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Iguana Specialist Group *Newsletter*

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The Iguana Specialist Group prioritizes and facilitates conservation, science, and awareness programs that help ensure the survival of wild iguanas and their habitats.

In This Issue

News & Comments

International Iguana Foundation Announces 2004 Grants The Board of Directors of the International Iguana Foundation (IIF) held their annual meeting at the Miami Metrozoo in Florida on 3 April 2004. The Board evaluated a total of seven proposals and awarded grants totaling $48,550 for the following five projects:

1) Establishing a second subpopulation of released Grand Cayman blue iguanas, Cyclura lewisi. Fred Burton, Blue Iguana Recovery Program. $11,000.

2) Conservation of the critically endangered Jamaican iguana, Cyclura collei. Peter Vogel and Byron Wilson, Jamaican Iguana Research and Conservation Group. $11,300.

3) Maintaining and optimizing the headstart release program for the Anegada Island iguana, Cyclura pinguis. Glenn Gerber (San Diego Zoo) and Kelly Bradley (Dallas Zoo and University of Texas). $11,250.

4) Translocation, population surveys, and habitat restoration for the Bahamian iguanas, Cyclura r. rileyi *and* Cyclura r. cristata. William Hayes, Loma Linda University. $7,500.

5) *Conservation biology and management of the Saint Lucian iguana,* Iguana iguana. Matt Morton (Durrell Wildlife Conservation Trust) and Karen Graham (Sedgwick County Zoo). $7,500.

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IUCN The World Conservation Union

Species Survival Commission

Obituary ❋ The herpetology and veterinary staff of the Gladys Porter Zoo sadly report the passing of the longest living member of the genus *Cyclura* on record.

At an estimated age of 69 years, "Godzilla," a male Grand Cayman blue iguana, died on May 26, 2004 of apparent chronic hepatic insufficiency. He was ill for about two weeks prior to his death, although at his advanced age, Godzilla required extraordinary maintenance for the seven years he resided at the Zoo. Totally blind in one eye and almost blind in the other, this animal routinely brought out the "hero" in the Gladys Porter Zoo's veterinarians.

Captured as a full-grown adult on Grand Cayman in 1950 by naturalist Ira Thompson, Godzilla weighed over 15 pounds and was estimated to be at least 15 years of age at his time of capture. He was imported to the U.S. in 1985 by Ramon Noegel of Life Fellowship Bird Sanctuary, and was placed on loan to the Gladys Porter Zoo in 1997.

Though gaunt and aged in appearance, Godzilla retained the characteristics of a territorial, dominant *lewisi* up until the time of his final illness. As a potential founder for the critically endangered population of Grand Cayman iguanas, many creative schemes were attempted to assist him in mating with a much more nimble female. He was a favorite of the Zoo's keeper staff and volunteers; he will truly be missed.

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Godzilla, at least 69 years old, died in May 2004. Photo by John Binns.

Cayman Brac Land Preservation ❋ The International Reptile Conservation Foundation (IRCF), a 501 c(3) non-profit corporation directed by John and Sandy Binns, has donated property on Cayman Brac to the National Trust for the Cayman Islands be used as a nature reserve. Twelve mile long Cayman Brac is a tilted plateau starting at sea-level and rising gradually to 150 ft high cliffs at its east end. The donated property is located in the western, lower lying reaches of an area at the top of the plateau known as the Bluff. It includes two deep rifts in the rocky landscape, which reach down past the underlying groundwater to create two narrow, linear waterways, locally known as the Splits. With surface water otherwise scarce on Cayman Brac, the Splits supports diverse semi-deciduous dry forest and a large concentration of wildlife, including an endemic subspecies of racer *(Alsophis cantherigerus*), an endemic subspecies of Cayman ground boa *(Tropidophis caymanensis*), two gecko species *(Aristelliger praesignis* and *Sphaerodactylus argivus*), a galliwasp skink *(Celestus maculatus*), and an endemic variety of the Cuban anole *(Anolis sagrei)*. The area was also once home to the endangered Sister Isles rock iguana (*Cyclura nubila caymanensis*) and could potentially be used as a relocation site for the species.

The Splits originally belonged to respected pioneer doctor, the late Dr. Hermann, who in turn bequeathed it to his four daughters Barbara H. Wolf, Louise H. Trost, Carol H. Shepard, and Shirley H. Andrews. Aware of their father's love for its wildlife and natural beauty, they felt it was appropriate that the property be donated through the IRCF, with the help of Fred Burton and Mat Cottam, to the National Trust as a protected nature reserve.

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During March, most of the iguanas were found in the same general area where they were last observed during the January trip. To date, the animals have moved between 13 and 391 meters from their respective release sites. We anticipate that some of the females released will lay eggs for the first time this reproductive season and we hope to document successful nesting during a trip scheduled for July. Plans are underway to release another 24 headstarted animals in October.

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Species Recovery Plan Workshop

In response to the need for a unified conservation strategy for the critically endangered Anegada Island iguana, *Cyclura pinguis*, a Species Recovery Plan (SRP) workshop was recently conducted at the Miami Metrozoo from April 1 – 2, 2004. Workshop participants represented the IUCN Iguana Specialist Group (ISG) and the National Parks Trust of the British Virgin Islands (BVINPT). Those present (pictured left to right below) included Kelly Bradley (Dallas Zoo), Allison Alberts (ISG Co-Chair, San Diego Zoo), Quentin Bloxam (Durrell Wildlife Conservation Trust), Lee Pagni (San Diego Zoo), John Binns (Intl. Reptile Conservation Foundation), Rick Hudson (ISG Co-Chair, Fort Worth Zoo), Steve Conners (Miami Metrozoo), Joseph Smith-Abbott (BVINPT Director), and Fred Burton (Blue Iguana Recovery Program). To insure consistency in the ISG's Species Recovery Planning process, Fred and Quentin were brought in as facilitators. Fred and Quentin previously ran successful SRP workshops in Grand Cayman (2001), Dominican Republic (2002) and Turks & Caicos (2003).

Although an SRP workshop had already been conducted in July 2001 in Tortola, that Plan was never finalized or formerly ratified, and was largely out of date. And though significant progress has been made since then on a number of important fronts towards saving *Cyclura pinguis* on Anegada, a number of "big picture" issues still need to be addressed. A coordinated plan of action, specifically dealing with local public awareness and perceptions, land development plans and protected areas, and invasive species control, was needed. Thus the purpose of this workshop was to review the 2001 draft plan and then condense it into prioritized action components. Crucially important to this process was that each actionable component had a time line, a potential funding source if needed, and a point person assigned who would be responsible for implementation.

The next step is that BVINPT staff member Nancy Woodfield will compile the document for review and publication, which will then go to John Binns for layout and creative design. Funds to publish a high quality document have been identified (envisioned as resembling the Ricord's Iguana SRP) and a late 2004 publication date is anticipated. This document will prove useful on a number of fronts including guiding the recovery plan process, providing accountability, heightening local and international awareness for the plight of the iguana, and highlighting critical funding needs for granting agencies. However the most important goal that this document can serve is that it be accepted and publicly ratified by the appropriate government bodies in the British Virgin Islands. This action is vital to saving the Anegada Island iguana on Anegada, and is essential to this species' long-term survival.

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The Anegada Island iguana Species Recovery Plan workshop participants.

in a high site), they settle into a more stable home range.

Young iguanas prefer to eat the tender parts of red mangrove, flowers and sprouts of black mangrove, verdolaga, buds of grasses that grow in dunes in spring, and soft foods they can tear or cut easily. As the temperature increases during the day, their appetites increase. During November, the iguanas born during the past year as well as the young of the current year begin to shed.

At one year of age, sexual characteristics begin to manifest themselves. In males, the dorsal spines become more prominent, the head begins to appear more robust, the scales of the jaw stand out, and the femoral pores become more obvious. At this age they begin to display characteristic head movements more frequently and vigorously and to enlarge the gular sac with abrupt and threatening movements. When they are in feeding groups, larger males display aggressively in front of females of the same age; smaller males and younger animals retreat, allowing the dominant males to eat undisturbed. Aggressive conduct is short-lived, after which the others approach and continue eating until the action is repeated again. Dominant males also defend basking perches, immediately attacking and displacing intruders. These dominant males will also attempt to mount small females that happen by them. A male will pursue a female, mount and hold her with a bite to the neck until she shakes herself free and escapes, then headbob.

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Anegada Island iguana (*Cyclura pinguis*)

Headstart Release Update

The ISG and British Virgin Islands National Parks Trust released 24 headstarted iguanas back into the wild on Anegada in October of 2003, with funding from the International Iguana Foundation. The released iguanas ranged from 4 – 6 years of age and 750 – 2050 grams (mean = 1215g). Two release sites were used: Windlass Bight (sandy coastal scrub) and Middle Cay (inland limestone woodland). Both sites received 12 iguanas with an equal sex ratio and similar size distribution. The release strategy was designed to compare the success of different sized animals in two markedly different habitat types.

Since the fall release, there have been follow-up field trips in November, January, and March to monitor the status of the released iguanas. To date, the released animals have experienced an 84% survival rate. Two animals have been lost at each study site. Of the four animals that died, three were males, and all were of medium size (890 – 1170g; mean = 1065g). The four smallest animals released (750 - 880g; mean = 823g) are still alive and doing well. Because of the high survival rate of the smallest animals released, we plan to decrease the minimum size of animals released this fall from 750g to 550g. Evaluating the success of incrementally smaller size classes over a number of years will allow us to determine the optimum size for release without risking the loss of a large number of animals.

A headstarted and recently released Anegada Island iguana. Photo by Rick Hudson.

The released animals appear to be adjusting well to life in the wild. Six individuals have constructed burrows at the sandy scrub field site and most animals at both sites are showing retreat site fidelity. The animals released in the rocky woodland are utilizing existing rock crevices for retreats. During the November trip, all of the 22 animals remaining at that time were recaptured and all but four animals had increased in weight (mean gain = 136g). Five animals were recaptured in March, and all had gained weight since November (mean gain = 106g).

Taxon Reports

St. Lucia iguana (*Iguana iguana*)

The St Lucia Iguana Project began in December 2001 as a collaboration between Durrell Wildlife (DW) and the St. Lucia Forestry Department (SLFD), in response to a perceived decline in the distribution and numbers of the iguana on St. Lucia. Ongoing genetic work suggests that this population may be distinct from all other green iguana populations so far analyzed. Since 2002, Sedgwick County Zoo (SCZ) has also been actively involved in supporting the project through logistical support and assistance in the field.

Iguanas have proven to be very difficult to locate in the densely vegetated habitats of St. Lucia, even in areas known to harbor them. In upcoming months we will evaluate the feasibility of flashlight surveys by night as a means of locating both adult and dispersing hatchling iguanas. Long-term residents of regions throughout St. Lucia will be surveyed more systematically regarding iguana sightings, as well as a perceived absence of iguanas. Together with satellite imagery to be obtained from the government, these surveys will be utilized to investigate habitat suitability across the island.

In part due to the difficulty of locating iguanas in non-nesting habitat, much of the emphasis on data collection during nesting and hatching has occurred at the two known nesting beaches, Louvet and Grand Anse. In 2003, SLFD assisted in collecting data from these beaches. Due to considerable human resource constraints, most data collection was concentrated at Louvet beach. In 2004, DW funded travel and subsistence for four volunteers to work in teams of two at each beach location for the duration of the nesting and hatching seasons. These volunteers receive valuable field support by local individuals, contracted by SLFD and DW. The aim is to use the data gathered to develop an appropriate technique that will be practical for long-term population monitoring.

Adult male (left) and emerging hatchling St. Lucia iguana. Photos by Matthew Morton.

Nesting activity on beaches. In early March 2003, SLFD began beach searches for indices of nesting activity (tail drags, disinterred eggshells, nest holes, and sightings of female iguanas) but nesting had clearly already begun by that time. In 2004, we have confirmed that nesting activity began in the first week of February. The 2003 data on nesting activity suggest a peak of activity in mid April, but a more complete picture will be obtained after 2004 monitoring is complete.

We restricted our searches to beaches, as these are the only sites where tail drags were easily visible. Also, we have no reports of nesting at non-beach sites (although two reports of hatchlings away from beach sites have been logged, it is unclear whether these represent nest sites or dispersing juveniles). We only found signs of nesting at two relatively remote beaches on the northeast coast, despite searches around the island. Many of the other beaches surveyed lacked the combination of thick beachside vegetation (primarily *Coccoloba uvifera* and *Tabebuia heterophylla*) and open sandy gaps that characterize the nest sites at Louvet and Grand Anse. Human (and associated domestic animal) usage of many of these other beaches (including illegal sand mining, tourist visitation, and fishing) appeared more intensive than at the two confirmed nesting beaches.

In 2004, we excavated eggs from six newly dug nests. Nest burrows and egg chambers were mapped up to the point at which the egg clutch was discovered. Mean clutch size was 22 eggs (range 16-25, sd ± 3.39) and mean depth of the egg chamber below the surface was 0.45 m (range 0.30-0.65, sd ± 0.11). The tunnel can have more than one entrance, and the iguanas do not necessarily use the initial entrance that was made when they began constructing the nest. The entrances are always covered, but sometimes characteristics of the terrain provide indirect information on nest structure. The length of the tunnels we have observed are between 35 and 151 cm. The size of the chamber depends on the size of the female and the depth of the area where the nest is excavated. Based on our observations to date, the depth to the last egg has been between 17 and 29 cm. As a rule the nests are constructed near the roots of herbaceous plants. When the iguanas are within the nest they cover the entrance, the chamber is only found open when work is being initiated on it.

There is evidence that the chosen nesting site is reused. In each nest we located we found the remains of hatched eggs from the previous year, indicating that suitable places for nesting are returned to year after year. As with the crocodile, the lack of suitable nest sites is a limiting factor affecting reproduction in this species. This may explain why females are forced to migrate for laying, giving rise to the gregarious behavior observed during nesting. We rarely found isolated nests. Following a similar pattern to the crocodiles, iguana nests are aligned linearly toward the edges of the area and form triangles when they are more to the center (the nests occupying the vertices of the triangles).

Clutch size observed to date is between three and thirteen eggs. The size and weight of each egg becomes more homogenous as the clutch size is greater. In small clutches eggs may be notable in both their length and width. The weight of eggs is between 40 and 125 grams. Egg fertility is surprisingly high; we have not found infertile eggs in sampled nests. Cases of hatching failure (no eclosion) have not been due to embryonic mortality but instead to extreme humidity, or flooding of the nest chamber. Hatchling size is between 26.4 and 33.6 cm overall length.

Response to climatic changes. Iguanas change their behavior in response to climatic changes, particularly as a result of low temperatures, more dramatically if accompanied by rains. Normally they begin activity at 0900 but when it is cold and wet they are able to stay in their refuges or on their perches for days without moving. Adults are less affected than young. Perches are generally situated where the sun warms them up in the morning. We have seen hatchlings remain for four days in refuges without leaving at ambient temperatures of 20°C with cold winds and rain (October 28 to November 2).

Cuban iguana at Guantánamo Bay. Photo by Allison Alberts.

During cold days in January, (19°C), large animals that could not find refuges in tree hollows, were located by 1600 on perches near the border of the estuary, where they could receive warmth from the sea during the night, as well as the first rays of morning sunshine. When sleeping outdoors, the iguanas select places that are almost always heavy branches dense with leaves, usually hiding their heads in the foliage. We located 16 iguanas from Cuatro Bocas to the Biological Station, all facing east (5 females and 11 males) and verified that they did not move during the night.

Behavior of hatchlings and yearlings. After freeing themselves from their eggs, recent hatchlings remain for several hours within the nest chamber, then initiate excavation towards the outside; excavations are made diagonally. When arriving at the surface, they emerge head first and remain calm for several minutes. When they leave the nest, they run at full speed looking for protection among the plants. The remaining iguanas use the tunnels opened by the first to leave the nest. During the first six months, hatchlings may remain in groups, sharing the refuge or tree where they live, but after this they begin to disperse. Once they obtain a suitable site (hollow in a tree or accumulation of weeds

Observations on the Population of *Cyclura nubila nubila* Inhabiting the Mount Cabaniguán Wildlife Refuge, Las Tunas, Cuba.

Translated/edited from Spanish by Jean-Pierre Montagne and ISG newsletter editiors (San Diego Zoo).

The Mount Cabaniguán wildlife refuge is one of the few protected areas of Cuba that is home to a population of Cuban iguana (*Cyclura nubila nubila*) that lives exclusively in mangroves and coexists with the American crocodile (*Crocodylus acutus*). Here we present our observations on the ecology of this population.

Habitat use. Generally, iguanas at this site inhabit red mangroves (*Rhizophora mangle*), almost always on the shore of the estuary, which allows them to bask in the sun at dawn and dusk. Other than in nesting sites, which are the only places unaffected by the tide, we rarely found iguanas on the ground, suggesting that they are arboreal at all ages. At La Salina, a high site with a strip of cacti, iguanas always construct their burrows beside or within cacti; the site is also excellent for nest construction. Crocodiles nest in the area each year prior to the iguanas, which prepares the soil for iguana nesting. The reason we did not find iguanas in rocky crevices is because the region is marshy and the tide floods the entire mangrove area. The hollows of trees, generally made by woodpeckers, can only lodge small animals, so we rarely found adults in them either. The arboreal refuges used by iguanas are located in those mangroves that have been divided by the wind and hollowed out by the action of the water. The heavy branches help the iguanas to camouflage themselves and at the same time serve as perches for sleeping. By 1600, we find iguanas at the place they will spend the night or close to it (principally in the cold season). Night perches vary according to the time and to interference from conspecifics. If they are in burrows, iguanas usually become active again by 0900.

Adults are territorial; especially males. Females are a bit more tolerant, and will occasionally allow other females near their perches. During the first year of life, iguanas can be gregarious. In October of 1995, while looking for unemerged crocodile nests in Jobabito we found an iguana nest out of which nine hatchlings emerged. We collected two individuals that measured 31.0 and 31.4 cm in overall length. In November of 2001, we saw something similar, but this time within a burrow left by a green woodpecker in a dry and fallen red mangrove. Four hatchlings emerged running at full speed and we caught one that measured 29.6 cm in overall length and weighed 49.7 g.

Feeding. We know that wild iguanas feed on fruits and flowers of black mangrove (*Avicennia nitida*), leaves of red mangrove, verdolaga de playa (*Portulaca olivacea*), small corpses of birds, fish, and crabs (*Aratus* and *Uca*), and fruits and leaves of *Opuntia* and *Harrisia*, *Talassia,* and grasses. They appear to actively select their preferred foods from those available. We have been amused to see two or more animals eating on the dune - when one finds a piece of its favorite food and another one approaches, it stampedes away to avoid having its food snatched away from it. Flowers are among the favorites, including those of black mangrove and verdolaga de playa.

Nesting. Iguanas begin laying at the end of crocodile hatching, during the first week of July. Peak laying generally occurs in the middle of the month, at which time females move toward the nest building areas: Jobabito, Salina, Ojo de Agua, Soloburén, and Jijira, although we have also found nests in Tío Lindo and the neighboring areas of the Biological Station. The nests consist of a tunnel and an incubation chamber.

Flowering Oputia. Photo by JP Montagne.

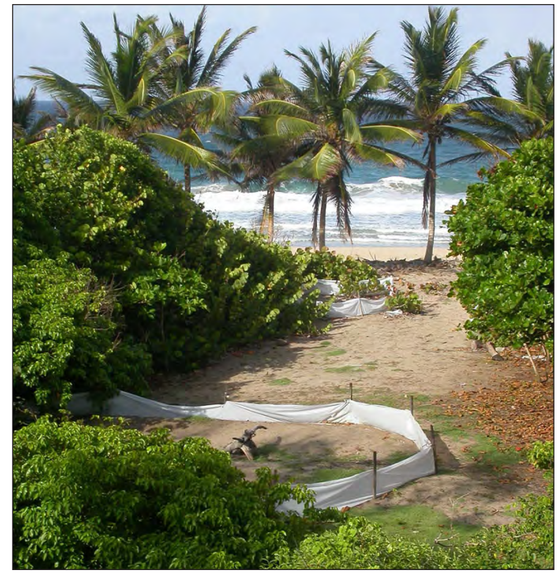
Data loggers to record temperature were installed in three active egg chambers plus a fourth chamber containing the shells of 19 apparently hatched eggs from a previous season. The latter location was selected over active nest sites because it was the site of many hatchlings with minor deformities (small tail kinks and skin lesions) in 2003 and temperature has been suggested as a potential cause.

Hatching. Nesting and hatching seasons are extensive and very nearly overlap. The last observed nest digging of 2003 was in the first week of May; the first hatchlings were seen the following week. From the last week in May 2003, and also from the first week in July in 2002, nine and six nest aggregations, respectively, were fenced with polythene sheeting and checked every 20-30 minutes throughout the day until 90 days after the last sighting of an adult female at the beach (corresponding to the reported incubation reported for *Iguana iguana)*. These nine fenced areas appear to represent the vast majority of nests on the Louvet beach, although some hatchlings are known to have emerged outside of these fences and were not counted.

In 2003 we counted 1,308 hatchlings. Mean SVL: 76 mm (60-94, n = 233); Tail length: 193 mm (131-212, n =233); body weight 14 g (5-19, n = 232 – the 5g individual was an outlier, clearly very dehydrated). The sex ratio was 1.00:0.83 F:M (*n* = 517). Based on 'pulses' of hatchling numbers (bearing in mind possible multiple clutch emergences, egg mortality, etc) we estimated clutch size as 17-20. From the hatchling counts, we estimated total hatchlings for the full season to be 1,734. Using our 2004 estimate of mean clutch size = 22, this gives an estimate of 79 successfully reproducing females at this site.

In 2004 we will attempt a more complete count of hatchlings at both Louvet and Grand Anse beaches and use the estimated number of females derived from this to calibrate the indices of nesting activity obtained during the nesting period. During hatching, we will also collect blood samples for health screens, and tissue samples for DNA analysis in order to gain insight into the level of genetic diversity that still exists in this seemingly small population, the degree of maternal fidelity to the nests where they were born, and the degree of gene flow between the two nesting beaches.

Nesting migration, juvenile dispersal, and mortality. In 2004 we captured a small sample (n = 6) of females at nests (both pre- and post- egg laying) and fitted them



Fenced nesting area, Louvet beach. Photo by Matthew Morton.

with radiotransmitters (*ca.* 15g each) on belts around their waists. We aim to estimate migration distances by following these females as they return to their normal home ranges. Later in 2004 we also plan to radiotag a small sample of hatchlings to study their movements in and around the nesting areas as they disperse. This work will hopefully also provide data on predation away from nests themselves and provide information on the confounding effects of emigration and survivorship.

Predation. As indicated by stomach content examination, mongooses are predating emerging hatchlings in the immediate vicinity of nests. Disturbingly, adult iguana remains were also found in the gut of one mongoose in 2004, indicating that mongooses are either eating adult iguana carrion, or possibly preying on live adult iguanas.

Cats appear to be a new threat on Louvet beach. In 2002 no cats were seen by researchers or project assistants, and long-time resident of the Louvet estate, Seko (Anthony Johnny), feels confident that cats have not previously occurred on the beach, at least in recent years. Throughout most of the 2003 hatching season, two cats were seen at the nest sites after dark. As with the mongooses, they were clearly targeting the nests; a number of kills were confirmed by uneaten tails and mutilated bodies of post emergent hatchlings, predated overnight (mongooses are diurnal). Assuming these animals have only arrived in this area in the last year, it

may be that no cat population is yet established here (Louvet beach is 2-3km from the nearest human community). Unfortunately, aggressive attempts to live trap these predators were unsuccessful in 2003.

Dogs do not appear to prey on hatchling iguanas but are a serious threat to adults. During March-May 2003 we found six remains of dead adult iguanas; at least three were at or near nests. Cause of death was not immediately apparent but dogs seem the only plausible culprits. At Louvet in particular, one dog was believed to be targeting the nest area; SLFD have sought help from the St. Lucia police to shoot the animal. This year we found clear evidence of egg predation by mongooses at nests on Louvet beach (footprints leading into opened nest tunnels, eggshells strewn around the entrance). Native predators include birds, primarily American kestrels (*Falco sparverius*), broad-winged hawks (*Buteo platypterus*) and herons (little blue herons *Egretta carerulea*, and green herons *Butorides virescens*; the yellow-crowned night heron *Nyctanassa violacea* is also present, although it hasnot been directly observed predating hatchlings). Boas (*Boa constrictor*) and fer-de-lance (*Bothrops caribbaeus*) are potential predators of hatchlings – both are present around the nest sites, though we have no observations of predation. There was also a single sighting of a boa (*Boa constrictor*) caught in the process of swallowing an adult iguana. (In 2004, three adult boas, two large enough to take adult iguanas, were seen in the 500m strip of sea grape bordering the nest areas at Louvet).

Louvet Estate entrance, with Seko, George Antoine (SLFD), and I-Stick and Sampson, (local residents contracted to install the sign). Photo by Matthew Morton.

Site Management. Thus far, the privately-owned Louvet Estate appears to have highest density of iguanas remaining on St. Lucia and the landowner seems enthusiastic about a voluntary wildlife management plan. Signage at the estate, and controlling access to critical nesting areas with a road chain, were funded by the International Iguana Foundation in 2003, have been the first concrete step in this direction. Defining patrol routes for SLFD to follow will be completed in 2004. We will also attempt to draft a more full management plan for this large estate (apparently > 500 acres) in 2004-5, incorporating proposed work on designation of protected areas along the northeast coast.

Community outreach. We continue to work with the SLFD Education Unit to develop a proposal for funding an education program. Since mid 2003, our focus has changed from an island-wide program to one centered on key communities in iguana habitat, with an emphasis on a community-led approach.

Our plan is based on a trial education program developed and delivered by SLFD in early 2003, which convened panels of teachers and parents to develop curricular activities for their community's children, thus engaging and sensitizing the adult population at the same time as the schoolchildren, rather than waiting for key messages to trickle-down from children to adults.

In addition, we are investigating the feasibility of small-scale eco-tourism initiatives on the northeast coast. Our approach is to address the apparently acute anthropogenic threats facing iguanas in these areas by 'investing' local people in their conservation, ideally providing some members of the community with employment. The local model for this has been the successful community-led Turtle Watch project at Desbarra, currently employing about 12 people, having brought in over EC$ 6,000 in 2003 alone and responsible for a decline in leatherback turtle poaching on Grand Anse beach and ongoing data collection on nesting.

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burrows were smaller than the occupied ones. In addition, abandoned burrows are closer on average.

Table 3 presents the means and the standard deviations of six variables measured in seven burrows of iguanas inhabited by females. Simple pairwise linear correlations between these variables revealed that entrance height was the variable with the highest correlation coefficients: with direction, 0.417; with thickness, 0.347; with width 0.369; with length, 0.425 and with depth, 0.335. Therefore, the entrance height was the burrow variable selected for the PCA.

Burrow height was then correlated with weight and morphological measurements (Table 4). Although the only statistically significant correlation was between burrow height and hindfoot nail length ($r=0.787$; $p < 0.05$), many other variables had (r) values between 0.30 and 0.60, especially the measurements of the lower extremities. Weight, head width, snout-vent length, and measurements representative of the anterior (humerus length) and posterior (femur length and hindfoot nail length) extremities were then used for PCA (Table 5). The two first components explained more than 70% of the total variation, and component I was positively associated with burrow height, weight, and all the morphological measurements, but especially femur length, humerus length, and hindfoot nail length, all of which are related to burrow excavation.

These results suggest that burrow entrance height can be a good indirect indicator of the size of the animal, and that it may be possible to use average values of burrow height to indicate the size structure of the study population.

Female Cuban iguana. Photo by Tandora Grant.

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Cuban iguana (*Cyclura nubila nubila*)

Burrows and Morphology of Cuban Iguanas (*Cyclura nubila*) Inhabiting Cruz del Padre Cays, Sabana-Camagüey Archipelago, North of Matanzas.

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Some ecological aspects related to the burrows and morphology of the Cuban iguana *Cyclura nubila nubila* were studied on Cruz del Padre Cay, to the north of the Cárdenas, Matanzas Province. For the Cuban iguana several observations indicate that burrows are the limiting key resource affecting population size, in the form of refuges from predators, climatic stress, and sites for oviposition (Berovides, in press). It is known that the availability of refuges can regulate the populations of some species of birds, freshwater fishes, amphibians, snails and other river invertebrates (Beck, 1955). Anecdotal references (Carey, 1975; Iverson, 1979) indicate the rapidity that areas containing trash piles, rocks, tree trunks, and other hiding places are colonized by juvenile iguanas, suggesting a deficit of this resource in the environment.

Diverse researchers have studied the Cuban iguana, but only a few make explicit references to their burrows (Sutcliffe, 1952; Hardy, 1956; Perera, 1985; Cubillas and Berovides, 1991; González et. al., 2001) which can be in rocks, in tree cavities or excavated in the sand. If burrows act as limiting resources for Cuban iguana populations, then the study of their characteristics, abundance, and potential for manipulation may have special importance for the long term effective conservation of this species, considered threatened with extinction and categorized by IUCN as vulnerable (Berovides et. al., 1996).

Our objectives were (1) to validate use of burrow abundance as an indirect measure of iguana abundance, as described in Cubillas and Berovides (1991); (2) to compare several measurements between occupied and unoccupied (abandoned) burrows, and (3) to determine whether or not a correlation exists between burrow characteristics and the morphological measurements of animals using it. All of our work was conducted with burrows excavated in the sand.

Materials and Methods. The study was completed in January 1999, under normal climatic conditions. The location of the study was Cruz del Padre Cay, north of Matanzas Province. This cay is characterized mainly by sandy ground and shrub vegetation (coastal xeric scrub) and the remainder is mangrove. Iguana burrows were studied in the area of Los Angulos beach.

Using a compass and tape measure, 19 sand burrows were measured for orientation, cover, entrance width (cm), overall entrance height (cm) [measured from ground surface to the base of the entrance], entrance height (cm) [measured from the inner edge (ceiling) of the entrance to the entrance base], thickness of the entrance (cm) [difference between the two inner measurements], and distances between burrows (m). Whether the burrow was occupied or not was also recorded. The plant cover surrounding each burrow was determined by method of line intercept (Franco et. al., 1992) with the burrow in the center and two 5 cm long perpendicular lines at intervals of 1m. The amount of contact that shrub vegetation (approximately 1m in height) made with the line intercept was recorded to give a measure of the number of shrubs/m along the line intercept.

The distances between burrows (N=16) allowed us to calculate burrow density (D_1) using the formula $D_1 = 1/2.78\ d^2 \times 10{,}000$ (Cottam and Curtis, 1956) and thus to indirectly estimate the density of iguanas (D_2) as $D_2 = D_1 \times O$ (Cubillas and Berovides, 1991), where O = percentage of occupation. The density of burrows estimated by this method was compared with that obtained in the study of a 0.56ha plot, where 20 burrows were detected.

All these measurements were made in an area of approximately 560m^2 (80x70m), in the northwest part of the sandy zone of the cay, about 22.4 m from the Los Angulos channel. On the opposite end of the sandy strip seven burrows were measured and opened, all of which were inhabited by adult females. For the burrows, the orientation, entrance width and height (cm) (as in the previous case), as well as length and depth (m), were measured. In the captured animals, the following variables were measured: weight (g) and 15 morphological variables, including the lengths (cm) of tail, head, femur, tibia, humerus, radius, fourth toenail on forefoot and hindfoot, fourth toe including nail on forefoot and hindfoot, overall length and snout-vent length, in addition to head width and the width of the left hindfoot excluding the fifth toe.

Means of the measured variables in occupied and unoccupied burrows were compared by T-tests.

	Plot	Distance / Burrows
Replicates	1	16
Average distances (mean ± S.D.)	-	10.2 ± 8.3
Burrows / hectare	35.7	34.2
Iguana / hectare	16.1	15.3

Table 1. Density estimates of iguanas based on two methods on Cruz del Padre cay.

	Occupied burrows (n = 9)	Unoccupied burrows (n = 10)
Variables	mean ± S.D.	mean ± S.D.
Orientation (degrees)	190.3 ± 112.6	188.8 ± 116.1
Cover	134.0 ± 35.4	159.0 ± 14.2
Entrance width (cm)	14.8 ± 4.8	11.7 ± 3.4
Entrance height (cm)	6.4 ± 3.0	5.1 ± 1.9
Entrance thickness (cm)	11. ± 5.3	7.7 ± 5.4
Burrow distance (m)	12.3 ± 10.0	8.2 ± 6.2

Table 2. Comparison of six variables between burrows occupied and unoccupied by iguanas on Cruz del Padre cay. Cover denotes the average contact of shrubs/m.

Variables	mean ± S.D.
Orientation (degrees)	105.7 ± 54.9
Entrance width (cm)	17.6 ± 4.7
Entrance height (cm)	5.9 ± 1.7
Entrance thickness (cm)	10.1 ± 4.4
Length (m)	2.9 ± 0.8
Depth (m)	52.6 ± 14.1

Table 3. Mean and standard deviations (S.D.) for six variables of seven iguana burrows occupied by females on Cruz del Padre cay.

Variables	mean ± S.D.	r
Weight	884.28 ± 278.31	0.531
Total length	60.48 ± 8.03	0.106
Snout-vent length	23.32 ± 4.66	0.222
Tail length	37.15 ± 9.22	0.021
Head length	4.65 ± 0.71	0.124
Head width	3.45 ± 0.96	0.383
Femur length	5.66 ± 0.79	0.428
Tibia length	5.98 ± 0.41	0.045
Humerus length	4.54 ± 0.54	0.333
Radius length	4.31 ± 0.50	0.484
Nail lenght (hindfoot)	0.97 ± 0.09	0.787
Nail length (forefoot)	0.79 ± 0.13	0.364
Fourth toe length (hindfoot)	4.63 ± 0.32	0.705
Fourth toe length (forefoot)	2.94 ± 0.36	0.320
Hindfoot length with nail	8.07 ± 0.54	0.341
Foot width	2.02 ± 0.22	0.420

Table 4. Mean and standard deviations (S.D.) of 15 morphological variables (cm) and weight (g), and their correlations with burrow entrance height in 7 individual female iguanas on Cruz del Padre cay.

Variables	Cp1	Cp2
Burrow height	0.681	0.006
Snout-vent length	0.599	0.747
Weight	0.879	0.335
Head width	0.693	0.523
Femur length	0.741	0.392
Humerus length	0.867	0.255
Hindfoot nail length	0.923	0.139
Eigemvalue	4.233	1.184
%	60.480	16.920

Table 5. Values of load factors in an analysis of main components, for six morphological variables and burrow entrance height for iguanas on Cruz del Padre cay.

Pairwise correlations were determined for various measurements of the open burrows that contained iguanas, as well as between the morphological measurements and weights from the captured individuals and these same burrow measurements in order to extract the relevant variables of both groups of measurements for principal components analysis (PCA).

Results and Discussion. Table 1 presents the estimates of burrow density based on the distances between burrows (N=16 measured) and its validation by direct counting. Both methods coincide given expected errors of estimation, and give density estimates of iguanas that are also similar, based on 45% occupation, determined at the same study site. These results reconfirm the utility of the method of indirect estimation of iguana density by the measurement of the distances between burrows, results similar to those obtained by González et. al. (2001) for the population of iguanas of Cayo Rosario. Nevertheless, our estimate of the percentage of burrow occupation (45%) was lower than the esitmate in that study (50%); than the one of Cubillas and Berovides (1991, 60%), and in others not published (63% Cayo Juan García, Cayos de San Felipe; 66% Cayo Obispo, Jardines del Rey), which indicates a possible recent extraction of mostly male individuals. When 11 burrows were opened (seven of which were part of the present study), only a single male was found.

Differences between occupied and unoccupied (abandoned) burrows in cover, width and entrance height, entrance thickness and distances between burrows were not statistically significant, either because no real differences exist or because of small sample size (Table 2). We believe the latter is more likely due to the fact that the observed differences are in the expected direction, given what is known about the ecology of iguanas in relation to their burrows. The observation that inhabited burrows tend to have less cover (Julio To Ramos, personal communication), agrees with our results. Also it has been observed that the juveniles tend to utilize several burrows that are abandoned quickly (Iverson, 1979). In our study, all the dimensions of the abandoned