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Food Preferences Of The White-Tailed Deer

(ODOCOILEUS VIRGINIANUS BOREALIS)
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KHUSHAL HABIBI

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FOOD PREFERENCES OF THE WHITE-TAILED DEER
(ODOCOILEUS VIRGINIANUS BOREALIS)
IN MICHIGAN

By

Khushal Habibi

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ABSTRACT

FOOD PREFERENCES OF THE WHITE-TAILED DEER (ODOCOILEUS VIRGINIANUS BOREALIS) IN MICHIGAN

By

Khushal Habibi

A study of food preferences of the white-tailed deer was conducted in three geographic regions in Michigan during the spring of 1979.

Food habits of deer were found to vary considerably between the ecological regions. Plants which were favored in one area often were neglected in another area where more palatable species were available. Preference ratings were not correlated with the abundance of particular species found in each locality.

Common elderberry, staghorn sumac, juneberries, red-osier dogwood, silky dogwood and gray dogwood were preferred region-wide in the southern part of the state. The dogwoods and juneberries showed the heaviest browsing in this area. In the north-central part of the lower peninsula nannyberry, quaking aspen, silky dogwood, red maple, American elm, sweetfern, willows and red and white oak were selected by deer while gray dogwood, red maple, American elm and sweetfern were utilized in large quantities. Preferred foods in the western part of the upper peninsula were red maple,

juneberries, American elm, red raspberry and a honeysuckle species. At this location, red maple, American elm, juneberries and balsam fir constituted the main bulk of the deer's diet.

American yew and white cedar, generally accepted to be highly-preferred white-tailed deer forages in the northeastern temperate forests were not encountered on the study plots. Their complete absence from the range possibly indicates that these species have been eliminated or drastically reduced from mainland habitats due to overbrowsing. Common elderberry seemed to be generally overbrowsed and possibly becoming much reduced by abundance. It was present only in small numbers over most of the range. Nannyberry and staghorn sumac were also utilized extensively where they occurred.

Over-utilization of preferred deer forages provides further evidence of over abundant deer throughout the state. Deer are too abundant for the present range to support. Widespread and intensive cuttings of forests, woodlots and small-holdings is called for to regenerate vegetative habitats. This can only be successful, however, where deer numbers are adequately reduced.

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INTRODUCTION

Those foods which are proportionately more frequent in the diet of an animal population than in the available habitat may be termed preferred foods. Species which are less abundant among the total foods consumed than in the available forage are known as neglected (or totally avoided) foods. Those foods which are eaten exactly to the extent to which they are available in the habitat, are neither preferred nor neglected and are considered neutral with regard to the feeding preferences of the consuming animal (Petrides 1975). Regardless of preference, principal foods are here regarded as those which constitute the main bulk of the diet.

Food preference studies have important ecological significance. As preferred species tend to be eaten heavily, they are depleted first and may be referred to as "decreaser" species in the habitat. The neglected species in turn, are "increasers" where grazing pressure is not severe. By measuring the available vegetation and the amounts consumed, the degree of utilization for particular species can be calculated. By determining the severity and persistence of forage species utilization, habitat trends toward improvement or degradation becomes evident. The suitability of the range for a given herbivore population and the range capacity to withstand use can be evaluated.

In this study, winter diets and browse preferences were reviewed for the northern woodland white-tailed deer (Odocoileus virginianus borealis) in Michigan. Evaluation was made of deer winter browsing habits at five sites in three widely-separated Michigan localities. The investigation was undertaken to establish guidelines to possible further research.

Objectives

The effort was made to determine in each area which forage species are preferred above others and which are important in the deer's diet in terms of bulk composition. The investigation was made to see to what extent browse use and preference values vary by geographic regions. Comparisons also were made for different sites within regions. Still further, since calculation for abundance and utilization can be made either by twig weights or numbers, the attempt was made to see which method was more suitable.

In this study, browse preference ratings were calculated only for winter. This season is when food resources tend to limit animal survival.

Study Areas

For a number of decades, the Michigan Department of Natural Resources (DNR) and its predecessor agencies have recognized three administrative regions which have distinctive

ecological and land use characteristics. A wildlife research station of the DNR is located in each region.

In the farmlands of southern Michigan, the Rose Lake Wildlife Research Station comprises 1350 ha. of relatively infertile lands situated astride the Clinton-Shiawassee county line (Figure 1). The original farms were abandoned during the great economic depression of the 1930's and were assigned to the DNR. A portion of muckland, known locally as Corey Swamp, also occurs on the Rose Lake Station. Two study sites were located on both upland and muck soil types in sections 13, 14, 23 and 24 of T5N, R1W.

The Houghton Lake Wildlife Research Station has a central location in the state's lower peninsula (Figure 1). Situated in Roscommon county, partly along the Muskegon river, the area is almost 90 sq. km. in size. Observations were confined to lowland deer habitats in the north-western part (sections 1, 2, 6, 11 and 12 T22N, R4W) and also two upland wooded areas on rolling hills in an adjacent township (sections 10 and 15 T24N, R3W).

The Cusino Wildlife Research Station in Alger County of the Upper Peninsula includes a 256 ha. fenced area (sections 19 and 30 T46N, R17W) in which, as on the above areas, deer food habits and forage utilization were appraised.

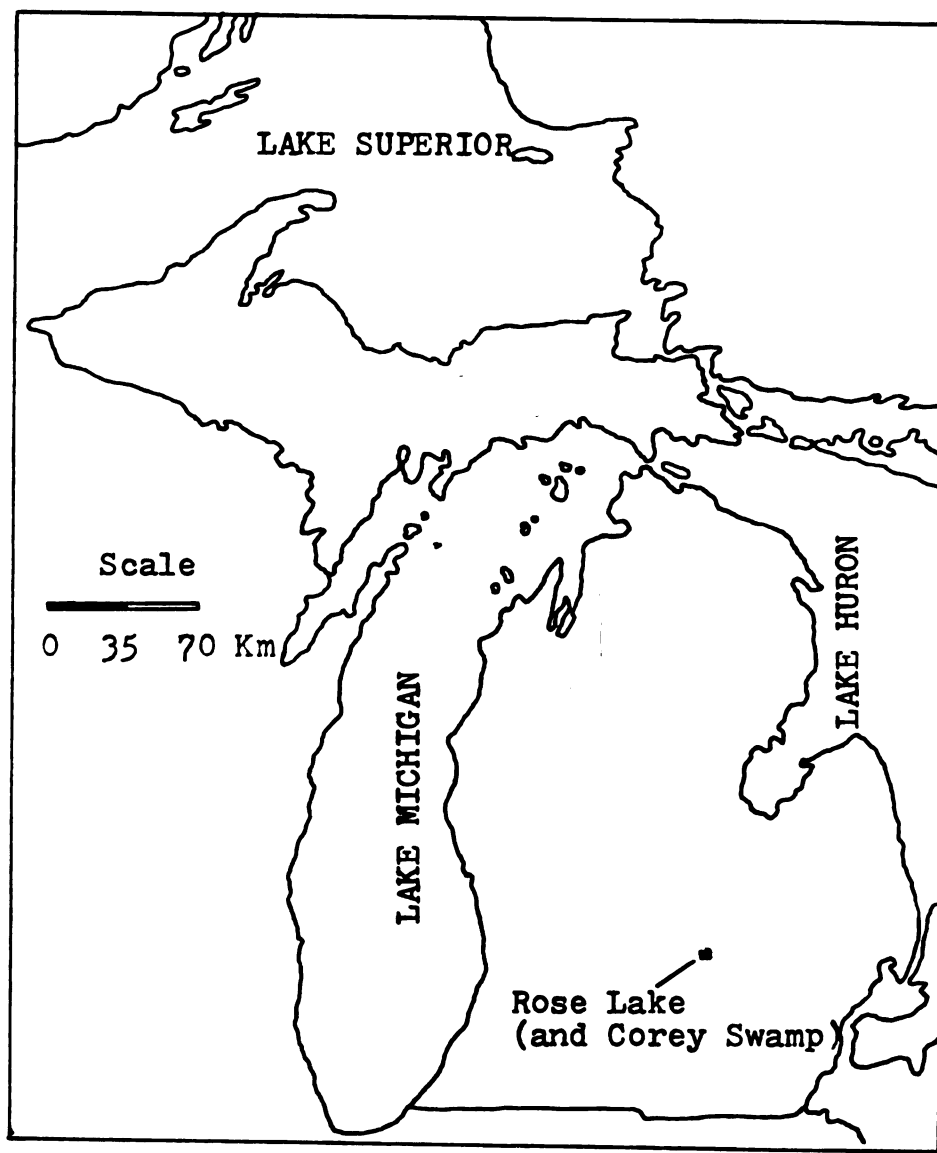


Figure 1. Map of Michigan showing the relative locations of the study areas.

Climate

The climate of Michigan is generally cold-temperate. Rainfall is sufficient during the April-October warm months (Seeley 1917). The study sites lay between $46^{\circ}5'$ and $47^{\circ}7'$ north latitude with some differences in climate between the regions (Figures 2a and 2b). Mean annual temperatures and rainfall equivalents recorded during the past ten years are 8.5°C and 761 mm. respectively for the East Lansing Station (15 km. west of Rose Lake), 5.9°C and 706 mm. at Houghton Lake and 5.2°C and 922 mm. at Chatham (32 km. west of Cusino).

High levels of precipitation, much of it in the form of snow, results in long winters in most parts of the deer range. Snow accumulates to a depth of 1 m. during the coldest months forcing deer to restrict their movements within yarding areas and resulting in intraspecific competition for forage (Severinghaus and Cheatum 1969, Verme and Ozoga 1971).

Soils

Rose Lake: The soils of the upland sites belong to the Boyer series and consist of well to moderately-drained loamy sands and loams on gently-sloping to steep moraines. The Corey Swamp soils are Houghton muck to a depth of 150 cm. or more. The surface layer is black and well-decomposed to a depth of 25 cm. (Pregitzer 1978).

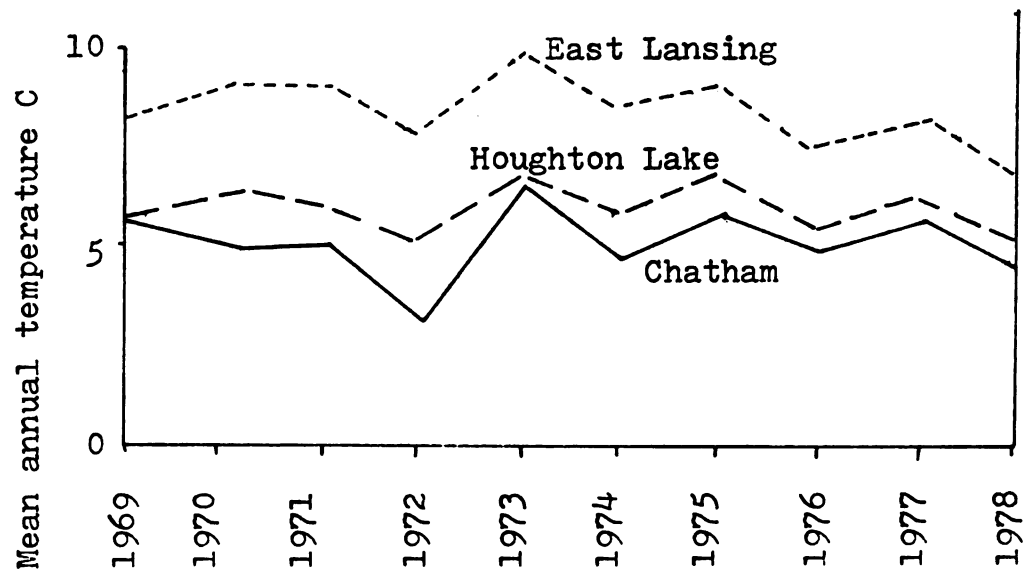


Figure 2 a

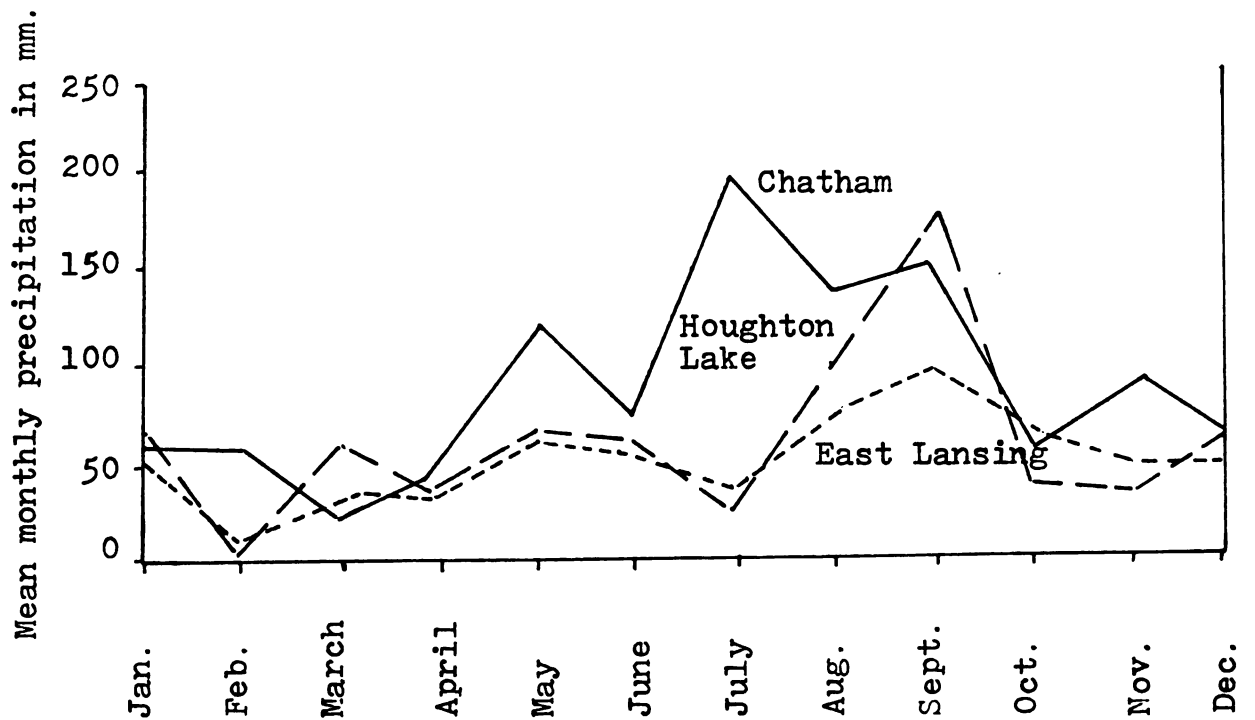


Figure 2 b

Mean annual temperatures since 1969 and monthly precipitation (rainfall equivalents) levels for 1978 at the study sites. Based on climatic data of National Oceanic and Atmospheric Administration, U.S. Department of Commerce.

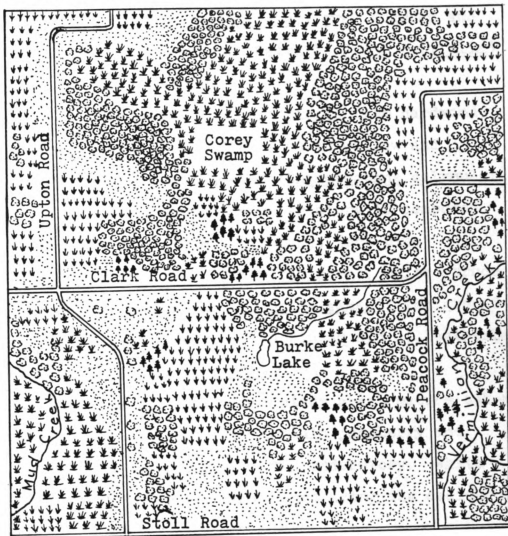
Houghton Lake: Most of the study area is lowland, with Rifle peat, a dark-brown, coarse soil rich in particulate matter. Surface soils are dark or gray or nearly black due to high organic matter (Veatch et al. 1924). Often adjacent, and developing under poor drainage conditions, are heavier Bergland mineral clay loams and Newton loamy sands.

Cusino: The soils at this location are basically sandy, highly acidic and low in fertility. Surface soils are gray with a characteristic subsoil or hardpan of rust-colored or brownish sand. Dark-brown Carbondale muck often extends to a depth of 30 to 60 cm. and is high in organic matter.

Vegetation

Rose Lake: Ranging from farmlands to forest, the area has a complex array of native communities. Over 90 species of trees, shrubs and herbs are known to occur. In upland woodlots, the oak-hickory (Quercus-Carya) association predominates (Figure 3). Gray dogwood (Cornus racemosa), juneberry (Amelanchier spp.), rose (Rosa spp.), red raspberry (Rubus idaeus), and blackberry (Rubus allegheniensis) occur in the understory. Between the forest stands are many abandoned old fields and open grassy knolls. Species such as Scotch pine (Pinus sylvestris) and autumn olive (Elaeagnus umbellata), not native to Michigan, have been planted in small stands. Corey Swamp, a portion of which extends into the Rose Lake Station, is mainly covered with shrubby vegetation. Silky dogwood (Cornus amomum),

Figure 3. Vegetation sketch of the Rose Lake Wildlife Research Station study area showing the major plant communities.



LEGEND

○ ○ ○ ○ ○ Hardwoods: oak-hickory

* * * * * Swamp: dogwoods and willows

+ + + + + Cultivation: corn and wheat

· · · · · Openings: grass

▲ ▲ ▲ ▲ ▲ Pine plantations: Scotch pine

Scale

0 400 800 m.

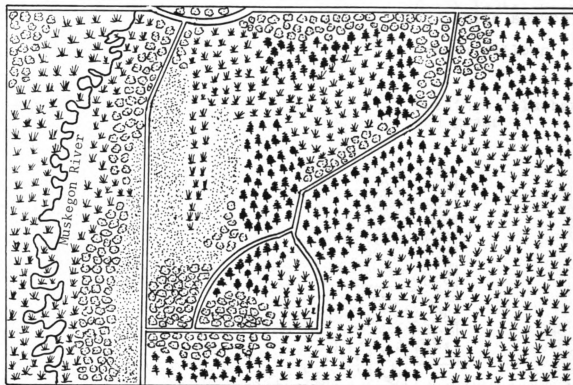
red-osier dogwood (Cornus stolonifera), gray dogwood and willow (Salix spp.) are common. Cattail (Typha latifolia) marshes occur in depressions.

Houghton Lake: The vegetation here ranges from hardwood stands and coniferous woods (Figure 4) to willow and cattail marshes and to leatherleaf (Chamaedaphne calyculata) wetpans. On the study site, the upper story is composed variously of white pine (Pinus strobus), jack pine (Pinus banksiana), red pine (Pinus resinosa), white spruce (Picea glauca) and balsam fir (Abies balsamea). The ground cover is dominated by blueberry (Vaccinium spp.), leatherleaf and sweetfern (Comptonia peregrina).

At the nearby Higgins Lake study area, mature oak-maple (Quercus-Acer) stands frequently contain juneberry and American elm (Ulmus americana) in the understory. White pine and balsam fir also are intermixed among the deciduous species.

Cusino: The vegetation at this northern location is predominately white birch-red maple but with white pine, white spruce and balsam fir as common conifers. Sprouts of red maple (Acer rubrum), American elm and juneberry form the bulk of understory vegetation. Although not extensive, a swampy portion of the fenced area is dominated by willows (Figure 5).

Figure 4. Vegetation sketch of the study area near Houghton Lake Wildlife Research Station showing the major plant communities.



LEGEND

○ ○ ○ ○ ○ Hardwoods: Aspen and white-ash

▲ ▲ ▲ ▲ Conifers: Jack pine and balsam fir

|||| Marshes: willows and cattails

□ □ □ □ Openings: blueberries and grass

Scale

0 500 1000 m.

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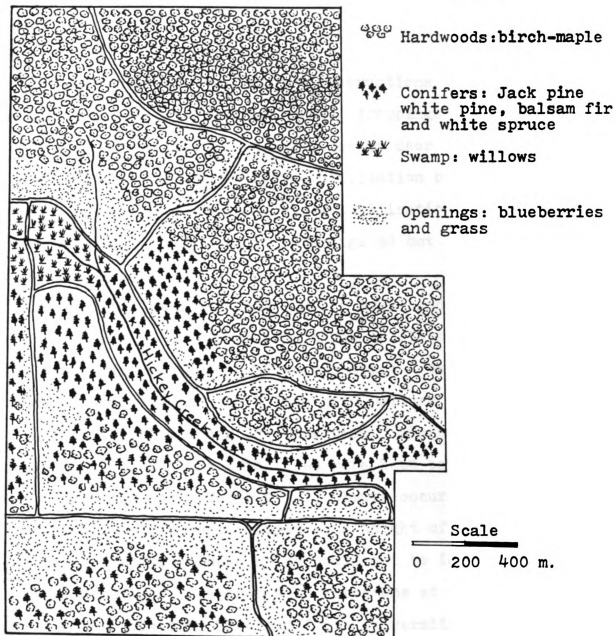


Figure 5. Vegetation sketch of the fenced enclosure at Cusino Wildlife Research Station indicating the major plant communities.

METHODS

Vegetation Survey

In each location, preliminary observations were made to determine the presence of deer tracks, droppings and browsed twigs. Areas of evident heavy use by deer were selected for further study. Only the utilization of browse was taken into consideration. The winter utilization of herbaceous plants by deer was not investigated but was believed to be slight.

All observations were made during April and May 1979. Browse clippings were made from 1000 circular plots each with one meter radius. 200 plots were clipped. These circles were located 50 m. apart in a grid pattern covering 50 ha. in each locality under investigation. Distances were measured by pacing and grid lines were kept equidistant by using a hand compass. Twigs of all plants occurring within the 3.14m^2 plots were clipped to a height of 2 m. and tallied by species. Those which could not be identified in the field were later compared with specimens at the Beal-Darlington Herbarium, Michigan State University.

The number of plots needed to sample the vegetation was found by using the formula $n = \frac{s^2 t^2}{d^2}$ (de Vos and Mosby 1971) where

n = number of samples required
 s = standard deviation of the number of twigs browsed
 t = t value at 95% confidence limit level
 d = margin of error (arithmetic mean times designated accuracy)

From a pilot study, it was determined that a sample of 180 plots would yield adequate results where the cover type was reasonably homogenous. Because of probable vegetative variability, 200 plots were clipped for study in each locality.

For each species, the number of twigs browsed was converted to weight by using average weights per twig (Shafer 1963). Mean weights cropped by deer were determined for each plant species and area by weighing 20 unbrowsed twigs clipped at identical diameters of comparable browsed specimens. These were dried at 105°C for 24 hours in standard laboratory ovens before weighing.

Though snowshoe hares (Lepus americanus) and cottontails (Sylvilagus floridanus), occur in areas inhabited by deer, these leporids cut twigs sharply at an angle of roughly 45 degrees while deer, lacking upper incisor teeth, break the twigs more roughly. No hare or rabbit browse signs, it is believed, were misidentified as those of deer.

Calculation of Preferred and Principal Values

Cook and Stoddart (1953) considered percentage utilization as an index to preference. Petrides (1975), however, found it generally to be better to calculate preference ratings on the basis of the percentage of a plant species in the animal's diet divided by its percentage availability

in the habitat. On this basis, a preference value may be determined which centers on 1.00 as a reference point. Species with values above 1.00 are those which are preferred by the animal while those below 1.00 represent neglected or avoided forages. A ratio of 1.00 occurs for plants eaten precisely in proportion to their abundance in the field. Values according to both the Cook-Stoddart and Petrides methods were calculated in this study.

Foods eaten in greatest quantities represent principal foods. These form the largest percentage of food items in the animal's diet.

Range Condition

The degree of utilization of available forage species was used as a guide to assess browsing pressure on the vegetation. As a very general rule, 50 percent of the total available annual production of a plant species can be removed without destroying its ability to regenerate (Stoddart et al. 1975). The physiological tolerance of a plant is affected by the time of forage removal, the parts removed and its association with other species present on the range (Webb 1957). Furthermore, shrubs and young trees have been found to withstand heavy utilization when cropping takes place in winter (Stoddart et al. 1975). In the absence of specific applicable data, however, the 50 percent

rule was taken as a standard to judge whether or not over-browsing occurred at a study site.

Vegetation Classification

The plants sampled were classified by growth as either shrubs or trees. Shrubs are woody plants which grow with a number of small stems and include such plants as sweetfern, witch-hazel and roses. Woody plants usually having only one stem or trunk are categorized as trees. Examples are pines, firs, oaks and maples.

Gray's Manual of Botany (Fernald 1950) was used as a standard reference for scientific names of plants.

RESULTS

Food Preferences

White-tailed deer displayed marked differences in the winter foods utilized in various parts of their range in Michigan. Species preferred in one area often were found to be neglected in another habitat.

In general, twigs of shrub species were consumed in larger quantities than were tree shoots. Shrubs were preferred over tree species on four of the five study sites (Table 1).

Rose Lake Woodlots: Of the 26 woody plants growing in this area (Table 2), 21 species were neglected or avoided as forage plants. Only four species were eaten by deer to a greater extent than indicated by their abundance. In descending order of preference, they were common elderberry (Sambucus canadensis), staghorn sumac (Rhus typhina), gray dogwood and juneberry. Black chokeberry (Pyrus melanocarpa) and white ash (Fraxinus americana), were totally avoided.

In terms of bulk contribution to the deer's diet, staghorn sumac, gray dogwood and juneberry were most important. Not only were these species sought out by deer as preferred species, they also comprised 73.41 percent of the total diet and 41.65 percent of the available forage. The preference rating for common elderberry was the highest

Table 1. Percentages of vegetation available and eaten by the white-tailed deer by forage classes based on 200 samples in each locality, winter 1979.

Area	Growth habit	<u>Average dry weights</u>		<u>Percentages</u>		
		Available ha. (kg.)	Consumed ha. (kg)	Available	In Diet	Removed
Rose Lake uplands	Shrubs Trees	38.18	8.44	67.93	85.59	22.10
		18.02	1.42	32.07	14.41	7.88
Corey Swamp	Shrubs Trees	94.00	42.44	93.49	98.60	45.14
		6.54	0.60	6.51	1.40	9.17
Houghton Lake	Shrubs Trees	33.88	4.33	80.17	87.48	12.78
		8.38	0.62	19.83	12.52	7.39
Higgins Lake	Shrubs Trees	15.77	0.48	55.00	45.41	3.04
		12.91	0.57	45.00	54.59	4.41
Cusino	Shrubs Trees	1.88	0.21	7.14	14.48	11.17
		24.39	1.24	92.86	85.52	5.08

Table 2. Food preferences of the white-tailed deer at Rose Lake upland site, Clinton county, Michigan, winter 1979.

Species	Average dry weights			Percentages		Preference Ratings	
	Per Twig (gr.)	(a) Available ha. (kg.)	(c) Consumed ha. (kg)	(A) Available Forage	(D) In Diet	Removed 100 c/a	Values D/A
<i>Sambucus canadensis</i>	0.425	0.15	0.11	0.27	1.12	73.33	4.15
<i>Rhus typhina</i>	1.750	6.46	2.45	11.50	24.84	37.92	2.16
<i>Cornus racemosa</i>	0.230	7.25	2.26	12.90	22.92	31.17	1.77
<i>Amelanchier</i> spp.	0.255	9.70	2.53	17.25	25.65	26.08	1.49
<i>Elaeagnus commutata</i>	0.230	0.42	0.07	0.75	0.72	16.66	0.96
<i>Quercus macrocarpa</i>	0.235	0.64	0.10	1.14	1.02	15.62	0.89
<i>Lonicera</i> spp.	0.110	1.60	0.22	2.85	2.23	13.75	0.78
<i>Cornus amomum</i>	0.360	2.75	0.35	4.89	3.54	12.72	0.72
<i>Quercus alba</i>	0.250	1.35	0.17	2.40	1.72	12.59	0.72
<i>Acer rubrum</i>	0.300	4.48	0.56	7.97	5.68	12.50	0.71
<i>Robina pseudo-acacia</i>	0.255	0.47	0.04	0.83	0.41	8.50	0.49
<i>Hamamelis virginiana</i>	0.330	0.51	0.04	0.92	0.41	7.84	0.44
<i>Rhus allegheniensis</i>	0.215	0.79	0.06	1.40	0.61	7.59	0.43
<i>Crataegus</i> spp.	0.200	0.98	0.07	1.74	0.72	7.14	0.41
<i>Rosa</i> spp.	0.127	1.08	0.07	1.92	0.72	6.48	0.37
<i>Quercus velutina</i>	0.205	2.30	0.14	4.09	1.42	6.08	0.35
<i>Populus tremuloides</i>	0.250	0.68	0.04	1.22	0.41	5.88	0.33
<i>Gleditsia triacanthos</i>	0.270	0.86	0.05	1.53	0.51	5.81	0.33
<i>Carya glabra</i>	0.670	1.77	0.10	3.15	1.01	5.64	0.32
<i>Viburnum cassinoides</i>	0.410	2.00	0.09	3.56	0.91	4.50	0.25
<i>Ulmus americana</i>	0.230	4.95	0.20	8.80	2.02	4.04	0.23
<i>Cornus florida</i>	0.495	2.13	0.08	3.79	0.81	3.75	0.21
<i>Rubus occidentalis</i>	0.210	0.58	0.02	1.04	0.20	3.44	0.19
<i>Vaccinium</i> spp.	0.195	1.62	0.04	2.88	0.41	2.46	0.14
<i>Pyrus melanocarpa</i>	0.145	0.32	0.00	0.57	0.00	0.00	0.00
<i>Fraxinus americana</i>	0.287	0.36	0.00	0.64	0.00	0.00	0.00
Total		56.20	9.86	100.00	100.00	17.54	1.00

of all and was nearly twice as high as its nearest competitor. Yet, because of its scarcity, this food made up only 1.12 percent of the animal's diet.

Deer concentrations in the Rose Lake area during winter are high. Five hundred animals are estimated to use the area then (Belyea, pers. comm. 1979). In comparison to the lowland Corey Swamp, however, the upland forage was not utilized heavily. Only 17.54 percent (Table 2) of the available browse was consumed by deer there, while a total consumption of 42.80 percent occurred in the Corey Swamp (Table 3). These data tend to confirm that deer are animals of shrublands (Figure 7) and early successional woodland stages, rather than of mature forests (Figure 6; see also Severinghaus and Cheatum 1969).

On the uplands, 70 percent of browse utilization was found to occur in woodlots near corn fields. Corn was cultivated by DNR personnel to provide supplemental food for deer during winter. It was heavily used so long as the supply lasted (Belyea, pers. comm. 1979). Deer also made use of available crops in private fields surrounding the station. Crop damage, though not alarming, was reported by farmers to occur in the area. The dependence of deer on the crop during the coldest part of winter was an unmeasured factor which certainly affected utilization of browse by deer in the area.

Table 3. Food preferences of the white-tailed deer, Rose Lake lowlands (Corey Swamp), Clinton County, Michigan, winter 1979.

Species	<u>Average dry weights</u>			<u>Percentages</u>		<u>Preference Ratings</u>	
	Per Twig (gr.)	(a) Available ha. (kg.)	(c) Consumed ha. (kg)	(A) Available Forage	(D) In Diet	Removed 100 c/a	Values D/A
- Cornus stolonifera	0.400	31.13	18.05	30.96	41.94	57.98	1.35
- Cornus amomum	0.360	18.92	10.84	18.81	25.18	57.29	1.34
- Sambucus canadensis	0.420	2.50	1.36	2.49	3.16	54.40	1.27
- Salix spp.	0.350	1.38	0.58	1.37	1.35	42.02	0.98
- Cornus racemosa	0.230	18.75	7.48	18.65	17.38	39.90	0.93
- Viburnum trilobum	0.310	0.28	0.11	0.28	0.25	39.28	0.89
- Rubus idaeus	0.110	0.53	0.18	0.53	0.42	33.96	0.79
- Betula pumila	0.259	2.70	0.74	2.68	1.72	27.40	0.61
- Ribes spp.	0.245	2.48	0.65	2.47	1.51	26.20	0.61
- Acer rubrum	0.300	0.70	0.18	0.70	0.42	25.71	0.60
- Viburnum lentago	0.255	1.22	0.24	1.22	0.56	19.67	0.46
- Rosa spp.	0.125	0.53	0.10	0.53	0.23	18.86	0.43
- Crataegus spp.	0.200	0.35	0.06	0.35	0.14	17.14	0.40
- Spiraea spp.	0.362	11.00	1.86	10.94	4.32	16.90	0.39
- Lonicera spp.	0.110	0.06	0.01	0.06	0.02	16.66	0.33
- Acer negundo	0.255	1.55	0.21	1.54	0.49	13.55	0.32
- Viburnum cassinoides	0.285	1.54	0.15	1.53	0.35	9.74	0.23
- Pyrus melanocarpa	0.145	0.98	0.09	0.97	0.21	9.18	0.22
- Ulmus americana	0.230	0.69	0.03	0.69	0.07	4.35	0.10
- Betula lutea	0.295	2.93	0.12	2.91	0.28	4.09	0.09
- Carya glabra	0.670	0.32	0.00	0.32	0.00	0.00	0.00
Total		100.54	43.04	100.00	100.00	42.80	1.00

Rose Lake Lowlands: Twenty-one species were recorded in the Corey Swamp lowlands on the Station. There, red-osier dogwood, silky dogwood and common elderberry were the preferred winter deer forages (Table 3). Gray dogwood, though contributing 17.38 percent of the total diet, was a slightly-neglected food. Red-osier, silky and gray dogwoods comprised 68.42 percent of the available forage there and 84.50 percent of the bulk contribution to the deer's diet. *Spirea* (*Spiraea* spp.), which ranked fourth in the percentage of available forage, constituting 10.94 percent of the browse, was not eaten to the degree warranted by its abundance. Pignut hickory (*Carya glabra*) was entirely avoided on this site.

Of all the study areas, Corey Swamp was the most heavily eaten. Though supporting dense and abundant forage (Figure 3), a removal of 42.80 percent of the available browse occurred there. It was evident that the number of deer using the area was high during winter. This heavy cover was used to provide both maximum protection from cold winds and adequate food as found by Ozoga and Verme (1968).

Houghton Lake: Of the 24 forage species tallied in this mid-state area, exactly half were preferred as foods by deer (Table 4). In descending order of preference, the favored group included nannyberry (*Viburnum lentago*),

Table 4. Food preferences of the white-tailed deer, Houghton Lake Wildlife Research Station, Roscommon County, Michigan, winter 1979.

Species	<u>Average dry weights</u>			<u>Percentages</u>		<u>Preference Ratings</u>	
	Per Twig gr.	(a) Available ha. (kg.)	(c) Consumed ha. (kg)	(A) Available Forage	(D) In Diet	Removed 100 c/a	Values D/A
<i>Viburnum lentago</i>	0.225	0.57	0.30	1.35	6.06	52.63	4.49
<i>Cornus amomum</i>	0.360	0.05	0.02	0.12	0.40	40.00	3.33
<i>Acer rubrum</i>	0.300	0.33	0.09	0.78	1.82	27.07	2.33
<i>Salix</i> spp.	0.350	5.25	1.34	12.41	27.07	25.52	2.18
<i>Cornus racemosa</i>	0.230	0.22	0.05	0.52	1.01	22.72	1.94
<i>Comptonia peregrina</i>	0.200	3.20	0.67	7.57	13.54	20.94	1.79
<i>Amelanchier</i> spp.	0.255	5.29	1.10	12.51	22.22	20.79	1.77
<i>Quercus rubra</i>	0.350	0.42	0.08	1.00	1.62	19.04	1.62
<i>Pyrus melanocarpa</i>	0.145	0.97	0.16	2.29	3.25	16.49	1.41
<i>Quercus macrocarpa</i>	0.235	0.69	0.10	1.63	2.02	14.49	1.24
<i>Fraxinus americana</i>	0.287	1.25	0.16	2.95	3.23	12.80	1.09
<i>Rosa</i> spp.	0.125	0.50	0.06	1.20	1.22	12.00	1.07
<i>Rubus idaeus</i>	0.110	0.09	0.01	0.21	0.20	11.11	0.95
<i>Spiraea</i> spp.	0.362	4.20	0.36	9.93	7.27	8.57	0.73
<i>Populus tremuloides</i>	0.250	1.98	0.15	4.70	3.03	7.57	0.64
<i>Rubus allegheniensis</i>	0.215	1.34	0.10	3.20	2.03	7.46	0.63
<i>Crataegus</i> spp.	0.200	0.29	0.02	0.69	0.40	6.89	0.58
<i>Rubus hispidus</i>	0.130	0.19	0.01	0.45	0.20	5.26	0.44
<i>Vaccinium</i> spp.	0.195	8.30	0.13	19.63	2.63	1.56	0.13
<i>Pinus banksiana</i>	0.291	2.34	0.02	5.54	0.40	0.85	0.07
<i>Chamaedaphne calyculata</i>	0.255	3.68	0.02	8.71	0.40	0.54	0.04
<i>Carya glabra</i>	0.670	0.03	0.00	0.07	0.00	0.00	0.00
<i>Xanthoxylum americanum</i>	0.140	0.03	0.00	0.07	0.00	0.00	0.00
<i>Abies balsamea</i>	0.180	1.05	0.00	2.47	0.00	0.00	0.00
Total		42.26	4.95	100.00	100.00	11.71	1.00

silky dogwood, red maple, willow, gray dogwood, sweetfern, juneberry, red oak (Quercus rubra), black chokeberry, bur oak (Quercus macrocarpa), white ash and a rose species. In terms of bulk contribution to the diet, however, only three forages ranked high. Willow, juneberry and sweetfern comprised 62.83 percent of the total diet. Pignut hickory, prickly ash (Xanthoxylum americanum) and balsam fir were avoided as forages. The other nine species were browsed to some extent but tended to be neglected by deer. Nannyberry and silky dogwood had the highest preference ratings but comprised only 6.46 percent of the animals' diet and were not important in terms of dietary bulk. As at Corey Marsh, the Cornus species were important and favored or near-favored foods.

Higgins Lake: Species composition was uncomplicated on the upland site; only 14 species were encountered during the survey. A total utilization of only 3.66 percent of the available browse (Table 5) indicated that the area was little used during winter months. The vegetation was sparse with poor undergrowth.

Six plant species were determined to be preferred. In order of preference, these were nannyberry, quaking aspen (Populus tremuloides), red maple, juneberry, red oak, American elm and white oak. Hawthorn (Crataegus spp.) and blackberry were entirely avoided by deer. Three forages, juneberry, red maple and American elm were both easily-available and preferred. Together, they constituted 37.52

Table 5. Food preferences of the white-tailed deer, Higgins Lake upland site, Roscommon County, Michigan, winter 1979.

	<u>Average dry weights</u>		<u>Percentages</u>		<u>Preference Ratings</u>		
	Per Twig gr.	(a) Available ha. (kg.)	(c) Consumed ha. (kg)	(A) Available Forage	(D) In Diet	Removed 100 c/a	Values D/A
<i>Viburnum lentago</i>	0.225	0.09	0.04	0.32	3.81	44.44	11.90
<i>Populus tremuloides</i>	0.250	0.15	0.02	0.52	1.90	13.33	3.65
<i>Acer rubrum</i>	0.300	2.22	0.26	7.74	24.76	11.71	3.19
<i>Amelanchier</i> spp.	0.255	5.50	0.32	19.18	30.48	5.82	1.59
<i>Quercus rubra</i>	0.350	1.80	0.08	6.28	7.62	4.44	1.21
<i>Ulmus americana</i>	0.230	3.04	0.13	10.60	12.38	4.27	1.17
<i>Quercus alba</i>	0.250	1.20	0.04	4.18	3.81	3.33	0.91
<i>Chamaedaphne calyculata</i>	0.200	1.47	0.03	5.12	2.86	2.04	0.56
<i>Hamamelis virginiana</i>	0.330	1.35	0.02	4.72	1.90	1.48	0.40
<i>Pinus strobus</i>	0.230	3.00	0.03	10.46	2.86	1.00	0.27
<i>Vaccinium</i> spp.	0.195	7.33	0.07	25.56	6.67	0.95	0.26
<i>Abies balsamea</i>	0.180	1.45	0.01	5.05	0.95	0.69	0.19
<i>Crataegus</i> spp.	0.200	0.05	0.00	0.17	0.00	0.00	0.00
<i>Rubus allegheniensis</i>	0.215	0.03	0.00	0.10	0.00	0.00	0.00
Total		28.68	1.05	100.00	100.00	3.66	1.00

percent of the available forage and comprised 67.62 percent of the diet. Though two species of conifers, white pine and balsam fir, made up 15.51 percent of the total available forage they constituted only 3.81 percent of the browse consumed.

Cusino: Only 13 species of woody plants were encountered on the sample plots. The low diversity of vegetation may be related, however, to the elimination of some species at browsing level. These formerly may have occurred in the fenced area but extirpated or drastically reduced by overbrowsing deer. Arnold and Verme (1963) in a ten-year study of the area reported that deer markedly-overbrowsed some of the preferred species. American yew (Taxus canadensis), they said, was eliminated. Similarly, white cedar (Thuja occidentalis) was reported by them to be reduced to 80 percent of its original availability. During the present study, neither Taxus nor Thuja was encountered on the clip plots.

In order of species preference, junberry, American elm, honeysuckle (Lonicera spp.), red raspberry and red maple were the most preferred food plants. No browsing was observed on jack pine, red pine, bristly blackcurrant (Ribes lacustre) or blackberry.

In terms of bulk contribution to the diet, red maple, balsam fir, American elm and junberry were taken in large

Table 6. Food preferences of the white-tailed deer, Cusino Wildlife Research Station, Alger County, Michigan, winter 1979.

Species	<u>Average dry weights</u>			<u>Percentages</u>		<u>Preference Ratings</u>	
	Per Twig gr.	(a) Available ha. (kg.)	(c) Consumed ha. (kg)	(A) Available Forage	(D) In Diet	Removed 100 c/a	Values D/A
<i>Amelanchier</i> spp.	0.255	0.81	0.16	3.08	11.03	19.75	3.58
<i>Ulmus americana</i>	0.230	1.34	0.17	5.10	11.73	12.68	2.30
<i>Lonicera</i> spp.	0.107	0.08	0.01	0.30	0.69	12.50	2.30
<i>Rubus idaeus</i>	0.115	0.18	0.02	0.68	1.38	11.11	2.03
<i>Acer rubrum</i>	0.300	7.88	0.79	30.00	54.48	10.02	1.82
<i>Abies balsamea</i>	0.180	5.31	0.19	20.22	13.10	3.58	0.65
<i>Vaccinium</i> spp.	0.195	0.68	0.02	2.59	1.38	2.94	0.53
<i>Pinus strobus</i>	0.230	4.35	0.08	16.56	5.52	1.84	0.33
<i>Picea glauca</i>	0.127	0.64	0.01	2.44	0.69	1.56	0.28
<i>Ribes lacustre</i>	0.145	0.11	0.00	0.42	0.00	0.00	0.00
<i>Pinus banksiana</i>	0.116	0.14	0.00	0.54	0.00	0.00	0.00
<i>Pinus resinosa</i>	0.400	4.73	0.00	18.00	0.00	0.00	0.00
<i>Rubus allegheniensis</i>	0.215	0.02	0.00	0.07	0.00	0.00	0.00
Total		26.27	1.45	100.00	100.00	5.52	1.00

quantities. These forages comprised only 58.40 percent of the available browse but contributed 90.34 percent to the total diet of the deer population. Of these, balsam fir was not a preferred species yet was eaten to a considerable extent. Honeysuckle and red raspberry, although preferred, and the three neglected species, blueberry, white pine and white spruce, had little dietary significance.

CONCLUSIONS

Regional Variations in Forage Preferences

Food habits of deer were found to vary considerably between ecological regions. Marked differences in floral composition and in edaphic and climatic characteristics on the various study sites (Stiteler and Shaw 1966) were followed by forage differences, perhaps in nutritional values but certainly in the degree to which various species were preferred as foods by deer.

Plants which were favored in one area often were neglected in another, where more palatable species were available. Healy (1971) in his study of forage preferences of tame deer in northwestern Pennsylvania found that preferences for individual plant species varied between sites. Yellow birch (Betula lutea) was browsed heavily in one part of his study area but avoided in other portions. In the present investigation, gray dogwood was highly preferred in the Rose Lake upland community (Table 7) but was neglected in the adjacent (2-3 km.) Corey Swamp where the equally-abundant but possibly more-succulent silky dogwood was selected (Table 7).

Red maple is considered an important deer food in the forests of north-eastern states (Woodworth and Lawrence 1966). They noted heavier use of red maple in the northern parts

Table 7. Variation in food preference rating of some preferred species at the Lower and Upper Peninsula study sites, Michigan, winter 1979.

Species	<u>Southern L.P.</u>		<u>North-central L.P.</u>		<u>Western U.P.</u>
	Rose Lake	Corey Swamp	Houghton Lake	Higgins Lake	Cusino
<i>Viburnum lentago</i>		0.46	4.49	11.90	
<i>Cornus amomum</i>	0.72	1.34	3.33		
<i>Cornus stolonifera</i>		1.35			
<i>Cornus racemosa</i>	1.77	0.93	1.94		
<i>Amelanchier</i> spp.	1.49		1.77	1.59	3.58
<i>Salix</i> spp.		0.98	2.18		
<i>Acer rubrum</i>	0.71	0.60	2.33	3.19	1.82
<i>Ulmus americana</i>	0.23	0.10		1.17	2.30
<i>Quercus macrocarpa</i>	0.89		1.24		
<i>Quercus rubra</i>			1.62	1.21	

of their study areas however, than in the southern regions. This species was both a major dietary item and a preferred food in the woodlots at Houghton Lake, Higgins Lake and Cusino, yet it was neglected at Rose Lake.

At the Houghton and Higgins Lakes sites, the oak (Quercus) group tended to be selected above other forages. But at Rose Lake, the deer population did not show preference for plants of this genus (Table 2).

In contrast, to many of these forages, juneberry was common throughout and in terms of bulk contribution retained high preference ratings on all sites where it occurred. This forage was sought out by deer throughout the state and was an important food in all areas. The dogwoods, although not as common as juneberry in the northern parts of the state, were preferred on wet sites. In the Corey Swamp, silky dogwood and red-osier dogwood were the main foods taken by deer. Coblenz (1970) also cites red-osier dogwood as a highly preferred species at the George Reserve, Washtenaw County, in southern Michigan.

Nannyberry, common elderberry and staghorn sumac grow in scattered clusters and, although not important in terms of availability, also were found to be highly desired by the white-tailed deer at all three sites in the Lower Peninsula. They are highly preferred by white-tailed deer in the northeastern forests (Petrides 1941, Webb 1959,

Nixon et al. 1970) also.

No correlation was found between the abundance of a particular species and its preference rating. Blueberry, despite its abundance in the low ground cover, was avoided by deer on the study areas throughout Michigan. Blueberries constituted 25.26 percent of the total available forage at Higgins Lake and 19.63 percent at Houghton Lake sites. Yet it was not selected and was, in fact, one of the most neglected species (Table 3 and 4). Petrides (1941) also noted little utilization of blueberry species in central New York despite being common in the habitat. In agreement with Hosley (1969), the utilization of coniferous species such as jack pine, white pine, red pine, white spruce and balsam fir was low. The five coniferous species which accounted for 58 percent of browse at Cusino nevertheless were all in the neglected category. Pignut hickory and prickly ash were avoided over most of the state, too.

Plant Species Endangered by Over-Abundant Deer

American yew is generally accepted to be highly-preferred winter white-tailed deer forage in the northern forest region (Petrides 1941, Arnold and Verme 1963, Hosley 1969). On the Great Lakes' islands where deer have not been introduced, this species normally is found in abundance. Palmer and King (1970) in a study of South Fox Island found that American yew

still comprised 95 percent of the total vegetation cover there despite the recently introduced deer herd. Its complete absence from the Michigan ranges studied probably indicates that American yew has been generally eliminated from mainland habitats. This certainly is due to severe browsing where deer are too abundant for the range to support without damage.

White cedar also was not encountered on the study plots. Older stands still occur in the regions studied but browse lines are commonplace. Foliage below the 2 m. level available to deer is generally lacking and young plants are scarce (Figure 8).

Range Condition

Preferred species constituted the main bulk of the winter diet of deer in all areas. Their dietary utilization rates on the study plots varied between 70.28 and 80.95 percent while their availability only ranged between 39.16 to 52.25 percent (Table 8). Red-osier dogwood and silky dogwood were removed to the extent of 57.98 and 57.32 percent, respectively, in the Corey Swamp but an overall abundance of the plants showed that they were able to regenerate sufficiently and were tolerant of browsing there.

On the Rose Lake uplands, common elderberry constituted only 0.27 percent of the available forage and

Table 8. Percentages of forage availability and utilization for all preferred browse plant species of the white-tailed deer, Michigan, winter of 1979.

<u>Study Site</u>	<u>Availability</u>	<u>Utilization</u>
Cusino (Upper Peninsula)	39.16	79.31*
Higgins Lake uplands (Northern Lower Peninsula)	44.64	80.95
Houghton Lake lowlands (Northern Lower Peninsula)	43.55	78.19
Rose Lake uplands (Southern Lower Peninsula)	41.92	74.53
Rose Lake lowlands (Southern Lower Peninsula)	52.26	70.28

* This enclosed deer population may have been higher than in surrounding areas. It was not known earlier that this was true.



Figure 8. White cedar browse line are commonplace wherever it occurs in deer habitat. The picture shows heavy deer browsing of the cedar in Rose Lake Wildlife Research Station where it is grown as an ornamental on a private owned plot.

yet was heavily used, with 86.60 percent of the available plants being eaten. This elderberry also constituted only 2.49 percent of the forage in Corey Swamp and yet was 54.50 percent utilized. This species was extremely rare and seemed likely to be generally overbrowsed. It was present only in small numbers throughout the deer range in Michigan.

At Houghton Lake, nannyberry ranked high in use with a total of 54.84 percent removed. As this species constituted only 1.16 percent of the available forage, it seemed to be highly selected. The twigs of most plants were entirely consumed by deer.

The forage preferences of deer must be affected by various climatic, edaphic and biotic factors of the environment. Further knowledge of these factors certainly will be of value in aiding deer management procedures in Michigan.

Despite the preliminary nature of the present findings, however, the evident over-utilization of preferred deer forages provides still further evidence of over-abundant deer throughout the state (Table 8). To the widespread evidence of browse lines and the frequent occurrence of winter-starved deer, must be added the severe over use of the most important and most-highly preferred winter deer foods.

To be sure, deer are not too abundant to satisfy public recreational desires. They are too abundant,

though, for the range to support. Habitat regeneration is called for through widespread and intensive cuttings of forests, woodlots and small-holdings. The white-tailed deer population, however, must be sharply reduced to bring it in balance with forage production. Otherwise damage to new vegetative growth will prevent range recovery and deer starvation will increase.

SUMMARY

In order to appraise the winter feeding habits of the white-tailed deer (Odocoileus virginianus borealis) in Michigan a study of food preferences was conducted in the spring of 1979. Research was undertaken in three localities of the state to compare to what extent forage use and preference values varied by geographic regions.

Lowland habitats with a heavy cover of shrubby vegetation doubtless provided maximum protection from cold winds. In any case, the more-adequate foods there were used more extensively than upland forests where there was a lack of undergrowth. The data tend to confirm that deer are animals of shrublands and early successional woodland stages, rather than of mature forests.

Food habits of deer were found to vary considerably between the ecological regions. Plants which were favored in one area often were neglected in another area where more palatable species were available. Preference ratings were not correlated with the abundance of particular species found in each geographic locality.

Common elderberry, staghorn sumac, juneberries, red-osier dogwood, silky dogwood and gray dogwood were preferred region-wide in the southern part of the state. The dogwoods and juneberries showed the heaviest browsing in this area. In the north-central part of the lower

peninsula nannyberry, quaking aspen, silky dogwood, red maple, American elm, sweetfern, willows and red and white oak were selected by deer while gray dogwood, red maple, American elm and sweetfern were utilized in large quantities. Preferred foods in the western part of the upper peninsula were red maple, juneberries, American elm, red raspberry and a honeysuckle species. At this location, red maple, American elm, juneberries and balsam fir constituted the main bulk of the deer's diet.

Blueberries, although abundant in areas where they occurred were neglected throughout the deer range. The utilization of coniferous species such as jack pine, white pine, red pine, white spruce and balsam fir was low in all areas. Pignut hickory and prickly ash were avoided over most of the range also.

American yew and white cedar, generally accepted to be highly-preferred white-tailed deer forages in the north-eastern temperate forests were not encountered on the study plots. Their complete absence from the range possibly indicates that these species have been eliminated or drastically reduced from mainland habitats due to over-browsing. Common elderberry seemed to be generally over-browsed and possibly becoming much reduced by abundance. It was present only in small numbers over most of the range. Nannyberry and staghorn sumac were also utilized extensively where they occurred.

Robina pseudo-acacia
Rosa spp.
Rubus allegheniensis
Rubus hispidus
Rubus idaeus
Rubus occidentalis
Salix spp.
Sambucus canadensis
Spiraea spp.
Taxus canadensis
Thuja occidentalis
Typha latifolia
Ulmus americana
Viburnum cassinoides
Viburnum lentago
Xanthoxylum americanum

Blacklocust
 Rose
 Blackberry
 Black dewberry
 Red raspberry
 Black raspberry
 Willow
 Common elderberry
 Spirea
 American yew
 White cedar
 Cattail
 American elm
 Wild raisin
 Nannyberry
 Prickly ash