GROUP SIZE AND COMPOSITION OF THE FLORIDA KEY DEER[1]

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Abstract: During January 1968 through September 1973, 233 Key deer (*Odocoileus virginianus clavium*) were marked for individual recognition and monitored to gain information on their life history, habitat requirements, and behavior. As part of the study, the group size and composition were studied and compared to that of other races of white-tailed deer. The group composition of Key deer was basically matriarchal, with the family group comprised of an adult doe with her offspring. Groups appeared less stable and the ties less strong between family members than those of other whitetails. Adult males were essentially solitary except for transitory associations with females during the breeding season and with other adult males when feeding and bedding during the summer. The weaker family ties between Key deer may reflect their history of isolation in an insular environment, where lack of predators and different competition and selective pressures from that on the mainland resulted in modified social organization and behavior.

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This paper reports on a study of Key deer group size and composition as it compares to other populations of white-tailed deer. Formation of family units appears characteristic of all deer in the genus *Odocoileus*; however, white-tailed deer appear the least gregarious (deVos et al. 1967:413). The social organization of white-tailed deer has been characterized as a matriarchal society with the basic family group comprised of an older doe with her fawns and offspring from previous years (Queal 1962:40, Severinghaus and Cheatum 1956:117, Tibbs 1967:38, Townsend and Smith 1933:305). Hawkins and Klimstra (1970:409) characterized the "family group" as "any grouping involving does and fawns that are spatially and socially related (frequency of association between all members of 50 percent or more) over a substantial period of time (usually several months)." Although generally small, groups as large as six (Chapman 1939:260) or seven individuals (Queal 1962:40) were not uncommon. Peterle (1975) suggested that the grouping of deer was related to food distribution, which influenced the formation of a cohesive social unit, which in turn may have been involved in population control. If this were the case it follows that populations of deer evolving under very different feeding conditions could be expected to exhibit differences in their sociobiology, which could be reflected in their group composition.

The Key deer, smallest of the eastern races of North American white-tailed deer, has been reported to occur only on a few of the lower Florida Keys (Barbour and Allen 1922). Although the history of these deer is largely unknown, it appears that the population fluctuated, with very low numbers occurring in some years (Barbour and Allen 1922, Dickson 1955:86, U.S. Fish and Wildlife Service unpublished Narrative Reports 1939–1967). It is currently considered endangered (U.S. Fish and Wildlife Service 1974). Information on the Key deer, prior to our study, was mainly from reports by

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local residents and occasional sightings in the early 1950's when the population was low (Dickson 1955:83).

In 1968 a study was initiated to investigate those factors influencing the Key deer population size, rate of increment, and relationships to the insular environment (Klimstra et al. 1974, unpubl. rep.). A study on behavior, social organization, and life history, which represented a portion of the investigation, was conducted to ascertain their effects on the population dynamics of the herd, and to contribute a feasible management program for this endangered species.

During this study data were gathered mainly around and within a portion of the Key Deer National Wildlife Refuge, including the north one-half (about 1,215 ha) of Big Pine Key. Largest of the lower Florida Keys, Big Pine has an area of about 2,430 ha, is 13.4 km long and 3.2 km wide at the widest point (Dickson 1955:20), and had an estimated population of 200–250 deer during the study (Klimstra et al. 1974, unpubl. rep.). Except for periods during January 1972 to 15 March 1972, and 16 June 1972 to 15 March 1973, staff of the Cooperative Wildlife Research Laboratory (CWRL), Southern Illinois University, Carbondale, were in residence on the islands from January 1968 until September 1973. Periods of about 2 weeks also were spent in the field during September and December 1972.

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METHODS

Techniques for capturing Key deer included use of portable nets (Silvy et al. 1975), trail traps, immobilizing drugs, and capture by hand (Klimstra et al. 1974, unpubl. rep.). Most of the 233 deer (32 adult males, 61 adult females, 19 yearling males, 22 yearling females, 70 fawn males, 29 fawn females) that were captured were marked with collars, bells, numbered ear tags, colored vinyl ear streamers, or ear tattoos. Collars, made from 7.6- × 40.6-cm strips of 0.32-cm gauge boltaron molded to conform to the shape of the deer's neck, were identified individually with numbers, letters, and symbols of Scotch-lite reflective tape. During the study radio transmitters were placed on 119 deer to facilitate locating them and observing their behavior.

Radio signals initially were detected with a vehicle-mounted antenna from various points along a road. Location of the deer was determined by triangulation. The vehicle then was driven to a point downwind of and as close as possible to the deer without disturbing it. A hand antenna was used to "walk in" on the deer; the signal was used to monitor it until it was visually located. The observer then stayed with the deer for as long as possible, noting its behavior and associations with other deer. The length of time deer were observed daily varied from a few seconds to over 10 hours. At times individuals of certain sex and age-classes were located and observed repeatedly throughout the day. This included observations of adult and yearling males and females during the breeding season, females during the prefawning period, and dams and fawns during the first week postpartum. At these times emphasis was on working with related radio-tagged deer to

determine the amount of interaction between them.

Care was taken during the location of deer to observe but not disturb them. At night when deer fed and loafed in open areas cleared of vegetation, they were observed for as long as possible from a vehicle. Night observations were limited to roadsides and other adjacent open areas, because the use of spotlights from vehicles was required. In some instances deer did not alter their behavior when lighted; however, often such observations disrupted the normal behavior, and deer fled.

Use of 7 × 35 binoculars facilitated identification of deer and observations of behavior. The date, time, location, weather conditions, associations with other animals, and behavior of marked and unmarked deer were recorded. Deer were considered together whenever they were within view of one another and were responding to each other throughout the period of observation, or whenever they were in contact through auditory or olfactory senses. For instance, some deer, separated by a distance of about 90 m and out of sight of each other, were considered together if they periodically looked in the direction of each other and moved together, as males followed females during the rut (Hardin 1974:133). Some, however, were not considered together even though they were adjacent to one another but, after brief interaction, went their separate ways. In some instances, associations could not be determined due to the short period of observation; in other instances, where the length of observation was very brief, knowledge of the individual deer's behavior was used to judge whether it was alone or responding to other deer.

From data based on field observations, we determined percentages of observations when marked deer were seen alone and with other deer, seasonal changes in social groups, and seasonal group sizes. Frequencies of association were determined for 27 deer belonging to 10 family groups monitored over a period of from 3 to 24 months. Based on (1) the number of times two deer, A and B, were seen together, (2) the number of times deer A was seen without B, and (3) the number of times deer B was seen without A, the frequency of association (Hawkins and Klimstra 1970), expressed as a percentage, was determined: $F.A. = (1)/[(1) + (2) + (3)] \times 100$. Behavior of individual deer was studied throughout the year to determine how, when, and why any changes in group composition occurred.

Frequencies of association were tested with the Student's *t*-test. Other data, which were compared as ratios or percentages, were analyzed with the chi-square contingency test. All statistical tests and tables were taken from Sokal and Rohlf (1969) and Rohlf and Sokal (1969). The level of significance selected and employed throughout the analyses was 0.05.

RESULTS AND DISCUSSION

The composition of Key deer groups was similar to that for other white-tailed deer; however, bonds between related Key deer appeared weaker, and Key deer were relatively more solitary. Of 13,743 observations of marked and unmarked deer, 9,853 (71.7 percent) were of single animals, whereas 3,890 (28.3 percent) were of 2 or more in a group (Table 1). Some observations of deer in groups represented feeding or breeding aggregations; these did not reflect strong social ties, usually included individuals that were together only once or twice a year, and lasted up to 24 hours in the case of breeding groups. The largest aggregation occurred in August (three does, three fawns, and three adult males) as females and fawns fed together while males harassed the females. Such a group was not permanent, but rather

Table 1. Sightings of marked and unmarked Key deer as singles and in groups of two or more.

Month	Observations of single deer	Observations of deer in groups of 2	3	4	5	6	7	8	9	Total
Apr	929(76.6)[a]	234(19.3)	38(3.1)	7(0.6)	4(0.3)					1,212
May	1,080(79.1)	243(17.8)	34(2.5)	3(0.2)	3(0.2)	2(0.1)				1,365
Jun	1,197(74.9)	332(20.8)	54(3.4)	13(0.8)	1(0.1)	1(0.1)				1,598
Jul	992(73.6)	279(20.7)	65(4.8)	9(0.7)		1(0.1)	1(0.1)			1,347
Aug	799(72.2)	245(22.2)	51(4.6)	6(0.5)	3(0.3)			1(0.1)	1(0.1)	1,106
Sep	592(76.7)	144(18.6)	29(3.8)	2(0.2)	4(0.5)	1(0.1)				772
Oct	611(67.6)	235(26.0)	44(4.9)	11(1.2)	2(0.2)	1(0.1)				904
Nov	702(68.0)	284(27.5)	45(4.4)	2(0.2)						1,033
Dec	911(66.7)	387(28.3)	57(4.2)	9(0.6)		1(0.0)	1(0.0)			1,366
Jan	663(67.2)	269(27.2)	51(5.2)	3(0.3)	1(0.1)					987
Feb	628(64.5)	272(27.9)	58(6.0)	8(0.8)	7(0.7)		1(0.1)			974
Mar	749(69.4)	267(24.7)	53(4.9)	8(0.7)	1(0.1)	1(0.1)				1,079
Total	9,853(71.7)	3,191(23.2)	579(4.2)	81(0.6)	26(0.2)	8(0.1)	3(0.0)	1(0.0)	1(0.0)	13,743

[a] Numbers in parentheses represent percentages of the total number of deer seen during the month.

represented a "random association" as described by Dasmann and Taber (1956:149). Sightings of six and seven deer in groups (Table 1) also represented temporary feeding or reproductive associations formed when several males harassed females accompanied by yearlings and fawns.

Deer were seen in groups most often during October through February; they were distinctly more solitary during March to September (Table 1). Fewer groups were noted during May, a reflection of the fawning activities of females and post-breeding activities of males. At this time newborn fawns did not move into open areas with does, yearling females had not reassociated with dams after being excluded during the fawning period, and males that lost antlers were solitary (Hardin 1974:73, 125).

Variation in group size has been reported for other white-tailed deer. Size and composition of white-tailed deer groups in Texas varied during the year (Michael 1970). Larger gatherings were formed when feeding than when bedding; in summer and winter, group size was smaller than average due to the abundance of single does and does with fawns, and rutting activities, respectively. Thomas (1966:27) noted that groups of Illinois deer increased in size from February to mid-April and decreased during late April and early May. In summer, groups were comprised of adult and yearling does, fawns, and yearling males, but no males 2.5 years or older were represented until the rutting season. Males formed small feeding groups during summer, but in September male group size declined. This was also reported by Crawford (1962:15) for the same herd. Pennsylvania deer behaved similarly; more females were seen alone in June than any other month (Tibbs 1967:31).

Fawn Associations

Records maintained for 10 (5 M, 5 F) radio-equipped, newborn fawns revealed that during the first day, fawns spent nearly 100 percent of the time with their dams. As they increased in age to around 5 weeks, more time was spent alone (Table 2). During the second, third, and fourth weeks, fawns were found to be alone during 68, 71, and 69 percent of the observations, respectively. During the first 3 months of life, male fawns were found alone more than females except during weeks 6, 7, and 10; however, differences were not statistically significant.

During the first 3 months, male fawns were alone in 68.8 percent of the observations, females in 54.9 percent. After about

Table. 2. Observations in which young fawns of known age were seen alone and with related deer.

Age (weeks)	Males			Females		
	Alone	With mother or sibling	Total	Alone	With mother or sibling	Total
0– 1	20(62.5)[a]	12(37.5)	32	10(47.6)	11(53.4)	21
1– 2	22(75.9)	7(24.1)	29	4(44.4)	5(55.6)	9
2– 3	13(72.2)	5(27.8)	18	7(70.0)	3(30.0)	10
3– 4	14(73.9)	5(26.1)	19	8(61.5)	5(38.5)	13
4– 5	16(94.1)	1(5.9)	17	8(72.7)	3(27.3)	11
5– 6	8(53.3)	7(46.7)	15	7(53.8)	6(46.2)	13
6– 7	10(66.7)	5(33.3)	15	7(70.0)	3(30.0)	10
7– 8	9(69.2)	4(30.8)	13	9(64.3)	5(35.7)	14
8– 9	6(46.2)	7(53.8)	13	6(35.3)	11(64.7)	17
9–10	12(66.7)	6(33.3)	18	7(70.0)	3(30.0)	10
10–11	10(58.8)	7(41.2)	17	4(40.0)	6(60.0)	10
11–12	12(80.0)	3(20.0)	15	7(46.7)	8(53.3)	15
0–12	152(68.8)	69(31.2)	221	84(54.9)	69(45.1)	153

[a] Numbers in parentheses represent the percentage of the total observations of fawns in each sex and age category.

3 months of age females were alone less, whereas males were alone in slightly over one-half of the observations until September and after November, when there was a decrease in the amount of time spent alone (Fig. 1). Males were alone significantly more than females during August, October, November, and March (based on 123, 126, 125, and 198 observations of marked fawns per month, respectively). Both males and females were alone more in March when family units separated just before the dams gave birth to fawns. It was not determined whether time spent alone was a result of the fawns' behavior or that of their dams, and therefore it was not apparent what caused the difference in the amount of time male and female fawns were solitary.

As fawns matured, the amount of time they spent with their dams and other deer

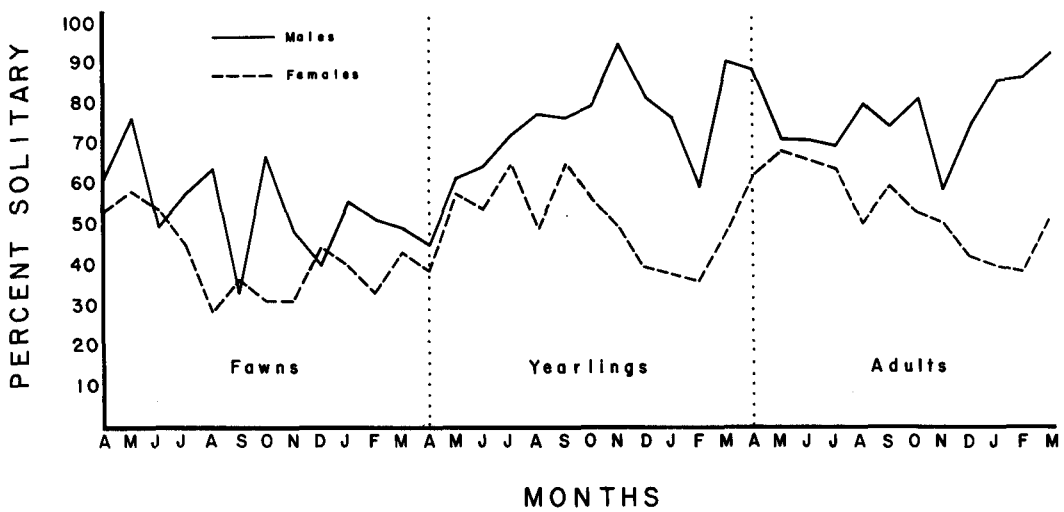

Fig. 1. Observations of solitary, marked Key deer. Percentages were based on the number of deer in each sex and age-class which were seen per month.

Table 3. Frequencies of association (F.A.) between marked does and their fawns.

	Adult doe-fawn doe			Adult doe-fawn buck		
Month	*N*	$\bar{X}_{F.A.}$	Range	*N*	$\bar{X}_{F.A.}$	Range
Apr	3	24.4	7.8–35.0	3	12.5	3.4–25.7
May	4	17.2	7.1–25.0	8	14.6	4.5–23.1
Jun	4	22.8	0.0–36.4	6	29.0	14.3–59.3
Jul	2	48.2	40.8–55.6	4	30.7	20.0–44.4
Aug	2	61.2	52.3–70.0	4	29.4	20.0–47.6
Sep	2	21.8	0.0–43.5	3	14.5	0.0–26.7
Oct	2	39.9	30.9–48.9	3	25.2	16.7–38.9
Nov	2	37.1	35.0–39.1	2	31.7	11.1–52.2
Dec	3	42.1	16.7–60.5	2	71.2	66.7–75.6
Jan	3	26.9	0.0–44.4	2	41.9	13.3–70.4
Feb	4	43.1	25.0–60.0	2	34.7	14.3–55.0
Mar	4	34.8	17.0–49.0	2	22.8	20.0–25.6
Total	35	33.4	0.0–70.0	41	26.6	0.0–75.6

Table 4. Frequencies of association (F.A.) between marked does and their yearlings.

	Adult doe-yearling doe			Adult doe-yearling buck		
Month	*N*	$\bar{X}_{F.A.}$	Range	*N*	$\bar{X}_{F.A.}$	Range
Apr	8	27.3	0.0–50.0	5	22.1	0.0–50.0
May	8	24.8	0.0–66.7	5	15.9	10.0–24.1
Jun	8	15.0	0.0–50.0	5	21.8	0.0–34.0
Jul	5	9.9	0.0–20.0	3	9.2	0.0–20.0
Aug	5	33.9	0.0–75.0	3	14.8	0.0–44.4
Sep	4	16.6	0.0–42.9	3	1.7	0.0– 5.0
Oct	3	32.9	24.6–42.9	3	0.0	0.0– 0.0
Nov	3	13.0	0.0–21.7	3	0.0	0.0– 0.0
Dec	3	30.3	20.7–42.9	4	15.0	0.0–60.0
Jan	3	37.0	10.0–71.4	1	0.0	0.0– 0.0
Feb	3	26.1	14.0–50.0			
Mar	3	22.7	8.7–40.0			
Total	56	23.9	0.0–75.0	35	12.7	0.0–60.0

increased. The primary association between does and fawns generally was maintained for almost a year; however, it was disrupted slightly during the breeding season, and some male fawns did not reassociate with their family groups. Often fawns were seen attempting to follow deer they encountered and on occasion showed care-seeking behavior toward unrelated deer and attempted to nurse. Females during June–August and males after November spent relatively more time with their dams. The only significant difference occurred in August when female fawns spent more time with their dams than did male fawns (Table 3).

During November through March, after fawns were 7 months of age or older, the frequency of association between dams and doe fawns averaged 37.0 percent, whereas that for dams and buck fawns averaged 40.4 percent. Hawkins and Klimstra (1970:410) found that for white-tailed deer in Illinois, the frequency of association during a comparable period and age was 72 percent for dams and doe fawns and 75 percent for dams and buck fawns. Based on this index of association, Key deer fawns appear much more solitary.

Yearling Associations

The proportion of time that marked yearling females were seen with does known to be their mothers varied from 29 percent in September to 68 percent in January. The sightings of yearling females with dams decreased during June and July, increased slightly in August, then was lower during September through November. In December, after the breeding season, yearling females and their does reassociated and were seen together up to 68 percent of the time. The association of yearling females with does decreased in February and March to less than 50 percent, prior to the birth of fawns. At this time yearling females showed signs of dispersal, possibly being driven out by their mothers or by aggressive does with new fawns (Hardin 1974:125). Thomas (1966:29) reported that in May and June white-tailed does chased and drove yearlings away, and Tibbs (1967:25) noted that when fawns were young, does were hostile toward other group members.

Hawkins and Klimstra (1970:411) found that the frequency of association between dams and their buck yearlings in Illinois was 3 percent in summer, whereas dams and

doe yearlings averaged 5 percent. Following the break-up of family units, Key deer dams averaged 18.5 percent with female yearlings and 17.2 percent with buck yearlings during April through July (Table 4). During and after August the frequency of association for dams and doe yearlings remained relatively high except during September and November when it dropped, probably due to breeding activities. During the period when fawns were between 4 and 8 months of age, Hawkins and Klimstra (1970:414) found that the dam and doe yearling frequency of association was 64 percent.

Data on associations involving yearling male Key deer were limited because many yearling males did not maintain associations with family groups, were not seen, or were known to have died after breaking away from the groups. Marked males spent from 0 percent in October, November, and January through March to 62 percent in August with their does. With the exception of one yearling male, the amount of time spent with the dams decreased from April through September; after October most yearling males were not seen with their does. One exceptional 2-year-old animal was still with his dam when she gave birth to fawns during both subsequent years after his birth. After April, marked yearling males were solitary in over 50 percent of the observations (Fig. 1).

Adult Associations

Adult females were alone most during April through July when they spent brief periods with their new fawns, and yet spent little time with other group members (Fig. 1). As fawns matured, the does spent increasing amounts of time with other deer as secondary associations were established with their yearlings. Does were relatively solitary just after birth of fawns, but they appeared to have a strong maternal bond toward their fawns or toward the area in which their fawns were hidden. This was evidenced by the persistent searching behavior of does whose fawns died and by a doe that swam daily between two keys to her fawn which was on an island having no fresh water (Hardin 1974:53).

Adult males spent significantly more time alone than did adult females in all months except May and November. In May males were alone in about 67 percent of the observations (Fig. 1) while there was regrowth of new antlers. They were relatively non-aggressive and associated with other males only during periods of feeding or bedding in open areas. During May, June, and July adult males were with other deer, mainly other males, in about 33 percent of the observations. In August there was less association between males, and the amount of time alone increased. As velvet was shed in September, no compatible buck associations were observed; however, males were seen together in association with females. By March males were alone in 90 percent of the observations.

Between mid-September and early December adult males were not seen to associate with one another unless there was overt aggression, or unless they were tending or otherwise harassing a female. The earliest recorded non-aggressive association after the breeding season was on 8 December when two males were seen moving together; the first sighting of males feeding together was on 23 December. The percentage of time that adult males were seen associating with one another ranged from 27 in June to a low of 6 in March. During March adult males with antlers and adult females were aggressive, whereas males without antlers were submissive and became solitary. In South Dakota, Progulske and Duerre (1964) found that few bucks frequented open meadows when antlers

were growing; they attributed this to secretive behavior resulting from physiological changes accompanying antler growth. They noted that summer feeding associations were established between adult males, and yearlings and adult males were seen with other deer more often.

Changes in Sociobiology

The social structure of Key deer was not fixed but rather a flexible, dynamic system that changed throughout the year in relation to the reproductive cycle. Small family groups, formed during June to September, were disrupted by the breeding activities in September, reformed during December through February, then were disrupted again in March and April as does gave birth to fawns (Hardin 1974:142). Such changes also were reflected by the changing dominance hierarchy of animals within the population (Hardin 1974:38).

Key deer show the same basic social structure as other white-tailed deer that have been studied; however, the social groups of Key deer appear much weaker as reflected by the lower frequencies of association. This social organization of Key deer may reflect their evolution in an insular environment where absence of predators and the tendency for most females to occupy the same range for life result in different selective pressures from those on the mainland. White-tailed deer exposed to predation tend to have greater chances for survival when young are more dependent on family members rather than being independent at an early age. White (1973) noted that, in Texas, those fawns that were most independent, active, and inquisitive were most susceptible to predation and accidents. Such selection against independent young would not exist to the extent that it is found on the mainland, because there are no native predators on the Key deer.

In northern populations deer typically leave their spring and summer ranges to spend the winter in large groups in deer yards (Severinghaus and Cheatum 1956: 139), where interactions between large numbers of unrelated deer occur. As they return to their spring and summer ranges, members of family units reassociate with much mutual grooming and interaction (Miller 1971). Strong bonds between family members seemingly would facilitate these annual reassociations and allow female members of family units to reoccupy overlapping ranges with minimal antagonism. Because female Key deer normally occupy the ranges that overlap with that of their dams (Silvy 1975:48), and because Key deer do not perform seasonal yarding behavior, the need for strong bonds to facilitate periodic reassociations after interacting with a number of unrelated deer would be less important.

One possible advantage of the weaker family ties may be a greater capability for dispersal by younger animals at times of relatively high population levels. If the deer population were reduced periodically at the edge of its range, such as on outlying islands (Klimstra et al. 1974, unpubl. rep.), a flexible social organization could result in greater dispersal from keys having high populations. Weaker social bonds between fawns or yearlings and their family groups would not serve to tie the young to one area; they thus would seem more likely to leave their home area than if closely associated with the matriarchal groups. In at least two instances during the study, marked Key deer females appeared to establish ranges in new areas (Silvy 1975:59). One 2-year-old doe left the range in which she was raised, and another doe was found on No Name Key after being captured and tracked for 7 months on Big Pine Key. The former shifted her range after the fawning season, when

maternal does drove other deer out of areas where they had fawns.

The group size and composition of deer may influence data gathering and subsequent management of the population if productivity is based on doe:fawn ratios determined from field observations. Such estimates of doe:fawn ratios may be misleading unless the social structure and behavior are considered. The Key deer is relatively solitary and fawns often feed in the vicinity of non-related deer and even try to nurse bucks or foreign does; therefore, basing productivity on field observations of does with fawns during the year can give erroneous estimates.

If the roles of populations on islands are to be appreciated, it is important to consider the evolution of island ecosystems (Mueller-Dombois 1975). The Key deer may have existed and evolved in its insular environment for a number of years, so it is not surprising that its social behavior differs from that of mainland populations, whether due to changes in its genotype or phenotypic expression. That the role of evolution under environmental conditions may affect the sociobiology of the population has been considered by Peterle (1975). If, as he noted, the evolution of deer under conditions of patchy food distribution may have led to a tight social system, it is not surprising that Key deer, which may have evolved in an area of year-round abundant food supplies and exist in the absence of native predators, show a modified form of group composition. At any rate, it is essential to note the evolutionary history of this insular form and manage it in light of this knowledge.

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