FOODS OF THE KEY DEER (ODOCOILEUS VIRGINIANUS CLAVIUM)

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Allan L. Dooley

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I hereby recommend that the thesis prepared under my supervision by

Allan L. Dooley

Entitled

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Master of Arts

W D Klimstra
In Charge of Thesis

William M Lewis
Head of Department

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INTRODUCTION

The first ecological study of the Key deer (Odocoileus virginianus clavium Barbour and Allen) was conducted June 1951 through September 1952 by Dickson (1955). Food habit studies were conducted by direct observation of deer feeding, browse evidence, pellet analysis, and one stomach analysis. Fifty-two plant species were recorded as Key deer food plants using these techniques (Dickson 1955). Direct observations of Key deer feeding were recorded only in rare instances due to the low deer population levels. Seventeen of 21 plant species recorded in this manner were the results of observations of one animal. Dickson (1955) stated that browsed plants were rarely found; but, in certain areas browsed plants were readily noted. A total of 19 plant species were recorded as foods based upon browse evidence. Dickson's pellet analysis included 293 pellet groups. Two methods of analyzing pellet materials were employed. Pellets were crushed and examined for seed, seed fragments, and other materials; and, histological methods were employed. Dickson stated that the H-shaped idioblasts found in the cortex of stems and twigs of Rhizophora mangle, scales of fruit and twigs of Mimusops emarginata (Syn. Manilkara bahamensis), and scales of Tillandsia sp. were easily identified. Twenty-seven plant taxa were identified as foods using this technique. The one stomach analyzed revealed the presence of Coccothrinax argentata and Ximenia americana fruits.

From December 1967 through June 1973 a comprehensive study of the Key deer was undertaken by the Cooperative Wildlife Research Laboratory, Southern Illinois University at Carbondale. The objectives of this study were to clarify certain aspects of the Key deer ecology (Klimstra 1974). In addition to analysis of movement and dispersal, social behavior and organization, reproduction and survival, study was made of food utilization. From December 1969 through December 1972, vegetation line transects were examined at 3-month intervals in five major plant communities on Big Pine Key. Observation of plants browsed was recorded but in a less organized manner. Also, nine exclosures were established in various plant communities to evaluate impact of deer feeding. Additionally, caloric values of potential foods were determined from 312 samples of 87 species of plants. Summarization of these observations and analyses was reported by Klimstra (1974).

Objectives of Present Study

During 1968-1973 rumen samples from 129 Key deer mortalities were preserved for food habits analysis. The use of rumen for information on herbivore food habits was stated by Dzieciolowski (1970: 103) who noted: "The botanical method of rumen content analysis gives a reliable qualitative characteristic of food consumption, and provides data for a listing of species consumed." Harlow and Hooper (1971) suggested that rumen analysis was an alternative to range surveys for determining foods eaten by deer. Crawford (1969)

reflected on the danger of evaluating deer range solely on the basis of woody browse. There is strong evidence that hardened woody twigs are of minor importance to deer in certain instances (Korshgen 1962). Studies in Florida by Harlow and Jones (1965), Harlow (1959), and Strode (1954) revealed that mainland Florida deer use a variety of other plants.

Analysis of Key deer rumen samples provided opportunity to determine plant species consumed, parts of plants utilized, seasonal dietary aspects, and local differences in vegetation utilization. With increased human development of remaining privately-owned lands, much excellent habitat will be greatly altered resulting in extensive changes in available deer foods. Hopefully, my study will contribute to a fuller appreciation for the needs of the Key deer in the development of long-range management plans for the Key Deer National Wildlife Refuge.

STUDY AREA

The Florida Keys form a crescent chain of small limestone islands extending south, approximately 150 miles from penninsular Florida. Soils on islands vary from thick marl depositions (calcium carbonate) to bare rock (öolitic formation) (Dickson 1955). The long-term rainfall at Key West, Florida (30 miles west of Big Pine Key) was 101.6 cm annually. Rainfall was normally greater than 10 cm per month from June-October, and the driest period normally occurred from December-March, when a mean of 4.4 cm was received per month (Klimstra 1974). Characteristically, January-March and October-December represented dry periods. The lack of soil depositions in many areas resulted in rapid runoff and pooling of rainfall in depressions. Thus, many of the plants are adapted to relatively xeric conditions.

Islands within the Key deer range are characterized by a thick growth of red mangrove (Rhizophora mangle) which is established in shallow salt water areas and may surround the islands. As elevation increases, red mangrove is replaced at approximately high tide level by other maritime plants such as black mangrove (Avicennia gerimans), white mangrove (Laguncularia racemosa), and buttonwood (Conocarpus erecta). These maritime zones usually grade into broadleaved hardwood hammock and pinelands which are not tolerant of salt water inundation. Pinelands are extensive on Big Pine Key, No Name Key,

and Little Pine Key within the Key deer range. The relative size, distribution, and composition of natural plant associations are primarily the result of elevation gradients and salt water influence (Dickson 1955).

Population estimates of Key deer have shown increase in numbers from an estimated 25 to 50 animals in 1949 to approximately 350 animals in 1973. An estimated two-thirds of the present population are on Big Pine Key with the remainder of the population located on other Keys in the vicinity of Big Pine Key (Klimstra 1974). Almost 6000 acres in size, Big Pine Key is one of the highest and largest islands in the area and has the greatest number of plant species (Dickson 1955). Six major cover types have been described on Big Pine Key. Cover types include: subdivisions 1,060 acres (18 percent), hammock 232 acres (4 percent), buttonwood-scrub mangrove 1,586 acres (28 percent), dense mangrove 579 acres (10 percent), hardwoods 742 acres (13 percent), and pinelands 1,584 acres (27 percent) (Klimstra 1974).

Approximately 3000 acres on Big Pine Key are within the boundary of the Key Deer National Wildlife Refuge (Fig. 1). Major cover types include: subdivisions 508 acres (17 percent), hammock 138 acres (5 percent), buttonwood-scrub mangrove 919 acres (31 percent), dense mangrove 277 acres (9 percent), hardwood 155 acres (5 percent), and pinelands 950 acres (32 percent). In addition to the total acreage in housing subdivisions, 264 acres are in roads, firelanes

and canals (Klimstra 1974).

During March through September 1973, 103 families represented by 474 species of higher vascular plants were collected from Big Pine Key. The number of plant species located in cover types was tabulated (Table 1). Disturbed areas exhibited the greatest species diversity followed by hardwoods (hammocks), pinelands, cultivated plants, strand (maritime), and marsh (fresh and brackish). Of the total plant species, 46.3 percent were forbs, 42.3 percent woody, and 11.3 percent graminid (grasses and sedges). The variety of cultivated plants available and the subtropical climate encouraged introduction of many plants. Several species were collected or observed as "naturalized" or escaped from cultivation (Table 2). Of these 33 plants, Brazilian pepper, Australian pine, papaya, and periwinkle were the most common "escapees" from cultivation.

METHODS

During January 1968 through September 1973, stomach contents from Key deer mortalities were preserved for food habit analysis. Available from Big Pine Key, No Name Key, Little Torch Key, Big Torch Key, and Ramrod Key were 112, 6, 5, 1, and 3 samples respectively; 2 were without location identification. The majority of samples were from roadkills on U.S. highway 1, State road 940, and Wilder Road on Big Pine Key (Fig. 2; Table 3).

Approximately 1 quart of rumen was taken from each of the 129 deer collected. Samples were placed in plastic containers and frozen. Age, sex, condition, location, date, and general information were recorded for each sample collected.

To accommodate identification of fragments of food recovered from rumen samples, a reference collection of plants occurring within the Key deer range was assembled. During March through September 1973, 477 plant species, representing 105 families were collected, identified, and placed in a permanent herbarium at the Cooperative Wildlife Research Laboratory, SIU. Samples of fruits and seeds were preserved for the majority of plants. Collecting efforts were concentrated on Big Pine Key; but, an attempt was made to obtain specimens reported from other Keys within the deer range.

Because of the limited number of mortalities in any one year the rumen samples were grouped by quarters to evaluate overall changes

which might exist in plant utilization. The calendar year was divided into four quarters, January-March, April-June, July-September, and October-December. Rainfall (mm) and distribution of samples collected on Big Pine Key for these periods were assembled (Tables 4 and 5), for possible use in evaluating seasonal aspects of plant use by deer. Although quarterly periods may not reflect the seasonal aspects or changes in the deer range relative to deer food habits, it should be recognized that due to the subtropical climate, plants grow almost continuously. According to Dickson (1955) many plants flower and fruit several times a year and there was probably no time when some of these fruits and flowers were not available to deer. Leaves were rarely lost and because many plants grew around salt water, their vegetative parts remained succulent.

Rumen Analysis

Rumen samples were prepared for analysis according to Robel and Watt (1970). A set of three sieves was constructed from standard 2-, 4-, and 8-mesh/inch hardware wire to separate rumen materials into homogeneous sized particles. A tub placed beneath collected materials passing through the larger screens during the washing process. Frozen samples were thawed and then washed through the series of three screens; and, a 28-mesh/inch sieve served as a filter for tub materials. The materials from the four screens were then transferred to separate sheets of blotting paper and spread for drying. At this stage, an initial survey of plant materials was con-

ducted, as delicate leaves were often easier to identify while wet. Plant material was identified, recorded, and then placed in a drying oven at 60° C for 4 hours prior to quantitative determination.

After drying, a volumetric measurement (cc) was made of materials from the largest screen (2-mesh/inch). This involved hand separation of each plant species, placing separated materials in a graduated cylinder, tamping lightly with a wooden dowel, and recording volume (Robel and Watt 1970).

The dried materials from the 4- and 8-mesh/inch screen were analyzed using the point method described by Chamrad and Box (1964). Dried materials from the two screens were transferred from the blotter paper, spread evenly in a 17x28 cm enamel tray, and a wooden pin frame (five pins) advanced at 1 cm intervals until 100 points were identified. A Bausch and Lomb stereo zoom scope (lx-6x) aided identification of plant material beneath the pin points. Chamrad and Box (1964) stated that relative percent volume of plant materials could be taken from pin hits in most cases. Thus, the values (percent) determined for each plant species and unknowns were translated into volumetric (cc) values. The translation was accomplished by taking the percent determined by point analysis, dividing by 100, and multiplying this proportion by the total volume of material examined. Total volumes of the 4- and 8-mesh/inch screenings were determined using the method described for an individual food item at the 2-mesh/inch screening. The 4- and 8-mesh/inch translation was represented

by the formula:

$$N\left(\frac{X}{100}\right) = A$$

where: X = percent composition of an item determined by the point analysis method (based on 100 pin hits)

N = total volume of the sample (cc)

A = item volume (cc)

After the relative volumes (cc) for individual food items were calculated at each screen level (i.e. 2-, 4-, and 8-mesh/inch), individual food item values were added at each screen level. Thus, the volume of each item in the entire sample was obtained. Plant materials identified but not registering a volume using this technique were recorded according to frequency of occurrence.

Materials retained on the smallest screen (28-mesh/inch) were examined for frequency of occurrence of food items only. Dirschl (1962), in a study of sieve mesh size related to analysis of antelope rumens, found no apparent difference in mean composition between U.S. standard sieve sizes (3 1/2, 5, and 7) in effecting quantitative analysis of antelope rumens. The extensive use by Key deer of a variety of small fruits made smaller screenings important in quantitative determinations of sample composition; but, this did not warrant use of screens smaller than 8-mesh/inch.

Due to the variable volumes present on the different screen levels, the translation of percentages determined by point analysis into volumetric values resulted in a closer approximation of individual

rumen composition. The use of an aggregate volume technique in establishing overall composition in the samples was probably more accurate than an aggregate percent method (Martin et al. 1946).

Percent volume of food items was calculated by adding values (cc) in each of the samples and dividing by the total volume of materials examined. These proportions of the total materials were then multiplied by 100 to obtain the percent composition of individual items in the samples.

The percent frequency of plants in the samples was calculated from the number of times an item was identified in the samples, divided by the total number of samples examined. This proportion was multiplied by 100 to obtain percent frequency.

Plant importance rating was calculated by multiplying the percent frequency and the percent volume of the food item. This value provided a relative index for rating a food item using both percent frequency and percent volume.

RESULTS AND DISCUSSION

Analysis of Techniques

Because of many uncontrollable variables in food habits studies, resulting data provide approximations (Martin et al. 1946). Some of these variables include differential rate of plant tissue breakdown in the rumen, variable passage through the digestive system, and differences in one's ability to identify segments of plant materials.

Schenck (1971) reported that differences between estimates of percent weights of food items using points and known percent weights were not significant except for certain forbs. One source of important variance was attributed to differential particle size. Cook and Box (1961) were of the opinion that the point technique was best suited to mixtures of homogeneous size. Robel and Watt (1970), comparing the point analysis technique with standard volumetric procedures, suggested that lack of uniform particle size in rumen was a source of error in the former method. However, there were potential time-saving advantages to the point method when: 1) a large number of stomachs were analyzed, and 2) mean values of items in the stomach were desired, rather than specific values for individual animals. Chamrad and Box (1964) found the point technique a fast, unbiased method of analyzing rumen contents provided: 1) materials were randomly distributed, and 2) no unusually large particles were present in the samples.

In evaluating summer foods of deer in northern Wisconsin, rumen

contents were washed through screens and analyzed using a point method (McCaffery et al. 1974). If the washed materials in the screens appeared to be of similar composition, only particles on the larger screen were analyzed.

Use of point analysis in my study eliminated the problem of variable particle size; and, in conjunction with volumetric procedures, represented a standard approximation of individual rumen composition. The number and distribution of samples collected for rumen analysis represented important factors affecting the resultant determinations of Key deer food plants. The majority of rumen samples were from roadkilled deer and the effects of sample distribution, yearly range fluctuations, man's activities, and distribution of food plants were additional variables which required consideration when evaluating results.

Key deer food plants

Overall food plants

Percent of aggregate volume, percent frequency, and importance ratings for all plants or plant groups identified in rumen samples were tabulated (Appendix A). Samples were obtained from 83 males, 44 females, and 2 unknown as to sex. The number of samples examined were 37, 29, 25, and 36 in January-March, April-June, July-September and October-December, respectively.

A total of 164 food plants were identified (Appendix B). Twenty-eight foods accounted for approximately 75 percent while 10 comprised 56 percent of the total rumen examined. Red mangrove (Rhizophora mangle) leaves and fruits; black mangrove (Avicennia germinans) fruits; Indian mulberry (Morinda royoc) leaves and fruits; silver palm (Coccothrinax argentata) flowers and immature fruits; brittle thatch palm (Thrinax microcarpa) immature fruits; blackbead (Pithecellobium keyense) leaves; grass leaves; pencil flower (Stylosanthes hamata) leaves; Acacia (Acacia spp.) fruits and leaves; and dilly (Manilkara spp.) fruits were most important. Red and black mangrove provided almost 24 percent of the total rumen. The former exhibited the greatest importance value based upon analysis of 129 samples. These data confirm observations of Dickson (1955); who found that 63.48 percent of 293 pellet groups contained red mangrove. My results showed 63.56 percent occurrence of red mangrove. For mainland Florida deer Harlow (1959) indicated that although a variety

of food plants was utilized, 20 items contributed 84 percent of the total volume from stomach samples. Strode (1954), studying the Ocala deer herd in Florida, identified 120 plant foods from stomach samples; 10 items made up 90 percent of the total volume and 4 yielded 75 percent.

Several food plant genera listed in Appendix A were represented by more than one plant species. Eighteen grasses (Poaceae) were differentiated on the basis of seed occurrence in rumen samples (Table 6). Although the majority of parallel-veined, leaf materials were considered grasses, distinction of individual species was not always accommodated. Based on seed parts, finger grass (Chloris petraea), Paspalum spp., and dropseed (Sporobolus spp.) were most frequent. Sedge (Cyperaceae) was identified in 10 rumen samples, with spikerush (Eleocharis cellulosa) occurring four times, Cyperus spp. three, and sawgrass (Cladium jamaicensis), Abilgaardia ovata, and Fimbristylis castanea each once. Nine species of Chamaesyce were identified (Table 7), with Chamaesyce blodgettii, C. deltoidea, and C. mesembryanthemifolia being most frequent. The most important food plants within genera, where two or more species were identified included: Manilkara bahamensis, Acacia pinetorum, Galactia parvifolia, Ipomoea acuminata, Sida acuta, Physalis angustifolia, Chiococca pinetorum, Melanthera parvifolia, and Agalinis maritima. Other plant genera were inadequate to provide a basis for ranking species.

Food plants were separated by plant type and location in habitat divisions (Appendix B; Tables 8 and 9). Forbs had the greatest number of species followed by woody plants, graminids (grasses and sedges) and cultivated plants. Disturbed areas (including cultivated plants) exhibited the greatest number of food plant species, followed by pinelands, hardwood (hammock), strand, and fresh and brackish marshes. Of woody food plants, hardwood (hammock) had the greatest number followed by disturbed areas, pinelands, strand, and marsh (fresh and brackish). The majority of forbs and graminids utilized by deer were present on disturbed areas. In terms of number present and deer food plants, disturbed areas had the greatest variety. All habitat and forage types present were utilized for food. Klimstra (1974) observed that no plant species appeared immune to Key deer use.

Percentages of forage types in the overall deer diet indicated woody plants (leaves and new growth stems) were most important, followed by fruits from woody plants, fruits and flowers of palms, forbs, and miscellaneous items (graminids, mushrooms, and pine needles) (Appendix A; Fig. 3). Hardened twigs of woody species were not important components; however, leaves and new woody growth of the most important browse species which included red mangrove, Indian mulberry, blackbead, acacia, erithalis (Erithalis fruticosa), saffron plum (Bumelia celastrina), white indigo berry (Randia aculeata), joewood (Jacquinia keyensis), catbriar (Smilax

havanensis), snowberry (Chiococca spp.), lantana (Lantana involucrata), rough velvet-seed (Guettarda scabra), and torchwood (Amyris elemifera) provided 42 percent of the overall diet. A variety of fruits and flowers were important in the deer diet. The bulk of fruits included those from: red mangrove (fruit root shoots), black mangrove, brittle thatch palm, dilly, acacia, silver palm, Indian mulberry, ground cherry (Physalis angustifolia), locust berry (Byrsonima cuneata), white stopper (Myrtus verrucosa), tallowwood (Ximenia americana), white mangrove (Laguncularia racemosa), seven-year apple (Casasia clusiifolia), guava (Psidium guajava), and barbettos cherry (Malpighia glabra). Flowers, stalk, and spathe from two palms, saw palmetto (Serenoa repens) and silver palm contributed significantly to the Key deer diet.

Almost 42 percent of the total deer diet was comprised of fruits and flowers. Studies by Lay (1969, 1965), Harlow (1959), Strode (1954), Harlow and Jones (1965), and Harlow and Hooper (1971) have indicated the importance of fruits in deer diets. The present study indicated that a great variety of plant species are eaten by Key deer. The seasonal dependence of deer on specific food and habitat types was more apparent when quarterly values of food plants were tabulated (Appendix C).

Seasonal Food Utilization

January-March

Thirty-seven rumen samples for January through March

(Appendix C) showed important foods to be red mangrove leaves and fruit root shoots; blackbead leaves; saw palmetto flowers, stalks, and spathe; erithalis leaves and fruits; morning glory (Ipomoea acuminata) flower buds, leaves, and stems; saffron plum leaves; graminid leaves; joewood leaves; mushroom stems and caps; and white indigo berry leaves. These 10 plants accounted for approximately 55 percent of the total food volume. Unidentified leaves and herbaceous stems accounted for 20.7 percent which was highest due to the relative increase in browse in rumen samples from this period.

A total of 84 food plants was identified; woody browse from such plants as red mangrove, blackbead, indigo berry, saffron plum, erithalis, Indian mulberry, acacia, joewood, and cat briar accounted for almost 60 percent of the total volume (Fig. 4). Fruits of woody plants such as Acacia farnesiana, red mangrove, and dilly comprised 13.1 percent of the total volume; this was the lowest for woody plant fruits during the four seasonal periods.

April June

Twenty-nine rumen samples for April through June (Appendix C) showed important foods to be silver palm flowers, immature fruits, and stalk; dilly fruits and leaves; red mangrove leaves and fruits; Indian mulberry leaves and fruits; acacia leaves and fruit pods; erithalis leaves and fruits; and blackbead leaves. These seven items accounted for 55.9 percent of the total food volume. Unidentified

material accounted for 16.5 percent of the volume.

Sixty-seven food plants were found; woody plants accounted for 72.8 percent of the aggregate volume, forbs 10.5 percent, palms 15.4 percent, and graminids, pine,and mushrooms 1.4 percent (Fig. 5). Fruits of woody plants such as dilly, red mangrove, Indian mulberry, and acacia were most important, comprising 37.7 percent of the aggregate volume. Browse from woody plants made up 35.1 percent. Palms comprised 15.4 percent of the volume, with silver palm flowers, immature fruits, and spathe most important.

July-September

Twenty-five rumen samples for July through September (Appendix C) indicated important foods to be brittle thatch palm fruits and stalks; black mangrove fruits; Indian mulberry leaves and fruits; silver palm fruits and flowers; erithalis leaves and fruits; and graminid leaves. These six items accounted for 61.5 percent of the total aggregate volume. Unidentified material yielded 11.9 percent of the total volume.

A total of 72 food plants was identified; woody plants contributed 62.0 percent, forbs 6.5 percent, palms 27.5 percent,and graminids, mushrooms, and pine needles 4.0 percent (Fig. 6). Fruits of woody plants were most important, contributing 36.1 percent of the total volume. Flowers and fruits of silver and brittle thatch palm contributed 27.5 percent to the volume, and this was the highest percent of diet attributed to fruits and flowers (63.5 percent) of the four

periods examined.

October-December

Thirty-six rumen samples representing October through December (Appendix C) showed black mangrove fruits the most important food item. Other important plants included red mangrove leaves and fruits; silver palm fruits; pencil flower leaves and stems; brittle thatch palm fruits; and morning glory (Ipomoea spp.) flowers, leaves, and stems. These six items accounted for 58.1 percent of the total aggregate volume. Unknown material (leaves and stems) made up 15.9 percent of the volume.

A total of 91 food plants was recorded; woody plants (leaves, herbaceous stems, and fruits) contributed 68.8 percent of the total volume, forbs 16.9 percent, and palms 10.4 percent (Fig. 7). Fruits of woody plants comprised 36.0 percent, while woody browse (leaves and herbaceous stems) contributed 32.8 percent.

Percentages of the forage types utilized by Key deer varied seasonally. Flowers and fruits contributed approximately 21, 53, 63, and 46 percent, while browse from forbs and woody plants contributed 73, 45, 32, and 49 percent of the diet during the four periods examined. Aspects of deer diet suggested increased availability and/or preference by Key deer for certain plant components on a seasonal basis.

White-tailed deer have been described exhibiting selectivity and preference in feeding (Zeedyk 1969). Selequist and Green (1968) noted relationships between oak mast availability and other forage utilized by penned deer in Arkansas. When oak mast became available, little else was utilized as food by deer. Harlow (1959) observed that when oak mast disappeared in late winter deer fed heavily on woody plants. Harlow and Jones (1965) reported that following disappearance of acorn and palmetto mast the quantitites of woody plants, forbs, and grasses increased in the diet of mainland Florida deer.

The variety and tropical affinities of many plants which contributed fruits and flowers represented factors effecting seasonal composition of deer diet. Fruits and flowers of several plant species were found in greatest quantity from April-November. Browse was present in greatest quantity from samples collected from December-March. The quarterly rainfall during the period of major sample collection (Table 4) indicated that average rainfall was lowest during January-March. This period corresponded to the time when browse

was most utilized by Key deer. The pattern of rainfall in this sub-tropical climate is an important factor effecting phenology of the majority of plants present within the Key deer range and appeared to correspond to the "seasonal" pattern of forage utilization witnessed in the deer diet.

Food Use by Month

The number of samples available for each month was as follows: January (13), February (10), March (14), April (9), May (10), June (10), July (12), August (6), September (7), October (9), November (17), and December (10). Nine foods, which accounted for over half of the total rumen, were plotted for each month (Figs. 8, 9, 10). Percentages of Indian mulberry, black mangrove, dilly, acacia, brittle thatch palm, and silver palm illustrated increased use of fruits or flowers from these plants. Quantities of browse from red mangrove, blackbead, and pencil flower exhibited monthly variations, but increases corresponded with absence of fruits and flowers from other plants.

Although monthly fluctuations occurred in use of certain fruits and flowers, several food plants contributed some browse throughout the year. These included: red mangrove, Indian mulberry, pencil flower, acacia, grasses, Chamaesyce spp., milk peas (Galactia parvifolia), saffron plum, catbriar, slash pine (Pinus elliottii var. densa), ground cherry (Physalis angustifolia), lantana, and Phyllanthus pentaphyllus. Other food plants contributing browse, were present in

samples from every month but one. These included: blackbead, erithalis, white indigo berry, joewood, Melanthera parvifolia, Spanish needle (Bidens pilosa), Sida acuta, and Tillandsia sp. These data support Klimstra's (1974) observation that certain plants were usually subjected to regular and continuous browsing by Key deer. Also indicated was the fact that the greatest quantities of browse from certain plants were recorded when fruits and flowers were least available.

Local Differences in Food Habits

In an effort to relate major vegetation type with foods eaten, samples were grouped to reflect three areas within the Key deer range (Appendix D). Area 1 represented 39 samples collected north of Watson Road on Big Pine Key (Fig. 2). Area 2 represented 40 samples collected from the east-west portion of U.S. 1 on Big Pine Key. Area 3 represented 15 samples collected from Keys other than Big Pine Key: No Name Key (6), Little Torch Key (5), Big Torch Key (1), and Ramrod Key (3).

Food items in samples representing Area 1 and Area 2 did not appear to be substantially different. Although certain differences did exist, important food plants used by deer were present and utilized on both area of Big Pine Key. However, an apparent difference existed in food utilization by deer from Keys other than Big Pine. Pigeon plum (Coccoloba diversifolia) and devil's potato (Echites umbellata) appeared in samples from No Name Key, and

erithalis, grasses, and morning glory (Ipomoea spp.) showed greater use on other Keys than on Big Pine Key. Acacia (Acacia pinetorum) was not present in samples from Keys other than Big Pine Key.

Klimstra (1974) reported that foods utilized by Key deer varied from one area of a Key to another and particularly from one Key to another. My study substantiated this observation. Variety of habitats and plants available to deer on certain Keys was more limited than on Big Pine Key. In part, differences in sample compositions may have reflected availability of certain plants; however, other unknown factors, unrelated to plant availability, were clearly indicated. Utilization of red mangrove is an example. Although relatively abundant on all islands, red mangrove comprised a smaller portion of the diet from deer on Keys other than Big Pine Key.

Management Implications

A variety of plants was utilized, but relatively few provided the bulk of the Key deer diet. Marked seasonal fluctuations in use of certain plant species and their parts were indicated. My study suggested the importance of maintaining a variety of habitat types and food plants available to Key deer. Man's continued development of islands such as Big Pine Key has resulted in clearing and loss of pinelands, hardwoods, and maritime zones. This has eliminated important food plants such as red mangrove, black mangrove, acacia, brittle thatch palm, silver palm, dilly, and blackbead. Continued loss of important habitats and food plants require that remaining,

protected lands be carefully managed to insure survival of a healthy Key deer population.

Additional measurements regarding abundance, utilization, and nutritional contributions of important foods are needed. Proper management of Key deer numbers in relationship to available habitat requires ability to predict and evaluate qualitative trends in habitat condition; thus, utilization and abundance of plants or plant parts considered important to Key deer should be monitored. Controlled burning, clearing, and reseeding techniques have been suggested as possible management practices to be tested on selected areas within the Key deer range (Klimstra 1974). The programs are designed to maintain a variety of habitat types for Key deer. Management programs play a role in the reproduction and success of Key deer food plants. The impact of experimental programs on important food plant species should be carefully evaluated prior to adoption of long-term management practices.

A thorough knowledge of Key deer life history is essential in establishment of sound management programs. The Key deer National Wildlife Refuge, and the protection it affords, provides the initial step in the maintenance of a viable Key deer population. As increased development of privately owned lands restricts the amount of quality habitat available to Key deer, additional research will be needed on food plant species considered important to the Key deer.

SUMMARY

1) As part of a five-year ecological study of the Florida Key deer conducted by the Cooperative Wildlife Research Laboratory, SIU, rumen contents from 129 Key deer mortalities were examined for botanical composition.

2) Rumen analysis was used to provide information regarding plant species consumed, qualitative and quantitative plant part consumption, seasonal aspects, and local differences which might exist in deer food plant utilization.

3) Samples were quantified by use of combined point and volumetric techniques.

4) A total of 164 plant foods were identified in the 129 rumen samples, with 28 plant foods comprising approximately 75 percent of the total volume examined.

5) Red mangrove fruit (root shoots) and leaves; black mangrove fruits; blackbead leaves; Indian mulberry leaves and fruits; silver palm flowers and fruit; brittle thatch palm fruits; pencil flower leaves and stems; graminid leaves; dilly fruits; and acacia fruits and leaves were most important.

6) Woody browse (leaves and new growth stems) comprised 40 percent of the total aggregate volume, woody plant fruits 27 percent, palm fruits, flowers, and spathe 14 percent, forbs 13 percent, and miscellaneous (graminids, mushrooms, and pine needles) 3 percent of the total diet.

7) "Seasonal" changes in use of forage classes and plant species occurred. Browse was found in greatest quantities in samples collected from the December-March period. Fruits and flowers from several plant species were found in greatest amounts from April-November.

8) Differences in rumen composition were most pronounced in comparison of Big Pine Key samples and those from other Keys. Although identified in samples from Big Pine Key, erithalis, grasses, and morning glory (Ipomoea spp.) appeared to be more important to deer on Keys other than Big Pine Key.

9) This study suggests the importance of maintaining variety of habitat types and food plants available to Key deer. Additional research is needed on 1) nutritional aspects of deer diet, 2) availability and utilization of specific food plants, and 3) responses of important food plants to proposed techniques of habitat manipulation within the Key deer range.

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TABLES

Table 1. Number and percent of total for plant species occurring in various cover types on Big Pine Key, Florida.

Cover Type	Number of species	Percent of Total
Disturbed areas (roadsides, subdivisions)	190	29.8
Hardwood (hammock)	126	19.8
Pinelands	118	18.6
Cultivated	94	14.7
Strand (maritime zone)	90	14.2
Marsh (fresh or brackish)	18	2.9
Total	636	100.0

Table 2. Exotic plants as escapees, Big Pine Key, Florida.

Species	Common name
Adenanthera pavonina	Sandalwood
Apium graveolens	Celery
Calliandra haematocephala	Powderpuff
Carica papaya	Papaya
Casuarina equisetifolia	Australian pine
Catharanthus roseus	Periwinkle
Citrus aurantiifolia	Key lime
Cocos nucifera	Coconut palm
Cordia sebestena	Geiger-tree
Crotalaria spectabilis	Rattlebox
Eugenia uniflora	Surinam cherry
Euphorbia tirucalli	Pencil cactus
Hibiscus rosa-sinensis	Hibiscus
Hibiscus tiliaceus	Mahoe
Ipomoea crassicaulis	Bush morning glory
Kalanchoe sp.	Alligator plant
Lantana camara	Shrub verbena
Lycopersicon esculentum	Tomato
Manilkara zapoda	Sapodilla
Muntingia calabura	Strawberry tree
Phoenix dactylifera	Date palm

Table 2. (continued)

Species	Common Name
Psidium guajava	Guava
Punica granatum	Pomegranate
Ricinus communis	Castor bean
Russelia equisetiformis	Coral plant
Schinus terebinthifolius	Brazilian pepper
Stenotaphrum secundatum	St. Augustine grass
Swietenia mahagoni	West Indian mahogany
Tamarindus indica	Tamarind
Terminalia catappa	Indian almond
Thespesia populnea	Seaside mahoe
Turnera ulmifolia	Turnera
Vitex agnus-castus	Chaste tree

Table 3. Location for 129 Key deer mortalities from which rumen samples were taken, Florida Keys.

Location	Number of samples	Percent total
Big Pine Key:		
U.S. 1	46	36
Wilder Road	11	9
State 940	33	25
Others	22	17
No Name Key	6	5
Little Torch Key	5	4
Ramrod Key	3	2
Big Torch Key	1	1
Unknown	2	1
Total	129	100

Table 4. Rainfall at Key West, Florida (30 miles west of Big Pine Key) during major period of sample collection (mm).[a]

Year	Quarter 1 (Jan-Mar)	Quarter 2 (April-June)	Quarter 3 (July-Sept)	Quarter 4 (Oct-Dec)
1968	201	447	393	278
1969	154	409	422	614
1970	318	120	535	217
1971	80	187	490	365
Average	188	291	460	369

[a]Data from U.S. Dept. Commerce, Climatological Data, Vol. 19-22.

Table 5. Number of rumen samples collected from Big Pine Key according to quarterly periods.

Year	Jan-Mar	Apr-June	July-Sept	Oct-Dec	Total
1968	5	11	4	5	25
1969	6	5	4	14	29
1970	8	4	6	5	23
1971	11	6	9	8	34
1972	1	0	0	0	1
Total	31	26	23	32	112

Table 6. Grasses identified in 129 Key deer rumen samples based on identifiable seed materials.

Species	Number times found	Percent frequency
Chloris petraea	16	12
Paspalum spp.	14	10
Sporobolus spp.	13	10
Panicum spp.	11	8
Dactyloctenium aegyptium	8	6
Andropogon spp.	7	5
Eleusine indica	3	2
Sorghastrum secundum	3	2
Eragrostis ciliaris	2	1
Setaria spp.	2	1
Lasiacis divaricata	2	1
Stenotaphrum secundatum	1	1
Monanthochloe littoralis	1	1
Distichilis spicata	1	1
Schizachyrium gracile	1	1
Total	85	65

Table 7. Occurrence of species of Chamaesyce in 129 Key deer rumen samples.

Species	Number times found	Percent frequency
Chamaesyce spp.	35	27
C. blodgettii	28	21
C. deltoidea	12	9
C. mesembryanthemifolia	9	6
C. hypericifolia	7	5
C. conferta	3	2
C. adenoptera	2	1
C. hirta	1	1
C. garberi	1	1
C. porteriana	1	1
Total	99	76

Table 8. Categories of 164 Key deer food plants as recorded from rumen samples.

Plant type	Number of species	Percent of Total
Forbs	69	42.0
Woody Plants	65	39.6
Graminids	23	14.0
Cultivated	7	4.3
Total	164	99.9

Table 9. Occurrence of 164 Key deer food plants within specific habitat divisions.

Habitat Division	Number and plant type			Total species occurrences	Percent of total
	woody	forb	graminid		
Disturbed areas (roadsides, subdivisions)	26	51	17	94	40
Hardwood (Hammock)	38	4	3	45	19
Pinelands	22	36	4	62	26
Strand (maritime zone)	13	6	6	25	11
Marsh (fresh or brackish)	3	1	4	8	4
					100

FIGURES

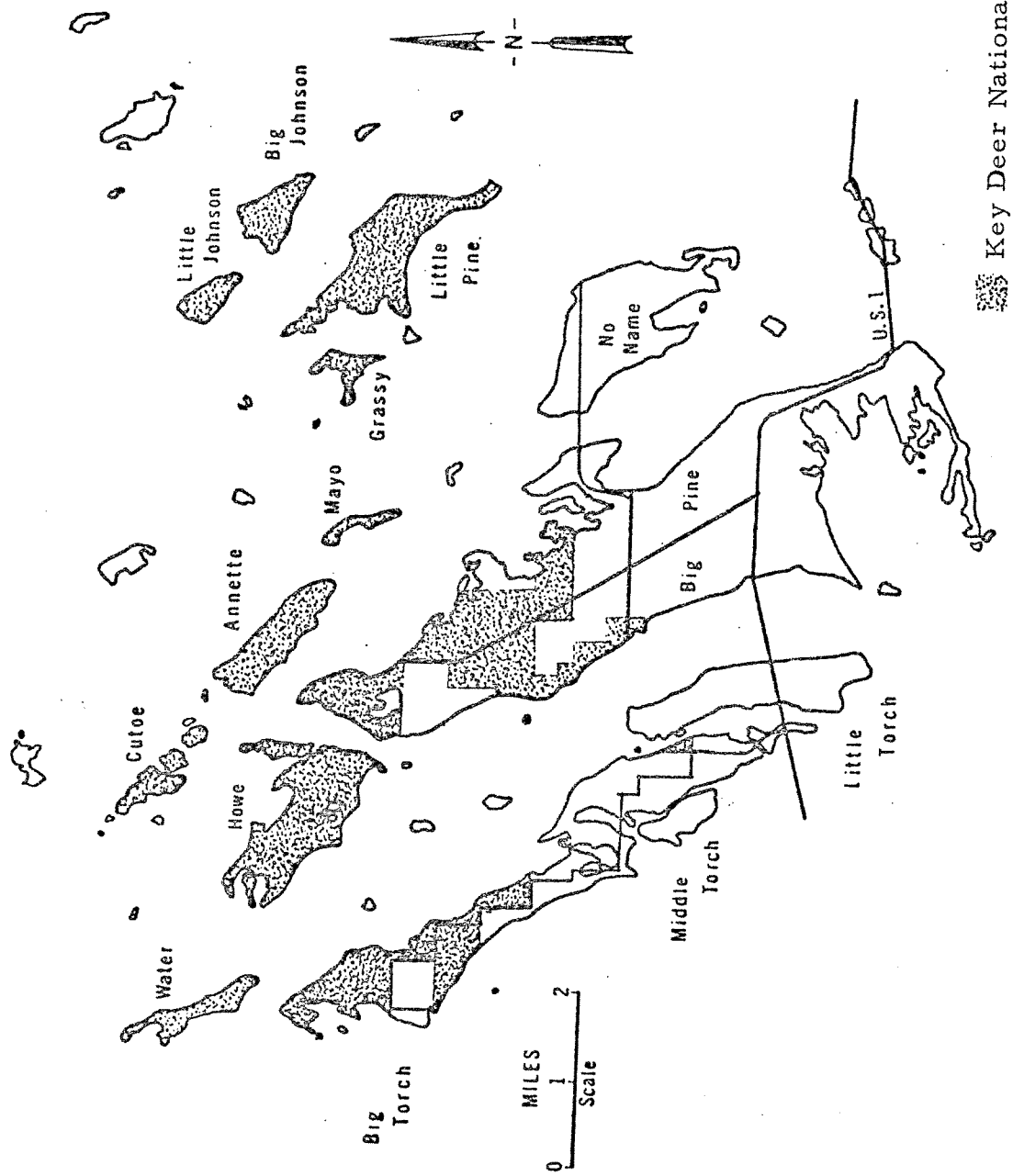

Fig. 1. Segment of lower keys within the Key deer range.

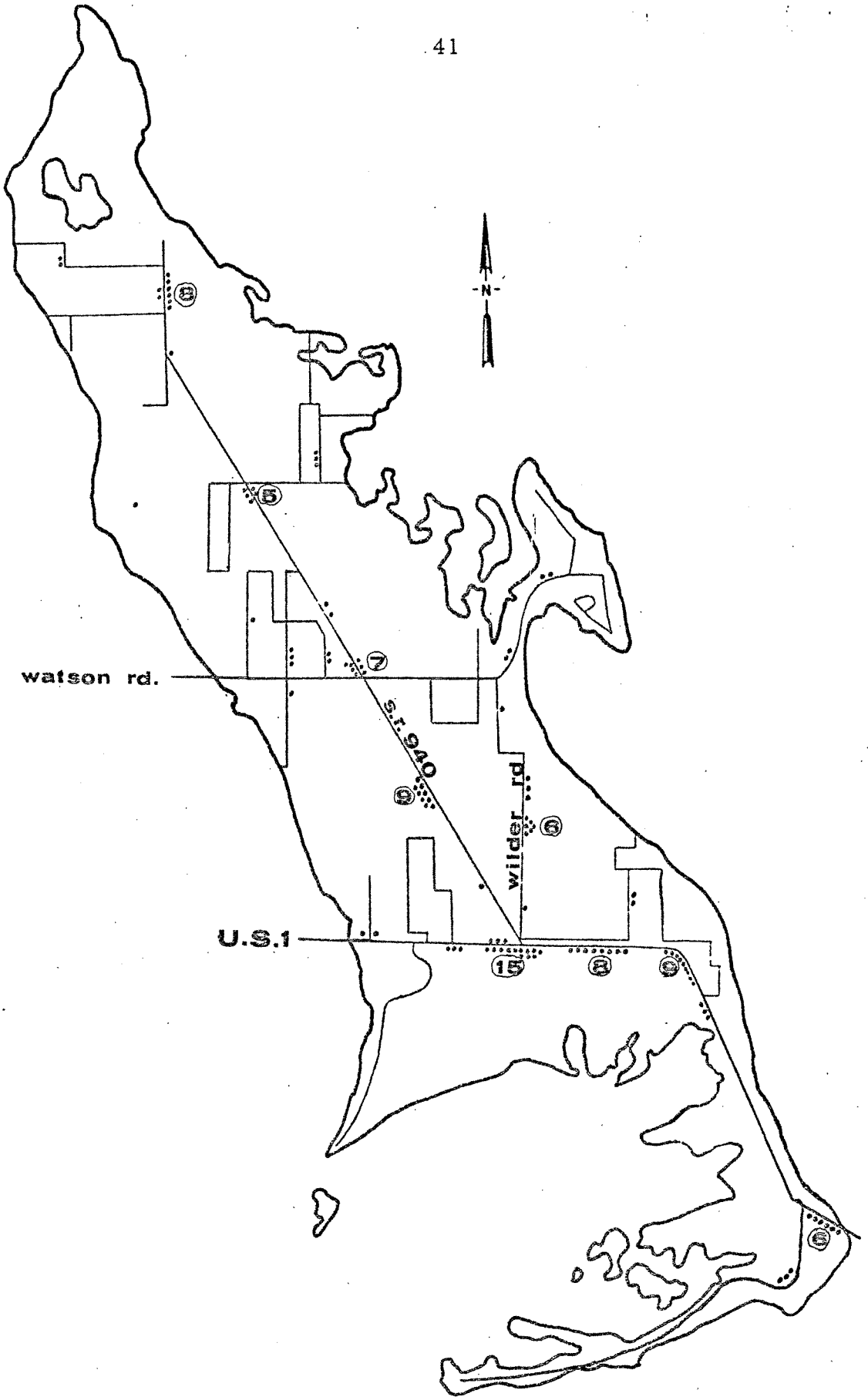

Fig. 2. Distribution of Key deer mortalities from which rumen samples were collected on Big Pine Key, Florida.

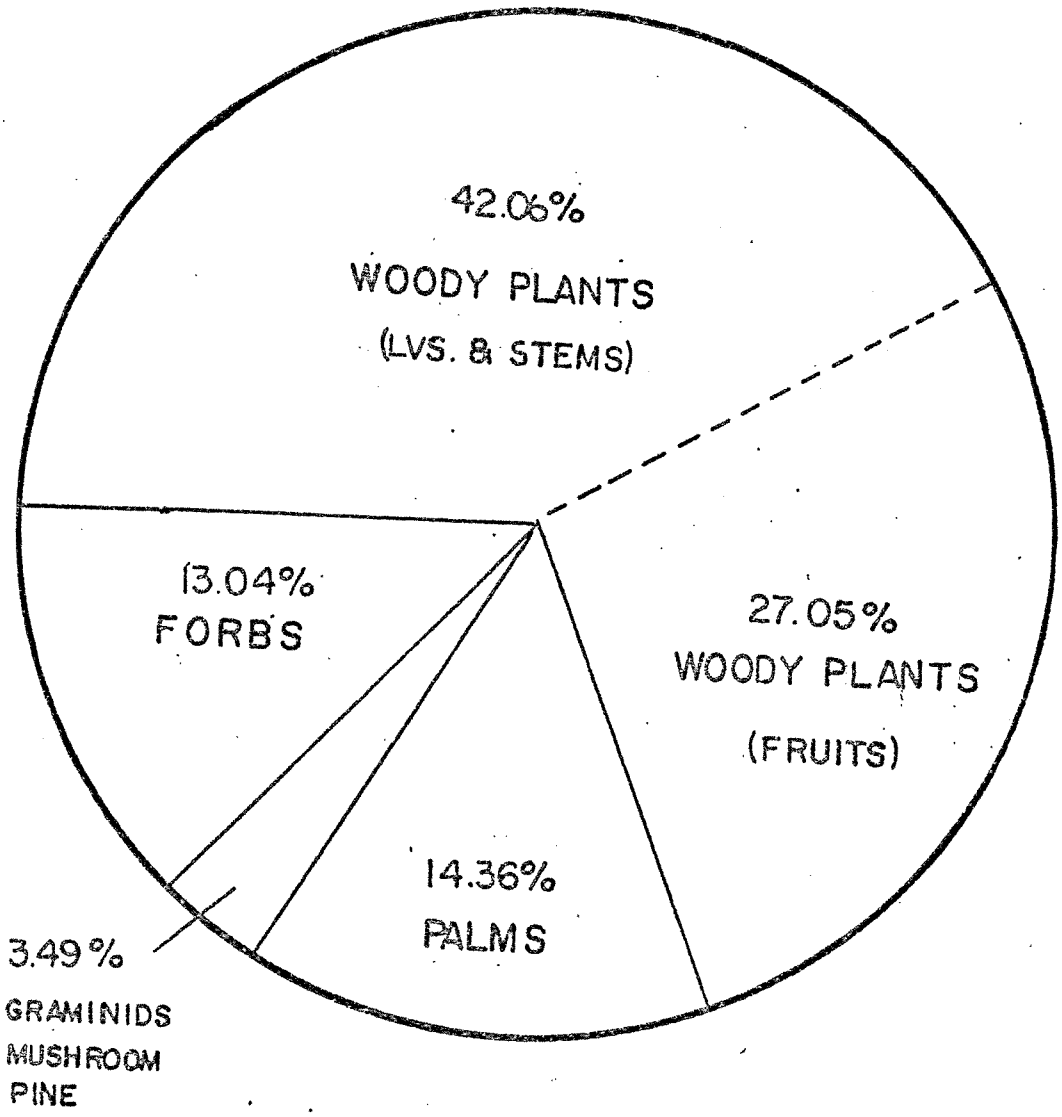

Fig. 3. Categories of plant foods utilized by Key deer based on 129 samples.

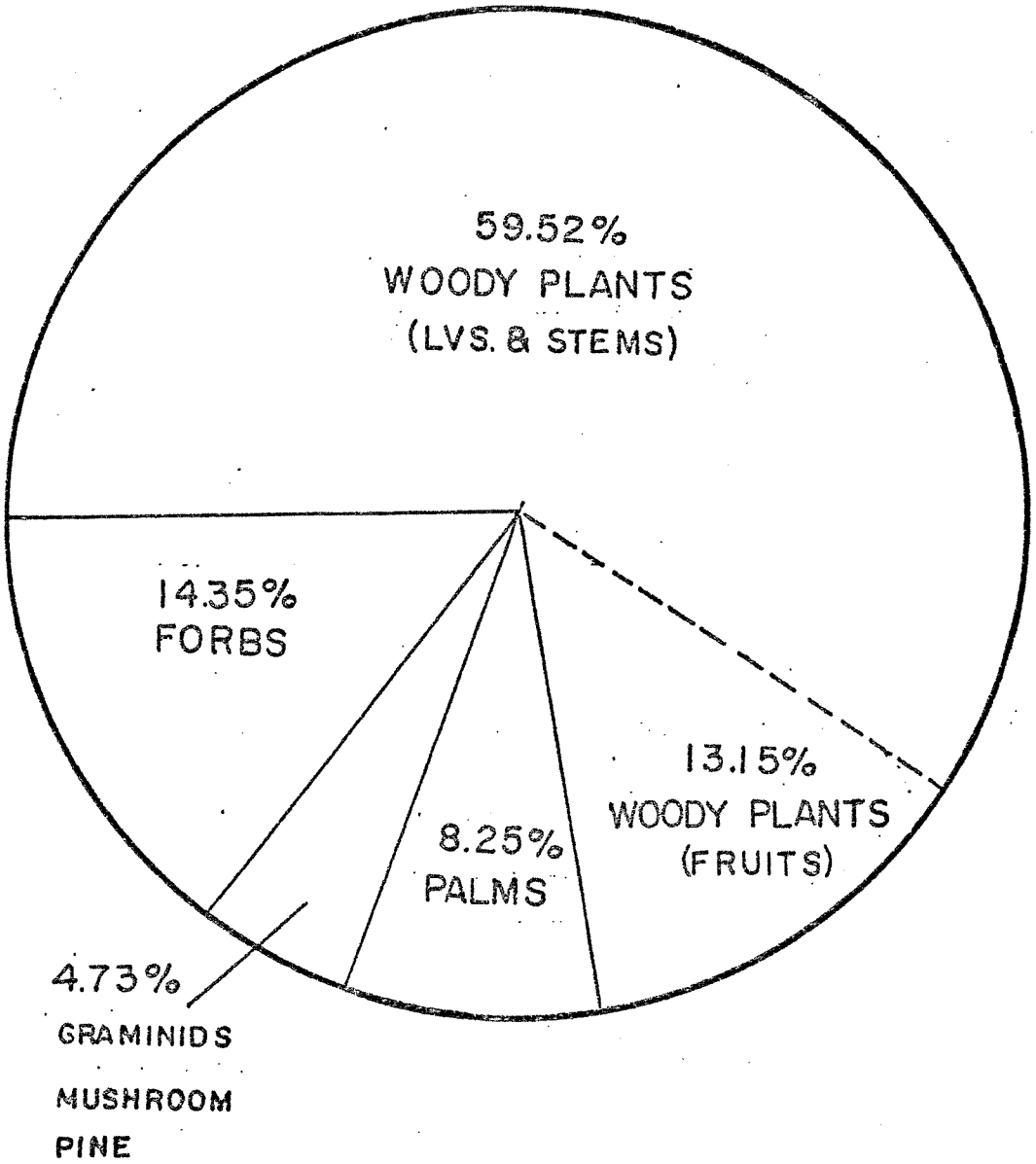

Fig. 4. Categories of plant foods utilized by Key deer based on examination of 37 rumen samples representing January-March.

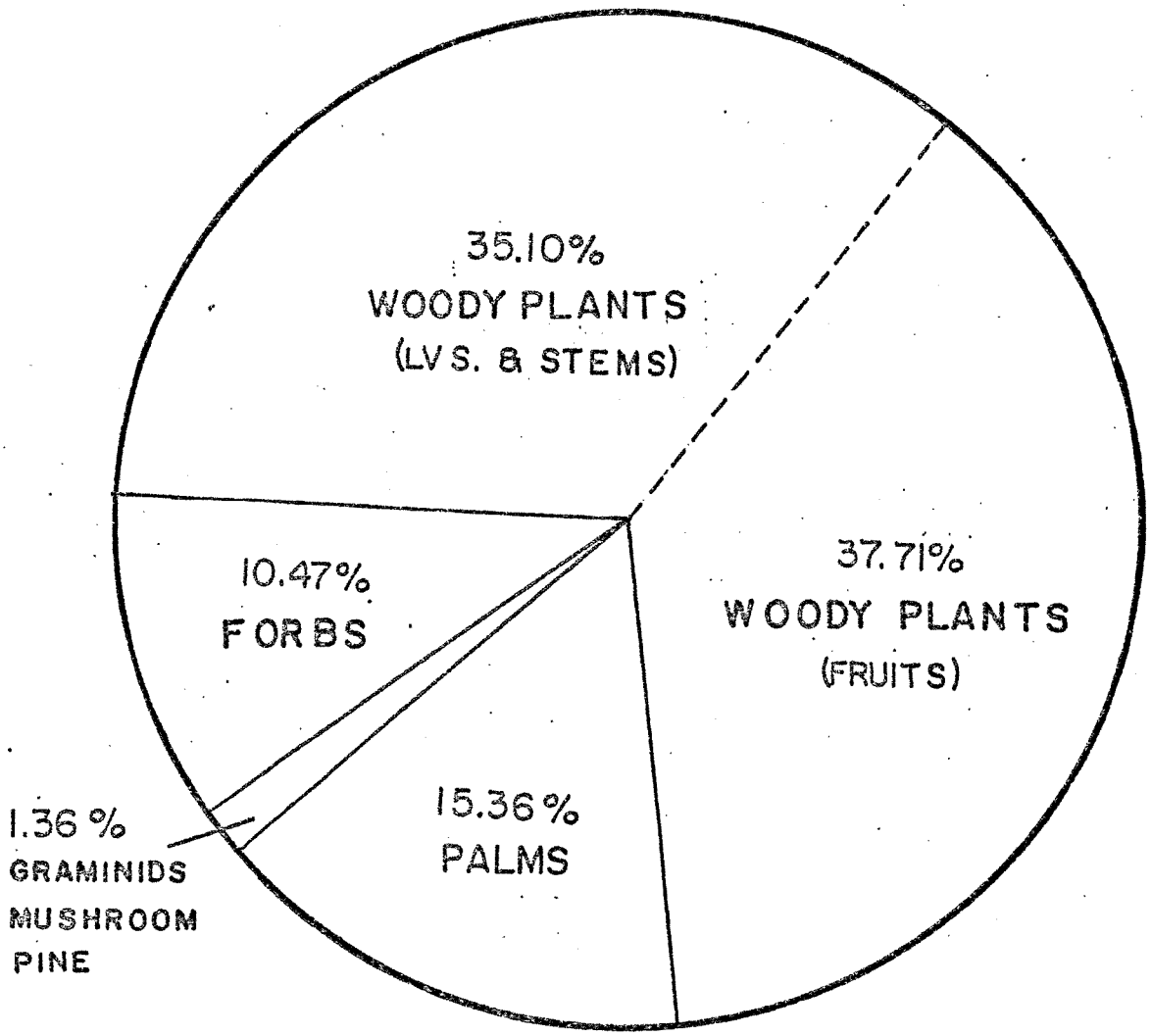

Fig. 5. Categories of plant foods utilized by Key deer based on examination of 29 rumen samples representing April-June.

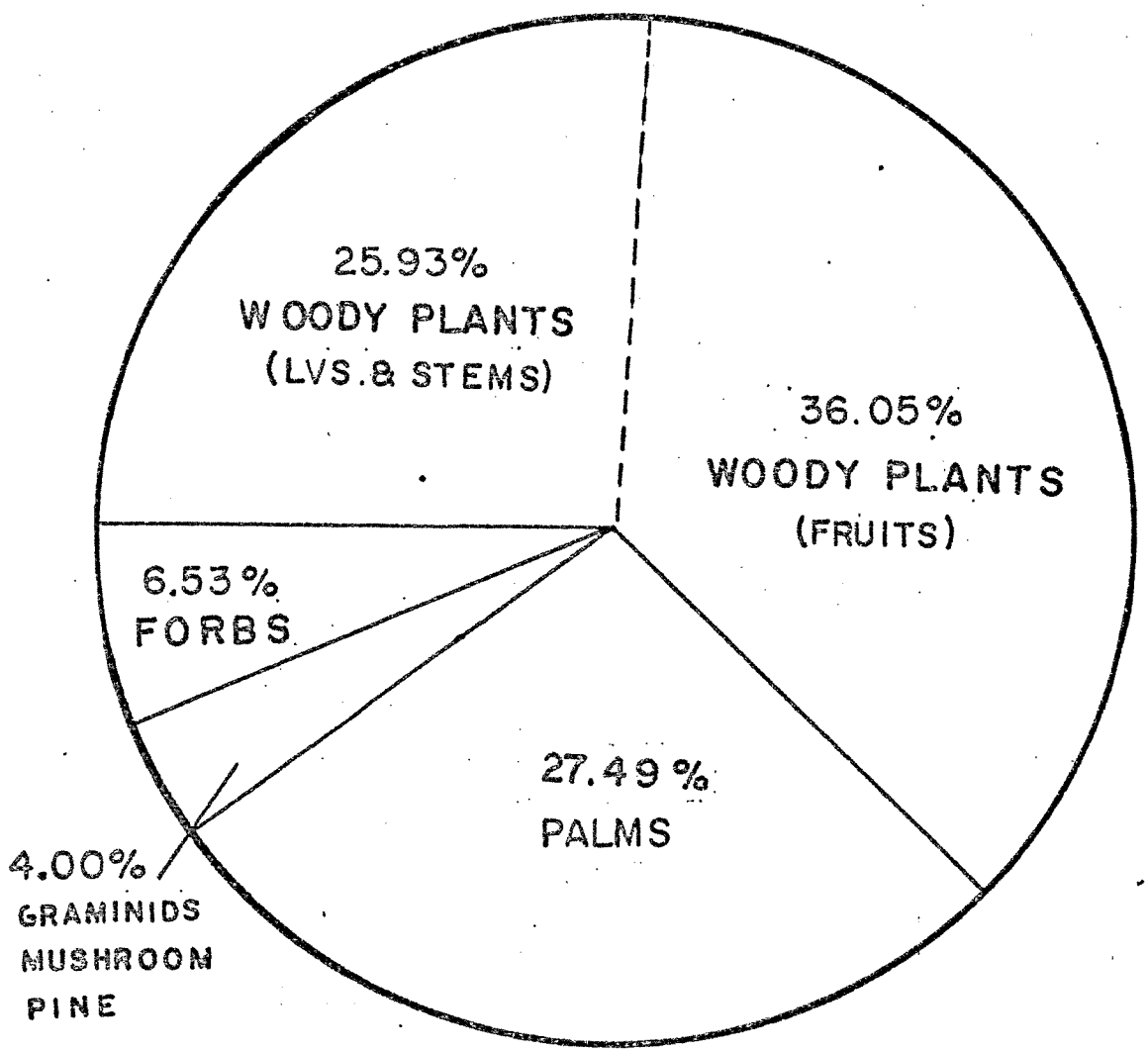

Fig. 6. Categories of plant foods utilized by Key deer based on examination of 25 rumen samples representing July-September.

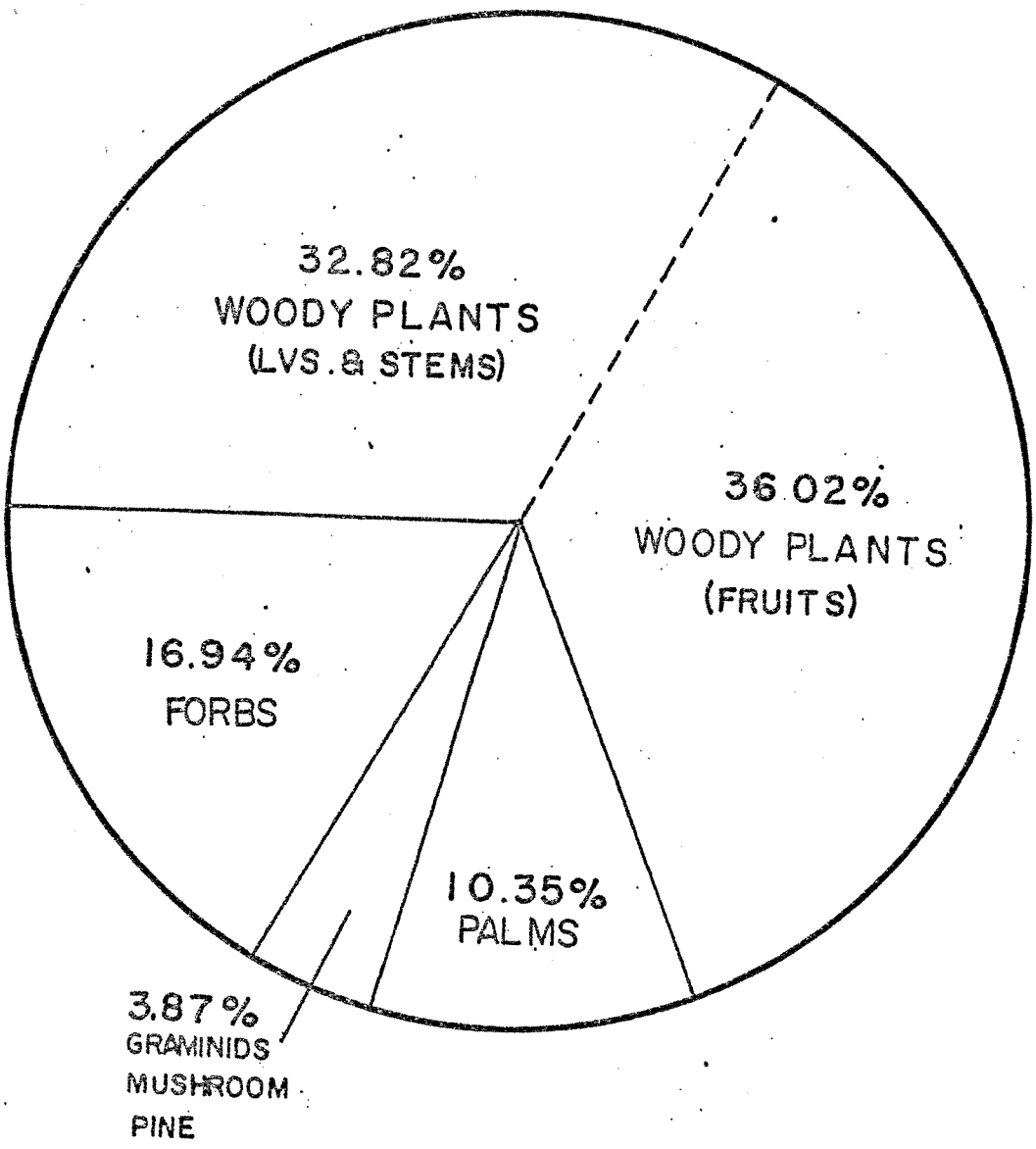

Fig. 7. Categories of plant foods utilized by Key deer based on examination of 36 rumen samples representing October-December.

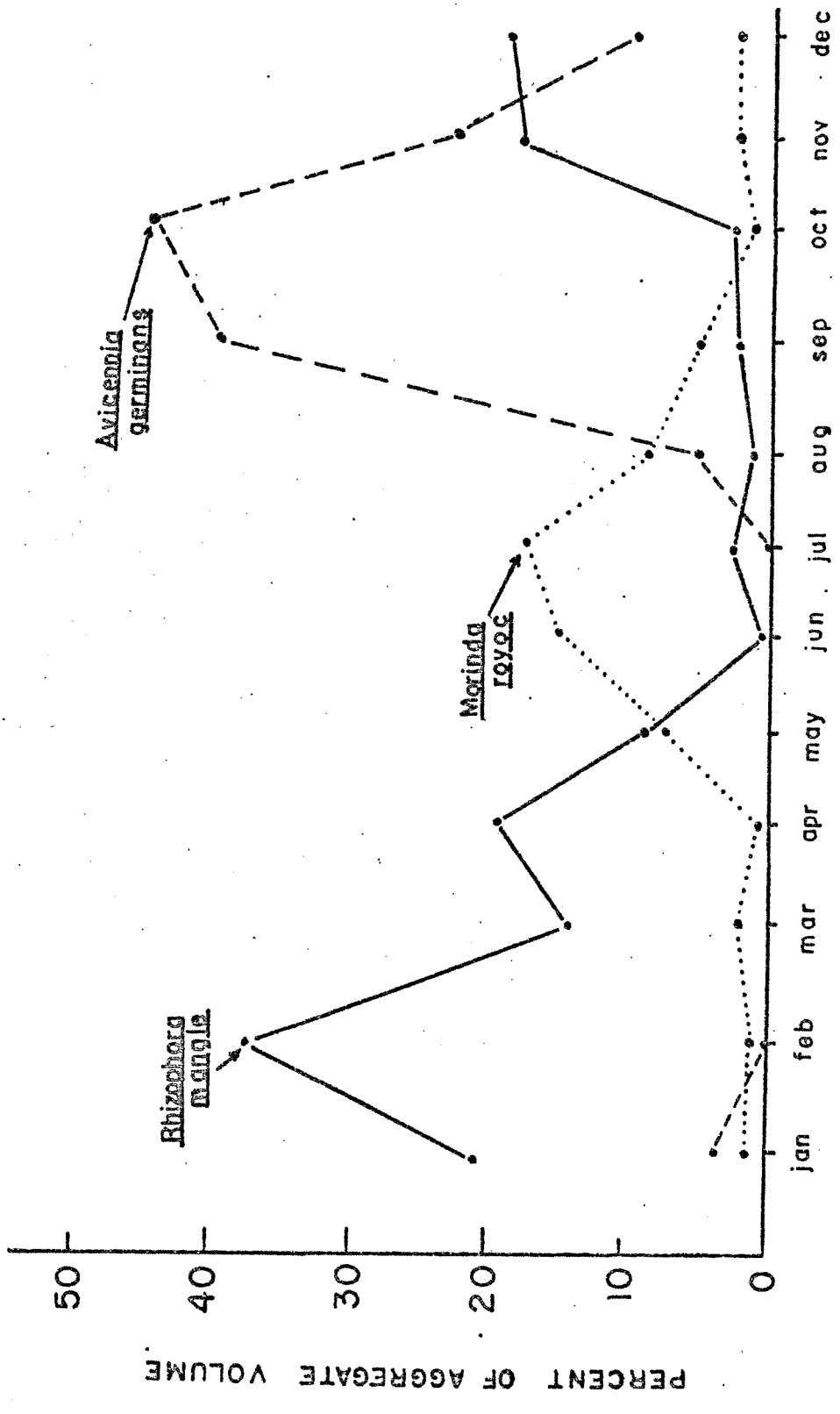

Fig. 8. Utilization of red mangrove (Rhizophora mangle), black mangrove (Avicennia germinans), and Indian mulberry (Morinda royoc), the three top-ranking Key deer foods.

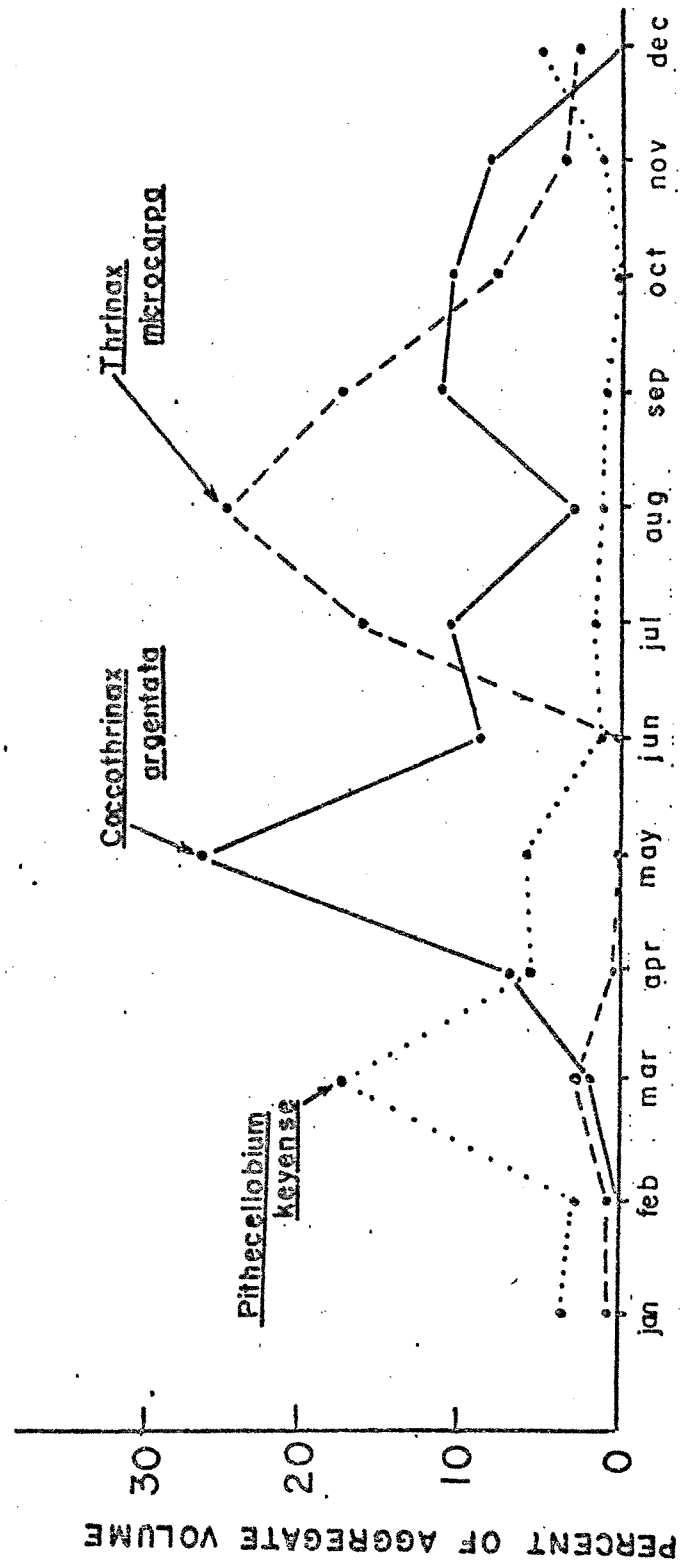

Fig. 9. Annual utilization of silver palm (Coccothrinax argentata), brittle thatch palm (Thrinax microcarpa), and blackbead (Pithecellobium keyense), the fourth, fifth, and sixth ranking Key deer foods.

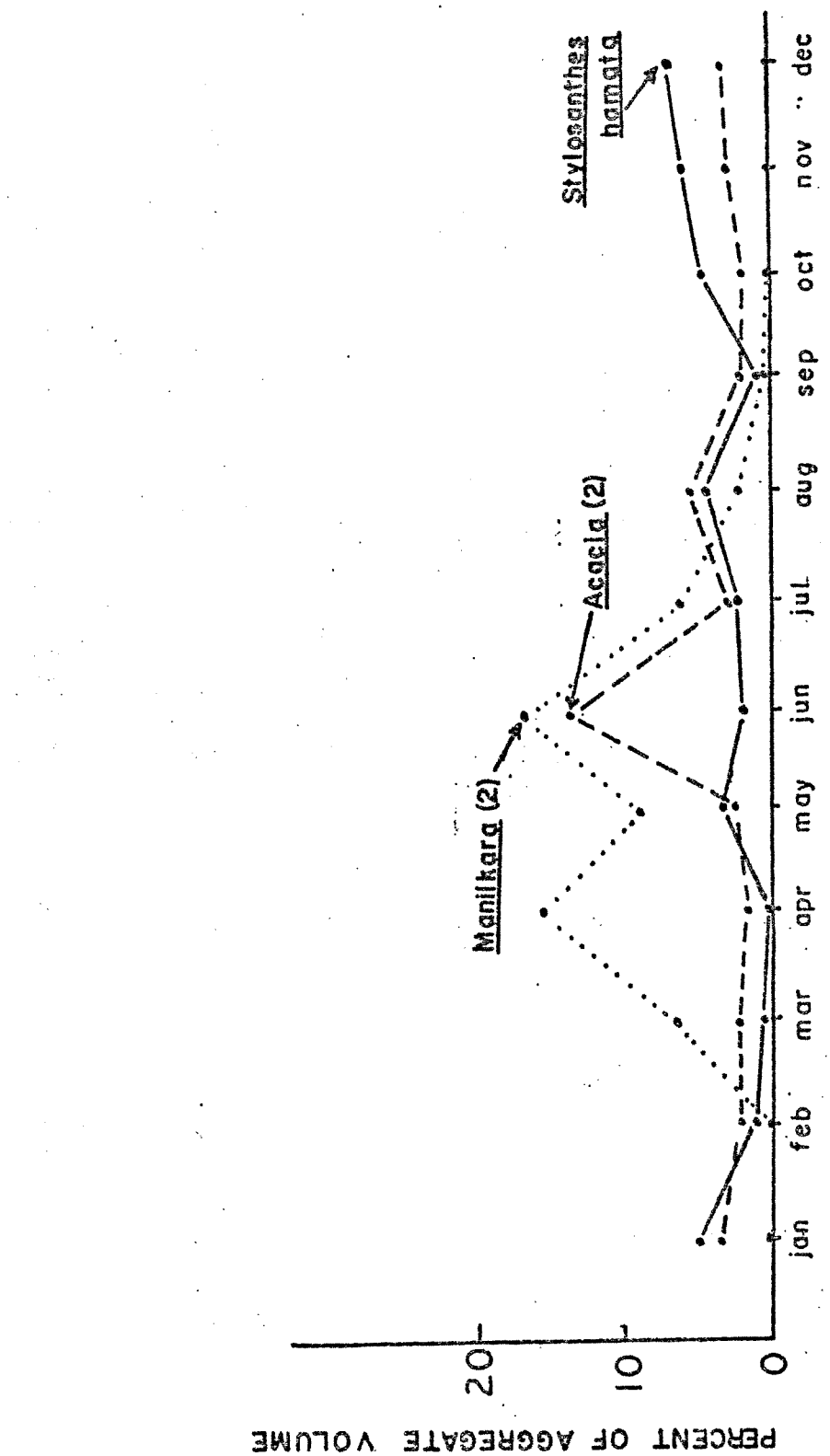

Fig. 10. Annual utilization of pencil flower (Stylosanthes hamata), sweet acacia (Acacia spp.) and dilly (Manilkara spp.), the eighth, ninth, and tenth ranking Key deer foods.

APPENDICES

Appendix A. Food items in rumen samples from 129 Key deer ranked according to importance value.

Plant	Percent frequency[a]	Percent volume[b]	Importance value[c]
1. Rhizophora mangle	63	12.15	765.45
2. Avicennia germinans	34	11.39	387.26
3. Morinda royoc	65	5.05	328.25
4. Coccothrinax argentata	34	7.39	251.26
5. Thrinax microcarpa	34	5.06	172.04
6. Pithecellobium keyense	48	3.33	159.84
7. Grasses (18)[d]	68	2.03	138.04
8. Stylosanthes hamata	49	2.77	135.73
9. Acacia (2)	43	3.00	129.00
10. Manilkara (2)	28	4.49	125.72
11. Chamaesyce (9)	76	1.02	77.52
12. Erithalis fruticosa	24	3.22	77.28
13. Serenoa repens	22	1.91	42.02
14. Bumelia celastrina	28	1.31	36.68
15. Galactia (2)	46	.78	35.88
16. Randia aculeata	29	1.12	32.48
17. Jacquinia keyensis	24	1.16	27.84
18. Smilax havanensis	37	.62	22.94
19. Pinus elliottii	66	.34	22.44
20. Mushroom	20	1.11	22.20
21. Ipomoea (2)	10	2.12	21.20
22. Sida (2)	29	.61	17.69
23. Physalis (2)	44	.21	9.24
24. Chiococca (2)	12	.76	9.12
25. Byrsonima cuneata	10	.83	8.30
26. Lantana involucrata	23	.30	6.90
27. Myrtus verrucosa	9	.72	6.48
28. Melanthera (2)	21	.19	3.99
29. Laguncularia racemosa	9	.42	3.78
30. Desmodium canum	10	.28	2.80
31. Agalinis (2)	9	.29	2.61
32. Guettarda scabra	6	.38	2.28
33. Tillandsia sp.	15	.14	2.10
34. Waltheria indica	6	.28	1.68
35. Rhynchosia (2)	12	.14	1.68
36. Ximenia americana	3	.55	1.65
37. Psidium guajava	5	.30	1.50
38. Passiflora suberosa	7	.21	1.47
39. Casasia clusiifolia	3	.48	1.44
40. Amyris elemifera	9	.15	1.35

Appendix A. (Cont.)

Plant	Percent frequency[a]	Percent volume[b]	Importance value[c]
41. Bidens pilosa	22	.06	1.32
42. Solanum (3)	8	.16	1.28
43. Metopium toxiferum	8	.16	1.28
44. Phyllanthus pentaphyllus	17	.07	1.19
45. Hibiscus rosa-sinensis	3	.34	1.02
46. Piriqueta caroliniana	11	.09	.99
47. Borrichia (2)	6	.16	.96
48. Flaveria (3)	5	.18	.90
49. Cassytha filiformis	9	.10	.90
50. Portulaca oleracea	9	.10	.90
51. Conocarpus erecta	14	.06	.84
52. Crotalaria maritima	6	.12	.72
53. Leucaena leucocephala	2	.30	.60
54. Malpighia glabra	2	.27	.54
55. Centrosema virginianum	10	.05	.50
56. Poinsettia pinetorum	5	.10	.50
57. Suaeda linearis	6	.08	.48
58. Ruellia caroliniensis	4	.11	.44
59. Heliotropium (2)	10	.04	.40
60. Malvastrum cochorifolium	3	.12	.36
61. Dipholis salicifolia	2	.17	.34
62. Hedyotis nigricans	10	.03	.30
63. Acalypha wilkesiana	2	.14	.28
64. Herissantia crispa	3	.09	.27
65. Eugenia myrtoides	2	.13	.26
66. Tamarindus indica	1	.25	.25
67. Pisonia discolor	2	.12	.24
68. Coccoloba uvifera	1	.20	.20
69. Pluchea (2)	1	.20	.20
70. Toxicodendron radicans	1	.19	.19
71. Cassia (2)	6	.02	.12
72. Citrus paradisi	1	.12	.12
73. Muntingia calabura	2	.05	.10
74. Neptunia pubescens	3	.03	.09
75. Suriana maritima	1	.09	.09
76. Myrica cerifera	2	.04	.08
77. Cyperaceae (5)	7	.01	.07
78. Sesuvium portulacastrum	3	.02	.06
79. Ernodea littoralis	2	.03	.06
80. Pteris longifolia	2	.03	.06
81. Sophora tomentosa	3	.02	.06

Appendix A. (Cont.)

Plant	Percent frequency[a]	Percent volume[b]	Importance value[c]
82. Polygala (2)	6	.01	.06
83. Coccoloba diversifolia	1	.06	.06
84. Acalypha chamaedrifolia	5	.01	.05
85. Aster dumosus	2	.02	.04
86. Haplopappus phyllocephalus	1	.03	.03
87. Croton linearis	3	.01	.03
88. Cissus trifoliata	1	.03	.03
89. Schinus terebinthifolius	1	.02	.02
90. Dyschoriste oblongifolia	2	.01	.02
91. Zanthozylum fagara	1	.02	.02
92. Reynosia septentrionalis	1	.02	.02
93. Echites umbellata	1	.02	.02
94. Salicornia sp.	1	.01	.01
95. Angadenia berterii	1	.01	.01
96. Stachytarpheta jamaicensis	1	.01	.01
97. Thuja orientalis	1	.01	.01
98. Casuarina equisetifolia	2	-	-
99. Linum arenicola	2	-	-
100. Borreria (2)	2	-	-
101. Cynoctonum sessilifolium	2	-	-
102. Mikania batatifolia	1	-	-
103. Lycium carolinianum	1	-	-
104. Eclipta alba	1	-	-
105. Oxalis sp.	1	-	-
106. Vernonia blodgettii	1	-	-
107. Alternanthera ramosissima	1	-	-
108. Evolvulus grisebachii	1	-	-
109. Liatris tenuifolia	1	-	-
110. Pectis leptocephala	1	-	-
111. Solidago stricta	1	-	-
112. Sonchus oleraceus	1	-	-
113. Ardisia escallonioides	1	-	-
114. Spigelia anthelmia	1	-	-
115. Desmanthus virgatus	1	-	-
Unknown material	100	16.47	
Total		100.03	

[a]Percent of samples containing food item.
[b]Percent of aggregate volume.
[c]Rating factor (volume x occurrence).
[d]Number of contributing taxa.

Appendix B. Plants utilized by Key deer as determined from analysis of 129 rumen samples.[1]

Plant	Parts eaten[1]	Major type of vegetation found[2]				
		D	H	P	S	FWM
Woody Plants						
(1) Acacia farnesiana	a, b		X		X	
(2) Acacia pinetorum	a, b, c	X		X		
(3) Agalinis maritima	a				X	
(4) Amyris elemifera	a		X			
(5) Angadenia berterii	a			X		
(6) Ardisia escallonioides	b		X			
(7) Avicennia germinans	a, b, c				X	
(8) Borrichia frutescens	a, c				X	
(9) Borrichia arborescens	a, c				X	
(10) Bumelia celastrina	a, b		X		X	
(11) Byrsonima cuneata	a, b			X		
(12) Casasia clusiifolia	b		X			
(13) Cassia aspera	a, b	X		X		
(14) Cassia keyensis	a	X		X		
(15) Casuarina equisetifolia	a	X				
(16) Chiococca alba	a, b		X			
(17) Chiococca pinetorum	a, b			X		

[1] Scientific names according to Long and Lakela (1971); exceptions are from Menninger (1956), Small (1933), or Watkins (1961, 1969).

Appendix B. (Cont.)

Plant	Parts eaten[1]	Major type of vegetation found[2]				
		D	H	P	S	FWM
Woody Plants						
(18) Cissus trifoliata	a		X			
(19) Coccoloba diversifolia	a	X	X	X		
(20) Coccoloba uvifera	b		X			
(21) Coccothrinax argentata	b, c			X		
(22) Conocarpus erecta	a, b, c		X		X	X
(23) Croton linearis	a			X		
(24) Dipholis salicifolia	a, b		X			
(25) Erithalis fruticosa	a, b		X		X	
(26) Ernodea littoralis	a	X		X		
(27) Eugenia myrtoides	b		X	X		
(28) Guettarda scabra	a		X	X		
(29) Heliotropium angiospermum	a, b	X	X			
(30) Herissantia crispa	a	X				
(31) Jacquinia keyensis	a, b		X		X	
(32) Laguncularia racemosa	a, b				X	
(33) Lantana involucrata	a, b	X	X			
(34) Leucaena leucocephala	a		X			
(35) Lycium carolinianum	a, b		X		X	
(36) Malvastrum corchorifolium	a, b	X				

Appendix B. (Cont.)

Plant	Parts eaten[1]	Major type of vegetation found[2]				
		D	H	P	S	FWM
Woody Plants						
(37) Manilkara bahamensis	a, b, c		X			
(38) Manilkara zapoda	b	X	X			
(39) Metopium toxiferum	a, b	X	X	X		
(40) Morinda royoc	a, b, c	X	X	X		
(41) Myrica cerifera	a			X		X
(42) Myrtus verrucosa	a, b, c			X		
(43) Pinus elliottii var. densa	a			X		
(44) Passiflora suberosa	a, b	X	X			
(45) Pisonia discolor	a		X			
(46) Pithecellobium keyense	a, b, c	X	X	X		
(47) Phyllanthus pentaphyllus	a, b, c	X		X		
(48) Psidium guajava	b	X	X			
(49) Randia aculeata	a, b	X	X		X	
(50) Reynosia septentrionalis	a		X			
(51) Rhizophora mangle	a, b				X	
(52) Schinus terebinthifolius	b	X	X			
(53) Serenoa repens	c			X		X
(54) Sida acuta	a, b, c	X				
(55) Sida ciliaris	a, b, c	X				
(56) Smilax havanensis	a, b, c	X	X	X		

Appendix B. (Cont.)

Plant	Parts Eaten[1]	Major type of vegetation found[2] D	H	P	S	FWM
Woody Plants						
(57) Solanum bahamense	a, b	X	X			
(58) Solanum blodgettii	b	X				
(59) Sophora tomentosa	a		X			
(60) Stachytarpheta jamaicensis	a, b	X				
(61) Suriana maritima	a		X			
(62) Thrinax microcarpa	b, c		X	X		
(63) Toxicodendron radicans	a	X	X			
(64) Ximenia americana	b		X			
(65) Zanthoxylum fagara	a		X			
Forbs						
(1) Acalypha chamaedrifolia	a, b, c	X		X		
(2) Agalinis purpurea	a, b, c	X		X		
(3) Alternanthera ramosissima	a, c	X	X			
(4) Aster dumosus	a, b, c	X				
(5) Bidens pilosa	a, b, c	X		X		
(6) Borreria ocimoides	a, b, c	X				
(7) Borreria terminalis	a, b, c			X		
(8) Centrosema virginianum	a, b, c			X		
(9) Cassytha filiformis	(vine)	X		X		
(10) Chamaesyce adenoptera	a, b, c	X		X		

Appendix B. (Cont.)

Plant	Parts Eaten[1]	Major type of vegetation found[2] D	H	P	S	FWM
Forbs						
(11) Chamaesyce blodgettii	a, b, c	X		X		
(12) Chamaesyce conferta	a, b, c	X		X		
(13) Chamaesyce deltoidea	a, b, c	X		X		
(14) Chamaesyce garberi	a, b, c	X		X		
(15) Chamaesyce hirta	a, b, c	X				
(16) Chamaesyce hypericifolia	a, b, c	X				
(17) Chamaesyce mesembryanthemifolia	a, b, c	X			X	
(18) Chamaesyce porteriana	a, b, c			X		
(19) Crotalaria maritima	a			X		
(20) Cynoctonum sessilifolium	a, b, c	X		X		
(21) Desmanthus virgatus	a, b, c	X		X		
(22) Desmodium canum	a, b, c	X				
(23) Dyschoriste oblongifolia	a, b, c	X		X		
(24) Echites umbellata	a	X		X		
(25) Eclipta alba	a, b, c	X				
(26) Evolvulus grisebachii	a			X		
(27) Flaveria floridana	a, c	X		X		
(28) Flaveria linearis	a, c	X				
(29) Flaveria trinervia	a, c	X				

Appendix B. (Cont.)

Plant	Parts Eaten[1]	Major type of vegetation found[2]				
		D	H	P	S	FWM
Forbs						
(30) Galactia parvifolia	a, b	X		X		
(31) Galactia spiciformis	a, b	X	X			
(32) Haplopappus phyllocephalus	a, c	X			X	
(33) Hedyotis nigricans	a, b, c	X		X		
(34) Heliotropium polyphyllum	a, b			X		
(35) Ipomoea acuminata	a, c	X				
(36) Ipomoea triloba	a	X				
(37) Liatris tenuifolia	a, c	X		X		
(38) Linum arenicola	a, b, c			X		
(39) Melanthera aspera	a	X				
(40) Melanthera parvifolia	a, b, c			X		
(41) Mikania batatifolia	a	X				
(42) Neptunia pubescens	a, b	X		X		
(43) Oxalis sp.	a	X				
(44) Pectis leptocephala	a	X				
(45) Physalis angustifolia	a, b, c	X		X		
(46) Physalis pubescens	a, b	X				
(47) Piriqueta caroliniana	a, b, c	X		X		
(48) Pluchea purpurascens	a, b	X				
(49) Pluchea rosea	a, b					X

Appendix B. (Cont.)

Plant	Parts Eaten[1]	Major type of vegetation found[2]				
		D	H	P	S	FWM
Forbs						
(50) Poinsettia pinetorum	a, b, c	X		X		
(51) Polygala boykinii	a, b, c			X		
(52) Polygala grandiflora	a, b, c			X		
(53) Portulaca oleracea	a, b, c	X				
(54) Pteris longifolia	a			X		
(55) Rhynchosia cinerea	a, b	X		X		
(56) Rhynchosia minima	a, b	X				
(57) Ruellia caroliniensis	a, b, c			X		
(58) Salicornia sp.	a, b, c				X	
(59) Sesuvium portulacastrum	a, c				X	
(60) Solanum americanum	a, b	X				
(61) Solidago stricta	a, b	X				
(62) Sonchus oleraceus	a, b	X				
(63) Spigelia anthelmia	a, b	X				
(64) Stylosanthes hamata	a, b, c	X				
(65) Suaeda linearis	a, b	X			X	
(66) Tillandsia sp.	a		X		X	
(67) Vernonia blodgettii	a, b, c			X		
(68) Waltheria indica	a, b, c	X				

Appendix B. (Cont.)

Plant	Parts Eaten[1]	Major type of vegetation found[2]				
		D	H	P	S	FWM
Basidomycetes						
(69) Boletus sp.	entire		X	X		
Cyperaceae (Sedges)						
(1) Abildgaardia ovata	b	X				
(2) Cladium jamaicensis	b					X
(3) Cyperus sp.	b	X	X	X	X	X
(4) Eleocharis cellulosa	b					X
(5) Fimbristylis castanea	b	X			X	X
Poaceae (Grasses)						
(1) Andropogon sp.	a, b	X				
(2) Chloris petraea	a, b	X				
(3) Dactyloctenium aegyptium	a, b	X				
(4) Distichilis spicata	a, b				X	
(5) Eleusine indica	a, b	X				
(6) Eragrostis ciliaris	a, b	X				
(7) Lasiacis divaricata	a, b		X			
(8) Monanthochloe littoralis	a, b				X	
(9) Panicum chapmanii	a, b	X	X			
(10) Panicum virgatum	a, b	X		X		
(11) Paspalum blodgettii	a, b	X		X		
(12) Paspalum setaceum	a, b	X				
(13) Schizachyrium gracile	a, b	X				

Appendix B. (Cont.)

Plant	Parts Eaten[1]	Major type of vegetation found[2]				
		D	H	P	S	FWM
Poaceae (Grasses)						
(14) Setaria sp.	a, b	X				
(15) Sorghastrum secundum	a, b			X		
(16) Sporobolus domingensis	a, b	X			X	
(17) Sporobolus virginicus	a, b	X			X	
(18) Stenotaphrum secundatum	a	X				
Cultivated plants						
(1) Citrus paradisi	b	X				
(2) Acalypha wilkesiana	a	X				
(3) Hibiscus rosa-sinensis	a, c	X				
(4) Malpighia glabra	b	X				
(5) Muntingia calabura	b	X				
(6) Tamarindus indica	a, b	X				
(7) Thuja orientalis	a	X				

[1] a = leaves and stems
b = fruits
c = flowers

[2] D = disturbed or developed areas (Roadsides, subdivisions, etc.)

H = Hardwood (Hammock)

P = Pineland

S = Strand (maritime zone)

FWM = Fresh or brackish marsh.

Appendix C. Food utilization according to quarterly periods as identified in 127 Key deer rumen samples.

Plant	(n=37) January-March		(n=29) April-June		(n=25) July-September		(n=36) October-December	
	Percent frequency	Percent volume	Percent frequency	Percent volume	Percent frequency	Percent volume	Percent frequency	Percent volume
1. *Rhizophora mangle*	87	20.57	48	8.64	40	2.74	66	14.03
2. *Avicennia germinans*	15	1.21	31	.20	40	15.22	55	26.01
3. *Morinda royoc*	51	1.93	68	7.75	92	10.39	58	2.10
4. *Coccothrinax argentata*	15	.84	48	14.47	48	8.58	33	6.25
5. *Thrinax microcarpa*	23	.82	6	.02	68	18.91	44	3.92
6. *Pithecellobium keyense*	71	8.15	48	2.72	40	1.09	30	1.35
7. Grasses	66	2.25	65	1.29	64	3.80	77	1.34
8. *Stylosanthes hamata*	43	1.82	34	1.37	48	1.61	69	5.35
9. *Acacia* spp.	48	2.85	51	5.90	44	2.23	30	1.28
10. *Manilkara* spp.	15	2.03	75	13.90	32	2.79	2	--
11. *Chameaesyce* spp.	69	.82	72	.82	80	1.16	86	1.27
12. *Erithalis fruticosa*	38	4.17	17	2.48	16	4.61	22	2.19
13. *Serenoa repens*	51	6.59	10	.87	--	--	16	.18

Appendix C (Con't.)

Plant	(n=37) January-March		(n=29) April-June		(n=25) July-September		(n=36) October-December	
	Percent frequency	Percent volume	Percent frequency	Percent volume	Percent frequency	Percent volume	Percent frequency	Percent volume
14. *Bumelia celastrina*	28	3.30	27	.43	28	.23	30	1.08
15. *Galactia* spp.	33	.49	58	.88	48	.51	50	1.09
16. *Randia aculeata*	46	1.94	27	1.78	8	.06	27	.60
17. *Jacquinia keyensis*	30	1.44	20	1.40	16	.37	25	1.24
18. *Smilax havanensis*	43	.71	31	.67	44	.74	30	.44
19. *Pinus elliottii*	69	.69	55	.06	52	.10	83	.43
20. Mushroom	33	1.79	3	.01	8	.10	30	2.08
21. *Ipomoea* spp.	15	4.23	6	1.18	--	--	13	2.50
22. *Sida* spp.	23	1.10	17	.04	24	.31	49	.85
23. *Physalis* spp.	33	.18	65	.30	52	.15	36	.21
24. *Chiococca* spp.	5	.54	13	1.62	12	.48	19	.40
25. *Byrsonima cuneata*	--	--	20	1.81	32	1.97	--	--
26. *Lantana involucrata*	17	.69	27	.17	24	.13	25	.22
27. *Myrtus verrucosa*	2	[illegible]	10	1.05	32	2.32	--	--

Appendix C (Con't.)

Plant	(n=37) January-March Percent frequency	Percent volume	(n=29) April-June Percent frequency	Percent volume	(n=25) July-September Percent frequency	Percent volume	(n=36) October-December Percent frequency	Percent volume
28. *Melanthera* spp.	25	.37	17	.15	16	.03	25	.20
29. *Laguncularia racemosa*	--	--	24	.81	20	1.15	--	--
30. *Desmodium canum*	2	.09	13	.86	12	.21	13	.01
31. *Agalinis* spp.	2	--	17	1.18	20	--	2	--
32. *Guettarda scabra*	12	.11	3	--	--	--	5	1.12
33. *Tillandsia* sp.	25	.24	20	.19	8	--	5	.10
34. *Waltheria indica*	12	.71	--	--	--	--	11	.32
35. *Rhynchosia* spp.	15	.06	6	.02	--	--	22	.37
36. *Ximenia americana*	--	--	6	2.13	4	.06	2	.04
37. *Psidium guajava*	5	--	3	--	4	.18	8	.85
38. *Passiflora suberosa*	5	.04	10	.07	8	.43	8	.33
39. *Casasia clusiifolia*	--	--	10	1.92	--	--	2	.02
40. *Amyris elemifera*	15	.16	10	.39	4	.02	5	.02
41. *Bidens pilosa*	20	.12	20	.04	20	.04	27	.05

Appendix C (Con't.)

Plant	(n=37) January-March		(n=29) April-June		(n=25) July-September		(n=36) October-December	
	Percent frequency	Percent volume	Percent frequency	Percent volume	Percent frequency	Percent volume	Percent frequency	Percent volume
42. *Solanum* spp.	7	.02	6	.12	8	.51	11	.09
43. *Metopium toxiferum*	5	.45	20	.12	8	.03	2	.04
44. *Phyllanthus pentaphyllus*	12	.01	13	--	20	.08	25	.16
45. *Hibiscus rosa-sinensis*	5	1.25	3	.03	8	.14	--	--
46. *Piriqueta caroliniana*	5	.02	17	.12	8	--	16	.18
47. *Borrichia* spp.	17	.51	3	.14	--	--	2	--
48. *Flaveria* spp.	2	.01	10	.47	--	--	8	.20
49. *Cassytha filiformis*	15	.13	--	--	8	.02	11	.21
50. *Portulaca oleracea*	2	--	6	.40	28	.01	5	--
51. *Conocarpus erecta*	12	.01	3	--	4	.14	33	.11
52. *Crotalaria maritima*	10	.09	--	--	8	.06	8	.27
53. *Leucaena leucocephala*	5	.69	--	--	--	--	2	.42
54. *Malpighia glabra*	--	--	6	1.08	4	.02	--	--

Appendix C (Con't.)

Plant	(n=37) January-March Percent frequency	Percent volume	(n=29) April-June Percent frequency	Percent volume	(n=25) July-September Percent frequency	Percent volume	(n=36) October-December Percent frequency	Percent volume
55. Centrosema virginianum	12	.09	6	.02	8	--	13	.09
56. Poinsettia pinetorum	7	.37	3	.02	4	--	5	--
57. Suaeda linearis	2	--	--	--	16	.42	8	--
58. Ruellia caroliniensis	5	--	--	--	4	--	8	.35
59. Heliotropium spp.	10	.09	13	.08	8	--	11	--
60. Malvastrum cochorifolium	--	--	3	.03	8	.48	2	.05
61. Dipholis salicifolia	5	.26	--	--	4	.54	--	--
62. Hedyotis nigricans	17	.08	--	--	8	--	11	.02
63. Acalypha wilkesiana	2	--	--	--	4	.20	2	.34
64. Herissantia crispa	5	.09	--	--	--	--	5	.22
65. Eugenia myrtoides	5	.08	--	--	--	--	2	.35
66. Tamarindus indica	2	.33	--	--	--	--	2	.53
67. Pisonia discolor	--	--	6	.39	--	--	2	.06
68. Coccoloba uvifera	--	--	--	--	4	.81	2	.15

Appendix C (Con't.)

Plant	(n=37) January-March Percent frequency	(n=37) January-March Percent volume	(n=29) April-June Percent frequency	(n=29) April-June Percent volume	(n=25) July-September Percent frequency	(n=25) July-September Percent volume	(n=36) October-December Percent frequency	(n=36) October-December Percent volume
69. *Pluchea* spp.	2	.14	--	--	4	.86	--	--
70. *Toxicodendron radicans*	2	.76	--	--	--	--	--	--
71. *Cassia* spp.	17	.08	--	--	--	--	5	.01
72. *Citrus paradisi*	--	--	3	.49	--	--	--	--
73. *Muntingia calabura*	--	--	3	--	8	.24	--	--
74. *Neptunia pubescens*	--	--	--	--	8	.09	5	.05
75. *Suriana maritima*	--	--	--	--	4	.46	--	--
76. *Myrica cerifera*	5	.17	--	--	--	--	2	--
77. Cyperaceae	10	--	3	--	4	--	11	.02
78. *Sesuvium portulacastrum*	--	--	3	.04	8	.04	5	.01
79. *Ernodea littoralis*	5	.03	--	--	4	.14	--	--
80. *Pteris longifolia*	5	.13	3	--	--	--	--	--
81. *Sophora tomentosa*	5	.02	--	--	--	--	5	.03
82. *Polygala* spp.	7	.01	6	.01	8	--	2	--

Appendix C (Con't.)

Plant	(n=37) January-March Percent frequency	January-March Percent volume	(n=29) April-June Percent frequency	April-June Percent volume	(n=25) July-September Percent frequency	July-September Percent volume	(n=36) October-December Percent frequency	October-December Percent volume
83. Coccoloba diversifolia	--	--	3	.24	--	--	--	--
84. Acalypha chamaedrifolia	5	--	--	--	4	--	11	.02
85. Aster dumosus	--	--	--	--	--	--	8	.05
86. Haplopappus phyllocephalus	--	--	--	--	--	--	5	.09
87. Croton linearis	7	.03	--	--	--	--	5	--
88. Cissus trifoliata	--	--	3	.13	--	--	--	--
89. Schinus terebinthifolius	2	--	--	--	--	--	2	.08
90. Dyschoriste oblongifolia	--	--	--	--	4	.01	5	.01
91. Zanthozylum fagara	--	--	--	--	--	--	2	.06
92. Reynosia septentrionalis	2	.07	--	--	--	--	--	--
93. Echites umbellata	2	.07	--	--	--	--	--	--
94. Salicornia sp.	--	--	--	--	4	.06	2	--
95. Angadenia berterii	--	--	--	--	4	.01	2	.02

Appendix C (Con't.)

Plant	(n=37) January-March Percent frequency	(n=37) January-March Percent volume	(n=29) April-June Percent frequency	(n=29) April-June Percent volume	(n=25) July-September Percent frequency	(n=25) July-September Percent volume	(n=36) October-December Percent frequency	(n=36) October-December Percent volume
96. Stachytarpheta jamaicensis	2	.02	--	--	--	--	--	--
97. Thuja orientalis	--	--	--	--	4	.04	--	--
98. Casuarina equisetifolia	--	--	3	.01	--	--	5	--
99. Linum arenicola	1	.01	6	--	--	--	--	--
100. Borreria spp.	7	--	--	--	--	--	--	--
101. Cynoctonum sessilifolium	--	--	--	--	--	--	8	--
102. Mikania batatifolia	--	--	3	.02	4	--	--	--
103. Lycium carolinianum	2	.02	--	--	--	--	2	--
104. Eclipta alba	2	.02	--	--	4	--	--	--
105. Oxalis sp.	2	--	3	--	--	--	--	--
106. Vernonia blodgettii	--	--	--	--	4	.02	--	--
107. Alternanthera ramosissima	--	--	--	--	4	--	--	--
108. Evolvulus grisebachii	--	--	--	--	--	--	2	--

Appendix C (Con't.)

Plant	(n=37) January-March		(n=29) April-June		(n=25) July-September		(n=36) October-December	
	Percent frequency	Percent volume	Percent frequency	Percent volume	Percent frequency	Percent volume	Percent frequency	Percent volume
109. *Liatris tenuifolia*	--	--	--	--	4	--	--	--
110. *Pectis leptocephala*	--	--	--	--	--	--	2	--
111. *Solidago stricta*	2	--	--	--	--	--	--	--
112. *Sonchus oleraceus*	2	--	--	--	--	--	--	--
113. *Ardisia escallonioides*	--	--	--	--	--	--	2	--
114. *Spigelia anthelmia*	--	--	--	--	--	--	2	--
115. *Desmanthus virgatus*	2	--	--	--	--	--	--	--
Unknown material	100	20.73	100	16.48	100	11.91	100	15.88
Totals		100.00		100.03		100.06		100.01

Appendix D. Comparison of food utilization for three areas within the Key deer range.

Plant	Area 1 (n=39) Percent frequency	Area 1 (n=39) Percent volume	Area 2 (n=40) Percent frequency	Area 2 (n=40) Percent volume	Area 3 (n=15) Percent frequency	Area 3 (n=15) Percent volume
1. Rhizophora mangle	69	15.55	57	9.95	60	4.92
2. Avicennia germinans	28	6.83	37	10.40	33	12.55
3. Morinda royoc	66	4.63	67	4.59	53	6.18
4. Coccothrinax argentata	20	5.72	42	10.07	13	4.93
5. Thrinax microcarpa	38	6.61	25	4.78	33	1.67
6. Stylosanthes hamata	48	2.21	50	1.78	26	.02
7. Pithecellobium keyense	56	6.10	45	2.11	66	3.55
8. Acacia sp.	7	.27	10	.02	--	--
Acacia pinetorum	53	2.43	30	1.82	--	--
Acacia farnesiana	2	.90	7	1.17	6	.53
9. Manilkara sp.	--	--	2	--	13	3.50
Manilkara bahamensis	17	1.91	27	3.96	--	--

Appendix D (Con't.)

Plant	Area 1 (n=39) Percent frequency	Area 1 (n=39) Percent volume	Area 2 (n=40) Percent frequency	Area 2 (n=40) Percent volume	Area 3 (n=15) Percent frequency	Area 3 (n=15) Percent volume
Manilkara zapoda	--	--	7	2.18	26	7.10
10. Grasses	74	1.88	67	1.37	66	7.49
11. *Chamaesyce* spp.	76	.72	65	.53	80	1.44
12. *Erithalis fruticosa*	15	1.37	30	5.34	66	9.24
13. *Serenoa repens*	41	3.02	15	1.29	20	.06
14. *Galactia parvifolia*	48	.49	25	.04	6	.14
Galactia spiciformis	5	.30	20	.42	--	--
15. *Randia aculeata*	35	.91	11	1.18	26	.40
16. *Bumelia celastrina*	25	.36	27	.73	46	1.30
17. *Jacquinia keyensis*	28	1.81	17	.68	20	.28
18. Mushroom	33	.96	17	1.56	--	--
19. *Smilax havanensis*	38	.71	30	.20	6	.12

Appendix D (Con't.)

Plant	Area 1 (n=39) Percent frequency	Area 1 (n=39) Percent volume	Area 2 (n=40) Percent frequency	Area 2 (n=40) Percent volume	Area 3 (n=15) Percent frequency	Area 3 (n=15) Percent volume
20. Pinus elliottii	84	.31	60	.53	33	.04
21. Sida acuta	15	.50	32	1.11	26	.10
Sida ciliaris	5	.09	10	--	--	--
22. Chiococca alba	5	.37	7	.73	--	--
Chiococca pinetorum	10	.60	2	.03	6	.18
23. Byrsonima cuneata	5	.29	12	1.15	13	.37
24. Physalis spp.	46	.11	52	.21	13	.01
25. Lantana involucrata	5	.01	42	.77	20	--
26. Myrtus verrucosa	12	.12	5	.52	--	--
27. Ipomoea spp.	2	.43	12	2.30	6	10.96
28. Melanthera spp.	38	.36	15	.27	20	.02
29. Laguncularia racemosa	5	.22	15	.18	6	1.12

Appendix D (Con't.)

Plant	Area 1 (n=39) Percent frequency	Area 1 (n=39) Percent volume	Area 2 (n=40) Percent frequency	Area 2 (n=40) Percent volume	Area 3 (n=15) Percent frequency	Area 3 (n=15) Percent volume
30. Agalinis spp.	7	.69	2	--	6	--
31. Desmodium canum	7	.23	10	.02	--	--
32. Rhynchosia spp.	12	.17	15	.04	13	.05
33. Guettarda scabra	12	1.27	5	--	6	--
34. Ximenia americana	2	.99	5	.84	6	.10
35. Metopium toxiferum	7	.39	7	.01	--	--
36. Tillandsia spp.	12	.04	15	.10	20	.21
37. Psidium guajava	2	--	12	.91	--	--
38. Casasia clusiifolia	--	--	2	.23	6	.04
39. Hibiscus rosa-sinensis	5	1.01	5	.12	6	.10
40. Amyris elemifera	12	.05	10	.23	6	--
41. Phyllanthus pentaphyllus	30	.03	--	--	6	.02
42. Borrichia spp.	17	.21	2	.21	6	.33

Appendix D (Con't.)

Plant	Area 1 (n=39) Percent frequency	Area 1 (n=39) Percent volume	Area 2 (n=40) Percent frequency	Area 2 (n=40) Percent volume	Area 3 (n=15) Percent frequency	Area 3 (n=15) Percent volume
43. Piriqueta caroliniana	15	.13	10	--	--	--
44. Passiflora suberosa	10	.31	7	.32	13	.20
45. Waltheria indica	7	.32	7	.37	20	.64
46. Cassytha filiformis	25	.27	--	--	--	--
47. Portulaca oleracea	2	--	12	.34	6	--
48. Heliotropium spp.	2	--	20	.07	13	--
49. Bidens pilosa	25	.11	30	.05	26	.13
50. Flaveria spp.	5	.16	10	.44	6	.02
51. Crotalaria maritima	17	.26	--	--	--	--
52. Conocarpus erecta	15	.04	7	--	26	--
53. Malpighia glabra	--	--	2	.69	--	--
54. Poinsettia pinetorum	5	.02	7	.31	--	--

Appendix D (Con't.)

Plant	Area 1 (n=39) Percent frequency	Area 1 (n=39) Percent volume	Area 2 (n=40) Percent frequency	Area 2 (n=40) Percent volume	Area 3 (n=15) Percent frequency	Area 3 (n=15) Percent volume
55. Centrosema virginianum	15	.07	2	--	--	--
56. Malvastrum cochorifolium	--	--	7	.39	--	--
57. Ruellia caroliniensis	10	.36	--	--	--	--
58. Acalypha wilkesiana	--	--	5	.36	--	--
59. Coccoloba uvifera	--	--	--	--	--	--
60. Pluchea spp.	2	.12	2	.56	--	--
61. Eugenia myrtoides	5	.44	2	--	--	--
62. Herissantia crispa	5	.07	5	.23	--	--
63. Pisonia discolor	--	--	5	.32	--	--
64. Suaeda linearis	--	--	2	--	20	--
65. Hedyotis nigricans	30	.08	--	--	--	--
66. Toxicodendron radicans	--	--	2	.64	--	--
67. Solanum blodgettii	--	--	5	.11	--	--

Appendix D (Con't.)

Plant	Area 1 (n=39) Percent frequency	Area 1 (n=39) Percent volume	Area 2 (n=40) Percent frequency	Area 2 (n=40) Percent volume	Area 3 (n=15) Percent frequency	Area 3 (n=15) Percent volume
68. Myrica cerifera	5	--	2	.14	--	--
69. Tamarindus indica	--	--	4	.84	--	--
70. Cassia spp.	20	.07	2	--	--	--
71. Muntingia calabura	--	--	7	.16	--	--
72. Leucaena leucocephala	--	--	2	.44	13	1.59
73. Citrus paradisi	--	--	2	.41	--	--
74. Solanum bahamense	2	--	2	--	6	.92
75. Neptunia pubescens	--	--	--	--	--	--
76. Ernodea littoralis	2	.02	--	--	--	--
77. Suriana maritima	2	.29	--	--	--	--
78. Sesuvium portulacastrum	2	.01	2	.03	6	--
79. Haplopappus phyllocephalus	5	.09	--	--	--	--
80. Pteris longifolia	5	.10	--	--	6	--

Appendix D (Con't.)

Plant	Area 1 (n=39) Percent frequency	Area 1 (n=39) Percent volume	Area 2 (n=40) Percent frequency	Area 2 (n=40) Percent volume	Area 3 (n=15) Percent frequency	Area 3 (n=15) Percent volume
81. Dipholis salicifolia	2	.20	--	--	13	1.03
82. Cyperaceae	10	--	5	--	13	--
83. Sophora tomentosa	7	.04	--	--	--	--
84. Polygala spp.	7	--	2	.01	--	--
85. Aster dumosus	2	.05	2	--	--	--
86. Cissus trifoliata	--	--	2	.10	--	--
87. Croton linearis	7	.01	2	--	--	--
88. Acalypha chamaedrifolia	12	.01	--	--	--	--
89. Salicornia sp.	--	--	--	--	--	--
90. Schinus terebinthifolius	2	--	2	.08	--	--
91. Zanthozylum fagara	--	--	--	--	--	--
92. Angadenia berterii	2	--	--	--	--	--
93. Dyschoriste oblongifolia	--		2	--	--	--

Appendix D. Con't.)

Plant	Area 1 (n=39) Percent frequency	Area 1 (n=39) Percent volume	Area 2 (n=40) Percent frequency	Area 2 (n=40) Percent volume	Area 3 (n=15) Percent frequency	Area 3 (n=15) Percent volume
106. Oxalis sp.	--	--	5	--	--	--
107. Alternanthera ramosissima	--	--	--	--	--	--
108. Ardisia escallonioides	2	--	--	--	--	--
109. Evolvulus grisebachii	--	--	--	--	--	--
110. Liatris tenuifolia	2	--	--	--	--	--
111. Pectis leptocephala	2	--	--	--	--	--
112. Solidago stricta	2	--	--	--	--	--
113. Sonchus oleraceus	--	--	2	--	--	--
114. Spigelia anthelmia	--	--	2	--	--	--
115. Echites umbellata	--	--	--	--	6	.15
116. Coccoloba diversifolia	--	--	--	--	6	.56
117. Desmanthus virgatus	2	--	--	--	--	--
Unknown material	100	21.75	100	15.46	100	15.48
Totals		99.61		99.63		99.79

VITA

Graduate School
Southern Illinois University at Carbondale

NAME: Allan L. Dooley DATE OF BIRTH: May 27, 1950

Address: 200 North 15th Street
Murphysboro, Illinois 62966

University Attended:	Years	Degree	Major
University of Montana Missoula, Montana	1968-1972	B.A.	Zoology

Honors:

Zoology Honor Society, S.I.U.

Thesis Title

Foods of the Key Deer (Odocoileus virginianus clavium)

Advisor: Dr. W. D. Klimstra