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Martin J. Folk

Willard D. Klimstra

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## URBANIZATION AND DOMESTICATION OF THE KEY DEER (*ODOCOILEUS VIRGINIANUS CLAVIUM*)

MARTIN J. FOLK AND WILLARD D. KLIMSTRA  
Cooperative Wildlife Research Laboratory, Southern Illinois  
University, Carbondale, Illinois 62901

**Abstract.**—Due to an explosive population increase of people, the endangered Florida Key deer (*Odocoileus virginianus clavium*) herd has rapidly become urbanized. We studied Key deer in housing subdivisions on Big Pine Key during 1989 and 1990 to identify people-associated changes in sociobiology. Maximum group sizes of Key deer were much larger in 1989-1990 than in 1968-1973. Tolerance of physical contact with humans and decrease in intraspecific interactions were evidence of domestication. Concentrations of Key deer in subdivisions were associated with level of feeding by residents. Enforcement of laws prohibiting feeding and management practices to lure deer from subdivisions are recommended.

A burgeoning human population results in an increase in human-deer interactions; hence, a better understanding of such relationships is required (Decker and Gavin 1987). Placement of preserves, parks, and refuges within and adjacent to human population centers, such as described for the greater Chicago metropolitan area (Witham and Jones 1987), requires careful and specialized wildlife management.

Big Pine Key, Monroe County, which supports 60-70% of the endangered Florida Key deer population (totaling 250-300), exhibits the fastest human population growth of the lower keys. The permanent human population increased from less than 806 in 1970 (Monroe County 1986) to 3,400 in 1988 (Sedway Cooke Associates et al. 1989). In addition, some 1,600 seasonal residents were present in 1988 (Sedway Cooke Associates et al. 1989). Excluding tourists, the island-wide density of people (roughly 2.2 people/ha) in the late 1980s was 18 times that of deer (about 0.12 deer/ha). Human-deer interactions are concentrated in housing subdivisions.

We hypothesized that through increased urbanization of their habitat, Key deer sociobiology had changed since the late 1960s and early 1970s.

The objectives of this study were to compare Key deer sociobiology and human-deer interactions among three subdivision areas of Big Pine Key, and to compare these urban Key deer with the biology of Key deer as recorded for 1968-1973 (Hardin 1974, Silvy 1975, Hardin et al. 1976, Klimstra and Dooley 1990).

#### STUDY AREA

Big Pine Key is located 170 km southwest of Miami and 48 km east-northeast of Key West, along U.S. Highway One. The island is about 13.3 km long and 3.3 km wide, with a maximum elevation of 3 m (Hardin et al. 1984). Vegetation of uplands is predominantly open pineland (*Pinus elliottii* Engelm. var. *densa* Little and Dorman, Scurlock 1987) with an understory of palms (*Thrinax morrisii* H. Wendl. and *Coccothrinax argentata* (Jacq.) L. H. Bailey, Scurlock 1987). The climate is subtropical/marine, with a mean annual temperature of 25°C and mean annual rainfall of about 97 cm (Schomer and Drew 1982).

Study areas one and two were within the Port Pine Heights subdivision at the north end of Big Pine Key (Fig. 1). These two study areas (34 and 24 ha, respectively) were analyzed separately because a steep-sided, high-walled canal presented a barrier to deer movement, resulting in relatively little interchange during the study. Undeveloped lots consisted mainly of grasses, with a few scattered trees and shrubs. The west side of Port Pine Heights was bordered by Pine Channel and the remainder of the subdivision was surrounded by lands of the National Key Deer Refuge.

Study area three consisted of 33 ha within the Eden Pines subdivision of central Big Pine Key (Fig. 1). This subdivision also was bordered by refuge lands. Predominant vegetation in vacant lots was woody, and few open grassy areas were present.

#### METHODS

Observations of subdivision deer were conducted from July 1989 through April 1990. Study areas were monitored continuously during 112 observation periods totaling 155 hours ( $\bar{X}$  obs. period = 1.4 hr, SD = 0.6). Observations were conducted during all daylight hours, with efforts concentrated at dawn and dusk. The observer toured a study area by bicycle until deer were sighted. These deer became focal individuals and were followed at distances great enough to avoid affecting their behavior. Time, location, group size, sex and age composition, movements, and general behaviors were recorded. Factors affecting deer behavior, especially human-related, were noted. Deer were video-taped to aid in identification of individuals and allow better interpretation of deer activities.

The study period covered the greater part of a complete annual cycle in the life of Key deer; for purposes of analyses, data were organized by biological season. Observations from July and August represented "postfawning," those from September through January were considered "rut," those from February and March "postrut," and observations from April "fawning." Postrut and fawning seasons were monitored only at study area two.

Maximum group size per observation period was analyzed to determine associations with study area, season, and time of day. A "group" of deer included individuals within view of each other and responding to each other, or within auditory or olfactory contact (Hardin et al. 1976). Data were analyzed using the Statistical Analysis System (SAS 1987). When analyses of variance showed significant ( $\alpha = 0.05$ ) differences, Duncan's Multiple Range Tests with  $\alpha = 0.05$  were used to separate means. Results were compared with Key deer group sizes recorded in 1968-1973 (Hardin et al. 1976), when people densities were low (about 0.3 people/ha) and there was minimal feeding of deer.

## RESULTS

**Study Area One.**—Mean maximum group size during postfawning was greater than during rut (Table 1). During postfawning, a typical group consisted of three adult females, a yearling male, and a fawn that were feeding in vacant, vegetated lots of the subdivision. During rut, groups were rarely observed, but individual yearling or adult males wandered through the subdivision. There was no significant difference in maximum group size among morning, mid-day, and evening observation periods (Table 1).

**Study Area Two.**—Mean maximum group size during postrut was greater than for rut (Table 1). Other comparisons of means among seasons were not significantly different. A typical group during postrut consisted of one adult buck, eight adult and yearling does, and five fawns. During fawning a usual group consisted of seven adult and yearling does and five fawns. The typical postfawning group included an adult buck,

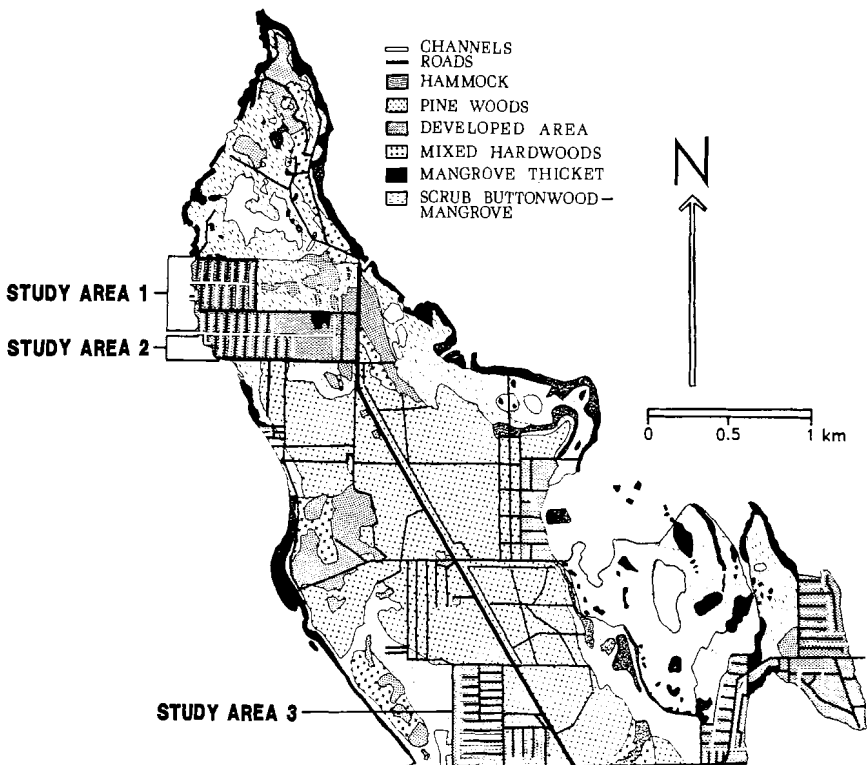


Figure 1. Study areas and surrounding habitat on the north half of Big Pine Key, Florida, where urban Key deer were observed during 1989 and 1990.

Table 1. Maximum group sizes ( $\bar{X} \pm SE (n)$ ) of Key deer observed in housing subdivisions on Big Pine Key, Monroe County, Florida, in 1989 and 1990. Means within columns for seasons and time of day are not significantly different ( $P = 0.05$ ,  $t$ -tests,  $F$ -tests, and Duncan's Multiple Range Tests) when followed by the same letter.

	Study area		
	One	Two	Three
Seasons			
Fawning		12.1 $\pm$ 1.7 (12)AB	
Postfawning	4.9 $\pm$ 0.7 (8)A	10.5 $\pm$ 0.6 (8)AB	3.4 $\pm$ 0.4 (9)A
Rut	1.2 $\pm$ 0.3 (17)B	9.7 $\pm$ 1.1 (23)B	2.1 $\pm$ 0.3 (20)B
Postrut		14.7 $\pm$ 1.4 (14)A	
	$t = -5.5$ $P < 0.0001$	$F = 3.1$ $P = 0.0341$	$t = -2.4$ $P = 0.0220$
Time of day			
Morning	3.1 $\pm$ 0.7 (11)A	13.8 $\pm$ 0.9 (24)A	2.8 $\pm$ 0.3 (13)A
Mid-day	0.7 $\pm$ 0.3 (3)A	6.1 $\pm$ 1.1 (15)B	0.3 $\pm$ 0.2 (6)B
Evening	2.2 $\pm$ 0.7 (11)A	13.1 $\pm$ 0.9 (18)A	3.4 $\pm$ 0.3 (10)A
	$F = 1.5$ $P = 0.2533$	$F = 17.9$ $P = 0.0001$	$F = 16.1$ $P = 0.0001$

eight adult and yearling does, and one fawn. During rut, groups usually included an adult buck, five adult and yearling does, and five fawns. These large groups observed during all seasons usually represented associations at or near areas where deer were fed by people. Maximum group size differed with time of day, with means for morning and evening greater than for mid-day (Table 1).

Study Area Three.—Mean maximum group size during postfawning was greater than during rut (Table 1). Groups consisted mainly of two "identifiable" adult females with two fawns that predictably loafed near a house where they had been fed. Maximum group size differed with time of day, with means for morning and evening greater than mid-day (Table 1).

Comparison of Study Areas.—Group sizes of Key deer observed in subdivisions during 1989 and 1990 were associated with the amount and consistency of feeding and watering by people. Maximum group size observed in study areas one, two, and three was 7, 21, and 5, respectively. Four households in study area one were known to provide food or water for deer, but feeding was not a daily occurrence and usually only table scraps were provided. Feeding of deer by tourists was minimal in study area one. In study area three, where maximum group size was similar to that of study area one, deer were fed landscape vegetation (normally unavailable to them because of a fence) on a regular basis at one household. Feeding by tourists was minimal. Extremely large group sizes (Fig. 2) observed at study area two were largely associated with consistent daily feeding and watering at a single residence. Large amounts of commercial feed (cracked corn, pelleted vegetable matter) were provided in a feedlot

operation two-three times daily. Five other households within 100 m and at least four other households in the west half of study area two also provided food and/or water. Large numbers of deer consistently gathered at the west end of the study area every morning and evening near feeding time. This attracted many tourists who also fed the deer.

Degree of domestication of Key deer, like group size, was associated with consistency of feeding and watering by humans in the three study areas. In study area one, where feeding was least consistent, deer fled from humans. In study area three, where feeding was more consistent, deer exhibited signs of domestication (i.e., permitted close approach by humans). Deer of study area two approached humans to beg for hand-outs.

## DISCUSSION

Mean maximum group size varied by season in all study areas. Relatively larger group size in study areas one and three during postfawning probably reflected movements to open areas with breezes during periods of high mosquito levels (Hardin 1974). In study area two relatively smaller sizes during rut were probably due to disturbance of feeding associations of does by rutting bucks.

Geographical distribution of habitats and physical features may have affected where deer were likely to congregate. Study area two provided



Figure 2. Large Key deer herd in a housing subdivision on Big Pine Key.

important open areas and was adjacent to an interspersed of relatively high quality habitats. Deer traveling north along the west coast of Big Pine Key and encountering the canal system of Port Pine Heights would be funneled into the west end of the subdivision (Fig. 1).

Based on repeated observations of identifiable individuals and consistency of group composition as to age and sex, we determined that many Key deer were "permanent" subdivision residents. This was most apparent in study area two where deer seemed dependent on feeding and watering.

The degree to which individual deer supplemented food from people with natural forage varied. Some spent considerable time foraging for native vegetation in vacant lots and on adjacent refuge lands where a distinct browse line was evident. Other deer concentrated on landscape plantings and some, especially adult bucks, specialized in opening trash bags and cans for scraps.

Movements of deer in study area two have apparently been affected by contact with people. A constant food and water supply has resulted in a reduction of home range size. In the west half of study area two where feeding was heaviest, density of deer was about 20 times that of "normal" (1 deer/12 ha, Silvy 1975). Deer moving from subdivision to refuge lands and vice versa were required to cross the busiest road in study area two; they often used this paved road as a trail. Even with speed limits as low as 40 km/hr (25 mph), 12% of Key deer road mortalities 1968-1988 occurred in subdivisions (Drummond 1989).

Key deer in study area two resembled a herd of cattle. Deer at the house where commercial feed was provided (the "feedlot") were fed in a long line on a concrete patio. In feeding, they stood side by side, often in physical contact. The deer generally moved with a slow walk with heads down in single file, following no apparent leader or dominant individual. Response to potential danger was usually no more than a glance in the direction of the source. Deer often bedded in open sites within 2 m of a road and were not disturbed by cars, pedestrians, and cyclists. Loud noises from within 40 m, such as circular saws, lawn leaf-blowers, and wood chippers brought little response. Deer usually ignored the observer, sometimes passing within 2 m. Even when they were not actively "begging," deer in study area two tolerated petting by people.

Group sizes of deer, especially in study area two, were in contrast with the findings of Hardin et al. (1976), who described Key deer as relatively more solitary than other white-tailed deer. Groups of  $\geq 6$  Key deer comprised only 0.09% of Hardin et al.'s (1976) 13,743 observations, and were considered temporary feeding or reproductive associations.

On two occasions during the 1989-1990 rutting season, four bucks were observed in close proximity and no sign of aggression was evident. Hardin et al. (1976) stated that during rut adult males were not observed

together unless there was aggression between them or attendance of a female. Breakdown in intraspecific behavior also seemed to occur in concentrations at the feedlot where there was little evidence of an expected matriarchal hierarchy and deer moved about in a random fashion. Dominance-submissive displays were not commonly observed, in contrast to Hardin's (1974) report that such usually occurred prior to recognition of an unknown deer. With the same group of deer at the feedlot day after day, meeting of "strangers" was probably a rare event; therefore, a decrease in behaviors which established recognition and social order would be expected.

Based on comparisons of Key deer group sizes, movements, and behaviors in 1989-1990 with those from 1968-1973, it appears that the sociobiology of the Key deer herd in certain subdivisions is being drastically affected by increasing contact with people. Changes in behavioral traits (i.e., reaction to presence of people, intraspecific interactions), as observed for Key deer, are the most important evidence of domestication (Price 1984).

Loss of alarm and flight response was observed for Key deer that were in daily contact with neighborhood dogs. We speculate that this may result in an increase in susceptibility to harassment by other dogs. Also of concern are dietary imbalances as unnatural food sources replace the normally highly diverse diet of wild deer (Klimstra and Dooley 1990). A high proportion of fawns in groups of deer that beg from people suggests that recruits into the Key deer population may be adapting to dependency on humans for food. Grizzled coats in deer that frequent the feedlot situation suggest presence of parasite/disease or other stress-related problems. A single dominant buck was usually present at the feedlot during the 1989-1990 rutting season. Presence of the same buck over multiple rutting seasons may have resulted in inbreeding. A comprehensive research program involving capture, marking, and monitoring of urban Key deer will be necessary for providing empirical evidence of these potential problems.

The problem of urbanization and domestication of Key deer is not restricted to the three study areas described in this paper; evidence has been observed throughout Big Pine Key and several neighboring keys. While this paper was in review, a domesticated Key deer was beaten to death with a baseball bat on Noname Key. Problems associated with urban Key deer may escalate because new residents on the island, upon seeing their neighbors feed the deer, probably are more inclined to do so.

Wildlife managers should feralize domesticated Key deer and prevent further domestication. Heavy feeding of deer has taken place at least several years; therefore, remedial actions should be taken immediately because gene pools altered by domestication may result in high mortality when animals are "reintroduced" or feralized back into natural habitats



(Price 1984). Feeding of Key deer is prohibited by state [F. A. C. 39-27.002 (5)] and federal (16 U. S. C. 1531) laws. Enforcement of these laws must be the first step in the feralization process.

In concert with stringent enforcement of the no-feeding laws, consideration should be given to capturing domesticated Key deer for movement to improved habitats on other islands within the Key deer range. Such actions would help alleviate the problems associated with the "weaning" of deer that would be expected to remain at their former feedlots after cessation of feeding. Capture techniques involving use of a portable net (Silvy et al. 1975) and a hand-held net gun (Drummond 1989) have been developed that result in relatively little injury or mortality of Key deer; however, relocation of domesticated Key deer may result in an unknown level of mortality.

Florida Keys residents are already encouraged to dump open vessels of rainwater to discourage mosquito propagation. Such practices also will discourage attraction of Key deer. Fresh water sources (natural wetlands and artificial watering devices) should be maintained on refuge land away from subdivisions. Other habitat management practices such as maintenance of forest openings and burning should be implemented to lure deer away from concentrations of people.

An explosive increase in human population on the limited insular habitat of the Key deer presents challenges for wildlife managers. Perhaps one of the greatest problems on Big Pine Key and in suburban and urban areas throughout the country is how to balance the needs of wildlife with the various attitudes of the public. An aggressive and continuous public education program is essential for teaching about the problems of feeding deer and the necessity of management practices such as prescribed burning. There must be diligent implementation of all laws designed to protect Key deer from people activities.

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