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FOODS OF THE KEY DEER

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ABSTRACT: *A comprehensive study (1967-1973) of Key deer resulted in 129 rumen samples from mortalities. Analyses yielded 164 plant foods of which 28 comprised about 75% of the total volume. In order of importance value, red mangrove, black mangrove, Indian mulberry, silver palm, brittle thatch palm, blackbead, grasses, pencil flower, acacia, and sapodilla were the 10 top ranking. Woody browse contributed 42% of total volume; woody plant fruits 27%; palm flowers, fruits and spathes 14%; forbs 13%; and miscellaneous 3%. There was seasonal change in use, reflecting individual plant phenology as related to weather. Clearly evidenced was diversity in the deer's diet suggesting habitat management must address variety between and within plant communities.*

THE first ecological investigation of the Key deer *(Odocoileus virginianus clavium;* Barbour and Allen, 1922), conducted June 1951-September 1952 (Dickson, 1955) included food habit studies based on direct observation of deer feeding, browse evidence, and pellet and stomach analyses. Fifty-two plant species were identified as Key deer foods. Direct observations of deer feeding yielded 21 plants; 17 were recorded for one animal. Dickson (1955) stated sign of browsing as rare and found only in certain areas; 19 plants were recorded as food. A total of 293 pellet groups was examined; based on seeds and seed fragments and histological characteristics 27 taxa were identified. The single stomach examined contained only fruits of silver palm *(Coccothrinax argentata)* and tallowwood *(Ximenia americana).*

During January 1968-September 1973 rumen samples from 129 Key deer mortalities were collected and analyzed to determine plants consumed, parts of plants utilized, seasonal dietary aspects, and local differences in vegetation utilization (Dooley, 1975). With increased development of privately-owned lands, excellent habitat is and will be altered resulting in extensive changes in available foods. Purpose of this study was to contribute a better understanding of Key deer habitat needs so as to enhance development of short-and long-range management plans for public lands in the Lower Florida Keys.

STUDY AREA—The Florida Keys form a crescent of small islands extending south/southwest approximately 208 km from peninsular Florida. Big Pine Key is the largest island (circa 2400 ha, 9.6 km long and 3.2 km wide) of the Lower Keys complex and the principal home of the Key deer. Soils vary from thick marl depositions to bare rock of the oolitic formation (Dickson, 1955). Average rainfall at Key West, Florida, 48 km west of Big Pine Key is 101.5 cm annually. Its occurrence is normally greater than 10 cm per month June-October and least during December-March, when a mean of 4.5 cm per month occurs (Klimstra et al., 1974). Characteristically, October-March represents a dry period. The lack of organic materials in many areas results in rapid runoff and pooling of rainfall in depressions. Thus, many plants are adapted to relatively xeric conditions.

Islands near sea level are surrounded by thick growths of red mangrove *(Rhizophora mangle)* established in shallow salt water tidal zones. With increase in elevation, red mangrove is replaced at approximately high tide level by black mangrove *(Avicennia germinans)*, white mangrove *(Laguncularia racemosa)*, and buttonwood *(Conocarpus erecta)*. These maritime zones, depending on island elevations, usually grade into hardwood and pineland habitats that are intolerant of salt water. Notable acreages of slash pines *(Pinus elliottii* var. *densa)* occur on Big Pine, No Name, Sugarloaf, Cudjoe, and Little Pine keys within the Key deer range; lesser stands are found on Big Knockemdown, Little Torch, Middle Torch, and Howe keys. The relative size, distribution, and composition of natural plant associations are primarily the result of elevation gradients and salt water influence (Dickson, 1955). Disturbed area habitats show greatest species diversity followed by hardwood, pineland, cultivated, strand, and marsh (Table 1). Of all plant species, 46.3% are forbs, 42.3% woody, and 11.3% grasses and sedges.

TABLE 1. Number and percent of total for plant species occurring in various cover types on Big Pine Key, Florida (Dooley 1975).

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

The total population of Key deer 1967-1973 was estimated at 350-400 having increased from 25-80 animals since 1950-51. Big Pine Key, which supports 60-65% of the population, provides a great variety and number of plant species (Dickson 1955). All the major habitat types found in the Lower Florida Keys occur on Big Pine (Klimstra et al., 1974).

METHODS—Stomach contents from 129 Key deer mortalities available for study represented 83 males, 44 females and 2 unknown from Big Pine (112), No Name (6), Little Torch (5), Ramrod (3), and Big Torch (1) keys; 2 lacked site identification. The majority represented roadkills on U.S. Highway 1, Key Deer Boulevard (State Road 940), and Wilder Road on Big Pine Key (Fig. 1). Approximately 0.95 l of rumen was taken from each deer collected; samples were placed in plastic containers and frozen until examined. Because of limited mortalities in any one year, rumen samples available were grouped by quarters (January-March (37), April-June (29), July-September (25), and October-December (36)) to evaluate seasonal changes in plant utilization.

Rumen samples were prepared for analyses according to Robel and Watt (1970) utilizing three sieves constructed from standard 5-, 10-, 20-mesh/cm hardware wire to separate rumen contents. Plant material was identified, recorded, and 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 5-mesh/cm screen (Robel and Watt, 1970). Dried materials from the 10- and 20-mesh/cm screen were analyzed using the point method described by Chamrad and Box (1964). Percent occurrence determined for each plant species and unknowns was translated into volumetric (cc) values by taking the percent determined by point analysis (Chamrad and Box, 1964), dividing by 100, and multiplying this value by the total volume of material examined.

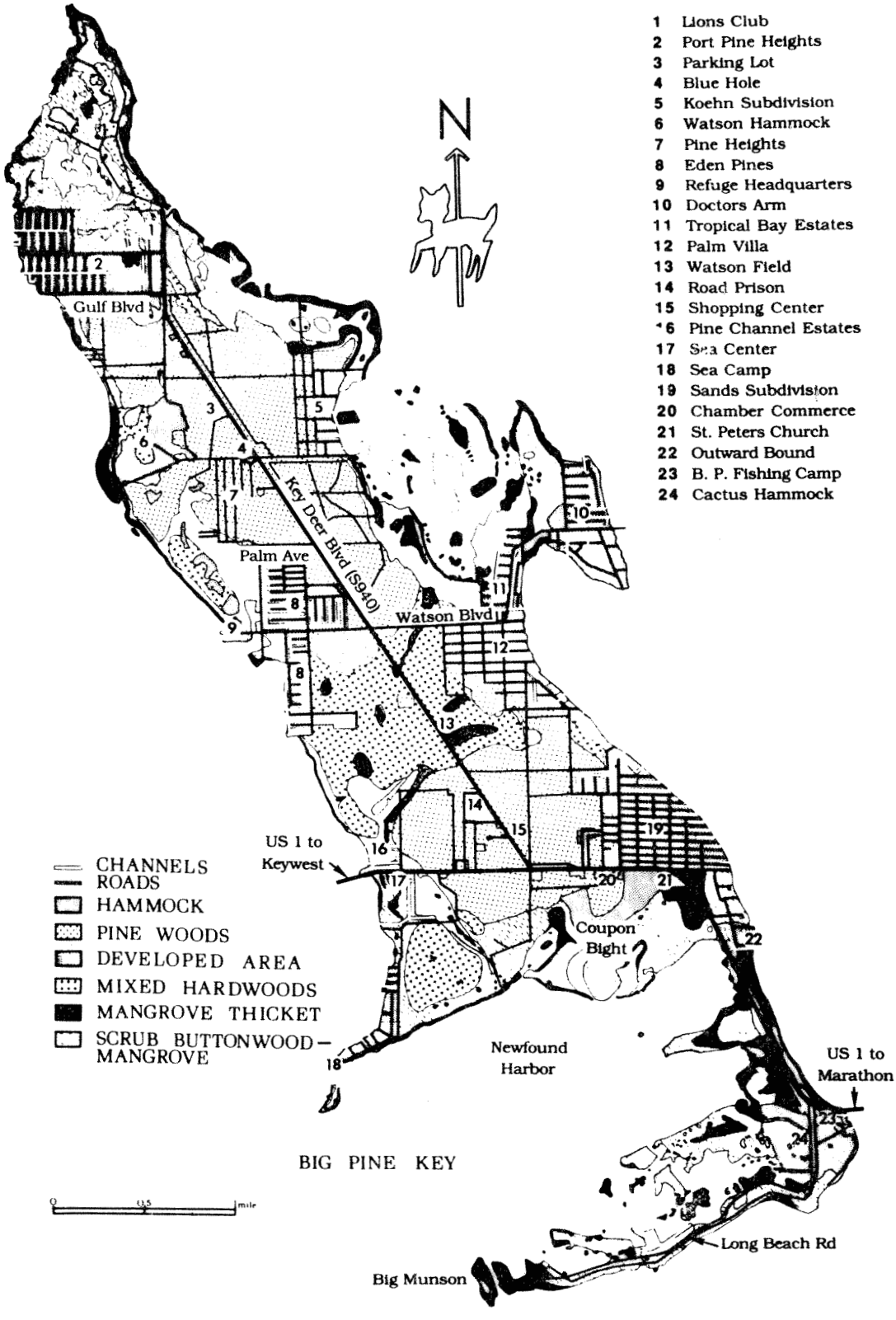

FIG. 1. Major plant communities, subdivisions, roads and miscellaneous sites, Big Pine Key.

The percent composition of individual food items was calculated by adding values (cc) in each of the samples and dividing by the total volume of materials examined, then these multiplied by 100. The percent frequency of plants was calculated from the number of times an item was identified, divided by the total number of samples examined. Plant importance rating was calculated by multiplying percent frequency and percent volume of the food item which provided a relative index for rating a given food item.

A plant reference collection, assembled from within the Key deer range, aided identification of plant foods. Common and scientific names were based on Long and Lakela (1971), Small (1933) and Watkins (1961); when there was difference, priority was given the most recent publication.

RESULTS AND DISCUSSION—A total of 164 food plants was identified in rumen samples (Table 2); 28 accounted for approximately 75% by volume while 10 comprised 56.6%. Red mangrove *(Rhizophora mangle)* leaves and fruits and black mangrove *(Avicennia germinans)* fruits yielded nearly 24%. Indian mulberry *(Morinda royoc)* leaves and fruits; silver palm *(Coccothri-*

TABLE 2. Foods with importance values greater than 2.0 as documented in rumen samples from 129 Key deer mortalities during December 1967-June 1973 (Dooley 1975).

Plant	Percent Frequency	Percent Volume	Importance Value
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	68	2.03	138.04
8. *Stylosanthes hamata*	49	2.77	135.73
9. *Acacia* spp.	43	3.00	129.00
10. *Manilkara* spp.	28	4.49	125.72
11. *Chamaesyce* spp.	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* spp.	46	0.78	35.88
16. *Randia aculeata*	29	1.12	32.48
17. *Jacquinia keyensis*	24	1.16	27.84
18. *Smilax havanensis*	37	0.62	22.94
19. *Pinus elliottii* var. *densa*	66	0.34	22.44
20. Mushroom	20	1.11	22.20
21. *Ipomoea* spp.	10	2.12	21.20
22. *Sida* spp.	29	.61	17.69
23. *Physalis* spp.	44	.21	9.24
24. *Chiococca* spp.	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* spp.	21	.19	3.99
29. *Laguncularia racemosa*	9	.42	3.78
30. *Desmodium canum*	10	.28	2.80
31. *Agalinis* spp.	9	.29	2.61
32. *Guettarda scabra*	6	.38	2.28
33. *Tillandsia* sp.	15	.14	2.10

[1]The complete list of 164 plant foods identified is on file in the office of the National Key Deer Refuge, Big Pine Key and the Cooperative Wildlife Research Laboratory, Southern Illinois University at Carbondale (Dooley 1975.)

nax argentata) flowers and fruits; brittle thatch palm *(Thrinax microcarpa)* fruits; blackbead *(Pithecellobium keyense)* leaves; graminid leaves; pencil flower *(Stylosanthes hamata)* leaves; acacia (*Acacia* spp.) fruits and leaves; and sapodilla (*Manilkara* spp.) fruits were also important. Red mangrove, which exhibited the greatest importance value, confirmed Dickson's (1955) finding that >63% of 293 pellet groups contained this species. By contrast, mainland Florida deer stomach contents indicated that, although a variety of food plants was utilized, 20 items contributed 84% of volume (Harlow, 1959) in one study; another yielded 120 plant foods, with 10 items making up 90% and 4 items 75% of volume (Strode, 1954).

TABLE 3. Plant type categories of 164 Key deer food plants as recorded from 129 rumen samples (Dooley 1975).

Plant Type	Number of Species	Percent of Total
Forbs	69	42.1
Woody Plants	65	39.6
Grasses and Sedges	23	14.0
Domesticated	7	4.3

Forbs contributed the greatest number of species used by deer followed closely by wood plants (Table 3). The variety of food used was representative of plants found in disturbed areas, followed by those of pinelands, hardwood, strand, and fresh and brackish marshes (Table 4). These data suggest a great variety and number of plant species (Klimstra et al., 1974) are subjected to Key deer use.

TABLE 4. Occurrence of 164 Key deer food plants within specific habitat types (Dooley 1975).

	Number and Plant Type			Total Species	
Habitat Division	Woody	Forb	Graminid	Occurrences	Percent of Total
Disturbed areas (roadsides, subdivisions)	26	51	17	94	40
Pinelands	22	36	4	62	26
Hardwood	38	4	3	45	19
Strand (maritime zone)	13	6	6	25	11
Marsh (fresh or brackish)	3	1	4	8	4

Percentages of forage types in the overall deer diet indicated woody plant leaves and new growth stems were most important (Fig. 2), followed by woody plant fruits, palm fruits and flowers, forbs, and miscellaneous items i.e., grasses, mushrooms, and pine needles. Although hardened twigs of wood species were not important, leaves and new woody growth of the most important browse species including 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*

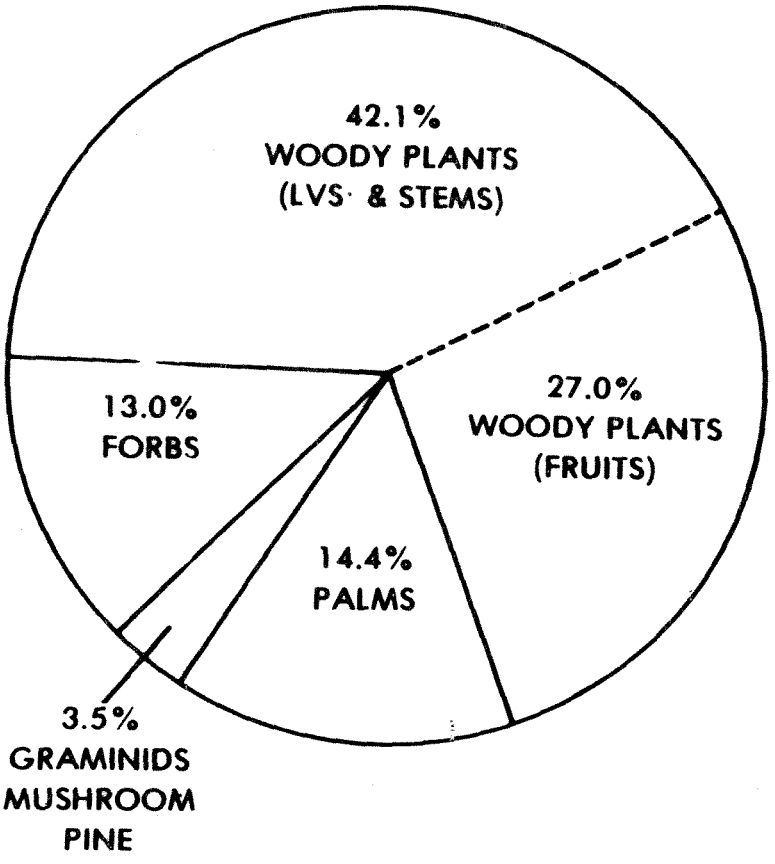

FIG. 2. Categories of plant foods utilized by Key deer based on 129 rumen samples.

involucrata), rough velvet-seed *(Guettarda scabra)*, and torchwood *(Amyris elemifera)* provided 42% of the overall diet. The variety of fruits and flowers important in the deer diet suggested regular and extensive use of red mangrove, black mangrove, brittle thatch palm, sapodilla, 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 Barbados cherry *(Malpighia glabra)*. Flowers, stalk, and spathes from saw palmetto *(Serenoa repens)* and silver palm also contributed importantly to the Key deer diet. The 42% fruit and flower use is similar to that documented for mainland deer (Lay, 1965; Harlow, 1959; Strode, 1954; Harlow and Jones, 1965; and Harlow and Hooper, 1971).

Seasonal Food Utilization—The 37 samples for January-March showed important foods to be red mangrove leaves and fruit; blackbead leaves; saw palmetto flowers, stalks, and spathes; erithalis leaves and stems; saffron plum leaves; grass and sedge leaves; joewood leaves, mushroom stems and caps; and white indigo berry leaves. These accounted for approximately 55% of the total food volume; unidentified leaves and herbaceous stems yielded 20.7% reflecting relative increase in browse in rumen samples for this period.

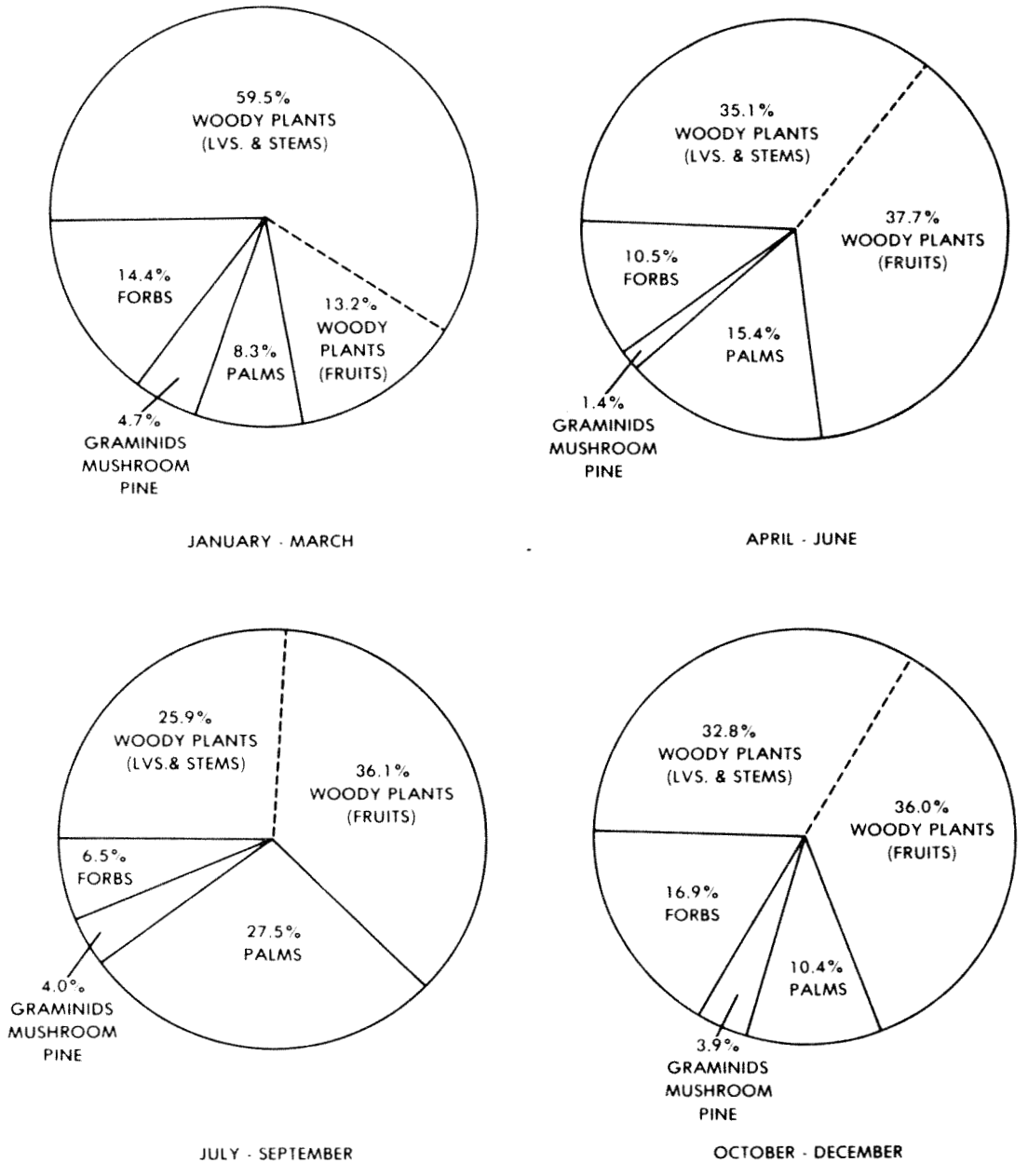

FIG. 3. Categories of plant foods utilized by Key deer based on 37 rumen samples for January-March, 29 April-June, 25 July-September, and 36 October-December.

Of 84 food plants, woody browse from red mangrove, blackbead, indigo berry, saffron plum, erithalis, Indian mulberry, acacia, joewood, and cat briar accounted for almost 60% of the total volume (Fig. 3). Fruits of sweet acacia *(Acacia farnesiana)*, red mangrove, and sapodilla comprised 13.1%, the lowest for woody plant fruits during the four seasonal periods.

The 29 samples for April-June showed silver palm flowers, fruits, and stalk; sapodilla 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 to be of importance. These accounted for 55.9% of the total food volume while unidentified material yielded 16.5%. Of 67 plants recorded, woody plants accounted for 72.8%; forbs 10.5%; palms 15.4%; and grasses, pine, and mushrooms 1.4% (Fig. 3). Fruits of woody

plants i.e., sapodilla, red mangrove, Indian mulberry, and acacia were most important, comprising 37.7% of the aggregate volume while browse made up 35.1%. Palms yielded 15.4%, with silver palm flowers, immature fruits, and spathe most important.

The 25 samples for July-September 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 grass and sedge leaves. These accounted for 61.5% of the total aggregate volume; unidentified yielded 11.9%. Of 72 plants identified, woody plants contributed 62.0%, forbs 6.5%, palms 27.5%, and grasses, mushrooms, and pine needles 4.0% (Fig. 3). Fruits were most important, contributing 36.1% of the total volume. Flowers and fruits of silver and brittle thatch palms provided 27.5% to the volume, the highest percent of diet attributed to fruits and flowers (63.5%) of the four periods.

The 36 rumen samples for October-December showed black mangrove fruits the most important food item. Others of importance 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 accounted for 58.1% of the aggregate volume; unknown leaves and stems made up 15.9%. Of 91 food plants recorded, leaves, herbaceous stems, and fruits of woody plants contributed 68.8% of the total volume; forbs 16.9%; and palms 10.4% (Fig. 3). Fruits of woody plants comprised 36.0% while their leaves and herbaceous stems contributed 32.8%.

Aspects of deer diet suggested increased availability and/or preference by Key deer for certain plant components on a seasonal basis. Flowers and fruits contributed approximately 21, 53, 63, and 46%, while browse from forbs and woody plants contributed 73, 45, 32, and 49% of the diet, respectively, during the four periods examined (Fig. 3). The variety and tropical affinities of many plants which contributed fruits and flowers represented factors affecting seasonal diet composition. Fruits and flowers of several plant species were found in greatest quantity April-November, while browse was greatest during December-March. The rainfall during quarterly sample collections indicated average rainfall was lowest during January-March; this corresponded to when browse was most utilized by Key deer. The pattern of rainfall in this subtropical climate is an important factor affecting phenology of the majority of plants within the Key deer range and appears to correspond with "seasonal" patterns of forage utilization witnessed in the deer diet.

Although monthly fluctuations occurred, several plants contributed some browse throughout the year. These included red mangrove, Indian mulberry, pencil flower, acacia, grasses, spurges (*Chamaesyce* spp.), milk peas (*Galactia parvifolia*), saffron plum, catbriar, slash pine (*Pinus elliottii* var. *densa*), ground cherry (*Physalis angustifolia*), lantana, and five-petalled leaf flower (*Phyllanthus pentaphyllus*). Other food plants present in samples from every month but one included: blackbead, erithalis, white indigo berry, joewood, small-leaved melanthera (*Melanthera parvifolia*), Spanish needle (*Bidens pi-*

losa), teaweed *(Sida acuta)*, and bromeliad (Tillandsia sp.). These data support Klimstra et al. (1974) observation that certain plants were subjected to regular and continuous browsing. Also indicated was that greatest quantities of browse from certain plants were recorded when fruits and flowers were least available.

Local Differences in Food Habits—To relate major vegetation type with foods eaten, samples were grouped to reflect three principal sources within the Key deer range. One source included 39 samples representative of the northern portion of Big Pine Key; another represented 40 samples from along U. S. 1 on Big Pine Key (Fig. 1); and, another represented 15 samples from other keys including No Name (6), Little Torch (5), Big Torch (1), and Ramrod (3). Food items in samples representing the two areas of Big Pine Key were not substantially different; but, there was variation reflecting the important food plants present on both segments. There was apparent difference in food utilization by deer of other keys as Pigeon plum *(Coccoloba diversifolia)* and devil's potato *(Echites umbellata)* appeared in samples from No Name, and erithalis, grasses, morning glory showed greater use than on Big Pine. Acacia did not occur in samples from other Keys.

This study substantiates Klimstra et al. (1974) observation based on browsing that foods utilized varied from one area of a Key to another and particularly from one Key to another. Variety of habitats and plants available to deer on certain Keys was more limited than on Big Pine Key. In part, differences in rumen sample composition and number 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, it comprised a smaller portion of deer diets on keys other than Big Pine.

Management Implications—The 164 documented Key deer plant foods was strong evidence of extensive use of all major habitat types (Table 4). Although a large number and variety of plants were recorded, relatively few provided the bulk of its diet (Table 1). There was obvious seasonal fluctuation in use of certain plant species and their parts. The above findings suggest maintaining a variety of habitat types and food plants available to Key deer is essential for effective habitat management. The continued development of islands, such as Big Pine Key, has resulted in clearing and loss of pinelands, hardwoods, and maritime zones. This has eliminated priority food plants such as red mangrove, black mangrove, acacia, brittle thatch palm, silver palm, sapodilla, and blackbead. Continued loss to prioritized human interests and needs of important habitats and food plants requires public-owned lands be effectively managed to insure survival of a healthy Key deer population. Although the National Key Deer Refuge and associated government-owned lands provide the foundation for maintenance of a viable Key deer population, increased development of private properties restricts the amount and availability of quality native habitats. Although use of roadsides and subdivisions is evident in the diets of deer, such man-controlled areas are not

in their best long-term needs and interests. First, few of the priority foods used occur there and; second, deer use of these areas greatly increases their vulnerability to human interaction, especially automobile encounters. It is believed the attraction to such land uses is the edge and openness they provide rather than quality of food resource.

Proper management of Key deer numbers in relationship to available habitat requires prediction and evaluations of qualitative trends in habitat condition; thus, utilization and abundance of plants and/or plant parts considered important to Key deer should be monitored. Controlled burning, clearing, and reseeding techniques to maintain a variety of native habitat types, have been identified as management for selected areas within the Key deer range (Klimstra et al., 1974). The impact of such activities on essential habitats and food plant species must be continuously evaluated to insure short-and long-term management practices accommodate Key deer needs.

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