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Male *Cyclura cornuta* courting a prospective lady-friend on Isla Cabritos, Dominican Republic. Photograph by Robert Powell.

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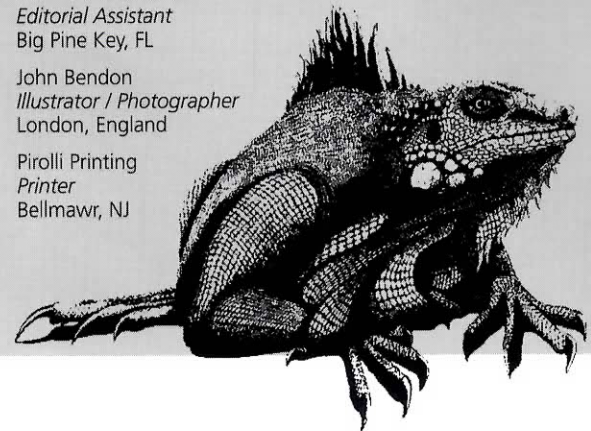
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The *Cyclura* of Parque Nacional Isla Cabritos

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If you want to see two species of *Cyclura* in natural habitat simultaneously, your only choice of destinations is the Dominican Republic (DR). The DR shares the island of Hispaniola with the Republic of Haiti; however, the biogeographic boundaries of the island differ substantially from the current political configuration. Two major islands, referred to as the North and South paleoislands, were joined when the

South Island “caught” the North Island after the latter collided with the Bahama Platform. This event probably occurred during the middle of the Tertiary period. Reef limestones were deposited in the former marine channel that separated the two islands. This area is now a barren valley known as the Plaine de Cul-de-Sac in Haiti and the Valle de Neiba in the DR. Much of this valley lies below sea level in the rainshadow of the Sierra de Neiba.

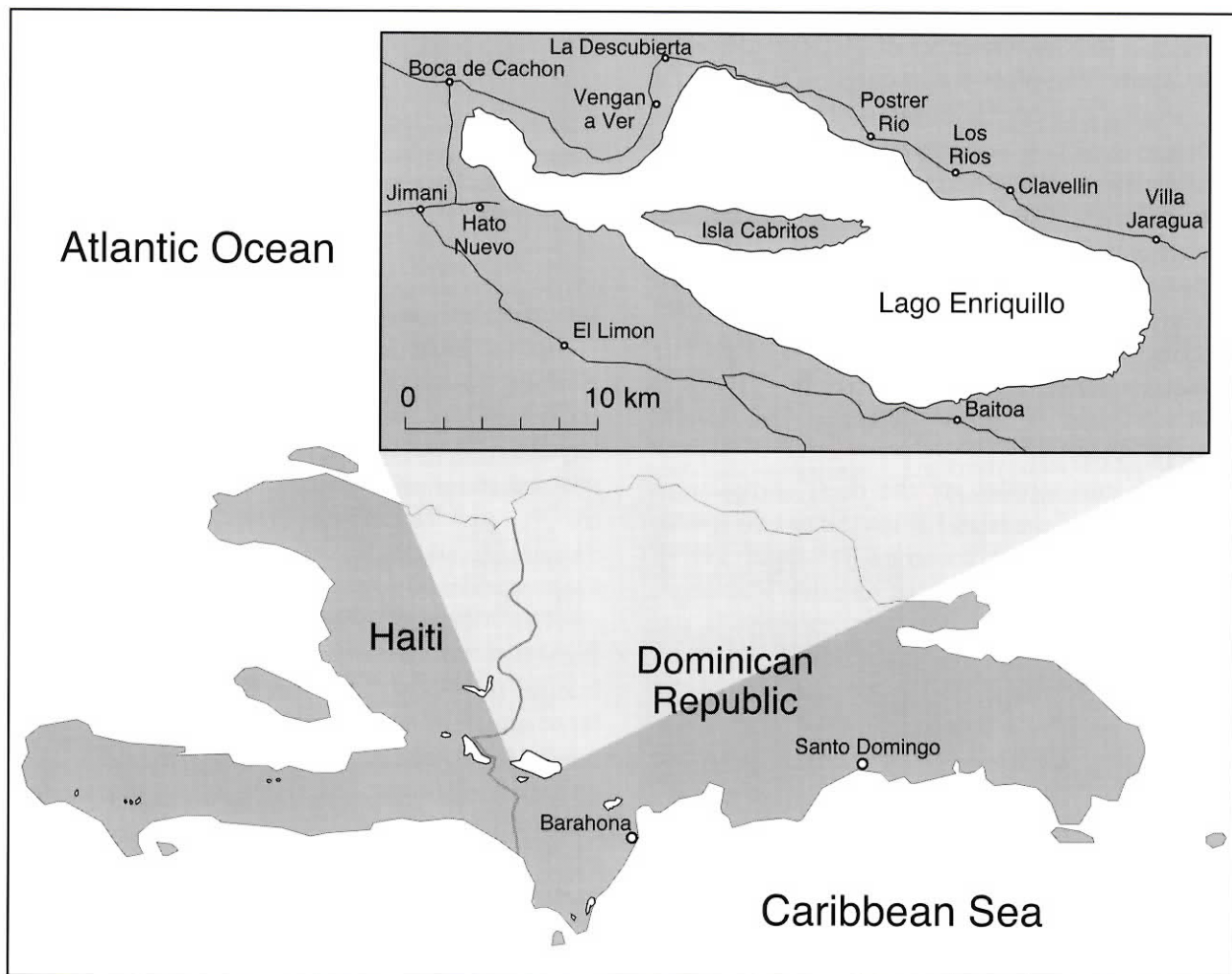


Figure 1. Parque Nacional Isla Cabritos in Lago Enriquillo, Dominican Republic.

Two of the four large lakes that characterize this valley lack outlets to the sea and are saline. Powell et al. (1999) provided a summary of the geological history of Hispaniola, listing pertinent references and documenting the herpetofauna of biogeographic regions, including the Valle de Neiba.

Lago Enriquillo is a hypersaline lake situated 40 m below sea level. It is named after a native-American Taino chieftain who successfully resisted Spanish efforts to enslave the indigenous population during the early colonial period. Annual temperatures in the area average 28 °C (Hoppe, 1989), although daily temperatures often exceed 40 °C during the summer months. Average annual rainfall is only 642 mm, most of which falls during two “rainy seasons,” one in late spring and the other in late summer and early fall (the latter associated with the hurricane season).

A small island (12 × 2.0–2.5 km), Isla Cabritos (Fig. 1), lies in Lago Enriquillo. It was incorporated into the Dominican system of national parks in 1974, and serves as a sanctuary for a flora and fauna that include a number of species endemic to Hispaniola. The plant community on the island is characterized as dry thorn forest (Fig. 2), and just about every plant is equipped to stick, stab, or scratch the unwary hiker. Cacti, including the tree cactuses, Caguey (*Neoabottia paniculata*) and Alpargata (*Opuntia moniliformis*), Cholla (*Opuntia caribaea*), and a tall cactus locally known as Cayuco (*Cereus hexagonus*), fill gaps between scrubby trees. The most common trees are Mesquite (*Prosopis juliflora*), Ziziphus (*Ziziphus rignoni*), and Catalpa (*Catalpa longissima*) (Hoppe, 1989).

Birds and reptiles are the most conspicuous components of the island fauna. Sixty-two species of birds have been recorded (Hoppe, 1989). Hispaniola’s largest flock of Greater Flamingos (*Phoenicopterus ruber*) feed on arthropods and mollusks, and Great Blue Herons (*Ardea herodias*) and Louisiana herons (*Hydranassa unicolor*) fish the shallows. Glossy Ibis (*Plegadis falcinellus*) and Roseate Spoonbills (*Ajaia ajaja*) frequent the shores, and Hispaniolan Palm Crows (*Corvus palmarum*) call raucously while carefully surveying visiting humans in hopes of soliciting (or stealing) a handout. The most famous inhabitants of the island, however, are the large, endangered reptiles, American Crocodiles (*Crocodylus acutus*), Rhinoceros Iguanas (*Cyclura cornuta*), and Ricord’s

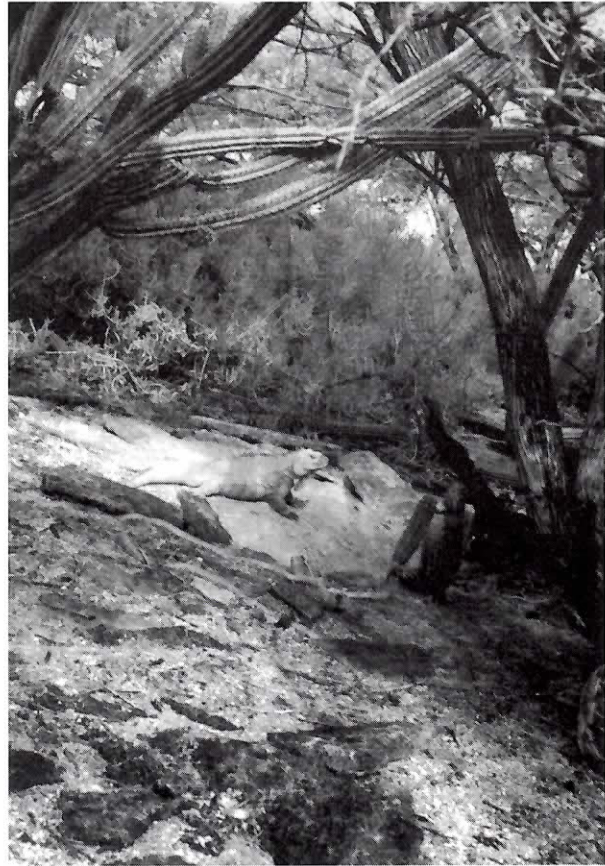


Figure 2. An adult male *Cyclura ricordii* outside its burrow on Isla Cabritos. Notice the characteristic vegetation. Photograph by Kim Schneider.

Iguanas (*Cyclura ricordii*).

In the summer of 1999, we were part of a National Science Foundation-funded undergraduate research program working in the Dominican Republic. In the course of our three-week studies of lizard communities, we made arrangements with the National Park Service (Dirección Nacional de Parques) to take a day off and visit Isla Cabritos to see crocodiles and iguanas in their natural habitat.

On 12 June 1999, we left our base in Barahona before dawn in order to catch an early boat to the island. The boat drivers generally prefer to return by early afternoon before the offshore winds, funneled through the valley from the east, kick up high waves. The morning was cloudy and surprisingly cool, exceedingly pleasant for humans, but less than ideal if you are searching for basking reptiles. Nonetheless, we had high hopes for success — and were almost immediately rewarded. While we were waiting on the dock as the drivers were preparing the boat for our trip, we saw a small

crocodile swimming nearby. Although not visibly disturbed by our presence, it swam away slowly, submerged, and was not seen again.

After an uneventful crossing, we docked on the north side of Isla Cabritos and took a trail that led us to the park station. Cicadas and the ubiquitous crows serenaded us as we wound our way along the path through the prickly vegetation. The ground underfoot was sandy, but often gave way to large areas of darker consolidated rock. Upon close examination, we observed that both rock and sand were composed of coral and shell fragments, relics of the ancient sea life inhabiting the former marine channel. After a short stop at the park station, where a visitor center is soon to reopen, our driver, now in the role of guide, led us toward the south side of the island to a beach where crocodiles frequently bask.

Along the way, our guide took us on a short detour to look for iguanas. Almost instantly, we spotted a large male *Cyclura ricordii* (Figs. 2, 3). Although we had been alerted to watch for iguanas, we were unabashedly amazed by his size and demeanor. We took some pictures, but the ruckus raised by our excited group scared the iguana back into its burrow. A short walk later, we arrived at the beach. Cautioned to remain quiet as the crocodiles are very sensitive to human disturbance, we approached from behind some vegetation along a shoreline dune. Unfortunately, no crocodiles were basking, but a large individual was swimming just off the beach (Fig. 4). Although it continued to swim away, we got a good look through binoculars and snapped some pictures.



Figure 3. An adult male *Cyclura ricordii* outside its burrow on Isla Cabritos. Photograph by Barb Banbury.



Figure 4. An adult *Crocodylus acutus* in Lago Enriquillo off the southern shore of Isla Cabritos. Photograph by Robert Powell.

The range of the American Crocodile includes coastal regions of southeastern North America, Central America, northwestern South America, Cuba, Jamaica, and Hispaniola. The species was once very abundant in Hispaniola, but is now found only at Lago Enriquillo and in the nearby Haitian lake, Etang Saumatre. The depletion of populations has mainly been the result of habitat destruction and hunting. Nest poaching has also affected the crocodile populations (Schubert and Santana, 1996). At Lago Enriquillo, nesting sites are scattered along the main shoreline and along the shores of Isla Cabritos. After hatching, the baby crocodiles, which cannot tolerate the high salinity of the lake, must move from the nesting beaches to fresh water habitat. Crocodile mothers nesting on Isla Cabritos have to carry their babies from the nesting beaches to areas where freshwater springs, called borbollones, empty into the lake. We visited Isla Cabritos at the end of the nesting season and saw an empty nest, littered with egg fragments, on the beach.

On the way back from the beach, we stopped again at the iguana burrow and found that the iguana had re-emerged and was sitting in a small patch of sunlight. This time we were quieter and everyone had a chance to take pictures and admire this beautiful animal for a few minutes.

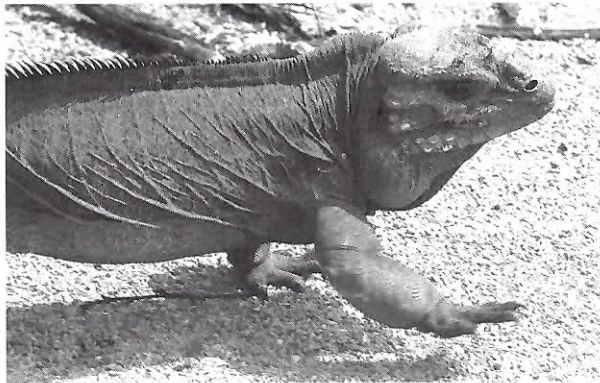
Cyclura ricordii is endemic to Hispaniola, where it can be found in the Valle de Neiba and on the lower Península de Barahona. Although it is common on Isla Cabritos, thanks to the legal protection provided by the island's status as a national park, other populations in Hispaniola are small and declining. These smaller populations on the main island are also genetically isolated from each other, which makes them even more vulnerable to extirpation. Because it is more of a habitat specialist than *C. cornuta*, *C. ricordii* is more susceptible to alterations in its habitat. Other threats include predation by and competition with exotic species and

hunting (J. A. Ottenwalder, pers. comm.). Captive breeding programs were established in the early 1990's at the Indianapolis Zoo and Parque Zoológico Nacional (ZOODOM) in Santo Domingo (Christie, 1996), but these are now inactive due to a lack of animals (W. Christie, pers. comm.). Since the level of success in these programs was low (J. A. Ottenwalder and W. Christie, unpubl. data), better captive husbandry techniques need to be developed. In any case, the breeding programs should be reestablished to help ensure a future for this species. One major threat to *C. ricordii* on Isla Cabritos is nest predation by feral cats. During our visit we did not observe any cats, hopefully a sign that the efforts to eradicate them, part of the IUCN/SSC West Indian Iguana Action Plan, are working.

In the meantime, the weather had cleared and the day was heating up, so we went looking for *Cyclura cornuta*. Our guide led us to a regularly visited burrow. Almost immediately, we saw a female, but she quickly retreated. This burrow was

situated under a limestone ledge, like most of the others we were to see. Ledges or the root systems of trees or bushes provide necessary support for large burrows in sandy soil, which would collapse if not reinforced. While continuing our search, one member of the group spotted a big male (Figs. 5, 6). Unlike the other individuals we had seen previously, he was not at all shy. Instead, he walked directly toward us before apparently losing interest and wandering away. The guide told us that this male, named "Pancho" by the guides, and a few other individuals had grown accustomed to human visitors and their handouts. This might not have been the most natural behavior, but it was an excellent opportunity to get a close look. On the way back to the dock, we saw several more Rhinoceros Iguanas (Figs. 7, 8) and a female *C. ricordii* (Fig. 9), most basking just outside their burrows. As they were less accustomed to visitors than Pancho, we were careful to maintain our distance.

Prior to the early 1950s, *Cyclura cornuta* was very common in the arid areas of Hispaniola, but populations have declined substantially. Even though the preferred habitat of *C. cornuta* is not favorable to human settlements, the introduction of



Figures 5, 6. Adult male *Cyclura cornuta*, named "Pancho" by the local guides. Photographs by Robert Powell.

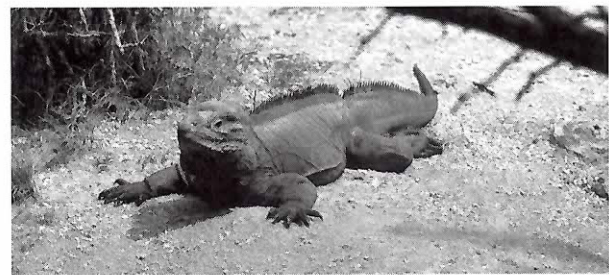


Figure 7. Young female *Cyclura cornuta* basking outside of its burrow on Isla Cabritos. Photograph by Robert Powell.



Figure 8. Male *Cyclura cornuta* courting a prospective lady-friend. Photograph by Robert Powell.

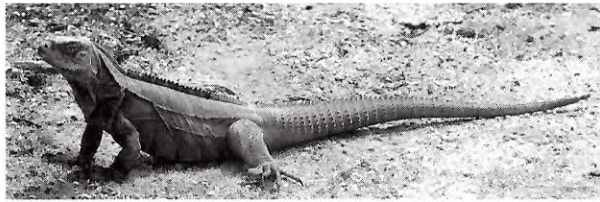


Figure 9. Adult female *Cyclura ricordii* on Isla Cabritos. Photograph by Robert Powell.

exotic animals has increased the competition with and predation on the iguanas. They have also been illegally hunted for food and the pet trade. Because Isla Cabritos is protected, it is one of the few areas where population densities appear to be near what are assumed to be pre-Columbian numbers.

On the boat ride back to the mainland, we stopped by the borbollones to look for more crocodiles. Instead, we got a close look at several flamingoes. One of them took off and flew over our heads (Fig. 10).

When we returned to the mainland, several people were waiting to visit the island. Most were Dominicans, testament to the growing awareness of the unique ecological value of the Lago Enriquillo area. Educational programs presented locally through slide shows and nationally on television illustrate natural communities and feature endangered species. Posters and brochures about the lake and its species are to be distributed throughout the country (Schubert and Santana, 1996). This heightened awareness among Dominicans is critical to the success of any conservation efforts.

Getting to Lago Enriquillo from Santo Domingo requires a 2½–3 hour drive, taking the road toward Barahona, turning right on the road to Neiba and continuing to La Azufrada (Fig. 1). At La Azufrada, you can take one of the commercial boats or one of the Parques boats (RD \$800; approximately US \$51) to the island. Park permits can be acquired at the main office of Dirección Nacional de Parques in Santo Domingo or at La Azufrada. The permits cost RD \$50 (approximately US \$3.50). The closest tourist accommodations are about one hour away in the town of Barahona. However, pensions (around US \$7/night) can be found in the nearby town of La Descubierta along with some small restaurants, the best of which is the “Iguana” restaurant. We encourage you to visit Isla Cabritos. You will have an amazing experience. For more information,



Figure 10. Flamingo flying overhead at Lago Enriquillo. Photograph by Robert Powell.

check <http://www.aguaita.com> (but note that it is in Spanish) or you can contact the Dirección Nacional de Parques directly for more information (fax: 809-472-4012; email: dnp@codetel.net.do).



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Cyclura Behavior During a Hurricane

(Including notes on results of storm surge and wind on habitat plants.)

Robert W. Ehrig
Finca Cyclura Reserve
Big Pine Key, Florida

The Atlantic Hurricane Season of 1998 was very active. There were ten hurricanes, including Hurricane Mitch, the strongest October storm ever recorded. On 25 September, 1998 there were four active hurricanes in the Atlantic Ocean, the first time since 1893 (National Hurricane Center). On 17 September, Hurricane Georges formed in the east Atlantic. By 20 September it was located 420 miles east of Guadeloupe in the Lesser Antilles with a peak intensity of 155 mph—a strong category 4 storm. On 21 September it grazed the U.S. Virgin Islands and Puerto Rico with 115 mph sustained winds.

In August 1978, Finca Cyclura was established as a permanent location to house a sustainable captive population of rhinoceros iguanas, *Cyclura cornuta*. The Big Pine Key site was chosen as the best possible location within the United States for a *Cyclura* breeding facility. Located about 105 miles north of Cuba, it is at the same latitude as the populations of the Bahamian iguana, *Cyclura cyclura inornata*. At that time, *Cyclura cornuta* was still being legally imported into the United States. It was felt that they would soon be listed under CITES as Appendix I and that they would continue to decline in Hispaniola due to habitat loss and unnatural predation. In 1980, the rhinoceros iguana was listed and became protected and importation was stopped. Finca Cyclura is a 3 acre site within the National Key Deer Refuge. It is located .4 miles inland from the eastern side of the second largest of the Florida Keys. The site was covered in native West Indian veg-

etation with elevations from 3 ft. above sea level to 4.7 ft. above sea level. Enclosures for *Cyclura* were constructed of concrete block cemented to the limestone cap rock that covered large areas on the site. Enclosures were constructed one to five blocks high with either 4 in. by 4 in. pressure treated pine, or 2.5 in. steel posts as supports for steel mesh fabric. All enclosures are at least 8 ft. high. It was well understood early in the project that hurricanes would have an impact on the site sooner or later.

On 22 September 1998, Georges struck the Dominican Republic with 120 mph winds and killed several hundred people. On 23 September, my wife and daughter evacuated the lower Florida Keys for central Florida. It was becoming obvious that the Keys were situated along the most likely path for this hurricane. The storm made landfall in eastern Cuba and tracked along the north coast on the 24th. By early morning on the 25th, Georges moved over the Straits of Florida and reintensified. I had spent four days preparing for the arrival. The house was boarded up with 5/8 in. plywood. Food, flashlights and over 40 gallons of fresh water were stored in anticipation of many days with no electric



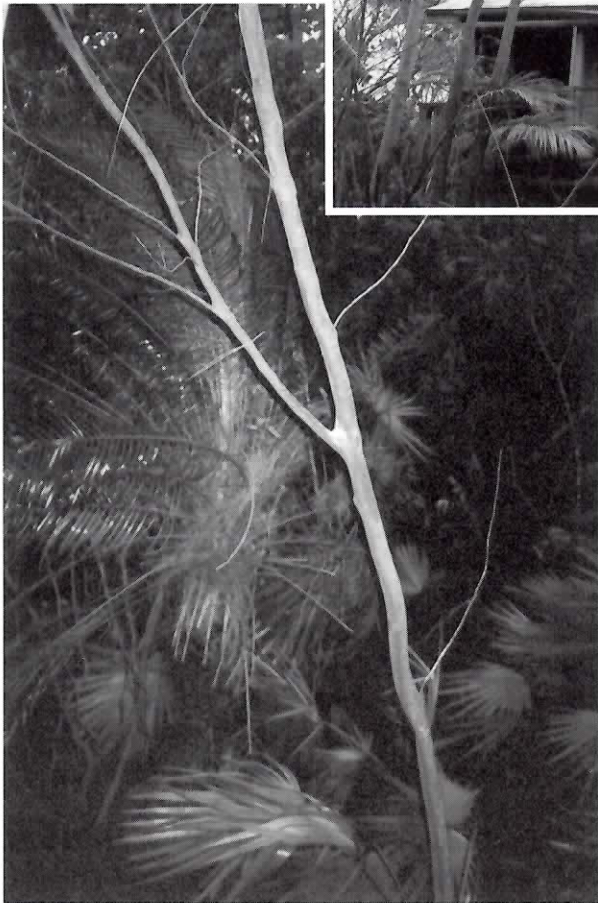
Winds blowing vegetation at 70 mph. Photograph: Robert W. Ehrig

power. Trees were trimmed and objects secured in anticipation of what was sure to be the worst weather in over 34 years. Thirty-four *Cyclura* were brought inside the house on the 24th. Another sixty iguanas would remain outside in their enclosures in what would be a real test of structural integrity. On the night of 24 September, I also enjoyed a meal consisting of all the food left in the freezer and I took a very long shower knowing this would be it. I put all the water I could fit in my empty freezer and went to sleep by midnight, knowing that hurricane conditions would probably not start before sunrise.

The Event

Friday, 25 September 1998 at 0600 hrs., I noticed that the power was gone. It was still dark as I got out of bed. The winds were at tropical

Right: The house after the storm—down, but not out.
Below: Palms blowing at 75 mph. *Photographs:* Robert W. Ehrig



storm intensity as I started to check animals by flashlight. I needed to check over twenty enclosures to make sure that no iguanas were in underground burrows where they could drown in the event of a storm surge. I moved my truck up the road to higher ground (about 7 ft. above sea level). The sun was rising by 0640 hrs. Only one iguana was found underground. The iguanas behaved as they did during storms, finding a secure spot in trees or among boulders and rockwork. All animals had been fed heavily in the days before the storm. Light rain was falling and the wind continued to pick up. I remember staring up at the large black olive tree, *Bucida buceras*, which, at thirty-five feet, towered over my house like a giant umbrella. I thought about the hours that I had spent a few days earlier trying to lighten the tree by trimming off hundreds of pounds of

branches. Its crown moved and shook in the wind. I checked iguana enclosures until 0945 hrs. by which time winds were at hurricane strength. The *Cyclura* all seemed calm and were tightly grasping whatever perches they occupied. All the enclosures have at least one solid side and/or

sections of steel roof. In most instances, iguanas seemed to find perches in wind shadows or in the most protected spot available. The wind blew solidly from due east. Trees were bent to the west and shaking violently. I sat on a porch in the lee of the building talking on the phone, amazed that it was still operational. Although the power was to be out for 11 days, the phone worked throughout the hurricane. I received several calls that morning including two from Europe. The storm center was 65 miles to the southeast of my location. This was just the beginning.

At 1030 hrs., I moved into the bedroom wing of my house knowing that I would be spending the duration of the storm there. This section is seven inches higher than the rest of the structure and has a 4 ft. by 10 ft. walk-in closet in the interior with the two main collar ties of the building running through it. All of the animals that I had

Right: Iguana enclosure covered in debris, but undamaged. Below: Tree damage.
 Photographs: Robert W. Ehrig



brought inside were in this building as well. The iguanas were boxed and bagged with some of the one-year-olds in mesh cages in my daughter's room. A large pair of very tame *Cyclura nubila* had the run of the bathroom. I cracked open a cold beer knowing it would be the last one for days. By 1100 hrs., the wind had picked up considerably. I tried to open the sliding glass door to the building but it was obvious that any movement out of the building was no longer possible. All of the windows were boarded except for part of the bathroom window and the three windows in my daughter's room. I had cut some pieces of 3/8 in. plywood to fit these openings in case of a window blowout. This afforded me a look at the storm which luckily had come during daylight hours. The sun never really did come out. It was overcast

all day but not raining very much. Georges was a dry storm. The sky had a yellow-gray look which I have never seen before or since. What the storm lacked in precipitation it more than made up in wind. Trees that I had grown or known for years had taken on strange positions and shapes. All were leaning or bent over to the west. As the wind increased, the remaining leaves were all being torn from the trees. Minute by minute the hardwood trees were becoming more bare. Palms folded over sideways. I also started to notice a few trees missing. The radio reported that the eye of Georges was moving into a position just south of Big Pine Key. The iguanas in the cages in the bedroom seemed normal, more concerned about my close scrutiny than about the storm outside. The Cubans in the bathroom seemed relaxed and normal, either unaware or unconcerned about the storm. The wooden house vibrated with the wind. Seaweed particles accumulated on the windows that were unboarded. We were in the eyewall.

At 1135 hrs., I noticed the first water on the ground below the building. The building is elevated above the ground level on 7 ft., 5 in. concrete columns and several inches of saltwater were now around them. I thought about the iguanas in their enclosures outside and the rapidly rising water. The wind was pulsing from the east, blowing steadily at 95 mph. The hurricane had moved in at high tide and I wondered how high this storm surge would go. The water was six inches up the column and rising quickly. I had a small shot of Ron Matusalem. The wind continued to pick up and the building gently vibrated, almost humming. At 1230 hrs., I wondered how long this

would last. The eye was staying south and the wind was unrelenting. I was getting used to the wind and it almost seemed to get quieter. Whatever this storm had to give we were getting the worst. The saltwater was a foot up the column and still rising. This could get serious, I thought. The trees I could see were shaking and bowed over. The wind was peaking at 110 mph. The seawater was at 22 in. up the column. It looked cloudy and white. It was surreal, as if this had been going on for days, not hours.

At 1310 hrs., the storm finally seemed not to be getting any stronger. The wind had shifted slightly to the south. The water at the base of the column had dropped an inch or two. The iguanas with whom I shared my retreat were as calm as ever. The wind still blew strong and I could sense

that if I tried to go out yet I would just be blown away. The water dropped another four inches.

At 1425 hrs., I left the building. I dropped to the ground and waded through the remaining storm surge. Trees were down everywhere and debris and branches blocked the paths. I was lost in my own backyard and becoming increasingly more disoriented as I tried to find my way around. I finally spotted some familiar spots and little by little found my way. I checked each of my animal enclosures, doing a fast head count and moving on to the next. In about two hours I was able to establish that everyone was alive. Amazingly, all the enclosures had survived intact. One had a large section of pine tree on the roof but was undamaged. On one enclosure, the wooden door hinges had come unscrewed from the frame but had remained in place. The water had continued to drop as I walked around—now it was just a few inches deep.

The iguanas seemed calm despite what they had been through. They had perched high enough that most would have been above the highest water level. In two cases, green iguanas were swimming around in the seawater in their cages. The *Cyclura cornuta* seemed to have found shelter behind walls and rockwork and hung on tightly during the storm. Our two Galapagos tortoises survived well although they had been floating during the peak of the storm. The 13-year-old was the one animal that seemed most upset. By 1600 hrs., winds were still strong but below 75 mph. It was over, and no one had died and no animals were loose.

Cyclura have existed for millions of years and over this time have adapted well to hurricane events. The islands where they evolved, whether small or large, are greatly affected by these storms. The instincts they have developed seem to ensure their survival. They assume a low profile, find a wind shadow above the water and hold on tight. Whether it is their innate wisdom, or their lack of it, they remain calm and survive. Georges was not a monster storm and surely if it had been a category 4 or 5 there could have been mortality. Hurricane Georges had a storm surge of 8.5 feet above mean sea level. A category 5 storm could have been double that. The instincts of these survivors would have still been extremely valuable to their prospects for survival.



BEFORE (inset): Large black olive, *Bucida buceras*, towers over the house at the start of the storm.

AFTER: The very same spot 28 hours later.

Photographs: Robert W. Ehrig

Notes on the results of storm surge and hurricane winds on habitat plants:

West Indian vegetation has evolved in a harsh environment. The plants that occur in *Cyclura* habitat are adapted to brutal hot dry conditions on thin soils in extremely rocky terrain. They are also affected by tropical storms and hurricanes. The tropical storms may bring heavy rains that the ecosystems absorb and produce abundant food crops that the iguanas depend on for survival. The vegetation is shaped by salt-laden winds on a daily basis and periodically may be submerged by extreme high tides that are produced by the passage of hurricanes. These storms may also produce extremely high winds. The trees and shrubs of *Cyclura* habitat are generally short in stature and have extremely hard woods or are designed to break apart during hurricanes.

The passage of Hurricane Georges on 25 September 1998, allowed me to experience the effects of a moderate hurricane first hand and to observe the results of the wind and storm surge on the vegetation. Finca Cyclura is located on the edge of the largest tract of pine rocklands in the Florida Keys. The native vegetation consists of pine and transitional West Indian hardwood hammock with some freshwater wetlands to the east. In addition, a number of palms and cacti of the Bahamas, Hispaniola, and Cuba have been planted on the site. Populations of many endangered trees and cacti of the Florida Keys have been planted on the site to ensure the survival of these plants as



This free-ranging, female Cuban iguana, *Cyclura nubila*, could not be found the day before the storm. She turned up the next day at her usual spot expecting a meal.

Photograph: Robert W. Ehrig

well. The populations of the cactus, *Opuntia corallicola* and *Opuntia triacantha* are the largest populations that now exist.

Hurricane Georges' winds affected the site for 28 hours. The storm surge flooded the site for about 10 hours. Four to eight inches of salt water were absorbed into the ground. The storm surge was 22-24 inches deep on the lowest parts of the property for 1.3 hrs. Some of the highest areas were not submerged at all. Other areas were submerged for various durations and to various depths. The shallow well on the property was 4 parts per thousand sodium chloride pre-Georges and 67 parts per thousand two weeks afterward. The salt water took over one year to completely work its way through the fresh water lens below the site.

On the following page is a partial list of the results of the hurricane on vegetation.

Acknowledgements

Thanks to David and Laurel Ehrlich for bringing a chainsaw and gasoline to me four days after Georges and returning to help run a chipper a week later. Thanks to Joyce Newman and Jack Benson for running in romaine, frozen vegetables, bananas, ice, and cold beer three days after the storm. Thanks to John Bendon for feeding a chipper for two days, two weeks after the storm.



A very shady spot 24 hours earlier. Photograph: Robert W. Ehrig

Conifers

Pinus elliottii var *densa*, slash pine

Within 90 days after the storm, 24% of this species was dead. The surprise was in June and July, 1999. After substantial rain, another 28% of the pines died within four weeks. It seemed that accumulated salts caused the mortality after they washed through. In Fall 1999, an additional 11% of the pines died. Mortality is at about 63%. Most of the oldest pines have died. Younger pines that have roots into plantings and filled areas seemed to be the most salt-resistant. Pines did well in wind. The pines in the forest to our west had about 10% treefall.

Palms

Coccothrinax argentata, silver palm

Pseudophoenix sargentii, buccaneer palm

Thrinax morrisii, brittle thatch

Thrinax radiata, thatch palm

All of these native palms, which are widespread in the Bahamas and other *Cyclura* habitats, did well. Many had distorted crowns from the wind but recovered completely within 1.5 years. The *Pseudophoenix* seemed most salt-resistant and liked the higher light levels after the storm. Only a few very low-lying palms were killed by salt. Several palms were broken in half by the wind.

Trees and Shrubs

Amyris elemifera, torchwood

No effects from storm

Ardisia escalloniodes, marlberry

Some salt burn

Bumelia celastrina, saffron plum

No effects

Bursera simaruba, gumbo limbo

Wind broke many trees, salt killed some low-lying trees that were exposed to long surge duration

Byrsonima lucida, guanaberry

Some low-lying trees killed by salt

Canella winterana, wild cinnamon

All trees above 3 ft elevation, no effects

Capparis flexuosa, limber caper

No effects

Casasia clusifolia, seven year apple

This iguana favorite was not affected by salt or wind

Chrysobalanus icaco, cocoplum

Some very low trees killed by salt

Chrysophyllum oliviforme, satinleaf

Most trees killed by salt, several high trees survive

Coccoloba diversifolia, pigeon plum

No effects

Coccoloba uvifera, seagrape

No effects from salt, some wind breakage

Conocarpus erectus, buttonwood

Slight salt burn on few plants, wind damage on large trees, and several large trees overturned but most did well

Erithalis fruticosa, black torch

No effects

Eugenia axillaris, white stopper

Slight burn on low-lying plants

Eugenia foetida, Spanish stopper

Some burn on low plants, most no effects

Eugenia rhombea, red stopper

No effects

Ficus aurea, strangler fig

No effects, some broken branches but both native *Ficus* stood up very well to hurricane winds for large trees.

Ficus citrifolia, short leaf fig

Very well to hurricane winds for large trees.

Guapira discolor, blolly

No effects, iguana favorite

Guettarda scabra, rough velvetseed

Low-lying died, higher trees burned

Gymnathes lucida, crabwood

No effects

Krugiodendron ferreum, black ironwood

This extremely heavy dense wood tree was not bothered much by salt but the wind blew trees into strange shapes.

Lasiacis divaricata, wild bamboo

No effects

Lysiloma latisiliquum, wild tamarind

No effects from salt, wind mangled some trees

Manilkara jaimiqui, wild dilly

No effects, iguana favorite

Mastichodendron foetidissimum, mastic

No effects except leaf loss

Metopium toxiferum, poisonwood

Most no effects, few very low-lying salt killed

Myrica cereifera, wax myrtle

Most killed by salt, most killed islandwide

Nectandra coriacea, lancewood

All killed by salt

Piscidia piscipula, Jamaica dogwood

No effects, several overturned

Pithecellobium guadalupense, blackbead

No effects, some split by wind

Reynosia septentrionalis, darling plum

No effects, iguana favorite

Swietenia mahagoni, mahogany

Few effects, leaf loss, breakage

WIISG REPORT

Jamaican Iguana Recovery Program

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The Jamaican iguana recovery program has remained a high priority for the West Indian Iguana Specialist Group (WIISG) since its inception in 1997. For the fifth time over the past four years, small groups of head-started Jamaican iguanas, *Cyclura collei*, have been released into their native habitat in the Hellshire Hills. As part of a strategy designed to restore the depleted wild population of iguanas, an ongoing series of experimental releases are underway in an effort to determine not only if iguanas reared in captivity since hatching can survive in the wild, but moreover, whether they can integrate into the natural breeding population. Since 1996, 26 young iguanas, hatched in the wild from 1991 - 1993 and then raised at the Hope Zoo in Kingston, have been released, all equipped with radio transmitters for monitoring. These releases have been cooperative endeavors between the University of West Indies (UWI), the Hope Zoo, the Natural Resources Conservation Authority (NRCA) and the Fort Worth Zoo. Funding from a core group of U.S. zoos has supported these releases, includ-

ing substantial grants from the American Zoo and Aquarium Association (AZA) and the Zoological Society of San Diego. The WIISG continues to provide logistical support to both the Hope Zoo headstarting effort and the field research program.

The Jamaican iguana was rediscovered in 1990 after being considered extinct for nearly half a century. A remnant population was found clinging to existence in the rugged and remote limestone forests of the Hellshire Hills along Jamaica's southeastern coast. Two active nest sites were also discovered and, given adequate protection, now provide a yearly source of hatchlings for headstart. This population exists today in a roughly 100 km² ecosystem which is being degraded and compressed as a result of charcoal burning. This factor, coupled with high juvenile mortality due to mongoose and cat predation, have brought the Jamaican iguana perilously close to the brink of extinction. Today, this species is considered to be one of the most critically endangered reptiles in the world. However, recent events provide cause for optimism.

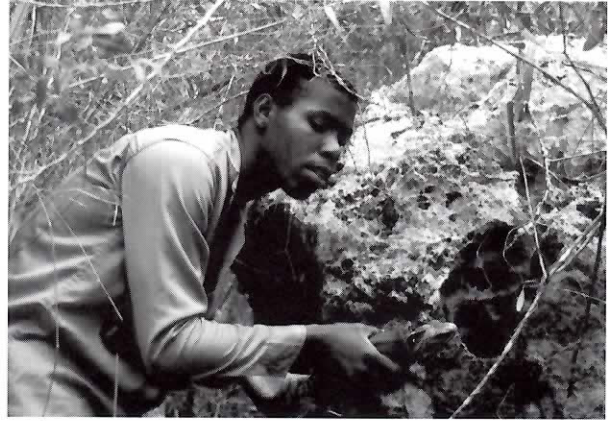
In April 1999, the Hellshire Hills, along with a significant portion of southeastern coastal Jamaica known as the Portland Bight (which includes the Goat Islands, Portland Ridge, Braziletto Mountains, and encompasses all marine areas out to the 200 meter depth contour) received official protection under a management agreement with a local NGO, the Caribbean Coastal Area Management (CCAM) Foundation. The Portland Bight Protected Area has a total area of



Cyclura collei wearing custom radio tracking vest. Photograph: Joe Wasilewski



Delano Lewis preparing to release an iguana (*C. collei*) after changing the batteries on the transmitter. Photograph: Joe Wasilewski



Delano with *C. collei*. Photograph: Joe Wasilewski



A trapped mongoose, humanely captured in the Hellshire Hills. Photograph: Joe Wasilewski

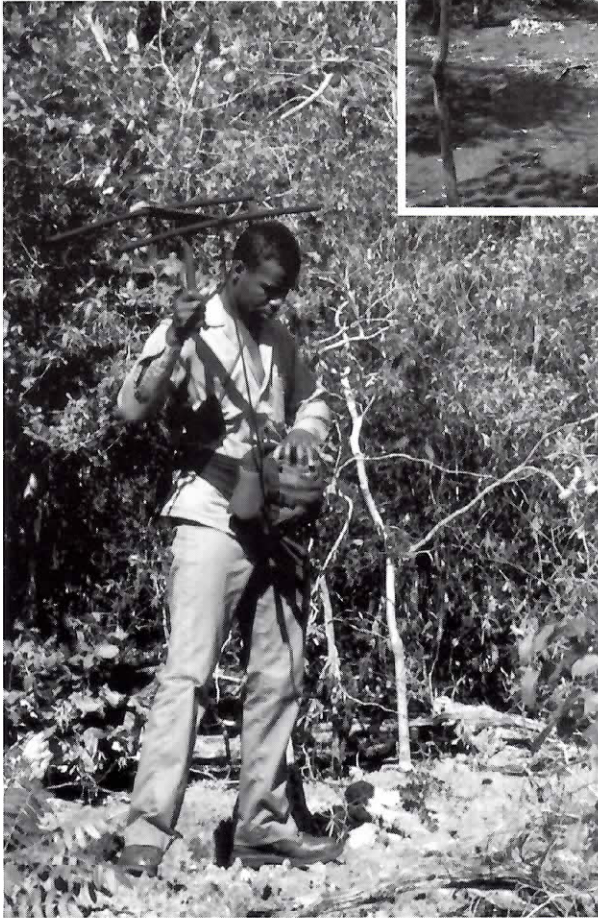
724 mi² (1876 km²) making it Jamaica's largest protected area so far. With the Hellshire Hills having finally been granted protection, attention can now be directed to Great Goat Island, part of the iguana's former range. Under CCAM's management plan, the Goat Islands are slated for tourism, including a field station with boats. The plan also includes restoring the iguana population to the island and the time appears right to begin developing plans to establish this as an iguana sanctuary.

The year 1999 also brought remarkable nesting results. At least 16 females nested this year and 104 hatchlings are known to have emerged, both record numbers since the project began in 1991. All but six of these were tagged and released to the wild. Efforts next year will be aimed at determining if any of the headstarted female iguanas are contributing to the breeding population. For the first time in the field project's nine-year history, several juvenile (1–2 year old) iguanas were captured,

suggesting that young iguanas are benefiting from the predator removal program undertaken by UWI staff to systematically trap mongoose, cats and rats from the core iguana areas.

The iguana release program has not been without its problems over the years, primarily related to radiotransmitter loss. A vest-type attachment was found to be optimal for securing transmitters, but finding a material that would withstand the rugged Hellshire Hills environment presented a major challenge. One of the predominant features of this ecosystem is the sharp limestone karst that forms crevices and retreats favored by iguanas. Generally, the vests would break down over several months and the transmitters would be shed, thus precluding the accumulation of any long-term monitoring data. The most that could be concluded was that the iguanas survived the short term following release, utilized the habitat in terms of locating food and refugia, and appeared

Below: Delano Lewis radio-tracking a *C. collei* in the Hellshire Hills.
 Photograph: Joe Wasilewski



Left: *C. collei* nest site, one of two discovered in the Hellshire Hills.
 Photograph: Joe Wasilewski



Above: Hope Zoo's iguana head start cages. Photograph: Joe Wasilewski

to acclimate well. Due to its durability, Cordura was considered the best material for these vests, however, it is not form-fitting and must be secured with elastic straps.

A breakthrough occurred in 1999 when a designer with the Nike Corporation learned of this dilemma and offered to help. Damon Clegg of Nike's All Conditions Gear Footwear Design Department began fabricating vests with a stretch Cordura material that was both rugged and form-fitting. Equipped with what we believe will be the prototype iguana vest (bearing the Nike trademark swoosh), six iguanas were released in November 1999 and are being successfully tracked. The current field team of Dr. Byron Wilson, predator control specialist, and student Delano Lewis, both affiliates of Dr. Peter Vogel of the Life Sciences

Department of UWI, are monitoring the iguanas daily and making visual sightings at least weekly. Especially encouraging are the recapture data that are beginning to accumulate. Interestingly, iguanas from previous years' releases are beginning to turn up in mongoose traps. In their daily rounds checking trap lines, the field crew has recorded 20 iguana captures (about ten individuals including several headstarts) in live traps, providing much-needed long-term survival data for the first time. With help from Nike, the team hopes to gather more specific information on dispersal and habitat utilization.

For their role in the project, Nike has received a considerable amount of positive press and public relations value. The story was carried by the Associated Press (AP) wire and featured in several major newspapers. Sports Illustrated magazine and National Public Radio (NPR) also covered Nike's involvement. The goal of the WIISG is to expand Nike's role in future release projects, not only in Jamaica but in Grand Cayman and the British Virgin Islands as well. Ultimately, we hope that Nike will become an official corporate sponsor for the WIISG and continue to work with the group as we strive to advance the developing science of reintroduction technology.

Left: The larger of the two nest sites in the Hellshire Hills used by the Jamaican iguana. Photograph: Joe Wasilewski

Below: *C. collei* after being released, showing no ill effects after the capture. Photograph: Joe Wasilewski



Sunset over the Hellshire Hills. Photograph: Joe Wasilewski

The Nike Corporation has already proven to be a caring and reliable partner, not only designing and manufacturing iguana wear, but also replacing vests and reimbursing the iguana project for a shipment lost in a customs warehouse fire in Jamaica. With Nike's continued support, we look forward to seeing more "fashion-savvy" iguanas bearing the trademark Nike swoosh in the coming years.



This article also submitted for publication in the IUCN/SSC journal *Species*.

A Nature Sanctuary on Utila

Gunther Kohler

Introduction

The Honduran Caribbean island of Utila (approx. 40 km² in area) houses a considerable number of animal and plant species of which several are exclusive to the island. The impressive Utila iguana (*Ctenosaura bakeri*) is one of them. This species is very much endangered. The Zoological Society Frankfurt, Germany, as well as the Senckenberg Nature Research Society are working towards a sustained conservation of this lizard by means of the "Conservation Project Utila Iguana, Honduras." Since 1997, a research and breeding station for iguanas has been operating on Utila. Unlike many other endangered iguana species, the Utila iguana has not been threatened by the destruction of its habitat so much as by over-hunting. Obviously, this will change dramatically within the near future.

A gigantic international airport is currently under construction on Utila along with the attendant infrastructure to accommodate tourist jets coming directly from Houston and Miami. In general, all signs on Utila indicate rapid and extensive development for mass tourism: several new resorts and hotels are being built and a four-lane highway from the airport to the town is under construction. On the North side of the island where the most important egg-laying sites for the iguana are located, the beach areas have been "cleaned" (burnt down) and divided into saleable portions. Once the beach areas have been sold, the mangrove swamps lying behind them will be "cleaned" as well and reclaimed by coral debris and garbage. The same thing occurred previously on the south side of the island (Blue Bayou and the former mangroves behind Cross Creek and RJ's).

Obviously, Utila has been slated for the development of mass tourism without consideration of ecological issues. In this scenario, the future of Utila's wild animals and plants holds little promise unless a nature preserve of considerable size can be created. Turtle Harbor Pond Refuge exists on maps, but it does not have any significant protected status.

Our goal

Creating and maintaining a protected natural area representing as many of Utila's native habitats and animal and plant species as possible with a view to long-term survival.

Size and location of the planned Nature Sanctuary

Based on the experiences gathered so far during field research on the biology of the Utila iguana and on the distribution of the amphibian and reptilian species on Utila, the region of Iron Bound seems to be most suitable for the planned protected area. An area of 1.5 to 2 km², which includes about 1 km of coastline, will include the following habitats: rocky coast, beach (behind the rocky belt), Caribbean dry forest, seasonal rain forest, and mangrove swamps. In this area we have been able to record all vertebrate species currently known to exist on Utila (including the three endemic lizard species) as well as the three species of mangrove known from the island. In no other location on the island do these four habitats occur in such close proximity.

Another advantage of the Iron Bound location is the fact that it is adjacent to the 1 km² parcel owned by Shelby McNab, president of the local nature protection organization, BICA-Utila. This area is made up largely of seasonal rainforest and Mr. McNab also proposes to retain his land as a nature preserve.

Project plan and estimated costs

Step 1: Buying of some 0.7 km², containing about 1 km coastline (*goal:* allocating beach habitat and habitat diversity). Estimated cost: \$600,000. **Step 2:** Buying of 0.8 km² mangrove adjacent to the area of Step 1 (*aim:* enlarging the protected area, connecting it with the Shelby McNab domain). Estimated cost: \$300,000. **Step 3:** Starting together with Step 1: safeguarding and development of the protected area. Estimated cost: \$100,000. In addition: maintenance measures (fences, stations, educational trails).

Concepts for the conservation of ecological values of the Nature Sanctuary

A minimal infrastructure must be set up in order to be able to protect the area efficiently. The boundaries of the protected area must be very clearly marked. A lath fence around the area, which does not hinder the animals, is a possibility. In strategically important places simple sentry posts must be erected. Several guards (Hondurans) must be employed to patrol the area. Educational trails, carefully planned to limit their impact on the ecology, are essential for the guards and are attractive for tourists. Elevated observation platforms have proven effective against poachers, because it is undetectable from below whether they are manned. Demonstration and explanation boards are important. In addition, volunteers can be on hand during egg-laying season (mid-March through end of April).

Ecological importance of the Nature Sanctuary and the long-term perspective

The proposed area houses an enormous diversity of animal and plant species. With the exception of the wet savannah (where few species are present), all habitat types as well as all known species of vertebrates on Utila are represented.

Hopefully, lodge and hotel owners possessing large lots are willing to conserve mangroves and forests as an attractive landscape. While these small pieces taken individually will not be suitable to conserve species, it is worthwhile trying to connect the remaining "nature islands" either by corridors or by agreed-upon introduction of hatchlings in order to ensure variability in the gene pool and avoid inbreeding in any isolated area. Further fragmentation and isolation of the smaller populations is serious, but it will not necessarily result in extinction of the species especially when appropriate protection measures are implemented. Once the protected area is established, expansion can be considered.

It cannot be overlooked that the present tourist development plans, presenting Utila as a "tourist paradise with hotel bunkers" and "clinically pure" beaches, may turn out to be economically unprofitable. It is quite possible that tourists will turn away within a few years because sufficient

well known "dream beaches" are available elsewhere. In this case it then makes sense to maintain a haven for the animal and plant species of Utila with the potential for dispersal in the future. It is clear that a protected area of this size is a minimum solution. However, observing the extreme rate of development on Utila and the minuscule size of the total area of the island, a protected area of this size is at least a basis for further activities. Hopefully, a well functioning protected area of this kind (one that is also of interest as a tourist attraction) will serve as an example.

Economic aspects related to the creation of a Nature Sanctuary on the island of Utila

The value of Utila as a tourist attraction is an important economic factor for the inhabitants of the island as well as for the State of Honduras. The Bay Islands together with the Maya ruins of Copán form the main attractions for travelers in the country. Under this premise it is very important to develop concepts that allow Utila to be developed as a tourist area for the long term and to ensure that the expected additional income will benefit the local people and the State of Honduras.

In order to do justice to the unique natural character of the island, it is important to recognize the geographic, geologic and ecological circumstances of the place as development is undertaken. For many visitors, the very original Caribbean landscape is the main attraction on Utila. Unfortunately, the volume and speed of recent development seems headed toward massive tourist exploitation. The small island dressed up as "nature's secret paradise" will hardly be able to cope with that situation, if you consider that the plant and animal world on land as well as in the sea is the principle attraction of Utila for the majority of visitors.

In the short term, the current development is creating jobs for local people, for instance with the construction of a new airport of massive proportion. In the long run, however, it can be expected that most of the income from the new large-scale tourist projects will flow into the pockets of foreign investors, a process which has already begun with the sale of beach lots. In addition, it is likely that the intensive development will lead to a dead-end-street. The interior of the island will hardly be exploitable because of its swampy soil composition

and mangrove vegetation. Furthermore, even along the coast there are only a limited number of areas suitable as bathing beaches, since at many places the surface consists of sharp coral rocks, which allow for the construction of roads only with considerable investment.

Utila's extremely limited resources will make large-scale tourism extremely problematic. Obvious problem areas include garbage, pollution and a scarcity of fresh water. Social problems are also inevitable with the influx of low-skilled laborers from the mainland attracted by the tourist projects. Unemployment problems will also inevitably ensue as the initial influx of tourists drops off.

The creation of one or more protected areas, guaranteeing the survival of the endemic Utila black iguana, *Ctenosaura bakeri* as well as numerous other animal and plant species, can provide the island with a long-term unique attraction if tourism is properly managed. Using educational trails as well as guided tours in the protected area in addition to the already existing visitor's center in the Iguana Station, visitors are given the opportunity to discover and observe reptiles and other animals in their natural environment.

Such a protected area will persuade many tourists to stay longer on the island and will add to the existing attraction of diving. The total Utila community (hotels, restaurants, etc.) will be able to profit from its existence. By creating a Nature Sanctuary the local populace will be employed both temporarily, installing fencing and labeling the area, by constructing the field stations as well as the trails for guarding and watching the area, and also permanently, as nature guides and guards for manning several sentry posts.

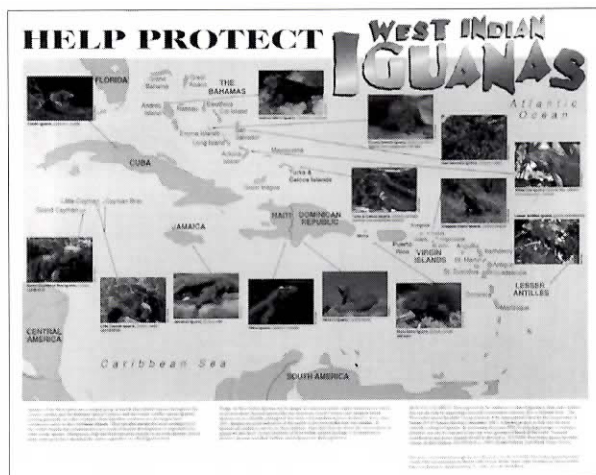
Financing of the Nature Sanctuary will be possible in the long term by tourists (gifts, taxes), the community of Utila (financial support because of mentioned economic profit for the whole community), private gifts ("mangrove stake holding") as well as by the support of nature conservation organizations. The project will also raise funds by means of selling postcards, posters and T-shirts.

The creation of a Nature Sanctuary will have a positive economic effect for the Utila community as well as for the country of Honduras as a whole. Simultaneously it will give a positive long-term perspective for the conservation of the biodiversity of Utila.



Iguanas of the West Indies Poster

The Fort Worth Zoo announces the publication of a beautiful new poster highlighting the conservation of Iguanas of the West Indies. Featuring rare and exceptional color photographs of 14 of the 18 *Cyclura* and *Iguana* species this high-quality poster measures 20 x 26 in. and is printed on a heavy-duty paper stock suitable for framing. Produced to assist the IUCN/SSC West Indian Iguana Specialist Group in promoting the preservation of these endangered lizards, all proceeds from the sale of this poster will help to fund critical iguana research and conservation projects throughout the Caribbean. Posters can be obtained in the U.S. for \$13.00 including postage and mailing tube; international orders are \$16.00. Checks or money orders (in U.S. currency) should be payable to the Fort Worth Zoo. Mail requests to:



Rick Hudson
Fort Worth Zoo
1989 Colonial Parkway
Fort Worth, TX 76110

IGUANA NEWSBRIEFS

Galapagos Iguanas Shrink to Survive El Niño

Scientists have discovered that iguanas on Ecuador's Galapagos Islands shrink to survive a shortage of food during El Niño, according to a report in Thursday's issue of *Nature*.

In two studies of Galapagos marine iguanas, one spanning 18 years and the other occupying eight years, scientists found that the herbivorous reptiles shrank as much as 2.7 inches, or 20 percent of their body length.

"Many people working with amphibians have seen this phenomenon but have not reported it because they don't believe it, or because the thinking is that vertebrates can't shrink," said Judy Stamps, a professor of evolution and ecology at the University of California at Davis.

The disbelievers included Martin Wikelski, a professor of ecology and evolution at the University of Illinois. Wikelski noted shrinkage in Galapagos marine iguanas over three periods (1982-83, 1987-88 and 1992-93) but dismissed the results as a measurement error. His thinking changed during El Niño's biggest year, 1997-98.

"In 1997-98, the animals had shrunk too much to ignore," he said. "We thought this couldn't be an artifact, so we plotted out the data. It turned out to be very interesting."

The iguanas shrank to increase their chance of survival during El Niño.

Galapagos marine iguanas feed on algae along the tidal basins of the rocky shores of the remote islands. Normally, the islands experience cold, nutrient-rich currents from

the west and south. During El Niño, however, their usual diet disappears. "Green and red algal species, which are the marine iguana's preferred food... are replaced in intertidal areas by brown algae which iguanas find hard to digest," according to the *Nature* article.

Upwards of 90 percent of the iguana population can die of starvation as a result of these environmental swings. Only the iguanas that shrink and slim down, making them more efficient at harvesting the tiny amounts of available food, survive.

"They shrink to reach a body size where survival is high. If they shrink a centimeter or so, they increase their survival rate by 10 percent. If they shrink more, they can increase survivability by 35 percent," said Wikelski.

In subsequent La Niña years, when cold, nutrient-rich waters return to the Galapagos, the iguanas eat well, get fat and start growing longer again. Adult iguanas can shrink and grow repeatedly throughout their lifetime.

If researchers are able to figure out the mechanisms behind the shrinkage and the renewed growth in bone, they may be able to apply the same triggers to humans to treat diseases such as osteoporosis from aging or bone loss during space flight, said Stamps.

The researchers hypothesize that bone absorption accounts for much of the shrinkage.

"You have to remember that bone is living tissue that is constantly being replaced, just like muscle," said Stamps.

Source: Environmental News Network staff

Mexican Iguanas Make Themselves at Home in Florida

A population of Mexican spiny-tail iguanas is growing on Gasparilla Island in the Florida island community of Boca Grande. It seems that several pet iguanas were released by their owners on the island 20 to 30 years ago and adapted well to freedom and Florida. The population has grown steadily and now exceeds 2000. The three foot long chunky lizards are a mixed blessing to the humans of Gasparilla island. The lizards are a conversation piece as a result of their antics, such as running through bars and knocking over barstools. But locals are less amused with their penchant for dining on decorative flowers and in gardens. The once sympathetic local press has begun printing recipes on how to cook iguanas.

Iguanas and Non-Human Primates Hang Together at Metro Zoo

As you probably know, green iguanas (*Iguana iguana*) have become established in south Florida. They are commonly seen on the grounds

of the Miami Metrozoo. Two areas where they have established residency are the colobus monkey (an African species) and the white-handed gibbon (from Asia) displays. The iguanas in these exhibits are recognizable individuals that have lived there for many months. They are regularly seen interacting with one another. The gibbons have been seen petting, sharing their food with the iguanas and slapping them. The slapping doesn't seem to bother the iguanas or keep them from approaching the gibbons. The situation with the colobus monkeys is much the same. The photo on the outside back cover shows a young colobus petting one iguana while it sits on the tail of another! Mixed species exhibits are often created in zoos to increase visitor interest by allowing people to see the interactions between different kinds of animals. Usually species from the same geographic region are exhibited together. We have no plans for removing the iguanas since they appear to be a source of enjoyment for the primates, and they have chosen these spots to live on their own. It would be interesting to know if iguanas interact with primates in their natural habitat.

Steve Conners, Miami Metrozoo.
Colobus photo by Barbara Crutchfield.



I.I.S. Bookstore



Photograph courtesy of Jayme Gordon

As a service to our members, a limited number of publications will be distributed through the I.I.S. Bookstore. The following publications are now available:

Green Iguana, The Ultimate Owner's Manual, by James W. Hatfield. 1996. **\$28.00** (including postage); **\$35.00** (nonmembers). Covers just about everything from birth to death of an iguana. 600+ pp. Limited quantities.

The Green Iguana Manual, by Philippe de Vosjoli. 1992. **\$7.00** (including postage); **\$8.75** (nonmembers).

Send check or money order (payable to International Iguana Society) **to:**

I.I.S. Bookstore
P.O. Box 366188
Bonita Springs, FL 34136

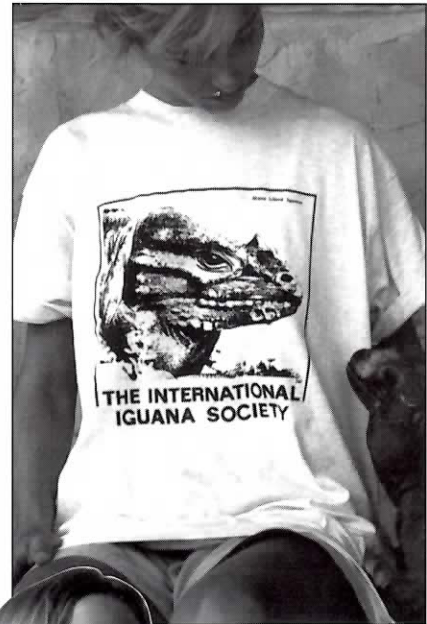
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A young colobus monkey petting one green iguana while it sits on the tail of another at the Miami MetroZoo. Photograph: Barbara Crutchfield

(NOTE: The U.S. does not encourage the keeping of any animals in the same enclosure with iguanas. Any such mixing of species could be harmful to the animals involved.)

