



# Lesser Antillean Iguana

*Iguana delicatissima*: Conservation Action Plan,  
2014—2016

Edited by Charles Knapp, Michel Breuil, Chloé Rodrigues, and John Iverson



International Union for Conservation of Nature

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# Lesser Antillean Iguana, *Iguana delicatissima*

## Conservation Action Plan, 2014 – 2016

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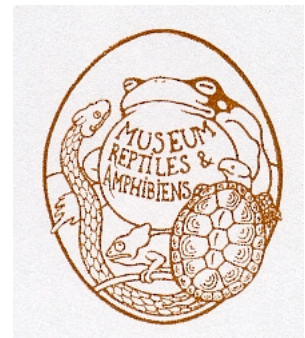
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## ABBREVIATIONS

CNIDC	Caribbean Network for <i>Iguana delicatissima</i> Conservation
CNSI	Caribbean Netherlands Science Institute, St. Eustatius
DEAL	Direction de l'Environnement, de Aménagement et du Logement (Regional Direction of the Environment for Martinique)
GECIPAG	Groupe d'Étude et de Conservation de l'Iguane des Petites Antilles en Guadeloupe
GRENAT	Association de Gestion et de Protection du Patrimoine Naturel de Saint-Barthélemy
IMARES	Institute for Marine Research and Ecosystem Studies, Wageningen University and Research Center
IUCN	International Union for the Conservation of Nature
ISG	Iguana Specialist Group
LASFA	L'Association pour la Sauvegarde et la Réhabilitation de la Faune Antillaise
LVV	Department of Agriculture Animal Husbandry and Fisheries of St. Eustatius
MNHN	Muséum National d'Histoire Naturelle
ONCFS	Office National de la Chasse et de la Faune Sauvage (National Hunting and Wildlife Agency, French West Indies)
SMPE	Service Mixte de Police de l'Environnement, a unit of the ONCFS
SSC	Species Survival Commission
STENAPA	St. Eustatius National Parks





## FOREWORD

Iguanas in the Lesser Antilles include only two species of the genus *Iguana*. Fossil evidence of the endemic Lesser Antillean Iguana (*Iguana delicatissima*) predates the arrival of Amerindians to the region some 7,000 years ago. Ancestors of the species most likely earned passage to the islands via rafting on flotsam ejected from flooding South American rivers. Similarly, some populations of the Green Iguana (*I. iguana*) predate the arrival of Amerindians and probably arrived to the islands in similar fashion. Evidence suggests that Amerindians transported iguanas of both species from island to island to establish widespread food reserves resulting in mixed populations (Grouard et al. 2010). In addition, large numbers of Green Iguanas have been released either intentionally or accidentally as a consequence of the international pet trade, as local curiosities, or as commensals aboard boats travelling between French Guyana and the French West Indies (Breuil 2013). Consequently, individual island populations of both species vary in origin, influence from human settlers, and level of interbreeding. This convoluted evolutionary history poses a challenge for conservation management because fundamental questions concerning species origin and genetic purity must be resolved as part of a larger conservation action plan.

Though the Green Iguana has a broad geographic distribution ranging throughout Central and South America, the Lesser Antillean Iguana is restricted to 10 main islands in the Lesser Antilles. The species has experienced dramatic declines since European contact, causing the extirpation of some populations and the severe decline of others. Habitat destruction, hunting, introduction of exotic predators and competitors, and hybridization with Green Iguanas threaten Lesser Antillean Iguanas with extinction across their range. The drivers for these extirpations have not been mitigated and the likelihood that these threats (most notably the spread of Green Iguanas) remain contained is improbable without proactive management. Consequently, the Lesser Antillean Iguana is considered Endangered according to the International Union for Conservation of Nature (IUCN) Red List of Threatened Species. Fortunately, the iguana inhabits numerous islands, and there are still areas free from the most egregious threats. Thus, if conservation measures are enacted quickly, both this iguana and its diverse habitats can be protected. Inaction will accelerate the iguana's decline within the Lesser Antilles and increase the likelihood of extinction in the future.

The Lesser Antillean Iguana represents a unique component of the overall biodiversity of the Caribbean region. We also know from recent studies that West Indian iguanas, as the dominant native herbivores on islands on which they occur, play a vital ecological role by promoting foliage growth through cropping, providing nutrients to developing seedlings, and dispersing seeds to new areas. Seed dispersal by iguanas may be significant for a number of coastal forest plant species, especially those with large or unpalatable fruits that are not dispersed by small birds or bats (Day et al. 2000). In addition, iguana eggs and young serve as important food pulses to communities of predators including invertebrates (e.g., the crab *Grapsus grapsus*), snakes (*Alsophis* and *Boa* spp.), lizards (*Ameiva* spp.), and birds (e.g., *Falco sparverius*).

The Lesser Antillean Iguana can be used as a representative species for protecting mid-elevation and coastal forests, along with their corresponding faunal communities.



The coastal forest communities of the Lesser Antilles are among the most imperiled areas in the Caribbean and harbor a suite of endemic and migratory species. Preserving these communities for the iguana will help offset the dramatic and continuing loss of biodiversity in the Caribbean and would be a significant step toward maintaining these natural habitats and associated wildlife in a healthy and self-sustaining state.

In October 2009, members of the IUCN SSC Iguana Specialist Group met on Dominica with regional experts and stakeholders to draft this comprehensive conservation action plan for the Lesser Antillean Iguana. The overall goal of the plan is to prioritize the conservation actions necessary to ensure the long-term survival of the Lesser Antillean Iguana throughout its natural range. The work presented here details managing the wild population, conducting ecological and genetic studies, implementing education awareness programs, establishing and managing a national park, and mobilizing financial, technical, and human resources. Achieving these objectives will preserve an important and unique component of Lesser Antillean natural heritage for future generations to appreciate and enjoy. This document is not static, but instead is designed to be fluid and updated as specific objectives are met and as conditions in the Lesser Antilles and within the conservation community change. The recovery plan is also intended to guide decision makers in government, and inspire funding agencies and the international conservation community to provide the attention this unique iguana species deserves.



## EXECUTIVE SUMMARY

This document presents a comprehensive plan for conservation measures considered essential to the long-term survival of *Iguana delicatissima* in the wild. It combines the knowledge and expertise of highly qualified experts from government and non-government organizations within the Lesser Antilles, with the collective conservation experience and scientific expertise of the IUCN SSC Iguana Specialist Group.

Since the 1960s, assorted informal and detailed studies have been conducted on a limited number of Lesser Antillean Iguana populations. Results from these studies allow managers to make some basic informed management decisions based on scientific data. However, islands in the archipelago are numerous and conditions on the ground dynamic. Thus, additional surveys and research, conducted by NGOs and students, are required to better understand the ecology of, and evolving threats to, this species throughout its range.

Local community support for conservation measures will be sought and maintained through major public awareness and education campaigns led by local conservation groups and ministries of education and the environment. After the management plan is complete, the results will be reviewed by local stakeholders and regional decision makers in order to guide management decisions that facilitate the long-term persistence of viable *Iguana delicatissima* populations in the Lesser Antilles.

Funding to implement this plan will be secured from a variety of local and international grants, supplemented with contributions from NGOs. Members of the IUCN SSC Iguana Specialist Group will assist with implementing the plan, but ultimately the real success of the plan hinges on local support through individual island nations.



## RESUME

Ce document présente un plan global pour la mise en place de mesures de conservation considérées comme essentielles pour la survie d'*Iguana delicatissima* *in situ*. Il combine la connaissance et l'expertise d'experts hautement qualifiés d'organisations gouvernementales et non gouvernementales des Petites Antilles avec l'expérience collective de conservation et l'expertise scientifique de l'UICN SSC Iguana Specialist Group.

Depuis les années 1960, des études diverses, informelles et détaillées, ont été menées sur un faible nombre de populations d'Iguanes des Petites Antilles. Les résultats de ces études ont permis aux managers de prendre des décisions de gestion élémentaires, fondées sur des données scientifiques. Toutefois les îles de l'archipel sont nombreuses et les conditions évoluent. Des suivis et recherches additionnels menés par des scientifiques, des ONGs et des étudiants sont donc nécessaires afin de mieux comprendre l'écologie et d'évaluer les menaces pesant sur cette espèce sur l'ensemble de sa distribution.

L'aide des populations locales pour les mesures de conservation sera obtenue et maintenue grâce à la communication au grand public et à des campagnes d'éducation menées par des associations de conservation locales et les ministères de l'environnement et de l'éducation. Après achèvement des études et des propositions du Plan National d'Action, les résultats seront analysés par les acteurs locaux et les politiques régionaux afin de guider les décisions de gestion qui permettront une stabilisation à long terme de populations viables d'*Iguana delicatissima* dans les Petites Antilles.

Les fonds nécessaires au développement de ce Plan d'Action seront obtenus de différentes bourses locales et internationales, additionnées à la contribution des ONGs. l'UICN SSC Iguana Specialist Group aidera à mettre en place ce Plan, mais son réel succès reposera sur l'investissement local, par les différentes nations insulaires.



## INTRODUCTION *by Charles Knapp and John Iverson*

The overall goal of this conservation action plan is **"To ensure the long-term survival of the Lesser Antillean Iguana as a flagship for the unique biodiversity of the Lesser Antilles, and perpetuate it as a symbol of pride for the people of the region."** Implementing an effective action plan for the iguana may prove challenging because the species inhabits multiple island nations with varying degrees of human-mediated environmental degradation and environmental policies. The geographic separation of the island nations and human-populated centers can hinder comprehensive awareness and education campaigns because of communication difficulties, expense, varied local priorities, and the unique human-related idiosyncrasies of each island. The presence of multiple islands, however, can facilitate conservation management, because negative pressures (e.g., cats, dogs, pigs) can be contained and protected areas managed more effectively.

Any management program for the Lesser Antillean Iguana must include ecological data garnered through past and future scientific studies. This document references past research when possible and stresses the need for additional research when and where required. Studies to date, though not comprehensive, demonstrate unique natural history attributes for the iguana depending on location within its broad distribution. Presently, we understand that iguanas inhabiting the southern islands of the species' range make long-distance migrations from island interiors to coastal nesting areas. During these migrations, gravid females are highly vulnerable to vehicular collisions. The demographic impacts of this mortality are exacerbated because of the iguana's delayed sexual maturity, slow population growth rates, and low levels of recruitment. However, the extent of this mortality and its demographic effects are unknown for any population in the Lesser Antilles. Therefore, investigations are crucial to determine the timing and migration routes of nesting females, rates of road mortality, and road attributes that increase the susceptibility to vehicular collision. These data must then be incorporated into mitigation activities such as sign postings, rumble strips, or other innovative techniques.

Studies have demonstrated that female iguanas congregate and nest in confined areas on some islands (e.g., Dominica, Chancel). Though nesting seasons vary by island and can be somewhat asynchronous, peak activity periods can be monitored over a relatively short time frame. Therefore, quantifying annual female nesting effort, as indicated by female activity at nest sites, could be an extremely useful and cost-effective method of assessing both the number of breeding females and the potential for hatchling recruitment into the population. Moreover, in the absence of labor intensive monitoring programs, the capacity to assess annual activity and variation in nesting populations would provide managers with a simple strategy for identifying critical migration corridors, and also improve the capacity to assess trends in localized Lesser Antillean Iguana populations.

A study on Dominica evaluated differences in iguana sex ratios, asymptotic size, characteristic growth rate, body condition, abundance, and densities between disturbed (i.e., low- to moderate-density villages and towns) and non-disturbed habitats (Knapp and Perez-Heydrich 2012). Contrary to expectations, there were no statistical effects of disturbed areas on density, sex ratio, body condition, or characteristic growth rates, yet there was a slight positive effect on asymptotic body



size for iguanas. Recognizing that *I. delicatissima* is still affected adversely by manifold threats, the results suggest that if factors such as degraded nest sites and killing by non-native mammalian predators are mitigated, then moderately disturbed, human-occupied areas can be managed as corridors or buffer zones for *I. delicatissima* in an increasingly fragmented landscape.

Certainly the most recent and urgent threat to the Lesser Antillean Iguana is the rapid spread of the non-native Green Iguana, *Iguana iguana*. Displacement through competition and hybridization with *I. iguana* appears to be the dominant factor in the disappearance of Lesser Antillean Iguana from islands throughout the Guadeloupe Archipelago. Hybridization between *Iguana* species has also been confirmed from many other islands in the French West Indies (Day and Thorpe 1996, Breuil et al. 2007). This process is rapid and contemporary extirpations of genetically pure *Iguana delicatissima* have been recorded from several islands (Breuil et al. 2007; Breuil, 2013). Issues pertaining to the protection status of non-native species must be resolved on some islands before the threat of green iguanas can be addressed effectively. Concurrent with legislative resolution, further genetic investigations must be conducted to determine the geographic distribution of both pure and hybridized populations.

Education and awareness campaigns have been sporadic yet ongoing throughout the Lesser Antilles. This document highlights a suite of education activities and should serve to galvanize provincial support and increase international funding opportunities. It is crucial that educational campaigns must be strengthened and maintained in order to promote a sustained environmental ethic. Ultimately, all conservation is local, and citizens of the Lesser Antilles must become stewards of the iguana and its habitat if future generations are to enjoy this magnificent animal.





**1. SPECIES ASSESSMENT** *The following assessment was completed in September 2010 by Charles Knapp, John Iverson, Michel Breuil, and Caroline Legouez.*



Male Lesser Antillean Iguanas (*Iguana delicatissima*) in combat  
Photograph by Charles Knapp

### 1.1 Taxonomy

The Lesser Antillean Iguana is classified currently as *Iguana delicatissima* (Laurenti 1768) and is phylogenetically distinct from its congener *I. iguana* (Linnaeus 1758) notably by the absence of a greatly enlarged subtymppanic plate, the absence of dark barring on the tail, skull morphology (Conrad and Norell 2010), and more than 15 morphological characters (Breuil 2013). Genetic data suggest that *I. delicatissima* has a much higher than expected level of genetic distinction from its sister taxon *I. iguana* (Stephen et al. 2012). Hybrids between *I. delicatissima* and *I. iguana*, with varying proportions of parental phenotypes, occur on Les Saintes, Basse-Terre, Grande-Terre, and Saint-Barthélemy in the French West Indies.

### 1.2 Geographic Range

Historically, this species is believed to have existed throughout the northern Lesser Antilles, from Anguilla to Martinique (Fig. 1). Its range included (main islands only): Anguilla; Saint-Martin (French West Indies and Netherlands Antilles); Saint-Barthélemy, including the islands of Fourchue (including Ilet au Vent and Petite Islette), Frégates and Chevreau (or Bonhomme); St. Eustatius (Caribbean Netherlands); St. Kitts and Nevis; Antigua and Barbuda; Guadeloupe, including the islands of Grande-Terre, Basse-Terre, islands of Petite Terre (comprising Terre de Bas and Terre-de-Haut), La Désirade, Les Îles des Saintes, and Marie-Galante; Dominica; and Martinique (including Îlet Chancel and Ramier introduced in 2006).



The Lesser Antillean Iguana has since been extirpated from Saint-Martin (French and Dutch sides), Antigua, Barbuda, St. Kitts, Nevis, and Marie-Galante (Fig. 2A). Ongoing surveys conducted on Guadeloupe since 2007 by the Groupe d'Étude et de Conservation de l'Iguane des Petites Antilles en Guadeloupe (GECIPAG) suggest that populations have been extirpated recently from Grande-Terre and Les Îles des Saintes. However, individuals are still present along with Green Iguanas (*Iguana iguana*) and hybrids on Basse-Terre, but biologically viable populations are most likely extirpated (M. Breuil unpublished data; Breuil et al. 2007; Breuil 2013; GECIPAG, personal communication).

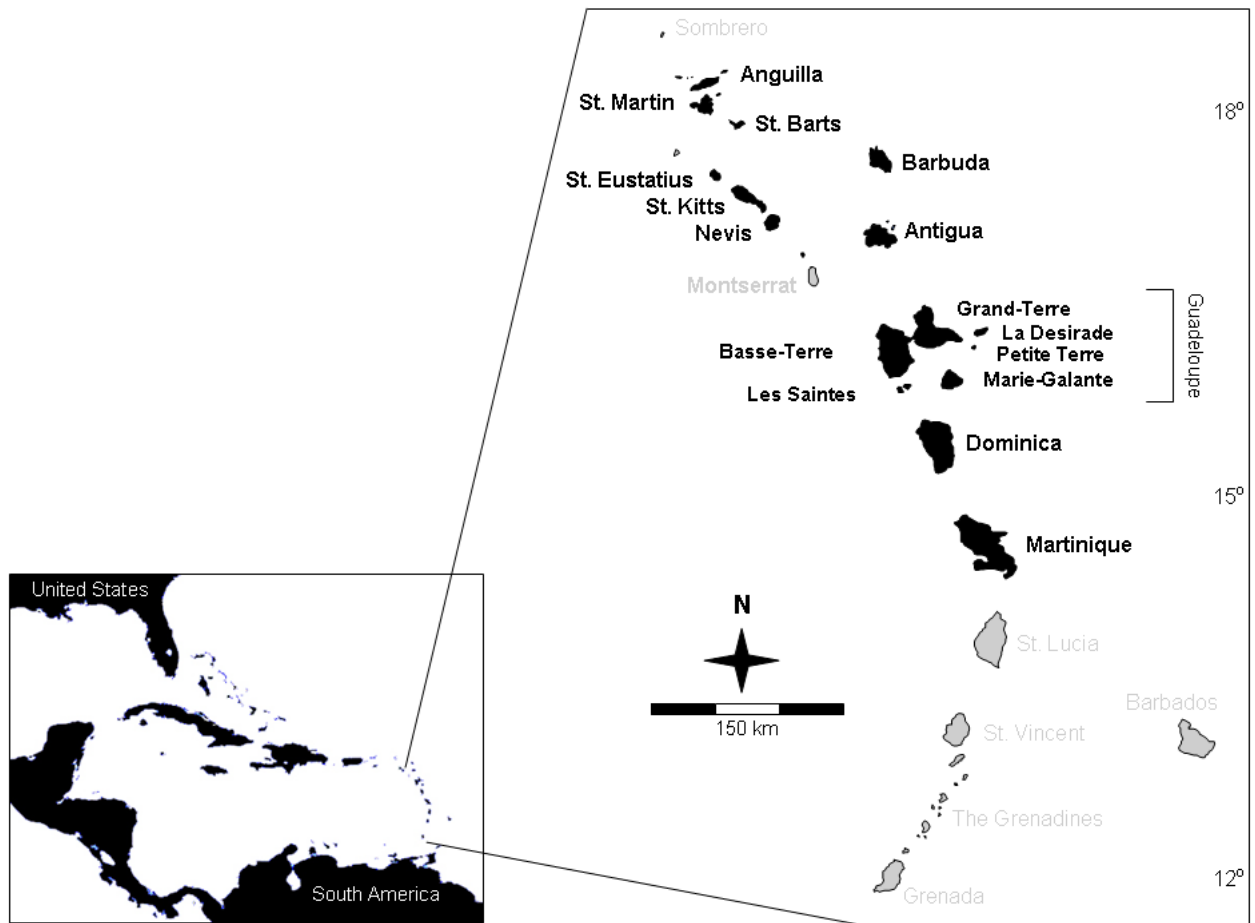


Figure 1. Natural range of *Iguana delicatissima* represented by black islands with bold text.



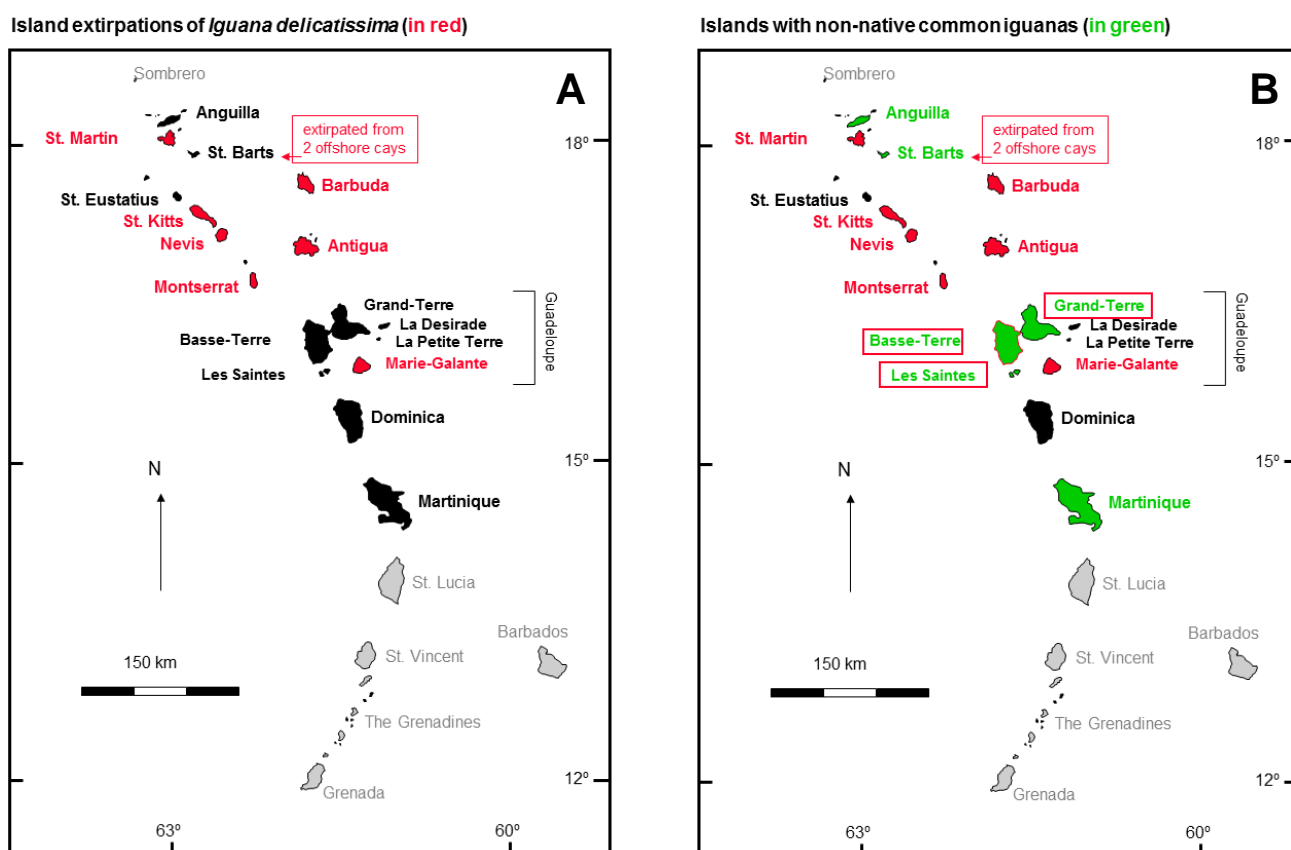


Figure 2. (A) Islands in red depicting extirpated *Iguana delicatissima* populations. (B) Islands currently with documented populations of the non-native Green Iguana (*I. iguana*) represented by green islands. Natural range of *I. delicatissima* represented by black islands with bold text. Island names surrounded by red rectangles represent *I. delicatissima* populations considered functionally extinct.

### 1.3 Status

Based on historical range data, the total population of *I. delicatissima* has most likely experienced declines of  $\geq 70\%$  since European contact. The current range of the species is estimated at no more than 3,000 km<sup>2</sup>, and the existing population is severely fragmented. Moreover, only three populations are considered stable, and others have been extirpated within the last decade. The drivers for these extirpations have not been mitigated and it is highly improbable that these threats (most notably the spread of Green Iguanas) will be contained without proactive management. Consequently, the iguana is considered Endangered according to the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species.

The Lesser Antillean Iguana can now be found only on the main islands of Anguilla, Saint-Barthélemy (including the islands of Île Fourchue and Frégate), St. Eustatius, Guadeloupe (including only the islands of Basse-Terre, Îles de Petite Terre, La Désirade), Dominica, and Martinique (including Îlet Chancel and Ramier). Population estimates using formal survey techniques have been conducted only on Les Îles de la Petite Terre (Guadeloupe), Îlet Chancel (Martinique), and Saint-Barthélemy. In



Martinique, the *I. delicatissima* population has been estimated using mark-recapture techniques, but the results are uncertain due to the low sample size and the inexperience of the survey team to detect iguanas. Additional mark-recapture estimates conducted by ONCFS suggest a population size between 800 and 1,000 individuals (Rodrigues and Laffitte 2013). The population from Pointe Colibri (16 ha) from the western coast of La Désirade has been estimated, using mark-recapture techniques, at 100 and 300 for males and females, respectively. Coarse population estimates for the remaining islands are based on limited surveys designed predominantly to locate iguanas for morphometric and genetic data collection. These population estimates are based subjectively on comparisons of observed density of iguanas and the extent of their range on each island. The population on Dominica is estimated also using site-specific mark-recapture data from 2007 to 2009 (C. Knapp unpublished data). Qualitatively, Dominica is believed to support the largest single population (10,000–15,000 adults) due to the extent of available coastal habitat and known distribution, whereas Les Îles de la Petite Terre supports the highest population density.

In Guadeloupe, populations are now extirpated from Grande-Terre since 2001 (Breuil et al. 2007), and Terre de Haut and Terre de Bas (Les Saintes). These extirpations were caused by numerous factors, but competition and introgression with Green Iguanas (*I. iguana*) is the most recent factor exacerbating the rate of decline. On Basse-Terre only a few individual *I. delicatissima* are present among Green Iguana and hybrid populations. To our knowledge, Green Iguanas are currently absent from La Désirade, and thus large concentrations of *I. delicatissima* persist at various sites. *Iguana delicatissima* is now extirpated from Marie-Galante. The first estimation of the Terre de Bas population of Les Îles de la Petite Terre (4,000–6,000 adults) was conducted in 1992–1993, three years after Hurricane Hugo (Breuil 1994a, Breuil et al. 1994). A second estimate was conducted by Lorvelec et al. (2007), but the results are questionable because of sampling methodology (Breuil and Ibéné 2008). Nonetheless, there seems little doubt that the two small islands are home to several thousand individuals (M. Breuil unpublished data).

The population of Chancel off the east coast of Martinique was estimated at approximately 250 adults in 1994 (Breuil 1994b). Subsequent estimates suggested a population size between 650 (Ourly 2006), 950 (Legouez 2007), 1,000 (M. Breuil unpublished data), and 847–1015 (Rodrigues and Laffitte 2013) adults. The increase is likely due to a release from hunting pressure, an increase in tree cover from approximately 20% of the island in 1947 to 50% currently, improvement and protection of the two historical nesting sites (Breuil 2000a, 2000b; Legouez 2007), and control of domesticated, free-roaming dogs. Elsewhere off the west coast of Martinique, nine adults were reintroduced to Ramier Islet in 2006 (Ourly 2006), and in 2008, 2010, and 2011 egg shells were found at a communal nest site suggesting that reproduction had occurred. In 2012, however, only two individuals were observed along with some excavation activity but no nests were identified (C. Rodrigues unpublished 2012 data). In September 2013, one nest and two adult *I. delicatissima* were observed, while two additional adults were discovered dead (M. Breuil unpublished data).

Elsewhere in the Lesser Antilles, the population of *I. delicatissima* on Anguilla was estimated at a maximum of 300 individuals (Gerber 1998). The most recent



population estimate for St. Eustatius is between 275 and 650 individuals (Fogarty et al. 2004) but the population appears to be in decline (Debrot et al. 2013). The species is now believed extirpated from Saint-Martin (where *I. iguana* is now present), St. Kitts, Nevis, Antigua and Barbuda, Bonhomme and Frégate. In 2011, Réserve Naturelle from Saint-Barthélemy augmented the population on Fourchue by translocating 14 individuals. An additional 14 individuals were reintroduced on Frégate (Le Quellec 2011). Based on available data, an estimate of total population size for *I. delicatissima* across the region is fewer than 26,000 individuals.

#### 1.4 Description

The Lesser Antillean Iguana is a large species with a maximum recorded snout-vent length (SVL) of 434 mm for males and 401 mm for females (Breuil 2002), although maximum body size varies among islands (Breuil 2002, 2003). Maximum recorded body mass is 3.5 kg in males and 2.6 kg for a gravid female (Day et al. 2000). Sexual dimorphism is evident in adults with males often displaying enlarged nuchal dorsal crest scales, enlarged gular spikes on the dewlap, enlarged femoral pores, and increased occipital scale development (Breuil 2013, Day et al. 2000, Gerber 1998, Schwartz and Henderson 1991). Adult body color is usually uniform, but may vary greatly among individuals and islands. Juvenile coloration is bright green with white streaks on the posterior region of the lower jaw and the shoulder, along with three white lateral side bars. Color darkens with age starting at the extremities and proceeding to the torso. The last area to change is the ventral region. Females retain juvenile coloration longer than males. In most populations adults will change to a dull gray-black, but in some populations, individual females will retain green color throughout life. Consequently, adult coloration may include variations of green, slate gray, and gray-black. The dewlap is green to slate gray. The jowls, jaw, throat, and snout whiten with age. Sexual dichromatism varies among populations, being much more distinct in the mesic southern populations and less varied in the xeric limestone island populations. In some populations, both sexes exhibit pink coloration around the jowls, although in most populations this trait is limited to males. Dorsal crest scales and dorsal head scales are pale blue in a few adult males (Pasachnik et al. 2006).

#### 1.5 Natural History

The Lesser Antillean Iguana occupies habitats from sea level to approximately 1,000 m (on Dominica). The species exists in xeric scrub, dry scrub woodland, littoral woodland, and mangrove, as well as lower and mid-altitude portions of transitional rainforest. The condition of these habitats varies from island to island, with iguanas able to survive in extremely xeric degraded habitats (less than 1,000 mm annual rainfall) to mesic forests (3,000–4,000 mm annual rainfall), in the absence of introduced predators or competitors (Day et al. 2000).

Both hatchlings and juveniles live predominantly in bushes and low trees, usually in thick vegetation offering protection, basking sites, and a wide range of food. With age, they climb higher and inhabit larger trees.

The Lesser Antillean Iguana is a generalist herbivore feeding primarily in the morning with a diet that includes leaves, flowers, and fruits of a wide range of shrubs and trees. Seasonal variation in feeding ecology exists, with folivory during the dry season shifting to folivory and frugivory during the wet season. Feeding is selective, with





fresh leaf growth, flower buds, and ripe fruits preferred. Seed dispersal by iguanas may be significant for a number of coastal forest plant species, especially those with large or unpalatable fruits that are not dispersed by small birds or bats (Day et al. 2000). Differences between populations in feeding ecology exist, reflecting local variation in plant species composition (either natural or as a result of introduced browsers). Like its congener the Green Iguana, the Lesser Antillean Iguana has been observed to be opportunistically carnivorous (Lazell 1973).

Sexual maturity appears to be reached at approximately two to three years, although breeding in males is unlikely to begin at this time due to inability to achieve dominance and defend a suitable territory. Longevity studies have yet to be conducted, but recent data suggest that individuals could reach 25 years in age. As of 2010, two wild caught *I. delicatissima* from Dominica housed at the Durrell Wildlife Conservation Trust were a minimum of 18 years of age and doing well. Generation length is estimated to be 11–14 years (C. Knapp unpublished data). Tagged iguanas in the field in 1997 (Chancel) and in 2000 (Saint-Barthélemy) were still alive as of 2013 (M. Breuil and C. Rodrigues unpublished data).

The timing of reproductive activity is highly variable in tropical reptiles, both within a given geographical area, as well as between distant sites, suggesting that multiple factors may influence reproductive timing (Censky 1995). Lesser Antillean Iguanas inhabiting arid environments (e.g., Petite-Terre and La Désirade) tend to exhibit a relatively synchronous reproductive season with females ovipositing one clutch generally from June to mid-August (Breuil and Thiébot 1994; Breuil 2002; Barré et al. 1997, Lorvelec et al. 2000, 2004a, 2004b, 2007). In more mesic environments (e.g., Dominica and Îlet Chancel, Martinique), the reproductive season is more asynchronous with oviposition starting in February (Dominica) or March (Îlet Chancel, Martinique) and continuing through August (Îlet Chancel, Martinique) and September (Dominica). It also has been suggested that iguanas from Dominica may double clutch in a year (Day et al. 2000), though Knapp (unpublished data) found no evidence of multiple clutches on Dominica from 2007 to 2010.

Nests are excavated in sandy, but also in clayish, well-drained soils exposed to prolonged sunlight (Breuil 2002). Clutch size is variable and has been reported from 20 to 30 eggs on Martinique (Bouton 1640), 13 to 25 on Guadeloupe (Du Tertre 1667), and up to 22 from iguanas originating from Dominica (Schardt 1998). A female from Îlet Chancel, Martinique oviposited 16 eggs with a mass ranging from 19.5 to 22.5 g (Legouez 2007).

Anecdotal evidence and data from captive animals suggest an incubation period of approximately 93–95 days.

Natural documented reptilian predators of hatchling iguanas include the racers *Alsophis rufiventris* (H. Madden pers. obs.) and *Alsophis sibonius* and the lizard *Ameiva fuscata*. Other recorded hatchling predators include a marine crab, *Grapsus grapsus*, and the American Kestrel, *Falco sparverius* (C. Knapp pers. obs.). The snake, *Boa constrictor*, has been documented to consume adult iguanas (Knapp et al. 2009), while major storm events can cause deaths to adults and hatchlings (Knapp and Valeri 2008).





## 1.6 Conservation Issues

Habitat loss and fragmentation were historically most extensive on the least mountainous islands, which were systematically cleared for agriculture, especially sugarcane. On these islands, the Lesser Antillean Iguana has either become extinct (e.g., St. Kitts, Nevis) or remains only in tiny remnant populations (e.g., Anguilla). As tourism superseded agriculture in importance, coastal development has further reduced the remaining habitat and significantly affected already-limited communal nest sites (Day et al. 2000). Road casualties occur regularly along coastal roads, which bisect iguana habitat on Dominica, Basse-Terre (Guadeloupe), La Désirade, and Saint-Barthélemy. On Dominica, casualties peak late in the dry season (May to July) when numerous gravid females are killed while migrating to coastal nest sites and early in the wet season (September) when hatchlings disperse from nests. On La Désirade and Saint-Barthélemy, there has been an increase in the number of off-road vehicles and a corresponding increase in deaths (Day et al. 2000; M. Breuil unpublished 2009 data).

Lesser Antillean Iguanas are impacted by a range of introduced predators. Feral and pet cats are believed to be significant predators of juvenile iguanas on Anguilla, and predation by both cats and dogs is a problem on Dominica. On Saint-Barthélemy, feral predators are few, but adult iguanas are known to be killed by guard dogs that run free within fenced properties where iguanas move to feed. Hatchlings and juveniles are within the prey size range of the Small Asian Mongoose (*Herpestes javanicus*), and the species is either extinct or highly threatened on all islands where mongoose occurs (e.g., Antigua and Barbuda). However, it is unclear how significant the impact of the mongoose is compared with other factors such as cats, since *I. iguana* remains very common on mongoose-inhabited islands (Day et al. 2000). Finally, Northern Raccoon (*Procyon lotor*) may pose a problem on La Désirade and other parts of Guadeloupe, as they are documented to prey on Green Iguanas (Smith et al. 2006).

Free-ranging and feral browsing competitors are present among almost all iguana populations, with the notable exceptions of Îles de la Petite Terre and most of Dominica. Goat and sheep populations are particularly large and of most concern on Anguilla, La Désirade, St. Eustatius, and Saint-Barthélemy, where extensive over-browsing continues to cause a shift in plant species composition and habitat structure (Breuil 2002). Thankfully, goats were removed from Frégate and Fourchue in the early 2000s (M. Breuil pers. obs.). Another threat, particularly on St. Eustatius, is the ongoing degradation of natural vegetation attributable to the spread of invasive alien species, most notably the Mexican Creeper (*Antigonon* sp.), which is mostly unpalatable to both goats and iguanas (Fogarty et al. 2004; Debrot et al. 2013).

In St. Eustatius, hunting is likely a minor problem, primarily because population densities are so low that it is not worth the effort. Locals are also afraid to enter the bush because aggressive feral bee colonies are common (F. Gibbs pers. comm.). Shelter and food availability on the island are abundant, and invasive predator densities in the wild are relatively low. Nevertheless, of the 28 documented instances of death or endangerment of iguanas during one study period, most were attributable to anthropogenic causes (Debrot and Boman 2014). Dogs kept in gardens in areas used by iguanas are a major danger. Other notable sources of iguana mortalities were



starvation (or drowning) in abandoned cisterns, traffic casualties, entanglement in fencing (Debrot and Boman 2014).

The influence of human presence and activity on gut-associated coliforms in *Iguana delicatissima* populations is recently garnering attention (G. Gentile unpublished data) because antimicrobial resistance patterns in gut-associated enterobacteria have been documented in iguanas (Thaller et al. 2010; Wheeler et al. 2012). Human/domestic livestock-iguana overlap is prevalent throughout the Lesser Antilles and may expose iguanas to antibiotic resistant microbial communities.

Attention to the impact of potential pathogens and associated antibiotic resistance is also particularly important in the light of a new possible threat represented by the actinobacterium *Devriesea agamarum* (Ballmann et al. 2014). This bacterium causes chronic proliferative dermatitis, with lesions occurring in several areas of the body, including around the oral cavity, the pericloacal region, and the legs. Septicemia is a frequent complication, resulting in the death of the affected animal. Since April 2011, several individuals of *I. delicatissima* on the island of St. Barthelemy have been found with large hard nodules and abscesses on the body. According to a case report of the Management of the Natural Reserve of Saint-Barthélemy, approximately 10% of the male population is affected. As this is the first time these lesions have been recognized in the St. Barthelemy *Iguana delicatissima* population since monitoring began, it is likely this is a newly introduced disease. A preliminary analysis performed by the National Wildlife Health Center (Wisconsin, USA) detected a mixture of bacteria and fungi in the nodules. The analysis determined the presence of *Salmonella* spp., *Corynebacterium* sp., and *Pseudomonas aeruginosa*, with *D. agamarum* being the most prevalent species. Consequences for management may be important. Indeed, although bacterial infections can be successfully treated with antibiotics in captive lizards, treatment could be ineffective in free-ranging iguanas because: 1) the treatment protocol is complex and prolonged over time, 2) treatment could be applicable only in less extreme cases, 3) the bacterium is persistent in moist environments, and 4) the bacterium could rapidly acquire resistance for a wide spectrum of antibiotics.

Displacement through competition and hybridization with *I. iguana* appears to be the dominant factor in the disappearance of Lesser Antillean Iguanas from islands throughout the Guadeloupe Archipelago (Fig. 2B). Hybridization between the two species has been confirmed through both molecular and morphometric analyses from Basse-Terre (Guadeloupe), Les Îles des Saintes (Day and Thorpe 1996), and elsewhere throughout their range (Breuil 2000c, 2002, 2013; Breuil et al. 2007; Breuil et al. unpublished 2009 data; Vuillaume 2012). This process is rapid and subsequent population extirpations have been recorded from several islands in the French West Indies (Breuil et al. 2007, M. Breuil, pers. obs. 2009). Until February 2014, the Green Iguana was a protected species on Guadeloupe, hindering population control measures. Since February 2014, the Green Iguana is no longer protected there but it is yet to be legally considered as an invasive species. Presently, only Dominica, Statia, Les Îles de la Petite Terre, La Désirade, and Îlet Chancel remain free of *I. iguana*. The threat is critical on Saint-Barthélemy due to the recent arrival of *I. iguana* to the island. Hybridization and aggressive displacement of the Lesser Antillean Iguana by Green Iguanas should be considered as serious threats to all remaining populations.



## 1.7 Conservation Actions Implemented

The Lesser Antillean Iguana is protected legally from hunting throughout much of its range, but enforcement of these regulations is extremely difficult and limited. On Dominica, the species is not formally listed as protected, and thus, there is a need to amend the Forestry and Wildlife Act to include provisions for the iguana.

The species is found in several nationally protected areas, including two national parks on Dominica. The species is found in other protected areas elsewhere including Les Îles de la Petite Terre (Guadeloupe), the Quill and the Boven (St. Eustatius), Îlet Chancel and the Reserve Biologique Domaniale de la Montagne Pelée (Martinique), and the Natural Reserve of La Désirade. A number of satellite islets around Anguilla, Antigua, Guadeloupe, Martinique, St. Martin and Saint-Barthélemy offer potential as protected areas and should be investigated.

In 2007, the French government commissioned an action plan to propose conservation measures in a concerted effort to protect this species (Maillard and Breuil 2007; Breuil et al. 2007; Legouez 2007). Extensive fieldwork has been conducted since 2007 in Guadeloupe and Martinique, with a completed action plan accepted by the Ministry in 2010. In 2010, management of *Iguana delicatissima* on Saint-Barthélemy was delegated to GRENAT with consultation from Michel Breuil (Breuil 2011a).

Research on the population biology and ecology of iguanas throughout the Lesser Antilles is ongoing, but further survey work is required in many parts of the range. The San Diego Institute for Conservation Research initiated a detailed study of the iguana on Dominica from 2006 to 2010 (Knapp 2007). Anguilla has not been surveyed in more than 10 years (Gerber 1998) and several offshore cays offer potential for introduction. Iguanas are believed extinct on Antigua (where mongooses are present), but there are a number of offshore cays that should be surveyed. On the French side of St. Martin, the most recent surveys from 2008–2009 yielded no reports of Lesser Antillean Iguanas (M. Breuil pers. comm. 2010). The iguana is reported extirpated from the Dutch side of the same island (Sint Maarten; Powell 2004), and only individuals of *I. iguana* have been observed recently (Kirsten Hines pers. comm. 2009). However, two islets offshore of St. Martin, Tintamarre and Pinel, were surveyed in 1996 by M. Breuil but are not suitable as translocation sites unless existing colonies of *I. iguana* are eradicated. There are recent reports that Lesser Antillean Iguanas may have re-colonized Barbuda following a hurricane, but this is unconfirmed. The north of Grande-Terre in Guadeloupe requires survey work. A small island with suitable habitat, Kahouanne, north of Basse-Terre, was surveyed in 2007 by GECIPAG and a project to translocate the remaining individuals on Basse Terre to that islet has been initiated to protect them from *I. iguana*. However, a hatchling Green Iguana was found on the island in July 2012 but must be confirmed. A Green Iguana was also photographed on Îlet Ramier in November 2013. This island off the coast of Martinique is home to a small translocated population of *I. delicatissima*.

Îlet Pigeon (also offshore from Basse-Terre) is unsuitable because of the presence of *I. iguana* (GECIPAG pers. comm. 2007–2009). The north of the main island of Martinique, and also Îlet Ramier where nine individuals were introduced in 2006, require further surveys. An additional translocation of iguanas from Chancel to Ramier was planned in 2012 but was not conducted. Many cays off the southern



Atlantic coast of Martinique should be surveyed as potential sites for re-introduction. The east coast of Dominica and several offshore islets along the east coast also need to be surveyed. Recent surveys on Saint-Barthélemy (Breuil 2011a) revealed the arrival of the Green Iguana (*I. iguana*). In order to protect the Lesser Antillean Iguana, 14 individuals were translocated to Frégate and 14 have been re-introduced to Fourchue.

Education and public outreach efforts are necessary throughout the range. On Dominica, perhaps the single most important bastion for the species, an important action is the development of an identification guide to assist officials in distinguishing Lesser Antillean Iguanas and Green Iguanas in order to ensure that the latter species is not introduced to Dominica. Similar actions are required elsewhere. A brochure was produced by ONCFS in 2011 for Martinique and targeted a range of stakeholders including the general public, firemen, and regional councilmen. Additional efforts are needed to distribute the brochures more broadly. Education priorities should also target la Désirade, which supports a large population of *I. delicatissima*. Hodge et al. (2003) recommended that *I. delicatissima* be designated an Anguillian national emblem (or animal) in order to promote conservation efforts. No official response occurred.

Captive Lesser Antillean Iguanas are maintained currently at the Durrell Wildlife Conservation Trust (UK), Chester Zoo (UK), and Fresno's Chaffee Zoo (USA). A private breeder in Germany is known to have *I. delicatissima* and unconfirmed individual breeders are believed to exist in France and Italy. Most captive Lesser Antillean Iguanas originated from Dominica. As the Dominican population is presently healthy, these individuals and their future offspring should remain in captivity in order to gather husbandry expertise, as well as growth and reproductive data. A long-term aim should be to gain captive breeding expertise that can then be applied *in situ*. Captive-bred individuals could be used for reintroduction to offshore islands and other protected areas known to have supported Lesser Antillean Iguanas historically, or for restocking depleted populations. Due to considerations of geographic variation, reintroductions should use iguanas from the same population or island bank whenever possible (as was the case for the reintroductions on Îlet Ramier and Saint-Barthélemy). However, recent molecular work by Vuillaume (2012) and Breuil et al. (unpublished data) suggest that genetic sub-structuring is present in Basse-Terre, Grande-Terre, Petite Terre, Désirade, Chancel and Saint-Barthélemy.

Realistically, however, there are still great difficulties in breeding this species in North American and European zoos. Additionally, limited space restricts effective population sizes in captivity, thereby hampering the efficacy of future re-introduction possibilities. Instead, head-starting on home-range islands using eggs or gravid females reduces the time and money required to run a facility. In some locations, however, a rapid genetic assessment of adults, or minimally hatchlings, must be conducted to ensure the genetic purity of program animals (R. Gibson and M. Goetz pers. comm. 2010).

## 1.8 Research Documented

Populations of *I. delicatissima* have been the subject of both intensive and cursory investigations since 1973. Lazell (1973) was the first to document in detail the geographical distribution, ecology, and behavior of both *Iguana* species in the Lesser



Antilles. Breuil (2002) provided an equally extensive overview in the French West Indies and synthesized data concerning the relationship of the two species of *Iguana*. Breuil (2003) provided a historical perspective of the status of both species of *Iguana* in the French West Indies. Hodge et al. (2003) discussed in detail the status of both *Iguana* species on Anguilla, and Powell et al. (2005) provided extensive information on both species on St. Eustatius, Saba, and St. Maarten. Knapp and Perez-Heydrich (2012) evaluated differences in iguana sex ratios, asymptotic size, characteristic growth rate, body condition, abundance, and densities between disturbed (i.e., low to moderate-density villages and towns) and non-disturbed habitats on Dominica. Breuil (2013) assessed morphological differences between *I. delicatissima*, *I. iguana*, and their hybrids. Additional references pertaining to *I. delicatissima* are presented in Pasachnik et al. (2006) and a complete synthesis of its natural history is in Henderson and Powell (2009). Valette et al. (2013) published a set of microsatellites specific to *I. delicatissima* and *I. iguana* that can be used to study the genetic substructure of *I. delicatissima*, estimate the type of hybrids (backcross, F1, F2), and calculate the degree of hybridization.



Table 1. Geographic, political, and human population data for territories with *Iguana delicatissima* populations. Iguana population status and threats are also included. Only main islands with documented iguana populations since 1990 are included. Extinct = EX, Present = P, PwH = Present but with hybrids of *I. iguana*, HO = Hybrids only, PwI = Present with *I. iguana* but no contact.

		<b>Saint Martin</b>				<b>Guadeloupe</b>						
	<b>Anguilla</b>	<b>Saint Martin</b>	<b>Sint Maarten</b>	<b>Saint Barts<sup>b</sup></b>	<b>Saint Eustatius</b>	<b>Grande Terre</b>	<b>Basse Terre</b>	<b>Petite Terre<sup>c</sup></b>	<b>La Désirade</b>	<b>Îles des Saintes<sup>d</sup></b>	<b>Dominica</b>	<b>Martinique<sup>e</sup></b>
<u>Territory</u>												
Land area (km <sup>2</sup> )	91	52	21	24	21	587	848	0.48	21	13	751	1,128
Political status <sup>a</sup>	UK OT	OCF	NE ANT	OCF	CN	ODF	ODF	ODF	ODF	ODF	INDEPEN	ODF
Population density (km <sup>2</sup> )	159	691	1,942	355	148	337	220	0	76	225	97	356
Hum. population	14,436	35,925	40,917	7,448	3,100	197,603	186,681	0	1,595	2,883	72,660	402,000
<u>Iguana</u>												
Population status of <i>I. delicatissima</i>	PwI	EX	EX	PwH <sup>f</sup>	P	HO	PwH	P	P	HO	P	PwI <sup>g</sup>
Legal protection <i>I. delicatissima</i>	?	yes		yes	yes	yes	yes	yes	yes	yes	yes	yes
Legal protection <i>I. iguana</i>	?	yes		no	N/A	no	no	no	no	no	N/A	no
Ecological data available				yes	yes			yes	yes		yes	yes (Îlet Chancel)
Protected areas		yes		yes	yes	yes		yes	yes		yes	yes
<u>Threats</u>												
Invasive plants					X			X				
Feral mammals	X			X	X			X	yes		X	X
Illegal hunting					X				yes		X	
Green Iguanas	X	X	X	X		X	X		X?	X		X
Habitat loss	X			X			X		yes		X	?
Cisterns/fences					X							
Road mortality				X	X		X		X		X	

<sup>a</sup> Political status: United Kingdom Overseas Territory (UK OT); Overseas Collectivity of France (OCF); Netherlands Antilles (NE ANT); Caribbean Netherlands (CN); Overseas Department of France (ODF)

<sup>b</sup> Saint-Barthélemy including the islands of Île Fourchue (including Îlet au Vent and Petite Islette), Îlet Frégate, and Île Chevreau (or Bonhomme)

<sup>c</sup> Comprising Terre de Bas and Terre de Haut

<sup>d</sup> Comprising Terre de Bas and Terre de Haut

<sup>e</sup> Including Îlet Chancel and Îlet Ramier

<sup>f</sup> *I. delicatissima* on Île Fourchue (including Îlet au Vent, Petite Islette, Frégate, and the Gros Islets) remains pure and without *I. iguana*

<sup>g</sup> Îlet Chancel and Îlet Ramier with pure *I. delicatissima*





## 2. OVERALL GOAL

*"To ensure the long-term survival of the Lesser Antillean Iguana as a flagship for the unique biodiversity of the Lesser Antilles, and perpetuate it as a symbol of pride for the people of the region."*



Male Lesser Antillean Iguana (*Iguana delicatissima*) on Dominica.  
Photograph by Charles Knapp



## REGIONAL GENETIC ANALYSES

**3.1 OBJECTIVE:** Use genetic analyses to guide conservation initiatives and to investigate past gene flow events for the Lesser Antillean and Green Iguanas throughout their range.

**3.1.1 RESULT:** The entire natural range of the Lesser Antillean Iguana is surveyed and blood samples collected in order to determine the genetic diversity between and among island populations. These data will identify potential populations of high genetic importance.

- a) Travel to all known, and potentially-inhabited, iguana localities in order to collect a comprehensive genetic dataset for both iguana species.

*High Priority Action:* Michel Breuil; ONCFS when monitoring populations; GECIPAG; Association GRENAT

*Funding:* 20,000 US\$

**3.1.2 RESULT:** All island locations with sympatric *Iguana delicatissima* and *I. iguana* are sampled aggressively in order to better understand hybridization dynamics and determine which populations are still comprised of pure *I. delicatissima*.

- a) Travel to all islands with sympatric populations of *I. delicatissima* and *I. iguana* and collect blood samples from the entire range in order to identify contact zones and potentially isolated *I. delicatissima* populations.

*High Priority Action:* Michel Breuil; ONCFS and GECIPAG (for Guadeloupe Islands) and Association GRENAT; LASFA; Natural Reserve of Saint-Martin

*Funding:* 25,000 US\$

**3.1.3 RESULT:** All existing and future samples are analyzed in the laboratory and the data used to manage both iguana species locally and throughout the region.

- a) Secure funding to analyze existing and future genetic samples.

*High Priority Action:* Michel Breuil; Genindexe

*Funding:* 25,000 US\$

- b) Develop a rapidly detectable nuclear marker to better understand the recent history and extent of hybridization between the two iguana species throughout the region.

*High Priority Action:* Michel Breuil; Genindexe

*Funding:* 25,000 US\$

- c) Obtain funding, develop protocol, and extract DNA from *I. delicatissima* and *I. iguana* subfossils to better understand pre-Columbian distributions, movements, and potential hybridization events.

*High Priority Action:* Michel Breuil; Archeozoological team from MNHN

*Funding:* 25,000 US\$

- d) Determine through genetic analyses where introduced Green Iguanas originated.

*Medium Priority Action:* Michel Breuil; Catherine Stephen; Genindexe

*Funding:* 20,000 US\$



## REGIONAL MICROBIAL ANALYSES

**3.2 OBJECTIVE: Examine the influence of human populations on microbial diversity and antibiotic resistance in *Iguana delicatissima* throughout the range in order to implement proactive conservation mediation programs.**

**3.2.1 RESULT:** The gut-associated enterobacterial community, and their potential resistance to antibiotics, is documented for the Lesser Antillean Iguana across its range.

- a) Travel to all known iguana localities in order to collect microbial samples and identify the dominant enterobacterial species in gut-associated aerobic microbiota.

*Medium Priority Action:* Maria Cristina Thaller; Luciana Migliore; Gabriele Gentile, Tor Vergata University; Michel Breuil; ONCFS; Association GRENAT

*Funding:* 20,000 US\$

- b) Screen for antibiotic resistance in gut-associated aerobic microbiota for *Iguana delicatissima* throughout its range.

*Medium Priority Action:* Maria Cristina Thaller; Luciana Migliore; Gabriele Gentile, Tor Vergata University; Michel Breuil; ONCFS; Association GRENAT

*Funding:* 20,000 US\$

- c) Investigate the molecular characterization of the genetic determinants of antibiotic resistance traits.

*Medium Priority Action:* Maria Cristina Thaller; Luciana Migliore; Gabriele Gentile, Tor Vergata University; Michel Breuil; ONCFS; Association GRENAT

*Funding:* 20,000 US\$

- d) Screen for presence of *Devriesea. agamarum* and associated antibiotic resistance in wild populations of *I. delicatissima*, and evaluation of health status of *I. delicatissima* populations throughout its range.

*Medium Priority Action:* Maria Cristina Thaller; Luciana Migliore; Gabriele Gentile, Tor Vergata University; Michel Breuil; ONCFS; Association GRENAT

*Funding:* 50,000 US\$

## REGIONAL EDUCATIONAL PRIORITIES

**3.3 OBJECTIVE: Implement a comprehensive education and awareness program at local and regional levels for conservation of the Lesser Antillean Iguana and the biodiversity of its habitat.**

**3.3.1 RESULT:** The Lesser Antillean Iguana becomes a flagship for biodiversity conservation on the islands it inhabits, stimulating community pride in this unique animal and an understanding of its interrelationship with its habitat.

- a) Develop and produce interactive educational materials promoting Lesser Antillean Iguanas and their conservation, for use in nature centers and at festivals.

*Medium Priority Action:* ONCFS, Association GRENAT, STENAPA, GECIPAG collaborating as a Caribbean Network for *I. delicatissima* Conservation (CNIDC)

*Funding:* 16,000 US\$ for two years



- b) Develop and distribute posters, fliers, signage, radio ads, newspaper features, postcards, stamps, DVDs, and relevant information posted on the websites of departments responsible for wildlife management.

*High Priority Action:* ONCFS; Association Le Gaïac; STENAPA; Association GRENAT

*Funding:* 30,000 US\$ for two years

**3.3.2 RESULT:** Iguanas and iguana conservation are incorporated into current coursework in schools throughout the Lesser Antillean region.

- a) Develop activities to be incorporated into classrooms, utilizing similar existing curricula as guides.

*Medium Priority Action:* Lee Pagni; ONCFS and Association Le Gaïac; STENAPA; Association GRENAT; ONCFS

*Funding:* 5,000 US\$

- b) Training workshop is provided so that teachers are comfortable with the new material.

*Medium Priority Action:* Lee Pagni; ONCFS and Association Le Gaïac; STENAPA; Association GRENAT

*Funding:* 5,500 US\$ for regional workshops

- c) Develop and use a PowerPoint presentation with recorded narration that identifies the unique qualities of the Lesser Antillean Iguana and its habitats, and outlines the threats to its survival.

*Medium Priority Action:* Michel Breuil, Charles Knapp, Chloé Rodrigues; Association GRENAT

*Funding:* 10,000 US\$ for computers and projectors

**3.3.3 RESULT:** Lesser Antillean Iguanas are no longer hunted, sold, or illegally held captive.

- a) Create and distribute fliers and posters that: 1) state that it is illegal to hunt, keep, or offer iguanas for sale; 2) list the fines and penalties from such actions; and 3) provides the phone number of the appropriate authorities.

*Medium Priority Action:* Dominican Forestry, Wildlife and Parks Division

*Funding:* 5,000 US\$



**3.4 OBJECTIVE: Establish an open communication link among all island nations in the region with populations of *Iguana delicatissima*.**

**3.4.1 RESULT:** Scientists and wildlife managers from across the region communicate regularly to exchange ideas, methodologies, and information resulting in better management and improved conservation initiatives.

- a) Create a listserve for all people responsible for the study, conservation, and management of the Lesser Antillean Iguana.

*Medium Priority Action:* Chloé Rodrigues; Charles Knapp; Arlington James; ONCFS; CNIDC; STENAPA; Association GRENAT

*Funding:* none

- b) Organize biennial meetings for scientists, wildlife managers, and educators from across the region in order to maintain cooperative relationships, facilitate better management practices, and draft collective research and management grants.

*Medium Priority Action:* Dominican Forestry, Wildlife and Parks Division; DEAL from Martinique and Guadeloupe; STENAPA; Association GRENAT

*Funding:* 40,000 US\$ for four years (two meetings)

**3.5. OBJECTIVE: All populations of Lesser Antillean and Green Iguanas are inventoried and recorded in order to document the remaining range of *I. delicatissima*, the rate of spread for *I. iguana*, and their population trends after contact, and to model future scenarios of dispersal.**

**3.5.1 RESULT:** The entire range of *I. delicatissima* is inventoried using local and international teams of scientists and volunteers.

- a) Martinique, particularly the north of the island, is inventoried using local and international teams.

*High Priority Action:* Chloé Rodrigues; David Laffitte; Julien Mailles; Michel Breuil; Charles Knapp; Lyndon Prince

*Funding:* 15,000 US\$ for two years including cartography updating

- b) Guadeloupe is surveyed extensively using local experts and volunteers.

*High Priority Action:* David Laffitte; Chloé Rodrigues; Michel Breuil; René Dumont (Petite Terre); Fortune Guiougou; Baptiste Angin

*Funding:* 25,000 US\$ for two years included cartography updating

- c) St. Martin is surveyed extensively including offshore islands Tintamarre and Pinel using local experts and volunteers.

*High Priority Action:* Natural Reserve of Saint-Martin assisted by ONCFS; Michel Breuil

*Funding:* 20,000 US\$

- d) Saint-Barthélemy is surveyed extensively using local experts and volunteers.

*High Priority Action:* Michel Breuil, Association GRENAT

*Funding:* 25,000 US\$



- e) Dominica is surveyed extensively using local experts and volunteers.  
*High Priority Action:* Dominica Forestry, Wildlife and Parks Division  
*Funding:* 25,000 US\$
- f) St. Eustacius is surveyed extensively using local experts and volunteers.  
*High Priority Action:* LVV; STENAPA  
*Funding:* 25,000 US\$
- g) Other islands not listed above are surveyed as needed.  
*High Priority Action:* TBD  
*Funding:* TBD

## TERRITORY-SPECIFIC PRIORITIES

### 4. DOMINICA

#### 4.1 OBJECTIVE: Guarantee legal and proactive regulatory policies to help conserve the Lesser Antillean Iguana and prevent the introduction of invasive species to Dominica.

**4.1.1 RESULT:** The Lesser Antillean Iguana is no longer hunted or harassed, and the Forestry, Wildlife and Parks Division has a legal mandate to prosecute offenders.

- a) Amend the existing Forestry and Wildlife Act to list *Iguana delicatissima* specifically as a protected species, thereby removing ambiguity on the legality of hunting or harassing the species.  
*High Priority Action:* Forestry, Wildlife and Parks Division; Ministry of Agriculture; Ministry of Legal Affairs  
*Funding:* none
- b) Draft a formal letter from the International Union for Conservation of Nature (IUCN) Iguana Specialist Group to be included with the amendment request of the Forestry and Wildlife Act.  
*High Priority Action:* Co-chairs of the IUCN Iguana Specialist Group  
*Funding:* none
- c) Increase arrests and judicial prosecutions of offenders found hunting iguanas.  
*Medium Priority Action:* Forestry, Wildlife and Parks Division  
*Funding:* none

**4.1.2 RESULT:** The Lesser Antillean Iguana is assured protection from introduced species such as the Green Iguana, *Iguana iguana*.

- a) Draft a policy statement to prevent the importation of any iguana including the Green Iguana and other potentially invasive species (e.g., Red-eared Slider Turtle, *Trachemys scripta*) to Dominica.  
*High Priority Action:* Forestry, Wildlife and Parks Division to the Division of Agriculture/ Plant Protection and Quarantine Unit  
*Funding:* none





- b) Develop an identification guide for port authorities that details the differences between the Lesser Antillean and Green Iguana (see Breuil 2013). The identification guide should highlight that no iguana should be allowed to enter the country and also include a number of the most invasive species that must not be allowed to enter the country (e.g., Red-eared Slider Turtles, *Scinax* spp., *Osteopilus septentrionalis*).

*High Priority Action:* Forestry, Wildlife and Parks Division; Charles Knapp

*Funding:* 2,000 US\$

- c) Develop and host a workshop for Customs and Port Authority personnel to educate about the dire consequences of introduced, invasive species such as Green Iguana, Red-eared Slider Turtle, mongoose, etc.

*Medium Priority Action:* Forestry, Wildlife and Parks Division; Bruce Weissgold; Charles Knapp

*Funding:* 1,000 US\$ (local); 10,000 US\$ (if regional)

**4.2 OBJECTIVE: The population dynamics, population trends, and natural history of *I. delicatissima* are studied and data used for conservation management.**

**4.2.1 RESULT:** The natural history of *I. delicatissima* is better understood throughout the range of habitats and locations on Dominica.

- a) The natural history of *I. delicatissima* is investigated on Dominica.

*High Priority Action:* Forestry, Wildlife and Parks Division; Charles Knapp

*Funding:* 15,000 US\$ per year

**4.3 OBJECTIVE: Expand and enhance coastal to mid-elevation protected areas on Dominica sufficient enough to conserve the unique biodiversity of these areas in perpetuity.**

**4.3.1 RESULT:** The Lesser Antillean Iguana is offered official protection in high-quality habitat that includes a continuous swath of land from coastal nest areas to inhabited inland forested valleys and mid-elevation slopes.

- a) Perform island-wide iguana surveys of both coastal and mid-elevation areas to document high priority areas that should be protected.

*High Priority Action:* Forestry, Wildlife and Parks Division; Charles Knapp

*Funding:* 1,500 US\$

- b) Document the ownership and status of land in areas under consideration for protection.

*Medium Priority Action:* Forestry, Wildlife and Parks Division; Department of Land and Surveys

*Funding:* none

- c) Explore the possibility of property owned currently by government, and vital to iguana conservation, being converted to protected status.

*Medium Priority Action:* Forestry, Wildlife and Parks Division; Department of Land and Surveys

*Funding:* none



- d) Explore the possibility of a cooperative protection agreement for iguanas among current private land owners holding high-quality iguana habitat.  
*Medium Priority Action:* Forestry, Wildlife and Parks Division  
*Funding:* none
- e) Explore the feasibility of private land purchases for protected areas and document current prices of parcels for future grant possibilities.  
*Medium Priority Action:* Forestry, Wildlife and Parks Division  
*Funding:* none
- f) Explore the feasibility of translocating iguanas into existing national parks (e.g., Cabrits) if habitat is enhanced.  
*Low Priority Action:* Forestry, Wildlife and Parks Division; Planning Department  
*Funding:* 1,500 US\$

**4.3.2 RESULT:** Existing protected areas are enhanced to better ensure the long-term protection of the Lesser Antillean Iguana.

- a) Explore the feasibility of augmenting nesting areas in Cabrits National Park.  
*Medium Priority Action:* Forestry, Wildlife and Parks Division; Charles Knapp  
*Funding:* 500 to 2,500 US\$ depending on if augmentation is recommended
- b) Explore the feasibility of enhancing nesting areas in Soufriere Scott's Head Marine Reserve at Champagne Bay by erecting privacy fencing for nesting females.  
*Medium Priority Action:* Forestry, Wildlife and Parks Division; Charles Knapp  
*Funding:* 500 to 5,000 US\$ depending on if enhancement is recommended

#### **4.4 OBJECTIVE: Mitigate threats to habitat integrity, ensuring suitable areas for the long-term protection of the Lesser Antillean Iguana.**

**4.4.1 RESULT:** The Planning Department is made aware of high-quality iguana habitat and therefore makes development recommendations that ensure the protection of such habitats.

- a) Perform island-wide surveys for high-quality iguana habitat and important population centers to provide planning assessors with information on iguana-sensitive habitat.  
*High Priority Action:* Forestry, Wildlife and Parks Division; Charles Knapp  
*Funding:* 1,500 US\$

**4.4.2 RESULT:** The proposed road enhancement project from Roseau to Portsmouth is constructed in a manner to reduce the destruction or fragmentation of iguana habitat.

- a) The coastal road construction agreement is reviewed and actions implemented to mitigate destruction of coastal nest sites and interference with coastal access for migrating females.  
*High Priority Action:* Public Works; Planning Department; Forestry, Wildlife and Parks Division; Charles Knapp  
*Funding:* none



**4.4.3 RESULT:** Coastal areas no longer serve as private dumping grounds, thereby ensuring viable nesting areas for iguanas along coastal slopes.

- a) Signs and structures designed to impede dumping along coastal areas are placed at commonly mistreated areas along the road.

*Medium Priority Action:* Public Works; Planning Department; Forestry, Wildlife and Parks Division; Charles Knapp

*Funding:* 5,000 US\$

**4.4.4 RESULT:** Deaths of iguanas stemming from road collisions are reduced or eliminated along coastal roads.

- a) Speed-calming structures such as rumble strips and road signs are installed in high-impact areas to alert drivers to slow down.

*High Priority Action:* Public Works; Planning Department; Forestry, Wildlife and Parks Division; Charles Knapp

*Funding:* 15,000 US\$

- b) The efficacy of speed-calming structures is evaluated using road surveys to ensure that iguana deaths from vehicle collisions are reduced.

*High Priority Action:* Public Works; Planning Department; Forestry, Wildlife and Parks Division; Charles Knapp

*Funding:* 2,500 US\$ per year

- c) Forestry Division staff members are trained to document iguana deaths from vehicle collisions throughout the year using donated Global Positioning System units.

*High Priority Action:* Forestry, Wildlife and Parks Division; Charles Knapp

*Funding:* 500 US\$

- d) Additional mitigation opportunities (e.g., iguana bridges, underpasses, artificial nesting sites on inland side of roads) are investigated and implemented if possible.

*Medium Priority Action:* Forestry, Wildlife and Parks Division; Charles Knapp

*Funding:* none to 20,000 US\$

**4.5 OBJECTIVE: Dominicans are made aware of and appreciate the uniqueness of the Lesser Antillean Iguana and the role that Dominica plays in preventing the species from going extinct.**

**4.5.1 RESULT:** An education center is developed at the Botanic Garden that highlights the biodiversity of the island and the importance of preserving nature.

- a) An iguana exhibit is constructed and maintained at the Botanic Garden to serve as an educational centerpiece highlighting the Lesser Antillean Iguana and its habitat. [Materials created under result 3.3.1 (a) could be dispersed here]

*Medium Priority Action:* Forestry, Wildlife and Parks Division; Charles Knapp; Jeff Lemm

*Funding:* 3,500 US\$



**4.5.2 RESULT:** Dominicans and international tourists are informed about the Lesser Antillean Iguana and its threats.

- a) Informative signs are designed and placed at tourist locations (e.g., Champagne Bay, Wotten Waven, etc.) to educate visitors to these sites. [Materials created under result 3.3.1 (a) could be dispersed here]

*Medium Priority Action:* Forestry, Wildlife and Parks Division; Charles Knapp

*Funding:* 3,500 US\$

**5. FRENCH WEST INDIES (FWI)** refers to the four territories presently under French sovereignty in the Caribbean: the two overseas departments of Guadeloupe and Martinique, plus the two overseas collectivities of Saint Martin and Saint-Barthélemy. The Guadeloupe department includes the islands of Basse-Terre, Grande-Terre, Îles des Saintes, Marie-Galante, La Désirade, and les Îles de Petite Terre.

**5.1 OBJECTIVE:** The population dynamics, population trends, natural histories, and general health parameters of *I. delicatissima* and *I. iguana* are studied, and the resulting data used are to better manage both populations.

**5.1.1 RESULT:** The natural history and competitive interactions of *I. delicatissima* and *I. iguana* are better understood throughout the FWI.

- a) The natural histories of both iguana species are investigated on Martinique, Guadeloupe, and Saint-Barthélemy.

*High Priority Action:* Chloé Rodrigues; David Laffitte; Michel Breuil; Baptiste Angin; Fortuné Guiougou; Association GRENAT

*Funding:* 20,000 US\$

- b) Comparative health screenings of both iguana species are conducted on Martinique, Guadeloupe, and Saint-Barthélemy.

*High Priority Action:* David Laffitte; Chloé Rodrigues; Michel Breuil; Association Ti Tè; Fortune Guiougou, Baptiste Angin, Association Le Gaïac; ONCFS; Association GRENAT

*Funding:* 10,000 US\$

- c) High-density iguana populations (Petite Terre, Desirade), and Chancel and Saint-Barthélemy are monitored continuously to detect any population declines caused by environmental, introduced-species interaction, or other factors.

*High Priority Action:* Baptiste Angin; Chloé Rodrigues; David Laffitte; Michel Breuil; Fortune Guiougou, Association Le Gaïac; Association Ti Tè; ONCFS; Association GRENAT

*Funding:* 20,000 US\$ for two years

- d) Standardized monitoring protocols are accepted and implemented throughout the study range in order to produce comparative research results.

*High Priority Action:* Completed as per National Action Plan for *Iguana delicatissima* Conservation on Guadeloupe, Martinique (for Chancel Islet, la Désirade, Petite Terre) and Saint-Barthélemy.

*Funding:* none



**5.2 OBJECTIVE: Habitat use and spatial ecology are understood for *I. delicatissima* and *I. iguana*, and the data used to better inform potential translocations.**

**5.2.1 RESULT:** Habitat use and spatial ecology for *I. delicatissima* are investigated in both natural areas and point-of-contact zones with *I. iguana* and the results used when planning translocation programs.

- a) Habitat use is studied using radio telemetry to determine habitat requirements and spatial ecology.

*Medium Priority Action:* ONCFS; Michel Breuil; Association Le Gaïac; Association Ti Tè; Association GRENAT

*Funding:* 35,000 US\$

**5.3 OBJECTIVE: Actions to mitigate threats to the long-term survival of the Lesser Antillean Iguana are endorsed and executed in order to prevent further population declines and safeguard existing healthy iguana populations.**

**5.3.1 RESULT:** Guarantee legal and proactive regulatory policies to help conserve the native *I. delicatissima* and eliminate the non-native *I. iguana* from Guadeloupe.

- a) Amend the existing Forestry and Wildlife Act to list specifically *Iguana delicatissima* as a protected species, and remove *I. iguana* and hybrids from protective status so that the latter may be removed when possible.

*High Priority Action:* DEAL of Guadeloupe; French Ministry of Ecology; ONCFS; members of the IUCN ISG; DEAL of Martinique

*Funding:* 1,000 US\$

- b) Draft a formal letter from the International Union for Conservation of Nature (IUCN) Iguana Specialist Group to be included with the amendment request of the Forestry and Wildlife Act.

*High Priority Action:* Co-chair of the IUCN Iguana Specialist Group

*Funding:* none

- c) Habitats with populations of *I. delicatissima* are protected and restored in order to assure good-quality habitat for existing and/or translocated populations.

*High Priority Action:* DEAL, local authorities

*Funding:* 9,000 US\$

**5.3.2 RESULT:** The Lesser Antillean Iguana is assured protection from introduced species such as the Green Iguana, *Iguana iguana*.

- a) Draft and implement protocol for control and removal of non-native *I. iguana* and hybrids.

*High Priority Action:* Chloé Rodrigues; David Laffitte; Michel Breuil; SMPE Martinique

*Funding:* 8,000 US\$

- b) Rescue remaining non-hybridized *I. delicatissima* from Guadeloupe and house them in temporary enclosures in order to prevent further hybridization events.

*High Priority Action:* GECIPAG; Baptiste Angin, Fortuné Guiougou, Association Le Gaïac; Michel Breuil; Parc National de la Guadeloupe

*Funding:* 150,000 US\$



- c) Reinforce existing captive breeding facility in countries of origin, or overseas, in order to maintain a secondary safe-guarded captive population in the event of catastrophe in the wild.

*Low Priority Action:* Gerardo Garcia at Chester Zoo; GECIPAG; Association GRENAT

*Funding:* 100,000 US\$

- d) Develop a two-language identification guide for port authorities that details the differences between the Lesser Antillean and Green Iguanas. The identification guide should also include a list of the most invasive species that must not be allowed to enter the country (e.g., Red-eared Slider Turtles).

*High Priority Action:* ONCFS; Michel Breuil; LASFA; GECIPAG; La Réserve Naturelle de Saint-Barthélemy; DEAL Martinique and Guadeloupe; Association GRENAT, Dominica Forestry, Wildlife and Parks

*Funding:* 5,000 US\$

**5.3.3 RESULT:** Additional *I. delicatissima* populations are established via translocation in order increase the number of viable population centers.

- a) Explore and perform habitat assessments of potential offshore cays or isolated areas where iguanas can be translocated.

*High/Medium Priority Action:* ONCFS; Michel Breuil; Anne Breuil; DEAL; GECIPAG; unidentified post graduate students; Association GRENAT

*Funding:* 10,000 US\$

- b) Perform natural history studies on existing translocated populations from Martinique and any future translocated populations.

*High/Medium Priority Action:* Chloé Rodrigues; David Laffitte; Michel Breuil; DEAL; GECIPAG, Association GRENAT

*Funding:* 12,000 US\$

**5.3.4 RESULT:** Populations of *Iguana iguana* are eliminated or reduced in order to reduce the risk of hybridization, or movement between islands.

- a) Eradicate Green Iguanas from harbors and shipping ports to reduce the probability of their spread to other islands.

*High/Medium Priority Action:* ONCFS; DEAL

*Funding:* 10,000 US\$

- b) Eliminate Green Iguanas from islands in contact with *I. delicatissima* in order to decrease likelihood of hybridization.

*Medium Priority Action:* ONCFS; DEAL

*Funding:* TBD





## 6. ST. EUSTATIUS

### 6.1 OBJECTIVE: Guarantee legal and proactive regulatory policies to help conserve the Lesser Antillean Iguana and prevent the introduction of invasive species to St. Eustatius.

**6.1.1 RESULT:** The Lesser Antillean Iguana is no longer hunted or harassed and if so, offenders are prosecuted.

- a) Amend articles in the *Statia Flora and Fauna Ordinance* to meet all requirements of the framework law.

*High Priority Action:* LVV; STENAPA

*Funding:* none

- b) Draft a formal letter from the International Union for Conservation of Nature (IUCN) Iguana Specialist Group to be included with the amendment request of the *Statia Flora and Fauna Ordinance*.

*High Priority Action:* Co-chairs of the IUCN Iguana Specialist Group

*Funding:* none

- c) Increase arrests and judicial prosecutions of offenders found hunting iguanas.

*Medium Priority Action:* STENAPA to develop greater awareness and closer cooperation with island police

*Funding:* none

**6.1.2 RESULT:** The Lesser Antillean Iguana is assured protection from introduced species such as the Green Iguana, *Iguana iguana*.

- a) Draft a policy statement to prevent the importation of any iguana including the Green Iguana and other potentially invasive species (e.g., Red-eared Slider Turtle, mongoose) to St. Eustatius.

*High Priority Action:* LVV; STENAPA

*Funding:* none

- b) Develop an identification guide for port authorities that details the differences between the Lesser Antillean and Green Iguanas. The identification guide should highlight that no iguana should be allowed to enter the country and also include a number of the most invasive species that must not be allowed to enter the country (e.g., Red-eared Slider Turtles).

*High Priority Action:* Charles Knapp

*Funding:* 2,000 US\$

- c) Develop and host a workshop for Customs and Port Authority personnel to educate about the dire consequences of introduced, invasive species such as Green Iguana, Red-eared Slider Turtle, mongoose, etc.

*Medium Priority Action:* Bruce Weissgold; Dolfi Debrot, IMARES

*Funding:* 1,000 US\$ (local); 10,000 US\$ (if regional)



**6.2 OBJECTIVE: Mitigate threats to habitat integrity and iguana survival, ensuring suitable areas for the long-term protection and preventing further population reduction.**

**6.2.1 RESULT:** Existing nesting sites are protected while additional nesting areas are developed to increase the potential for successful nesting events.

- a) Explore the feasibility of augmenting nesting areas in existing national parks and in suitable residential areas near the boundary of these parks (especially Quill NP).

*Medium Priority Action:* STENAPA

*Funding:* 2,500 US\$ for implementation of pilot projects.

- b) Advise developers and develop mandates that nesting areas are considered when proposing new developments.

*Medium Priority Action:* STENAPA (currently implemented)

*Funding:* none

**6.2.2 RESULT:** Iguana habitat is restored or augmented to increase use by iguanas.

- a) Phase out the use of harmonica wire fencing used to delineate property boundaries in order to reduce accidental death of iguanas.

*Medium Priority Action:* LVV (currently implemented)

*Funding:* none

- b) Implement an “Iguana-friendly yard” awareness program by advising and encouraging private land owners and developers to implement initiatives that facilitate the survival of the Lesser Antillean Iguana.

*Medium Priority Action:* STENAPA

*Funding:* 500 to 5,000 US\$ depending on action implemented

**6.2.3 RESULT:** Iguana numbers are increased through direct conservation action to prevent further population reduction.

- a) A conservation breeding facility is constructed at the office headquarters of the Department of Agriculture Animal Husbandry and Fisheries in order to serve as a headstart and rehabilitation facility, as well as an education center (see 6.4.1 below).

*Low Priority Action:* LVV; CNSI

*Funding:* 100,000 US\$

**6.3 OBJECTIVE: Habitat use and spatial ecology are understood for *I. delicatissima* and data used to better inform management.**

**6.3.1 RESULT:** Habitat use and spatial ecology for *I. delicatissima* are investigated in both natural areas and semi-natural areas in order to inform management.

- a) Habitat use is studied using radio telemetry to determine habitat requirements and spatial ecology.

*Medium Priority Action:* CNSI; STENAPA; IMARES

*Funding:* 15,000 US\$



**6.4 OBJECTIVE: The people of Statia are made aware of and appreciate the uniqueness of the Lesser Antillean Iguana, and the importance to protect the iguana on island.**

**6.4.1 RESULT:** An education center, in association with a conservation breeding facility, is developed at the office headquarters of the Department of Agriculture Animal Husbandry and Fisheries that highlights the biodiversity of the island and the importance of preserving nature.

- a) An iguana exhibit is constructed and maintained at the office headquarters of the Department of Agriculture Animal Husbandry and Fisheries to serve as an educational centerpiece highlighting the Lesser Antillean Iguana and its habitat.

*Medium Priority Action:* Department of Agriculture Animal Husbandry and Fisheries

*Funding:* 20,500 US\$

**6.4.2 RESULT:** People of Statia are informed about the Lesser Antillean Iguana and its threats.

- a) Informative signs are designed to educate islanders.

*Medium Priority Action:* STENAPA

*Funding:* 3,500 US\$



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## Appendix

### MEETING PARTICIPANTS

#### Dominica

Bertrand Jno. Baptiste – Forestry, Wildlife and Parks Division  
Ronald Charles – Forestry, Wildlife and Parks Division  
Stephen Durand – Forestry, Wildlife and Parks Division  
Bradley Guye – Environmental Coordinating Unit  
Petrea Honychurch – Land Use Section, Physical Planning Division  
Arlington James – Forestry, Wildlife and Parks Division  
Randolph Winston – Forestry, Wildlife and Parks Division

#### France

Michel Breuil (via conference call) – Paris Muséum National d’Histoire Naturelle

#### Guadeloupe

René Dumont – Réserve Naturelle de Petite-Terre  
Fortuné Guiougou – Groupe d’Étude et de Conservation de l’Iguane des Petites Antilles en Guadeloupe (GECIPAG)

#### Martinique

Vincent Arenales del Campo – Direction Régionale de l’Environnement (DIREN)  
Caroline Legouez – Office National de la Chasse et de la Faune Sauvage (ONCFS)  
Chloé Rodrigues - Office National de la Chasse et de la Faune Sauvage (ONCFS)  
David Laffitte - Office National de la Chasse et de la Faune Sauvage (ONCFS)

#### United States

Allison Alberts – San Diego Zoo, Director of Conservation Research, President of IIF  
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Tandora Grant – San Diego Zoo  
Kirsten Hines – IUCN Iguana Specialist Group  
Mike Hoffman – IUCN SSC – CI CABS Biodiversity Assessment Unit  
Rick Hudson – Fort Worth Zoo, Executive Director of IIF  
John Iverson – Earlham College  
Charles Knapp – San Diego Zoo and Shedd Aquarium  
Jeff Lemm – San Diego Zoo  
Stesha Pasachnik – University of Tennessee  
Catherine Stephen – Utah Valley University  
Bonnie Raphael – Wildlife Conservation Society  
Bruce Weissgold – CITES Management Authority at United States Fish and Wildlife Service





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