HABITAT USE BY RACCOONS (*PROCYON LOTOR*) IN A SANDHILL/WETLAND MOSAIC OF NORTH-CENTRAL FLORIDA

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ABSTRACT

Raccoons (*Procyon lotor*) were trapped in November 1991 and February, May, and August 1992 at the Ordway Preserve in north-central Florida. Use of five habitat types (sandhill, swamp, hammock, old field and upland clear-water-lake fringes) by 20 radio-collared individuals was monitored from November 1991 to May 1992. Results indicated a preference by raccoons for mesic habitats on the preserve, although there was considerable individual variability. Sandhill, the critical habitat type for the threatened species, *Gopherus polyphemus*, was used less than expected according to availability. Two raccoons accounted for 34% of the locations in the sandhills. Habitat types were used differently by males and females and for foraging and resting. Most rest sites were in trees, and squirrels' nests were the most commonly used tree rest sites.

RESUMEN

Se capturaron mapaches (*Procyon lotor*) en noviembre de 1991 y febrero, mayo y agosto de 1992 en la Reserva Ordway, en el centro-norte del estado de Florida. Entre noviembre de 1991 y mayo de 1992 se monitoreó el uso por 20 individuos con radio-collares de cinco tipos de hábitat ("sandhills", pantanos, bosques de maderas duras, campos abandonados y costas de lagos de tierras altas). Los resultados indicaron una preferencia de los mapaches por los hábitats más húmedos, aunque hubo gran variabilidad individual. Los "sandhills", el tipo de hábitat crítico para la especie amenezada *Gopherus polyphemus*, fueron usados menos que lo esperado según su disponibilidad. Dos mapaches contribuyeron el 34% de las localizaciones en ese hábitat. Los distintos tipos de hábitat fueron usados de manera diferente por machos y hembras y para forrajeo y descanso. La mayoría de los sitios de descanso estuvieron en árboles; los nidos de ardillas fueron los sitios de descanso más comunes en árboles.

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INTRODUCTION

Raccoons are omnivorous and opportunistic feeders. In most habitats plants are more important than animal foods in their diets (Kaufmann 1982), although they can be very efficient predators. Eggs and hatchlings of birds and reptiles are especially vulnerable to being taken by raccoons. Many threatened or endangered species of these two taxa are suffering inordinately from continued or increased raccoon predation pressure in the face of declining habitat (Urban 1970; Worth and Smith 1976; Davis and Whiting 1977; Landers et al. 1980; Anderson 1981).

In the sandhills of Florida, raccoons are predators of gopher tortoise (*Gopherus polyphemus*) eggs and hatchlings (Douglass and Winegarner 1977; Smith 1992). The gopher tortoise is confined to xeric sandhills, where the soil is suitable for the construction of its extensive burrow systems. It is a keystone species of that habitat type (Eisenberg 1983), and many vertebrate and invertebrate species depend on its burrow for their survival. Its numbers have declined by an estimated 80% in the last 100 years (Auffenberg and Franz 1982).

Raccoons, in contrast, experienced a continent-wide population increase that began about 50 years ago (Sanderson 1987) and was accompanied by an expansion into more xeric habitats not utilized heavily when population levels were lower. Today, with more raccoons using xeric gopher tortoise habitats, fewer gopher tortoises, and less habitat suitable for gopher tortoises, raccoon predation could play a significant role in limiting tortoise numbers.

The Katherine Ordway Preserve-Carl Swisher Memorial Sanctuary (henceforth called the Ordway Preserve) is a 3750 ha mosaic of sandhill uplands, hammocks, old fields, and wetlands in Putnam County, Florida, about 40 km east of Gainesville. A recent study of gopher tortoises on the preserve documented predation on eggs and hatchlings by raccoons (Smith 1992). The objective of this study was to describe habitat use by raccoons during the winter and spring at the Ordway Preserve. Data on the extent and pattern of raccoon use of sandhills, the critical gopher tortoise habitat, would be useful for the management of a major predator of a keystone species at the Ordway.

Raccoons are generally found in greater numbers in swamps and bottomland hardwoods than in pine forests and sandhills in Florida and Georgia (McKeever 1959; Caldwell 1963). However, they can reach relatively high densities in some xeric upland habitats (Worley 1980). On St. Catherines Island, Georgia, when overall raccoon densities were low, raccoons were relatively more abundant in mesic oak forests and close to the coast, but when densities were high, they were evenly distributed throughout all habitat types, including the higher and drier areas (Hudson 1978). In the southeastern United States, no studies have documented the use of wetland and upland habitats within the same area by individual raccoons. North Dakota prairie raccoons used wetlands and uplands differently according to age, sex, and reproductive status (Fritzell 1978).

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STUDY AREA

A large proportion of the Ordway Preserve is sandhill uplands, including the turkey oak (*Quercus laevis*) barrens associations, longleaf pine (*Pinus palustris*)-scrub oak associations and longleaf pine-wiregrass (*Aristida stricta*) associations (Franz and Hall 1991). These communities are characterized by rather open canopies and grassy ground cover (dominated by *Aristida stricta* and *Sporobolus junceus*). Productivity of these uplands is low (Humphrey et al. 1985).

Approximately 36% of the preserve is wetlands, including isolated upland "clear water" lakes and their fringes, seasonally-flooded swamp forests, "dark water" lakes, which are darkly stained with organic acids and connected to the swamp forest system, and freshwater marshes. Swamp forests encompass several vegetative associations dominated by slash pine (*Pinus elloittii*), red maple (*Acer rubrum*), sweet bay (*Magnolia virginiana*), black gum (*Nyssa sylvatica*), and pond cypress (*Taxodium ascendens*) (Franz and Hall 1991).

Mesic hardwood hammocks are found along the swamp forests and dark water lakes. These include associations dominated by laurel oaks (*Quercus hemisphaerica*), sand live oaks (*Quercus geminata*), pignut hickories (*Carya glabra*), water oak (*Quercus nigra*), and sweet gum (*Liquidambar styraciflua*), with understories consisting of seedlings and saplings, sparkleberry (*Vaccinium arboreum*), and saw palmetto (*Senoa repens*) (Franz and Hall 1991).

Sand live oak hammocks are more xeric associations dominated by sand live oaks, usually in more upland areas. Understory may include various blueberry species (*Vaccinium* spp.) and sabal palm (*Sabal palmetto*) (Franz and Hall 1991).

The area has a long history of human use and habitation, and old fields in various stages of succession are scattered throughout the preserve. Native and exotic species found in these areas include sand live oaks, laurel oaks, longleaf pines, persimmon (*Diospyros virginiana*), winged sumak (*Rhus copallina*), and blackberries (*Rubus* spp.). Monocultures of loblolly pines (*Pinus taeda*) planted in straight rows are found in some parts of the preserve (Franz and Hall 1991).

The five habitat types used in this analysis were sandhill, swamp forest, hammock, old field, and clear-water-lake fringe. The "hammock" habitat type included both the mesic hardwood hammock associations and the sand live oak hammocks. "Clear-water-lake fringes" were the meadows surrounding the upland lakes and ponds.

METHODS

Capture and Handling

Fifty-three raccoons were captured in Tomahawk traps baited with a mixture of sardines and cat food. Trapping was conducted for four or five consecutive days in November 1991, and February, May, and August 1992, for a total of 402 trap nights. Trap sites were located in hammock (40%), sandhill (30%), and swamp forest (30%).

Raccoons captured for the first time were anesthetized with ketamine hydrochloride (Ketaset, Bristol Laboratories, Syracuse, NY) at a dosage of 10 mg/kg estimated body mass (Bigler and Hoff 1974) and were measured, weighed, and ear-tagged. In November and February, 29 animals classified as adults, based on large size, permanent dentition, and testicular or mammary development, were fitted with radiocollars (Advanced Telemetry Systems, Bethel, MN) weighing an average of 75.4 grams, which represented 1.5% of the average body weight of radiocollared males and 2% of females. These collars were removed from recaptured animals in May and August. Recaptured animals were identified, weighed, and released. Following recovery from anesthesia, all animals were released at the site of capture.

Radio Telemetry

The radio-telemetry portion of the study was conducted from November 1991 to May 1992. Radiocollared animals were located by triangulation (Kenward 1987) with portable telemetry equipment from known locations along roads, or by following the signal to the animal. When an animal was located at a rest site, the habitat type, type of rest site, and presence of other raccoons, if known, were recorded. If the rest site was in a tree, the tree species was recorded when known, and the diameter at breast height (DBH) was measured. Mean triangulation error (Heezen and Tester 1967) for bearings taken from 200 to 600 m away was 58.8 m, with a 95% confidence interval of 34.0-83.6 m.

To obtain the requisite sample sizes necessary for habitat-use analysis, radio-tracking effort was designed to ensure that a minimum of 50 locations was obtained on each of at least 20 radio-collared animals (Allredge and Ratti 1986). Raccoons were located during the daytime one or more times a week. During nighttime tracking sessions, one to four individuals were located every two hours throughout the night. Each raccoon was followed all night at least once every two months. Approximately 40% of locations on each animal were collected at night and 60% were daytime locations. Data for nine radio-tagged animals with fewer than 50 locations were excluded from the habitat-use analysis.

Habitat Availability

A habitat map of the area was created by digitizing habitat contours from 1":200' aerial photos (Florida Department of Transportation, 1989) using the ERDAS (Version 7.5, ERDAS, Inc., Atlanta, GA) geographic information system. The digitized maps were converted into the ARC/INFO (Version 3.4D, Environmental Systems Research Institute, Redlands, CA) geographic information system format for editing and manipulation. Universal transverse mercator (UTM) reference points were obtained at the Ordway using a Magellan Global Positioning System (GPS) to get UTM coordinates of known locations visible on the aerial photos. The ARC/INFO map was transformed to UTM coordinates with a root mean square (RMS) error of 0.015 with six reference points. This indicates that the coordinates calculated for any given point should be within 15 m of the true coordinates.

Habitat-type composition of individual home ranges of the 20 raccoons located ≥50 times was determined by overlaying the minimum convex polygon (Mohr 1947) of each raccoon with the ARC/INFO habitat map. Minimum convex polygons (MCP) were calculated with program HOME RANGE (Ackerman et al. 1990), converted into ERDAS format using HOME22 (S. Breneman unpubl. program), and then into ARC/INFO format using ERDAS's conversion program. Lake areas were subtracted from the MCPs and proportions of different habitats available were based on non-lake land area. The boundaries of the study area were defined by an MCP calculated from all locations of the 20 raccoons combined. Habitat-type composition of the study area was determined by converting this polygon into ARC/INFO format in the manner described above, and overlaying it with the habitat map (Fig. 1).

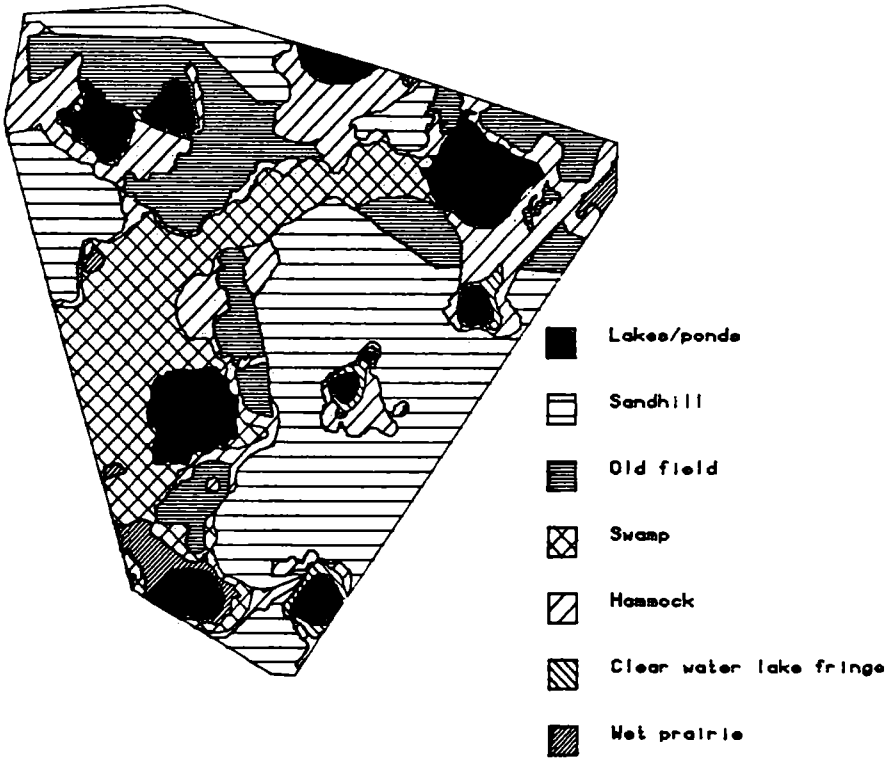

Figure 1.--Habitat types within the minimum convex polygon of all locations of raccoons located ≥50 times (1123 ha), Ordway Preserve, November 1991-May 1992.

Data Analysis

The significance level for all tests was set at 0.05. I made my analysis of habitat use by comparing use and availability with Friedman's (Conover 1980) and chi-square goodness-of-fit (Neu et al. 1974) tests on all locations and then comparing proportions of traps and number of captures in closed- (swamp and hammock) and open-canopy (sandhill and clear-water-lake fringe) habitat types with a binomial test (Hintze 1987; Ott 1988).

For the Friedman's test, I assumed that habitat availability was the same for all animals. A habitat's availability was defined as the proportion of that habitat

type found in the study area (i.e. in the minimum convex polygon of the locations of all 20 raccoons). Fisher's LSD was used to determine which habitat types accounted for differences observed (Conover 1980; Allredge and Ratti 1992).

Chi-square goodness-of-fit tests were done between proportions of habitat within each animal's home range (MCP) and the number of locations for that animal in each habitat type. When a significant chi-square value was obtained, Bonferroni confidence intervals (Byers et al. 1984) were calculated to determine which habitat types were not being used in the expected proportions.

The Friedman's and chi-square methods were both used because each has different strengths and limitations (Allredge and Ratti 1986, 1992; White and Garrott 1990). The Friedman's test assumes that locations of each animal are independent of those of other animals but does not require independence of locations of the same animal (Allredge and Ratti 1992). It gives equal weight to each animal, regardless of the number of locations, and differences in individual preferences can increase the probability of false significant tests (Allredge and Ratti 1992). The chi-square test assumes that all locations of an individual animal are independent (Allredge and Ratti 1992), but is not affected by individual preferences.

In this study, all animals used in the analysis had a similar number of locations (50-65). Locations of different animals were assumed to be independent, because there were few locations where different animals were together and these were discarded for the analyses. Locations of many of the individual study animals were not statistically independent (Walker 1993), however. Allredge and Ratti (1992) recommend that if independence between locations is questionable, chi-square analysis may still be used, but conclusions should be limited to the study animals per se, and not extrapolated to other populations of the species.

Mean number of habitat types in male and female home ranges was compared using a *t*-test (Hintze 1987). Sex differences in mean proportions of different habitat types per individual home range, sex differences in habitat use, and differences in habitats used for foraging and resting were tested by chi-square tests of independence (Hintze 1987; Ott 1988). Locations were classified foraging when animals were known to be moving due to changes in locations between readings. These movements could also include reproductive or other social activities.

I wanted to determine if there were differences in the types of rest sites used by male and female raccoons, so proportions of ground and tree rest sites used were compared by sex using a binomial test (Hintze 1987; Ott 1988), and selection of different types of tree rest-sites was compared using a chi-square test of independence (Hintze 1987; Ott 1988). Mean DBH of trees used as rest sites by each sex were compared with a *t*-test.

Accuracy of locations obtained by triangulation from telemetry data is a problem in habitat-use studies when the confidence ellipse of the location includes more than one habitat type (White and Garrott 1986; Samuel and Kenow 1992). In this study, most habitat patches were relatively large in relation to the degree of

triangulation error, and 10% of all locations were actual sightings for which habitat type was recorded without error. Locations that fell exactly on a boundary (n = 12) were discarded, and for all other locations I counted the habitat type within which the location fell, regardless of how close it was to the boundary (White and Garrott 1990). The effect of errors in classification of habitat type of locations is to lower the power of the tests to detect habitat selection (increased Type II error rate) (White and Garrott 1990). As most of the tests in this study comparing habitat use and availability detected differences, this was not a problem.

RESULTS

Habitat Use

Use-availability analyses indicated that raccoons did not use all habitats according to their availability. Sandhill was the most widely available habitat type, although hammock and swamp combined, or all of the closed-canopy forest, covered almost as large an area (Table 1). In the Friedman's test, ranks of habitat availability differed significantly from ranks of habitats used (T_2 = 23.316, df = 4 and 76, $p < 0.01$). In the multiple comparisons, the habitat types used fell into two categories. Habitat types in the first category (swamp, hammock, and clear-water-lake fringes) were used more than those in the second (old fields and sandhills). Use of habitat types within each category did not differ. The rank ordering of least-preferred to most-preferred habitat type was sandhill, old field, clear-water-lake fringe, hammock, and swamp forest (Table 1).

Proportions of habitats available and number of locations in each habitat type differed for every animal except one (Female #9, χ^2 = 4.17; df = 3; p = 0.24). Bonferroni confidence intervals demonstrated great individual differences in habitat use, although an overall pattern emerged. The majority of individuals used swamps more than expected (12 out of 18), hammocks (12 out of 20), and clear-water-lake fringes (6 out of 8) in proportion to their availability, and sandhills (11 out of 19) and old fields (17 out of 19) less than expected (Table 2). Less than one-third (n = 6) of the radio-collared raccoons accounted for two-thirds (67%) of the locations in the sandhill. Only two males (#16 and 24) contributed 34% of the total locations in the sandhill.

Habitat composition of the mean male and female home range was not significantly different χ^2 = 6.99, df = 4 and $p > 0.10$) (Table 3). Mean number of habitat types per male (4.63) and female (3.83) home range was not different (t = 0.659, df = 18, and p = 0.518). However, habitat use was significantly different between males and females (χ^2 = 23.2, df = 4 and $p < 0.001$) (Table 3). Differential use of the sandhill was the major contributor to the chi-square value,

Table 1. Proportion of total land area (1123 ha) represented by different habitat types within a minimum convex polygon of all raccoons located ≥ 50 times, and rank of preference by raccoons according to Friedman's test, Ordway Preserve, November 1991-May 1992.

Habitat	Proportion of Area	Rank
Sandhill	.40	5
Hammock	.19	2
Swamp	.18	1
Old field	.18	4
Clear water fringe	.02	3
Wet prairie *	.02	*

* Wet prairie was found on the edges of the study area and no raccoons were located in it.

with males using sandhill more than expected and females less than expected. The habitats also were used differently for foraging and resting ($\chi^2 = 48.77$, df = 4 and $p < 0.001$). Again, the sandhill was the largest contributor to the chi-square value, being used more than expected for foraging and less than expected for resting. The swamp was used less than expected for foraging and more than expected for resting, and the clear-water-lake meadows were used more than expected for foraging.

Overall trap success averaged 28.5%. Significant differences in trap success between closed-canopy and open-canopy sites were found in November ($p = 0.01$), February ($p = 0.02$), and May ($p = 0.02$), with greater trap success in closed-canopy sites. In August, trap success did not differ between the two types of sites ($p = 0.98$).

Rest Sites

In all habitats combined, 91.1% of the rest sites located were in trees. Animals were located on the ground or underground only in the swamp and hammock. Ground rest sites were under elevated root masses or in thick vegetation, such as palmetto, Virginia willow, or blackberry bushes. The exact location of 29 of the 143 rest sites in trees could not be determined due to poor visibility. For the remaining arboreal locations, six types of rest sites were identified, the most frequent (34.2%) being nests of fox and gray squirrels (*Sciurus niger* and *S. carolinensis*) (Table 4).

Table 2. Habitat availability, habitat use, and results of Bonferroni confidence intervals (BCI), by habitat type and individual. Habitat availability (Av) = % of home range represented by that habitat type; Habitat use (U) = % locations within that habitat type; BCI = ND for no difference between use and availability, > for use greater than availability, and < for use less than availability, at alpha = 0.05. Ordway Preserve, Florida, November 1991-May 1992. (H = Hammock; Sw = Swamp; OF = Old field; SH = Sandhill).

Raccoon	H Av/U/BCI	Sw Av/U/BCI	OF Av/U/BCI	SH Av/U/BCI	ME Av/U/BCI
Males					
1	45/36/ND	17/53/>	27/ 7/<	11/ 4/<	—
8	20/13/ND	34/81/>	31/ 2/<	15/ 4/<	—
12	24/18/ND	32/73/>	37/ 0/<	7/ 8/ND	—
16	16/32/>	16/14/ND	20/10/<	44/43/ND	1/ 2/ND
17	36/33/ND	17/52/>	24/ 2/<	21/11/ND	2/ 2/ND
18	21/14/ND	23/72/>	35/ 0/<	19/14/ND	1/ 0/<
24	11/33/>	6/14/ND	12/ 5/<	66/46/<	3/ 2/ND
33	25/43/ND	6/14/ND	25/18/ND	42/22/<	2/ 2/ND
Females					
2	19/ 4/<	55/91/>	26/ 0/<	1/ 6/ND	—
3	43/78/>	6/ 9/ND	25/12/<	23/ 5/<	3/ 0/<
4	29/52/>	—	—	62/32/<	10/15/ND
5	20/28/ND	64/68/ND	16/ 4/<	—	—
9	8/ 7/ND	74/85/ND	8/ 5/ND	10/ 3/ND	—
13	47/84/>	—	12/ 0/<	33/12/<	7/ 4/ND
19	16/10/ND	44/82/>	39/ 2/<	1/ 6/ND	—
21	34/ 8/<	35/82/>	13/ 0/<	18/10/ND	—
25	19/49/>	8/25/>	11/ 2/<	62/25/<	—
26	23/38/ND	24/44/>	36/11/<	17/ 7/<	—
28	24/13/ND	30/79/>	30/ 0/<	17/ 8/<	—
29	20/12/ND	29/70/>	12/ 0/<	39/19/<	—
Total	12 ND 6 > 2 <	6 ND 12 > 0 <	2 ND 0 > 17 <	8 ND 0 > 11 <	6 ND 0 > 2 <

* No difference for any habitat type, based on non-significant chi-square test ($\chi^2 = 4.17$; df = 3; $p = 0.24$).

The proportions of rest sites in trees and on or under the ground differed for males and females ($p = 0.04$), with males using a larger proportion of ground rest sites than females (Table 4). Males and females also used different types of tree rest sites ($\chi^2 = 14.17$, df = 5, $p = 0.01$). The major contributors to the chi-square value were male (less than expected) and female (greater than expected) use of tree cavities, although these alone could not account for the significance of the test. When types of tree rest sites were grouped into categories according to the level of

Table 3. Average proportions of different habitat types within male (mean minimum convex polygon with lake area subtracted = 259.88 ha) and female (mean minimum convex polygon with lake area subtracted = 65.67 ha) home ranges (HR), and proportion of male and female locations in each habitat type (Loc), Ordway Preserve, Florida, November 1991-May 1992.

	Male		Female	
	HR[1]	Loc[2]	HR[1]	Loc[2]
Hammock	.25	.28	.25	.31
Swamp	.21	.46	.31	.53
Old Field	.26	.05	.19	.03
Sandhill	.28	.20	.24	.11
Clear-water fringe	.01	.01	.02	<.01

[1] Home-range habitat-type composition not significantly different by sex.
[2] Locations per habitat type differ by sex ($p < 0.001$).

Table 4. Types and frequency of use of raccoon rest sites by habitat and sex, Ordway Preserve, Florida, November 1991-May 1992. (H = Hammock; Sw = Swamp; OF = Old field; SH = Sandhill).

	Habitat type					Sex	
	H	Sw	OF	SH	Total	M	F
On ground[1]	2	9	0	0	11	8	3
Underground	1	2	0	0	3	1	2
Tree[2]	87	31	4	21	143	51	92
Unidentified	16	12	1	0	29	11	18
Cavity	17	4	0	1	22	2	20
Squirrel nest	18	9	1	10	39	12	27
Crotch	11	1	1	3	16	7	9
Branches	15	3	0	1	19	10	9
Spanish moss	9	1	1	5	16	7	9
Vines	0	1	0	1	2	2	0
Undetermined	2	3	1	0	6	3	3
	90	45	5	21	163	63	100

[1] Proportion of ground (on or under) and tree sites differed by sex ($p = 0.04$).
[2] Types of tree rest sites differed by sex ($p = 0.01$).

protection they provided (1, cavities; 2, nests/Spanish moss/vines; and 3, branch/crotch of trees), males' preferential use of less-protected sites (branch/crotch of tree) was the largest contributor to the significant chi-square value ($\chi^2 = 24.53$, df = 2, $p < 0.001$), with differential male and female use of tree cavities also making a large contribution.

Eleven species of trees were used by raccoons for rest sites, with three species of oak (*Quercus hemisphaerica, Q. geminata, and Q. laevis*) accounting for the most use. Mean DBH of trees chosen by males (40.08 cm, SD = 15.13, 95% confidence interval = 34.5-45.6) was smaller than that of trees chosen by females (46.69 cm, SD = 16.11, 95% confidence interval = 42.2-51.13 cm), although the difference was not significant ($t = -1.85$, $p = 0.07$).

DISCUSSION

Habitat Use

Both the Friedman's and the chi-square tests indicated that swamp forest is used more than expected based on its availability at the Ordway, and sandhill and old fields less than expected. In both analyses, use of hammocks and clear-water-lake fringes falls between these two extremes. The rank ordering of least to most preferred habitat types from the Friedman's test (sandhill, old field, clear-water-lake fringes, hammock, and swamp forests) roughly reflects a moisture gradient from less to more mesic. That there was greater trap success in closed-canopy mesic (swamp forest and hammocks) than in open-canopy xeric (sandhill) sites also indicates a preference by Ordway raccoons for more mesic habitats. This preference for mesic habitats is similar to that found in studies of raccoon habitat-use in other areas (Stuewer 1943; McKeever 1959; Sonenshine and Winslow 1972; Fritzell 1978; Hudson 1978) and to that of the previous study done in north-central Florida based on trails picked up by hunting dogs (Caldwell 1963).

However, there was considerable individual variability in habitat use. One source of this variability was sex of the raccoon. Males made greater use of sandhills than females. This could be because of greater movements by males (Walker 1993), presumably due to their greater body size (Walker 1993) and metabolic needs, and to their reproductive activities. The mean number and proportion of different habitat types in male and female home ranges were not significantly different, so habitat availability was approximately the same overall for the two sexes. Thus, the greater use of sandhills by males is not merely a reflection of larger male home-range size.

Not all individual variability could be accounted for by sex, however. Some raccoons "specialized" by concentrating their activities in certain habitat types. For most females and some of the males, the majority of their locations were in one

particular habitat type. Swamp specialists were males #8, 12, and 18, and females #2, 5, 9, 19, 21, 28, and 29. Females #3 and 13 were hammock specialists. No raccoons had a majority of locations in any of the other three habitat types. The remaining raccoons had locations distributed more evenly over more than one habitat type.

Two of the more open habitat types, the sandhill and the clear-water lake meadows, were used more for foraging than expected, and the swamp, the most dense habitat type, was used more for resting than expected. This appears to indicate that raccoon distribution is restricted by availability of cover and protective rest sites. However, as raccoons at the Ordway, especially the males, did not tend to use rest sites that afforded much protection from adverse weather conditions (see **Rest Site Use** discussion below), perhaps protection from current and historic predators could be the explanation for this pattern of habitat use. Current raccoon predators at the Ordway are packs of domestic dogs from bordering areas and alligators, and historic predators included the Florida panther and humans.

Rest Site Use

Due to the mild climate of north-central Florida, raccoons in this area are probably not limited by availability of den sites that provide adequate protection from adverse weather, as they are in some areas in the northern parts of their range (Stuewer 1943). Although this study doesn't provide year-round information on rest-site use, during the wintertime, the coldest time of the year, both males and females were often found resting in the open on branches of trees, in places that offered very little protection from the elements, but allowed them to absorb the rays of the winter sun.

Males used less-protected sites on branches and in the crotch of trees more than females, and females used tree cavities more than males. Females were also less likely to use ground rest sites. They used larger trees than males, although the size difference was not significant. This preference for a more protective environment is consistent with their smaller body size (Walker 1993) and their need to protect their young from the weather and from predators. However, the use of smaller trees and fewer tree cavities by males may be a result of their greater use of the sandhills, where average tree diameter is probably smaller and tree cavities much less available. Data on the distribution of rest sites available for males and females would be necessary to make any conclusions.

The preference for trees as rest sites exhibited by raccoons at the Ordway also has been reported in other areas (Worley 1980; Rabinowitz and Pelton 1986; Allsbrooks and Kennedy 1987), although in most areas other types of rest sites are preferred (Butterfield 1944; Mech et al. 1966; Urban 1970; Hoffmann and

Gottschang 1977; Endres and Smith 1993). As in this study, on an island in a lake in central Tennessee, females used tree cavities more than males, especially during the summer, when they were used as maternal dens (Endres and Smith 1993). Juvenile males on the island preferred ground dens during every season.

The overwhelming use of trees for rest sites in this study may have been due to less need for protection from harsh weather than in other areas, lower availability of other types of rest sites, and the fact that only adults were radio-collared. Reasons proposed for extensive use of tree rest sites in a study in the south-Florida scrub (Worley 1980), that sites high above the ground were cooler because of less reradiation and more air movement, that there were fewer insect pests in sites high in the trees, and that these sites afforded protection from ground predators and increased range of visual surveillance, are also possibilities. The Florida scrub study provided year-round data, though, and this study was conducted only in the winter and spring, mostly during the coolest months of the year, so escape from the heat probably was not a major factor.

Raccoon Use of Critical Gopher Tortoise Habitat

The sandhills where gopher tortoises live are not the preferred habitat of the Ordway raccoons. Most raccoons used this habitat type less than expected based on availability. This could be due to the lower productivity of the habitat (Humphrey et al. 1985), which may result in less food available or to less protection and cover available. The latter explanation is supported by the fact that the sandhills were used more for foraging by raccoons than for resting, and that males, which used less-protected rest sites, used the sandhills more than females.

A very large proportion of the raccoon locations in the sandhills was attributable to a small proportion of the raccoons. Although no raccoon was located in the sandhills a majority of the time, two males (#16 and 24) were located there more often than in any other habitat type. These two males accounted for one-third of the sandhill locations. Along with one other male (#33) and three females (#4, 25, and 29), they accounted for two-thirds of the locations in the sandhills. Most of the remainder of the locations in that habitat seemed to be occasional foraging forays by individuals who lived mainly in the swamp and hammock interspersed with the sandhills.

Removal of raccoons has been demonstrated to enhance hatchling yield among turtles in Iowa (Christiansen and Gallaway 1984). More research on the extent of raccoon predation on gopher tortoises at the Ordway is needed in order to determine if removal of the small number of raccoons that frequent the sandhills on a regular basis may decrease predation on gopher tortoises. Because it is often difficult to determine what predator is responsible for a raided nest or the death of

a hatchling, an experimental removal of the "sandhill specialist" raccoons might be the best way to approach the question.

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