

Recent Literature

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ISG Contact Information

Allison Alberts, Co-Chair
Zoological Society of San Diego
Email: aalberts@sandiegozoo.org

Fredric Burton, Deputy Chair
National Trust for the Cayman Islands
Email: fjburton@candw.ky

Richard Hudson, Co-Chair
Fort Worth Zoo
Email: RHudson@fortworthzoo.org

Miguel Garcia, Deputy Chair
Department of Natural and Environmental
Resources, Puerto Rico
Email: miguelag@umich.edu

<http://www.iucn-isg.org>



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USA

Editors:
Tandora Grant
Allison Alberts

Iguana Specialist Group
Newsletter

Volume 10 • Number 2 • Winter 2007

News & Comments

Grand Cayman Iguanas Hatch ✨ The San Diego Zoo's Conservation and Research for Endangered Species (CRES) is pleased to announce the hatching of three Grand Cayman blue iguanas. The hatchlings emerged from their eggs over a three-day period from September 17-19, 2007. The first-time mother, who weighed only 550 grams, nested four eggs in the soil of a potted Hibiscus plant at the off-exhibit lizard facility at CRES. The nesting and hatching dates are similar to those for iguanas in Grand Cayman. The eggs each weighed an average of 56.5 grams and measured 66 mm long by 45 mm wide. The eggs were placed on a mixture of vermiculite and water at a ratio of 1:1, by weight, and incubated at a temperature of 30° C. The first animal pipped after 83 days of incubation. The hatchlings weighed an average of 44.2 grams and measured 97 mm SVL.

The Grand Cayman blue iguana (*Cyclura lewisi*) is considered by many to be among the most endangered lizards in the world. Threats include severe habitat loss and fragmentation, road traffic, and intense predation from non-native feral and domesticated animals. The Blue Iguana Recovery Program was developed among several international collaborators to reverse the iguana's path to extinction by headstarting, breeding, and releasing iguanas within protected reserves in Grand Cayman. To date, over 250 iguanas have been released and the prospect for species survival is slowly improving. One of the many program goals is to develop a self-sustaining ex-situ captive population that mirrors the genetic diversity of the remaining wild population and provides a hedge against catastrophic loss in Grand Cayman.

The dam hatched in 2001 at the headstart and breeding facility in Grand Cayman. She and the sire (hatched 2002) were brought to CRES in 2005 with eight other juveniles representing five founder pedigrees new to the United States captive population. This is the first breeding of this species at San Diego; only two other zoos (Gladys Porter and Indianapolis) have bred blue iguanas in the United States in the last decade.



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

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Grand Cayman iguana (*Cyclura lewisi*) hatchlings at the San Diego Zoo - CRES. These babies are part the ex-situ population managed by partners in the Blue Iguana Recovery Program. Photos by Jeff Lemm.



2007 Annual ISG Meeting

The annual Iguana Specialist Group meeting will be held 3-8 January 2008 on Utila Island, Honduras.

During the 2005 and 2006 ISG meetings, attention has been given to a group of four critically endangered *Ctenosaura*, the *melanosterna* clade, from Honduras, the Bay Islands, and Guatemala. To address the critical needs of this threatened group of Ctenosaurs, a workshop will also be held to bring together local stakeholders to develop a management plan seeking solutions to curb further declines. Depending on the expertise available at the workshop, *bakeri*, *melanosterna*, *palearis*, and *oedirhina* species will be addressed.

The annual meeting schedule also includes participation in a Town Meeting on Utila, tour of the Utila Iguana Station, and a field trip for observing wild iguanas.

For more information contact Sandy Echternacht and Stesha Pasachnik.
 echterna@utk.edu
 spasachn@utk.edu

For more information on Ctenosaurs, see:
<http://www.iguanafoundation.org/article.php?articleID=71>

Captive breeding in zoos, to prevent loss of diversity before release, should be considered. We have already begun studying islets that have good potential for such translocations as we previously did in Martinique. We are ready to examine all propositions from abroad (island governments, associations, zoos, etc.) to translocate some of the last pure *I. delicatissima* from Basse-Terre to common iguana-free islets. In Basse-Terre, Grande-Terre, Les Saintes, and St. Maarten, it is now impossible to control *I. iguana*, which could be at very high density on private grounds where people feed them.

Petite Terre Natural Reserve. Petite Terre Natural Reserve was created in 1998 after the discovery and reporting by Breuil of this huge unknown population in 1994. At the time, only a preliminary population estimate was possible due to time constraints and the dense vegetation cover and inaccessibility of the area. We estimated 4,000 to 6,000 adults were possible and stressed to the French Ministry of Ecology the approximate nature of this calculation as well the importance of this population for conservation. Since 1995, the local association AEVA has applied the transect method to assess an effective population size for this reserve (Lorvelec 2007). We have submitted a manuscript to Applied Herpetology evaluating their transect methods and presenting the problems with determining a true population size for this reserve.

This summer all three of us were in Petite Terre at the request of Direction Régionale de l'Environnement to assess and propose a new protocol for studying this *I. delicatissima* population. It was easily seen that the distribution of iguanas is patchy and non-homogenous even within the same habitat, as we observed in Chancel. Compared with a theoretical distribution, females outnumber males in the nesting areas whereas the opposite is true in the non-nesting areas. With the construction of a management pathway in Petite Terre in 1995, new nesting grounds were created temporarily, though the vegetation has progressively re-grown over this opening. Throughout the reserve, as the vegetation cover varies from year to year the detectability of iguanas is dramatically effected and we have seen changes in their distribution during and outside of the nesting period as well as the onset of female nesting migration. Because of this variability, transect methodology alone is not adequate for assessing population size.

The impact of hurricanes on Petite Terre also needs to be evaluated for effects on iguana population



Photo 4. A very strange individual from the same population as Photos 1-3. This iguana is melanistic, has a somewhat banded tail, nuchal tubercles, low number of gular spikes, no subtympnic plate, and a punctuated dorsal coloration. Photo by Michel Breuil.

stability and persistence. Depending on the severity, vegetation will lose its leaves, be uprooted or branches broken, or be desiccated. If there are large swells, salt water will be washed inland and change the salinity of the soil. Because females lay their eggs just behind the beaches, eggs can also be destroyed by beach erosion. It is likely that different age and size classes will vary in terms of their survivability and growth rate. Delays in growth will adversely affect the age of sexual maturity and an individual's reproductive potential.

As no iguanas have been captured, marked, and monitored in Petite Terre since 1995, very little is known of the population's basic demography. These data are necessary before a true assessment can be made regarding population health and conservation needs. Local government authorities in Guadeloupe have recently changed and are aware that more studies are needed. They have asked for the creation of a "Guadeloupean Iguana Group" to propose and undertake new scientific studies modelling those we have conducted in Chancel where we have a solid comprehension of the population dynamics.



Michel Breuil
 Muséum National d'Histoire Naturelle, Paris
 mabreuil@club-internet.fr

Fortuné Guiougou
 Groupe Iguane de Guadeloupe (Le Gaïac)
 Fortuneguougou@wanadoo.fr

Béatrice Ibéné
 L'Association pour la Sauvegarde et la Réhabilitation
 de la Faune des Antilles (LASFA)



Photo 2. Iguana iguana female. Note the banded tail, the nuchal tubercles, the subtympnic plate, and the green punctuated coloration. Photo by Michel Breuil.

not observed. Among all the observed iguanas two seemed to be pure *I. iguana*, eight were hybrids (some close to *I. iguana*, others closer to *I. delicatissima*), and one looked like a melanistic hybrid (Photo 4). A melanistic population is known from the island of Saba (Powell et al., 2005).

Les Saintes. We have no recent data concerning the *I. delicatissima* population from Les Saintes. Our last observations are from 1995 and we cannot affirm that this species is still reproductively pure or hybridizing. Even if there are some old pure *I. delicatissima* individuals still surviving as mentioned in Lorvelec et al. 2007, more reproductive data are needed before determining the stability of this population.

Sint Maarten / Saint Martin. Remaining populations of *I. delicatissima*, if any, from Saint Martin are endangered because of the great expansion of *Iguana iguana*. This non-native population originated as escaped pets, releases, as well as about 120 escapees from a cargo ship recently. Misguidedly, the Nature Foundation of Sint Maarten captured these iguanas and released them in other places where some of them have established flourishing populations (Powell et al. 2005). Robert Powell proposed that *I. delicatissima* is vanished from St. Maarten, and we do not have recent data concerning its presence on the French side (Saint Martin). Our last observation of individuals was made in 1996; nor do we have recent evidence of reproductive purity.

Research and Conservation Actions. In 2006, the French Ministry of Ecology, Equipping, and Sustainable Development launched a restoration plan to save this Lesser Antillean endemic species. This plan comes 12 years after our publication describing competition and hybridization as the main cause of regression of *I. delicatissima* and that the situation is critical and the present expansion of *I. iguana* is rapid. As part of this plan, all administrations in charge of nature conserva-

tion in Guadeloupe and Martinique are requested by the Ministry to work together to save this emblematic species and also to re-survey the population in Petite Terre Natural Reserve (see below).

Our two-year action plan and studies in progress for Martinique were described in the ISG Newsletter 10(1). A manuscript has also been submitted to the journal Applied Herpetology. The situation for *I. delicatissima* in Martinique is quite different than in Guadeloupe. In Guadeloupe, the islands of Petite Terre, La Désirade, and St. Barthélemy are currently free of *I. iguana* but in danger of potential invasion by rafting, as was the case in Anguilla. Second, the islands of Les Saintes, Basse-Terre, and Grande-Terre have remnant *I. delicatissima* living sympatric with *I. iguana* and are effectively unable to remain reproductively pure due to the high number of hybrids and *I. iguana*. From our recent data, it is clear that all natural *I. delicatissima* populations are lost in Basse-Terre, Grande-Terre, Les Saintes, and Saint-Maarten. The physical presence of adults on these islands does not ensure these populations are sustainable.

Our research in Summer 2007 included capture and tissue sampling of individuals from these populations. All captured iguanas were PIT-tagged and released. Our goal is to continue sampling the hybrid and pure populations from Petite Terre, Désirade, Saint-Barth, Chancel, and Martinique to identify pure *I. delicatissima* specimens using genetic analysis. Once analysis is completed, pure *I. delicatissima* can be recaptured and used to create new populations on islets and islands where *I. iguana* is not present.



Photo 3. Huge hybrid male. Note the row of nearly isodiametric scales, the coloration, and the subtympnic plate. Photo by Michel Breuil.



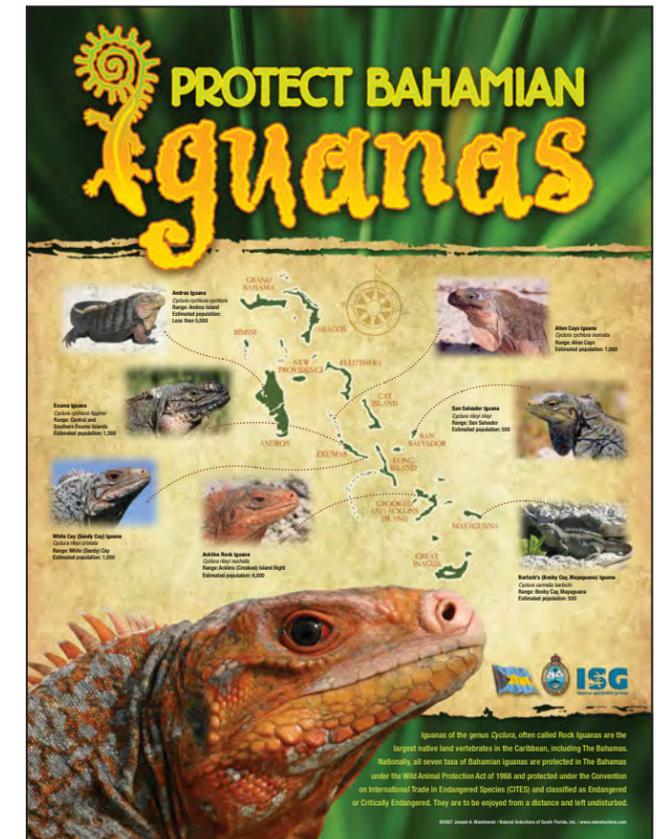
Sandra Brown, a teacher on South Andros, proudly displays her groups' activity on habitat loss (left). Bill Toone (pictured below at left), San Diego Zoo, leads a group of teachers from Central and North Andros on a fieldtrip. Both were part of the teacher training workshop. Photos by Lee Pagni.



Andros Iguana Outreach ✨ In October, The Zoological Society of San Diego and the Bahamas National Trust collaborated on a series of teacher workshops on Andros Island, Bahamas. Supported by a grant from the United States Fish and Wildlife Service's Wildlife Without Borders program, the goal of the workshops was to improve public support for conservation of the endangered Andros iguana (*Cyclura cyclura cyclura*). 34 educators representing all 19 public schools on the island took part in two 2-day workshops. The workshops focused on improving the educators' knowledge of Andros iguana natural history, conservation, and their pine forest habitat.

In addition to the workshops, a number of materials were developed to further support the dissemination of iguana conservation related information within the community. Educators were trained on how to use a portable education kit that contains lessons and related materials on Andros iguana conservation. They also received custom t-shirts to promote community pride in conserving the iguanas. In addition, The Central Andros Iguanas Football Club received a series of full-color trading cards that were created as a fun way to inform the youths and their families about Andros iguana natural history, threats, and conservation. Sports equipment with the Club's logo and a conservation message were also produced and given to the Club to support their efforts in Andros iguana conservation and youth development.

Lee Pagni
San Diego Zoo - CRES
leeontour@yahoo.com



New posters have been created by ISG member Joe Wasilewski highlighting Bahamian iguanas. The poster features photographs of all seven taxa and the respective islands they inhabit. Initially 1,000 posters were donated for placement in every school in The Bahamas. Posters are also available for \$9.99 plus \$3.00 shipping and handling. A portion of each sale will be donated to Bahamian iguana conservation initiatives. Please contact jawnatsel@bellsouth.net for more information.



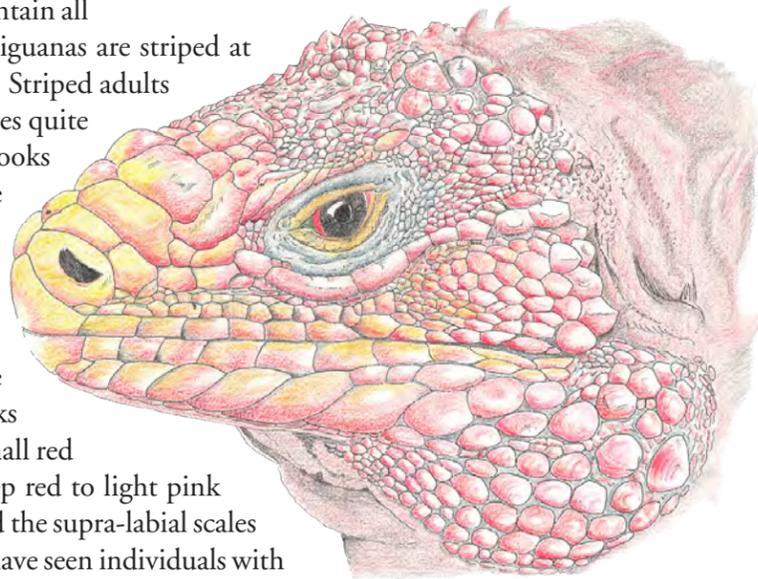
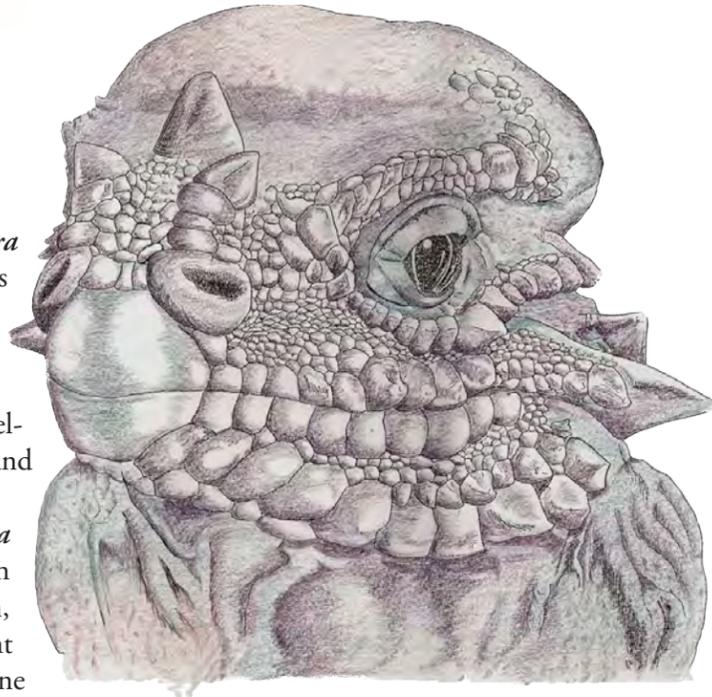
Cyclura Color Variation

Above. White (Sandy) Cay iguana (*Cyclura rileyi rileyi*). Most of these highly endangered iguanas are basically orange, with blotches of varying colors overall. These can be whitish, bluish, or grey/blue, and sometimes the percentage of blotches is more than the basic orange. The orange itself varies into yellow; some are more yellow than orange. Females and males appear similar morphologically.

Middle. Mona Island iguana (*Cyclura cornuta stejnegeri*). Mona iguanas are basically grey but with an overall color tint, making them either grey/green, grey/brown, or grey/blue. This is most evident in bright sunlight. Usually, each clutch from a nest has just one tint, unlike *Iguana iguana* whose clutches can contain all permutations of green iguana coloring. Mona iguanas are striped at birth and retain this for approximately one year. Striped adults are sometimes seen and old iguanas are sometimes quite black. This individual has very spiky scales and looks very large but is smaller than a same-age male which have more prominent scales.

Right. Andros Island iguana (*Cyclura cychlura cychlura*). These iguanas are very varied in color. Most have dark grey bodies with black feet. All digits on the feet have one white scale above each claw, unlike other *Cyclura*. Necks tend to be bluish or greyish, some with sparse small red scales. Heads are multi-colored; some have deep red to light pink jowls and sub-labial scales. Around the snout and the supra-labial scales can be light to dark orange, and nearly yellow. I have seen individuals with very pale heads (whitish pink) with random black irregular spots. Males and females are not noticeably different from each other. Jowls and some side parts of the face can either have conical-shaped or dome-shaped scales. The number of large lower jaw scales is not symmetrical, varying by as many as three between sides (seven on one side, ten on the other).

John Bendon
lizardwizard@btinternet.com



Lesser Antillean iguana (*Iguana delicatissima*)

2007 Surveys in the Guadeloupean Archipelago. Using our previous survey data, maps of *Iguana delicatissima* and *Iguana iguana* in the Guadeloupean archipelago were last published by Breuil in 2002. For *Iguana delicatissima*, most of the data for Basse-Terre were collected between 1992 and 1995. With help from members of Le Gaiac (local representative of the Guadeloupean Iguana Group, the national restoration plan for *I. delicatissima*) and members of L'Association pour la Sauvegarde et la Réhabilitation de la Faune des Antilles (L'ASFA), we conducted summer field research to determine the status of this West Indies endemic. We visited the previously known populations of *I. delicatissima* on Basse-Terre, Grande-Terre, and Petite Terre.

Basse-Terre. Beginning twelve years ago, we have known of a population containing about a dozen *I. delicatissima* and zero *I. iguana* in the north of Basse-Terre. This population has been monitored by one of us (FG). In Summer 2007, we observed six iguanas in good condition, although only two appeared to be true *I. delicatissima* and the other four hybrids. Two additional iguanas jumped from their trees too quickly to be identified.

On Ilet Goyave (leeward coast), *I. delicatissima* was last noted in the 1950s (Underwood, 1962), whereas by the 1960s Lazell (1973) saw only *I. iguana*. We also only observed *I. iguana* in a small ravine behind the beach in front of these islets. To us it is clear that *I. delicatissima* has been replaced there by *I. iguana*, as it is now the case nearly everywhere. On Rocher de Malendure, in the vicinity of Ilets Pigeon, we observed 15 iguanas that were phenotypically all *I. iguana*. Another population, not previously known by Breuil in 2002, was discovered in 2007 by Jérôme Guerlotté (Guadeloupean Iguana Group, University of Pointe-à-Pître) and located south between Malendure and Pointe à Lézards. 18 iguanas were observed in good condition: four *I. delicatissima* females, one *I. iguana* male, and 13 hybrids of both sexes with three more similar to *I. delicatissima* and ten closer to *I. iguana*. An additional five iguanas were seen but not identified. No iguanas were found in Morne Lézards where the species was observed ten years ago. In October 2007, L'ASFA observed three iguanas on Morne Machette: one *I. delicatissima* male, one hybrid, and one undetermined. This morne (hill) site is situated 500 meters north of Morne Lézard.

On the windward coast, we visited the “Ravine du Carbet” near Capesterre, which is the southernmost and largest *Iguana delicatissima* population in Basse-Terre. This area was disturbed by a highway in 2003, which was constructed without the mandatory impact study necessary to minimize consequences to wildlife. This is one of the locations Mark Day and Breuil collected tissue samples for genetic analysis in 1993 (Day and Thorpe 1996). In 1992-1993 the most abundant species was *I. delicatissima*, but orange hybrids were also present along with a few rare common iguanas. An orange iguana was genetically sequenced and shown by Day to be a hybrid. Now, iguanas are rare in this place and we were only able to spot four individuals: one *I. iguana*, one *I. delicatissima*, and two hybrids. The construction of this highway, as well as local people hunting iguanas for food, has had a great impact on the iguana population. Due to time constraints, we did not assess the populations between Sainte-Marie and Capesterre where both species were found in 2002.

A huge male *I. delicatissima* that was present in Vallombreuse in 2002 is still alive. He is probably 20-25 years old. There are now two other iguanas there: one *I. delicatissima* (young male) and one *I. iguana* (undetermined sex) (Cedric Coutelier, pers. comm.).

Grande-Terre. On Grande-Terre, we visited the last place where we saw an *I. delicatissima* in 2001, which was a female living in a hybrid population (Photo 1). Unfortunately we did not see this individual, but we identified the three hybrids pictured in the 2000 ISG Newsletter 3(2). Seven iguanas were caught total, and four were observed in good condition (Photos 2 and 3). Unfortunately phenotypically pure *I. delicatissima* were



Photo 1. Iguana delicatissima photographed in August 2001 on Grande-Terre (Saint-François). This female is from the same population as individuals in Photos 2, 3, and 4. It was perhaps the last pure representative of *I. delicatissima* in Grande-Terre. Photo by Michel Breuil.

the coastal areas. A female (30 cm SVL) killed on 3 May 2007 (Photo 1) contained 13 eggs and a female (30.5 cm SVL) killed on 8 May 2007 had 11 eggs. In order to quantify the effects of road mortality on the Lesser Antillean iguana, I will conduct road surveys in conjunction with population demography studies. Continual road surveys will be a collaborative effort with the Dominican Forestry Division staff to quantify current levels of road-kill mortality and identify its impact on population sustainability and demography. Surveys will also be used to identify and qualify attributes of important road-crossing points sustaining high-frequency mortality events. Data from this study can then be used to implement mitigation actions on Dominica and also be applied to future recovery strategies on other islands throughout the Lesser Antilles.

Two copulation events were observed on 24 April and one event observed on 4 May 2007 (Photo 2). Two communal nesting areas were discovered. One area was located on the coastal slope south of the Sunset Bay Club. The area appears to have been formed by a landslide and is approximately 72 m². In April and May, iguanas were routinely seen digging at this site and eggs shells were scattered along the base of the slope. A similar, yet smaller area was discovered at Champagne Bay. Both sites were punctuated by burrow entrances in different developmental stages. It appears that animals have to dig extremely deep into the sides of slopes to secure a reinforced position for their eggs. Another nesting site was discovered on the small section of Batali Beach. Numerous tracks and burrows were observed in this area. The surface also was littered with old iguana and sea turtle egg shells. The lizard, *Ameiva fuscata*, was observed eating iguana



Photo 2. Dead iguana on side of road above Batali Beach, Dominica revealed 13 eggs when necropsied. Photo by Charles Knapp.



Photo 2. Male # 1 mating with unmarked female at Sunset Bay Club, Dominica. Photo by Charles Knapp.

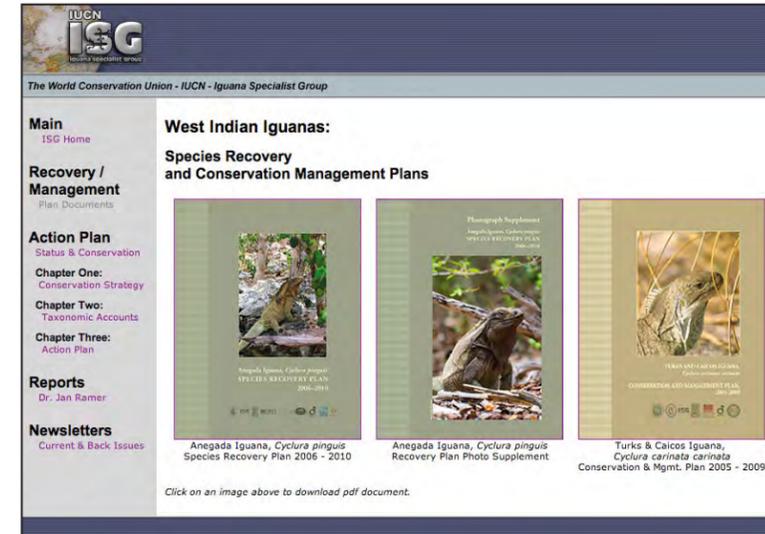
eggs at Champagne Bay. It is unclear if the lizards dug the eggs from beneath the surface or if the eggs were already at the surface at time of predation. The iguanas are extremely wary while engaging in nesting behavior and therefore difficult to observe. In the future I will construct blinds in order to observe nesting behavior and record exact oviposition sites in order to uncover eggs and subsequently estimate hatchling rates.

The communal nesting site along the Batali Beach slope was destroyed by hurricane Dean on 17 August. Numerous eggs and hatchlings were observed dead on the nesting slope (natural history note has been submitted to Herpetological Review). Prior to hurricane Dean striking the island in August, numerous iguana hatchlings were observed in this area. Although the site was destroyed, I suspect females will use the additional nesting sites in the area in 2008. Future plans include enclosing nesting areas with barriers in order to capture and mark hatchlings after they emerge from nests. I also intend to erect a drift fence with bucket traps along the coastal ridge above Batali Beach in order to capture dispersing hatchlings to estimate hatchling survivorship. A subset of iguanas will be affixed with radio transmitters to obtain precise movement data.

I will return to Dominica in April 2008 and will work with the Forestry Division to get the 2008 programs on line. I thank Mr. Arlington James and the staff at the Division of Forestry, Wildlife, and Parks for their support and permission to conduct this study.



Charles Knapp
San Diego Zoo - CRES
cknapp@sandiegozoo.org



Iguanas in the News

Long Beach Man Indicted for Smuggling Rare and Endangered Iguanas into U.S. in his Prosthetic Leg.
U.S. Attorney's Office, Central District of California
Press Release - September 21, 2007

LOS ANGELES, CALIFORNIA. A resident of Long Beach, California was indicted today on federal smuggling charges for bringing into the United States several extremely rare iguanas after stealing them from a nature preserve in the Republic of the Fiji Islands and concealing them in his prosthetic leg.

Jereme James, 33, was named in a one-count indictment returned this afternoon by a federal grand jury in Los Angeles. The smuggling charge, which carries a penalty of up to five years in federal prison, alleges that James stole three hatchling Fiji Island banded iguanas (*Brachylophus fasciatus*) and brought them to the United States in violation of federal and international law.

The Fiji Island banded iguana is threatened with extinction and is protected under an international treaty known as the Convention on International Trade in Endangered Species of Wild Fauna and Flora. While

We are pleased to announce the online publication of the Turks and Caicos Iguana Conservation and Management Plan (CAMP) and the Anegada Iguana Species Recovery Plan (SRP). Both plans can be found on the Iguana Specialist Group website - <http://www.iucn-isg.org/recoveryplan/cover.php>

These plans would not have been possible without contributions from a number of dedicated individuals, institutions, and funding organizations including Disney Wildlife Conservation Fund, IUCN, Sir Peter Scott Fund, and the Peretti Foundation. As electronic documents, the plans can be readily updated to address changing issues. Please feel free to join in the ongoing conversation about how these plans can be best used for the conservation of their target species.

Lee Pagni
San Diego Zoo - CRES
leeontour@yahoo.com

on a trip to Fiji in September 2002, James allegedly abducted three young iguanas from an ecological preserve. He then allegedly brought them into the United States by concealing them in a special compartment he had constructed in a prosthetic leg that he uses.

After receiving a tip that James possessed several specimens of the endangered species, the United States Fish and Wildlife Service opened an undercover investigation. During the investigation, James told an undercover operative that he sold a trio of Fiji Island banded iguanas four years ago for \$32,000. After a series of meetings with the defendant, Fish & Wildlife Service agents executed a search warrant at James' house in July and recovered four Fiji Island banded iguanas.

James will be summoned to appear for an arraignment in United States District Court in Los Angeles next month. An indictment contains allegations that a defendant has committed a crime. Every defendant is presumed innocent until and unless proven guilty in court.

Taxon Reports

Andros iguana (*Cyclura cyclura cyclura*)

Rapid Ecological Assessment for Iguanas on South Andros Island. The Bahamian Andros iguana (*Cyclura cyclura cyclura*) is the largest native terrestrial vertebrate, and the only iguana in the Bahamas that is not confined presently to small cays. Consequently, the lizards face unique anthropogenic pressures relative to other islands in the archipelago and are listed as Endangered under 2004 IUCN Red List criteria.

In 2002, the Bahamas National Trust (BNT), the non-government organization mandated with managing national parks in the country, established the Central Andros National Parks (total area 115,770 ha). These areas were established to protect inland forest, coral reef, and wetland nursery areas on North Andros Island. At the time, no detailed ecological data were available for the endemic iguana. Therefore, little input concerning iguana habitat requirements or current distribution patterns was incorporated in delineating protected area boundaries. As a result, the current protected areas are not ideal for iguana conservation because, relative to other localities, they are located in areas with historically degraded iguana habitat, feral non-indigenous mammalian predators, relatively high human population density, and a history of illegal hunting pressure.

In 2006, the Nature Conservancy, in partnership with the BNT, and with grant support from the Kerzner Marine Foundation, organized a rapid ecological assessment of the marine and terrestrial ecosystems on the west side of North Andros Island. This science-based assessment, performed by an interdisciplinary team of natural resource experts and local fishing guides, was conducted to identify critical conservation areas in order to maintain ecosystem function. The assessment also was conducted to fill information gaps on the distribution of high-profile endangered species such as flamingos, sea turtles, and iguanas.

A critical oversight in the 2006 assessment was neglecting the south end of Andros Island. Without a formal assessment of the area, comprehensive data are lacking necessary to identify critical conservation

zones across the entire island. The 2006 assessment revealed that the west side of North Andros Island was not ideal iguana habitat and demarcating additional protected areas there would not benefit the endangered endemic iguana. Therefore, the current assessment of South Andros Island, supported by an anonymous grant distributed via the International Iguana Foundation, was conducted to identify comprehensive distributional patterns for the Andros iguana throughout its range. Objectives for the assessment included 1) locating areas of relatively high iguana density and correlating density with environmental variables including vegetation, elevation, and substrate composition, and 2) conducting general herpetofauna surveys to produce species distribution lists. To increase the breadth of the survey, a sea turtle assessment team was included to determine species composition, demography, and relative abundance of sea turtles from South Andros.

Methods. From 27 September to 5 October 2007 we conducted visual encounter surveys from 30 sites located primarily south of Lisbon Creek (Fig. 1). Tiamo Resorts, located in South Bight served as base camp.

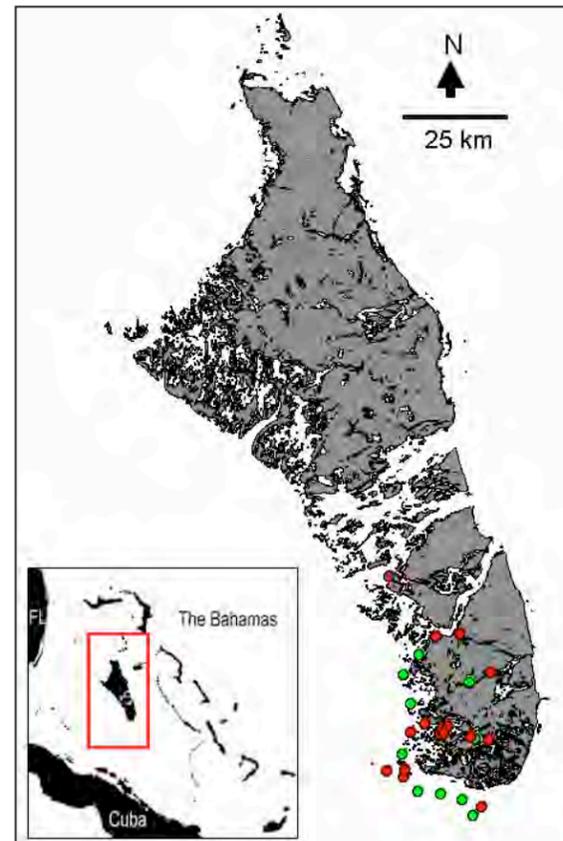


Figure 1. Map depicting sites visited during the 2007 rapid ecological assessment. Red circles represent sites where iguanas were recorded.

Lesser Antillean iguana (*Iguana delicatissima*)

The Lesser Antillean iguana (*Iguana delicatissima*) occupies less than ten main islands of the northern Lesser Antilles. Habitat degradation, non-native predators and competitors, hunting, road mortality, and genetic introgression with *Iguana iguana* threaten *I. delicatissima* with extinction across their range. Moreover, many extant populations have been reduced to extremely low levels in limited areas thereby causing concern about the long-term viability of the species. The Commonwealth of Dominica is believed to support the largest, single population of *I. delicatissima* because of its expansive, undisturbed coastal habitat. This population provides the opportunity to study the species under natural conditions prior to catastrophic declines and subsequent cascading demographic perturbations occurring elsewhere in the Lesser Antilles.

San Diego Zoo's center for Conservation and Research for Endangered Species (CRES) has initiated a study focusing on investigating coastal populations of *I. delicatissima*. Specifically, we will investigate life-history variation between disturbed and undisturbed iguana populations. Study variables include clutch size, age to reproduction, nest-site selection, hatch rate, juvenile and adult survival, and diet. Because coastal features on many of the Lesser Antillean islands are similar, data from "control" undisturbed and disturbed sites will be used to predict the fate of populations on Dominica, and other islands where coastal development is increasing due to tourism. In addition to investigating life histories, we will radio-track hatchlings from nests to record dispersal and survival, and document significant predators between the two sites.

Working with coastal *I. delicatissima* populations on Dominica provides a means to close the gap in connecting different landscapes using charismatic species as conservation flagships. Currently, parrots are seen as a flagship for inland mesic forests, while sea turtles represent beach habitat. However, the coastal scrub areas lack such a focal species and *I. delicatissima* has charisma and conservation appeal. Additionally, Dominica is one of the last strongholds for *I. delicatissima* and the methodologies used and results garnered during this study could be used as a model for other islands in the Lesser Antilles. Furthermore, we will establish a conservation footprint to spin off and replicate on other islands, using our results as leverage elsewhere. Finally, iguanas are charismatic conservation ambassa-

dors and we will work with local educators to develop programs focusing on iguanas and their importance to the island. Educational opportunities include providing hands-on field-research experiences with students and teachers. We will also engage students with educational classroom lectures involving study animals.

Introductory studies of *I. delicatissima* were conducted on Dominica during April 22-May 13 and August 15-September 7, 2007. Batali Beach and Champagne Bay, which are both located on the western coast of Dominica, were chosen as initial focal study sites. Iguanas were also captured from an additional six locations in order to initiate a multi-year mark/recapture study to estimate population density, survivorship, and growth rates. Radio transmitters were affixed to 11 iguanas (2 males, 9 females) at Batali Beach to determine movement patterns to and from nesting areas.

Summary Research Results April-May 2007

- 63 iguana captures (27 males; 36 females)
- 51 blood samples
- 11 iguanas affixed with radio transmitters
- 9 documented road-kills - 8 from a 5 km stretch of road above Batali Beach (5 confirmed female)
- 3 copulation events recorded
- 2 communal nesting sites documented (1 each at Batali Beach and Champagne Bay)
- Reconfirmed predation of iguana eggs by the lizard, *Ameiva fuscata*

Summary Research Results August-Sept 2007

- 72 iguana captures including four recaptures (45 males; 22 females; 5 juveniles)
- 60 blood samples
- 1 documented road-kill above Batali Beach (unknown sex)
- Confirmed mortality of eggs, hatchlings, and adults by hurricane Dean
- Confirmed predation by a *Boa constrictor* on a female iguana

Iguana road-kills appear to be problematic especially during the breeding season. Nine carcasses were discovered in three weeks along the 5 km stretch of road above Batali Beach. Based on necropsy evidence, five females were among the dead. The other four could not be distinguished because of the poor condition of the carcasses. One female recently oviposited and appeared to be migrating back inland from the coastal area. The other females appeared to be migrating from inland to

After a couple of intensive years of research on the Fijian Crested Iguana Sanctuary island of Yadua Taba, it seems like work on the basic natural history of this species is now slowing down. Suzi Morrison, PhD student from the Australian National University, returned from her fourth and final field trip in September 2007 and is now analysing data on iguanas (reproduction, habitat requirements, population ecology, and juvenile recruitment), Pacific rats, crazy ants, and tropical dry forests, with conservation of the iguanas and their habitat in mind. Her nesting ecology study, conducted from early 2006 to early 2007, provided insight into breeding patterns, nesting habitat, and hatching success rates. During her study, 14 nesting females were located which allowed Suzi to record the first information on nesting in the wild. Clutches ranged from two to four eggs (three average) and females invested equally in each egg, independent of clutch size. Clutch mass averaged 20% of female body mass and we now know that individual female iguanas don't breed every year due to this large investment and the harsh environment in which they live. Nests sites were monitored for the duration of incubation, which ranged from less than 8 to 9.5 months, an amazing incubation period for a lizard. Nests were revisited during the hatching period and over 90% of eggs hatched successfully, with only a small proportion lost to predation by Pacific rats. This is great news, as the extent of rat predation on crested iguana eggs was unknown and there are Pacific rats on every island in the South Pacific!

Clare Morrison, University of the South Pacific, and her team of students and colleagues have completed crested iguana diet and habitat use research, also on

Yadua Taba, and two manuscripts are currently under review. Scott Keogh, Australian National University, and colleagues have completed phylogenetic analyses on inter- and intra-population relatedness using all available Pacific iguana tissue samples. Peter Harlow visited Yadua Taba in February 2007 and collected crested iguana blood films from Suzi's marked population, to compare red blood cell parasite loads in the wet and the dry season in the same individuals. Earlier this year the results of surveys in 2000 and 2003 on the distribution and abundance of crested iguanas on islands where they were historically recorded was finally published (Harlow et al. 2007). The Fijian Crested Iguana 'Species Recovery Plan' (from the ISG meeting in Suva, Fiji in November 2004) is now finally completed and ready for publication in early 2008.



Peter Harlow
Taronga Zoo
pharlow@zoo.nsw.gov.au



Adult male Fijian crested iguana (*Brachylophus vitiensis*).
Photo by Peter Harlow.

This location provided access to the east and west coasts as well as numerous creeks leading into the interior of the island. We used local guides to help navigate the labyrinth of waterways of South Andros. Team members participating in the surveys ranged from three to five persons.

Team members conducted encounter surveys by walking collectively in the same direction at least five meters apart to minimize double counting animals. Size class (adult, subadult, hatchling) were recorded for each iguana observed. An index of observed iguanas per unit effort (person hours) was calculated for each location. Iguana scat and tail drags were also recorded. We failed to encounter iguanas from one location but recorded iguana tail drags, thus the location was recorded as having iguanas present. General vegetation characteristics, the presence of feral mammals, termite mounds, and other herpetofauna encountered were also recorded. We captured 14 iguanas from four locations to record morphometrics and collect 0.5 ml blood samples.

Results and Discussion. We visited from 1 to 7 sites per day (total = 30 sites, mean = 3.8, SD = 2.1) for 10 to 120 minutes (mean = 41, SD = 33 min.). A total of 68.3 person hours was tallied searching for iguanas and ranged from 0.5 to 8.0 person hours (mean = 2.1, SD = 1.6 person hrs.) per site. We did not work on 30 September 2007 because of severe rain. Two primary habitat types were encountered during this survey including pine woodland, and palm shrubland with fringing beach scrub and mangrove habitats. Broadleaf coppice was encountered at one site. Islands in the western bay of Grassy Creek and in the Water Cays located southwest of mainland South Andros were characterized by a circular sand ridge with a low-lying, flooded center consisting of mangrove species (*Avicennia germinans* and *Rhizophora mangle*) and buttonwood (*Conocarpus erectus*). An east-west gradient of exposed limestone was recorded both on mainland South Andros and in the chain of cays south of the mainland.

Iguanas were observed at 19 sites (63% of 30 sites), while recent tracks were observed at another site. A total of 97 iguanas was observed during the surveys (median = 3; range 1-25 iguanas per site). The highest concentrations were identified from two cays in the west bay of Grassy Creek and on Alcorine Cay. No feral animals were observed from any location. Comparisons of the 2006 North and present South Andros assessments are illustrated in Table 1.

	2006 (n = 39)	2007 (n = 30)
Sites with iguanas present	7 (18%)	20 (67%)
Total # of iguanas observed	43	97
Sites with feral hogs	8 (83% of North Andros sites)	0 (0%)
Median # of non-Cyclura reptile species per site	2	3

Table 1. Differences between North (2006) and South (2007) Andros west side surveys.

Seven species of amphibians and reptiles were observed during the surveys including *Alsophis vudii*, *Ameiva auberi*, *Anolis distichus*, *Anolis sagrei*, *Anolis smaragdinus*, *Cyclura cyclura*, *Eleutherodactylus planirostris*, and *Leiocephalus carinatus*. Exclusive of the non-conspicuous species (e.g. *A. vudii* and *E. planirostris*), species number at each site ranged from zero to five (median = 3). The most common non-*Cyclura* species recorded were *A. sagrei* (24 of 30 sites; 80%) followed by *L. carinatus* (20 of 30 sites; 67%) and *A. auberi* (16 of 30 sites; 53%). Also, because of the rapid survey scheme and notable lack of snake species, caution should be used when interpreting these data. However, this assessment provides basic richness and distribution data, which can be used to develop additional detailed survey assessments.

Conclusions. Based on the 2006 assessment, the west side of North Andros Island is low in elevation and dominated by palm shrubland with compressed mud substrate. Based on the 2007 assessment, the west side of South Andros consists typically of a 10–30 meter wide sand ridge running parallel with the shoreline with extensive mangrove flats behind the ridge. The extreme west sides of both North and South Andros are not ideal iguana habitat because tidal fluctuations often raise water table levels to just below or above the surface. Iguanas can inhabit these areas but only if there are areas of exposed limestone or if the habitat is adjacent to pine woodland areas. If these characteristics are not present, iguana densities are greatly reduced.

On South Andros, iguana densities were greatest beginning five kilometers from the west side and increased toward the center of the island. An area of small cays located in the west bay exiting Grassy Creek from the north creek extension was identified as an important area for iguanas. Every cay surveyed in the bay was inhabited by iguanas and eleven hatchlings (11% of 97 total iguanas) were observed. The islands

are small and relative iguana population size per cay is low but genetic diversity is most likely maintained by overwater dispersal in the calm bay. A hatchling was observed in the middle of a 200 meter wide channel and numerous other hatchlings were observed on the water edge. An iguana nest in the sand with nine eggs was also found on a cay. Sand nests are thought to be uncommon in this species and these cays would make an ideal study area for future study of this behavior.

Andros Island harbors a vast amount of terrestrial biological diversity in general, and the South Andros area in particular holds great potential for iguana conservation. The isolated small and large cays of the south/southwestern area (south of Mangrove Cay) lack feral animals and are far from human settlements. These areas are relatively pristine in comparison to North Andros. No roads exist in these areas and feral pigs are non-existent because of the North Bight water separation. Additionally, commercial logging practices were not initiated in the area because much of the pine-land is on hummocks of high ground surrounded by lower elevation mangrove and marsh. These isolated "pine islands" support the largest pines remaining in the Bahamas and are areas of high conservation priority for iguanas. Protected areas designed for iguana conservation should therefore be demarcated south of Lisbon Creek. Based on this survey and past research, I strongly suggest that large protected areas encompass Sandy Cay in South Bight and adjacent Alcorine Cay down to Grassy Creek. I will be presenting my recommendations to the Bahamas National Trust in February 2008.

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Charles Knapp
San Diego Zoo - CRES
cknapp@sandiegozoo.org



Bahamian iguanas (*Cyclura cyclura inornata* and *C. rileyi nuchalis*)

Our field research strategy this year (our 28th) was somewhat different than our usual primary focus on mark-recapture studies on Leaf Cay and U Cay in the Allen Cays. Over the past few years we have noticed that some iguanas on Leaf Cay and U Cay are becoming more wary of our attempts to capture them. Hence, we wanted to relax our efforts on the iguanas on those two islands in 2006 and 2007, in preparation for a major sampling effort there in May of 2008. Thus, like last year, we visited Leaf and U Cays only to collect and replace our digital temperature loggers there. This change freed us to accomplish a number of other goals that required more travel time among islands, and therefore a little less total time in the field. Our other goals this year included: 1) visit and assess the introduced population on Alligator Cay in the Exuma Land and Sea Park; 2) collect blood samples from iguanas on Alligator Cay to compare to samples from the parental population on Leaf Cay; 3) collect blood samples from the two very small iguana populations on tiny islands north of Leaf Cay in the Allen Cays; 4) assess reproduction (as we did last year) on the now substantial population of iguanas on Flat Rock Reef Cay in the northern Allen Cays, and collect more blood in order to determine the island source of origin of those iguanas; and 5) survey the introduced population of *Cyclura rileyi* on Bush Hill Cay in the Exuma Cays Land and Sea Park. All of these goals were accomplished, although an updated USFWS CITES import permit was unavailable at the time of our departure and collected blood samples had to be left under the care of Sandra Buckner in Nassau.

Alligator Cay. We spent the entire day of 25 June on Alligator Cay attempting to capture iguanas. They were exceptionally skittish and twelve of us working for a full day captured only ten iguanas (4 male, 6 female). All ten were juveniles (15-25 cm SVL) and none were previously marked from Chuck Knapp's work. We also found the remains of four dead iguanas which were delivered to Sandra Buckner, along with several carcasses found in May by Chuck Knapp. While on the cay we never saw a single large adult, nor did we see any evidence of nesting, even though it should have been the height of nesting season when we were there.

Mona Island iguana (*Cyclura cornuta stejnegeri*)

The National Science Foundation (NSF) will provide funding to conduct a Population Viability Analysis (PVA) for the Mona Island iguana (*Cyclura cornuta stejnegeri*). This initiative is part of a comprehensive project led by the Center for Applied Tropical Ecology and Conservation (CATEC) - University of Puerto Rico, in collaboration with the Puerto Rico Department of Natural and Environmental Resources (DNER). The required funding will be available starting in Fall 2007 for a period of three years, with the aim of developing careers and training in science and technology for students of minority groups.

The recovery plan for the endangered Mona Island iguana is currently obsolete. In the last decade critical data have been gathered and a number of management strategies (e.g. feral cat removal, enclosure for reducing egg predation) have been implemented for improving survivorship of individuals and increasing the population size. We seek to combine, analyze, and interpret all information to produce a Population Viability Analysis (PVA) for this species. This document will be used for identifying and ranking population parameters where financial and human resources need to be allocated and to update the recovery plan which will be a blueprint for the long term recovery of this endangered lizard.

We have data on the following aspects of Mona Island iguana biology: clutch size (Wiewandt 1977), nesting success rates (Wiewandt 1977; Pérez-Buitrago unpublished), wild juvenile mortality (Pérez-Buitrago 2000), predator impact (García et al. 2001), individual growth rates (unpublished data), dispersal (Pérez-Buitrago 2007), health of adult animals, habitat use in several different vegetation types (Pérez-Buitrago and Sabat 2007), and an estimate of the iguana population size on Mona Island (Pérez and Sabat 2000). Moreover, we have recently initiated research to: estimate male and female reproductive success using genetic markers, gather in-depth data on home range and habitat use in different areas, and ultimately, estimate the population size and effective population size utilizing combined genetic marker and population information. Nevertheless, to conduct the PVA appropriately, we require additional information on age of first reproduction, sex ratio (hatchlings and adults), inter-birth interval, wild hatchling survivorship, breeding population,

adult mortality, hatchling/juvenile growing rates, and population estimates from island-wide surveys.

We are currently implementing management programs aimed at 1) controlling hatchling and nest predators and 2) increasing the recruitment of juvenile iguanas into the breeding population by rearing them in enclosure cages until they reach a predator-safe size - a headstart (HST) program. Started in 1999, this project has maintained husbandry techniques adequate to produce releasable iguanas after 24-30 months in captivity (García et al. 2007). The first group of iguanas was released in 2001, and to date, around 135 HST iguanas are part of the wild population. These iguanas have survived and even reproduced, demonstrating that the HST initiative has been successful. However, it is unknown how many HST iguanas are needed to reach a sustainable population size. This critical parameter will be also obtained with the PVA. Our ultimate goal is to delete this species from the Endangered Species List within five to seven years.

To produce the PVA, we will use a Lefkovich-type demographic analysis (Caswell 2001) to evaluate the population growth rate based on vital rates. The life cycle will include several stages (eggs, hatchlings, small non-reproductive individuals and one or two reproductive stages). From this we will conduct sensitivity analysis and their related estimates of confidence intervals. In addition we will evaluate the effect of demographic and temporal stochasticity and density dependent models on growth rates and population persistence. The approach used here will have a broader impact and likely be useful for other *Cyclura* and Iguanid species that are presently being managed (Alberts et al. 1997; Knapp 2001; Goodman et al. 2005; Iverson et al. 2006).

A local meeting for data gathering and detecting gaps in information will be conducted in 2008. We seek to support the participation of at least one external iguana expert to assist in the completion of the PVA. The expected date to complete this PVA is 2010.



Miguel A. García
magarcia@drna.gobierno.pr

R. Tremblay
Nestor Pérez-Buitrago
Alberto A. Álvarez

Department of Natural and Environmental Resources
and University of Puerto Rico