottonwood	59	33	38	35.6
Robusta poplar	53	8	15	71.7
Caragana	51	5	8	84.3
Chinese elm	32	2	5	84.4
Red cedar	31	1	3	90.3
White willow	31	3	4	87.1
Siberian elm	25	0	0	100.0
Northwest poplar	25	0	0	100.0
TOTAL	3,541	521	754	

poplar (100%), amur maple (Acer ginnala Maxim.) (93%), green ash (92%), hackberry (93%), and eastern red cedar (90%). Trees with poorest survival included dogwood (30%), ponderosa pine (37%), and cottonwood (Populus deltoides L.) (36%).

Many factors affect tree survival. The Soil Conservation Service reported that they received poor planting stock of cottonwood, dogwood, and ponderosa pine in 1980. This may have influenced survival greatly.

The care and maintenance of shelterbelts can also affect survival. The Soil Conservation Service recommends that shelterbelts be kept clean of vegetation for the first 5 years. All the shelterbelts in this study were void of vegetation between the rows, but many had forbs and weeds between the trees.

Animal damage can also affect tree survival. Hunt (1968) found that there was an average of 6.5% less survival of loblolly pine (Pinus taeda L.) due to animal damage. Black et al. (1979) attributed a 14% difference in survival due to animal damage.

Animal Damage Survey

Of the 2,787 trees examined in 1980, 403 had sustained animal damage by the following spring (Table 3). Of those trees, 326 (81%) received slight damage, 59 (15%) received moderate damage, and 18 (4.5%) received severe damage (Table 3).

Five trees were damaged in the fall by pocket gophers (Geomys bursarius) which resulted in death of those trees (Table 4). Over the winter 398 trees received damage. Tree species receiving

Table 3. Occurrence of animal damage to 2,787 trees and shrubs in 19 shelterbelts in Brookings County, South Dakota.

Species	Number of trees Examined	Damaged Slight 0 - 33%	Moderate 34 - 66%	Severe 67 - 100%	Total
Hackberry	242	58	13	5	76
Green ash	676	55	15	3	73
Lilac	324	66	4	0	70
Amur maple	191	45	16	1	62
Honeysuckle	629	27	4	0	31
Dogwood	41	21	4	3	28
Cottonwood	21	10	2	1	13
Northwest poplar	25	12	0	0	12
White willow	27	9	1	0	10
Caragana	43	7	0	2	9
Chinese elm	27	5	0	2	7
Robusta poplar	38	5	0	1	6
Siberian elm	25	3	0	0	3
Blue spruce	204	3	0	0	3
Red cedar	28	0	0	0	0
Rocky Mountain juniper	169	0	0	0	0
Ponderosa pine	77	0	0	0	0
TOTAL	2,787	326 (80.9%)[a]	59 (14.6%)	18 (4.5%)	403

[a]This is the percentage of total trees examined that were placed in that category.

Table 4. Number and percent of 2,787 trees and shrubs damaged from least to greatest in the fall and spring on 19 shelterbelts in Brookings County, South Dakota.

Species	Number of trees Examined	Damaged Fall	Winter	Percent	X^2
Rocky Mountain juniper	169	0	0	0.0	0.0
Ponderosa pine	77	0	0	0.0	0.0
Red cedar	28	0	0	0.0	0.0
Blue spruce	204	0	3	1.5	0.206
Honeysuckle	629	0	31	4.9	4.103*
Green ash	676	2	71	10.5	18.930*
Siberian elm	25	0	3	12.0	0.752
Robusta poplar	38	0	6	15.8	2.929
Caragana	43	1	8	18.6	5.301*
Lilac	324	0	70	21.6	51.816*
Chinese elm	27	0	7	22.2	6.482*
Hackberry	242	0	76	31.4	90.465*
Amur maple	191	0	62	32.5	66.212*
White willow	27	0	10	37.0	13.028*
Northwest poplar	25	0	12	50.0	26.809*
Cottonwood	21	2	11	52.4	26.154*
Dogwood	41	0	28	68.3	99.121*
TOTAL	2,787	5	398		

*Significant difference in the number of trees damaged compared to the preceding species using chi-square analysis.

heaviest damage during the winter were dogwood (68%), cottonwood (52%), and northwest poplar (50%). Dogwood received significantly more ($P \leq 0.05$) damage than all other species (Table 4). Honeysuckle, green ash, Siberian elm, and robusta poplar received significantly less ($P \leq 0.05$) damage than other deciduous species.

McCabe (1945) found that cottonwood was rarely damaged and willows (Salix spp.) were severely damaged. He also reported heavy damage to Chinese elm (Ulmus parvifolia L.) and hackberry, and light damage to dogwood, green ash, and lilac. I observed severe damage to dogwood and light damage to willows, Chinese elm, and hackberry. Species with similar damage between the 2 stduies were green ash, lilac, and honeysuckle.

Coniferous species received significantly less ($P \leq 0.05$) damage than deciduous species. Baer (1980) observed similar results on rabbit damage in a shelterbelt in Kingsbury County, South Dakota. He reported that 24% of ponderosa pine trees were damaged while 100% of lilac, crab apple (Malus sp.), and hackberry trees were damaged. McCabe (1945) reported that eastern red cedar and jack pine (Pinus banksiana Lamb.) were the only coniferous species receiving damage. He also observed that several deciduous species received extensive damage including willows, Chinese elm, hackberry, birches (Betula spp.), oaks (Quercus spp.), and fruit trees. Dalke and Sime (1941) reported that rabbits preferred deciduous species over red pine (Pinus resinos Ait.) and white pine (Pinus strobus L.).

Branch damage was found on 170 (42%) of the trees (Table 5). Of this number, 122 received slight damage, 35 moderate damage, and 13

Table 5. Type, number, and percent of trees and shrubs damaged in Brookings County, South Dakota, study areas.

Area damaged	Number damaged	Percent damaged
Stem		
upper	23	5.7
middle	55	13.7
basal	16	4.0
total	94	23.4
Branch		
slight	122	30.4
moderate	35	8.7
heavy	13	3.2
total	170	42.3
Crown	138	34.2
TOTAL	403	99.9

heavy damage. Crown damage was the second most common form of damage. Crowns were damaged on 138 (34%) of the trees. Ninety-four (23%) trees received stem damage. Of this number, 23 received slight damage in the upper stem region, 55 in the mid stem region, and 16 in the basal region.

Cottontail and whitetailed jackrabbits (Lepus townsendii) damaged 78% (313 trees) of the trees examined, voles damaged 8%, and deer 7% of the trees (Table 6). Cattle and pocket gophers caused the least amount of damage. Staebler et al. (1954) and Black et al. (1969, 1979) have reported rabbits to be one of the major causes of animal damage in the Pacific northwest.

Rodent damage was less severe than rabbit damage. Due to a lack of snow cover, small mammals may have had adequate food sources without feeding on trees.

Several trees were damaged by livestock. These injuries could have been prevented with adequate fencing around the shelterbelts.

Overall, shelterbelt damage was not severe. Those trees damaged usually had branches clipped or crowns removed. The crown damage was caused by livestock and deer and usually occurred on shrubs. In a more severe winter, food could become scarce for animals and more damage to trees might occur.

Laboratory Feeding Preferences

Differences in the amount of gnawing between deer mice and prairie voles were significant (ANOVA; $P \leq 0.05$) (Appendix table 1). Significant differences (ANOVA; $P \leq 0.05$) were also present in the amount of gnawing on individual species of trees by all 3 animal species (Appendix table 2).

Table 6. Animals causing damage, number of trees damaged, and percent of trees and shrubs damaged in Brookings County, South Dakota, study areas.

Species causing damage	Number of trees damaged	Percent damage
Rabbit	313	77.8
Vole	33	8.2
Deer	27	6.7
Sheep	24	5.9
Cattle	4	0.7
Pocket gopher	3	0.7
TOTAL	403	100.0

Honeysuckle was gnawed significantly more ($P \leq 0.05$) than other woody species by both deer mice and prairie voles (Table 7). Ash and Siberian elm were gnawed significantly more ($P \leq 0.05$) than pine or cedar by both mice species. In Illinois, Jokela and Lorenz (1959) observed that deciduous trees were generally preferred food items over coniferous trees by Microtus spp. They found that up to 60% of ash trees were damaged and pine and cedar had less than 16% damage. Dice (1945) and Littlefield et al. (1946) found that pine was preferred over other woody species in coniferous plantings. Cayford and Haig (1961) and Sartz (1970) found that pine and fir (Abies spp.) were preferred and spruce avoided.

Elm and honeysuckle were gnawed significantly more ($P \leq 0.05$) than pine, cedar, and ash by rabbits (Table 8). All deciduous tree species were gnawed more than pine.

The preference for elm over other woody species by rabbits has been reported previously. McCabe (1945) found elm to be highly preferred over other woody species. He also reported that honeysuckle was moderately preferred and pine, cedar, and ash were rarely preferred. Dalke and Sime (1941) found that elm was preferred, pine was slightly preferred, and ash was avoided.

Movements of Rodents

During the 7 month live-trapping period, 73 animals were captured 133 times (Table 9). Deer mice and short tailed shrews were captured most frequently. Voles were captured most frequently in the spring and short tailed shrews were captured most often in September.

Table 7. Ranking of mean gnawing values of deer mice and prairie voles based on Student-Newman-Keul test.[a]

Dear mice	Pine	Cedar	Ash	Elm	Honeysuckle
Mean	0.17	0.71	1.50	1.75	3.38
Standard Error	0.10	0.29	0.30	0.34	0.29
Prairie vole					
Mean	0.79	1.00	2.00	2.21	3.88
Standard Error	0.26	0.31	0.34	0.27	0.12

[a]Underscored lines indicate that means are the same (connected by a continuous line) and those that are significantly ($P \leq 0.05$) different (discontinuous line).

Table 8. Ranking of mean gnawing values of cottontail rabbits based on Student-Newman-Keul test.[a]

Species	Pine	Cedar	Ash	Honeysuckle	Elm
Mean	1.29	1.42	1.79	2.13	2.83
Standard Error	0.26	0.24	0.29	0.24	0.27

[a]Underscored lines indicate that means are the same (connected by a continuous line) and those that are significantly ($P \leq 0.05$) different (discontinuous line).

Table 9. Animal species captured and the number of captures of each species by months in a mature shelterbelt in Brookings County, South Dakota, 1980.

Animal species	Individuals captured	Total captures by month							
		April	May	June	July	August	September	October	Total
Deer mice	26	13	9	4	8	11	2	4	51
Short tailed shrew	25	0	0	1	10	3	27	2	43
Prairie vole	9	6	9	7	1	0	0	0	23
Meadow jumping mice	3	0	0	0	1	0	4	0	5
Thirteen lined ground squirrel	6	0	0	0	5	2	0	0	7
Eastern fox squirrel	2	0	0	0	1	1	0	0	2
Short tailed weasel	1	0	0	0	0	0	1	0	1
Cottontail rabbit	1	0	0	0	0	0	1	0	1
TOTAL	73	19	18	12	26	17	35	6	133

Deer mice were captured every month and their movements were statistically analyzed. Insufficient data were available to analyze movements of other species or to test the third hypothesis. During the 7 month study 813 boards were tracked by deer mice (Appendix table 3). Track counts indicated that most movements occurred in July, August, and September.

Deer mice exhibited substantial arboreal movement with significantly more ($P \leq 0.05$) movement occurring at lower elevations (Table 10). Previous studies showed that deer mice were good climbers (Meserve 1977, Rosenzweig et al. 1975). They moved as high as 245 cm which is higher than other studies have reported for Peromyscus maniculatus (Holbrook 1979) and Peromyscus californicus (Meserve 1977). Several authors concluded, however, that deer mice were primarily terrestrial when they coexisted with other cricetids (Meserve 1976, Holbrook 1979).

Deer mice moved significantly more ($P \leq 0.05$) in green ash than in hackberry trees in September (Table 11). They also moved significantly more ($P \leq 0.05$) in green ash and hackberry than in the other tree species in September. Deer mice moved significantly less ($P \leq 0.05$) in pine than other trees during August and September.

There are many reasons that rodents climb trees. Meserve (1977) suggested that behavioral patterns including exploration, escape from predators, foraging, and social interaction explained part of their climbing activities. Competition may also be important in partitioning movements into 3 dimensions (Taylor and McCarley 1963, Layne 1970, Matson 1974, Holbrook 1979). It is possible that

Table 10. Number of boards tracked by deer mice during July, August, and September 1981 in a mature shelterbelt in Brookings County, South Dakota.

Height at which boards were tracked	Number of boards with tracks from deer mice		
	July	August	September
Ground	84[a]	58[a]	48[a]
61 cm	59[b]	75[a]	41[a]
123 cm	42[b]	43[a]	28[b]
184 cm	18[c]	34[b]	26[c]
245 cm	12[c]	25[b]	17[c]
TOTAL	215	235	160

[a], [b], [c]Indicates that those numbers in each column with the same letter are not significantly different ($P \geq 0.05$) and those with different letters are significantly different ($P \leq 0.05$).

Table 11. Total number of deer mice tracks on boards during July, August, and September 1981 in a mature shelterbelt in Brookings County, South Dakota.

Tree combinations	Number of boards tracked by deer mice		
	July	August	September
Green ash vs. hackberry	63 vs. 56	76 vs. 65	60 vs. 37*
Green ash, hackberry vs. elm	119 vs. 43	140 vs. 48	97 vs. 28*
Green ash, hackberry, elm vs. honeysuckle	162 vs. 24	188 vs. 24	125 vs. 22
Green ash, hackberry, elm, honeysuckle vs. pine	186 vs. 29	202 vs. 23*	147 vs. 13*

*Indicates a significant difference ($P \leq 0.05$) within months using chi-square goodness of fit test, in movement by deer mice between tree combinations listed.

competition existing between other species of mice and deer mice caused the deer mice to move in the trees.

Holbrook (1979) found that cricetids did not prefer to move in a specific taxa of tree or shrub. She stated that most of the arboreal movement occurred on logs and small shrubs. McCloskey (1975) and Meserve (1977) found that height, angle, and diameter of branches were related to climbing behavior. Meserve (1976, 1977) also found that arboreal movement was related to the use of fruits and foliage in certain bushes. Deer mice may prefer to eat the fruits of green ash compared to other species. They may also eat hackberry fruits and use hackberry trees for nesting. I found 6 nests in hackberry trees, 2 nests in pine, and 1 nest in honeysuckle at the 184 and 245 cm levels. Stah (1980) observed that deer mice and white footed mice (Peromyscus luecopus) nested as high as possible under experimental conditions. Nicholson (1941) found that white footed mice preferred nest boxes in trees compared to boxes on the ground. Deer mice avoided feeding and moving in pine trees.

Home range size of the 5 mice studied varied from 0.04 hectares to 0.08 hectares, with a mean area of 0.06 hectares. Figures 2 and 3 show the area of movement by the 2 most active mice. The size of home ranges is comparable to those reported by Storer et al. (1944). They found that home range size varied from 0.049 to 0.097 hectares in a California transition zone forest. In a Michigan beech-maple forest, Blair (1942) found that home range size varied from 0.36 to 0.93 hectares. Stickel (1968) summarized home range size for all species in the genus Peromyscus.

Figure 2. Movements of mouse L1 and location of capture points. Dots indicate points at which the mammal was tracked. Numbers indicate how many times the mammal was tracked at that location.

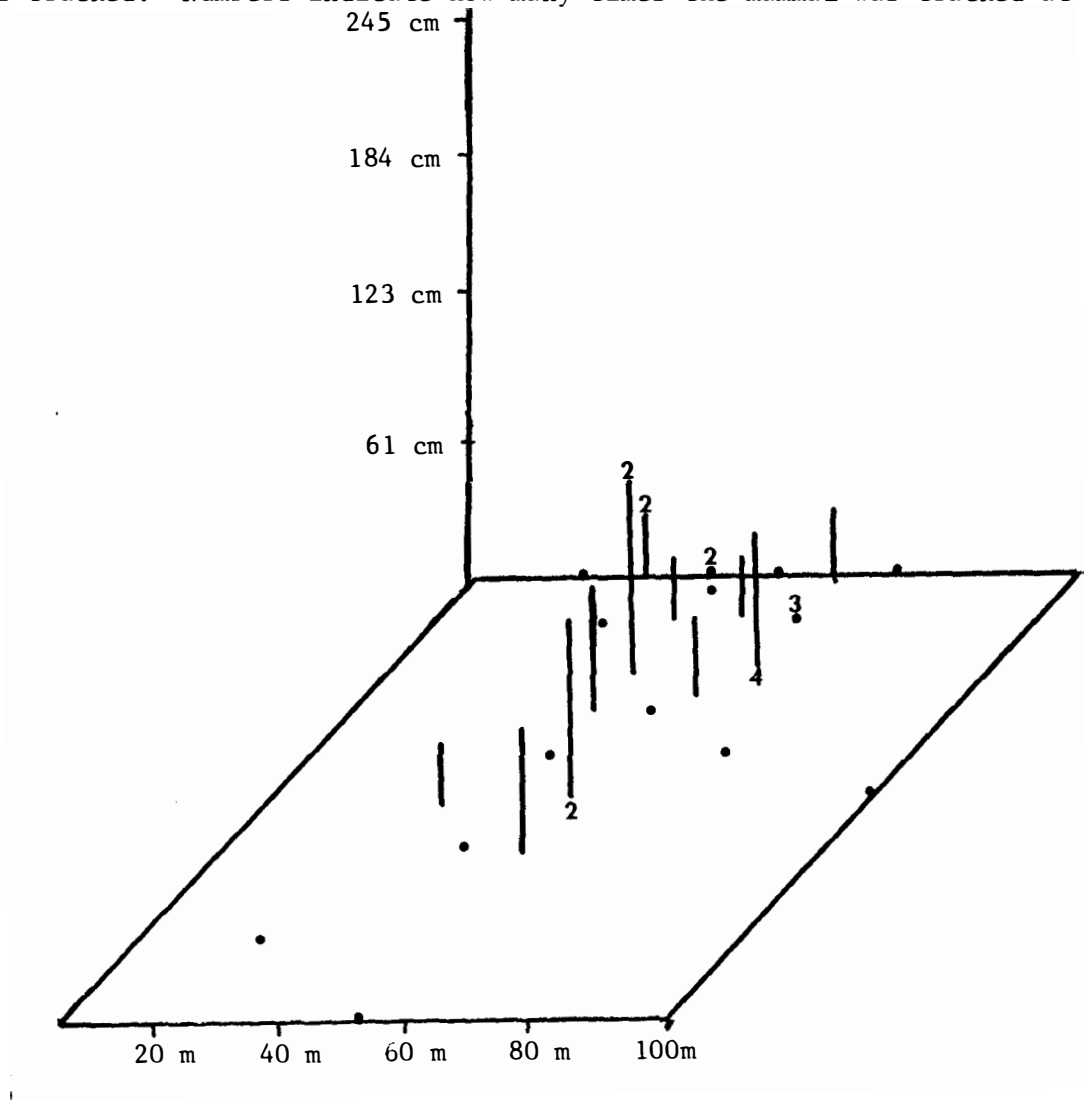
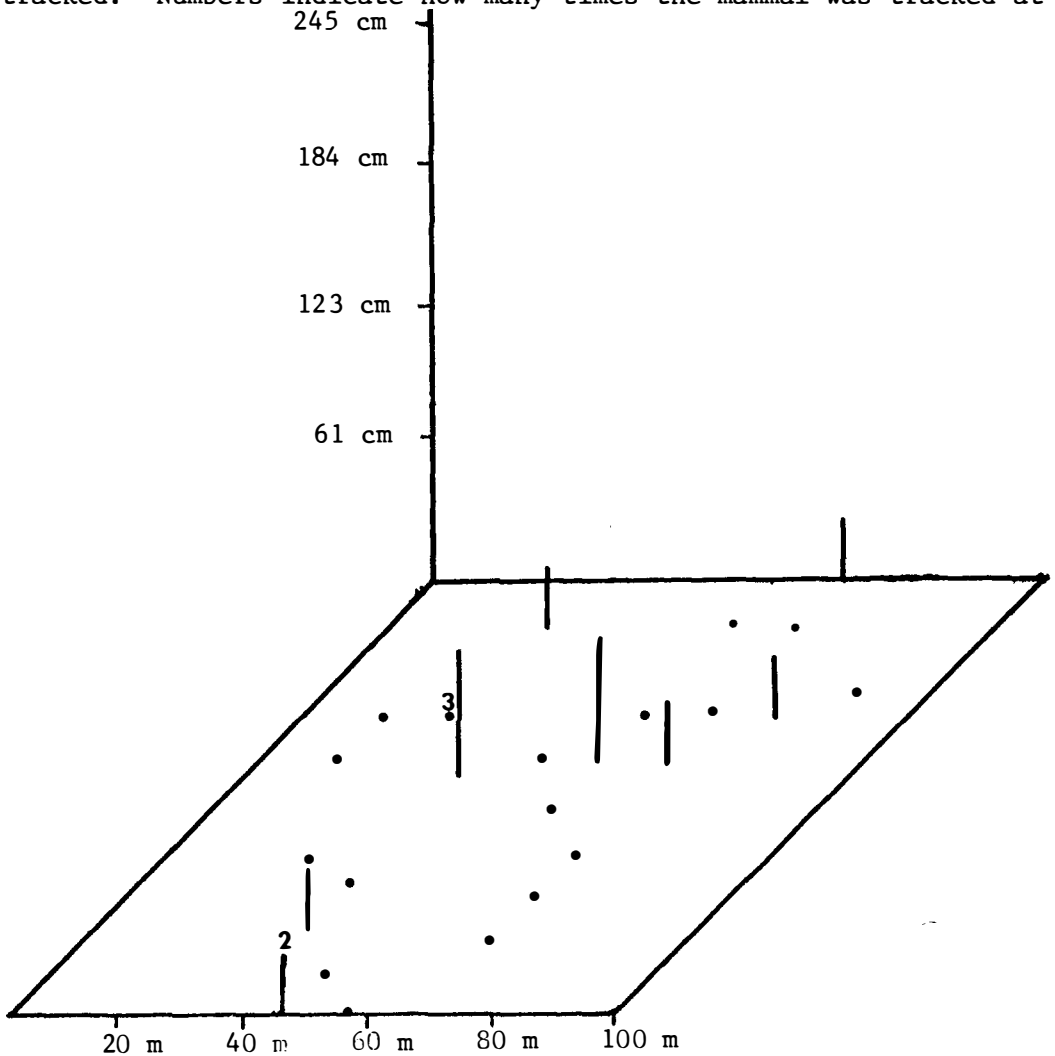


Figure 3. Movements of mouse L4 and location of capture points. Dots indicate points at which the mammal was tracked. Numbers indicate how many times the mammal was tracked at that location.



CONCLUSIONS

Animal damage in the shelterbelts I examined was not severe enough to warrant control. The winter was a mild one and the possibility exists that in winters with heavy snow, damage could become severe. When food supplies dwindle, the animals, particularly rabbits, could attack the young supple browse and damage some shelterbelt plantings.

There was a tendency for both rabbits and rodents to prefer feeding upon the deciduous trees more than coniferous trees. Dogwood was the most severely damaged species and the coniferous species were the least damaged by animals. Rabbits caused the most damage to young trees.

No studies have been conducted on home ranges of deer mice in shelterbelts and no direct comparisons can be made on home range size. Shelterbelts are unique wooded areas and have a tendency to be long and narrow, rarely encompassing more than 4 hectares. Because of limitations on size of shelterbelts, it might be possible that the ranges of deer mice are reduced and they rely more on arboreal movement in their daily travels. Deer mice preferred to move in green ash and hackberry trees and this movement generally occurred in the lower elevations of trees.

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APPENDIX

Appendix table 1. Analysis of variance of gnawing values on trees by mice.

Source of variation	Sum of squares	DF	Mean square
Mouse	13.537	1	13.537*
Tree	286.025	4	71.506*
Mouse x Tree	1.942	4	0.485
Residual Var.	414.941	230	1.804
Total	716.445	239	

*Indicates a significant difference at $P < 0.05$.

Appendix table 2. Analysis of variance of gnawing values by cottontail rabbits for 5 woody species.

Source of variation	Sum of squares	DF	Mean square
Tree	36.09	4	9.023*
Residual Var.	245.67	115	2.136
Total	281.76	119	

*Indicates a significant difference at $P < 0.05$.

Appendix table 3. Number of boards tracked by deer mice by month and tree species in a mature shelterbelt in Brookings County, South Dakota.

Month	Number of boards tracked					
	Siberian elm	Ponderosa pine	Green ash	Hackberry	Honeysuckle	Total
April	5	0	0	3	0	8
May	12	13	17	17	6	65
June	11	12	26	22	11	82
July	43	29	63	56	24	215
August	48	23	76	64	24	235
September	28	13	60	37	22	160
October	10	3	21	10	4	48
Total	157	93	263	209	91	813