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THE LIZARD COMMUNITY FROM COZUMEL ISLAND, QUINTANA ROO, MEXICO

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RESUMEN

Para determinar las prioridades de conservación para las comunidades animales se requiere del conocimiento general de su composición y estructura. Aquí se presenta información básica sobre la composición y estructura de la comunidad de lagartijas en la Isla de Cozumel. Los muestreos incluyeron observación y captura de animales a lo largo de 19 transectos en los diferentes tipos de vegetación. Nueve species de lagartijas se colectaron/observaron durante tres salidas al campo. Cinco especies se consideraron especialistas de habitat y cuatro como generalistas. Se reconocieron quince microhabitats. *Aristelliger georgeensis* y *Sceloporus cozumelae* fueron espcialistas de microhabitat. La selva baja subcaducifolia tuvo la diversidad Alfa más alta pero una alta diversidad Beta indica grupos similares de lagartijas a traves de la isla. La clasificación de las especies basada en información ecológica y biogeográfica nos indica que las especies raras: *Cnemidophorus cozumela*, *Sceloporus cozumelae* y *Aristelliger georgeensis* están en peligro de extinción en la isla.

Palabras Clave: Lagartija, comunidad, caribe, México.

ABSTRACT

Setting conservation priorities for animal communities requires general knowledge of their composition and structure. This paper presents basic information on the composition and structure of the lizard community of Cozumel Island, Quintana Roo, Mexico. Sampling procedures included capture of live animals and observations along 19 transect lines in the different vegetation types of the island. Nine species of lizards were collected/observed during three field trips. Five species are habitat specialists and four are habitat generalists. Fifteen different microhabitats were recognized. *Aristelliger georgeensis* and *Sceloporus cozumela* were microhabitat specialists. Tropical semideciduous forest accounted for the highest Alpha diversity, but high Beta diversity indicated similar lizard assemblages throughout the island. Classification of the species based on ecological and biogeographical data indicated that rare species, *Cnemidophorus cozumela*, *Sceloporus cozumelae* and *Aristelliger georgeensis*, are threatened on the island.

Key Words: Lizard, community, Caribbean, México.

INTRODUCTION

Although Mexico is one of the most biologically diverse countries of the world and it harbors the richest herpetofauna of the world (Mittermeir 1988, Flores-Villela and Geréz 1988), little is known about the basic biology of individual species. In order to protect this diverse assemblage of species, we need to know more about the composition and structure of communities. Mexican lizard studies have been conducted mainly in desert environments (Alvarez *et al.* 1989, Barbault 1977, Barbault and Grenot 1977, Barbault *et al.* 1978, Gallina *et al.* 1985, González-Romero *et al.* 1989, Maury 1981, Maury and Barbault 1981, and Ortega *et al.* 1986), and only a few have been carried out in the mexican tropics (e.g., Lee 1980, López-González *et al.* 1993).

The present study aims to contribute to the knowledge of the composition and structure of the lizard community of Cozumel Island, analyzing the spatial, microenvironmental and temporal distribution of the species in the different habitats.

Study Area

The study area is located in the Caribbean sea, 17 km east of the coast of Quintana Roo, between 20°13' and 20°30' N latitude, 86°47' and 87°03' W longitude. The island has an area of approximately 490 km² and consists of the remains of calcareous reefs. Tropical semideciduous forest is the dominant vegetation (Instituto de Ecología 1985).

Vegetation types on the island were identified based on criteria developed by the Instituto de Ecología (1990). Vegetation communities sampled were: (1) Beach, defined as that area from the high-tide line to the limits of coastal shrub; (2) Coastal Shrub, mainly consisting of *Coccoloba uvifera*; (3) Coconut plantation; (4) Mangrove forest which is an association of *Laguncularia racemosa-Avicennia germinans*; (5) Low flooded forest, a community dominated by *Acelorrhaphe wrightii*, and (6) Tropical semideciduous forest, an association of *Esenbeckia pentaphylla, Psidium sartorium* and *Bursera simaruba*.

MATERIAL AND METHODS

Field trips to the island were carried out during the 1985, August 1986 and September 1990. Field trips represented 2280 man/hours of effort (3 persons each trip). Field effort began at 500 h and ended until 2100 h (≈16 h/day). The 19 localities sampled are shown in figure 1. Nineteen transects 500-700m in length were walked at different times of the day beginning at 0600 h and finishing at 1700 h. Lizards seen were recorded and specimens were collected by hand or with rubber bands.

Surveys techniques ranged from looking under fallen trees and rocks to searching in the canopy of the forest and vines. Data collected for each specimen were date, time of observation/collection, habitat (vegetation type), microhabitat.

Alpha diversity was expressed as species richness (i.e. number of species) per habitat. Beta diversity was calculated as s/a-1; where s is the total number of species present, and a is the mean of the sum of species present on each habitat (Magurran 1988).

Niche breadth B was calculated as $B = 1/(\sum_{i=1}^{n} Pi^2)$

Where P is the proportion of individuals found on microhabitat i (Levins 1968). Absolute niche breadth Bs was calculated as Bs = B-1/N-1, where B is niche breadth and N is the number of microhabitats used (Colwell and Futuyma 1971). A Bs value of 1 for a given species means that all substrates were used in equal proportions, while a value aproaching 0 means that a few substrates were used at a high frequency and many substrates were used at a low frequency.

The index $O_{jk} = \sum_{i=1}^{n} P_{ij} \ P_{ik} / \sqrt{\sum_{i=1}^{n} P^2_{ij} \sum_{i=1}^{n} P^2_{ik}}$ was used to measure niche overlap.

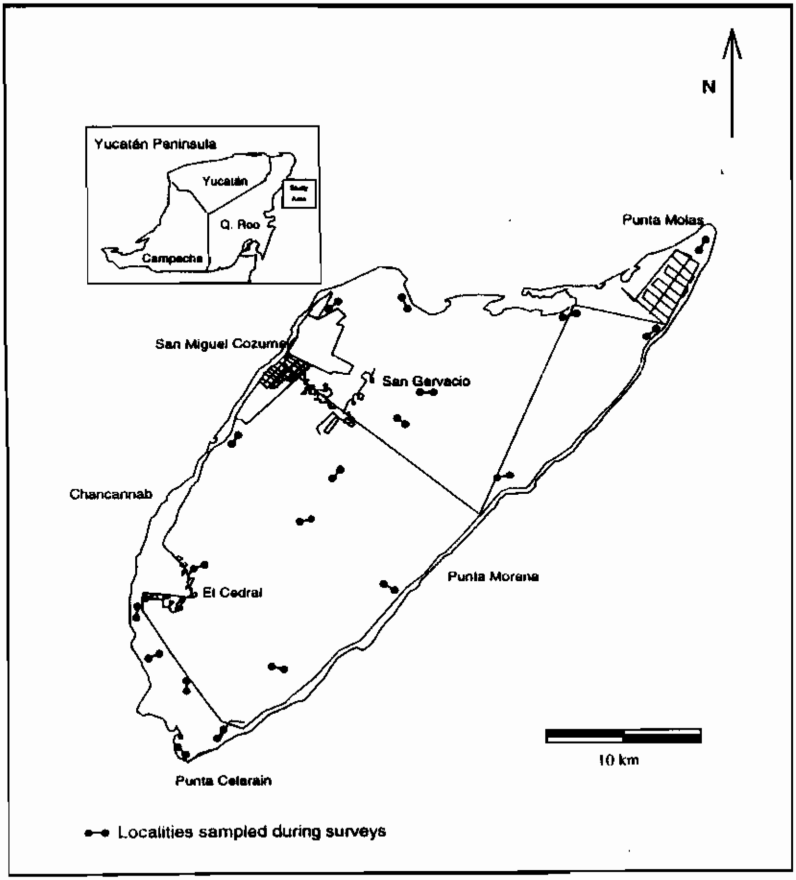

Figure 1
Sample sites on Cozumel Island, Quintana Roo.

Where P_{ij} and P_{ik} are frequencies of microhabitat use by species **j** and **k** (Pianka 1973). Zero means no overlap and 1 means total overlap. These data analyses were done with the program SPOVRLAP.BAS from the package Statistical Ecology (Ludwig and Reynolds 1988).

Relative abundance was used to categorize species using the following classfication. Rare species were those with from 1 to 5 records, uncommon species from 6 to 15 records, common from 16 to 25 records and abundant more than 26 records (Call 1982, Crump 1971).

Biomass per species was calculated using the mean of recorded weights multiplied by the number of organisms and divided by the total biomass.

RESULTS AND DISCUSSION

Taxonomic composition

The complete lizard community of Cozumel island includes 14 species (Duellman 1965, Lee 1996, this study). The lizards are represented by seven families: Gekkonidae, Iguanidae, Corytophanidae, Phrynosomatidae, Polychridae, Scincidae and Teiidae. Species found during this study are shown in table 1. Five species known to occur on the island but not accounted on this study were the geckoes *(Sphaerodactylus glaucus* and *S. millepunctatus and, Hemidactylus frenatus and H. turcicus),* and the scincid *(Eumeces schwartzei)* (Harris and Kluge 1984, Lopez-Gonzalez 1991; Lee 1996). The current existence of *Anolis cristatellus* has been questioned and is considered extirpated from Cozumel (Lee 1996). As expected for an island, a relatively closed ecosystem, the number of species is low compared to the adjacent mainland, where 23 species of lizards have been recorded (Instituto de Ecología 1990, Lee 1980, 1996, López González 1991).

Table 1

Lizard distribution on the vegetation types of Cozumel island. BE (beach), CS (costal shrub), CO (Coconut plantation), MG (mangrove forest), LF (low-flooded forest), SF (tropical semidesiduous forest). 1 = Present, 0 = not present.

SPECIES	BE	CS	CO	MG	LF	SF	Total
Aristelliger georgeensis	1	1	1	1	1	1	(6)
Anolis rodriguezii	0	0	0	0	1	1	(2)
Anolis sagrei	0	1	1	1	1	1	(5)
Basiliscus vittatus	0	0	0	1	1	1	(3)
Ctenosaura similis	1	1	1	1	1	1	(6)
Iguana iguana	0	0	0	1	1	1	(3)
Sceloporus cozumelae	1	1	0	0	0	0	(2)
Mabuya unimarginata	0	0	0	0	0	1	(1)
Cnemidophorus cozumela	1	1	1	0	0	1	(4)
TOTALS	4	5	4	5	6	8	

Also, the low species richness can be explained by taxonomically distant species (Vitt and Carvalho 1995) with only two congeneric species, the *Anolis*.

At Lavrado, Brazil, Vitt and Carvalho (1995) recorded 8 lizard species, this low number of species was partly related to the lack of sit and wait foragers(only two). Comparatively, our lizard assemblage has five sit and wait foragers (*Aristelliger georgeensis, Anolis rodriguezii, A. sagrei, Basilliscus vittatus,* and *Sceloporus Cozumela)*.

Habitat Utilization

Five species (*Anolis rodriguezii, Basiliscus vittatus, Iguana iguana, Sceloporus cozumelae* and *Mabuya unimarginata*) were found in only one habitat. Four species (*Aristelliger georgeensis, Anolis sagrei, Ctenosaura similis, Cnemidophorus cozumela*) used a variety of habitats (Table 1). Alpha diversity was higher in the tropical semideciduous forest, where 89% of the species were recorded. The habitats with the lowest alpha diversity were the beaches and the coconut plantations, with four species each. Beta diversity was 0.70, which means that it would be necessary to sample many habitats to find a different faunal assemblage.

Habitat similarity

Based on data in table 2, high values of similarity exist between the beach and the coastal shrub (88.8%) and the beach and the coconut plantation (75%), and also between the coastal shrub and the coconut plantation (88.8%). This probably reflects the ecotone effect of the coastal shrub between the beach and the coconut plantation. There was a 90.9% value between the mangrove and the low flooded forest and a 76.9% between the mangrove and the tropical semideciduous forest. An intermediate value was found between the low flooded forest and the semievergreen forest (85.7%), reflecting also an ecotone position of the low flooded forest. The location of patches of coastal shrub was usually in between beaches and coconut plantations, and the position of low flooded forest was between mangrove and semievergreen forest.

Table 2

Lizard communities similarity in different habitats. BE (beach), CS (costal shrub), CO (Coconut plantation), MG (mangrove forest), LF (low-flooded forest), SF (tropical semideciduous forest).

	BE	CS	CO	MG	LF	SF
Beach	1	88.8	75.0	44.4	40.0	50.0
Coastal shrub		1	88.8	60.0	54.5	61.5
Coconut plantation			1	66.6	60.0	66.6
Mangroove				1	90.9	76.9
Low flooded forest					1	85.7
Semideciduous forest						1

Microhabitat Distribution

Fifteen different microhabitats were used by lizards during the surveys (Table 3). Niche breadth values are given in Table 4. The species with a broadest niche was *Anolis sagrei* (9.6) followed by *A. rodriguezi* (8.78). Both species were found on 93.3% of the substrates. Species with narrow niches were: *Aristelliger georgeensis* (1.47), *Sceloporus cozumelae* (1.53), *Cnemidophorus cozumela* (2.02).

Microhabitat use can be related to the structural fragmentation concept of Lord and Norton (1990). A change in the number of plants characterizing a site can produce circumstances more favorable for one species than another. For example, if we modify the beach and coastal shrub landscape, reducing the number of places with bushes that provide cover for *Sceloporus cozumelae*, the number of animals of this species will be reduced and probably the number of *Cnemidophorus cozumela* will increase. Overlap niche index is shown in Table 5, significant overlap values were obtained between *Anolis sagrei* and *A. rodriguezii* (0.729, $X^2 = 0.632$, $P < 0.005$). Overlap present for both anole species very likely is diminished in the food dimension of the niche. Because *Anolis rodriguezii* is smaller than *A. sagrei*, we think based on data from other species of anoles (Losos 1990, Roughgarden 1974, Schoener 1968), that they likely used different kinds of prey.

For *Sceloporus cozumelae* and *Cnemidophorus cozumela* overlap is not as wide as with the anoles, but nevertheless it is significant (0.273, $X^2 = 2.596$, $P < 0.005$). Segregation in these two species can be explained in terms of differences in foraging strategies. *Sceloporus* are sit and wait foragers, whereas *Cnemidophorus* are active foragers (Ortega *et al.* 1992, Pianka 1973, Vitt and Carvalho 1995).

Activity patterns

Most lizards were active between 0700 and 0900 h with a peak activity at 0800 h and other at 1400 h (Fig. 2). No activity was registered at noon, probably because this is the hottest part of the day. The disappearance of most individuals around midafternoon could be a common pattern of neotropical areas (i.e. Vitt and Carvalho 1995). Active individuals of *Aristelliger georgeensis* were found during daylight hours throughout the survey, but always in the shade.

Relative Abundance

Dominant species in the community based upon number of lizards seen during each of our field trips, were *Anolis sagrei* (102), *Cnemidophorus cozumela* (76), *A. rodriguezii* (55) and *Basiliscus vittatus* (54). These species contribute 75.7% of the total number of lizards recorded. Using Crump's classification (1971), five species are abundant: *Anolis sagrei, A. rodriguezii, Basiliscus vittatus, Ctenosaura similis* and *Cnemidophorus cozumela*. Two are common: *Sceloporus cozumelae* and *Mabuya unimarginata*. For the last two species, *Iguana iguana* can be considered uncommon and *Aristelliger georgeensis* is rare

Table 3
Relative distribution of the lizard species from Cozumel Island over the various microhabitats or substrates (habitat use).

Species	Abun.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A. georgeensis	5	0	0.2	0	0	0.2	0.6	0	0	0	0	0	0	0	0	0
A. rodriguezii	55	0.036	0.073	0.2	0.127	0.127	0.109	0.127	0.055	0.018	0	0.018	0.018	0.018	0.036	0.018
A. sagrei	102	0.059	0.186	0.059	0.147	0.147	0.137	0.029	0.049	0.01	0	0.039	0.039	0.069	0.020	0.010
B. vittatus	54	0.019	0.019	0.093	0.037	0	0.019	0	0.296	0	0.093	0.037	0	0.111	0.093	0.185
C. similis	41	0.024	0.195	0.244	0.024	0	0	0.024	0.220	0.098	0.024	0.024	0.024	0.024	0.073	0
I. iguana	8	0	0.5	0	0.125	0	0	0	0.250	0	0	0	0	0.125	0	0
S. cozumelae	19	0	0	0	0	0	0	0	0.053	0	0.158	0	0	0	0.789	0
M. unimarginata	24	0	0	0.167	0.375	0	0.125	0	0.042	0.083	0	0.083	0.042	0	0	0.083
C. cozumela 76	0	0	0	0	0	0	0	0.671	0.013	0.026	0.092	0	0.013	0.184	0	

Abreviations and numbers are: Total number seen for each species (Abundance), over tree stumps (1), over tree trunks (2), over rocks (3), over logs (4), over trees <5 cm DBH (5), over limbs (6), over grasses (7), open ground (8), rocky ground (9), ground between grasses (10), ground between herbs (11), tree base (12), over bushes (13), ground between bushes (14) and among litter (15).

Table 4
Niche breadth (B) and absolute niche breadth (Bs) for the lizard species.

SPECIES	B	Bs
Aristelliger georgeensis	1.47	0.03
Anolis rodriguezii	8.78	0.56
Anolis sagrei	9.6	0.61
Basiliscus vittatus	6.09	0.36
Ctenosaura similis	5.02	0.29
Iguana iguana	2.90	0.14
Sceloporus cozumelae	1.53	0.04
Mabuya unimarginata	4.79	0.27
Cnemidophorus cozumela	2.02	0.07

Table 5
Overlap niche matrix of the lizard community.

	Ag	Ar	As	Bv	Cs	Ii	Sc	Mb	Cc
A. georgeensis	0.000	0.091	0.084	0.000	0.018	0.000	0.000	0.001	0.000
A. rodriguezii		0.000	**0.729**	0.012	0.019	0.000	0.000	0.004	0.000
A. sagrei			0.000	0.020	0.021	0.001	0.000	0.001	0.000
B. vittatus				0.000	0.041	0.001	0.001	0.006	0.006
C. similis					0.000	0.001	0.000	0.005	0.001
I. iguana						0.000	0.000	0.000	0.000
S. cozumelae							0.000	0.000	**0.273**
M. unimarginata								0.000	0.000
C. cozumela									0.000

Bold numbers are significative values of niche overlap.

Relative Biomass

Total biomass was 85.415 kg, of which two species constitute 92.8% of the total, *Iguana iguana* and *Ctenosaura similis*. This was expected, since they contribute most of the biomass of the area (i.e. Alvarez *et al* .,1989).

Reproductive patterns

Species recorded during this study have different times and modes of reproduction, and different clutch sizes (Fitch 1982) that may affect the structure of the community. Most of the species (7) have only one clutch per year. Only anoles have a continuous reproduction throughout the year. Seven species are oviparous, only *Mabuya unimarginata* is viviparous. *Cnemidophorus cozumela* is parthenogenic (Fitch 1970). This last species is interesting because it does not have to expend energy looking for a mate and engaging in courtship. Possibly this is a cause of its relative high abundance on the island.

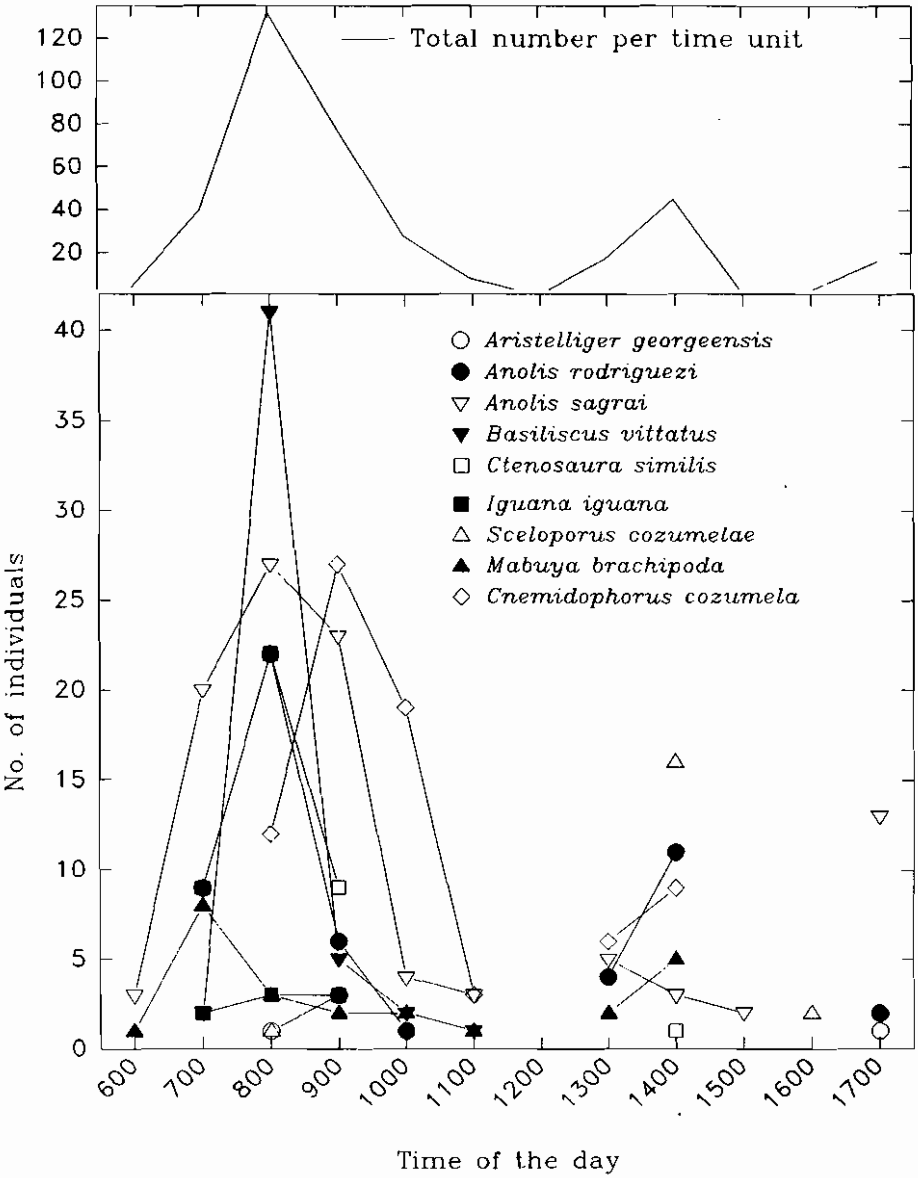

Figure 2
Activity patterns of the lizard species recorded during the present study. Sampling interval encompasses 0600 to 1700 h.

Species Classification

Based upon their degree of rarity, species can be ordered following Rabinowitz (1981). As shown in Table 6 the most vulnerable species from a biogeographic point of view are: *Cnemidophorus cozumela,* and *Sceloporus cozumelae* and *Aristelliger georgeensis*. *C. cozumela* is restricted to the northeastern coast of the Yucatan Peninsula in Quintana Roo and, *S. cozumelae* is distributed from Celestum Yucatan to central Quintana Roo along the coast (Instituto de Ecología 1990, Lee 1980, 1996; López González 1991) and the last one has been recorded from coastal Belize and Quintana Roo, Mexico. From an ecological perspective the most vulnerable species regarding habitat specificities are: *Anolis rodriguezii*, *Basiliscus vittatus*, *Mabuya unimarginata*, *Iguana iguana* and *Sceloporus cozumelae*. The last species is vulnerable because its main habitat, the beach is the most limited habitat on the island and most likely to be developed. Finally from a population view the most vulnerable species are *Aristelliger georgeensis* and *Iguana iguana*, because they seem to have a relative low abundance in the island.

Table 6

Species classification based upon biogeographical, ecological and population parameters.

	Wide Distribution		Endemics	
	Eurieic	Stenoic	Eurieic	Stenoic
Dense pop.	As Cs	Ar Bv Mb	Cc	Sc
Rare pop.		Ii	Ag	

(Ag) *Aristelliger georgeensis*, (Ar) *Anolis rodriguezii*, (As) *Anolis sagrei*, (Bv) *Basiliscus vittatus*, (Cs) *Ctenosaura similis*, (Ii) *Iguana iguana*, (Sc) *Sceloporus cozumelae*, (Mb) *Mabuya unimarginata*, (Cc) *Cnemidophorus cozumela*. Species classification follows Rabinovich (1986).

Data in Table 6 suggests that the most vulnerable species on the island are: *Cnemidophorus cozumela*, *Sceloporus cozumelae* and *Aristelliger georgeensis*. Our results are important to the conservation of these species and the rest of the biotic components of the island. We need to start planning for the conservation and management of the green iguana (*Iguana iguana*) which is economically important but threatened due to nest predation and commerce in skin and meat products. Currently the island is experiencing a high amount of human impacts that will make any conservation efforts difficult.

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