Surprisingly little is known about the natural history and behavior of Lesser Antillean Iguanas (*Iguana delicatissima*). This is an adult female from St. Eustatius. *Photograph by Robert Powell.*

Conservation of Iguanas (*Iguana delicatissima* and *I. iguana*) in the Lesser Antilles

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Abstract.—Lesser Antillean iguana populations include at least two species, *Iguana delicatissima* and *I. iguana*, the latter of which may actually represent several species-level taxa. *Iguana delicatissima* is endemic to the region, as are at least two unique populations of *I. iguana*. Other populations in the region may have arrived naturally from South American by means of over-water dispersal, been introduced by Amerindians within the past 7,000 years, or been introduced within the past several decades as a by-product of the international pet trade. Although most extant populations of *I. delicatissima* are critically endangered, declines have been documented for several, and the gene pools of others have been contaminated as a consequence of hybridization with introduced populations of *I. iguana*, the species is considered only "vulnerable" according to IUCN Red List criteria. *Iguana iguana* is not listed. Protection is afforded both species under the auspices of CITES Appendix II, which lists all iguanids, but which includes provision for the harvest and export of *I. iguana* from many nations without consideration of the genetic distinctiveness of any population.

Most island populations are small, which renders them vulnerable to natural or human-mediated, stochastic or non-random events. In addition to hybridization, development-related habitat destruction and alteration, introduction of alien plants, predators, and competitors, and ongoing hunting pressure contribute to the precarious state of most populations. Conservation plans must be implemented and will have to include provisions for surveys and field research, establishment of protected areas within which livestock must be controlled, predator control strategies in some instances, extensive educational efforts, and, in at least the instance of the St. Lucian Iguana, a captive-breeding and headstarting program.

Key Words: Lesser Antillean Iguanas, *Iguana delicatissima*, Green Iguanas, *Iguana iguana*, Lesser Antilles, Conservation, Habitat Degradation, Mammalian Predators and Competitors, Hybridization

Introduction

Iguanas in the Lesser Antilles comprise a mosaic of two species with populations of varying antiquity and origins. Although the ancestors of extant and extirpated populations undoubtedly arrived in the islands from South America or offshore continental islands, some apparently managed the voyage by natural over-water dispersal via rafts of vegetation originating in flooding South American rivers. Other populations evidently had a helping hand from humans. Endemic Lesser Antillean Iguanas (*Iguana delicatissima*) appear to have been established since long before Amerindians began their trek north from South America some 7,000 years ago. Effectively isolated from their ancestors, they diverged and eventually colonized as many as 17 major islands on eight island banks. Similarly, some insular populations of Green Iguanas (*I. iguana*) appear to predate human arrival in the archipelago, with those on St. Lucia and Saba (and maybe Monserrat) developing sufficient genetic and morphological differences (Malone and Davis 2003) that they might warrant taxonomic distinction. Populations on the southernmost islands (e.g., Grenada, St. Vincent and the Grenadines) also probably originated from ancestors that arrived by natural means, and the lack of distinction from mainland ancestors may merely reflect geographic proximity, occasional recruitment by means of more recent rafting events, and similar selective pressures. However, some evidence suggests that Amerindians, may have translocated iguanas from island to island, establishing populations destined to serve as sources of food during later trips. In addition, large numbers of individuals have been released on islands either intentionally or accidentally in association with the international pet trade. Consequently, individual island populations include interbreeding mixtures of animals of both species, and at least some Green Iguana populations may include both descendants of ancestors predating human settlement and others from released or escaped pets within the past several decades.

Status of *Iguana delicatissima*

The species is listed in CITES Appendix II and as "vulnerable" in the most current IUCN Red List (Hilton-Taylor 2000). All populations are protected from hunting, although enforcement ranges from non-existent to sporadic. The species' original range extended from Martinique in the south to Anguilla in the north. However, populations have been extirpated on Barbuda, Saint Kitts, Nevis, Antigua, Les Îles des Saintes, Marie-Galante, and St.-Martin/St. Maarten. Breuil (2002) recently listed the populations on Dominica, Îles de la Petite Terre, and La Désirade as vulnerable. Apparently only that on Petite Terre is stable and

only that on Dominica is of even moderate size (Anonymous 2004a). However, even the "stable" population on Petite Terre suffered greatly during a prolonged drought in 2001 (Breuil 2002 and references therein). Breuil (2002) listed populations on Basse-Terre, Îlet Chancel (Martinique), and St.-Barthélemy as endangered, and those on Antigua, Anguilla, Barbuda, Île Fourchue and satellites (St.-Barthélemy), Grande-Terre, Martinique, St.-Martin, and St. Eustatius as critically endangered — and those on Antigua, Barbuda, and St.-Martin/St. Maarten have already disappeared (Fogarty et al. 2004), along with populations on St. Christopher (St. Kitts), Nevis, and Marie-Galante.

A Lesser Antillean Iguana (*Iguana delicatissima*) from Anguilla. Note the lack of an enlarged subtympanic scale, which distinguishes this species from *I. iguana*. *Photograph by Glenn Gerber.*

Adult Saban Iguanas (*Iguana iguana*) are melanistic and become completely black with age. *Photograph by John S. Parmerlee, Jr.*

The most obvious feature distinguishing St. Lucian Iguanas (*Iguana iguana*) from those on other Lesser Antillean islands is the prominent "horns." *Photograph by Matt Morton.*

Status of *Iguana iguana*

Because of the species' broad continental range, which extends from México through Central America and much of northern South America, and a general lack of recognition of genetic variability among populations, protective measures are considerably less stringent than for *I. delicatissima*. *Iguana iguana* is listed in CITES Appendix II, but export quotas exist for many countries, primarily for live animals (pet trade) or products (leather goods and meat). No distinction is made for native versus introduced or for continental versus insular populations. Hunting is usually prohibited, but enforcement of laws is lax at best. In Grenada, Green Iguanas are considered game animals (Powell 2004), with a "regulated" hunting season and bag limits. Both are routinely ignored by local hunters.

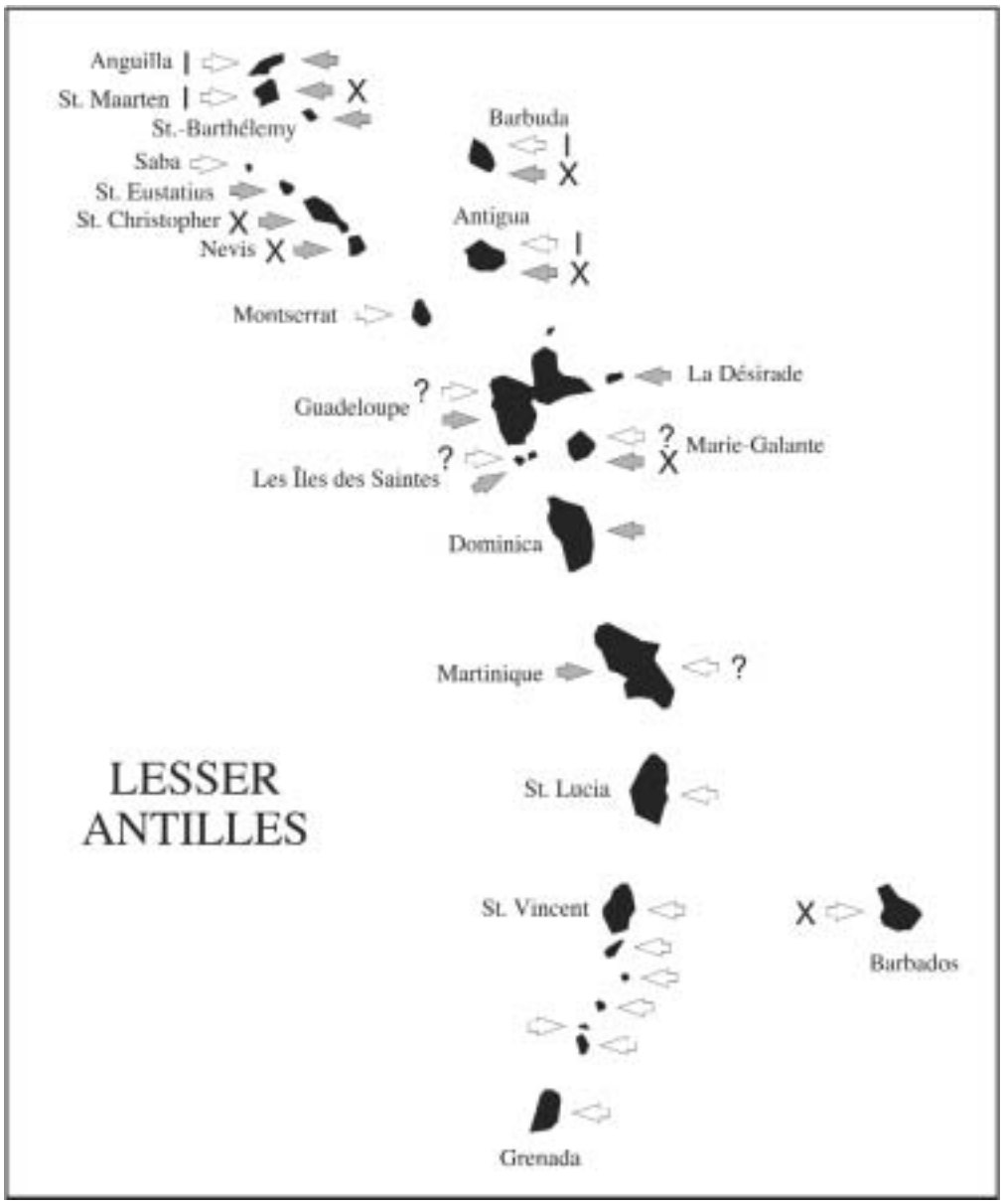
In the Lesser Antilles (Breuil 2002, Schwartz and Henderson 1991), presumably native populations occur on Grenada, St. Vincent and the Grenadines, St. Lucia, Saba, and Montserrat. Populations of unknown or mixed origin are on Martinique, Guadeloupe, Les Îles des Saintes, and Marie-Galante; and populations presumed or known to be introduced occur on Antigua, Barbuda, St.-Martin/St. Maarten, and Anguilla. A population on Barbados is extirpated (Breuil 2002).

Island Populations and Threats

As for all island species, especially those on small islands, populations are at constant risk of extirpation. Many Lesser Antillean islands can provide suitable habitat, but often are less than ideal for large animals vulnerable to extinction. Most islands are small, which inevitably leads to small population sizes and an increased risk of extirpation due to natural or human-mediated, stochastic or non-random events. Human population growth with accompanying improvements in infrastructure, often associated with increasing demands of tourist-related development, leads to habitat destruction and alteration. In addition, introduction of alien predators and competitors and ongoing hunting pressure all contribute to the iguanas' plight.

These threats and their impact on iguana populations are essentially similar to those facing populations of Rock Iguanas (*Cyclura* spp.) in the Bahamas, Cayman Islands, and Greater Antilles, and have been discussed previously in this issue by Alberts (2004), Burton (2004a), and Wilson and Vogel (2004). However, two additional, separate threats face populations of *I. delicatissima* on St. Eustatius and on Martinique, Guadeloupe, and possibly Anguilla. Mexican Creeper (*Antigonon* sp.) was introduced onto St. Eustatius as an ornamental garden plant, but has escaped and covers entire regions of the island, where it actively threatens native vegetation (Fogarty et al. 2004). No effective means of control has been identified. Even goats find the Creeper unpalatable and will eat it only in the absence of any alternatives. The impact on plants consumed by iguanas has not been assessed, but the danger is obvious.

The second threat facing populations of *I. delicatissima* on Martinique and Guadeloupe is the possibility of hybridization with introduced populations of *I. iguana*. The possibility of previous, "natural" contact between the two species on various Lesser Antillean islands cannot be disregarded, despite the fact that the natural distribution of the two species appears to be allopatric. Fossil remains of *I. iguana* are known from Grande-Terre (Guadeloupe), where *I. delicatissima* presumably occurs naturally. Also, Breuil (2002) noted that the one figure in Seba (1734) that was not an illustration of *I. iguana* and on which Laurenti (1768) largely based his description of *I. delicatissima* was probably a hybrid, indicating that contact between the two species is not a recent phenomenon (see Pasachnik et al. 2005 for a complete list of pertinent references and an extensive discussion of the species' nomenclatural history). Intermittent contact, with the possibility of introgression into native populations of either species, quite possibly occurred on several islands (although the statement in Anonymous 2004a that "Dominica, La Désirade and La Petite Terre are the only islands where just *Iguana delicatissima* is thought to live" is not warranted or accurate, as no reason exists to doubt the "purity" of populations on Anguilla or St. Eustatius). Regardless, in recent years, human-mediated introductions of *I. iguana* onto islands inhabited by *I. delicatissima* and reductions in the extent of suitable habitat caused by human encroachment have dramatically magnified the frequencies of contact between the two species on Martinique and Guadeloupe, where populations of "pure" *I. delicatissima* have essentially disappeared.



Distribution of Lesser Antillean iguanas. Islands on which *Iguana delicatissima* has been found are indicated by gray arrows, whereas those on which *I. iguana* has been found are indicated by white arrows. Arrows with an X indicate that the population has been extirpated, those with an I indicate an introduced population, and those with question marks indicate populations of unknown origin (see text). Note that no island is known to have ever supported two native populations of different species.

In 1995, as a consequence of Hurricane Luis, a floating mat of logs and uprooted trees carried at least 15 *I. iguana*, presumably from Guadeloupe, to Anguilla (Censky et al. 1998), providing irrefutable evidence of over-water dispersal by rafting. Although the "raft" landed near the eastern tip of Anguilla, far from the areas occupied by native *I. delicatissima* (Hodge et al. 2003), a decision to catch and destroy any Green Iguanas was implemented in order to avoid any possibility of contaminating the native gene pool. Although recent reports indicate that Green Iguanas still occur on Anguilla (Hodge 2003), no evidence exists that hybridization has occurred.

Looking to the Future

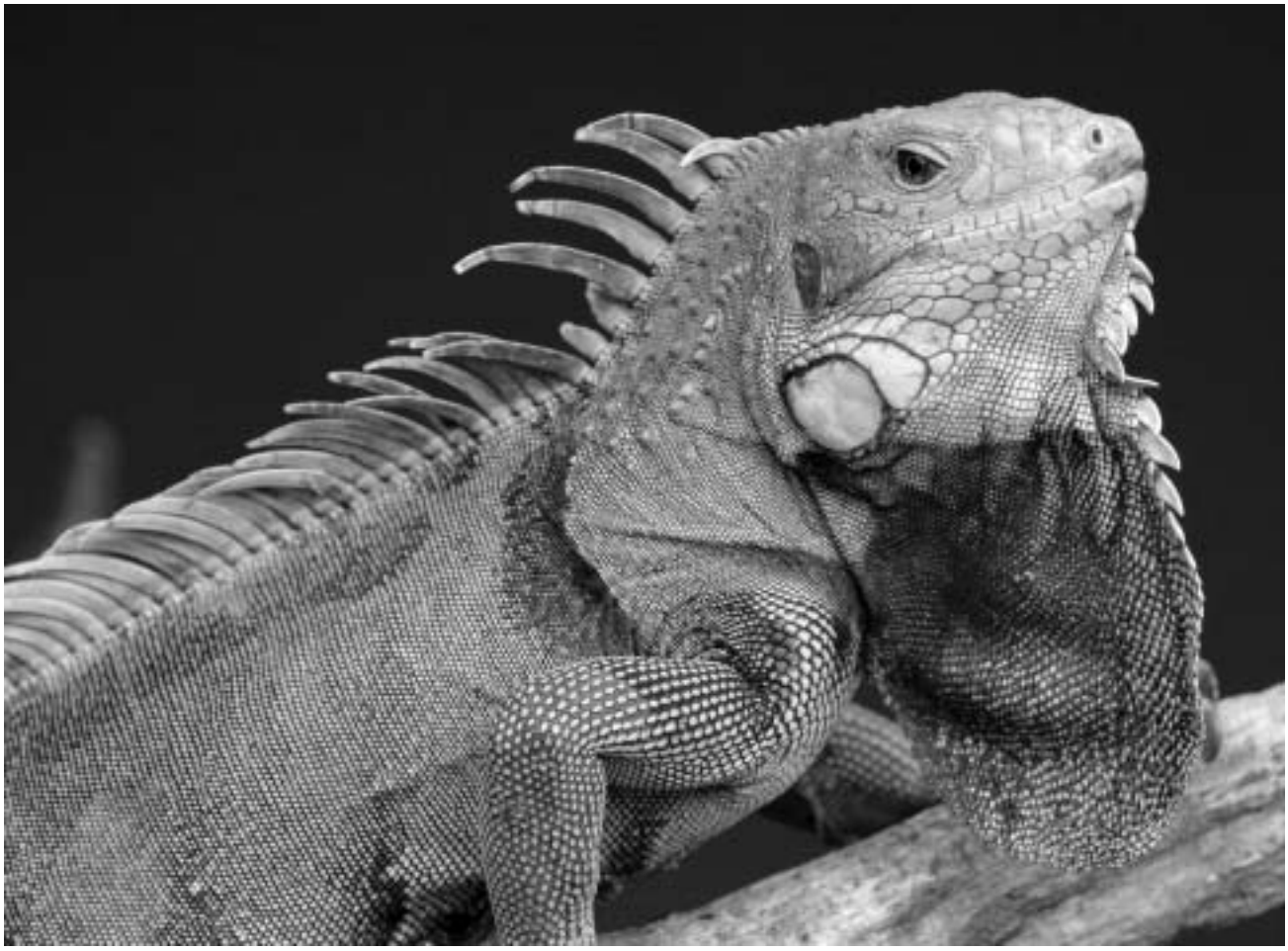
Unlike essentially all other West Indian iguanas, management strategies developed for the conservation of Lesser Antillean populations face the possibly insurmountable hurdle of involving a number of different governmental entities in any development and implementation of species recovery plans. Complicating matters even more is the reality that needs vary considerably from island to island. However, some generalities apply. If *Iguana delicatissima* and unique insular populations of *I. iguana* are to be saved, plans will have to include surveys and field research, establishment of protected areas within which livestock must be controlled, predator control strategies, massive educational efforts, and, in a few instances, captive-breeding and head-starting programs.

We know surprisingly little about the abundance and distribution of Lesser Antillean iguanas. Basic surveys have utilized various methods, many of which are not comparable. Also, because iguanas often are confined to the most rugged and remote regions of the respective islands on which they occur, many populations have not been surveyed recently — and some not at all. Furthermore, the basic biology of most populations has not been examined and many of the available studies may be compromised to varying degrees by focusing on animals acclimated to some degree of human activity. Assumptions that each population requires substantially the same essential resources may or may not apply. We simply lack the information necessary to make that determination. Consequently, we can only

Like most other populations of *Iguana delicatissima*, that on Anguilla is critically endangered. *Photograph by Glenn Gerber.*

The unusual pattern of this juvenile *Iguana iguana* from Saba provides support for the contention that this island population is specifically distinct. *Photograph by John S. Parmerlee, Jr.*

St. Lucian Iguanas, like those from Saba, are morphologically and genetically distinct from populations on the South and Central American mainland and the more southerly Lesser Antillean islands. *Photograph by Matt Morton.*



An adult male Green Iguana (*Iguana iguana*) from St. Maarten. All iguanas on St. Maarten are descendants of escaped or released pets. The Lesser Antillean Iguanas (*I. delicatissima*) endemic to the island have been extirpated. *Photograph by John S. Parmerlee, Jr.*

guess at changes resulting from recent development or at the impact of hurricanes on populations occupying increasingly smaller parcels of suitable habitats. Any effective management plan must include provisions for a single administrative entity that will be responsible for establishing guidelines for surveys and for training participants to assure the comparably reliable data that will be necessary for establishing priorities.

Basic surveys are most necessary on Montserrat, where the status of the *I. iguana* population is unknown and on islands, such as St. Vincent, the Grenadines, and Grenada, from which we have no current data on the populations. In addition, surveys on islands where *I. delicatissima* is in gravest danger of extinction (e.g., Anguilla, Île Fourchue and satellites, and St. Eustatius) should be implemented on a recurring and regular basis. Populations of iguanas on Guadeloupe and Martinique, which may represent hybrid "swarms," need to be monitored in order to evaluate ongoing interactions between the two species in order to better understand the relevant dynamics in anticipation of possible contact between them elsewhere. Field research on the basic biology of populations are needed for all populations, but priority should be given to better understanding the unique populations of *I. iguana* on Saba and St. Lucia (Morton 2004) and those populations of *I. delicatissima* in gravest danger of extinction (see above).

An adult female *Iguana delicatissima* on a Tamarind Tree in St. Eustatius, a favorite food tree. *Photograph by Robert Powell.*

Human encroachment on iguana habitats is inevitable unless protected areas are established and their boundaries enforced. The situation is least critical on islands (e.g., Saba and Dominica) with established reserves and rugged terrains that defy development in many areas. The needs are greatest on islands already heavily developed (e.g., St.-Barthélemy), with essentially no public land (e.g., Anguilla), or where protected

areas exist, but are being degraded rapidly by invasive plants and free-ranging livestock (e.g., St. Eustatius). Establishing satellite populations to reduce the threat of stochastic events, which has been implemented, for example, for several Rock Iguanas (see Alberts 2004), is not practical in most instances. Either satellite islands with suitable habitat do not exist or they are privately owned and unavailable. Also, many of the possible candidates support populations of feral dogs or cats or introduced mongooses (*Herpestes javanicus*), which would have to be eliminated at considerable cost in money and effort.

Education is critical for any conservation effort. Local residents of many Lesser Antillean islands are unaware that native iguana populations are endangered, that populations on several islands are unique, or that populations on other islands are composed entirely of individuals that are descended from escaped pets. That lack of awareness translates into a lack of support for conservation plans and a lack of concern for ongoing exploitation of iguanas for food, often by guest workers from other nations where iguana harvesting is a well-established tradition. This can be countered only by extensive educational programs. Current efforts are sporadic and vary in effectiveness. Anguilla, for example, has issued commemorative stamps and the National Trust successfully solicited funding for a book on the island's reptiles and amphibians (Hodge et al. 2003), which is being used in educational programs. A consortium of private and public entities on Saba has established a month-long "Sea & Learn" program (http://www.seaandlearn.org/), during which resident and visiting "experts" provide educational programs and outings for residents, students, and tourists. The St. Eustatius National Parks (STENAPA) Foundation regularly visits the nation's public and private schools and provides opportunities for students to learn about conservation both in and out of the classroom. In addition, with financial support from the International Iguana Society, signs promoting iguana conservation have been posted across the island (Anonymous 2004b, 2004c; Fogarty et al. 2004). On St. Lucia, the International Iguana Foundation and the Durrell Wildlife Conservation Trust have funded signs asking people to keep dogs on leashes in areas occupied by iguanas (Bendon 2003).

Captive-breeding programs for *I. delicatissima* exist at the Jersey Zoo in the English Channel Islands and the Memphis and San Diego zoos in the United States. However, success has been limited, with only the Jersey Zoo producing offspring (one in 1997 and eight in 2000). To the best of my knowledge, no captive-breeding programs for any Lesser Antillean Green Iguanas exist. Some discussion on Anguilla has addressed the possibility of headstarting individuals in anticipation of establishing a satellite population on an offshore island, but concrete plans are yet to be completed. On St. Lucia, iguana nests are monitored and protected, but no headstarting program exists. The St. Lucian Iguana, however, is a prime candidate for headstarting and for an *ex situ* captive breeding program. The principal impediment appears to be a general lack of recognition that this population is unique and worthy of such efforts.

Malone and Davis (2003) eloquently discussed the sometimes tragic consequences of establishing conservation priorities on taxonomies that do not reflect true phylogenetic relationships, citing the extinction of all but one population of the Tuatara (*Sphenodon guentheri*), that mistakenly had been considered but a subspecies of the more widely distributed *S. punc-*

An emaciated Green Iguana (*Iguana iguana*) after an over-water arrival on Anguilla via a floating mass of vegetation. *Photograph by Judy Dudley.*

This young adult Saban Iguana is mostly black, but retains some markings on the head. *Photograph by Robert Powell.*

This gravid female Saban Iguana was quite tolerant of humans. *Photograph by Robert Powell.*

tatus and, consequently, for which no protection was afforded. Malone and Davis (2003) also provided data indicating that similarly erroneous taxonomies exist for West Indian iguanas. The elevation of *Cyclura lewisi* to full species (Burton 2004b) effectively corrected one error, but any formal recognition of distinctive clades within *I. iguana* has not been addressed.

Management plans must be developed and implemented for Lesser Antillean iguanas, but two substantive barriers exist: (1) Governmental agencies and non-governmental conservation organizations must recognize the value of the unique insular populations currently classified as *I. iguana* and move ahead with conservation plans without waiting for the erroneous taxonomy to be formally corrected. (2) Those same entities must realize the precarious situation facing *I. delicatissima*, in spite of the fact that, as a species, it is merely "vulnerable" according to the current IUCN Red List (Hilton-Taylor 2000). In light of the precarious existence of nearly all populations, the extirpation of several, and observed declines and genetic contamination in others, those that remain must be afforded effective protection now, before the situation deteriorates further. In the meantime, educational efforts must be expanded or developed and implemented, with a particular emphasis on the potential harm to current and future conservation efforts if no consideration is given to the genetic distinctiveness or innate biological value of populations of either species.

Adult St Lucian Iguanas feature distinct bands of black or dark gray on a pale background. *Photograph by Matt Morton.*

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