REPTILE SURVEYS OF PINE ROCKLAND HABITAT IN SIX MIAMI-DADE COUNTY PARKS

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ABSTRACT: *We surveyed the reptile fauna of pine rockland habitat in six Miami-Dade County parks using quadrat sampling in 1996–97 and time-constrained sampling in 2001. Time-constrained sampling detected similar numbers of reptile species per park as quadrat sampling in one-quarter as much time. We detected only 7–8 reptile species per park regardless of park size, which ranged from 2.4 to 80.9 ha. Of 15 reptile species found using both survey methods, five are nonnative. The most frequently observed species were the nonnative brown anole (*Anolis sagrei*) and tropical house gecko (*Hemidactylus mabouia*), whose population apparently has increased during the five years between surveys. Pine rockland has a higher proportion of native to nonnative reptile species than human-modified habitats in Miami-Dade County. Standing and fallen dead South Florida slash pines (*Pinus elliottii *var.* densa*) provide important refugia for many rockland reptile species, but these microhabitats are often destroyed by the periodic fires that prevent succession to tropical hammock. Additional survey methods are necessary to detect uncommon and widely dispersed species, such as large snakes.*

Key Words: Reptiles, pine rockland, exotic species, sampling techniques, Florida

PINE rockland habitat occurs along the large outcropping of oolitic Miami limestone that extends from Miami through Homestead to the Long Pine Key area of Everglades National Park. The Miami Rock Ridge is 6–16 km wide and mostly 2–7 m above sea level (Snyder et al., 1990). The ridge has a very irregular surface; pinnacle rock (weathered oolitic limestone) and solution holes are common, and sandy soil is primarily restricted to occasional shallow depressions in the surface rock. In the Miami area, ca. 97% of pine rockland has been destroyed since European settlement, and the highly fragmented remaining patches are embedded in a matrix of agricultural and residential landscapes (O'Brien, 1998). Only 14% of the 420 pine rockland fragments (1524 ha) outside of Everglades National Park are in public ownership (O'Brien, 1998). Some of the largest and most intact tracts of pine rockland are under the jurisdiction of Metro Dade County Parks and Recreation Department.

Dalrymple (1988) surveyed pine rockland in Everglades National Park using drift fences, but no similar survey has been conducted in the highly fragmented pine

rockland fragments outside the park. Because of surface oolitic limestone, installation of drift fences and pitfall traps is difficult in rockland habitat. A less labor-intensive method is needed to inventory the herpetofauna of rockland tracts. The original purpose of this study was to assess the effectiveness of quadrat sampling at detecting the state-threatened rim rock crowned snake (*Tantilla oolitica*) in rockland habitat in six Miami-Dade County parks. After quadrat sampling proved unsuccessful, we decided to compare the effectiveness of time-constrained sampling versus quadrat sampling at detecting reptile species in pine rockland in these six parks. Both sampling methods have set time limits, but quadrat sampling involves intensively searching a circumscribed area, whereas time-constrained sampling is restricted only by the boundaries of the habitat or study area (Campbell and Christman, 1982).

DESCRIPTION OF THE STUDY AREA—The study was conducted in pine rockland in six disjunct Miami-Dade County parks, with two parks in each of three size classes: ≤4 ha, 10–20 ha, and >40 ha. All parks are situated in southern Miami-Dade County between Kendall and Cutler Ridge. The two smallest parks are Pine Shore Preserve (2.4 ha) at SW 128 Street and SW 112 Avenue, and Ned Glenn Preserve (4.0 ha) at SW 188 Street and SW 87 Avenue. The medium-sized parks are the Tamiami Complex Addition Preserve (= Tamiami Complex; 10.5 ha) at SW 134 Street and SW 122 Avenue, and Rockdale Preserve (16 ha) between SW 144 Street and SW 152 Street just west of U.S. Highway 1. The largest parks are the Charles Deering Estate at Cutler (= Deering Estate; 46.5 ha) north of SW 167 Street and east of SW 72 Avenue, and the Larry and Penny Thompson Memorial Park (= Thompson Memorial Park; 80.9 ha) north of SW 184 Street and east of SW 134 Avenue. We surveyed pinelands at the north end of Deering Estate south of SW 152 Street, and the south end of Thompson Memorial Park south of SW 182 Terrace.

Pine rockland typically consists of an open-canopied forest of South Florida slash pine (*Pinus elliottii* var. *densa*) with a patchy understory of tropical and temperate shrubs and palms, including saw palmetto (*Serenoa repens*), cabbage palm (*Sabal palmetto*), poisonwood (*Metopium toxiferum*), winged sumac (*Rhus copallina*), rough velvet seed (*Guettarda scabra*), myrsine (*Myrsine floridana*), live oak (*Quercus virginiana*), and marlberry (*Ardisia escallonioides*). Ground cover is variable and often includes broomsedge (*Andropogon* spp.), wiregrass (*Aristida* spp.), muhly grass (*Muhlenbergia* spp.), rattlebox (*Crotalaria* spp.), partridge pea (*Cassia fasciculata*), coontie (*Zamia pumila*), and pinefern (*Anemia adiantifolia*) (Florida Natural Areas Inventory, 1990; Snyder et al., 1990).

Canopy closure by trees (mostly young slash pines) ≥5 m tall is 15–25% at all parks except Ned Glenn Preserve and Thompson Memorial Park, which have <5% canopy closure. Shrub cover (i.e., woody vegetation 0.5–5 m tall) is ≥50% at all parks. Exposed oolitic limestone covers ca. 20–30% of the surface in all parks except Ned Glenn Preserve and Thompson Memorial Park, which have ≥40% exposed surface limestone. Most parks have some areas with ≥75% exposed surface limestone. Anthropogenic debris was observed at all sites except Deering Estate and Thompson Memorial Park.

Relatively few large pine trees in the parks survived Hurricane Andrew, which struck Miami-Dade County on 24 August 1992 (Loope et al., 1994). Many standing pine snags (i.e., dead trees) with bark were present during surveys in 1996–97, but many had fallen by 2002. Due to subsequent fires and decomposition, remaining snags typically lacked bark and often consisted of only heartwood cores. Ned Glenn Preserve, Rockdale Preserve, and Thompson Memorial Park had few snags with rotten wood or loose bark suitable for sampling in 2002. In 2000, Ned Glenn Preserve was completely burned by two wildfires, and 4.5 ha of the area sampled in Thompson Memorial Park and 1.2 ha of Rockdale Preserve were burned by wildfires (Hazelton, 2002). In 2000–01, three wildfires burned 1.5 ha of Pine Shore Preserve (Hazelton, 2002). The portion of Deering Estate sampled was last burned in 1989 (Warren-Bradley, 2002), and Tamiami Complex has apparently not burned recently.

METHODS—Two randomly located quadrats (1000 m^2) were established in each park and sampled in September 1996 and May 1997 by two to four persons. Four man-hours of sampling was conducted per quadrat during each visit for a total of 96 man-hr of quadrat sampling. Sampling consisted of searching for reptiles by turning rocks, logs, and other debris; inspecting solution holes; raking through debris, soil, and rock rubble with a potato rake; and peeling loose bark off pine snags. During the second site visit, quadrats were moved $\geq$25 m away from the original quadrats because some types of refugia, particularly loose bark on snags, were destroyed during the first visit.

Time-constrained sampling was conducted in May 2002 by two persons in the same vicinity as the previous quadrats. Ned Glenn Preserve, however, was sampled in September 2002. Voucher specimens of nonnative herpetofauna were collected and deposited in the Florida Museum of Natural History (FLMNH), University of Florida (UF collection). One person used a "stump-ripper" snake hook, while the other person used a blowgun that shot tapered corks. Four man-hr were spent sampling each park; thus, only one-quarter as much effort was expended as in quadrat sampling. Time-constrained sampling involved similar searching techniques as quadrat sampling, but less surface debris was raked and fewer rocks turned. We were able to search most snags and fallen logs in all but the two largest parks, Deering Estate and Thompson Memorial Park, during the 4 man-hr of time-constrained sampling.

We decided to include only reptile sightings when comparing the effectiveness of different survey techniques, because amphibian presence and abundance are usually dependent upon suitable precipitation and nearby breeding sites. Suitable wetlands for reproduction of native amphibian species are not present near most of the rockland tracts sampled.

RESULTS—Combining both months of sampling, 5–6 reptile species were found per site using quadrat sampling (Table 1). Combining all six sites, 10 reptile species were recorded on quadrats, excluding a Florida box turtle (*Terrapene carolina bauri*) shell and shed snake skins (Table 1). During limited sampling outside quadrats, we detected three additional reptile species—scarlet kingsnake (*Lampropeltis triangulum elapsoides*), rough green snake (*Opheodrys aestivus*), and eastern diamondback rattlesnake (*Crotalus adamanteus*)—that suggested the possible efficacy of time-constrained sampling in pine rockland.

Time-constrained sampling five years later yielded 3–7 reptile species per site and a total of 12 reptile species for all six sites combined, excluding a box turtle shell, active gopher tortoise (*Gopherus polyphemus*) burrow, and shed diamondback rattlesnake skin (Table 1). The bark anole (*Anolis distichus*), reef gecko (*Sphaerodactylus notatus*), and ground skink (*Scincella lateralis*) were detected only during time-constrained sampling (Table 1). The mean number of reptile species

TABLE 1. Reptile species observed on quadrats in September 1996 and May 1997 and during time-constrained sampling in May or September 2002 of pine rockland in six Miami-Dade County parks, Florida. Numbers in parentheses represent shed snake skins, active tortoise burrows, or unhatched gecko eggs; X's represent gecko eggs observed but not counted.

Species	Pine Shore	Ned Glenn	Tamiami Complex	Rockdale	Deering Estate	Thompson Memorial
Turtles						
Gopherus polyphemus	0	0	0	0	1(2)	0
Sep 96/May 97	0/0	0/0	0/0	0/0	(1)/1	0/0
May or Sep 02	0	0	0	0	(1)	0
Terrapene carolina shell	0	0	2	0	0	0
Sep 96/May 97	0/0	0/0	0/1	0/0	0/0	0/0
May or Sep 02	0	0	1	0	0	0
Lizards						
Anolis carolinensis	13	4	1	2	0	8
Sep 96/May 97	6/5	2/2	1/0	1/1	0/0	3/1
May or Sep 02	2	0	0	0	0	4
Anolis distichus	0	0	0	0	2	0
Sep 96/May 97	0/0	0/0	0/0	0/0	0/0	0/0
May or Sep 02	0	0	0	0	2	0
Anolis sagrei	33	13	46	44	43	35
Sep 96/May 97	8/8	2/2	18/17	17/10	18/3	1/9
May or Sep 02	17	9	11	17	22	25
Eumeces inexpectatus	5	10	3	2	5	4
Sep 96/May 97	3/0	0/3	0/0	1/1	0/2	2/1
May or Sep 02	2	7	3	0	3	1
Hemidactylus garnotii	8	2	3(16)	5(2)	7(8)	3
Sep 96/May 97	3/5	0/2	0/2	2/3	5/0	1/2
May or Sep 02[1]	0(0)	0	1(16)	0(2)	2(8)	0(0)
Hemidactylus mabouia	17(5)	8	11(8)	18(11)	0	22(1)
Sep 96/May 97	0/0	0/2	0/0	0/0	0/0	0/0
May or Sep 02[1]	17(5)	6	11(8)	18(11)	0	22(1)
Hemidactylus unhatched eggs	24	0	>2	9	>2	11
Sep 96/May 97	7/17	0/0	X/1	6/3	2/X	2/6
May or Sep 02	0	0	1	0	0	3
Scincella lateralis	0	1	0	0	0	0
Sep 96/May 97	0/0	0/0	0/0	0/0	0/0	0/0
May or Sep 02	0	1	0	0	0	1
Sphaerodactylus notatus	0	0	0	0	1(2)	0
Sep 96/May 97	0/0	0/0	0/0	0/0	0/0	0/0
May or Sep 02[1]	0	0	0	0	1(2)	0
Snakes						
Coluber constrictor	0	(1)	0	0	2	0
Sep 96/May 97	0/0	0/(1)	0/0	0/0	0/0	0/0
May or Sep 02	0	0	0	0	2	0
Crotalus adamanteus	0	0	(1)	0	0	0
Sep 96/May 97	0/0	0/0	0/0	0/0	0/0	0/0
May or Sep 02	0	0	(1)	0	0	0
Diadophis punctatus	0	0	0	1	0	0
Sep 96/May 97	0/0	0/0	0/0	0/1	0/0	0/0
May or Sep 02	0	0	0	0	0	0

TABLE 1. Continued.

Species	Pine Shore	Ned Glenn	Tamiami Complex	Rockdale	Deering Estate	Thompson Memorial
Elaphe guttata	0	0	5	0	0	(1)
Sep 96/May 97	0/0	0/0	1/0	0/0	0/0	0/0
May or Sep 02	0	0	4(7)	0	0	(1)
Ramphotyphlops braminus	2	0	1	4	2	1
Sep 96/May 97	1/1	0/0	1/0	3/0	1/1	1/0
May or Sep 02	0	0	0	1	0	0
Unidentified snake skin	(1)	0	(1)	(1)	0	(1)
Sep/May 97	(1)/0	0/0	(1)/0	0/(1)	0/0	0/(1)
May or Sep 02	0	0	0	0	0	0
Total[2]	78	38	70	76	63	73
August 96/May 97	21/19	4/11	21/19	24/16	24/7	8/13
May or Sep 02	38	23	30	36	32	52
No. species[3]	7	7	9	7	8	7
August 96/May 97	5/4	2/5	4/3[4]	5/4	4/4	5/4[5]
May or Sep 02	4	4	7	3	7	5

[1] Eggs were incubated to determine species.
[2] Excludes eggs, burrows, turtle shells, and shed skins.
[3] Includes eggs, burrows, turtle shells, and shed skins but does not include off-quadrat species.
[4] *Lampropeltis triangulum* and *Crotalus adamanteus* were recorded off quadrats in May 1997.
[5] *Opheodrys aestivus* was recorded off quadrats in September 1996.

detected per site did not differ using both methods ($t = 0.70$, df = 10, $P = 0.50$), but time-constrained sampling required one-quarter as much effort and covered a larger area than quadrat sampling.

In the three size classes of parks, we detected a mean of 7.0 or 8.0 reptile species after combining the results of both sampling methods and including wildlife sign. Although both methods appeared to be reasonably successful at detecting common species, they were ineffective at detecting uncommon or widely dispersed species, such as large snakes. We did not find any rim rock crowned snakes. Five of the 15 reptile species detected in at least one park are nonnative: bark anole, brown anole (*Anolis sagrei*), Indo-Pacific gecko (*Hemidactylus garnotii*), tropical house gecko (*H. mabouia*), and Brahminy blind snake (*Ramphotyphlops braminus*) (Table 1).

Eighty-nine percent of 225 anoles (*Anolis* spp.) were observed on the ground, on bushes or palmetto fronds, on fallen pine logs, or on trunks of snags (Table 2). The proportion of anoles observed in these four microhabitats differed significantly between sampling methods ($\chi^2 = 28.6$, df = 3, $P < 0.0001$), but some of this difference could be due to habitat differences between years. Seventy-one percent of 28 southeastern five-lined skinks (*Eumeces inexpectatus*) were found under pine logs, under rocks or other objects, under bark on snags, or inside the wood of snags (Table 2). All Brahminy blind snakes except one were found in, under, or immediately adjacent to a fallen log or snag (Table 2); two individuals were found in September 1996 under the bark on pine snags ca. 1 m above the ground. All five corn snakes (*Elaphe guttata*) were found inside the wood of pine snags.

TABLE 2. Number of individuals of the most common reptiles observed in various microhabitats during quadrat searches (QS) in September 1996 and May 1997 and during time-constrained sampling (TCS) in May or September 2002 of pine rockland in six Miami-Dade County parks, Florida.

	Anolis spp.		*Hemidactylus* spp.		*Eumeces inexpectatus*		*Ramphotyphlops braminus*	
Microhabitat	QS	TCS	QS	TCS	QS	TCS	QS	TCS
On ground or rock	22	22	0	0	1	0	0	0
On trunk of live pine	4	3	0	0	0	0	0	0
On trunk of snag	11	29	0	0	0	2	0	0
On bush or palmetto frond	38	25	0	0	0	0	0	0
On fallen log	44	10	0	0	0	1	0	0
On wooden fence	0	4	0	2	0	0	0	0
Under fallen pine log	2	0	0	0	3	0	1	1
Under rock or other object	0	1	1	1	2	2	1	0
Under bark on pine log	0	0	5	0	1	0	2	0
Under bark on snag	3	4	9	18	2	2	1	0
Inside fallen pine log	0	0	1	2	1	2	1	0
Inside wood of snag	0	3	10	52	2	7	2	0
In soil at base of snag	0	0	0	1	0	0	1	0
Total	124	101	26	76	12	16	9	1

Eighty-three percent of 102 geckos (*Hemidactylu*s spp.) were found under the bark or inside the wood of snags. Gecko eggs were found in similar microhabitats as adults. Eggs collected during the time-constrained survey hatched 0–39 days later and yielded valuable species occurrence information, such as the presence of the Indo-Pacific gecko at Rockdale Preserve. We observed only one Indo-Pacific gecko in 2002 at Tamiami Complex but collected 16 eggs. At times, we were unable to capture a gecko, and visual identification of species was sometimes problematic.

DISCUSSION—During quadrat searches,we found an average of 5.2 reptile species per site and 10 species overall, excluding wildlife sign (i.e., shed skins and gopher tortoise burrows). During time-constrained sampling, we found 4.5 reptile species per site and 11 species overall in one-quarter as much time and during only one sampling period. Our comparisons of the effectiveness of the two sampling methods are complicated by possible changes over the five-year period in the number of species, relative abundance of species, or searchable microhabitats at various sites. Also, different observers were used during our surveys, which only had one observer (KME) in common. The only previous study in Florida that compared these two sampling methods was conducted in eight different habitats or sites in Marion County (Florida Game and Fresh Water Fish Commission, 1976). This earlier study found time-constrained sampling(average of 7.0 reptile species per site) to be more effective than quadrat sampling (3.7 reptile species per site), but only half as much time was spent searching quadrats (2 man-hr per 1000-m^2 quadrat) as during our study.

Our results suggest that time-constrained sampling is a more efficient method for surveying reptiles in pine rockland than quadrat sampling, but some of the

observed differences may have been due to changes in reptile communities or habitats between years. Additional simultaneous comparisons of the two sampling methods using the same observers are necessary before definitive conclusions can be drawn. The use of additional survey methods would help compile a more complete species list. Drift fences with funnel traps are effective at trapping a variety of herpetofaunal species (e.g., Dalrymple, 1988; O'Hare and Dalrymple, 1997; Enge, 2001), but are difficult to install in rockland because of surface limestone and shallow soil. In large rockland tracts intersected by roads, vehicular surveys would probably detect additional species, particularly snakes (Dalrymple et al., 1991). Time-constrained sampling would probably have been more effective if both persons had been equipped with snake hooks for turning objects, searching snags and logs, and raking through debris. The person with the blowgun could not easily conduct some microhabitat searches without a snake hook.

Geckos, southeastern five-lined skinks, and some snake species hide primarily in pine snags and logs, which are often destroyed by fire. Suitable pine snags for sheltering reptiles were numerous when quadrat sampling was conducted because of the effects of Hurricane Andrew, and 15 reptiles were found under bark and 15 reptiles inside the wood of snags (Table 2). However, suitable snags were less abundant during time-constrained sampling because wildfires in 2000 at three of the parks destroyed much of the above-ground deadwood microhabitats. Relatively few pine snags retained bark, and most reptiles sheltered instead in those snags with rotten wood that had not burned completely, which explains why we found 66 reptiles inside snags but only 24 reptiles under bark during time-constrained sampling (Table 2). We found corn snakes only inside pine snags but suspect they would have also been found under the bark of snags, if more snags had had bark or if air temperatures had been cooler. Although fire destroys some refugia, it sometimes kills pine trees and creates new refugia. Periodic fires, which probably occurred every 3–10 years during pre-Columbian times, are necessary to prevent succession of pinelands to tropical hammock, which may take only 20–30 years on the mainland in southern Florida (Robertson, 1953; Alexander, 1967; Hofstetter, 1984). If understory development progresses longer than 8–10 years in pinelands, fires are precluded or catastrophic (Robertson, 1954; Loope and Dunevitz, 1981; Snyder, 1986).

We might have been less successful at detecting small, secretive snake species, such as the southern ringneck (*Diadophis p. punctatus*) and Brahminy blind snake (theoretically, also the rim rock crowned snake), during time-constrained sampling than during quadrat sampling because we spent less time turning rocks and raking through the fire-depleted debris. Finding Brahminy blind snakes above the ground in snags corroborates observations of arboreal activity in this species (Das and Wallach, 1998). Several explanations might account for discrepancies in observations of anoles in various microhabitats using the two methods. During time-constrained sampling, we might have been looking farther ahead and been more prone to detect anoles on the trunks of pine snags before they either ascended out of sight or descended to the ground. The much slower and more intensive quadrat sampling might have resulted in better detection of anoles on bushes, palmetto fronds, and fallen pine logs. We also suspect that one observer (KLK)

used only during time-constrained sampling was better at spotting anoles from afar.

A drift-fence survey in pine rockland in Everglades National Park recorded 13 reptile species, all native, with green anoles predominating (Dalrymple, 1988). Species detected in Everglades National Park but not in the six parks we surveyed were the striped mud turtle (*Kinosternon baurii*), island glass lizard (*Ophisaurus compressus*), eastern indigo snake (*Drymarchon corais couperi*), dusky pigmy rattlesnake (*Sistrurus miliarius barbouri*), peninsula ribbon snake (*Thamnophis sauritus sackenii*), and eastern garter snake (*T. s. sirtalis*). The paucity of nearby wetlands and scarcity of anurans in the county parks surveyed probably account for our failure to find the latter three snake species, which prey heavily on anurans. We detected the following native species that were not trapped in pinelands in Everglades National Park: gopher tortoise (Deering Estate), rough green snake (off-quadrat in Thompson Memorial Park), scarlet kingsnake (off-quadrat in Tamiami Complex), and diamondback rattlesnake (Tamiami Complex). The relatively small tracts of pine rockland contained in Miami-Dade County parks are more depauperate than similar habitat in Everglades National Park, but even the smallest tracts support populations of some species, particularly nonnative lizards. Fewer individuals and species of herpetofauna were trapped in pinelands than in wet prairies or hammocks in Everglades National Park, and the presence of many species in pinelands is dependent upon interdigitating prairies and scattered hammocks (Dalrymple, 1988). Wet prairies are absent in all the county parks we surveyed, and intact hammocks are present only at Deering Estate. We suspect that the ringneck snake, corn snake, and Everglades racer (*Coluber constrictor paludicola*) are present in most of the county parks surveyed, and the primary prey of the latter two species is probably nonnative lizard species.

Upland snake species with large home ranges have undergone severe population reductions in southern Florida (Wilson and Porras, 1983). The largest pineland surveyed, Thompson Memorial Park, is adjacent to extensive pinelands on Metrozoo property. Metrozoo staff have observed only one indigo snake and one diamondback rattlesnake during the past six years in the zoo's ca. 178 ha of undeveloped (mostly pinelands) and 121 ha of developed areas, but frequently they have observed racers, eastern coachwhips (*Masticophis f. flagellum*), and ringneck snakes (Conners, 2002). We observed none of these species during either quadrat or time-constrained sampling in a 30-ha portion of Thompson Memorial Park, although some of these species are undoubtedly present. We were surprised to find a diamondback rattlesnake in Tamiami Complex, one of the smaller preserves, both in 1997 and 2002 (shed skin), and we suspect that the two sightings were not of the same individual. The total amount of suitable diamondback rattlesnake habitat remaining in the area is less than that of the smallest home range size (25.7 ha) found for an individual rattlesnake in northern Florida (Timmerman, 1995). Potentially suitable rattlesnake habitat includes 10.5 ha in the preserve, 7 ha of nearby pinelands, and a mown powerline right-of-way with very little cover. The available habitat is surrounded by a warehouse complex, subdivision, plant nursery, and the Florida Turnpike.

Our findings suggest that the gecko community has changed during the five years between surveys. In 1997, we found two tropical house geckos only in Ned Glenn Preserve. In 2002, however, we found 71 tropical house geckos in five parks (Table 1) and incidentally observed one that was diurnally active in the garden portion of the sixth park, Deering Estate. In 1997, we found 29 Indo-Pacific geckos in five parks, whereas in 2002, we found only four individuals in three parks. Meshaka and co-workers (1994) suggested that the tropical house gecko probably occurred in Florida prior to its documentation in 1990 in the upper Florida Keys, Monroe County (Lawson et al., 1991), and it was probably introduced at multiple sites in Miami and the Florida Keys via imported commercial plants. The tropical house gecko is rapidly expanding its range and has already replaced the longer established Indo-Pacific gecko on buildings in some areas (Meshaka, 2000), and we suspect that the same replacement process is occurring in Miami-Dade pinelands.

Conservatively, at least 24 nonnative reptile species currently have established populations in Miami-Dade County. In the future, species in South Florida that are habitat-specific and have limited ranges will likely become endangered, extirpated, or extinct as their habitat is destroyed, and populations of native and exotic species that are adapted to disturbed, urban, or agricultural environments will increase (Forys and Allen, 1999). Of all reptile species or sign observed in all six parks combined, 12 species are native and five are exotic. In contrast, only three native and seven exotic reptile species were found during a survey of the Doc Thomas House, a 1.4-ha tract of seminatural pineland/hammock habitats in South Miami, Miami-Dade County (Meshaka, 1999a). Four native and eight exotic reptile species were found at the Kampong, a 4-ha botanical garden in Coconut Grove, Miami-Dade County (Meshaka, 1999b). This suggests that the presence of pine rockland tracts, particularly large ones, in the urban landscape of Miami-Dade County might ensure the continued survival of some native reptile species in an area that is increasingly dominated by exotic species. Several exotic reptile species, such as the bark anole, knight anole (*Anolis equestris*), and Tokay gecko (*Gekko gecko*), are common in the surrounding human-modified landscape but apparently seldom invade remnant pockets of pine rockland.

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