

THE IMPACT OF FERAL CATS AND DOGS ON POPULATIONS OF THE WEST INDIAN ROCK IGUANA, *CYCLURA CARINATA*

JOHN B. IVERSON

*Department of Natural Science, The Florida State Museum, Museum Road, University of Florida,
Gainesville, Florida 32611, USA*

ABSTRACT

*A population of rock iguanas, *Cyclura carinata*, inhabiting Pine Cay in the Caicos Islands was nearly extirpated during the three years following construction of a hotel and tourist facility. The decline, from an estimated adult lizard population of nearly 5500, was due primarily to predation by domestic dogs and cats introduced to the island simultaneously with hotel construction. Population declines on other nearby islands were also attributed to predation by these feral mammals.*

INTRODUCTION

Among the most rapidly declining of the world's reptile species are the rock or ground iguanas of the genus *Cyclura*. These primarily herbivorous lizards are endemic to the West Indies, and their populations are steadily dwindling in the face of man's intervention. Two extinct species, *Cyclura mattea* and *C. portoricensis*, were finally extirpated from St Thomas and Puerto Rico, respectively, during pre-Columbian times, presumably by the native Indians (Miller, 1918; Barbour, 1919). The Navassa Island endemic, *Cyclura cornuta onchiopsis* (= *nigerrima*), was last reported by Schmidt (1921); it is now also extinct (Thomas, 1966). The last substantiated reports of living Jamaican iguanas, *Cyclura collei*, were made in the late 1940s (Lewis, 1946; Woodley, 1971). Since then only a single mummified carcass has been found despite intensive search efforts (Woodley, 1971; Mittermeier, 1972). The species must be presumed extinct. Of the remaining seven extant species (*vide* Schwartz & Thomas, 1975), none is free from persecution by man and his animals (Honegger, 1968).

The decline of populations of the rock iguanas, as well as those of the marine and land iguanas (*Amblyrhynchus* and *Conolophus*) in the Galapagos, is usually blamed

on predation by, or competition with, introduced feral mammals such as rats, dogs, cats, goats, pigs and mongooses (Lewis, 1944; Dowling, 1964; Carey, 1975; and review in Wiewandt, 1977). However, the direct effects of the introduction of these animals on undisturbed, relatively natural populations of iguanas have been poorly documented. This paper relates the systematic extirpation of an island population of the Turks and Caicos Islands iguana, *Cyclura carinata*, following the introduction of cats and dogs.

MATERIALS AND METHODS

The natural history and social behaviour of *Cyclura carinata* were studied on Pine Cay and adjacent islands in the Caicos Islands, British West Indies, between September 1973 and June 1976 (Fig. 1). The results of the behaviour and ecology study, as well as locations and complete descriptions of the study islands, appear in Iverson (1977).

Pine Cay (350 ha) was chosen as the principal study island in 1973 not only because of the obvious abundance of lizards, but also because construction of a large hotel and clubhouse complex had just begun on the island. This offered the opportunity to record the effects of increased human occupation on a theretofore relatively undisturbed iguana population.

A flush transect method similar to the 'King strip census' (see Giles, 1971, for discussion) was utilised for lizard density and population size estimates. The technique consisted of traversing a permanent census trail on Pine Cay (Fig. 1) during the lizards' major activity periods. Distance along the transect route where each lizard was flushed and distance from trail to lizard (before being flushed) were recorded. A total of 103 transects was run during the course of the study. The accuracy of this method was confirmed by comparison with data from one of the primary study areas (SW Blind), through which the transect route passed and from which reliable density data were available. The success of flush transects on Pine Cay was the result of the character of the island itself as well as that of the lizard. *Cyclura* on the study island were very wary and typically ran when a human approached. Although many lizards were seen during transects, detecting most was possible only after they bolted off noisily over leaf litter. This technique could therefore be successful only in areas where the vegetation was dense enough to prevent the lizard from seeing the observer until he was within audible range of the noise made by the flushed lizard. Such was the case along the transect route I utilised.

Flush transect data were used to compute adult lizard densities by four methods. The first (Method A) was a modification of the Frye strip census method as used by Overton (1953) for quail. The second method (Method B) utilised only the number of lizards flushed within 10 m of the transect, and assumed that all lizards within this

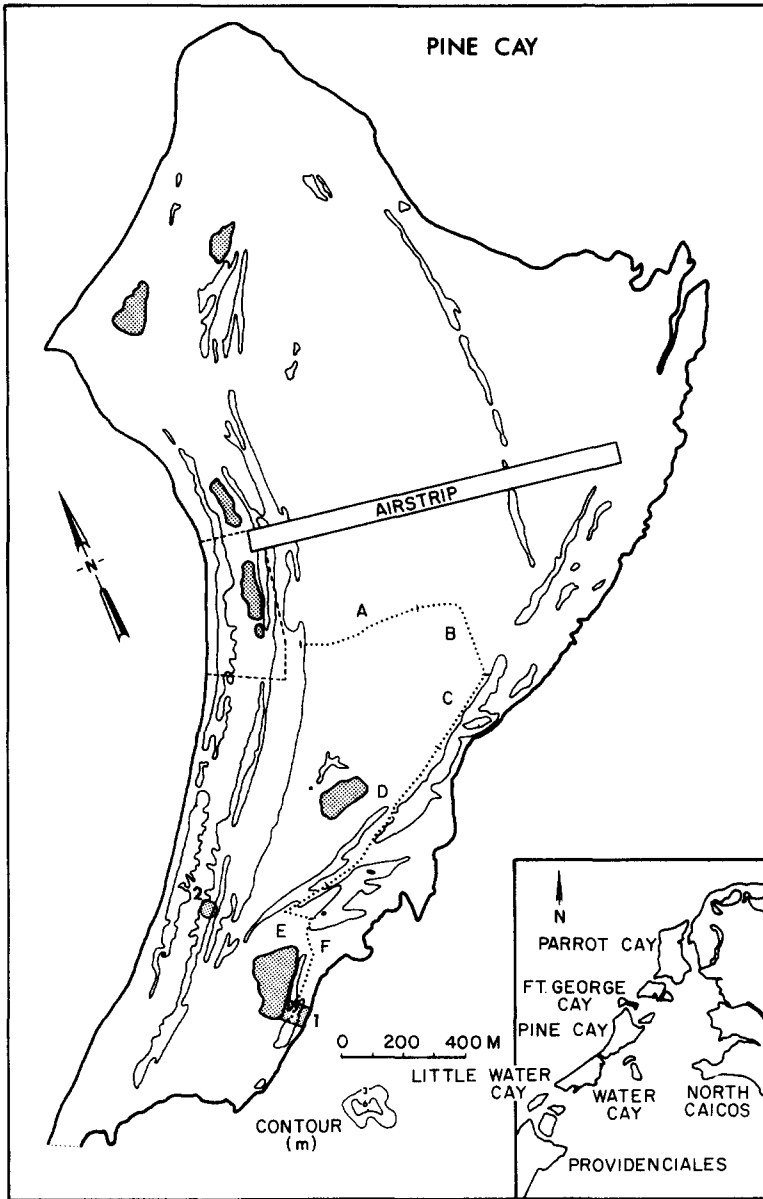


Fig. 1. Topographic map of Pine Cay, Caicos Islands, showing locations of primary study site (1 = SW Blind) and flush transect route. Letters A through F indicate sectors of transect (dotted line). Other trails and roads are not illustrated. Dashed line encloses limits of hotel grounds. Unnumbered shaded areas indicate lakes.

boundary could be seen or heard. The density was expressed in the formula:

$$\text{Density} = \frac{\text{Number}}{\text{Area}} = \frac{N}{dL}$$

where N = number of lizards flushed within 10 m, L = length of transect, d = width of transect (in this case, 20 m).

Method C was a variation of the King strip census method as discussed by Hayne (1949) and expanded by Giles (1971). The final method (D) was that of Gates *et al.* (1968). Calculations, application, and acceptability of each of these methods to the lizard data are discussed in Iverson (1977). Only those data from transects yielding maximum density values are reported here.

RESULTS AND DISCUSSION

Lizard densities for each sector of the flush transect route early in the study are given in Table 1. Sector A of the transect route, because of its proximity to human activity, supported extremely low densities of lizards even at the beginning of the study. Data from that sector were therefore excluded from the initial mean density calculation. That value, obtained by averaging all density estimates obtained for sectors B through F by all four methods in June and July 1974, was 26.88/ha. This compares well with the value of 31.1/ha based on known adult inhabitants of optimum habitat at the SW Blind study area at that time. Based on area and density values for primary habitats on Pine Cay at that same time (early summer, 1974) the adult *Cyclura* population was estimated at nearly 5500 (Iverson, 1977).

Both the maximum number of iguanas encountered on flush transects (Table 2, Fig. 2) and the densities computed from those transects (Table 3, Fig. 3) decreased steadily during the study period. These data also clearly indicate the effects of proximity to human settlement: lizards in those sectors nearest to human activity (i.e. those alphabetically closer to A; see Fig. 1) showed the earliest declines and disappeared first. Since lizards were not disturbed or removed from the transect route in the course of my studies, their disappearance was presumed to be entirely the result of other human-related interferences.

TABLE 1
DENSITIES/HA OF ADULT *Cyclura carinata* ALONG FLUSH TRANSECT ROUTE ON PINE CAY, CAICOS ISLANDS, DURING JUNE-JULY 1974. VALUES ARE MEANS OF ALL FOUR METHODS; INDIVIDUAL VALUES FOR EACH METHOD ARE IN IVERSON (1977)

Sector	A	B	C	D	E	F	Total
Length	426.5 m	376.7 m	304.3 m	605.7 m	235.6 m	339.4 m	2288 m
Mean density	1.656	17.730	20.745	31.284	27.812	36.842	19.639

Note: See Fig. 1 for location of transect sectors. The SW Blind study area is part of Sector F.

TABLE 2
 MAXIMUM NUMBERS OF ADULT LIZARDS FLUSHED DURING A SINGLE TRANSECT, BY SECTOR

Sector Length	A 426.5 m	B 376.7 m	C 304.3 m	D 605.7 m	E 235.6 m	F 339.4 m	Total 2288 m
June-July 1974	1	8	10	29	9	17	67
September 1974	1	6	8	20	14	14	54
November-December 1974	0	0	2	5	3	9	18
April 1975	1	3	3	9	6	10	24
July-August 1975	0	1	3	4	2	7	11
November 1975	0	0	0	1	1	6	6
May 1976	0	0	0	1	0	0	1
June 1976	0	0	0	0	0	0	0

Note: November and December data are less reliable due to weather. Sector A is closest to human settlement; Sector F, furthest.

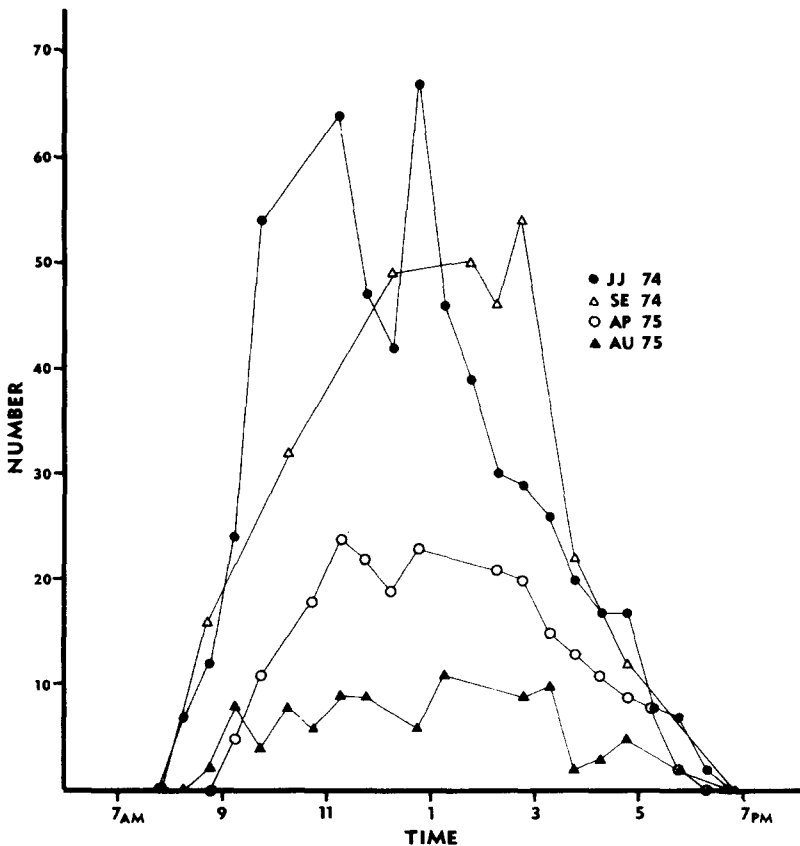


Fig. 2. Decline in total number of adult *Cyclura carinata* sighted during half-hour flush transects on four separate trips to Pine Cay: June-July 1974; September 1974; April 1975; August 1975. Times are EDT. A single lizard was flushed during transects in May 1976 and none in June 1976.

TABLE 3
CHANGE IN MAXIMUM CALCULATED DENSITY/HA OF ADULT *Cyclura carinata*
ALONG FLUSH TRANSECT ROUTE. VALUES ARE MEANS OF ALL FOUR METHODS;
INDIVIDUAL VALUES FOR EACH METHOD ARE IN IVERSON (1977)

Date	Entire transect	Sector F only
June-July 1974	19.639	36.842
September 1974	15.746	25.750
April 1975	5.657	18.945
August 1975	4.398	19.303
May 1976	0.109	0

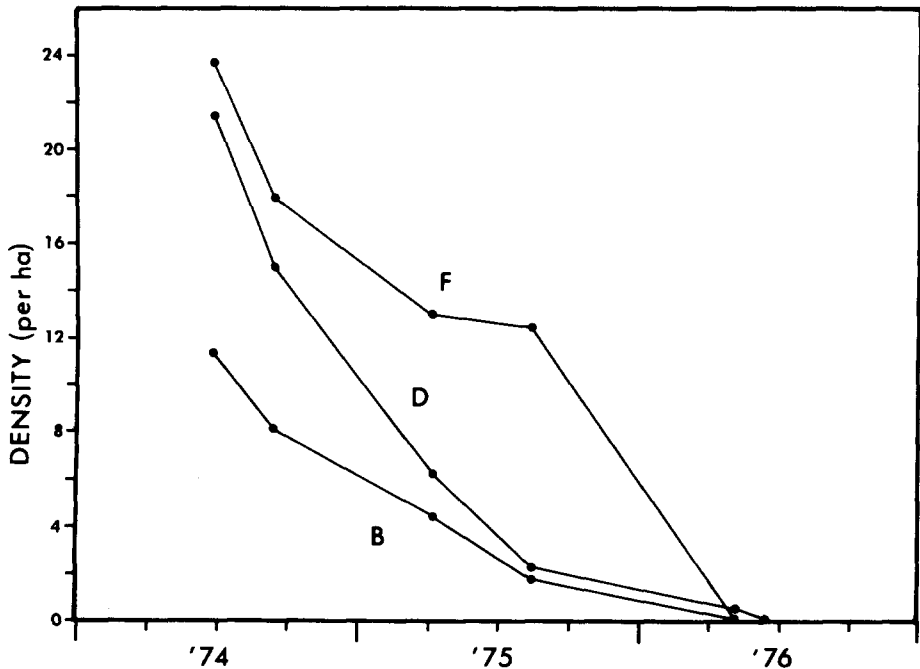


Fig. 3. Decline in density of *Cyclura carinata* along selected sectors of flush transect on Pine Cay following initiation of hotel construction during the summer of 1973. Letters indicate transect sector (see Fig. 1 for location; B is closest to human settlement, F is furthest). Density values are averages of methods A and B only.

The entire iguana population on Pine Cay, estimated to exceed 15,000 individuals in June and July 1974 (Iverson, 1977), was almost completely extirpated during the following two years. Not a single iguana was flushed during five transects, and evidence (by spoor) of only five iguanas (4 large males and 1 young adult) was found on the entire island during a week of investigation in June 1976. *Cyclura carinata* had thus been nearly extirpated from Pine Cay. A similar decline also occurred on

Water Cay, connected by a narrow isthmus to Pine Cay. However, no such declines were noted on Little Water Cay or Fort George Cay (at least until 1976), both of which had received very little human interference in recent history (but see later). The relationship of the observed population decreases to human occupation cannot be denied.

Of all the ramifications of human exploitation, those which most affect the survival of *Cyclura carinata* are habitat destruction and direct predation by man and animals introduced by him. Iguanas are clearly rare or absent from the larger islands of the Turks and Caicos banks, i.e. those most populated with humans and feral mammals (Table 4). However, as is the case for many of the world's wildlife species (Denney, 1974), domestic dogs (*Canis familiaris*) and cats (*Felis domesticus*) apparently represent the greatest threat to *Cyclura carinata* populations, and have been the most significant contributors to the demise of iguanas on at least Pine and Water Cays. This determination was based on direct observations as well as circumstantial evidence.

Cats

Prior to the construction of the hotel on Pine Cay in 1973, only a few cats lived on the island. There was, moreover, little evidence that these feral cats were affecting the dense iguana population. I believe this can be attributed to their very low numbers and the presence of a more easily available food source: rats thrived on Pine Cay in high densities in the 1950s and 1960s (Rabb & Hayden, 1957; Liam Maguire and George Nipanich, pers. comm.).

When hotel construction began in September 1973, there was a sudden influx of staff and workmen, many of whom brought cats and dogs. Many of these free-ranging pets became feral, mother cats repeatedly removing litters born in residences to the 'bush' (personal observation). Initially, rats may have provided a ready food resource. The once dense rat populations soon virtually disappeared, with only small populations remaining around older buildings (Liam Maguire, pers. comm.; and personal observation). At this point, the cats apparently preyed upon a higher proportion of lizards, crabs, and birds, suggested by observations of their feeding behaviour and examination of faecal pellets.

The cats on Pine Cay employed at least three foraging strategies to obtain lizards, depending on the time of day. During early morning hours, before lizard emergence, they excavated shallow burrows inhabited by curly-tail lizards (*Leiocephalus*) and juvenile *Cyclura*. This was presumably also the case in later afternoon following submergence, although this was not documented. I saw cats with freshly caught lizards in their mouths as early as 15 to 20 minutes before sunrise, and up to 2 hours before typical iguana emergence times. As lizard burrows have a distinct odour, detectable at their entrances by even the human nose, I believe that cats are capable of following the odour gradient to its greatest concentration at the burrow. Support for this comes from observations made when captive juvenile *Cyclura* placed in

TABLE 4

STATUS OF *Cyclura carinata* ON ISLANDS OF THE TURKS AND CAICOS BANKS. QUESTION MARKS INDICATE LACK OR UNCERTAINTY OF DATA. NOTE: THE CAICOS ISLANDS ARE LISTED GEOGRAPHICALLY COUNTERCLOCKWISE AROUND THE BANK. AREAS ARE FROM SADLER (1975) OR ESTIMATED FROM TOPOGRAPHIC MAPS. A = ABUNDANT; U = UNCOMMON; R = RARE (IF ANY); E = EXTIRPATED

<i>Island</i>	<i>Approximate area (km²)</i>	<i>Status</i>	<i>Feral mammals present</i>	<i>Source^a</i>
Grand Turk	18.1	R	Dogs, cats	Hesse
Salt Cay	6.5	E	Dogs, cats	Hesse
Turks Island Cays	2.6	R?	?	—
Gibbs				
Long				
Penniston				
Pear				
Cotton				
East				
Big Sand Cay	0.8	A	?	Hesse
South Caicos	22.0	R	Cats, dogs, donkeys	Iverson, Auffenberg, Hesse
East Caicos Cays	22.0	A-U	None	Auffenberg
Plandon				
Middle Creek				
Nigger				
Hog				
East Caicos	46.6	A?	Cows, donkeys	Hesse
Iguana Cay	0.1	A	?	Ray & Sprunt (1971:73)
Middle Caicos	124.3	R	Dogs, cats	Hesse
North Caicos	108.8	R	Dogs, cats	Hesse
North Caicos Cays	7.8	?	?	—
Highas				
Conch				
Bay				
Major Hill				
Parrot	5.2	E	Dogs	Coleman, Hesse
Dellis Cay	1.6	A	None	Hesse
Grouper	0.8	A	(As of 1976) dogs	Hesse
Ft George	0.5	A	(As of 1976) dogs	Iverson
Pine Cay	3.9	R	Cats, dogs	Iverson, Hesse
Water Cay	3.9	U	Cats	Iverson, Hesse
Little Water Cay	0.5	A	No cats or dogs	Iverson, Hesse
Donna Cay	0.3	A	None	Coleman
Mangrove Cay	1.0	A	None	Coleman
Providenciales	97.1	E	Dogs, cats	Auffenberg
West Caicos	23.3	E	?	Coleman
Southern Cays	7.8			
White		?	?	—
Pear		?	?	—
Bush		?	?	—
Ambergris		A	?	Hesse
Fish		?	?	—
Six Hills		A	?	Honegger (1968)
Middleton		A	None	Iverson, Hesse
Long		U	Cats	Iverson
Total	505.5			

^a Personal observations by Chuck and Kathy Hesse of Pine Cay, Tommy Coleman of Parrot Cay, Walter Auffenberg, and the author.

plastic bags were occasionally brought into my quarters for measurement. Within minutes, cats were scratching at the door to gain entry. If allowed to enter they would always find the lizards within 30 seconds, even when the plastic bags were hidden under cloth bags on top of an overhead shelf. Such capabilities greatly decrease search times and increase prey capture success.

As emergence time approaches, cats employ their usual sit-and-wait strategy (Christian, 1975) near lizard burrows. Emerging lizards are torpid and easily obtained; *Leiocephalus* and juvenile *Cyclura* suffer heavy mortality by this method. This technique is also commonly used by natives in securing adult *Cyclura* for food. This sit-and-wait strategy is to some extent used during the lizard's normal activity period, but active stalking is much more common. Cats were observed to take *Cyclura* up to 235 mm snout-vent length and 510 g, subduing them immediately with neck bites. Unlike dogs (see later), the cats always ate the lizards they killed. Only three scats from feral cats on Pine Cay were found during the course of the field work, but two of these contained skin and skeletal elements of adult iguanas. During two months of field work in early summer of 1974, pet cats were observed daily bringing lizards (*Leiocephalus* and *Cyclura*) to their kittens. Most of the offspring of the cats became feral as they matured, and thus subsisted entirely on native wildlife.

The feral cat population on Pine and Water Cays increased continually during the study. In 1974, feral cats were encountered at a rate of about 1/two weeks of field work. By June 1976, daily sightings were the rule. Cat tracks on sandy roads were rare in 1973 at a time when iguana tracks were so plentiful that estimating lizard numbers on this basis was impossible. By late spring 1976, lizard spoor was almost non-existent and that of cats could be found virtually everywhere on both Pine and Water Cays.

Rand (1967) also believed that domestic cats were the most important predators on *Anolis lineatopus* in Jamaica, and their detrimental effects on other natural ecosystems are well documented (review in McKnight, 1964; Coman & Brunner, 1972; George, 1974).

Dogs

Grant (1937) and Hirth (1963) both considered dogs the most serious predator on the iguanas, *Cyclura pinguis* and *Iguana iguana*, respectively. Free-ranging dogs on Pine Cay were also responsible for killing many iguanas. Though the total dog population only averaged between two and three during the study, these few spent most of each day chasing and killing iguanas. Dogs frequently ranged over the entire island in a single day. They often crossed the sandy isthmus to Water Cay and were observed making forays on its most southerly shores, nearly 5 km from human habitation. They were frequently observed chasing and killing adult *Cyclura*, and attempting to exhume lizards they had chased into retreats. This latter behaviour was probably responsible for the deaths of more iguanas than direct predation, since the dogs frequently succeeded only in plugging the lizard's burrow, entombing it

within. Dogs on Pine Cay apparently chased and killed *Cyclura* mainly for 'sport'; they were regularly fed by humans and left as many carcasses as they consumed. Freshly killed iguanas were often taken from the mouths of dogs (and cats); sometimes only portions of the bodies could be salvaged. Fresh carcasses of 18 obviously dog-killed adult *Cyclura* were collected on Pine Cay and Water Cay during field work, although many more were seen.

Whereas lizard numbers near the SW Blind decreased slowly during most of the study period (due to its distance from the centre of the dogs' activity ranges at that time), between November 1975, and May 1976, the population was finally totally extirpated. The majority of the burrows showed evidence of digging by dogs; many had caved in and all were inactive.

During this same time-interval, the dogs began swimming the channel separating Pine Cay from Grouper and Fort George Cays (Fig. 1), both with dense iguana populations. Prior to that time, only one iguana carcass had ever been found during four visits to Fort George, but during a half day in June 1976, four were discovered (they were not the object of search) in a small area at the western end of the island. While adults seemed to be less abundant than in the past, inactive lizard burrows were unquestionably more common. In June the dogs were visiting Grouper and/or Fort George Cays daily. The iguanas on these islands will probably suffer the same fate as those on Pine Cay.

ACKNOWLEDGEMENTS

My studies of *Cyclura carinata* would not have been possible were it not for the generous efforts of the New York Zoological Society, the Florida State Museum, Walter Auffenberg, C. W. Maguire, Bill and Ginny Cowles, Françoise de Rouvray, Gaston Decker, and my wife, Sheila. Walter Auffenberg, John Behler, Wayne King and Tom Wiewandt commented on early drafts of the manuscript. Chuck and Kathy Hesse, Tommy Coleman, and numerous other Caicos Islanders shared their knowledge of iguana populations with me.

REFERENCES

- BARBOUR, T. (1919). A new rock iguana from Porto Rico. *Proc. biol. Soc. Wash.*, **32**, 145-8.
- CAREY, W. M. (1975). The rock iguana, *Cyclura pinguis*, on Anegada, British Virgin Islands, with notes on *Cyclura ricordi* and *Cyclura cornuta* on Hispaniola. *Bull. Fla St Mus. biol. Sci.*, **19**, 189-233.
- CHRISTIAN, D. P. (1975). Vulnerability of meadow voles, *Microtus pennsylvanicus*, to predation by domestic cats. *Am. Midl. Nat.*, **93**, 498-502.
- COMAN, B. J. & BRUNNER, H. (1972). Food habits of the feral house cat in Victoria. *J. Wildl. Mgmt*, **36**, 848-53.
- DENNEY, R. N. (1974). The impact of uncontrolled dogs on wildlife and livestock. *Trans. N. Am. Wildl. and nat. Resour. Conf.*, 39th, 257-91.

- DOWLING, H. G. (1964). Goats and hawks—A new theory of predation on the land iguana. *Anim. Kingd.*, **67**, 51–6.
- GATES, C. E., MARSHALL, W. H. & OLSON, D. P. (1968). Line transect method of estimating grouse population densities. *Biometrics*, **25**, 135–45.
- GEORGE, W. G. (1974). Domestic cats as predators and factors in winter shortages of raptor prey. *Wilson Bull.*, **86**, 384–96.
- GILES, JR., R. H. (ed.) (1971). *Wildlife management techniques*. Washington, DC, The Wildlife Society.
- GRANT, C. (1937). Herpetological notes with new species from the American and British Virgin Islands, 1936. *J. Dept. Agric., Univ. P. Rico*, **21**, 503–22.
- HAYNE, D. W. (1949). An examination of the strip census method for estimating animal populations. *J. Wildl. Mgmt*, **13**, 145–57.
- HIRTH, H. F. (1963). Some aspects of the natural history of *Iguana iguana* on a tropical strand. *Ecology*, **44**, 613–15.
- HONEGGER, R. E. (1968). *Red data book 3: Amphibia and Reptilia*. Zurich, International Union for Conservation of Nature and Natural Resources, Survival Service Commission.
- IVERSON, J. B. (1977). *Behavior and ecology of the rock iguana, Cyclura carinata*. PhD dissertation. University of Florida, Gainesville.
- LEWIS, C. B. (1944). Notes on *Cyclura*. *Herpetologica*, **2**, 92–8.
- LEWIS, C. B. (1946). Jamaican lizards. 34–6. In *Glimpses of Jamaican natural history*, ed. by C. B. Lewis, **2**, 34–6. University of West Indies, Institute of Jamaica.
- MCKNIGHT, T. (1964). Feral livestock in Anglo-America. *Univ. Calif. Publ. Geogr.*, **88**, 1–78.
- MILLER, G. S. (1918). Mammals and reptiles collected by Theodoor de Booy in the Virgin Islands. *Proc. U.S. natn. Mus.*, **54**, 507–11.
- MITTERMEIER, R. A. (1972). Jamaica's endangered species. *Oryx*, **12**, 258–62.
- OVERTON, W. S. (1953). *Progress reports for investigations project, W-33-R, April 1 and July 1*. Tallahassee, Florida Game and Freshwater Fish Commission.
- RABB, G. B. & HAYDEN, JR., E. B. (1957). The Van Voast-American Museum of Natural History Bahama Islands expedition record of the expedition and general features of the islands. *Am. Mus. Novit.*, **1836**, 1–53.
- RAND, A. S. (1967). Ecology and social organization in the iguanid lizard *Anolis lineatopus*. *Proc. U.S. natn. Mus.*, **122**, 1–79.
- RAY, C. & SPRUNT, A. (1971). *Parks and conservation in the Turks and Caicos Islands*. Privately printed.
- SADLER, H. E. (1975). *Turks Island landfall*. Privately printed.
- SCHMIDT, K. P. (1921). The herpetology of Navassa Island. *Bull. Am. Mus. nat. Hist.*, **44**, 555–9.
- SCHWARTZ, A. & THOMAS, R. (1975). A checklist of West Indian amphibians and reptiles. *Carnegie Mus. nat. Hist., Spec. Publs*, **1**, 1–216.
- THOMAS, R. (1966). A reassessment of the herpetofauna of Navassa Island. *J. Ohio herpet. Soc.*, **5**, 73–89.
- WIEWANDT, T. (1977). *Ecology, behavior, and management of the Mona Island ground iguana, Cyclura stejnegeri*. PhD dissertation. Cornell University, Ithaca, New York.
- WOODLEY, J. D. (1971). The Jamaican ground iguana in Hellshire. In *Hellshire Hills scientific survey, 1970*, ed. by J. D. Woodley, 127–33. University of West Indies, Institute of Jamaica.

NOTE ADDED IN PROOF

The author visited Pine Cay in March 1978 and found no evidence of Iguanas on the island; they have been completely extirpated. The stomach of a cat killed during that visit was stuffed with carcasses of smaller lizards (*Anolis scriptus* and *Leiocephalus psammotromus*). Populations of these lizards on Pine Cay are also now declining rapidly.