



Although some females were quite large, they usually retained some green color along their lower sides. *Photograph by Robert Powell.*



Adult female in a private garden on the lower leeward slope of The Quill. Iguanas were abundant in this area, with each lushly planted plot supporting at least 1–3 individuals. Animals were not bothered by the sharp-edged leaves of the “Razor Plant.” *Photograph by Robert Powell.*



Sint Eustatius

Sint Eustatius, showing localities mentioned in the text. *Illustration by John Binns (modified from an original by John S. Parmerlee, Jr.).*

Revisiting St. Eustatius: Estimating the Population Size of Lesser Antillean Iguanas, *Iguana delicatissima*

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The Lesser Antillean Iguana, *Iguana delicatissima*, is in trouble. The species is listed in CITES Appendix I and as “vul-



Iguanas basking or resting in trees blended in well and were often difficult to see. Although large adults are relatively immune from predation, juveniles may be taken by large snakes (*Alsophis rufiventris*) or birds-of-prey, such as Red-tailed Hawks (*Buteo jamaicensis*) or American Kestrels (*Falco sparverius*). Photograph by John S. Parmerlee, Jr.

nerable” in the most current IUCN Redlist. As for all island species, especially those on small islands, populations are at constant risk of extirpation. Islands of the Lesser Antilles, although they can provide suitable habitat, are less than ideal for a large animal on the brink of 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 habitat destruction and alteration, introduction of alien predators and competitors, and ongoing hunting pressure all contribute to the iguana’s plight.

The species’ original range, from Martinique in the south to Anguilla in the north, is shrinking. Populations have been extirpated on Barbuda, Saint Kitts, Nevis, Antigua, Les Îles des Saintes, Marie Galante, and St.-Martin/St. Maarten. Michel Breuil recently listed the populations on Dominica, Îles de la Petite Terre, and La Désirade as vulnerable; those on Basse-Terre, Îlet Chancel (Martinique), and St.-Barthélemy as endangered; and those on Antigua, Anguilla, Barbuda, Île Fourchue and satel-



View of Statia from Boven Hill: the rugged Northern Hills are in the foreground, a portion of the Cultuurvlakte, the central plain, is visible, and The Quill is in the background. Photograph by Sean P. Fogarty.



An adult male in the Northern Hills, where iguanas were locally abundant, especially along forested ridges and in densely vegetated guts in this relatively xeric area. *Photograph by Sean P. Fogarty.*



An adult female regularly spent the night in this Tamarind Tree. Here she awaits the early morning sun. Tamarind leaves were commonly eaten. *Photograph by Robert Powell.*

lites (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.

Sint Eustatius, commonly known as Statia, is the northernmost island on the St. Christopher (St. Kitts) Bank, which also includes St. Kitts and Nevis. Within its 19.9 km² live 2900 people and about 8000 goats. The most noticeable feature of the Statian landscape is The Quill, a 600-m tall dormant volcano in the southeastern corner of the egg-shaped island. The Northern Hills lie in the smaller end of the “egg” at the northwestern corner of the island. Although not especially tall, with Boven Hill rising the highest at 289 m, these hills are characterized by steep slopes and deep guts (gullies). Between The Quill and the Northern Hills lies the Cultuurvlakte, the island’s central plain. Vegetation on the island ranges from extremely dry scrub and woodland in the northern hills to lush evergreen seasonal forest inside the crater of The Quill.

In 2000, Steven Reichling published a report stating that fewer than 300 iguanas remained on Statia when he visited in November 1999. This followed a 1992 population estimate by Mark Day and Brian Leysner stating that approximately 300 animals were on the island. We have no further information regarding the methods used in the latter study. However, the apparent population decline is similar to what has been seen on islands elsewhere in the Lesser Antilles, where once abundant iguanas have suffered from habitat encroachment, overhunting, competition for food with feral livestock (goats, cattle, and burros), and predation by mongooses, rats, dogs, and cats. In addition, on at least some islands, introduced Green Iguanas (*Iguana iguana*) compete for habitat and food and, in some instances, have hybridized with native *I. delicatissima*.

The 2004 Survey

In June 2004, we attempted to update the current status of the species on Statia. While a density estimate was not the main objective of our trip, it developed naturally from the behavioral work in which we were already engaged. That research required searching for both wild and human-habituated iguanas over much of the island. Most of our work focused on three areas, Gilboa Hill, the estates on the northwestern slope of The Quill, and the cliffs above Smoke Alley Beach. In each of these areas, we saw and recorded most of the iguanas present. We also saw animals on Boven Hill and on the western slope of The Quill.

Overall, we saw 33–37 different individuals on the island, with about 22 of these in habitats not frequented by humans. We spent 28–30 hours searching in the Northern Hills and approximately 85 hours looking for snakes on The Quill. We also spent approximately four hours looking for animals in landscaped gardens around private residences (numbers of search hours are rough estimates, since most of our time was spent observing rather than searching for iguanas).

We estimated relative densities, as Reichling did, by calculating the hours searched per iguana seen. We also used the same seven habitat zones described in his paper: Quill crater, outer slopes of The Quill, foothill scrub around the base of The Quill, Island Estates development, Cultuurvlakte (central plain), foothills and guts bordering the Northern Hills, and the Northern Hills themselves (Boven, Gilboa, Little Mountain,

Signal). The only time spent in the foothill scrub at the base of The Quill and in the foothills and guts bordering the Northern Hills was in transit to other areas. We saw no iguanas in either area. Hours searched per iguana seen in other areas were: Northern Hills — 1.8 (0.7 on Gilboa and 3.3 on Boven; Reichling 2.75), Island Estates — 0.2 (Reichling 1.8), outer slopes of The Quill — 8.3 (this is relatively high, but observers in this area were not looking primarily for iguanas; Reichling found none), and Cultuurvlakte — 0.4 (all along the cliffs above Smoke Alley Beach; Reichling found none). Reichling found one iguana per 7.3 search hours in the northern foothills and guts, where we did not search. Note that all of our data are in hours searched per individual iguana seen, not per sighting, as multiple sightings of the same individual would have inflated our numbers (when in doubt regarding the identity of a given individual, i.e., whether previously seen or not, we erred on the side of caution). However, our Cultuurvlakte and Island Estates encounter rates are undoubtedly high, since we searched only in areas where we knew that iguanas occurred.

Our sighting rates were much higher than we had anticipated from the data that Reichling had presented. Therefore, we believed that an adjusted whole-island population estimate was justified. In order to do this, we used the same habitat zones as before. Our observations on Gilboa Hill were made in what we designated “optimal” and “good” habitats. Based on similarities in topography and vegetation, we identified “optimal” and “good” and “other” habitats in the entire Northern Hills, for which we calculated areas. We then extrapolated from our encounter rates on Gilboa Hill to the entire Northern Hills, resulting in a population estimate of 174–404 for that region of the island.

During our visits to the grounds of three private residences in the Island Estates area, we found three iguanas in each. By conservatively estimating that comparable numbers of individuals lived in at least one- to two-thirds of the 63 estates in the area, we estimated that approximately 63–126 animals occur in this area.

We had to employ different techniques to estimate the population sizes in other areas, such as the outer slopes of The Quill, the Smoke Alley cliffs, and sites at which locals indicated iguanas were present. We assumed that population densities were lower than in the Northern Hills because (1) Reichling saw no animals on The Quill, (2) our encounter rates were relatively low (predicated, at least in part, by the fact that most person-hours on The Quill were by observers looking for terrestrial snakes along well-established trails, rather than largely arboreal iguanas that may well have been more common in areas far from the trails), and (3) the degraded state of much of the understory vegetation, attributable largely to the ubiquitous feral goats. However, the area is extensive, includes considerable suitable habitat, and the fact that individuals using a very different search image found iguanas collectively suggest that a substantial population exists. Based largely on our encounter rates and the proportion of the total area of the slopes surveyed, we estimate that 30–60 iguanas occupy the slopes of The Quill.

The Smoke Alley cliffs, above which the King’s Well Hotel is located, are home to several individuals. At least five to seven animals live on that portion of the slope behind the hotel, in



This adult male was foraging for fallen fruit on the Smoke Alley cliffs. Unlike females, large males lose all traces of the green coloration typical of juveniles. *Photograph by John S. Parmerlee, Jr.*



Even before exposure to direct sunlight, thermal images revealed that iguanas were considerably warmer than their environment. *Photograph by John S. Parmerlee, Jr.*



Acclimated to humans, this female responded to the photographer's presence only after a very close approach. *Photograph by Robert Powell.*

what may be the highest density on the entire island. As many as 14 individuals were known to occur in that limited area until very recently (within the past two years) and evidence of reproduction exists in the form of juveniles observed at several locations as far along the cliffs as the office of the St. Eustatius National Parks Foundation (STENAPA) near the harbor. Based on actual observations and a crude assessment of habitat quality, a conservative estimate of population size in this area is 10–50 individuals.

Other areas in which locals indicated that iguanas were present and which had been cited in the literature as good iguana habitat include the English Quarter, the nearby foothill scrub habitat, and comparable habitat extending around The Quill to the north and east. Because we did not search there and the habitat is severely degraded, much of it overgrown with Mexican Creeper (*Antigonon* sp.), we were uncomfortable counting any iguanas in those areas, although isolated pockets of suitable habitat probably support a few individuals.

When we combined all of our population estimates from the areas listed, the worst- and best-case scenarios were 275 and 650, respectively. Very subjectively evaluating our assessments of the island's habitats and the current status of threats to the population, we believe that the most likely population size is about 425. Because we assumed that no iguanas occupied areas where we were unable to confirm any individuals (notably those portions of the Northern Hills we did not visit, the Quill crater, and the lower slopes of The Quill, which include the English Quarter), our numbers should be considered highly conservative.

That this estimate is nevertheless considerably higher than Reichling's estimate of fewer than 300 animals in 1999 is not surprising. We saw half again as many animals while expending less time and effort. Our estimate also exceeds Day and Leysner's 1992 estimate of 300 individuals. This is good news, but could it be an illusion?

Growing Population or Artifact?

The circumstantial evidence suggests that the apparent upturn in the iguana population is real. First, locals in the Island Estates area indicated to us that the number of sightings of iguanas crossing roads has been growing in recent years. These areas are relatively immune from iguana hunting, because much of the area consists of large, gated properties. Also, animals that live on the grounds of protected private residences are undoubtedly reproducing, resulting in the repopulating of the adjacent Quill slopes. Second, we found animals on the slopes of The Quill, where Reichling saw none in either 1992 or 1999. Third, while he was unable to find animals on the Smoke Alley cliffs in 1999, they are now relatively abundant. The King's Well Hotel, which had been holding and breeding animals at the time, released 14 animals sometime after Reichling's visit. These animals and their offspring seem to be thriving. Fourth, when two of us initially went scouting for iguanas in the Northern Hills, having never seen iguanas in a natural setting, we found three iguanas in the first four hours of searching! This was a far higher density than any of us had expected, especially for inexperienced spotters. Finally, two other

variables strongly suggest support for the higher numbers, the incidence of hurricanes and an apparent decline in hunting pressure.

Several long-time Statian residents independently commented that iguanas become very difficult to find for periods of up to several months after major hurricanes. They attributed this to disruptions of habitats and defoliation of most plants that would usually provide cover and food. The 1992 population estimate was probably not affected by hurricanes, as three years had passed since Hugo in 1989. However, hurricanes may have dramatically affected the 1999 estimate. When Reichling made his observations in November 1999, José, a category one hurricane, had passed within 15 nautical miles in October and Lenny, a category four, had passed within 29 nautical miles just days earlier. In addition, Georges, a category 3 hurricane, had passed within 14 nautical miles of Statia the year prior. The combined effects of these hurricanes on the iguana population is difficult to assess, but may well have been responsible for the decline in numbers between 1992 and 1999, and may account, at least in part, for the apparent increase in the numbers of iguanas during the hurricane-free years subsequent to Reichling's visit.

Iguanas have been a source of food to islanders since Amerindians first arrived on Statia. Even today, some men on the island, particularly non-resident workers from other Caribbean islands, apparently believe that eating iguana will enhance their

sexual energy. Also, Nicole Esteban, Director of STENAPA, still receives occasional reports of iguana barbecues. However, based on equally anecdotal evidence, the problem appears to be less pervasive than during the 1990s. At that time, long-term residents reported that they routinely saw kids carrying iguanas to town in an effort to acquire some spending money. Whether educational efforts (see below) are paying off, more Statians are beginning to understand the value of having iguanas on the island, or merely because the availability of goods is better now, the potential benefits of poaching iguanas seem to be diminishing.

Ongoing Conservation Concerns

The principal threat to Statia's iguanas remains habitat alteration and degradation. Although the human population is not growing rapidly, improvements in infrastructure and any new construction, especially if they impinge on either the Northern Hills or the slopes of The Quill, have the potential to reduce available habitat. Of greater concern is the ongoing degradation of natural vegetation attributable to the spread of invasive alien species, most notably the Mexican Creeper (*Antigonon* sp.), and to the largely unchecked impact of feral herbivores. Goats, burros, and even cattle are abundant, and range freely in even the most "natural" areas. Aggravating the problem is the fact that goats will eat the Creeper only in the absence of other forage (iguana are presumably just as discriminating). Ongoing efforts at the Botanical



Iguanas were locally abundant along the Smoke Alley cliffs, where at least some individuals were formerly held captive at the King's Well Hotel. *Photograph by Robert Powell.*



Shaded by The Quill and the cliffs, iguanas sleeping in trees often remained in place until the mid-morning sun provided ample heat. *Photograph by Robert Powell.*



Goats are abundant and ubiquitous in even the most remote locations, such as this hillside in the Northern Hills. They have dramatically degraded the natural vegetation and often compete directly with iguanas for food. *Photograph by Sean P. Fogarty.*

Garden, situated on the windward eastern slope of The Quill, dramatically illustrate the problem. Fences exclude goats but not the Creeper, and, as the latter grows over the fences, its dense growth provides access to the goats. Continually removing the invasives is labor-intensive and unproductive in the long term. Unless biological agents can be employed to reduce the incidence

of the Creeper and the goat population is either contained or dramatically reduced in size, iguanas will survive only in localized pockets extremely vulnerable to exploitation or stochastic events.

The Quill and the Northern Hills have been designated parts of St. Eustatius's national park system, and consequently are afforded some protection against development, if not against goats and invasive plants. Because the promotion of ecotourism to complement excellent offshore diving opportunities is the most likely means of enhancing the nation's economic growth, reasonable hope exists that current disputes over ownership of the Northern Hills and the problems created by too many goats will eventually be resolved in favor of nature — and therefore the iguanas, which themselves could serve as a tourist attraction. In the immediate future, we can only hope that the situation does not deteriorate so quickly that more enlightened policies can be instituted and effectively enforced in time.

Predation by both humans and animals also remains a concern. Although mongooses are not present on St. Eustatius, dogs and cats are abundant. Both have been shown to cause declines in iguana populations throughout the West Indies. Even if pets remain, efforts to control feral predators should be employed. Human predation appears to be declining, and ongoing educational efforts, largely by STENAPA, should have an increasingly greater impact, as today's students become involved in developing and implementing policies. Although iguana hunting is already illegal and fines have been legislated, enforcement is essentially nonexistent. Consequently, a complete cessation of hunt-



This iguana (indicated by the arrow) seems to be seeking protection from the sign that had just been posted on the lower slopes of the Smoke Alley cliffs. Fourteen of these signs were provided to the St. Eustatius National Parks Foundation by the IIS. *Photograph by Victoria H. Zero.*



Although primarily arboreal along the Smoke Alley cliffs, iguanas were not adverse to crossing open ground, even pausing to bask for short periods. *Photograph by Robert Powell.*



This bright green juvenile basking in a palm tree above the Smoke Alley cliffs is testament to successful recruitment. *Photograph by Robert Powell.*

ing activities will depend on widespread public support that should increase, as students, who now benefit from environmental programs in the schools, become actively engaged citizens. Problems with guest workers from other islands, many of whom see iguanas only as a resource to be exploited, will continue — but should be more readily addressed if locals cease hunting animals and begin to view them as an economic asset.

Acknowledgements

Nicole Esteban and the staff, interns, and volunteers at STENAPA were immensely helpful during our stay on Statia. Heather Heinz (North Carolina State University), Trevor Joyce (University of Alaska Southeast), Abigail Maley (Ohio Wesleyan University), Aaron Savit (St. John's College), and Robert Henderson (Milwaukee Public Museum) all contributed field observations. Fieldwork was funded by grant No. DBI-0242589 awarded by the National Science Foundation to Robert Powell.

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