SEASONAL RANGE ANALYSIS FOR WHITE-TAILED DEER ON THE BROAD RUN WILDLIFE RESEARCH AREA

by

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INTRODUCTION

Annual production of browse plants, characterized by hardened woody stems, has been measured on the Broad Run Wildlife Research Area by Whelan (1962), Thompson (1962) and Patton (1963). However, more recent work by Harlow and Hooper (1971) on analyses of white-tailed deer (*Odocoileus virginianus*) rumen contents revealed that woody stems are not as important in the diet of deer in the Southeastern United States as are other forages. Analysis of rumen contents collected from the Broad Run Area during the 1967 through 1972 hunting seasons (Harlow et al. 1975) suggests that browse comprises only a small percentage of the total diet of the deer in this area.

No measurements of the production of important non-browse food plants eaten by deer have been made on the Broad Run Wildlife Research Area. The objectives of this study were:

1. To estimate the quantity of important deer foods produced in the mixed oak-pine forest cover type during five sampling periods.
2. To determine the nutrient composition of individual important deer foods or mixtures of these foods which approximate the seasonal diets of deer.
3. To estimate the nutrient quality of the important deer foods and mixtures of these foods to the deer by determining dry matter digestibility using an *in vitro* digestion procedure.

LITERATURE REVIEW

Deer foods of the Ridge and Valley Province have been studied by observing tractable lead deer feeding and by examination of rumen contents collected from wild deer. Whelan et al. (1971) used three lead deer to study selectivity of spring forages in a seven-year-old pine seed-tree cut in western Virginia. The spring diet consisted of 69 percent forbs, 14 percent broadleaf evergreens, 11 percent deciduous hardwoods, 3 percent grasses and sedges, and 2 percent conifers. Green leaves constituted 82 percent of all foods taken, 7 percent were living stems, 6 percent were living flowers, 4 percent were dried leaves, and 1 percent were dried flowers. Data on plant parts and plant species selected by the three lead deer, listed in numerical order of importance, were presented. On the same study area, Crawford et al. (unpub.) used lead deer to determine food selectivity during the summer. Forbs were taken 58 percent of the time, deciduous hardwoods were taken 32 percent of the time, and grasses and sedges were taken 9 percent of the time. Green leaves were taken 74 percent of the time, followed by live stems and twigs, fruit, flowers and dry leaves which were taken 13, 5, 5, and 3 percent of the time, respectively. Again, detailed information on plant species and plant parts selected were given. Harlow et al. (1975) examined rumen samples collected during the fall from the Broad Run Wildlife Research Area, Craig County, Virginia for a six-year period. During three years when acorns were abundant, mast in the rumen varied from 64 to 94 percent by volume. In the three years when acorns were scarce, fruits in the rumen samples varied from less than 1 to 16 percent by volume. Evergreen forbs made up 0-12 percent and 25-54 percent in the acorn and non-acorn years, respectively, and herbaceous forbs made up less than 1 and 1-13 percent in these years.

Nutrient quality varies between species, within species, and within individual plants. Dietz (1965), Reynolds (1967), and Blair and Halls (1968) all reported the tendency for phosphorus and crude protein to be highest in the spring during growth, and decrease as the plants matured while crude fiber tended to increase from spring to winter. Similarly, Bailey (1967) found that protein content was greater near the tips of witch-hobble (Viburnum alnifolium) twigs than in the non-growing portion. Blair and Epps (1967) reported that protein and phosphorus content was highest near the tip of rusty blackhaw (Viburnum rufidulum) twigs. Bailey (1967) found that buds from the lower portion of the crown had a higher protein content than those from the upper portion of the crown and that flower buds were higher in crude protein than vegetative buds. Dietz (1965) and Blair and Halls (1968) found leaves to be richer in protein than twigs. Hundley (1956) found slight differences in the chemical composition of the same species of plant growing in different soils.

Bissell (1959) stated that caution should be used in interpreting data from chemical analysis of forage, since deer can apparently select the more nutritious plants as shown by their selection of plants with high protein content.

The tendency for both mule and white-tailed deer to be smaller and less productive on ranges with poorer quantity and quality of forage has been reported by many authors including: Einarsen (1946), Morton and Cheatham (1946), Cheatham and Severinghaus (1950), Swank (1956), Taber (1956), Juleander et al. (1961), Thorsland (1967) and Short et al. (1969). Einarsen (1946) found that protein was significantly higher in the diet of a population of large deer than in that of a population of small deer. Swank (1956) thought that low protein and phosphorus levels in range forages may be limiting factors which influence reproduction and growth of deer in the southwest. Short et al. (1969) reported that in the southeast upland deer are smaller and less productive in the wild, but when placed on a nutritious diet these deer had better growth and reproduction than deer which were fed a diet similar in nutrient composition to that eaten by wild deer. Fawn losses due to poor diet were considered by these investigators to be a major factor in limiting population size.

The nutritional requirements of deer are not as well known as would be desired, but some information is available. Ullrey et al. (1971) formulated a diet composed of 92.9 percent dry matter, 17.6 percent crude protein, 2.0 percent ether extract, and 4.6 percent ash. Cell wall constituents were 40.5 percent, acid detergent fiber - 17.6 percent, lignin - 3.8 percent and gross energy - 4.20 kcal/gram. Vitamins A, D, and E were supplied in a premix and phosphorus was adequate. This diet has been used successfully in feeding deer of all ages and appears to be adequate in nutrient composition for growing fawns and lactating does.

Verme (1967 and 1969) found that does on quantity restricted diets produced fewer live fawns than those fed an ad libitum diet, and a larger proportion of males were produced on restricted diets. Dietz (1965) feels that if the range produces enough palatable forage there should not be an energy deficiency and that some other nutritional factors, most likely protein or phosphorus, may be limiting.

In pen studies, Ullrey et al. (1967) found that 12.7 percent crude protein was not adequate for optimal growth in male white-tailed deer fawns but 20.2 percent was probably sufficient. However, French et al. (1956) reported that 13 to 16 percent crude protein resulted in optimum growth. Einarsen (1946) thought that die-offs in deer populations were imminent if the crude protein level in available forages was reduced to 5 percent. McEwen et al. (1957) found that captive adult deer could tolerate a diet containing only 7 percent protein during the winter. Six 18 month old deer barely survived on a diet with only 4 or 5 percent protein and showed intermediate growth on a diet of 9 or 10 percent protein. Murphy and Coates (1966) fed 3 groups of does isocaloric diets with 7, 11, and 13 percent protein; fawn production and fawn and doe survival were better on the higher protein diets. Increased fawn mortality on low protein diets was primarily due to delayed milk production.

Dietz (1965) stated that a phosphorus deficiency may cause a failure to conceive, and Stanley (1951) reported that in cattle a phosphorus deficiency may retard growth, reduce milk production, cause irregularity in ovulation, and result in improper cleaning at parturition.

McEwen et al. (1957) found that a level of 0.27 percent phosphorus in the diet did not cause a reduction in health or body size in captive white-tailed deer but did limit antler growth. French et al. (1956) reported that white-tailed deer require 0.25 percent phosphorus in their diet. Torgerson and Pfander (1971) stated that deer need a 1:1 or 2:1 calcium: phosphorus ratio, while Dietz et al. (1959) stated that although a 2:1 ratio is optimum, a ratio as wide as 5.5:1 is acceptable. Ullrey et al. (1973) found that when dietary phosphorus was 0.25 to 0.27 percent and dietary calcium 0.18 or 0.22 percent white-tailed deer fawns showed low weight gains. In the same study bone strength and composition suggested that 0.40 percent dietary calcium and 0.25 to 0.27 percent phosphorus were adequate for normal development.

Tilley and Terry (1963) compared a two-stage *in vitro* digestion technique with *in vivo* digestion for sheep and obtained similar results for dry matter digestibility. Johnson and Dehority (1968) reported that dry matter digestibility and digestible energy of forages can be predicted more accurately by a two-stage *in vitro* digestion technique than by analysis of forages for acid detergent fiber, acid detergent lignin, or cell wall constituents. Oh et al. (1966) reported that the two-stage *in vitro* digestion technique was superior when a mixture of forages was being analysed, but solubility of forage cellulose in cupriethylene diamine (CED), dry matter solubility in 10 N H_2SO_4 (DMS) and dry matter disappearance by an artificial rumen technique were equally valid for analysis of individual samples. Short et al. (1973) reported that values for acid detergent fiber in leaves do not give good estimates for their digestibility. Pearson (1970) described the in vitro technique in detail, and stated that dry matter digestibility increased with time up to 24 hours but since this increase is very slight after 12 hours either 12 or 24 hours of digestion time may be used. Although Pearson (1970) felt that it was best to use rumen inoculum from deer which had been feeding on forages similar to those being analysed, Palmer and Cowan (1974) found that inoculum from cattle gave similar results and could be used instead.

Shafer (1963) reported that a twig-count method was nearly as accurate in determining the amount of browse available as a clip and weigh method. The weight estimation technique was less accurate, but it was suggested that double sampling involving clipping and weighing vegetation on some of the plots would improve its accuracy. Thompson (1962) reported that the twig count method is an efficient and accurate method of determining the quantity of browse available. Pechanic and Pickford (1937) reported that a weight estimation technique was effective for determining range and pasture production, and Schwan and Swift (1941) recommended this method for evaluating big game range and found the estimates to be within 20 percent of the actual weight.

STUDY AREA

The Broad Run Wildlife Research Area contains 3901 ha (9,640 acres) of forest land in compartments A, B, C, and E and is located on North Mountain in Craig County, Virginia, about 10 miles south of Newcastle on highway 311. Elevation varies between approximately 455 and 915 m (1500 and 3000 feet).

The vegetative cover and soils on the study area are typical of those which occur in the mountains in the Ridge and Valley Province of southwestern Virginia. The soils are derived from two rock formations, Brallier shale and Chemung sandstone which are composed of almost equal amounts of interbedded shale and sandstone. In general, the overstory consists of second growth hardwoods, mainly oaks, and some pines, particularly on the western and southwestern exposures where pitch (*Pinus rigida*) and table mountain pines (*P. pungens*) are abundant; this type comprises 20 percent of the total area. The eastern and northeastern exposures support stands of mixed oaks, primarily scarlet (*Quercus coccinea*), white (*Q. alba*) and chestnut (*Q. montana*) oaks, and also contain some Virginia pine (*P. virginiana*). The mixed oak-pine cover type comprises approximately 19 percent of the area. Sheltered coves support mainly white oak, tulip poplar (*Linodendron tulipifera*), hickory (*Carya* spp.) and white pine (*P. strobus*); this cover type makes up approximately 33 percent of the area.

Generally, the land in the study area can be classified as relatively poor for forest production due to its shallow, infertile soils. Therefore, it is better suited for wildlife and outdoor recreational uses. In 1957, the study area was designated as a wildlife research area by a cooperative agreement between the U.S. Forest Service, the Virginia Commission of Game and Inland Fisheries, the Virginia Cooperative Wildlife Research Unit, and Virginia Tech's Division of Forestry and Wildlife Resources.

METHODS

Selection and Location of Study Areas

Four study areas were selected so that a range of conditions within the mixed oak-pine cover type could be investigated. Each section of mixed oak-pine shown on a cover type map and located near the access road or near an agricultural clearing was assigned a number and four section numbers were obtained from a table of random numbers. Figure 1 shows the location of the study areas selected in this manner. Study area "A" was located in Compartment B and surrounded Clearing 26 on the north, south and east sides. Study area "B" was in Compartment B on the north side of the access road and next to the boundary between Compartments B and C. Study area "C" was in Compartment C, on the north side of the access road near the boundary of Compartment B. Study area "D" was in Compartment C on the southeast side of Clearing 8.

Description of Study Area

Canopy Closure

The canopy closure was estimated during the June sampling period using the centers of the forage sampling quadrates as plot centers. A circular plot with a radius of 10 feet was estimated by pacing. Two observers individually estimated the canopy closure above this plot and the average was recorded.

Basal Area

Basal area was measured using a wedge prism with a basal area factor

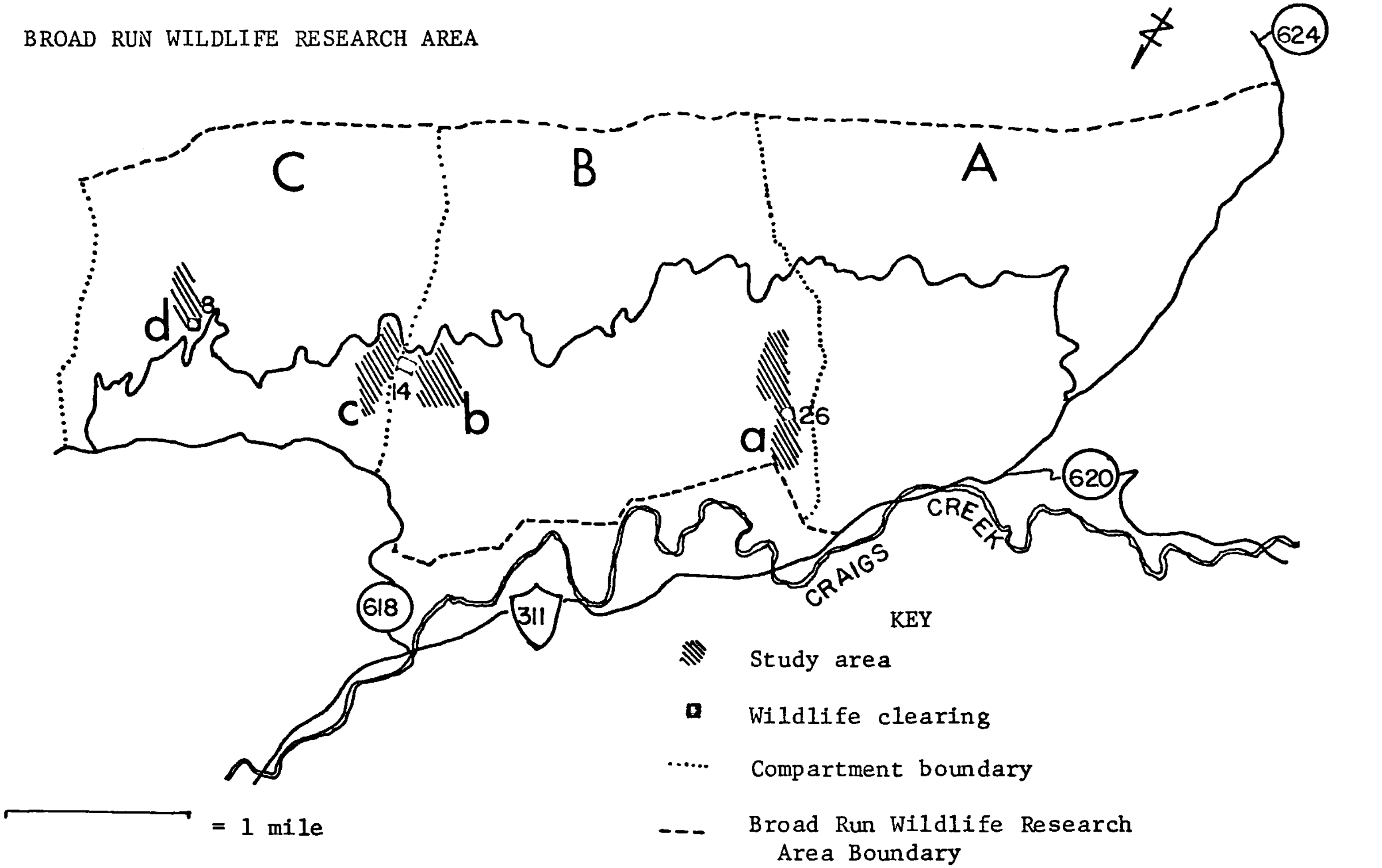

Figure 1. Location of four study areas (a, b, c, d) and three compartments (A, B, C) within the Broad Run Wildlife Research Area, Craig County, Virginia.

of 10 as described by Husch (1963:164-166). The plot centers were located at 5 chain intervals along transects which crossed contour lines. The starting points for the transect lines were located along a base line at distances chosen from a table of random numbers, and any possible transect within 5 chains of a previously selected one was excluded. All distances were measured by pacing. The base lines were as follows: for area "A", a line extending along and on either side of the west side of clearing 26; for areas "B" and "C" the top of the ridge separating them; and for area "D", a line extending from clearing 8 along the west edge of the cover type.

Site Index

Because the study areas cannot strictly be considered even aged stands, a true site index cannot be determined. However, to give some measure of the quality of the areas, the height of three co-dominant and dominant pitch pine and three co-dominant and dominant scarlet oak in each study area were measured with an Abney level; and an increment boring was taken at 4.5 feet from the ground. The height and ages of the scarlet oaks were compared with the site-index curves for upland oak from Schnur (1937). Site index curves for pitch pine could not be found; the site index for pitch pine was estimated using Doolittle's (1958) comparisons of site index for 10 species in the Southern Appalachians.

Forage Production

Quadrat Size and Location

The quadrat size was one square meter. Quadrats were laid out using a wooden frame with three rigid sides and one removable side to facilitate placing plots around trees or in brush.

The transect lines were located in the same way as those for basal area quadrates with the exception that any possible transect within 1 chain was excluded. The quadrates were located at 1 chain intervals along the transects. All distances were measured by pacing.

Plants and Plant Parts Collected

Fall food habits data were available from analysis of rumen samples collected from legally harvested deer on the Broad Run Wildlife Research Area by Harlow et al. (1975). The forages which this study indicated were important deer foods were sampled during the fall period. Harlow and Hooper's (1971) data from the Southern Appalachians were used to determine important forages for the summer and winter sampling periods. The spring flush (April) samples included those species shown to be important winter or spring foods by Harlow and Hooper (1971) and the late spring (May) samples included those that they listed as important spring or summer foods.

The following portions of important forage species found within a plot up to a height of 4.5 feet were collected and weighed or their weight was estimated: leaves and twigs of woody plants were considered separately and only the current annual growth was taken; acorns were divided into either the red or white categories and were weighed without the caps; for all other species of living plants all parts above the ground were considered. Only those dead leaves which had fallen during the autumn of sampling were taken. Although they were eaten in fairly large quantities during the winter, dry oak leaves were not measured because they were so abundant it was felt that the time could better be used to collect information on more important but less common forages.

All the plant parts collected were placed in pre-weighed, labelled paper bags and weighed to the nearest gram on a spring balance with a capacity of 200 grams. The forage samples were taken to the laboratory, dried in an oven at 65 C, until weight loss stopped, and reweighed to determine oven dry weight from which percent dry matter and dry matter production were calculated.

Initially a weight estimate, double sampling technique was considered. In the first phase two investigators independently estimated the weights of all forages within each quadrat. The forages were then clipped and weighed and the ratio of the mean estimate to the actual weight was determined. Quadrats were treated in this manner until the ratios for the common forages stabilized and a ratio estimator was obtained for each. In this first phase, the quadrats were not located as described previously but were selected to contain common forages to facilitate obtaining the ratio estimator. In the second phase, the quantity of each forage present was estimated by the same two observers and corrected using the ratio estimator. Occasionally quadrats were clipped and weighed to check the accuracy of the observers estimates. The quadrats used in this phase were located as described in the previous section.

The ratio estimator method was used for the summer sampling but was then abandoned for the following reasons. First, establishing a weight estimator was a time consuming practice which would have created special problems in the spring sampling periods which were short and involved rapid changes in vegetation growth. Second, it was frequently necessary to skip several days in the field due to class schedules, which further increased the amount of time needed to obtain a ratio estimator and commonly resulted in the need for several practice quadrats in order to estimate with any accuracy. In addition, the need for using the same two people on each day of sampling made scheduling difficult, especially during those seasons when class schedules needed to be considered.

For the fall, winter, and spring seasons all quadrats were clipped and the vegetation was weighed.

Forage Quality

Sample Collection

The plants which were clipped and dried to determine percent moisture were saved for nutritional analysis. In addition, forage species which occurred only on a few quadrats or were found only in small quantities on the quadrats were collected whenever they were encountered. Approximately 200 grams fresh weight of each infrequently occurring forage was collected. These plants were dried in the same way as those collected on the quadrats. This method insured that the forage samples came from several areas within the cover type and would represent the area as a whole, rather than only one segment. All samples which were analysed for nutrient content came from at least ten areas except rhododendron (*Rhododendron maximum*). Rhododendron is rare on the mixed oak-pine cover type and only one clump was found.

Sample Preparation

The dried plants were ground in a micro Wiley Mill to pass a forty-mesh screen and stored in airtight jars for subsequent analysis.

Composite diets for the summer, fall, and winter periods were mixed for analysis of nutrient quality. For the fall period, food habits information was available from the Broad Run Wildlife Research Area (Harlow et al. 1971) and the three fall diets were mixed according to these data. No food habits data were available from Broad Run for the other seasons: summer and winter diets were mixed using Harlow and Hooper's (1971) data for the southern Appalachian mountains. In all cases the food habits were reported by percent volume of the rumen contents. To convert from percent volume to percent dry matter in the diet, the percent by volume was multiplied by the percent dry matter of each species. An aggregate or composite diet was prepared by combining the dry weights of each species represented in the seasonal diet.

A composite diet was not mixed for either the spring flush (April) or spring (May) sampling periods. Many major foods reported by Harlow and Hooper (1971) for spring and by Whelan et al. (1971) from lead deer work were either unavailable or rare on the mixed oak-pine cover type on Broad Run. Furthermore the spring food habits studies of Harlow and Hooper (1971) summarizes data for samples collected from March 18 through

June 1, while the available vegetation on Broad Run was similar to winter conditions in the early spring and approached summer conditions by late spring. Whelan et al. (1971) conducted the lead deer forage selectivity study in a clearcut area in which the vegetation differs from that in the mixed oak-pine cover type. Therefore, it is doubtful that a diet mixed from these data would be representative of the diet of a deer foraging in the mixed oak-pine cover type. For these reasons it did not seem reasonable to mix a composite diet for these periods and individual forages were analysed instead. Species selected for analysis to represent the early spring period included forages that Harlow and Hooper (1971) reported to be important foods during the winter and/or spring seasons and which were common on the study areas. Late spring forages which were analysed were those that were reported to be important spring and/or summer foods and were common in the area. The forages analysed for the early spring period were collected from April 1 through April 30; late spring samples were collected from May 1 through May 30.

The summer composite diet represented 88 percent of the diet by volume, as reported by Harlow and Hooper (1971). The composition of this composite diet on a dry matter basis was as follows: 32 percent red maple (*Acer rubrum*) leaves, 19 percent oak leaves, 16 percent legumes of which bush clover (*Lespedeza violacea*) was the only representative found in any quantity on the area, 14 percent fungi, 12 percent dogwood (*Cornus florida*)leaves, and 7 percent sourwood (*Oxydendrum arboreum*)leaves. The summer samples were collected from June 20 through June 24.

Three composite diets were mixed for the fall season. One diet represented the fall diet in years when acorns were abundant and included 90 percent by volume of the foods reported by Harlow et al. (1975) for these years. This composite diet contained 80 percent acorns, 16 percent dry oak leaves, 3 percent fungi, and 1 percent panic grass (Panicum spp.) on a dry weight basis. Due to the extremely poor acorn crop during the year of study, enough acorns could not be collected to mix several composite diets which would differ in the amounts of red and white acorns. Only one diet was mixed with 39 percent red oak acorns and 41 percent white oak acorns.

To represent the fall diet when acorns were scarce, two diets were mixed to determine what variation would result if different percentages of the reported diet were represented. One diet included 67 percent by volume of the foods for the years without acorns and consisted of 45 percent teaberry (Gaultheria procumbens), 27 percent dry oak leaves, 11 percent fungi, 6 percent galax (Galax aphylla), 5 percent panic grass, 4 percent trailing arbutus (Epigaea repens), and 2 percent greenbrier (Smilax spp.) on a dry weight basis. The second composite diet for years without acorns included 87 percent of the reported diet and was comprised of 37 percent teaberry, 22 percent dry oak leaves, 9 percent fungi, 5 percent galax, 4 percent panic grass, 3 percent trailing arbutus, 2 percent greenbrier, 4 percent hardened woody stems (equal amounts of sourwood, red maple, and oak), 4 percent Virginia pine needles, 3 percent ferns, 3 percent bush clover, 3 percent cinquefoil (Potentilla canadensis and P. simplex) and 1 percent succulent woody stems (equal amounts of sourwood, red maple, and oak). The fall samples were collected from late September through mid-November.

The winter composite diet comprised 72 percent of the winter diet reported by Harlow and Hooper (1971), but it should be noted that 24 percent of the reported diet was not available on the mixed oak-pine cover type during the winter. The composite for winter was comprised of 35 percent rhododendron leaves, 26 percent panic grass, 13 percent fungi, 6.6 percent dry oak leaves, 6.0 percent galax, 4.6 percent mountain laurel (Kalmia latifolia) leaves, 2.6 percent teaberry, 3.2 percent hardened rhododendron twigs, 1.8 percent succulent rhododendron twigs, 1.1 percent greenbrier leaves, 0.3 percent trailing arbutus, and 0.2 percent cinquefoil. In addition, rhododendron and mountain laurel leaves were analyzed individually because the former, which made up a major portion of the diet, is rare on the area while the latter is quite common. Furthermore, in Harlow and Hooper's (1971) study in the southern Appalachians, rhododendron consistently outranked mountain laurel in amount taken, while the Broad Run data (Harlow et al., 1975) showed no clear trend suggesting that availability of these two species may be of importance in determining the relative amounts taken. All winter samples were collected during January and February.

The following forages were analyzed for the early spring sampling period: blueberry leaves (Vaccinium spp.), blueberry stems, greenbrier stems, teaberry, cinquefoil, panic grass, mountain laurel leaves, dry oak leaves, and trailing arbutus. The late spring samples included blueberry leaves, green oak leaves, greenbrier leaves, red maple leaves, galax, sourwood leaves, bush clover, and mountain laurel leaves.

In addition a composite diet, prepared from those samples which were analyzed individually, was mixed for each spring period. No attempt was made to approximate the spring diet of the deer when preparing the two spring composite diets. The early spring composite diet consisted of 27.9 percent mountain laurel leaves, 17.4 percent blueberry leaves, 17.0 percent teaberry, 16.4 percent blueberry stems, 9.0 percent dry oak leaves, 8.6 percent greenbrier stems, 1.7 percent trailing arbutus, 1.1 percent cinquefoil and 0.9 percent panic grass on a dry weight basis. The late spring composite diet contained 21.6 percent green oak leaves, 19.0 percent red maple leaves, 17.5 percent sourwood leaves, 14.1 percent mountain laurel leaves, 12.7 percent blueberry leaves, 8.5 percent clover, 5.3 percent galax and 1.2 percent greenbrier leaves, on a dry weight basis.

The _in vitro_ dry matter digestibility of the two diets was obtained to determine if the _in vitro_ dry matter digestibility of individual species could be used to predict the digestibility of a composite diet prepared from them.

Analytical Procedures

All forage samples were analyzed for gross energy by oxygen bomb calorimetry using a Parr series 1230 oxygen bomb calorimeter with a series 2601 automatic adiabatic control system, and for dry matter digestibility by a two stage _in vitro_ digestion technique described by Pearson (1970). The Virginia Tech Forage Testing Laboratory analysed all samples for lignin content (Van Soest, 1967) and for proximate composition (A. O. A. C. 1965). Soluble carbohydrates were extracted from all samples by the procedure of Smith (1969) and assayed as described by Wolf and Ellmore (1973). Phosphorus content of all samples was determined by the Virginia Tech Animal Science Department on wet-ashed samples using the nitric and perchloric acids procedure (Fiske and Subbarow 1925).

Calculations

Kilocalories/Hectare/Day of Key Forages

During the summer sampling period the key forages included bush clover, dogwood leaves, greenbrier leaves, oak leaves, panic grass, red maple leaves, and sourwood leaves. For the fall sampling period, fungi, galax, greenbrier stems, panic grass, teaberry and trailing arbutus were considered to be key species. Key species for winter included cinquefoil, fungi, galax, greenbrier stems, mountain laurel leaves, panic grass, teaberry, and trailing arbutus.

Early spring (April) key forages included blueberry leaves, cinquefoil, greenbrier stems, mountain laurel leaves, panic grass, teaberry, and trailing arbutus. During May, bush clover, galax, greenbrier leaves, mountain laurel leaves, oak leaves, panic grass, red maple leaves, and sourwood leaves were considered key species. Although Harlow and Hooper (1971) reported blueberry leaves to be an important spring forage, and they were readily available during both April and May, they were included as a key forage only during the April period for the following reasons. First, blueberry leaves were readily available in April while few other fresh foods were available in any quantity at this time, but the forages available in May were more varied and similar to summer conditions. Second, Harlow and Hooper's (1971) data indicated that blueberry leaves were important during the period from March 18 through June 1, or at least some portion of that period, but unimportant during the summer. Third, the analysis of nutrient content indicates that blueberry leaves are a high quality food in April when few other foods of high quality are available, but their nutrient content declined somewhat by May when forages of better quality are available. For these reasons, it seemed reasonable to assume that consumption of blueberry leaves is concentrated during April.

The duration of the five seasons was designated as follows: Spring flush - April 1 through April 30 (30 days); Spring - May 1 through May 31 (31 days); Summer - June 1 through September 15 (107 days);Fall - September 16 through November 30 (76 days); and Winter - December 1 through March 31 (121 days).

The following formula was used to calculate the energy production of key forages:

$$\text{Kcal/ha/day} = \frac{\text{IVDMD} \times \text{GE} \times \text{P}}{\text{D}}$$

where IVDMD is the percent <u>in vitro</u> dry matter digestibility, GE is the gross energy in kilocalories per kilogram, P is production of key forage species in kilograms per hectare, and D is the number of days in the season. For the two spring periods, energy production in kilocalories per hectare per day was calculated for each species and summed. For the other seasons the values for the composite diet were used.

Digestible Energy Requirements of the Deer Herd

The herd requirement in kcal/ha/day was calculated based on the following assumptions: (1) an estimate of 180 deer on the 3013 ha (7445 acres) which comprise compartments A, B, and C; or 1 deer per 16.4 ha (41 acres) (Weekes 1974); (2) approximately 573 ha of Broad Run are in the mixed oak-pine cover type, so if the deer herd is evenly distributed the equivalent of 35 deer depend on this cover type for food; (3) hunting season data from Broad Run indicate that 15 percent of the deer are less than 1 year old, 46 percent are 1-2 years old, and 39 percent are over 2 years old. If the sex ratio is 50:50 the mixed oak-pine type supports 7 bucks and 7 does which are over 2 years old; 8 bucks and 8 does which are 1-2 years old; 3 bucks which are less than 1 year old, and 2 does which are less than 1 year old; (4) the digestible energy requirement per day for maintenance and normal growth is 168 kcal/ $kg^{.75}$ for young bucks, 155 kcal/$kg^{.75}$ for young does, 160 kcal/$kg^{.75}$ for adult bucks, and 158 kcal/$kg^{.75}$ for adult does (Ammann et al. 1973, Ullrey et al. 1969); (5) the mean body weights for the various sex, age and seasonal classes in kg were taken from Broad Run Hunting Season data (Whelan unpub.), Pennsylvania State University growth studies (Long et al. 1965), the equations for growth rates of yearling and adult, male and female white-tailed deer (Moen 1973), and Virginia Tech Deer Research Facility growth studies (Buckland 1974). The average weights, raised to the 0.75 power, of the various classes are presented in Appendix Table I.

The requirements for maintenance and growth were calculated for each sex and age class for all seasons from the following formula:

$$R = \frac{W \times E \times N}{A}$$

where R is the digestible energy requirement for growth and maintenance of yearlings and maintenance of older deer of one segment of the herd in kcal/ha/day; W is the weight of one animal in kg raised to the 0.75 power, E is the digestible energy requirement in kcal/kg$^{.75}$/day, N is the number of deer in the sex and age class, and A is the area of the mixed oak-pine cover type in ha. The R values for all sex and age classes in a season were summed to give the overall digestible energy requirement for that season.

The requirement for lactation is based on the assumptions that: (1) does of 1-2 years of age produce 1.0 fawn/doe and older does produce 1.65 fawns/doe (Moen 1973); (2) lactation occurs from June 1 to August 31 or 92 days (Moen 1973); (3) a doe with 1.0 fawn produces 5655 g of milk per day during June 1 - June 15; 6750 during June 15 - June 30; 6750 during June 30 - July 15; 6000 during July 15 - July 31; 4500 during July 31 - August 15; and 2800 during August 15 - August 31; (4) does over 2 years old produce 1.65 fawns per doe and produce 1.65 times as much milk as does with 1.0 fawns; (5) it requires 0.7 kcal of digestible energy to produce 1 g of milk.

The energy required for lactation during each half month period for each age class was calculated by the following formula:

$$E = M \times 0.7 \times N \times D$$

where E is the energy required for lactation during a given period in kcal; M is the amount of milk produced per day in grams by one doe in the age class; 0.7 is a constant equal to the energy in kcal needed to produce 1 g of milk; N is the number of does in the age class; and D is the number of days in the period. To obtain the total figure for any month the E values for all periods and age classes within that month were summed.

RESULTS AND DISCUSSION

Description of Study Area

Canopy Closure

The estimated mean canopy closure was 56, 61, 60, and 56 percent for study areas A, B, C, and D respectively. There was no significant difference ($P < .05$) between the canopy closures of the four areas.

Basal Area

The basal areas of individual species and total basal area for each of the study areas are presented in Table 1. There was no significant difference ($P < .05$) between the four study areas in total basal area.

Site Index

The mean site indices at 50 years for scarlet oak were 57, 60, 51, and 58 for study areas A, B, C, and D respectively. The corresponding ranges were 52-61, 57-62, 47-53, and 55-60. The mean site index for scarlet oak on all study areas was 56. For pitch pine the site indices at 50 years were 50, 53, 44, and 52 for study areas A, B, C, and D, respectively. The mean site index for pitch pine was 50.

Stand Age

The stands are not even aged. The ages of the co-dominant and dominant scarlet oaks on the four study areas ranged from 43 years to 66 years based on 12 increment borings. There was considerable overlap between study areas.

Table 1. Basal areas by study area and species for the mixed oak-pine cover type of the Broad Run Wildlife Research Area, Craig County, Virginia, 1974.

Species	Study Areas A	B	C	D
	(mean sq ft/A and 80% confidence intervals)			
Scarlet oak	27.0 ± 6.0	24.0 ± 5.1	31.1 ± 5.2	29.5 ± 5.8
White oak	9.0 ± 0.9	13.5 ± 2.0	15.0 ± 5.1	6.5 ± 3.1
Northern red oak	2.0 ± 0.4	9.0 ± 3.6	6.5 ± 3.6	5.0 ± 1.8
Black oak	1.5 ± 1.4	1.5 ± 1.1	5.5 ± 2.4	6.0 ± 3.1
Chestnut oak	4.5 ± 2.2	5.0 ± 3.3	1.0 ± 0.9	4.5 ± 2.2
Pitch pine	20.0 ± 4.1	25.5 ± 4.9	21.0 ± 5.8	21.5 ± 6.7
Virginia pine	2.0 ± 1.6	1.5 ± 1.9	2.5 ± 1.3	0.5 ± 0.7
Red maple	0.5 ± 0.7	2.5 ± 2.3	0.5 ± 0.7	3.0 ± 1.7
Sourwood	1.0 ± 0.9	3.0 ± 3.3	2.0 ± 1.2	3.0 ± 2.2
Dogwood	-	3.0 ± 2.2	3.0 ± 2.2	-
Blackgum	-	0.5 ± 0.7	1.0 ± 0.9	-
Hickory	0.5 ± 0.7	0.5 ± 0.7	0.5 ± 0.7	0.5 ± 0.7
Shadbush	2.5 ± 1.9	-	0.5 ± 0.7	-
Tulip poplar	-	-	-	0.5 ± 0.7
Total	70.0 ± 5.4	89.5 ± 4.8	89.5 ± 6.3	79.5 ± 6.1

[a]To convert basal area in square feet per acre to basal area in square meters per hectare: 4.37 x basal area in square feet per acre.

The ages of the pitch pine were more variable. The ranges in age were 45-66 years and 48-57 years for study areas B and C, respectively. On area A four pitch pines were bored; one was 57 years old and one was 61 years old. While these were comparable to the ages of all oaks and the pines on areas B and C; the other two were 98 and 110 years old. On area D, the ages of the pines ranged from 102-109 years of age.

Forage Quality

Ether Extract

The ether extracts of the forages are presented in Table 2. The ether extract includes not only digestible fats and oils but also several indigestible fractions such as the essential oils. For instance, deer in this area eat large quantities of ericaceous plants which frequently contain high levels of essential oils. Several of these, such as mountain laurel leaves, rhododendron leaves, blueberry leaves, and the fall and winter composite diets which contained large amounts of ericaceous plants, are high in ether extract. Since high levels of ether extract may reflect undigestible fractions, it is a poor indicator of forage quality.

Soluble Carbohydrates

The soluble carbohydrate content of the forages analysed was quite variable and ranged from 9.2 to 37.4 (Table 3). Although soluble carbohydrates contain primarily soluble starches and sugars it is not in itself a good measure of the value of the food as an energy source. For instance, the fall diet which contained acorns was

Table 2. Proximate analysis of composite diets and individual forages (Broad Run Wildlife Research Area, Craig County, Virginia, 1973-1974).

	Crude Protein (%)	Ether Extract (%)	Crude Fiber (%)	Ash (%)	N.F.E. (%)
April					
Blueberry l.	19.50	3.50	10.91	3.18	62.91
Blueberry s.	5.50	2.51	30.69	2.46	58.84
Cinquefoil	12.50	1.90	18.67	8.22	58.71
Greenbrier s.	6.50	0.35	24.49	1.80	66.86
Mtn. laurel	8.13	3.45	19.57	2.99	65.86
Panic grass	10.88	0.81	28.85	3.35	56.11
Teaberry	7.75	2.27	22.55	3.61	63.82
Trailing arbutus	9.00	2.48	19.50	2.85	66.17
Dry oak l.	6.88	3.55	22.91	3.20	63.46
May					
Blueberry l.	11.88	3.51	18.90	2.73	62.98
Clover	18.00	1.84	30.05	3.12	46.99
Galax	10.38	2.18	27.93	4.03	55.48
Greenbrier l.	15.50	2.61	22.33	5.39	54.17
Mtn. laurel l.	9.50	5.30	22.42	3.70	59.08
Fresh oak l.	13.75	2.39	20.46	3.50	59.90
Red maple l.	13.63	3.00	15.80	3.94	63.63
Sourwood l.	15.25	2.69	18.65	4.54	58.87
Summer composite diet	12.75	2.97	27.38	5.15	51.75
Fall composite diets					
w/o acorns #1	7.69	4.63	23.95	5.02	58.71
w/o acorns #2	7.69	4.33	22.59	4.68	60.71
w/ acorns	5.50	2.62	18.96	3.15	69.83
Winter					
Comp. diet	6.63	3.39	22.95	3.36	63.67
Mtn. laurel l.	7.13	5.23	18.60	2.70	66.34
Rhododendron l.	5.63	5.00	23.78	2.80	62.79

1. = green leaves
2. = green stems

Table 3. Percent soluble carbohydrates, lignin, phosphorus, *in vitro* dry matter digestibility (IVDMD), and caloric value for individual forages and composite diets (Broad Run Wildlife Research Area, Craig County, Virginia, 1973-1974).

	Soluble Carbohydrate (%)	Gross Energy (kcal/g)	Lignin (%)	Phos. (%)	IVDMD (%)
April					
Blueberry l.	27.7	5.032	8.64	0.344	57.3
Blueberry s.	11.9	4.896	22.97	0.089	15.7
Cinquefoil	15.2	4.308	16.94	0.190	42.1
Greenbrier s.	10.0	4.705	25.08	0.073	18.6
Mtn. laurel l.	14.6	5.094	17.62	0.081	18.7
Panic grass	9.2	4.402	12.54	0.144	25.7
Teaberry	16.4	4.831	24.52	0.074	24.5
Trailing arbutus	19.2	4.817	23.81	0.100	20.3
Dry oak leaves	17.1	4.747	34.74	0.034	9.7
May					
Blueberry l.	16.9	4.783	19.57	0.134	50.7
Clover	15.6	4.710	12.16	0.168	50.3
Galax	12.9	4.460	14.14	0.140	57.5
Greenbrier l.	13.9	4.831	14.10	0.226	53.3
Mtn. laurel l.	19.3	5.137	18.12	0.148	9.2
Fresh oak l.	17.5	4.667	15.39	0.166	35.9
Red maple l.	28.2	4.560	11.43	0.222	53.1
Sourwood	15.3	4.397	13.46	0.200	53.6
Summer diet	20.6	4.584	12.46	0.157	44.0
Fall diets					
w/o acorns #1	20.4	4.722	16.60	0.105	34.8
w/o acorns #2	21.6	4.764	17.96	0.105	31.3
w/ acorns	37.4	4.491	15.06	0.106	26.7
Winter					
Comp. diet	19.0	4.424	14.92	0.078	44.4
Mtn. laurel	22.6	--	--	0.069	--
Rhododendron	28.1	--	--	0.054	--

l. = green leaves
s. = green stems

high in soluble carbohydrates, but the low digestibility reduces its nutritional value. However, some forages which were lower in soluble carbohydrates but were highly digestible may be of greater value.

Crude Fiber and Nitrogen-Free-Extract

Crude fiber and nitrogen-free-extract values are presented in Table 2. The nitrogen-free-extract component contains some indigestible portions such as lignin, and the crude fiber component contains cellulose which can be digested by ruminants. Therefore, these two components are limited in their usefulness as indicators of forage quality for ruminants.

Protein

The protein content of individual forages and composite diets is presented in Table 2.

During April all but three of the forages which were analysed contained more than the 7 percent crude protein recommended for winter survival of white-tail deer (McEwen et al. 1957). The 3 forages containing less than 7 percent protein are blueberry twigs, greenbrier twigs, and dry oak leaves; these food items are probably some of the less important of the forages analysed based on the work of Harlow and Hooper (1971). At this season, however, blueberry leaves contained 19 percent protein, more than enough for growth and lactation.

In general, the May forages were high in protein; none were lower than the suggested winter allowance (McEwen et al. 1957). Many of those forages which food habits studies suggest would be important foods at this time, such as fresh oak leaves, greenbrier leaves, red maple leaves, sourwood leaves, and bush clover contain more than enough crude protein for growth and lactation.

The summer composite diet contained 12.75 percent protein. This level may be sub-optimal for production, survival, and growth of fawns or lactation as indicated by the work of Ullrey et al. (1967), French et al. (1956), and Murphy and Coates (1966). However, based on a study by Murphy and Coates (1966), this level of protein should be adequate for production of some fawns.

The fall diet-with-acorns contained only 5.50 percent protein; this low protein level is marginal for survival and is approaching the level at which Einersen (1946) suggests that die-offs are likely. However, the period of time when acorns are abundant is relatively short and the protein content of the overall fall diet may more closely approach 7.69 percent protein or the level found in the fall diet-without-acorns. This is adequate for survival. The protein content of the fall diet with acorns may not be realistic. Similar diets mixed from forages and acorns collected on the Broad Run Area in years when acorns were abundant averaged 8.9 percent protein (Harlow et al. 1974). The reasons for this difference are not known.

The winter diet contained 6.63 percent protein or perhaps slightly more if mountain laurel were substituted for rhododendron. This is somewhat lower than the level that McEwen et al. (1957) reported to be adequate for winter survival but is above the level where die-offs are likely (Einersen 1946).

Selectivity or the addition of non-key forages may result in the amount of protein which the deer actually consume being different than that in the composite diet. This situation makes interpretation somewhat difficult when the protein level of the composite diet is marginal, as it was in the summer and winter.

Phosphorus

Table 3 lists the phosphorus content of the individual forages and the composite diets. All individual food items, except blueberry leaves in April were lower in phosphorus than the levels of 0.25-0.27 percent which have been reported as being adequate for optimum growth and development (McEwen et al. 1957; French et al. 1956; Ullrey et al. 1973). Greenbrier, red maple, and sourwood leaves collected in May approached the suggested levels but did not reach them.

No data were available on the phosphorus requirements of lactating or pregnant does or for the minimum levels which deer could tolerate during the winter. However, since lactating domestic ewes require only slightly more than all classes of lambs (0.20-0.22 percent compared to 0.14-0.21 percent); and pregnant and lactating beef cattle require 0.15 and 0.18 percent phosphorus, respectively compared to 0.16-0.21 percent for wintering calves (Maynard and Loosli 1969), it seems likely that does would not require a great deal more than is needed for growth and development.

Selective feeding and the addition of less important forages in the diet may cause the actual phosphorus intake to be slightly different than was indicated by the composite diets.

In Vitro Dry Matter Digestibility

Effect of Forage Composition on Digestibility

The digestibility of a forage is dependent upon the composition of that forage. For instance, inspection of the data in Tables 2 and 3 indicate that, in general, digestibility was depressed when protein was at low levels and/or lignin was at a high level. These tendencies are reflected in the high digestibilities of new leaves in the spring and the low digestibility of spring forages which had overwintered. The low protein content of the fall diet containing acorns helps explain the low digestibility of this diet.

One component of the ether extract (Table 2), the essential oils, is known to depress digestibility. However, because of the other components in the ether extract, the relationship between *in vitro* dry matter digestibility and ether extract was not clear. The ericaceous plants tend to be high in essential oils. Mountain laurel leaves collected in April had overwintered; these leaves were lower in ether extract and nearly two times as digestible as the young mountain laurel leaves collected in May. It is likely that the reversal in seasonal trends of digestibility is due to seasonal changes in the amount of essential oils in the leaves.

The fall diets-with-acorns mixed by Harlow et al. (1975) were 65.4 percent digestible compared to 26.7 percent digestible for the diet mixed in this study. Because the *in vitro* dry matter digestibility of the fall composite diets-without-acorns were similar for the two studies, it is probable that a real difference exists. The relatively high protein content of Harlow's fall diet (8.9 percent compared to 5.5 percent) probably accounts for the considerable difference in percent digestibility.

In Vitro Dry Matter Digestibility of Spring Forages

The expected *in vitro* digestibility of the April composite diet, based on the weighted mean of the *in vitro* digestibility of the individual samples is 25.4 percent, compared to 26.0 percent *in vitro* dry matter digestibility of the composite mixed from the individual samples. For the May samples, the expected digestibility was 42.9 percent, compared to 45.1 percent for the mixture. It appears that, for these two periods at least, the digestibility of individual samples may be used as a prediction of forage value of composite diets prepared from these samples.

Forage Quantity

Dry Matter Production

The dry matter production of individual key species, total key species and total forages are presented in Tables 4 through 8. Study area A produced more key forages in all seasons and more total forages in all but one season than any of the other study areas. The exception occurred during the fall, when dead oak leaves, a product of the canopy rather than the forest floor, were measured. Since short-lived fungi grow rapidly following favorable conditions, which may occur many times during the year, the results of this study do not represent annual production of fungi and should only be considered as

Table 4. Dry matter production of key deer forage species and total forage production during the spring flush (April) sampling period for the mixed oak-pine cover type of the Broad Run Wildlife Research Area, Craig County, Virginia, 1974.

Forage	Study Areas A	Study Areas B	Study Areas C	Study Areas D	Mean All Areas
	(mean kg/ha and 80% confidence interval)				
Blueberry l.	12.2 + 4.2	0.7 + 0.3	2.3 + 1.2	0.4 + 0.3	3.9
Cinquefoil	1.1 + 0.4	0.3 + 0.2	0.3 + 0.3	t	0.4
Greenbrier s.	0.3 + 0.3	1.4 + 1.0	0.3 + 0.2	0.9 + 1.1	0.7
Mountain laurel l.	11.6 + 9.7	-	-	5.1 + 3.3	4.2
Panic grass	0.1 + 0.1	0.2 + 0.3	0.4 + 0.2	0.1 + 0.2	0.2
Teaberry	5.4 + 2.0	2.5 + 1.0	4.9 + 2.2	1.2 + 0.6	3.5
Trailing arbutus	1.8 + 1.2	-	1.5 + 0.5	0.6 + 0.7	1.0
Total (key species)	32.5 +11.4	5.2 + 1.6	9.8 + 3.1	8.3 + 4.1	24.0
Total (all species)	57 + 14	18 + 4	22 + 4	15 + 5	28

l. = green leaves
s. = green stems

Table 5. Dry matter production of key deer forage species and total forage production during the spring (May) sampling period for the mixed oak-pine cover type of the Broad Run Wildlife Research Area, Craig County, Virginia, 1974.

Forage	Study Areas A	B	C	D	Mean all areas
	(mean kg/ha and 80% confidence intervals)				
Clover	0.3 + 0.4	0.6 + 0.7	-	0.1 + 1.2	0.3
Galax	0.2 + 0.2	0.4 + 0.4	-	1.1 + 1.0	0.4
Greenbrier l.	1.2 + 0.6	1.0 + 0.6	0.6 + 0.3	0. +	0.7
Mountain laurel l.	13.3 + 7.3	-	-	1.6 + 2.1	3.7
Oak l.	31.0 + 8.9	13.0 + 3.5	4.6 + 2.6	2.6 + 3.1	12.8
Panic grass	0.4 + 0.2	t	0.1 + 0.5	t	0.1
Red maple	1.1 + 0.7	1.2 + 1.3	0.4 + 0.6	1.3 + 1.4	1.0
Sourwood l.	2.4 + 2.2	2.0 + 2.0	3.3 + 2.0	2.4 + 1.8	2.5
Total (key species)	49.8 +12.4	18.32+ 4.4	9.0 + 3.3	9.2 + 4.3	21.6
Total (all species)	212 + 27	72 + 9	50 + 8	49 + 12	96

l. = green leaves

Table 6. Dry matter production of key deer forage species and total forage production during the summer sampling period for the mixed oak-pine cover type of the Broad Run Wildlife Research Area, Craig County, Virginia, 1973.

Forage	Study Areas A	B	C	D	Mean all areas
	(mean kg/ha and 80% confidence intervals)				
Clover	2.7 ± 2.4	0.1 ± 0.1	-	0.3 ± 0.3	0.8
Dogwood l.	0.4 ± 0.2	-	3.8 ± 4.7	t	1.0
Greenbrier l.	6.0 ± 1.1	4.3 ± 1.3	4.8 ± 1.1	2.8 ± 0.7	4.5
Oak l.	27.0 ± 7.0	13.3 ± 4.6	11.5 ± 6.3	5.7 ± 4.8	14.4
Panic grass	0.1 ± 0.1	-	0.8 ± 0.8	-	0.2
Red maple l.	t	1.5 ± 1.8	2.5 ± 2.0	0.4 ± 0.3	1.1
Sourwood l.	1.2 ± 1.2	-	3.9 ± 4.7	1.6 ± 1.1	1.7
Total (key species)	37.1 ± 7.4	19.2 ± 5.0	27.3 ± 9.0	10.7 ± 4.9	23.6
Total (all species)	215 ± 28	150 ± 21	133 ± 17	130 ± 24	157

l. = green leaves

Table 7. Dry matter production of key deer forage species and total forage production during the fall sampling period for the mixed oak-pine cover type of the Broad Run Wildlife Research Area, Craig County, Virginia, 1973.

Forage	Study Areas (mean kg/ha and 80% confidence intervals)				Mean all areas
	A	B	C	D	
Fungi	2.5 ± 1.7	1.4 ± 0.8	1.1 ± 0.6	3.9 ± 2.0	2.2
Galax	8.9 ± 4.6	-	0.2 ± 0.3	4.4 ± 4.4	3.3
Greenbrier s.	0.6 ± 0.4	0.5 ± 0.3	0.4 ± 0.2	0.2 ± 0.2	0.4
Panic grass	1.6 ± 1.3	0.3 ± 0.2	0.1 ± 0.2	0.2 ± 0.2	0.5
Teaberry	30.0 ± 7.2	1.2 ± 0.6	3.2 ± 1.5	6.5 ± 2.3	10.24
Trailing arbutus	11.1 ± 5.5	2.1 ± 0.9	0.9 ± 1.2	0.2 ± 0.3	3.6
Total (key species	54.7 ± 8.5	5.5 ± 3.0	6.0 ± 2.4	15.4 ± 5.3	20.4
Oak l.	585 ± 71	763 ± 97	389 ± 39	878 ± 94	654
Total (all species)	644 ± 69	771 ± 97	399 ± 39	903 ± 94	678

s. = green stems
l. = dead oak leaves which are included in the total.

Table 8. Dry matter production of key deer forage species and total forage production during the winter sampling period for the mixed oak-pine cover type of the Broad Run Wildlife Research Area, Craig County, Virginia, 1973-1974.

Forage	Study Areas A	B	C	D	Mean all areas
	(mean kg/ha and 80% confidence intervals)				
Cinquefoil	0.2 ± 0.2	0.1 ± t	t	-	0.1
Fungi	-	0.1 ± t	2.7 ± 1.7	1.2 ± 0.5	1.0
Galax	4.8 ± 3.8	-	-	1.5 ± 0.3	1.6
Greenbrier s.	0.1 ± 0.1	0.2 ± 0.2	0.3 ± 0.1	t	0.2
Mountain laurel l.	8.6 ± 5.1	-	3.3 ± 1.0	9.4 ± 7.1	5.3
Panic grass	t	0.8 ± 0.6	t	-	0.2
Teaberry	13.8 ± 2.6	2.4 ± 0.3	1.9 ± 0.8	2.3 ± 0.9	5.1
Trailing arbutus	3.3 ± 2.2	-	0.5 ± 0.2	0.1 ± 0t	1.0
Total (key species)	30.9 ± 7.8	3.7 ± 1.5	8.8 ± 4.4	14.6 ± 7.3	14.5
Total (all species)	63 ± 9	12 ± 4	19 ± 5	26 ± 8	30

s. = green stems
l. = green leaves

an indicator of relative abundance between seasons.

The dry matter production of individual non-key forages may be found in Appendix Tables III through VII.

Digestible Energy Production

Estimated digestible energy available in key forage species on the study area is presented in Table 9; values are expressed in kilocalories per hectare per day. Figure 2 shows the relationships between digestible energy production by study area, mean digestible energy production, and the digestible energy requirement of the deer herd. In addition, the portion of the required digestible energy which will be supplied by key forages is indicated, assuming that the diet is similar to that reported in the food habits studies of Harlow and Hooper (1971) and Harlow et al. (1975), and that the digestible energy of the key forages is similar to that of species which the deer consume in small quantities but which were not included in the composite diets.

The mixed oak-pine cover type will produce enough digestible energy to meet the herd requirement at all seasons of the year with the possible exception of the months (June - August) when lactation is occurring (Table 10), if the deer use all of the key forages available. On the individual study areas enough key forages were produced to meet the needs of the herd on all but B and D in the summer; B and C in the fall; and B and C in the winter.

For the summer, winter and fall, non-key forages comprised only about 16 percent of the total diet. Although key and non-key forages were assumed to be equal in digestible energy (Figure 2), the contribution

Table 9. Digestible energy available in key forage species produced on four study areas of the mixed oak-pine cover type, Broad Run Wildlife Research Area, Craig County, Virginia, 1973-1974.

	Season Length (days)	Areas A (kcal/ha/day)	B	C	D	Mean (kcal/ha/day)
April	30	1187	236	509	299	558
May	31	2279	1120	583	554	1134
Summer	107	698	362	515	202	444
Fall[a]	76	1073	108	118	302	400
Winter	121	501	59	112	236	227

[a]Acorns excluded

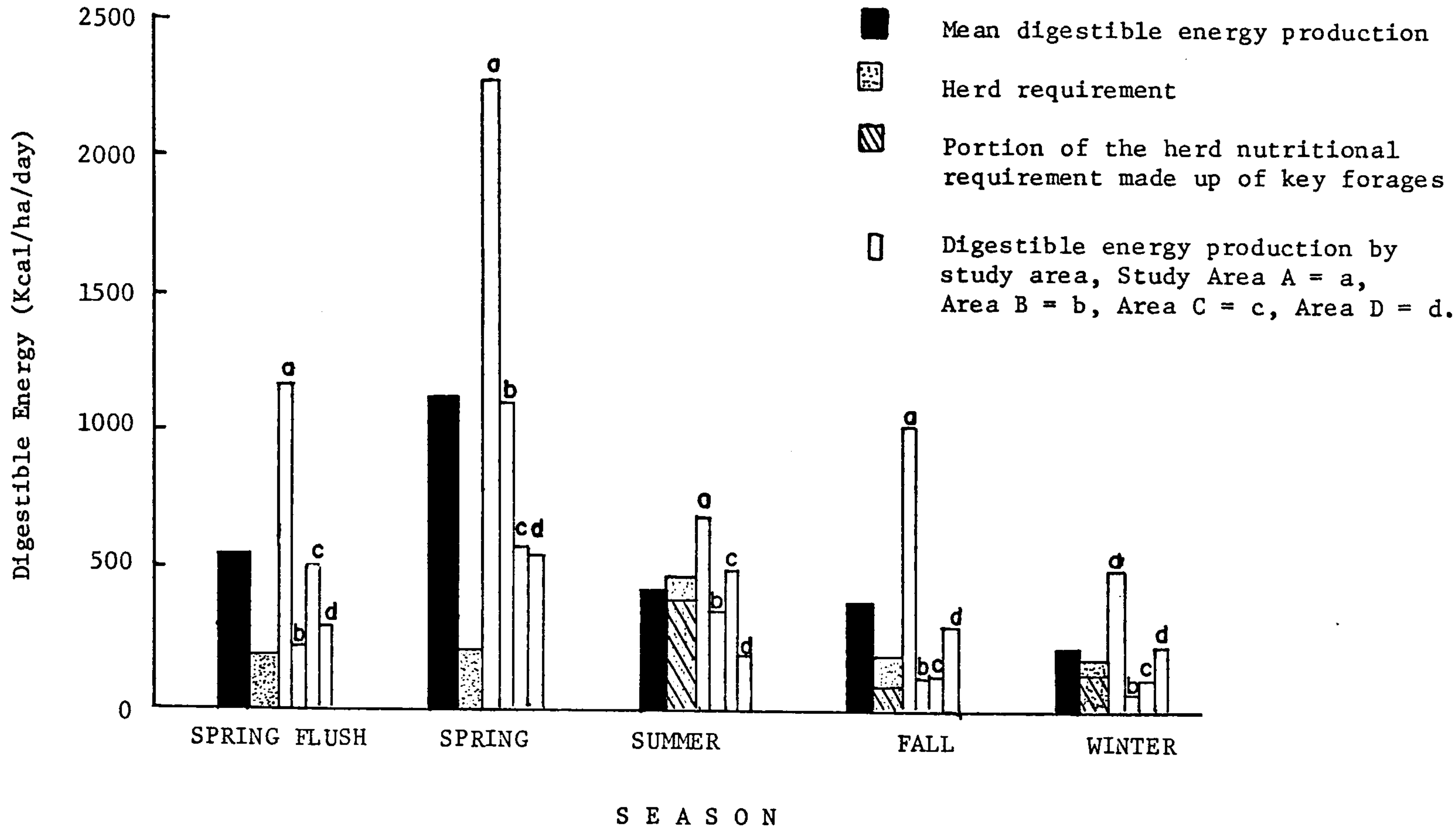

Figure 2. Digestible energy available in key forage species for the four study areas and their mean digestible energy production compared to the digestible energy requirements of the herd. These data assume that foods are eaten in the same proportions as indicated in food habits studies and that key and non-key forages are equal in digestible energy.

Table 10. Mean digestible energy available in key forage species, digestible energy required by season for deer in the mixed oak-pine cover type, and the suitability of this forest type to meet energy requirements at 100, 50, and 25 percent utilization of available forage. Broad Run Wildlife Research Area, Craig County, Virginia, 1973-1974.

Season	Mean Digestible Energy (kcal/ha/day)		Ratio (Available/Required)[a]		
	Available	Required	100	50	25
April	558	185	3.01	1.51	0.76
May	1134	191	5.94	2.97	1.49
Summer					
June	444	463[c]	0.96[c]	0.48[c]	0.24[c]
July[b]		472[c]	0.94[c]	0.47[c]	0.24[c]
August[b]		341[c]	1.30[c]	0.65[c]	0.33[c]
Fall[c]	400	187	2.14	1.07	0.53
Winter	227	184	1.23	0.62	0.31

[a]At utilization rates of 100, 50, and 25 percent.
[b]Production data not available in these months, June production data was used.
[c]Acorns excluded

of non-key forages toward meeting digestible energy requirement was probably slight due to their small proportion in the diet. However, only study areas B and C supplied enough key forages (in the fall) to meet that portion of the herd requirement which is likely to be met by consumption of key forages (Figure 2).

However, the above assumes that the deer utilize 100 percent of the available forage, which is unrealistic. If one assumes, for illustrative purposes, that the deer use 50 and 25 percent of the forage available (Figure 3) the mean energy production of this mixed oak-pine forest type will not reach the required level during the winter and summer (with lactation) at the 50 percent utilization rate, and will only be sufficient during May at the 25 percent utilization rate.

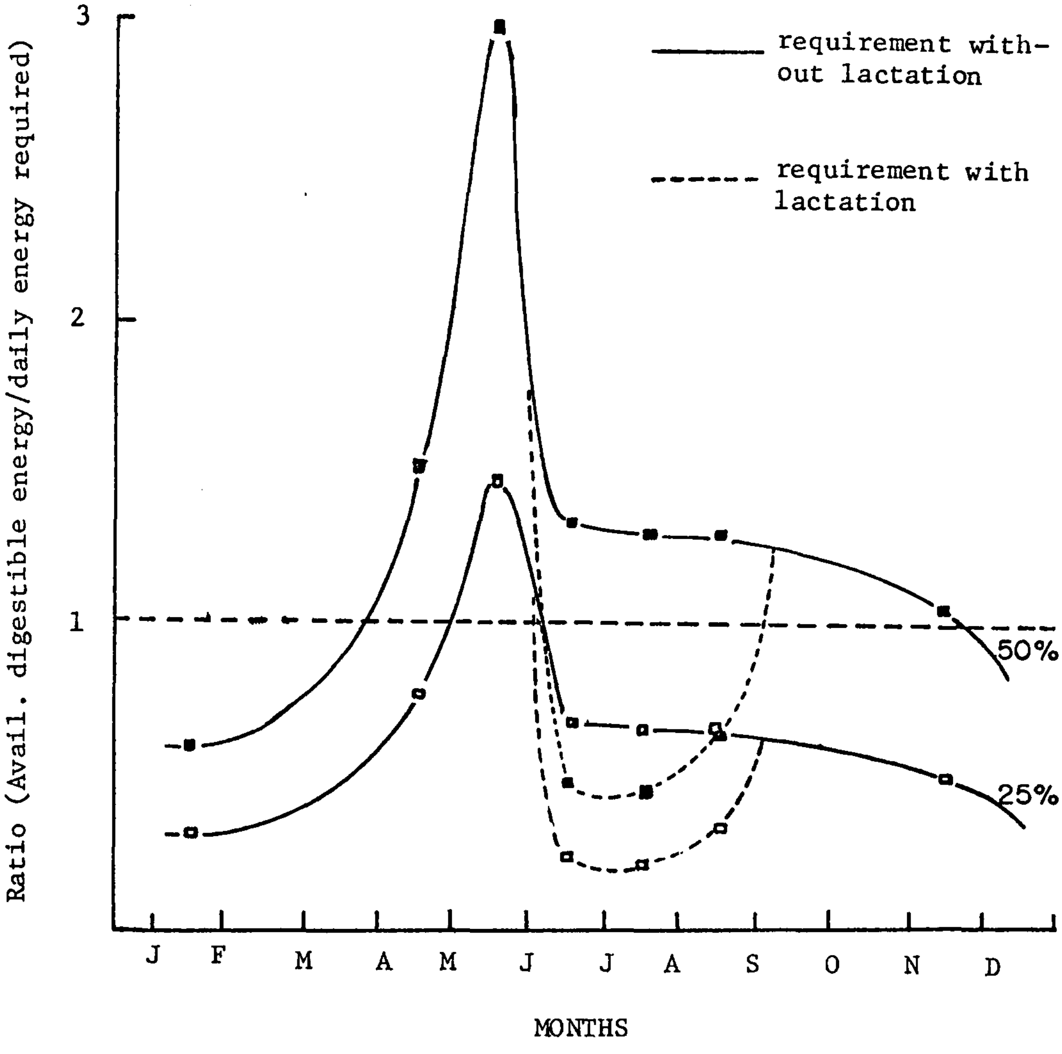

Figure 3. The ratio of available digestible energy in key forages to the daily digestible energy requirement for the deer herd (50 and 25 percent utilization rates) Data from Table 10.

CONCLUSIONS

Study Areas

The variation in production for individual forages was so great that statistically significant differences between the study areas could rarely be detected. However, field observations as well as the consistently higher forage production on study area A indicates that this area produces more forage than the other areas.

In Vitro Dry Matter Digestibility: Individual vs Composite

Where a relatively few readily available species make up the composite diet, it would be feasible to determine the *in vitro* dry matter digestibility of each individual species. This could provide more information if the IVDMD of individual forages can be used to predict the IVDMD of a composite diet mixed from them. In the future it would be beneficial to compare the IVDMD of individual forages with the IVDMD of composite diets mixed from them to determine if the digestibility of a composite can be predicted with reliability from the weighted mean of the *in vitro* digestibilities for its individual components.

Protein

There is little reason to suspect that the deer suffer a protein deficiency in April since most of the key species contained a greater percentage of protein than is needed for survival. Furthermore, lactation and growth of young fawns are not important concerns at this season. In May, protein appears to be adequate for survival, lactation, and growth of fawns since several important forages contained more than enough for these functions. Protein content of the summer composite diet indicates that protein intake is probably close to optimum for fawn production and growth (Murphy and Coates, 1966) during this season. The fall and winter diets are apparently adequate for survival. In the study by Murphy and Coates (1966), each group of captive does consumed the same level of protein throughout the year. However, a wild doe will usually be on a lower protein diet during the fall, winter and early spring than during late spring or early summer. Therefore, this leaves some question as to the protein levels needed at different seasons for optimal reproduction.

Phosphorus

Although the indications are that the Broad Run deer's phosphorus intake is probably less than optimum, it is difficult if not impossible to draw any clear cut conclusions. Selective feeding may result in a higher phosphorus intake than my results indicate, especially during the spring and early summer when rapidly growing forage is vailable. A major increase in phosphorus consumption above that indicated by the percent phosphorus of the composite diets for fall and winter seems unlikely, due to the lack of rapidly growing plant parts. However, since the lower limit of the phosphorus requirement is not known it is impossible to evaluate the situation.

Digestible energy production

Figure 3 indicates that at 50 percent utilization of available forages the mixed oak-pine cover type produces more than enough digestible energy for the deer herd during the spring and fall but does not produce enough digestible energy to meet the lactation requirement of the herd or the requirement for winter. This may not be too serious since does normally loose weight during lactation and all deer loose weight due to feed restriction (Long et al. 1965) during the winter and gain weight during the spring and fall. At the 25 percent utilization rate, however, production is inadequate at all times except May: if the deer are using forages at this rate, then they would have to depend on other cover types to supply an abundance of under story vegetation or increase consumption of non-key forages.

During those falls when acorns are abundant, digestible energy production probably is more than adequate. Data reported by Harlow et al. (1975) indicate that about 950 kcal/ha/day are available: This food production gives fall available:required ratios of 5.08, 2.54, and 1.27 at the 100, 50 and 25 percent utilization rates.

Management Implications

The summer months, when lactation occurs, is the most critical period in this cover type at present, and it is this season which will require the greatest increase in digestible energy production if the deer herd is to increase. At this season the leaves of several deciduous hardwoods, of which red maple, oak, sourwood and dogwood were found in the cover type, and legumes are important forages. Thinned or clear-cut areas may prove helpful for the former; where legumes are relatively rare, plantings may be necessary. On Broad Run in summer the need for deciduous hardwood leaves is probably more critical than the need for legumes since the agricultural clearings provide some legumes. More study is needed to determine what effect different management practices would have on specific foods. For instance observations on the area suggest that blueberries may crowd out some of the forbs, including some evergreen forbs so that clearing or burning may not increase key forage production during the winter period. The relationships between the forages which are important during different seasons need to be known before a specific management plan can be outlined which will best meet the varying seasonal nutritional needs of the deer.

The study also indicates a possible phosphorus deficiency. However, the phosphorus requirements for different functions and seasons are not known and this information is needed to determine if a real problem exists. Since the soils of this region tend to be deficient in phosphorus, fertilization or supplementation in salt licks may prove to be the only feasible means of increasing the deer's phosphorus intake. The first would be expensive and the second could create a problem in a hunting area since it is similar to baiting.

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Appendix Table I. Average metabolic body weight coefficients ($kg^{0.75}$) for different sex and age groups of white-tailed deer during five seasons as compiled from several sources.

Sex	Age	Season: July	Nov.	Feb.	April	May
		($kg^{0.75}$ live weight)				
M	0-1	6.42	13.42	15.29	16.21	16.81
F	0-1	6.42	11.78	14.09	14.69	15.61
M	1-2	17.97	19.40	17.67	17.67	18.27
F	1-2	16.21	17.97	18.27	18.50	19.20
M	2+	22.46	24.50	22.46	21.86	22.76
F	2+	20.0	20.6	20.96	21.56	21.56

Appendix Table II. Plant species recorded in the mixed oak-pine cover type on the Broad Run Wildlife Research Area, Craig County, Virginia, 1973-1974.

Scientific name	Common name
Acer rubrum	Red maple
Amelanchier arborea	Shadbush
Anemone lancifolia	Anemone
Angelica atropurpurea	Angelica
Carya spp.	Hickory
Castanea dentata	American chestnut
Ceanothus americanus	New Jersey tea
Convallaria montana	Wild lily of the Valley
Cornus florida	Flowering dogwood
Crataegus spp.	Hawthorn
Dioscorea villosa	Wild Yam
Epigaea repans	Trailing Arbutus
Fraxinus nigra	Ash
Galax aphylla	Galax
Gaultheria procumbens	Teaberry
Gillenia trifoliata	Bowman's Root
Goodyera spp.	Rattle Snake Plantain
Hamamelis virginiana	Witch Hazel
Heiracium venosum	Hawk Weed
Kalmia latifolia	Mountain Laurel
Lactuca canadensis	Wild Lettuce
Lespedeza violacea	Bush Clover
Lirodendron tulipifera	Tulip popler
Lysimachia quadrifolia	Whorled Loosestrife
Nyssa sylvatica	Blackgum
Oxydendrum arboreum	Sourwood
Panicum spp.	Panic Grass
Pinus pungens	Table Mountain Pine
P. rigida	Pitch Pine
P. strobus	White Pine
P. virginiana	Virginia Pine
Polygonatum biflorum	Solomon's Seal
Potentilla canadensis	Cinquefoil
P. simplex	Cinquefoil
Prunus serotina	Cherry
Quercus alba	White Oak
Q. borealis	Northern Red Oak
Q. coccinea	Scarlet Oak

Appendix Table II. Plant species recorded in the mixed oak-pine cover type on the Broad Run Wildlife Research Area, Craig County, Virginia, 1973-1974 (continued).

Scientific name	Common name
Q. montana	Chestnut Oak
Q. velutina	Black Oak
Rhododendron maximun	Rhododendron
R. nudiflorum	Azalia
Robinia pseudoacacia	Black Locust
Rosa spp.	Rose
Rubus spp.	Blackberry
Sassafras albidium	Sassafras
Smilax spp.	Greenbrier
Smilacina racemosa	False Solomon's Seal
Solidago spp.	Goldenrod
Vaccinium stamineum	Deerberry
Vaccinium spp.	Blueberry
Viburnum acerifolium	Maple-Leafed Viburnum
Viola spp.	Violet
Vitis spp.	Grape

Scientific names from Strausbaugh and Core, 1952, 1958, 1964 and 1971.

Appendix Table III. Dry matter forage production of non-key species during the spring flush (April) sampling period for the mixed oak-pine cover type of the Broad Run Wildlife Research Area, Craig County, Virginia, 1973-1974.

	Study Areas			
	A	B	C	D
	(mean kg/ha and 80% confidence interval)			
FORBS				
Aster	0.1 ± 0.2	0.2 ± 0.2	0.1 ± 0.2	0.1 ± 0.2
Bowman's Root	0.1 ± 0.1	0.1 ± 0.1	-	-
Fern	-	-	t	-
Galax	-	-	-	1.0 ± 2.0
Hawkweed	0.2 ± 0.1	-	t	-
Lactuca	-	t	-	-
Solomon Seal	-	-	0.1 ± t	-
Wild Yam	-	-	-	t
Violet	t	-	-	t
DECIDUOUS WOODY				
Cherry l.	t	t	t	t
s.	t	t	t	t
Dogwood l.	0.1 ± 0.1	0.1 ± 0.1	t ± 0.1	-
s.	t	0.8 ± 0.4	0.6 ± 0.5	-
Grape l.	t	-	-	t
s.	t	-	-	t
Greenbrier l.	t	t	t	t
Hawthorn l.	0.1 ± 0.1	-	-	-
s.	t	-	-	-
Hickory l.	-	-	-	-
s.	-	0.1 ± 0.1	-	-

l. = green leaves
s. = green stems

Appendix Table III. Dry matter forage production of non-key species during the spring flush (April) sampling period for the mixed oak-pine cover type of the Broad Run Wildlife Research Area, Craig County, Virginia, 1973-1974 (continued).

Forage	Study Areas A	B	C	D
	(mean kg/ha and 80% confidence intervals)			
Maple-leafed				
Vibernam l.	t	-	t	0.2 ± 0.2
s.	0.1 ± 0.1	-	0.1 ± 0.1	0.1 ± 0.1
Oak l.	t	0.2 ± 0.2	0.2 ± 0.1	t
s.	2.2 ± 0.8	0.8 ± 0.6	0.6 ± 0.5	1.0 ± 1.0
Red Maple l.	t	t	t	t
s.	t	t	0.3 ± 0.3	t
<u>Rubus</u>	0.5 ± 0.4	0.2 ± 0.2	0.1 ± t	-
Sassafrass l.	0.1 ± 0.1	0.5 ± 0.3	0.1 ± t	0.4 ± 0.2
s.	1.1 ± 0.6	2.2 ± 1.1	1.4 ± 1.4	0.5 ± 0.5
Shadbush l.	-	-	-	0.1 ± t
s.	-	-	-	t
Sourwood l.	-	-	t	0.3 ± 0.3
s.	-	-	0.1 ± 0.1	t
Witch hazel l.	-	-	-	t
s.	0.1 ± 0.1	-	-	0.1 ± 0.1
EVERGREEN WOODY				
Mountain laurel s.	1.0 ± 0.9	-	-	t + 0.2
Virginia Pine l.	4.0 ± 7.2	-	0.2 ± 0.2	t
s.	0.4 ± 2.2	-	t	t
FUNGI	-	0.5 ± 0.6	-	-

Appendix Table IV. Dry matter forage production of non-key species during the spring (May) sampling period for the mixed oak-pine cover type of the Broad Run Wildlife Research Area, Craig County, Virginia, 1973-1974.

Forage	Study Areas A	B	C	D
	(mean kg/ha and 80% confidence intervals)			
FORBS				
Aster	0.6 ± 0.4	0.3 ± 0.2	1.0 ± 0.7	t
Anamone	t	t	t	-
Bowman's root	-	-	0.1 ± 0.1	-
Cinquefoil	2.0 ± 1.0	0.5 ± 0.4	0.5 ± 0.3	-
Trailing arbutus	3.7 ± 1.8	-	0.1 ± 0.2	t
False Solomon seal	t	0.1 ± 0.1	-	-
Fern	-	0.1 ± 0.1	t	t
Hawkweed	0.2 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	-
Lactuca	t	t	0.1 ± 0.1	-
Loosestrife	0.4 ± 0.3	0.1 ± 0.1	0.3 ± 0.2	0.1 ± 0.2
Mint	t	-	-	-
Solomon seal	0.2 ± 0.2	0.3 ± 0.2	0.2 ± 0.1	t
Teaberry	3.7 ± 2.4	1.1 ± 1.1	1.6 ± 0.9	0.7 ± 0.4
Violet	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1	0.1 ± 0.1
Wild yam	0.3 ± 0.4	0.3 ± 0.2	0.2 ± 0.1	t
DECIDUOUS WOODY				
Ash l.	0.1 ± 0.1	-	0.1 ± 0.2	-
s.	t	-	t	-
Azalia l.	-	-	1.2 ±	-
s.	-	-	t	-
Blackgum l.	8.6 ±	2.2 ± 1.4	2.8 ± 2.0	6.9 ± 5.5
s.	0.3 ± 0.2	0.2 ± 0.1	0.1 ± 0.1	0.2 ± 0.1

l. = green leaves
s. = green stems

Appendix Table IV. Dry matter forage production of non-key species during the spring (May) sampling period for the mixed oak-pine cover type of the Broad Run Wildlife Research Area, Craig County, Virginia, 1973-1974 (continued).

Forage	Study Areas A	B	C	D
	(mean kg/ha and 80% confidence intervals)			
Cherry l.	t	0.3 ± 0.3	0.6 ± 0.7	-
s.	t	t	t ± 0.1	-
Chestnut l.	-	t	-	-
s.	-	-	-	-
Dogwood l.	-	t	-	t
s.	0.1 ± 0.1	0.3 ± 0.2	0.2 ± 0.1	t
Grape l.	0.2 ± 0.2	-	0.2 ± 0.2	0.4 ± 0.4
Greenbrier l.	1.2 ± 0.6	1.0 ± 0.6	0.6 ± 0.3	0.1 ± t
s.	0.2 ± 0.2	0.4 ± 0.2	0.3 ± 0.2	0.3 ± 0.1
Hawthorn l.	1.4 ± 0.8	-	0.4 ± 0.4	-
s.	t	-	t	-
Hickory l.	0.6 ± 0.7	t	0.3 ± 0.4	-
s.	t	-	t	-
Maple-leaf vibernam	0.9 ± 1.9	0.8 ± 1.1	t	-
s.	0.2 ± 0.2	t	t	-
New Jersey tea l.	t	-	-	-
Oak l.	31.0 ± 8.9	13.0 ± 3.4	4.6 ± 2.6	2.6 ± 3.1
s.	1.1 ± 0.4	0.4 ± 0.2	0.1 ± 0.1	0.1 ± 0.1
Red maple l.	1.1 ± 0.8	1.2 ± 1.2	0.4 ± 0.6	1.3 ± 1.4
s.	0.1 ± 0.1	t	t	t
Rose l.	t	-	-	-
<u>Rubus</u> l.	0.3 ± 0.3	0.1 ± 0.1	0.2 ± 0.1	-
Sassafrass l.	14.2 ± 5.0	17.6 ± 4.4	12.7 ± 3.2	10.3 ± 4.2
s.	0.9 ± 0.4	0.8 ± 0.2	0.9 ± 0.2	0.3 ± 0.1
Shadbush l.	2.9 ± 2.4	t	0.1 ± 0.1	t
s.	0.1 ± 0.1	t	t	t

Appendix Table IV. Dry matter forage production of non-key species during the spring (May) sampling period for the mixed oak-pine cover type of the Broad Run Wildlife Research Area, Craig County, Virginia, 1973-1974 (continued).

Forage	Study Areas A	B	C	D
	(mean kg/ha and 80% confidence intervals)			
Sourwood l.	2.4 ± 2.2	2.0 ± 2.0	3.3 ± 2.0	2.4 ± 1.8
s.	0.2 ± 0.2	0.1 ± 0.2	0.2 ± 0.1	0.1 ± 0.1
Tulip popler l.	-	t	-b	t
s.	-	t	-	t
Vaccinium l.	71.0 ±12.6	19.2 ± 6.6	8.5 ± 3.1	12.3 ± 4.2
s.	12.5 ± 2.4	3.4 ± 1.2	1.4 ± 0.6	1.8 ± 0.6
Witch hazel l.	4.5 ± 0.2	0.9 ± 0.9	1.0 ± 1.0	5.5 ± 3.4
s.	0.1 ± 0.2	0.1 ± 0.1	t	0.2 ± 0.2
EVERGREEN WOODY				
Mountain laurel s.	2.2 ± 1.1	-	-	0.1 ± 0.1
Virginia pine l.	t	0.5 ± 0.6	-	t
s.	t	0.3 ± 0.4	-	t
White pine l.	16.6 ± 14.6	--	-	-
s.	1.3 ± 1.1	-	-	-
FUNGI	t	-	0.5 ± 0.5	-

Appendix Table V. Dry matter forage production of non-key species during the summer sampling period for the mixed oak-pine cover type of the Broad Run Wildlife Research Area, Craig County, Virginia, 1973-1974.

Forage	Study Areas A	B	C	D
	(mean kg/ha and 80% confidence intervals)			
FORBS				
Angelica	0.2 ± 0.3	-	t	-
Aster	0.2 ± 0.3	0.7 ± 0.9	-	0.1 ± 0.1
Bowman's root	-	-	t	-
Cinquefoil	0.3 ± 0.3	-	0.3 ± 0.4	-
Trailing Arbutus	2.0 ± 1.9	-	-	0.6 ± 0.5
False Solomon seal	0.1 ± 0.2	t	0.2 ± 0.2	t
Fern	0.3 ± 0.3	0.3 ± 0.3	-	1.0 ± 0.8
Galax	-	-	-	1.3 ± 1.2
Goldenrod	t	t	0.1 ± 0.1	t
Hawkweed	-	-	0.2 ± 0.3	-
Loosestrife	1.4 ± 0.9	0.2 ± 0.2	0.1 ± 0.1	0.1 ± 0.1
Rattle snake plantain	-	-	-	0.5 ± 0.7
Solomon seal	-	-	0.1 ± 0.1	-
Teaberry	32.7 ± 4.4	2.3 ± 1.0	4.9 ± 2.0	4.9 ± 1.5
Violets	t	-	-	t
Wild lily of the valley	0.6 ± 0.8	0.1 ± 0.1	t	t
Wild yam	0.1 ± 0.2	0.1 ± 0.1	-	t

Appendix Table V. Dry matter forage production of non-key species during the summer sampling period for the mixed oak-pine cover type of the Broad Run Wildlife Research Area, Craig County, Virginia, 1973-1974 (continued).

Forage	Study Areas A	B	C	D
	(mean kg/ha and 80% confidence intervals)			
EVERGREEN WOODY				
Mountain laurel	12.5 ±10.1	-	1.8 ± 2.3	5.1 ± 3.4
Virginia pine needles	3.1 ± 2.1	-	-	-
DECIDUOUS WOODY[a]				
Blackgum	9.1 ± 3.5	16.5 ± 5.9	9.5 ± 5.7	7.2 ± 2.4
Blueberry l.[b]	55.8 ±12.4	43.6 ± 9.6	25.1 ± 5.4	42.9 ±13.4
s.[c]	32.0 ± 6.5	31.0 ± 7.0	26.5 ± 6.0	32.5 ± 9.0
f.[d]	-	0.1 ± 0.1	t	0.1 ± 0.1
Cherry	t	-	0.2 ± 0.3	0.1 ± 0.1
Chestnut	-	3.2 ± 4.2	-	-
Deerberry	4.5 ± 2.1	9.8 ± 7.7	10.3 ± 4.9	6.4 ± 3.5
Grape	-	0.4 ± 0.5	0.8 ± 0.7	-
Hawthorn	1.0 ± 1.3	-	-	-
Hickory	0.9 ± 0.8	-	-	-
Locust	-	-	-	0.4 ± 0.4
Maple-leafed vibernam	0.8 ± 0.7	-	-	t
Rubus	t	-	t	-
Sassafrass	17.8 ± 4.2	22.0 ± 5.8	25.0 ± 8.1	14.3 ± 3.0
Shadbush	0.5 ± 0.5	0.6 ± 0.8	t	0.1 ± 0.1
Witch hazel	1.9 ± 1.4	t	-	1.5 ± 0.7

[a]green leaves unless otherwise specified
[b]l. = green leaves
[c]s. = green stems
[d]f. = flowers

Appendix Table VI. Dry matter forage production of non-key species during the fall sampling period for the mixed oak-pine cover type of the Broad Run Wildlife Research Area, Craig County, Virginia, 1973-1974.

Forage	Study Areas			
	A	B	C	D
	(mean kg/ha and 80% confidence intervals)			
Acorns (red)	-	0.8 + 0.4	0.9 ± 0.7	0.7 ± 0.4
Acorns (white)	0.4 + 0.4	0.4 ∓ 0.3	0.2 ± 0.3	1.3 ∓ 0.9
Dry oak leaves	584.9 ∓71.2	762.8 ±96.7	389.1 ±38.9	877.9 ±94.1
Grape leaves	-	t	-	-
Sourwood leaves	3.9 ± 2.8	1.7 ±	3.4 ± 1.8	7.2 ± 3.1

Appendix Table VII. Dry matter forage production of non-key species during the winter sampling period for the mixed oak-pine cover type of the Broad Run Wildlife Research Area, Craig County, Virginia, 1973-1974.

Forage	Study Areas			
	A	B	C	D
	(mean kg/ha and 80% confidence intervals)			
FORBS				
Aster	0.1 ± 0.1	0.1 ± 0.1	t	t
Fern	-	-	-	0.2 ± 0.1
EVERGREEN WOODY				
Virginia pine 1.	4.3 ± 1.8	2.2 ± 0.3	-	-
DECIDUOUS WOODY TWIGS				
Blueberry	19.7 ± 3.0	2.9 ± 3.9	5.3 ± 1.4	8.0 ± 2.2
Deerberry	2.6 ± 1.2	-	0.3 ± 0.1	0.8 ± 0.2
Dogwood	0.2 ± 0.1	1.2 ± 0.9	0.5 ± 0.1	0.9 ± 0.3
Greenbrier	0.3 ± 0.1	0.2 ± 0.2	0.3 ± 0.1	t
Hawthorn	0.3 ± 0.1	-	t	-
Oak	1.8 ± 1.0	t	0.6 ±	0.6 ± 0.2
Red maple	-	t	0.1 ± t	t
Sassafrass	1.5 ± 0.7	1.2 ± 0.6	3.0 ± 1.0	1.0 ± 0.5
Sourwood	0.3 ± 0.1	0.3 ± 0.2	0.3 ± 0.1	t
Witch hazel	-	-	0.1 ± t	t

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SEASONAL RANGE ANALYSIS FOR THE WHITE-TAILED DEER

ON THE BROAD RUN WILDLIFE RESEARCH AREA

Karen I. Morris

(ABSTRACT)

The mixed oak-pine cover type was evaluated as white-tailed deer range on four study areas by measuring dry matter production of key forages and determining their nutrient composition. Composite diets containing plant species which represented the major portions of each seasonal diet as indicated by food habits studies, were mixed for the summer, fall and winter seasons. For the spring flush and spring seasons, individual key forages were analysed. All samples were assayed for soluble carbohydrates, lignin, phosphorus, gross energy, proximate composition, and *in vitro* dry matter digestibility. Digestible energy production in kcal/ha/day was calculated seasonally for key forages. The ratios of digestible energy available in key forages to that required by the estimated deer herd were 3.01, 5.94, 0.96, 2.14, and 1.23, for the spring flush, spring, summer, fall, and winter, respectively. These ratios indicate the potential of the study areas to support the estimated population density of 1 deer per 16.4 ha. The mixed oak-pine cover type appears to be adequate to support the estimated deer herd if 50 percent of the key forages are consumed seasonally but inadequate if only 25 percent are used. During all seasons, forage protein appeared to be adequate and phosphorus was possibly lower than that required for optimal animal performance.