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FOODS OF DEER IN SOUTHERN WISCONSIN

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ABSTRACT

Food habits of white-tailed deer in southern Wisconsin were determined from 246 rumens collected between November 1976 and March 1980. Forty-five genera of uncultivated plants and 6 genera of cultivated species were identified, although only 18% of the taxa attained a seasonal combined percent frequency and percent volume value greater than 2. The important forage categories determined by season were: spring -- herbaceous materials, summer -- herbaceous materials and leaves of woody vegetation, fall -- fruits or seeds and herbaceous materials, and winter -- fruits or seeds and woody fragments. Principal foods eaten were corn, grasses/sedges, alfalfa, and acorns when available. One deer was estimated to consume 1 bu of standing corn/year and 92 lb of alfalfa/year. Annually the average farm would lose 5-15 bu of corn and 0.2-0.7 tons of alfalfa.

CONTENTS

INTRODUCTION

Mustard and Wright (1964), Nixon et al. (1970), Coblentz (1970), and Ward and Hardin (1977) have reported on food habits of white-tailed deer on agricultural range in the midwest. However, food habits of agricultural range whitetails in Wisconsin have been described only in general terms by Dahlberg and Guettinger (1956), Stroebe (1971), and Hale (1973). A quantitative summary of rumen analyses, similar to that by McCaffery et al. (1974) for deer in northern Wisconsin, is not available for the southern farmland region. In particular, estimates of the volumes of agricultural crops consumed by deer and the market value of these agricultural losses are unknown.

Cultivated crops, especially corn and soybeans, represented 41-56% of the foods eaten by deer on agricultural ranges of the midwest (Murphy 1970); oak leaves, acorns, wild fruit, seeds, forbs, and browse were the more important natural forage items. In Iowa, the diet consisted of 56% cultivated foods, the bulk of which was corn (Mustard and Wright 1964). Nixon et al. (1970) found that Ohio deer utilized noncultivated foods in relation to their availability. Dahlberg and Guettinger (1956) and Stroebe (1971) indicated that maximum deer densities in southern Wisconsin were determined by farmer tolerance of deer damage to crops, rather than by the ability of the habitat to support deer.

A knowledge of food preferences and the relative consumption rates of natural and cultivated foods provides a basis for evaluating the potential impact of higher or lower deer densities on agricultural crop production and other plant communities. This study determined seasonal forage utilization by southern Wisconsin deer in relation to availability of cultivated and natural foods. By associating specific costs to agriculture, we were able to estimate the relative economic impacts of deer densities.

Our rumen collection area in southern Wisconsin (Fig. 1) is typical of the nonyarding agricultural deer range described by Murphy (1970) which features less than 20% forest cover and level to gently rolling topography. Woodlands occur as scattered woodlots of oak-hickory or as bottomland hardwoods. In 1978, farms occupied 84% of the land area in Columbia, Dane, Dodge, and Sauk counties where rumens were collected (Wis. Dep. Agric. Trade and Consum. Prot. and U.S. Dep. Agric. 1980). About 57% of the acreage in the collection area was used in the production of corn, hay, or soybeans, or was forested (Table 1).

METHODS

Vehicle-killed deer were the primary source of rumens sampled. Other sources included: shot animals (hunting-season and illegal kills), dog-kills, and accident victims (e.g., getting hung up on fences). Rumens found to be empty and those from fawns which contained milk were not taken in for analysis.

Rumen samples were collected between November 1976 and March 1980. Occurrences of major foods were compared by month and also among the following periods: spring (21 March-20 June), summer (21 June-22 September), fall (23 September-21 December), and winter (22 December-20 March). In the 4-county collection area, prehunt deer populations ranged from 15.1 to 39.8 deer/mile^2 (Table 2).

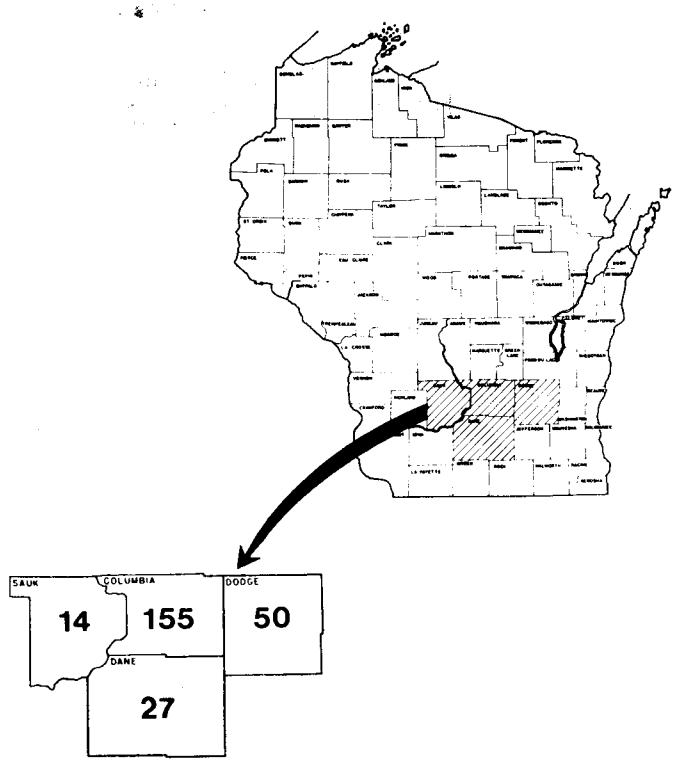

FIGURE 1. Distribution of 246 rumen samples collected from 1976 to 1980.

Samples were collected and preserved similar to methods used by McCaffery et al. (1974) and were analyzed using the point-frame method (Chamrad and Box 1964). One hundred points were taken in each sample and percentage volume estimates were derived therefrom. Presence was recorded for species occurring in the sample but not hit by any of the points. Whenever possible, identification and classification of plants was made to the lowest taxonomic level, utilizing Courtenay and Zimmerman (1972) and Fassett (1976). Additional references for taxonomy were Scott and Wasser (1980) and Fernald (1950). Identification of fruits and seeds was aided by using Martin and Barkley (1961) and the U.S. Department of Agriculture (1948). Fragments were placed in a forage category whenever possible. Fungi were combined as a single group, as were grasses and sedges. Grasses were believed to be consumed in greater quantities than sedges.

Food items were placed in 1 of 5 forage categories: (1) fruits or seeds, (2) herbaceous materials, (3) woody fragments, (4) leaves of woody vegetation, (5) miscellaneous pieces. An importance value for each species was calculated by adding the percent volume and percent occurrence then dividing the sum by 2. For each sample, the combined importance values equalled 100. Foods constituting less than 1% by volume, frequency, or importance value were denoted as present in "trace" (T) amounts.

Different parts of certain food items, e.g., corn

TABLE 1. Mean agricultural and forest land use in 4 southern Wisconsin counties, 1977-79.

Land Use	Columbia (748 miles^2)[1]	Dane (1198 miles^2)	Dodge (880 miles^2)	Sauk (837 miles^2)
Agricultural				
Grain corn	22.8[2]	24.9	21.9	13.0
Silage corn	4.2	5.1	6.7	3.1
Alfalfa hay	10.2	14.6	15.9	14.4
Other hay	1.1	1.4	2.3	1.6
Soybeans	1.3	1.1	0.4	0.5
Subtotal	39.6	47.1	47.2	32.6
Forest				
Conifers	0.9	0.2	0.5	1.2
Oak-hickories	7.6	6.6	1.4	16.2
Other types	8.3	2.9	5.7	10.8
Subtotal	16.8	9.7	7.6	28.3
TOTAL	56.4	56.8	54.8	60.9

[1]Land area of study.
[2]Percent of land in county.

TABLE 2. Mean prehunt deer populations in southern Wisconsin, 1977-79.

	Columbia	Dane	Dodge	Sauk
Mean prehunt population[1]	13,699	3,689	2,625	17,388
Deer range (miles^2)[2]	344	170	174	478
Deer/mile^2 on deer range	39.8	21.7	15.1	36.4

[1]Determined by the sex-age-kill method.
[2]Derived from McCaffery (1973).

TABLE 3. Sex and age classes for 246 southern Wisconsin deer from which rumen samples were collected, 1976-80.

	Ages						
	Fawns		Adults				
Season	Males	Females	Males	Females	Unknown	Total	(%)
Spring	0	0	30	47	4	81	(33)
Summer	3	3	8	13	1	28	(11)
Fall	12	20	23	38	2	95	(39)
Winter	9	13	3	17	0	42	(17)
TOTAL (%)	24(10)	36(15)	64(26)	115(47)	7(3)	246	(100)

seeds and corn stalks, were placed in separate forage categories (Appendix A).

Availability of agricultural crops and average farm sizes were determined from data supplied by county agricultural agents to the Wisconsin Statistical Reporting Service. The amount of forested habitat was obtained from Spencer and Thorne (1972). Comparisons were made between the foods eaten, crop availability (Wis. Dep. Agric. Trade and Consum. Prot. and U.S. Dep. Agric. 1980), and crop losses reported in deer damage claims.

RESULTS AND DISCUSSION

Sample Sizes

Two hundred forty-six rumen samples were collected (Columbia County, 155; Dodge County, 50; Dane County 27; and Sauk County 14). Ninety-two percent (226) were from vehicle-killed deer. Most samples (39%) were collected during the fall (Table 3) when vehicle-killed deer were most available (Pils and Martin 1979). Adult does (47%) were the sex-age cohort most frequently collected (Table 3).

Forty-five genera of wild plants, and 6 genera of cultivated species, were identified. Eighty-two percent of the taxa noted attained an importance value of 1 or less in any season (Appendix A), suggesting that although southern Wisconsin deer eat a wide variety of plants, they utilize a much smaller group of items as their main sources of forage (Table 4).

Seasonal Utilization

Spring. Herbaceous materials accounted for 64% of the total volume (Fig. 2); 26 genera of plants were identified. Although a wide variety of plants were eaten, only grasses/sedges, alfalfa, corn, and white dog's-tooth-violet comprised at least 2% of the aggregate volume (Table 4). A few rumens contained a single herb such as white dog's-tooth-violet or cattail. White dog's-tooth-violet, a spring ephemeral, was also utilized by Missouri deer (Korschgen et al. 1980). Grasses/sedges were probably eaten to supplement diets during spring "green-up".

Summer. Fifteen genera of plants were identified; miscellaneous pieces accounted for the greatest

TABLE 4. Most common foods found in rumens of 246 southern Wisconsin deer from spring to winter, 1976-80.

	Spring		Summer		Fall		Winter	
Taxa[1]	Volume[2]	Occur.[3]	Volume	Occur.	Volume	Occur.	Volume	Occur.
Fruits or Seeds								
Corn	13	52	6	18	28	66	36	64
Oak acorn					13	38		
Common apple					2	19		
Cherry					2	8		
Grape							2	2
Herbaceous Materials								
Unknown	27	85	16	79	11	75	5	41
Alfalfa	13	52	7	43	10	46	1	12
Grasses/sedges	19	86			8	70	7	50
Corn			3	4				
White dog's-tooth-violet	2	3						
Woody Fragments								
Unknown	2	51					19	79
Eastern juniper							3	19
White pine							3	5
Virginia creeper							2	2
Leaves								
Unknown tree or shrub	4	42	23	79	10	68	5	69
Misc. Pieces	15	46	34	86	11	50	12	43
TOTAL	95		89		95		94	

[1]Includes only those taxa comprising at least 2% of the aggregate volume.
[2]Percent of aggregate volume.
[3]Percent of samples containing food item.

volume, 34% (Fig. 2). The miscellaneous pieces were mostly herbaceous plants and tree or shrub leaves that were too masticated to identify. Identified tree and shrub leaves were also important food items (importance value of 22).

Alfalfa, corn plants, and corn kernels each represented at least 2% of the aggregate volume (Table 4). Various prickly plants such as Canada thistle and prickly lettuce were also eaten. Unusual items, such as feathers and insects (Appendix A), may have been eaten incidentally while deer were browsing on plants.

Fall. The greatest number of plant genera (37) were identified in the fall. Fruits or seeds with an aggregate volume of 48% (Fig. 2) were the most important forage items. Corn kernels accounted for 28% of the volume. Acorns, apples, cherries, alfalfa, and grasses/sedges each made up at least 2% of the volume (Table 4).

Leaves of woody plants comprised 10% of the food volume (Fig. 2). Since the leaves usually were dead tissue, some may have been picked up incidentally while deer fed on acorns. However, in years with little or no acorn use, dead leaves were also consumed (Table 5).

Winter. The most important winter forage categories were fruits or seeds (39% volume) and woody fragments (30% volume, Fig. 2). Only 17 genera of plants were identified in winter samples. Kernels of corn, with 36% of the total volume, ranked 1st (Table 4). Grapes, grasses/sedges, Virginia creeper, eastern juniper, and white pine, comprised from 2 to 7% by volume.

The primary winter habitat requirement for white-tailed deer throughout the corn belt is cover (Mustard and Wright 1964, Murphy 1970). After the corn is picked in the fall, southern Wisconsin deer utilize woodlots, shrub swamps, and marshes for cover and food especially in winters with deep snow. Southern Wisconsin winters are usually not as severe as is characteristic of northern regions, and starvation rarely occurs. However, the winter of 1978-79 was extremely cold with deep snows. A winter severity index, based on snow depth and minimum temperatures reached 2024 in southeastern Wisconsin, the highest value in 30 years, compared to a mean of 732 (R. Dumke, Wis. Dep. Nat. Resour., pers. comm.). Snow depth in February was greater than 17 inches over the 4-county area. By contrast, the winter of 1979-80 had a severity index of only 448 and less than 4 inches of snow covered the ground in February.

Deer starvation was documented in several areas of southern Wisconsin in 1978-79 (Pils 1981). Deer were actually yarded in some areas (e.g., Horicon Marsh, Dodge County). In the 11 samples collected during February 1979, woody fragments accounted for 54% by volume. For 10 rumens collected in February 1980, woody fragments comprised only 19% of the volume. Corn volume in the February 1979 samples was 30%, compared to 39% in 1980. Apparently some deer were able to utilize standing corn in the severe winter of 1978-79 while others were forced to eat less nutritious foods and may have been more susceptible to starvation.

Major Foods

Corn. Corn is grown throughout the area and grain

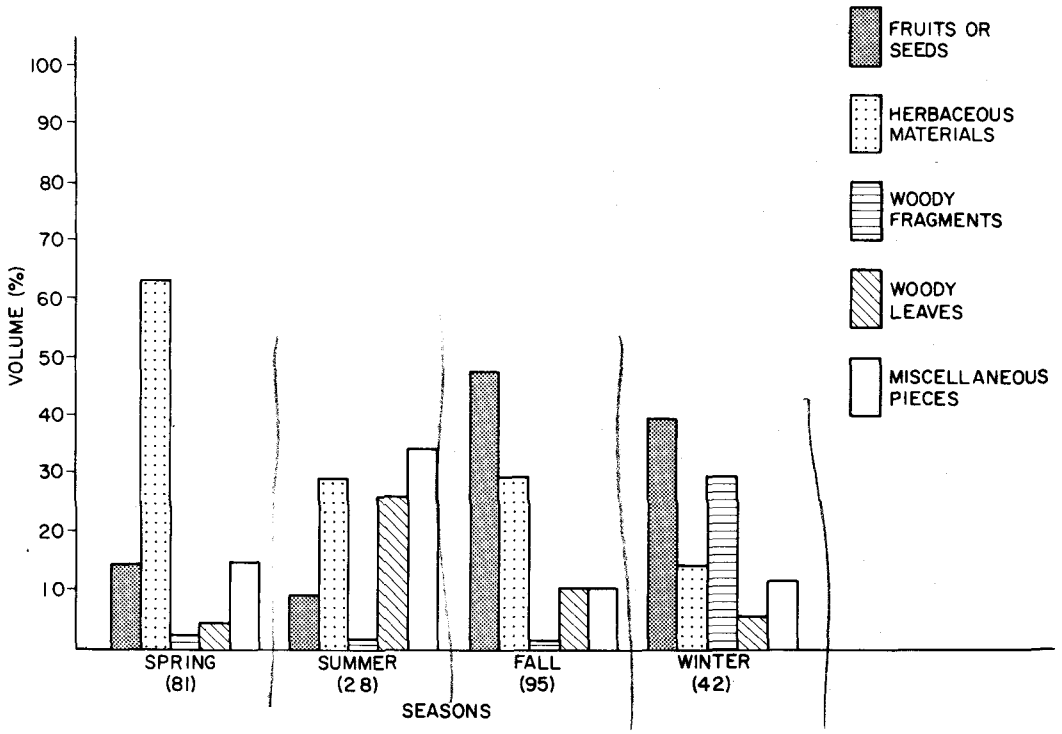

FIGURE 2. Seasonal diet of 246 southern Wisconsin deer in terms of 5 major forage categories. Sample sizes are listed below seasons.

TABLE 5. Fall use of corn, acorns, and woody leaves.

Year	Rumens (No.)	Frequency: Corn Only No.	Corn Only %	Acorns Only No.	Acorns Only %	Corn & Acorns No.	Corn & Acorns %	Neither No.	Neither %	Volume (%): Corn	Acorn	Woody Leaves
1976	23	9	39	4	17	4	17	6	26	27	19	13
1977	11	9	82	0	0	1	9	1	9	30	1	10
1978	13	11	85	0	0	0	0	2	15	36	0	7
1979	48	16	33	14	29	13	27	5	10	26	17	10
ALL	95	45	47	18	19	18	19	14	15	30	9	10

corn acreage makes up from 13.0 to 24.9% of the land use in the 4-county area (Table 1). Corn ranked 2nd in deer crop damage payments in Wisconsin during 1977-79 (Table 6). In 1978, the average grain corn acreages/deer (prehunt population) for farms in deer range were: 2.5 acres -- Sauk County, 3.9 acres -- Columbia County, 8.9 acres -- Dodge County, and 7.2 acres -- Dane County. (For crop and farm statistics by county, see Appendix B).

In summer, we found that 6% of volume was ear corn while 3% was parts of the corn plant. If we assume that a deer eats 5 lb of food/day (465 lb from 21 June through 22 September) and percent volume approximates percent of food consumed by weight, 1 deer would eat 28 lb (0.5 bu) of standing corn in summer. This is a minimum loss estimate and would be greater if the corn was eaten while in the milk stage and the developing ear was injured. Damage to the corn plant would also result if the growing point was nipped early in the summer. This physical damage, as well as losses from stalks knocked down, is difficult to quantify in terms of net losses to production.

Based on average corn harvest, 100% of the corn is standing in September, 80% in October, and 10% in November (R. Kriesel, Wis. Dep. Agric., pers. comm.). Normally, little corn remains standing in December. These are long term averages with yearly weather conditions affecting the actual harvest chronology. When precipitation is minimal during the fall, more corn is picked than if wet weather prevails.

The current Wisconsin estimate of waste corn left in the field after harvesting is 5% (D. Rohweder, Univ. Wis. - Madison Dep. Agron., pers. comm.) or about 5 bu/acre. Sauk County with the lowest ratio of corn to deer, would have about 12 bu of waste corn/deer; Columbia County, 20 bu/deer; Dodge County 42 bu/deer; and Dane County, 38 bu/deer. The availability of this corn is directly related to the extent and type of fall plowing, which is dependent on the date of freeze-up and local farming practices. With increased acreage being chisel plowed, more waste corn should be available to deer. Snowfall also affects availability by covering waste corn, but in most years there is no major snowfall prior to mid-November.

During the fall, monthly volumes of corn in rumen samples varied between 14 and 37%, averaging 24% (Table 7). One deer would eat an average of about 2 bu of corn during the fall.

TABLE 6. Average deer damage claims paid for agricultural crops damaged in Wisconsin, July 1977 to June 1979[1].

Agricultural Crop	Mean No. Claims	Mean Value $	Mean Value %
Commercial gardens	9	$ 45,976	35.9
Corn	61	30,311	23.7
Orchards	20	23,870	18.7
Strawberries and raspberries	5	8,338	6.5
Hay	21	7,097	5.5
Soybeans	9	5,198	4.2
Trees, shrubs, nursery stock	4	4,254	3.3
Small grains	15	2,871	2.2
TOTAL	144	$127,915	100.0

[1]From Wisconsin Department of Natural Resources: 1977-78 Wildlife damage report. Bur. Wildl. Manage. files, 3 pp. and 1978-79 Wildlife damage report, Bur. Wildl. Manage. files, 3 pp.

We do not know if, during the harvesting season, deer prefer standing or picked corn. Assuming that deer feed in direct proportion to the ratio of standing to waste corn, each deer would consume in fall about 0.5 bu of standing corn and 1.4 bu of waste corn. With large amounts of waste corn available, it is not surprising that deer consume considerable corn in November and December.

In winter, rumens contained 36% corn and in spring 13% (Table 4). Most of this corn is waste since very few fields remain unpicked. However, if there is an unpicked field near a deer wintering area and if deep snow covers waste corn, feeding and thus corn loss can be extensive.

When standing corn is consumed, there is a direct monetary loss to the farmer. Using the average farm size for each county and assuming that the entire farm is deer range containing an average density of deer, we estimated the loss of corn/farm due to deer (Appendix B). The average farm in Columbia County during the summer and fall would lose 15 bu (0.3% of the crop); Sauk County,

TABLE 7. Corn consumed by 1 deer (23 September - 21 December).

	September	October	November	December	Total
Days (no.)	8	31	30	21	90
Food eaten[1] (lb)	40	155	150	105	450
Volume in corn (%)	14	15	37	20	24(avg.)
Corn eaten (lb)[2]	6	23	56	21	106
Standing corn eaten (%)	100	80	10	0	-
Standing corn eaten (lb)	6	18	6	0	30
Waste corn (lb)	0	5	50	21	76

[1]Assuming 5 lb of food eaten/day.
[2]56 lb/bu.

13 bu (0.4%); Dane County 7 bu (0.1%); and Dodge County, 5 bu (0.1%). If corn is worth $3/bu, a single deer would consume standing corn worth $3 and individual farms would lose from $15 to $45 of standing corn to deer annually.

If deer eat only standing corn when available, during the fall, 1 animal would consume 3 bu during the 90-day period. In Columbia and Sauk counties (2 high deer density counties), the prehunt deer population could, at a maximum level, consume 0.7 and 1.2% of the total grain corn crops respectively, produced on farms included in deer range. Individual farms or groups of farms in localities with above average deer densities could suffer higher losses (as suggested by damage claims). Overall, the potential total losses of corn to deer are relatively low.

Alfalfa. Alfalfa, an important forage crop in Wisconsin's dairy economy, occurs throughout the study area and accounted for 10.2-15.9% of the land area in the 4 counties (Table 1). Alfalfa hay is 2nd among agricultural crops in the number of deer damage claims and 5th among crop damage payments for deer (Table 6). Damage claims for alfalfa represented about 6% of the total payments. Average alfalfa acreages in 1978 per deer (prehunt population) for farms in deer range were 1.9 acres -- Columbia County, 2.9 acres -- Sauk County, 4.5 acres -- Dane County, and 7.1 acres -- Dodge County.

Other types of hay, mainly red clover, are less common in the area (Table 1). The rumen importance value of red clover was less than 1% and its use or damage by deer was not considered significant.

Alfalfa was found in rumens from every month except January. From April through December, the percent occurrence varied from 27 to 71% (Fig. 3). New growth was present from mid-April until the 1st killing frost which usually occurred by mid-October. During the other 6 months, deer feed primarily on the dead vegetative material.

In spring, alfalfa represented 13% of the food consumed; the greatest volume was found in April (Table 8). The rapid increase in occurrence from March to April (Fig. 3) suggested that deer may prefer plants with a high nutrient content during alfalfa's early growth stages (Smith 1968). The 1st cutting usually takes place in June and may explain the low volume (2%) in June. The increased use in July may result from feeding on regrowth.

Alfalfa averaged 10% of the entire fall volume consumed, and comprised 18% of the October volume. If freezing lowered the palatibility of alfalfa, it could explain the decline in occurrence from October to November (Fig. 3).

Economic losses to deer feeding on alfalfa are not easy to quantify. A loss of yield occurs when alfalfa is eaten during the spring and summer, directly reducing the amount harvested. Using the percent volume found in spring (13%) and summer (7%), and assuming it is equivalent to percent consumption by weight, 1 deer would consume 92 lb of alfalfa (Appendix C). Using the average size farm and alfalfa acreage for each county and assuming that the entire farm is deer range containing an average density of deer, we estimated the standing crop/farm loss of alfalfa to deer (Appendix B). The average farm in Columbia County would lose 0.7 ton (0.7% of the crop); Dodge County, 0.2 (0.2%); Sauk County, 0.6

TABLE 8. Alfalfa use by season and month.

	By Season[1]		By Month	
Month	Vol. (%)	Occ. (%)	Vol. (%)	Occ. (%)
January	1	12	0	0
February			T	13
March			1	5
April	13	52	46	54
May			12	52
June			2	58
July	7	43	11	66
August			8	27
September			3	50
October	10	46	18	68
November			8	35
December			6	71

[1]Winter (22 December - 20 March), Spring (21 March - 20 June), Summer (21 June - 22 September), and Fall (23 September - 21 December).

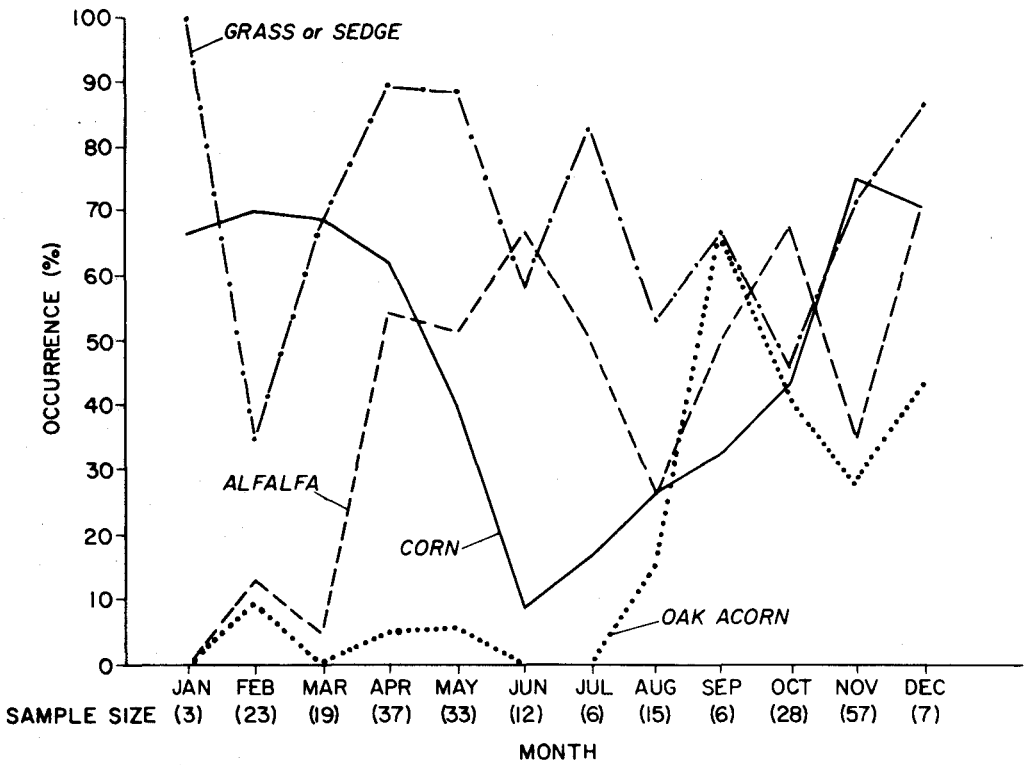

FIGURE 3. Monthly use of 4 major deer foods in southern Wisconsin as determined by rumen analysis. Samples sizes are listed below months.

ton (0.5%); and Dane County, 0.3 ton (0.3%). With alfalfa worth $45/ton, 1 deer would consume alfalfa worth $2 and average farms would lose from $9 to $31.50 of alfalfa to deer in the spring and summer. If a deer ate only alfalfa throughout the spring and summer, 920 lb would be consumed per deer.

When deer feed on the 1st crop of alfalfa, there may be a carry-over effect on subsequent crops and when deer feed on alfalfa plants during the growing season, especially in fall, there may be an adverse effect on yield during subsequent years (Mullen and Rongstad 1979). The longevity of the stand may also be shortened since alfalfa does not seed itself or propragate by vegetative means. Deer also feed on grasses in hayfields and the grass yield is not reduced. Over time, with a decline in the number of alfalfa plants, grass and weeds may get a competitive edge and increase until the alfalfa yield is no longer economical. The effect of deer on subsequent cuttings and future yields is not clearly understood and, therefore, could not be included in our estimate of damage.

Acorns. Forested lands account for 7.6-28.3% of the land area in the 4 counties (Table 1) and are dominated by oak and hickory. Nonconifer wooded acreages/deer were: 5.6 acres -- Columbia County, 15.2 acres -- Dodge County, 8.3 acres -- Sauk County, and 19.7 acres -- Dane County.

Forbes et al. (1941) examined red oak acorns and reported that in terms of composition, digestibility, and digestible nutrients, acorns are one of the most important of natural deer foods. Goodrum et al. (1971) cited the importance of acorns as a deer food in both the south and midwest. McCaffery et al. (1974) noted heavy utilization of acorns in northern Wisconsin and suggested that the fat accretion from acorns may make the difference between death and survival for some deer during severe winters.

Red, black, white, and bur oaks occur throughout the study area and no acorn species differentiation in the rumen sample was possible. Goodrum et al. (1971) found that acorns of the white oak group were more palatable to deer than the red oak group. Acorn production is influenced by several factors including year to year and species to species variability, weather, heredity, and size and age of tree.

Annual acorn occurrence in the fall rumen samples varied from 0 to 56% based on rumens with acorns only and corn and acorns both (Table 5); annual volume ranged from 0 to 19%. Although no mast surveys were conducted, it appears from our samples that 1976 and 1979 were better acorn production years than 1977 and 1978. Pils (1981) found in November 1976 rumen samples from southwestern Wisconsin, that acorns had a 97% frequency of occurrence and 64% of total volume.

In the 2 best years, acorns averaged 18% by volume. This would equate to 81 lb of acorns consumed/deer during the 90 days. Duvendeck (1957) found in a Michigan study of 11 species of oaks that in excellent years, trees greater than 14 inches in diameter would produce 35 lb of acorns/tree; in a medium quality crop, 20 lb/tree. Woodlots in the same general area of southern Wisconsin (March 1975) averaged 28 oak trees/acre greater than 14 inches

in diameter. Based on the above averages, in a medium quality crop year there would be 11,000 lb of acorns produced/deer in Dane County, 4,600 lb in Sauk County, 8,500 lb in Dodge County, and 3,100 lb in Columbia County. If a deer consumed 18% (81 lb acorns during the fall in a medium quality crop year), about 2% of the fall acorn crop would be consumed. If a deer consumed only acorns in the fall, it would eat 450 lb.

In medium acorn years, acorns would be present in winter with some left in spring (Duvendeck 1957). Also, deer will dig through 12-16 inches of snow and travel 0.5 mile from deer yards to feed on acorns (Duvendeck 1957). When deer can obtain 0.5 lb of acorns/day/100 lb of body weight, plus starvation browse species, they will survive a 90-day winter period (Duvendeck 1956).

In good acorn years there may be a decrease in the amount of corn eaten by deer. In 1977 and 1978, with little or no acorn use, the comparative frequency and percent volume of corn in rumens was higher than in the 2 years with higher acorn use (Table 5). A chi-square test of the occurrences in rumens of corn and of acorns and of both between years (3 by 4 test) yielded a value of 19.79 which with 6 df is significant at $P<0.01$. Thus it is highly probably that there is a difference in yearly corn/acorn frequencies. If 1977 and 1978 are grouped as poor acorn years and compared with 1976 and 1979 grouped, the corn volume percents are higher for the poor acorn years, but a t-test fails to establish significance ($P>0.10$, $t = 0.93$, 93 df).

Other Foods. Deer damage claims have been paid on a number of agricultural crops other than corn and hay (Table 6). Production of soybeans accounted for 19,100 acres while snap beans, lima beans, and carrots totaled less than 2,000 acres in the 4-county area (Wis. Dep. Agric. Trade and Consum. Prot. and U.S. Dep. Agric. 1980). Soybeans, unknown beans, and carrots were found in our rumen samples, but these food items were uncommon and importance values were less than 1%.

Claims for deer damage paid to orchards in 1977-79 ranked 3rd in monetary value (Table 6). Most of the damage caused by deer is done when they nip on buds and small twigs. We did not detect any apple buds or browse in the rumens. Apples represented only 2% by volume in the fall, but had a frequency of occurrence of 19%. In the study area, commercial orchards are not common and some of the apples eaten may have been from wild growing trees.

Possible detrimental effects of deer on native species of plants were difficult to document. Deer browsing may have an influence on some herbaceous plant populations and concern has been expressed on the effect(s) that deer are having on the lady slipper orchids at Summerton Bog, a state scientific area in Marquette County. In southern Wisconsin, the relatively mild winters and abundance of agricultural crops lessen the impact high deer densities could have on woody species. However, because of excessive browsing on woody species caused by a high deer population in Governor Dodge State Park, a deer season was established in 1971 (Pils 1981).

CONCLUSIONS

Crop losses due to deer on the average farm are small when compared with losses to other causes. Total corn losses due to deer on the average farm were only 0.1% of the crop or about 10 bu. Alfalfa losses average 0.4% of the crop or 0.5 tons/farm. Insect loss to grain corn cost the average Wisconsin farmer $9.68/acre in 1980 (Wis. Dep. Agric. Trade and Consum. Prot. and U.S. Dep. Agric. 1981). The average cost for insect damage and control for alfalfa was $ .80/acre. Waste corn after harvesting is estimated at about 5 bu/acre.

Deer provide potential benefits to the farmer. Hunting leases can provide direct monetary benefit and deer harvested can provide a return from the crops eaten. Using 1977-79 Department of Natural Resources harvest rates for study area counties, 2 deer would be harvested on the average farm (194 acres). The highest harvest was in Columbia County with 3.2 deer taken on the average farm. Deer can also provide days of hunting recreation directly to farmers and their families, as well as aesthetic benefits, such as viewing the deer.

When deer damage occurs and becomes important on an individual farm or a group of farms in a given locality, it outweighs the benefits derived, and becomes a serious problem. In southern Wisconsin, the deer population is best kept in check by either-sex hunting seasons or the harvest of antlerless deer with hunter choice permits. One potential means of compensating farmers for crops eaten by deer would be to allow them 1st priority in obtaining hunter choice permits.

Farmers themselves could potentially reduce losses to deer by picking their corn 1st in areas closest to wooded tracts or by reducing the amount of fall plowing (to retain waste grain and stubble) while standing corn is still present. Chisel plowing rather than conventional plowing will provide more waste corn for deer.

Close cooperation between farmers and wildlife managers is the key to maintaining control of deer herds within the agricultural range and reducing the potential impact of deer damage to crops. Agricultural interests must be willing to support adequate antlerless harvests (hunter choice quotas) based on scientifically determined management recommendations. Conversely, wildlife managers must continue to be available to adivse landowners on deer damage abatement practices, when and if serious local situations arise.

LITERATURE CITED

Chamrad, A.D., and T.W. Box
1964. A point frame for sampling rumen contents. J. Wildl. Manage. 28(3):473-76.

Coblentz, B.E.
1970. Food habits of George Reserve deer. J. Wildl. Manage. 34(3):535-40.

Courtenay, B., and J.H. Zimmerman
1972. Wildflowers and weeds. Van Nostrand Reinhold Co., New York. 144 pp.

Dahlberg, B.L., and R.C. Guettinger
1956. The white-tailed deer in Wisconsin. Wis. Conserv. Dep. Tech. Wildl. Bull. No. 14. 282 pp.

Duvendeck, J.P.
1956. A basic formula for managing oak for game. Mich. Dep. Conserv. Rep. No. 2088. 3 pp.

1957. Oak management and acorn crop forecast for deer in Michigan's lower peninsula. Mich. Dep. Conserv. Rep. No. 2156. 5 pp.

Fassett, N.C.
1976. Spring flora of Wisconsin. 4th ed. rev. by O.S. Thomson. Univ. Wis. Press, Madison. 413 pp.

Fernald, M.L.
1950. Gray's manual of botany. Am. Book Co., New York. 8th ed. 1632 pp.

Forbes, E.B., L.F. Marcy, A.L. Voris, and C.E. French
1941. The digestive capacities of the white-tailed deer. J. Wildl. Manage. 5(1):108-14.

Goodrum, P.D., V.H. Reid, and C.E. Boyd
1971. Acorn yields, characteristics, and management criteria of oaks for wildlife. J. Wildl. Manage. 35(3):520-32.

Hale, J.B.
1973. The fruit farm blues, or doing something about deer damage. Wis. Conserv. Bull. 38(5):16-17.

Korschgen, L.J., W.R. Porath, and O. Torgerson
1980. Spring and summer foods of deer in the Missouri Ozarks. J. Wildl. Manage. 44(1):89-97.

March, J.R.
1975. Characteristics of upland woodlots on a southeastern Wisconsin study area. Wis. Dep. Nat. Resour. Final Rep. Study No. 109. Pittman-Robertson Proj. W-141-R-10. 11 pp.

Martin, A.C., and W.D. Barkley
1961. Seed identification manual. Univ. Calif. Press, Berkeley. 221 pp.

McCaffery, K.R.
1973. Reinventory of statewide deer range. Wis. Dep. Nat. Resour. Perf. Rep. Pittman-Robertson Proj. W-141-R-8. 31 pp.

McCaffery, K.R., J. Tranetzki, and J. Peichura, Jr.
1974. Summer foods of deer in northern Wisconsin. J. Wildl. Manage. 38(2):215-19.

Mullen, C.A., and O.J. Rongstad
1979. Evaluation of deer damage to hay in southern Wisconsin. pp. 143-53 in A. Jackson, ed. Test method for vertebrate pest control and management materials. Am. Soc. Testing Materials. 258 pp.

Murphy, D.A.
1970. Deer range appraisal in the midwest. pp. 2-10 in White-tailed deer in Midwest. U.S. For. Serv. Res. Rep. NC-39 North Cent. For. Exp. Stn.

Mustard, E., and V. Wright
1964. Food habits of Iowa deer. Iowa Conserv. Comm. Pittman-Robertson Proj. W-99-R-3. 35 pp.

Nixon, C.M., N.W. McClain, and K.R. Russell
1970. Deer food habits and range characteristics in Ohio. J. Wildl. Manage. 34(4):870-86.

Pils, C.M.
1981. The white-tailed deer in Governor Dodge State Park. Wis. Dep. Nat. Resour. Res. Rep. No. 109. 20 pp.

Pils, C.M., and M.A. Martin
1979. The cost and chronology of Wisconsin deer-vehicle collisions. Wis. Dep. Nat. Resour. Res. Rep. No. 103. 5 pp.

Scott, T.G., and C.H. Wasser
1980. Checklist of North American plants for wildlife biologists. The Wildl. Soc. 58 pp.

Smith, D.
1968. The establishment and management of alfalfa. Wis. Agric. Exp. Stn. Bull. No. 542. 22 pp.

Spencer, J.S., Jr., and H.W. Thorne
1972. Wisconsin's 1968 timber resource -- a perspective. U. S. For. Serv. North Cent. For. Exp. Stn. Resour. Bull. NC-15. 80 pp.

Stroebe, H.A.
1971. Deer management in southern Wisconsin, 1960-70. Wis. Dep. Nat. Resour. 20 pp.

U.S. Department of Agriculture
1948. Woody plant seed manual. U. S. Gov. Print. Off. Misc. Publ. No. 654. 416 pp.

Ward, W.C., and J.W. Hardin
1977. Milo in the deer of white-tailed deer from southern Illinois. Trans. Ill. Acad. Sci. 70(1):47-56.

Wisconsin Department of Agriculture, Trade and Consumer Protection and U. S. Department of Agriculture
1980. Wisconsin agricultural statistics, 1980. Wis. Agric. Rep. Serv., ed. 99 pp.

1981. Wisconsin cooperative pest survey bulletin 26(7):40-41.

APPENDIX A. Importance values of all foods found in 246 rumina of southern Wisconsin deer by season, 1976-80[1].

Taxa	Season			
	Spring	Summer	Fall	Winter
Fruits or seeds				
Corn (Zea mays)[2]	12	5	20	25
Oak acorn (Quercus sp.)	1	2	10	1
Common apple (Malus pumila)	1		3	1
Cherry (Prunus sp.)		1	2	
Grape (Vitis sp.)			1	1
American bittersweet (Celastrus scandens)			T	
Aster (Aster sp.)	T		1	
ASTERACEAE		1		
Bean (Phaseolus sp.)[2]			T	
Bitter nightshade (Solanum dulcamara)			T	
Carrot (domestic) (Daucus carota)[2]			T	
Common soybean (Glycine max)[2]			T	T
Curly dock (Rumex crispis)	T			
Dogwood (Cornus sp.)		1	T	
Elm (Ulmus sp.)	T			
Gray dogwood (Cornus racemosa)			T	
Hawthorn (Crataegus sp.)			T	
Legume (FABACEAE)	T			
Maple (Acer sp.)	T			
Milkweed (Ascelepias sp.)				T
Mock cucumber (Echinocystis lobata)			T	
Mushroom (AGRARICACEAE)	1		1	
Plum (Prunus sp.)			T	
Poison sumac (Rhus vernix)			T	
Rose (ROSACEAE)	T			
Smartweed (Polygonum sp.)		T	T	
Sumac (Rhus sp.)	T	T	1	
Unknown	T	3	T	
Unknown berry				T
Virginia creeper (Parthenocissus inserta)			T	T
Subtotal	15	13	40	29
Herbaceous Materials				
Unknown	22	16	12	7
Alfalfa (Medicago sativa)[2]	11	7	9	2
Grass or Sedge (POACEAE or CYPERACEAE)	18	6	10	9
Corn[3]	1	2		
White dog's-tooth-violet (Erythronium albidum)	1			
Aster[3]			T	T
Avens (Geum sp.)			T	
Bitter nightshade[3]			T	
Buttercup (RANUNCULACEAE)	T		T	
Canada thistle (Cirsium arvense)	T	1	T	
Common cattail (Typha latifolia)	1			
Clover (Trifolium sp.)[2]	1	1	T	
Common soybean[3]			T	
Dandelion (Taraxacum sp.)	2	1	1	
Goldenrod (Solidago sp.)			T	
Mint (LAMIACEAE)	1			
Plantain (Plantago sp.)	T			
Pondweed (Potamogeton sp.)			T	

APPENDIX A. (Cont.)

Taxa	Season			
	Spring	Summer	Fall	Winter
Herbaceaous Materials, cont.				
Prickly lettuce (Lactuca serriola)		1		
Ragweed (Ambrosia sp.)			T	
Red clover (Trifolium pratense)[2]	T		T	
Rose[3]	T		T	
Sheep sorrel (Rumex acetosella)	T		T	
Thistle (Cirsium sp.)				T
Toothwort (Dentaria laciniata)	T			
Unknown root	T			1
Wild geranium (Geranium maculatum)	T			
Willow flower (Salix sp.)	T			
Woodfern (Dryopteris sp.)	T		T	1
Wood sorrel (Oxalis sp.)		1		
Subtotal	59	34	34	20
Woody Fragments				
Unknown	6	5	4	18
Eastern juniper (Juniperus virginiana)			T	4
White pine (Pinus strobus)				2
Virginia creeper[3]				2
American elder (Sambucus canadensis)				T
American filbert catkin (Corylus americana)				T
Common buckthorn (Rhamnus cathartica)			T	
Common juniper (Juniperus communis)				1
Dogwood[3]			T	
Eastern arborvitae (Thuja occidentalis)				1
Pine (Pinus sp.)	T			T
Raspberry (Rubus sp.)	T		T	
Red pine (Pinus resinosa)				2
Rose[3]	T		T	
Sumac[3]	T			
Tamarack larch (Larix laricina)			T	
Unknown catkin				T
Willow (Salix sp.)	1		T	1
Subtotal	7	5	5	30
Woody Leaves				
Unknown tree or shrub	6	19	11	10
American linden (Tilia americana)			T	
Aspen (Populus sp.)	T		T	
Boxelder maple (Acer negundo)	T	1		
Buckthorn[3]			T	
Common chokecherry (Prunus virginiana)	T			
Dogwood[3]	T	1		
Elm[3]			T	
Gooseberry (Ribes sp.)		1	T	
Gray dogwood[3]			T	
Oak[3]		1	T	
Rafinesque viburnum (Viburnum rafinesquianum)			T	
Raspberry[3]			T	
Red maple (Acer rubrum)	T			
Serviceberry (Amelanchier sp.)	T			
Willow[3]		T	T	
Subtotal	7	22	12	10
Miscellaneous Pieces				
Unknown fragment	12	25	10	11
Feather	T			T
Insect	1	T	T	T
Subtotal	13	26	10	12

[1]Importance value = (percent volume plus percent occurrence) divided by 2.
[2]Cultivated species.
[3]Taxa found in other forage categories.
T = trace.

APPENDIX B. Crop and farm statistics by county.

	Columbia	Dane	Dodge	Sauk
Deer/farm Calculations				
Deer range (mile^2)	344	170	174	478
Deer range (mile^2) in private farms[1]	310	150	154	458
Deer/mile^2 on private farms[2]	44.2	24.6	17.0	38.0
Size of farm (mean no. acres)	210	179	169	219
Deer (mean no.)/farm	14.5	6.9	4.5	13.0
Corn Loss Calculations				
Grain corn/farm (mean no. acres)	57	50	40	32
Grain corn (bu)/acre	104	104	94	100
Grain corn (bu)/farm	5,928	5,200	3,760	3,200
Grain corn/deer (mean no. acres)	3.9	7.2	8.9	2.5
Waste corn (bu)/deer[3]	20	38	42	12
Standing grain corn (bu) loss/farm	15	7	5	13
% of standing grain corn loss/farm	0.3	0.1	0.1	0.4
Alfalfa Loss Calculations				
Alfalfa/farm (mean no. acres)	27	31	32	38
Alfalfa (tons)/acre	3.5	3.2	3.2	3.2
Alfalfa (tons)/farm	95	99	102	122
Alfalfa/deer (mean no. acres)	1.9	4.5	7.1	2.9
Alfalfa (tons) loss/farm	0.7	0.3	0.2	0.6
Alfalfa (%) loss/farm	0.7	0.3	0.2	0.5

[1]Estimated area of deer range in private farms.
[2]Assumed all deer were feeding on private farms.
[3]Waste corn is 5% of total crop (D. Rohweder, Univ. Wis.-Madison Dep. Agron., pers. comm.)

APPENDIX C. Amount of food item consumed by season.

Food Item and Season	% Volume by Season	No. Days in Season	Total Food Consumed (lb)/Day	Food Consumed (lb)/Deer/Season
Corn[1]				
Summer	0.06	93	5	27.9
Alfalfa				
Spring	0.13	91	5	59.2
Summer	0.07	93	5	32.6
Subtotal				91.8
Acorns				
Fall	0.18	90	5	81.0

[1]Fall data for corn consumed is found in Table 7.

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