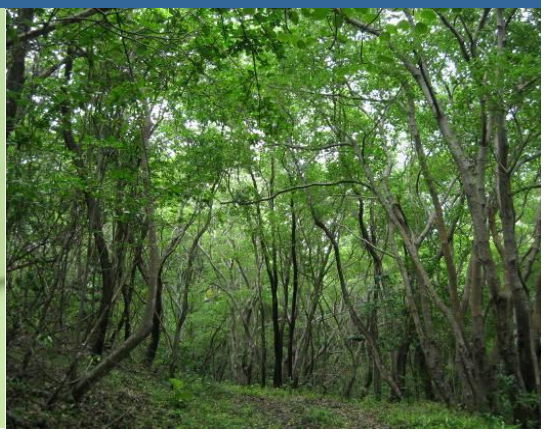
FCG International Ltd
in association with
AFC Consultants International GmbH

TECHNICAL REPORT 2

Presented to the European Commission and
Banana Industry Trust





NATIONAL FOREST DEMARCATION AND BIO-PHYSICAL RESOURCE INVENTORY PROJECT

CARIBBEAN – SAINT LUCIA

SFA 2003/SLU/BIT-04/0711/EMF/LC

THE STATUS AND MANAGEMENT OF SAINT LUCIA'S FOREST REPTILES AND AMPHIBIANS

By

JENNIFER C. DALTRY

Conservation Biologist, Fauna & Flora International

2009

Cover illustrations: Elfin Shrubland on Mount Gimie Range (Roger Graveson, FCG); Forest Gecko *Thecadactylus rapicaudus*; Deciduous Seasonal Forest at Grande Anse (Jenny Daltry, FCG-FFI).

PUBLISHED BY

FCG (Finnish Consulting Group) International Ltd

Helsinki, Finland

RECOMMENDED CITATION

Daltry, J.C. (2009) *The Status and Management of Saint Lucia's Forest Reptiles and Amphibians*. Technical Report No. 2 to the National Forest Demarcation and Bio-Physical Resource Inventory Project, FCG International Ltd, Helsinki, Finland.

The National Forest Demarcation and Bio-Physical Resource Inventory Project was funded by the European Union under the auspices of the Banana Industry Trust, and implemented by the Finnish Consulting Group (FCG) International Ltd in collaboration with the Saint Lucia Forestry Department.

Table of Contents

Executive Summary

This study of Saint Lucia's forest herpetofauna was carried out as part of the National Forest Demarcation and Bio-Physical Resource Inventory Project. It entailed a literature review, interviews, and nationwide field surveys.

Nineteen native species of reptiles and amphibians (three extinct), and nine alien species (three extinct) have been recorded in Saint Lucia to date, all of which are illustrated and described in this report Endemicity is remarkably high among the native forest community, with seven nationally endemic species, and five endemic subspecies. All but one of the extant species were seen during the present survey.

To assess and compare the diversity and relative abundance of reptiles and amphibians in different forest types, 55 sites were intensively surveyed for an hour apiece using visual search techniques. The forest class with by far the greatest diversity and abundance of species was mature Deciduous Seasonal Forest (seven species confirmed, and a mean encounter rate of 36.8 individuals per hour), followed by mature Freshwater Swamp Forest and Semi-Evergreen Seasonal Forest. Forests that naturally had significantly lower species diversity and abundance were Elfin Shrubland (only one species confirmed), Lower Montane Rainforest, Fumarole Vegetation and Mangrove. Human degradation of all forest classes was significantly associated with an increased number of alien invasive species. These findings were corroborated with additional, opportunistic surveys, interviews with local experts, and the literature.

These findings tell us that the existing forest reserve system on Saint Lucia is woefully inadequate in representing and protecting the nation's herpetofauna. Ironically, the forest classes that are *best* represented in the protected area system have the *lowest* diversity and abundance. The species-rich Deciduous Seasonal Forests and Freshwater Swamp Forests are largely outside of the protected zone and thus at risk. An important exception to this rule are the xeric Maria Islands (12ha), which supports seven native species, many of which are scarce or absent from the 'mainland'. This survey also found encouraging signs that the rare and important Semi-Evergreen Seasonal Forest - a mesic forest type that was largely cleared for agriculture in the past – is regenerating where farms have been abandoned for economic or other reasons.

After assessing and comparing the conservation significance of major forest classes, the conservation status of every native forest species was examined. Drawing on historical records and comparisons with other West Indian islands, this study found most of Saint Lucia's native forest species have declined significantly in distribution range and population size; some to critically low levels. By applying the IUCN categories of threat, at least six endemics now qualify as globally threatened with extinction, i.e. *Critically Endangered*: Saint Lucia racer; *Endangered*: Saint Lucia whiptail; or *Vulnerable*: Saint Lucia pygmy gecko (both subspecies), Saint Lucia thread snake, and, perhaps surprisingly, Saint Lucia fer-de-lance. If it is taxonomically distinct, the Saint Lucia iguana also qualifies as Critically Endangered. When these findings are pooled with additional considerations of economic use, cultural values and ecological importance, the reptiles that emerge as the nation's highest conservation priorities are the iguana, racer and whiptail lizard.

The greatest threats to Saint Lucia's native forest herpetofauna - and the root cause of most of their declines - are alien invasive animals. These include predatory mammals, e.g. the opossum, rats, dogs, cats and feral pigs and, most importantly, the mongoose. Alien invasive reptiles and amphibians also pose a great danger to native species through predation, competition and hybridization. The introduced green iguanas near Soufriere present a clear hazard to the native iguana through competition and hybridization. This field survey also discovered that the alien Watts' anole has become widely dispersed and appears to be displacing the endemic Saint Lucia anole in disturbed habitats. There is an extremely high risk of more alien species invading the near future, assisted by human transport. There are a number of other threats to the forest herpetofauna which are also important and are discussed in this report, including habitat loss, hunting and agrochemical pollution. Loss of

genetic diversity, stochastic effects and climate change are serious impending threats to the species and subspecies that are scarce or confined to offshore islands.

In addition to identifying gaps in the protected area system, this study highlighted some disturbing weaknesses in the Wildlife Protection Act 1980 (revised 2001). While this important piece of legislation has been very successful in combating over-exploitation, it was not designed to - and thus largely fails to - address other, greater threats to Saint Lucia's herpetofauna. Furthermore, the legal status of only five of the 12 extant native forest species, and none of the six extant alien species, is explicitly defined in the Act, leaving many species in a legal grey area.

Taking into account the legislative limitations and other known constraints to the management of Saint Lucia's herpetofauna (public attitudes, human and financial resources, information, technological limitations), a series of practical management recommendations are proposed. The objective of these is to conserve Saint Lucia's unique and important forest herpetofauna, including enabling the most threatened species to recover:

Management Recommendations (See Chapter 6 for more details)

Objective: Control the introduction and spread of alien invasive species that endanger forest herpetofauna

- Keep the offshore islands free of alien invasive species [TOP PRIORITY]
- Eradicate the introduced green iguanas to conserve the Saint Lucia iguana [TOP PRIORITY]
- Control harmful alien invasive mammals from priority sites on the main island
- Minimise the probability of non-native species invading Saint Lucia [TOP PRIORITY]
- Minimise the probability of species from Saint Lucia invading other countries

Objective: Revise the national legislation to reflect the current needs of Saint Lucia's herpetofauna

- Revise the next edition of the Wildlife Protection Act [TOP PRIORITY]

Objective: Secure the protection and regeneration of important dry and mesic forest sites on Saint Lucia

- Establish at least one new nature reserve to protect dry forest wildlife communities on the main island of Saint Lucia [TOP PRIORITY]
- Formulate local agreements to preserve important wildlife habitats and forest corridors

Objective: Update and use the Red List system to guide and support improved management

- Enable IUCN to list all native Saint Lucia reptiles with appropriate categories of threat on the international Red List [TOP PRIORITY]
- Develop a National Red List
- Prepare and implement species conservation action plans for Saint Lucia's most threatened herpetofauna

Objective: Conduct applied research to inform and monitor the management of Saint Lucia's herpetofauna

- Assess the status and ecological needs of, and threats to, the least-known species [TOP PRIORITY]
- Elucidate the impacts of different alien invasive animals on native reptiles and amphibians
- Monitor selected populations and forest habitats to evaluate and guide management decisions
- Conduct applied research on improved medical treatment for snakebites

Objective: Strengthen local and national understanding and support for conservation

- Increase public interest in and awareness of Saint Lucia's reptiles and amphibians
- Heighten public understanding of the impact of alien invasive species

1 Introduction

1.1 Purpose and Scope of this Report

This study was conducted as part of the National Forest Demarcation and Bio-Physical Resource Inventory Project, funded by the European Community under the Saint Lucia SFA2003 Programme of Economic and Agriculture Diversification and Poverty Reduction through Integrated National Resources Management "To survey and demarcate the physical parameters of the public forest reserve and conduct a comprehensive biophysical inventory/ assessment and management system of forest resources".[1]

As advised by the Forestry Department, the project team has taken 'forest' to mean all forms of natural or near-natural terrestrial vegetation, even though the term is often locally applied to the rainforest alone. The broader definition includes all of the offshore islands and all parts of the mainland apart from urban, suburban and agricultural areas.

Reptiles and amphibians form essential components of the biological diversity of Saint Lucia's forests, and no national forest management system would be complete without considering their status and requirements. The species reported to occur on Saint Lucia (Section 1.3) include a suite of island endemics and globally threatened species, several potentially damaging alien invasive species, cultural icons, and at least one medically significant species. Aside from their intrinsic interest and value, reptiles and amphibians have a pivotal role in West Indian forest food webs - chiefly as the leading consumers of forest invertebrates - and help to shape and maintain healthy, diverse forests (Goldwasser & Roughgarden, 1993; Waide & Reagan, 1993; Roughgarden, 1995; Section 4.2.8).

The main purposes of this report are to document the current status and distribution of extant species of reptiles and amphibians in Saint Lucia, and to identify threats and ecological needs that should be addressed, especially those relevant to the new forest management plan. As well as drawing on existing literature and the combined knowledge of expert naturalists and managers in Saint Lucia, this report will also present original data from a rapid nationwide survey that was carried out in 2008 and 2009.

In line with the project objective above, this report will focus on *terrestrial* species, and especially those occurring in forests. Saint Lucia's marine herpetofauna, which comprise four species of sea turtles, are important, but largely outside the scope of this report.

1.2 Saint Lucia: A Brief Introduction

Saint Lucia is located within the Windward Islands of the Lesser Antilles in the West Indies. Its closest neighbouring islands are Martinique, 32km to the north and Saint Vincent, 40km to the south. Saint Lucia is the second largest island of the Lesser Antilles with an area of 616km^2, with the maximum length and width of 43km and 21km, respectively. The human population is close to 166,838 residents, giving a mean density of approximately 1,036/km^2, but much of the island's interior is uninhabited.

Volcanic in origin, Saint Lucia has a mountainous topography dominated by a central ridge running almost the full length of the island from north to south. Numerous steep offshoot ridges extend to both sides of the coasts. Some valleys are broad and occupied by large banana plantations, including Cul-de-sac, Roseau and Mabouya.

[1] Specifically, this study contributes towards Result 3: A comprehensive report on the current state of forest resources (timber, non-timber, biodiversity), with recommendations for sustainable management practices; and Result 5: An assessment of wildlife use attributes identifying critical habitats and recommendation for sustaining habitats of important, rare or endangered animal species.

These valleys, together with the area around the town of Vieux-Fort in the South, account for most of the flat lands of the country. The central southern part of the country has high mountains (Mount Gimie being the highest at 958m). The coastlines, particularly the east coast, are deeply indented by near-vertical cliffs and have a number of narrow sandy beaches.

The island's tropical marine climate is characterized by relatively uniform high temperature throughout the year. The dry season is roughly from January to April and the rainy season from May to August, with usually sunny, warm weather from September to October. (This pattern is variable, however, and the present study regularly experienced torrential storms). Tropical storms and hurricanes are infrequent, with the majority of West Indian tropical cyclones passing to the north of Saint Lucia. The hottest period is May to October, and the coolest, December to March, giving a mean annual temperature of approximately 26°C at sea level. Annual rainfall varies from 1,524-1,778mm in the north to 2,540-3,683 mm in the mountainous interior of the south.

There are more than 20,000 hectares of natural vegetation types in Saint Lucia, of which 9,146 hectares are within the Government Forest Reserves (protected forests). Graveson (2009) described the different types of forest cover, which range from a very xeric littoral shrubland and mangroves on the coast to a lush rainforest and elfin shrubland in the high peaks.

Approximately 30% of Saint Lucia's land area is pastoral and arable land. Originally the mainstay of the economy, agriculture has been in decline in recent years, contributing only 3.4% of Gross Domestic Product (GDP) in 2005, with bananas the principal export crop. The economy of Saint Lucia has shifted to a service economy, with tourism the largest economic sector, accounting for 13.6% of GDP in 2005.

1.3 Known Herpetofauna

Breen (1844) declared *Saint Lucia is infested by countless reptiles*. In fact twenty-eight[2] species of reptiles and amphibians have been recorded from Saint Lucia to date (Table 1).

The species and subspecies names throughout this report generally follow Schwartz & Henderson (1991), but follow Breuil (2002) and Miralles (2005) for *Mabuya*. Descriptions and illustrations of all of the existing species can be found in Section 5. Six species are probably no longer present on Saint Lucia (*Eleutherodactylus martinicensis, Leptodactylus fallax, Mabuya mabouya, Sphaerodactylus elegantulus, Sphaerodactylus vincenti, Clelia errabunda*). At least nineteen are native, or probably so (see Section 4.1). Endemicity is high, with seven full endemic species: three lizards (*Anolis luciae, Cnemidophorus vanzoi, and Sphaerodactylus microlepis*) and four snakes (*Bothrops caribbaeus, Clelia errabunda, Leptotyphlops bruilei*, and *Liophis ornatus*).

Saint Lucia also has five endemic subspecies of reptiles: *Gymnophthalmus pleii luetkeni* (main island of Saint Lucia); *G. p. nesydrion* (Maria Major only); *Sphaerodactylus microlepis microlepis* (main island of Saint Lucia); *S. m. thomasi* (Maria Major only); and *Boa constrictor orophias* (main island of Saint Lucia). A sixth subspecies, *Sphaerodactylus vincenti diamesus* was also attributed to Saint Lucia in the 1960s, but this may have been an alien introduction rather than a true native (see Section 4.1).

[2] The green iguana (*Iguana iguana*) will be treated throughout this report as a species distinct from the Saint Lucia iguana, chiefly because of fundamental differences in their physical appearance, history, conservation value and management needs. Both iguanas might, however, be lineages of the same species. The Saint Lucia iguana will be referred to as *Iguana cf iguana*: the latin abbreviation '*cf*' (*confer*, to compare) indicates that it is more similar to *Iguana iguana* than any other known species, but its identity is unconfirmed.

Table 1 Reptiles and amphibians of Saint Lucia

[Square brackets indicate species that are unconfirmed or extinct]

	Scientific Name	*Common Name (English)*	*Common Name (Creole)*	*Species Profile*
1	***Bufo marinus***	Cane toad	Kwapo, Kwapo-Lad	Page 53
2	***Eleutherodactylus johnstonei***	Johnstone's whistling frog	Ti tolin	Page 55
3	***[Eleutherodactylus martinicensis]***	[Martinique whistling frog]	[Gounouy]	Page 57
4	***Scinax ruber***	Red-snouted tree frog		Page 59
5	***[Leptodactylus fallax]***	[Mountain chicken]	Kwapo	Page 61
6	***Caretta caretta***	Loggerhead		n/a
7	***Chelonia mydas***	Green turtle	Toti blan, Toti vè	n/a
8	***Dermochelys coriacea***	Leatherback turtle	Toti cerkeil, Toti d'lo	n/a
9	***Eretmochelys imbricata***	Hawksbill turtle	Toti karet	n/a
10	***Anolis extremus***	Barbados anole	Zanndoli	Page 63
11	***Anolis luciae***	Saint Lucia anole	Zanndoli	Page 65
12	***Anolis wattsi wattsi***	Watts' anole	Zanndoli	Page 67
13	***Cnemidophorus vanzoi***	Saint Lucia whiptail	Zando	Page 69
14	***Gymnophthalmus pleii (*subspecies *luetkeni* and *nesydrion)***	Rough-scaled worm lizard	Zanndoli tè, Chofèy solèy, Koylèv-tè	Page 71
15	***Hemidactylus mabouia***	House gecko	Mabouya	Page 73
16	***Hemidactylus palaichthus***	Antilles leaf-toed gecko or rock gecko		Page 75
17	***Iguana cf iguana***	Saint Lucia iguana	Léza, gwo zandoli	Page 77
18	***Iguana iguana***	Green iguana	Léza, igwàn	Page 79
19	***[Mabuya mabouya]***	[Southern Antillean skink]	Mabouya	Page 81
20	***[Sphaerodactylus elegantulus]***	[Antiguan pygmy gecko]		Page 83
21	***Sphaerodactylus microlepis (*subspecies *microlepis* and *thomasi)***	Saint Lucia pygmy gecko		Page 85
22	***[Sphaerodactylus vincenti]***	[Central Lesser Antillean pygmy gecko]		Page 87
23	***Thecadactylus rapicaudus***	Forest gecko		Page 89
24	***Boa constrictor orophias***	Saint Lucia boa	Tet chyenn	Page 91
25	***Bothrops caribbaeus***	Saint Lucia fer-de-lance	Sepan	Page 93
26	***[Clelia errabunda]***	[Saint Lucia cribo]	[Cribo]	Page 95
27	***Leptotyphlops bruilei***	Saint Lucia thread snake		Page 97
28	***Liophis ornatus***	Saint Lucia racer	Kouwès	Page 99

1.4 Previous Herpetological Research

Herpetological research in Saint Lucia to date has fallen largely into four main categories: pure taxonomic research, studies of the distribution of the introduced anole lizards, conservation-oriented research on selected threatened species and sites, and studies of the epidemiology and clinical effects of Saint Lucia's only venomous snake.

There has been a long history of taxonomic studies throughout the West Indies. Research in Saint Lucia was largely carried out during the British colonial period, when numerous specimens were deposited in museums in

the UK and the USA. Notable taxonomists during the nineteenth and twentieth centuries included Samuel Garman, Thomas Barbour and James Lazell (Museum of Comparative Zoology, Harvard), Albert Schwartz (Miami) and Garth Underwood (The Natural History Museum, London). Their work resulted in the formal naming and description of most of Saint Lucia's endemic species and subspecies: the lizards *Anolis luciae*, *Cnemidophorus vanzoi*, *Gymnophthalmus pleii nesydrion*, *Sphaerodactylus microlepis microlepis*, and *Sphaerodactylus microlepis thomasi*, and snakes *Clelia errabunda*, *Liophis ornatus* and *Bothrops caribbaeus*. Schwartz & Henderson (1991) provided a comprehensive volume on all known species in the West Indies, including Saint Lucia, which remains the best available reference for this country. In 2008, genetic and morphological research by another evolutionary biologist, Blair Hedges of the National Museum of National History in Washington DC, resulted in the formal recognition of the seventh endemic full species, the Saint Lucia thread snake, *Leptotyphlops bruilei* (Hedges, 2008).

Based on visits in the 1960s and 1970s, Lazell (1972) and Gorman (1976) conducted some studies on the distribution of the introduced Watts' anole, *Anolis wattsi*, and Barbados anole, *A. extremus*, and discussed how these alien species were interacting with the native Saint Lucia anole, *A. luciae*. During the 1990s, Nick Giannasi (University of Bangor) conducted a short investigation into whether the endemic Saint Lucia anole could hybridize with the Barbados anole (Giannasi *et al.* 1997). The 1990s, and 2000s also saw the beginning start of a series of ongoing management-oriented studies into the ecology, status and distribution Saint Lucian iguana, *Iguana cf iguana*, and Saint Lucia whiptail lizard, *Cnemidophorus vanzoi*, as part of the Saint Lucia Forestry Department and Durrell Wildlife Conservation Trust's programmes to conserve these rare lizards (e.g. Brice & Bloxam, 1995; John, 1999; Dickinson & Fa, 2000; Dickinson *et al*. 2001; Brown, 2008; Murton, 2008; Young *et al.*, 2006).

The Saint Lucia fer-de-lance or pitviper, *Bothrops caribbaeus*, has also drawn some attention due to its medical importance and the unusual effects of its venom. Numeric *et al.* (2002) and Gutiérrez *et al.* (2008) published articles on the clinical effects and treatment of Saint Lucia fer-de-lance bites. In 2009, a student of the University of East Anglia completed her Masters of Science thesis on the historical and present epidemiology of bites by the Saint Lucia fer-de-lance (Breach, 2009).

2 Methods

2.1 Standardized Field Survey

2.1.1 Selection of survey plots

A stratified, non-random sampling method was used to sample and compare the distribution and relative abundance of reptiles and amphibians. To ensure that all major forest classes in Saint Lucia were represented, the draft vegetation map developed by Roger Graveson (2009) was used to select sites within "Dry Forest" (i.e., littoral evergreen forest and deciduous seasonal forest, including riparian, degraded and high quality forms), "Mesic Forest" (semi-evergreen seasonal forest), "Wet Forest" (lower montane rainforest, montane rainforest and cloud montane rainforest) and "Mangrove". Wherever possible, the herpetological study covered the same sites that were examined by the project botanist (Graveson, 2009) and mammalogist (Clarke, 2009). To more fully understand the impact of forest disturbance on reptile and amphibian populations, degraded forest areas on the edges of settlements, farms and plantations were also sampled. Due to the limited time, the selection of sites within these strata was non-random, and most sites were within an hour's walk of a forest trail or minor road. A description of the sites can be found in Annex 1. I recorded the location (coordinates using the Universal Transverse Mercator system) and elevation (metres above sea level) of the centre of the site using a GPS Garmin etrex. To improve the accuracy of the elevation reading, the GPS was given time to 'fix' on at least four satellites and achieve an estimated position error of no more than 15 metres.

2.1.2 Survey methods

The standardized study was conducted on 20 dry days between 2 February and 27 July 2009. One full hour was spent by the author at each plot (the start times varied between 07:30h and 17:45h) and a combination of search techniques were used to locate reptiles and amphibians: visual scanning of the trees and the ground, turning over logs, rocks and other debris, lifting loose bark, and raking through leaf litter. Every species seen was recorded, together with the number of individuals. Species were identified using Schwartz & Henderson (1991), with additional reference to illustrations in Schwartz (1965a,b) and Malhotra & Thorpe (1999), and using the author's previous experience of working with nearly half of the resident species over the past 15 years. Captured specimens were released promptly in the same site.

This simple form of Visual Encounter Survey gave a measure of the number of individuals seen per hour. This measure is assumed to be correlated with the actual number or density of individuals in the area surveyed, and can therefore provide a useful index for comparing the *relative abundance* of the same species in different areas (Heyer *et al.* 1994). For example, if eight Saint Lucia anoles are seen per hour in Site A and only one Saint Lucia anole is seen per hour in Site B, we can infer the lizards are approximately eight times more abundant in Site A than Site B, without determining the exact number of lizards present in each site. Comparing the relative abundance of different *species* must be exercised with more caution, however, because differences in behaviour or appearance can make one species significantly more or less easy to detect than another.

Recognising that temperature and humidity can affect the activity and, hence, the detectability of reptiles and amphibians (e.g. Daltry *et al.* 1998), the ambient temperature and relative humidity of every site was recorded one metre above the ground using a digital Thermo-Hygro™ thermohygrometer (accurate to ±5%RH and ±1ºC), at 0, 30 and 60 minutes. Annex 1 presents the mean ambient temperature and relative humidity at the time each site was surveyed.

The forest type of every plot was provisionally determined from a draft vegetation map prepared by Roger Graveson in January 2009, and photographs and detailed notes were taken to record the forest phenology, paying particular attention to signs of human impact. The plots were later re-classified using the final, more detailed vegetation classification system of Graveson (2009). These forest classes were further classified as low, medium or high quality, according to how mature and natural the forests were in each plot. For example, a Lower Montane Rainforest that had been planted with a few non-native timber trees was rated Medium, while a Deciduous Seasonal Forest that had been heavily impacted by grazing and reduced to predominantly acacia scrub and grassland was rated as Low.

2.1.3 Data analysis

Wilcoxon-Mann-Whitney tests were performed manually, using the methods and probability tables given by Siegel & Castellan (1988). Other statistical tests were conducted using the Addinsoft™ statistical package XLSTAT version 2009.4.05.

2.1.4 Limitations and constraints

This survey was constrained by severe storms, other project demands, restricted access to vehicles and, for much of the study period, a lack of maps suitable for navigation into remote areas. The most important limitation of this survey was the relatively small area surveyed at each location (approximately 100m^2), which was probably inadequate for detecting species that are scarce or highly localized, such as the iguana. Ideally, this study would have used a random sampling method, surveyed every site for at least three hours during a fixed time of day (to minimise bias from diurnal variation in animal activity), and repeated every suite at night (to survey nocturnal species more thoroughly).

Nevertheless, owing to the strong geographic variation in the distribution and abundance of Saint Lucia's forest herpetofauna, the methods used were sufficient to detect some statistically significant patterns in the diversity and relative abundance of reptiles and amphibians in different forest types.

2.2 Opportunistic Field Records

To develop comprehensive species distribution maps, all sightings of reptiles and amphibians were opportunistically recorded by the author while travelling around the country in 2008 and 2009, including roadkills. The location of every sighting was recorded using a hand-held global positioning system (Garmin™ etrex). Seven two-hour forest walks were conducted at night to search for geckos and other nocturnal species.

Other members of the project biological team were encouraged to record reptiles or amphibians during their work, and the timber inventory team and 'parrot team' were requested to record any sightings of the Saint Lucia fer-de-lance, *Bothrops caribbaeus*, and Saint Lucia boa, *Boa constrictor orophias*.

2.3 Literature Review and Consultations

More than 115 reference materials (listed in Section 7) were used to gain a further understanding of the historical and present status and distribution. Many of these are in the author's private collection; others were downloaded from the Forestry Department website (www.slumaffe.org), and other online libraries. A number of forestry personnel and naturalists on the island were also consulted in 2008 and 2009.

3 Results

3.1 Standardized Field Survey

3.1.1 Data collected

In the one hour spent at each plot, the author examined approximately 100m^2 of forest and turned over between 30 and 80 rocks and other objects. 55 forest plots were surveyed (representing 55 hours: Figure 1), and 14 species and 1,009 individuals were recorded during the standardized surveys. Annexes I and II summarise the data gathered from these sites in chronological order.

3.1.2 Relative abundance and distribution

Based on the number of individuals observed, the abundance of each species can be ranked as follows, starting with the most numerous: *Anolis luciae* (n=507 individuals), *Eleutherodactylus johnstonei* (n=234), *Anolis wattsi* (n=183), *Sphaerodactylus microlepis* (n=32), *Cnemidophorus vanzoi* (n=10), *Gymnophthalmus pleii* (n=19), *Bufo marinus* (n=10), *Anolis extremus* (n=3) and *Leptotyphlops bruilei* (n=3), *Hemidactylus palaichthus* (n=2), *Hemidactylus mabouia* (n=2), and *Boa constrictor orophias* (n=1), *Scinax ruber* (n=1), and *Thecadactylus rapicaudus* (n=1). The following three species that occur in Saint Lucia were not observed during the standardized plot surveys: *Bothrops caribbaeus*, *Iguana iguana*, and *Liophis ornatus*.

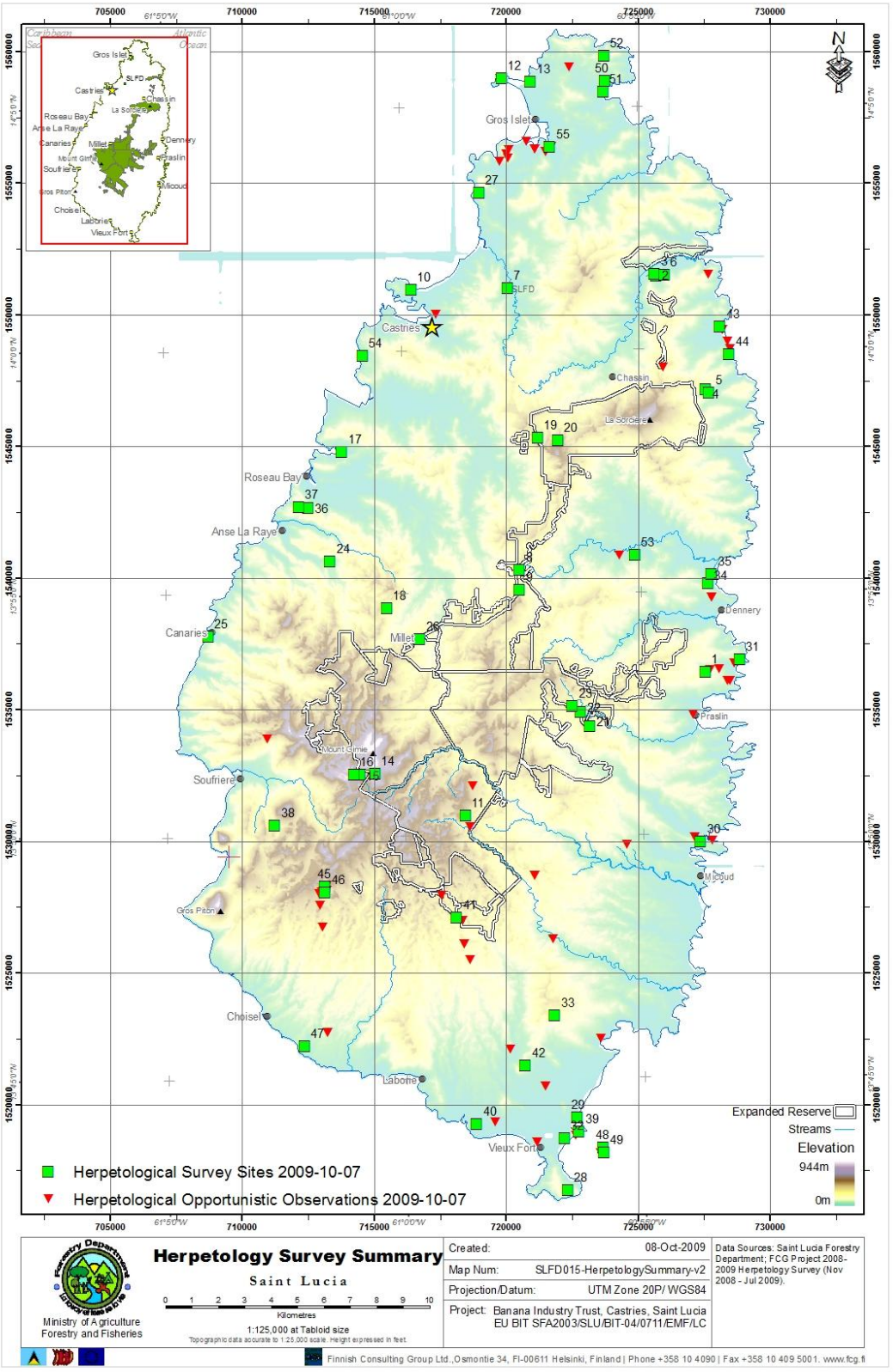
Some of the identified species were highly localized, occurring in only one or a few plots. The fifth most numerous species - the Saint Lucia whiptail lizard - for example, was observed only in one plot on Maria Major Island. It is therefore more meaningful to rank the species according to how many plots they were found in, as an index of how widely distributed they are: *Anolis luciae* (n=51 plots), *Eleutherodactylus johnstonei* (n=41), *Anolis wattsi* (n=14), *Bufo marinus* (n=7), *Sphaerodactylus microlepis* (n=6), *Gymnophthalmus pleii* (n=4), *Leptotyphlops bruilei* (n=2), *Hemidactylus mabouia*[3] (n=2), *Hemidactylus palaichthus* (n=1), and *Anolis extremus* (n=1), *Boa constrictor* (n=1), *Cnemidophorus vanzoi* (n=1), *Scinax ruber* (n=1) and *Thecadactylus rapicaudus* (n=1).

While such rankings should always be viewed with caution because species vary in detectability, the lizard *Anolis luciae* and frog *Eleutherodactylus johnstonei* stand out on both lists as being credibly the two most abundant and widespread reptiles and amphibians in Saint Lucia's forests. Three species that were not observed during this study - the Saint Lucia fer-de-lance, *Bothrops caribbaeus*; the Saint Lucia iguana, *Iguana cf iguana;* and the Saint Lucia racer, *Liophis ornatus* - on the other hand, may be inferred to be among the rarest or most highly localized.

For some of the most conspicuous and widespread species, these visual encounter survey data can be extrapolated to conservatively estimate their actual population density (utilizing the fact that the total area surveyed was approximately 4,900m^2 on the main island of Saint Lucia and 200m^2 on Maria Major). Estimated densities of the anole lizards are included in Section 4.2.4.

[3] It may be surprising to see the common house gecko or woodslave *Hemidactylus mabouia,* ranked among the least frequently observed species. This species typically inhabits buildings, however, and the survey plots were in forest. The only specimen found during the standardized surveys was in a secondary forest plot less than 50 metres from a school building in Rodney Bay.

Figure 1. Map of survey areas, showing standardized survey plots (squares, n=55) and additional, opportunistic records (triangles).



3.1.3 Herpetofaunal diversity among forest types

The diversity and relative abundance of species varied markedly among forest types (Figure 2, page 12).

The least diverse, and least densely populated plot was in **Elfin Shrubland**, where only two individuals of one species, *Eleutherodactylus johnstonei*, were detected. This finding was in line with Malhotra *et al.*'s (2007) observation (on Dominica) that Elfin Shrubland is too cool and wet for native reptiles.

In the **Lower Montane Rainforest** plots (n=10), only three species (*Anolis luciae*, *Anolis wattsi* and *Eleutherodactylus johnstonei*) were detected. Encounter rates in Lower Montane Rainforests (n=9) were significantly lower than in other forests from which enough plots were sampled to test: Semi-Evergreen Seasonal Forest (n=9) (Wilcoxon-Mann-Whitney U-test: U=11.5; p=0.016), Deciduous Seasonal Forest (n=22) (U=26.5; p=0.002), and Littoral Evergreen Forest (n=8) (U=7.5; p=0.004). This suggests that the overall density of reptiles and amphibians is relatively low in the rainforest. Perhaps surprisingly, the lower quality Lower Montane Rainforest plots (areas that had been planted with non-native trees and were close to settlements) had a greater abundance of animals, but this was largely due to incursions of the invasive *Anolis wattsi*.

With a total of five species recorded during plot surveys, the **Semi-Evergreen Seasonal Forests** were more diverse than the rainforest, and had a greater abundance of individuals. The mean encounter rate of reptiles and amphibians in high- medium- and low-quality Semi-Evergreen Seasonal Forests was just over 26 individuals per hour. In the lower quality forest, however, the invasive *Anolis wattsi* again accounted for a greater proportion of the animals seen. Eighty-two reptiles and amphibians were recorded in one plot near Anse La Raye - the highest count in this study - of which 72 were *Anolis wattsi*.

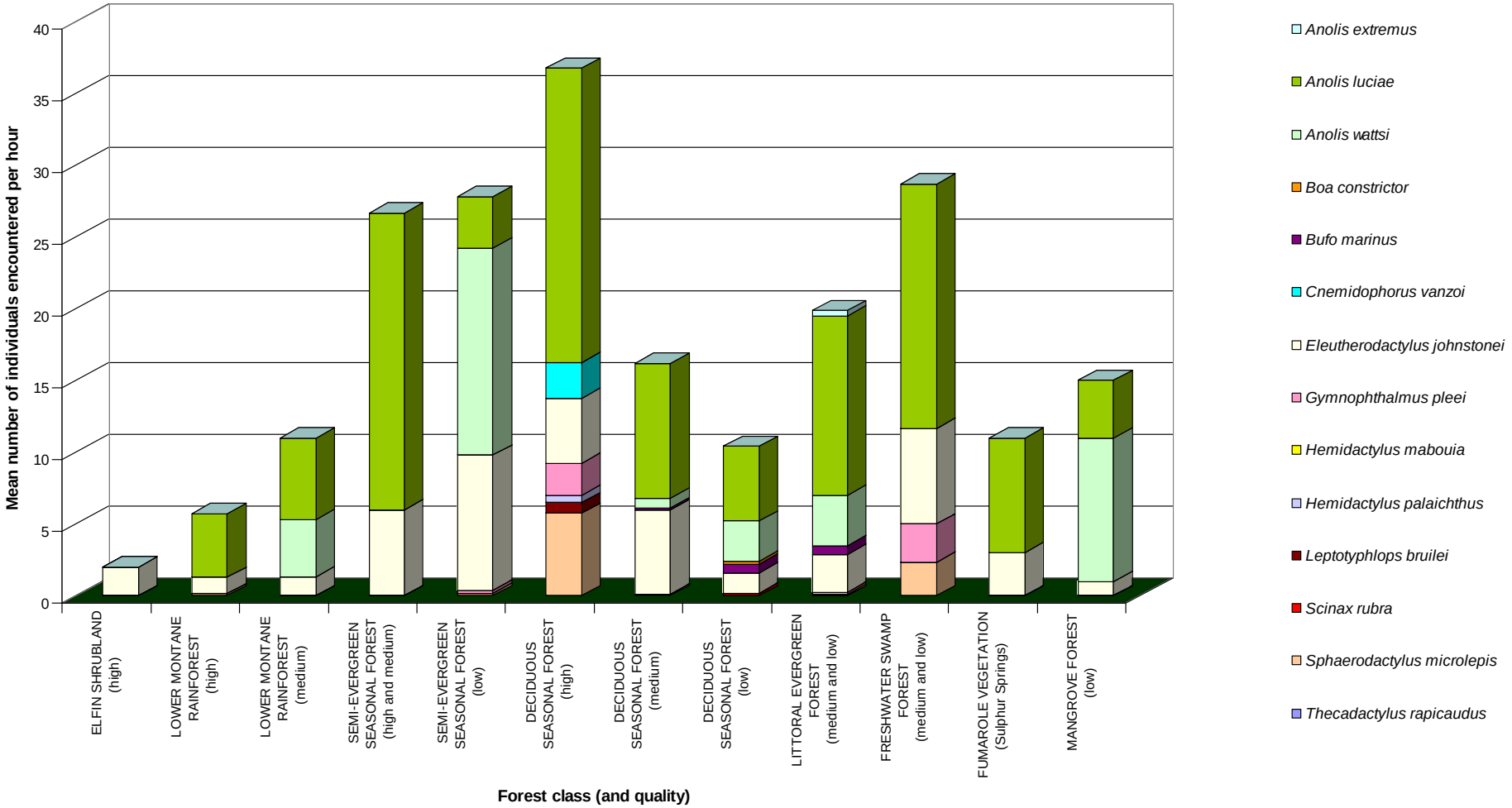
High-quality (mature and intact) **Deciduous Seasonal Forest** exhibited the greatest density of individuals, with a remarkably high mean encounter rate of 36.8 individuals per hour[4]. This was also found to be one of the two most species-rich forest types, with seven species detected, all of which are considered native to Saint Lucia. In the more degraded forms of Deciduous Seasonal Forest (medium and low), however, the density of herptiles was significantly lower (Kruskal-Wallis test: K=11.2, df=2, p=0.004). In the most heavily impacted (low-quality) form, more than one third of the fauna detected (34.6%) were alien invasive species (*Anolis wattsi*, *Bufo marinus* and *Scinax ruber*). In comparison with the high quality Deciduous Seasonal Forest plots, the relative abundance of *Anolis luciae* was approximately half in the medium quality group, and only one quarter in the low quality forest.

The three **Freshwater Swamp Forest** plots supported a very high density of reptiles and amphibians (mean encounter rate of 28.7 animals per hour), second only to the high quality Deciduous Seasonal Forest. Within-group variation was high, however, with one site in Grande Anse accounting for five native species and 56 individuals.

[4] The high quality Deciduous Seasonal Forest group included two plots from Maria Major, which should arguably be treated separately because they represent an offshore island free of rats, mongooses and other alien mammals. Even when these two anomalous plots are excluded, however, the high quality Deciduous Seasonal Forest plots had an impressive mean encounter rate of 35 individuals per hour.

Figure 2. Relative abundance of species in different forest classes.

Mean number of individuals recorded in plots in Elfin Shrubland (n=1); Lower Montane Rainforest (high quality, n=7); Lower Montane Rainforest (medium quality, n=3); Semi-Evergreen Seasonal Forest (high and medium quality, n=3); Semi-Evergreen Seasonal Forest (low quality, n=6); Deciduous Seasonal Forest (high quality, n=4); Deciduous Seasonal Forest (medium quality, n=11); Deciduous Seasonal Forest (low quality, n=7); Littoral Evergreen Forest (n=8); Freshwater Swamp Forest (n=3); Fumarole Vegetation (n=1); Mangrove (n=1).Class names follow Graveson (2009).



Of the rare forest classes, **Fumarole Vegetation**, by the Sulphur Springs, was represented by only one plot. Only two species were recorded here – the ubiquitous Saint Lucia anole *Anolis luciae*, and Johnstone's whistling frog *Eleutherodactylus johnstonei* – and their densities were low, as would be expected in such a hostile, acidic environment.

Only one **Mangrove Forest** plot was assessed, in Marigot Bay. This had a moderate diversity and abundance of reptiles and amphibians, but two-thirds of the specimens were Watts' anoles (*Anolis wattsi*), living on outbuildings and walkways. This plot was therefore ranked as low quality and probably atypical of a natural mangrove forest.

3.1.4 Comparisons between the forest herpetofauna of Saint Lucia with other islands

Several surveys in other parts of the Lesser Antilles have assessed the relative abundance of reptiles and amphibians using similar techniques.

The most directly comparable was a herpetological survey of Montserrat in 1995 by Fauna & Flora International (Daltry 1995a,b). Although this study was more comprehensive - involving a three-person team spending seven hours surveying every site (including three hours after dark), the data are comparable because they were presented as the number of individuals seen per hour and grouped according to habitat type (forest type). Before the volcanic eruptions in 1995, Montserrat was a lushly forested with a similar variety of forest types and many species in common with Saint Lucia. Montserrat's most notable differences are the lack of alien invasive mongooses and opossums, and the absence of large native snakes.

Figure 3 to Figure 6 compare the encounter rates per hour for the same species, or their closest analogues, in each major forest type. For Montserrat, I have gone back to the raw field data and extracted only records made during daylight (the night records contained a greater number of amphibian and gecko sightings).

What is most striking about these figures is the high relative abundance of **tree lizards (genus *Anolis*)** on Saint Lucia, outnumbering Montserrat's *Anolis lividus* by more than 4:1 in all forest classes. I infer from this difference that Montserrat's anole population is at a surprisingly low density, rather than Saint Lucia's anole populations being abnormally dense. Although the present study was not designed to produce accurate density estimates, the fact that these lizards are especially easy to see, and the fact that I surveyed approximately 100m^2 per hour, would suggest a mean density of at least 922/ha for *Anolis luciae*, and 332/ha for *Anolis wattsi* in Saint Lucia forests, with recorded peaks of 3,900/ha for *Anolis luciae* in plot 48 (Maria Major) and 7,200/ha for *A. wattsi* in plot 37 (Anse La Raye).

These estimates might sound high, but lizards of the genus *Anolis* are well known to be capable of very high densities; the record being 23,600 *Anolis stratulus* per hectare on Puerto Rico (Reagan, 1992)! Other published densities of Caribbean anoles include *A. cristatellus* (1,000-1,100/ha on Guana Island, British Virgin Islands: Rodda *et al.* 2001), *A. pulchellus* (50/ha on Guana Island: Rodda *et al.* 2001), *A. stratulus* (13,400-52,800/ha on Guana Island: Rodda *et al.* 2001), *A wattsi* (4,780-9,950/ha on Saint Eustatius: Henderson & Powell, 1999). My tentative estimates for Saint Lucia's *Anolis luciae* and *A wattsi* and therefore well within the expected ranges for species of their size. Murton (2008) used a more thorough method of distance sampling to measure *Anolis luciae* densities on the offshore islands, and calculate their densities to be 76/ha (Praslin island), 331/ha (Rat island) and 2,390/ha (Maria Major). My data from Maria Major (plots 48 and 49) give a similar estimated mean density of 2,700/ha for this island.

Figure 3. Relative abundance of reptiles and amphibians in Lower Montane Rainforest on Saint Lucia and Montserrat.

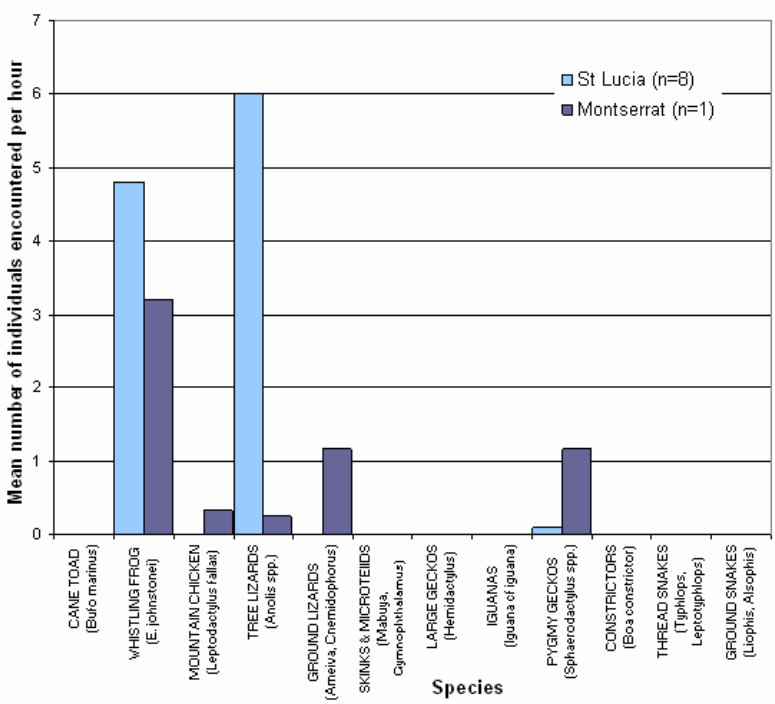


Figure 4. Relative abundance of reptiles and amphibians in Semi-Evergreen Seasonal Forest on Saint Lucia and Montserrat.

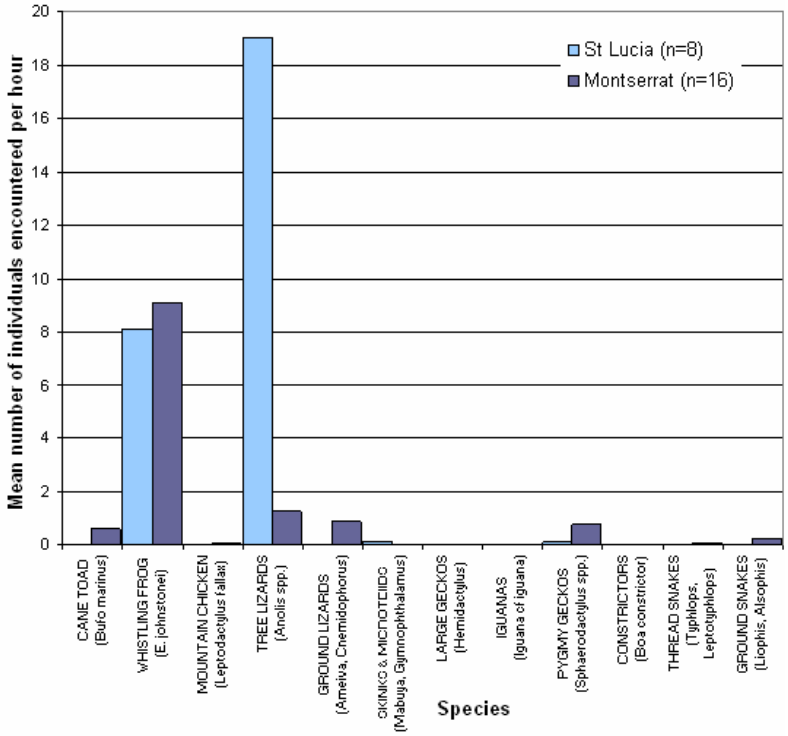


Figure 5. Relative abundance of reptiles and amphibians in Deciduous Seasonal Forest on Saint Lucia and Montserrat.

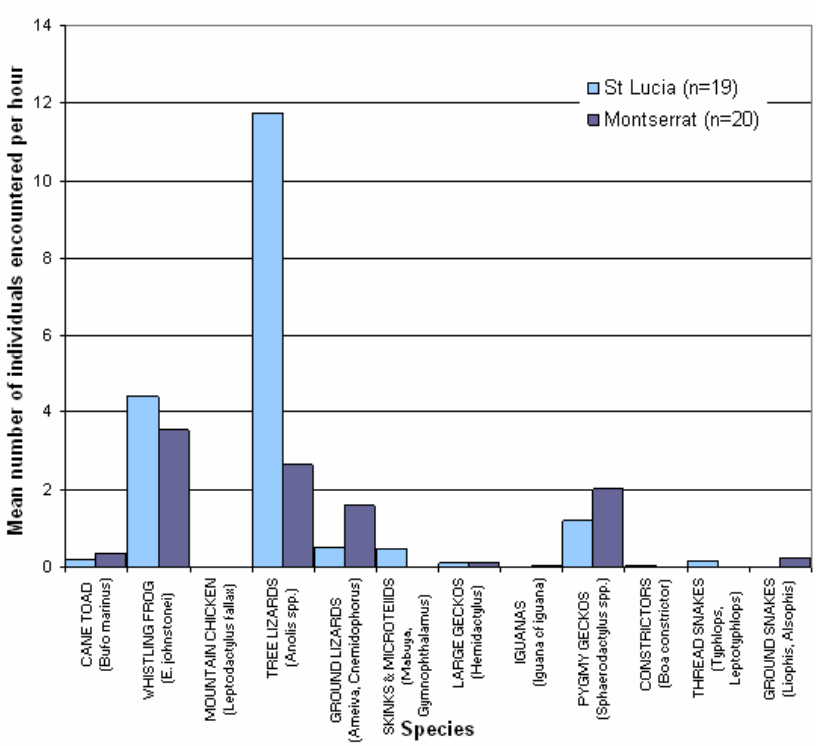
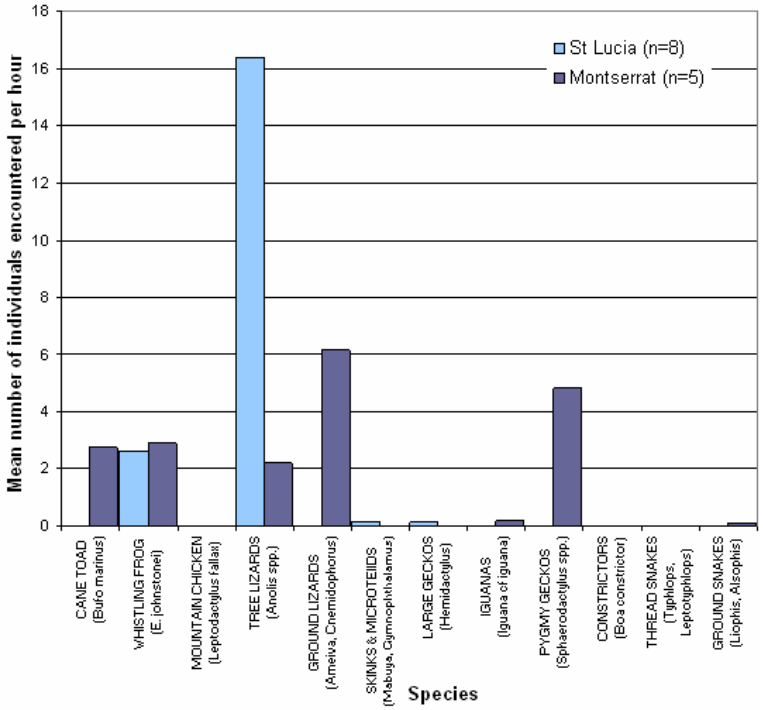


Figure 6. Relative abundance of reptiles and amphibians in Littoral Evergreen Forest on Saint Lucia and Montserrat.



The ubiquitous **Johnstone's whistling frog, *Eleutherodactylus johnstonei,*** appeared to be almost equally abundant on Saint Lucia (where is probably native) and Montserrat (where it was probably introduced), thriving in a wide range of habitats on both islands. The highest published density of non-aggregated frogs is 20,570/ha for the closely related *Eleutherodactylus coqui* in Puerto Rico (Stewart & Rand 1991), but I have been unable to find a published density estimate for *E. johnstonei*. Their density in some parts of Saint Lucia probably numbers in the hundreds if not thousands per hectare.

Skinks (*Mabuya mabouya* on Saint Lucia, *M. sloanii* on Montserrat) and the skink-like **microteiid lizards** (*Gymnophthalmus pleii* on Saint Lucia only) are relatively difficult to find on both islands. These data suggest a genuine scarcity of these animals, especially *Mabuya*, which are very active lizards and should easily be seen above ground in fine weather (Malhotra & Thorpe, 1999). On Dominica, Bullock & Evans (1990) recorded *Mabuya mabouya* attaining densities of 751/ha, but no sightings of *Mabuya mabouya* were made during this study, which supports Boulenger's (1930) opinion that this species is extinct on Saint Lucia. The rough-scaled worm lizard, *Gymnophthalmus pleii*, was seen in several plots on Saint Lucia, but its current distribution is very patchy. Using distance sampling, Murton (2008) estimated the density of *G. pleii* to be only 65.5/ha on Praslin island. In contrast, the closely-related *G. underwoodi* reaches densities in excess of 5,000/ha on mongoose-free islands off Antigua (unpublished data).

The number of sighting of **thread snakes** or worm snakes (*Leptotyphlops bruilei* on Saint Lucia, *Typhlops monastus* on Montserrat) was also low on both islands. While this might suggest these snakes are very rare, the fact that these animals live underground means that the specimens found under rocks may represent only the tip of the iceberg. With the possible exception of Maria Major, however, it is doubtful whether the density of Saint Lucia's *Leptotyphlops bruilei* comes anywhere close to the recorded densities of *Typhlops richardi* of 300-580/ha in the British Virgin Islands (Lazell, 1991; Rodda *et al.* 2001).

No **constrictors** occur on Montserrat, and only one boa (*Boa constrictor*) was observed during the 55 hours of standardized plot surveys on Saint Lucia, equivalent to 2.08 per hectare on the main island. This rough estimate is at the lower range of published population density estimates for the same species on other islands (e.g. between 0.5 and 16.4/ha on islands off Belize: Boback, 2005). My present surveys could have missed individuals high in the forest canopy, however.

For almost other taxa, Saint Lucia compares very poorly with Montserrat. **Ground lizards** (*Cnemidophorus vanzoi* on Saint Lucia, and its analogue *Ameiva pluvionotata* on Montserrat) are missing from mainland Saint Lucia, leaving a conspicuous gap in the forest ecosystem. The high density of *Anolis* lizards in Saint Lucia's forests may profit from the absence of ground lizards and hence reduced competition for invertebrates or even reduced predation on small *Anolis*. Using distance sampling in Saint Lucia, Young *et al.* (2006) and Murton (2008) gave population densities of *Cnemidophorus vanzoi* of 12/ha on Rat Island (newly reintroduced), 164.9/ha on Praslin island and 194.6/ha on Maria Major island.

No **iguanas** were detected in any of the forest plots on Saint Lucia (n= 55), but they were detected in 11.6% of the Montserratian sites (n=43), including Semi-Evergreen Seasonal Forest, Deciduous Seasonal Forest and Littoral Evergreen Forest. The overall mean encounter rate in Montserrat was 0.05 iguanas per hour. This difference between the two islands appears to be real - Saint Lucia's iguanas are known to be highly localized and now scarce (Daltry 2000; Morton, 2007). The 1995 data from Montserrat may give an insight into how abundant and widespread Saint Lucia's iguanas would have been in the past.

Pygmy geckos are present on both islands (*Sphaerodactylus microlepis* on Saint Lucia, *S. fantasticus* on Montserrat), but were significantly more widespread and attained much higher densities on Montserrat. Across all surveyed sites on Saint Lucia (n=55) and Montserrat (n=43), the density of pygmy geckos was three times higher on Montserrat. This appears to indicate a real difference in densities, not one that can be explained by differences in behaviour On other islands, species for which densities have been published include *Sphaerodactylus sputator* (801 per hectare on Saint Eustatius: Hensley *et al.* 2004); *S. sabanus* (188/ha: Hensley *et al.* 2004), *S. parvus* (up to 52,000/ha on Anguilla: Nava *et al.* 2001) and *S. macrolepis* (up to

67,000/ha on Guana Island, British Virgin Islands: Rodda *et al.* 2001). Based on my experience of working on many of these islands, I consider the density of *Sphaerodactylus microlepis* on Saint Lucia to be unnaturally low, with the possible exception of relatively small patches of high quality deciduous forest on Grande Anse and Maria Major where these pygmy geckos were easy to find.

Ground snakes of the family Colubridae are now absent from mainland Saint Lucia. A relic population of the Saint Lucia racer *Liophis ornatus* has survived on Maria Major, but no individuals were seen during either of my two surveys of the island. The racer's closest analogue on Montserrat, the Lesser Antillean racer *Alsophis antillensis,* was frequently seen during the Montserrat study, with a mean encounter rate of 0.20 individuals per hour. Very high densities of racers have been recorded on other mongoose-free islands, including *Liophis* [=*Alsophis*] *portoricensis* (50/ha on Guana Island: Rodda *et al.* 2001) and *Alsophis antiguae* (5-15/ha on Great Bird Island, Antigua: Daltry *et al.* 2001). There are not enough data from the present or previous studies to estimate the density or total number of *Liophis ornatus* on Maria Major.

As indicated above, Bullock & Evans (1990) survey of Dominica's lizards tended to find higher population densities than my study found in Saint Lucia. Like this study, however, they demonstrated significantly lower densities in rain forests, and higher densities in coastal woodlands (i.e., Deciduous Seasonal Forests). The latter had an unprecedented combined lizard biomass of 44.7kg/ha.

While Saint Lucia has compared poorly with mongoose-free Montserrat, Dominica and Guana Island (BVI) in terms of the density of many of its species, Germano *et al.* (2003) reported lower encounter rates on Grenada, which, like Saint Lucia, has mongooses. Apart from having a high abundance of *Eleutherodactylus* and *Anolis* (mean encounter rates of *A. aeneus* and *A. richardii* exceeded 20 per hour during daytime searches in a variety of forest types on Grenada, cf 12.5 *A. luciae* and *A. wattsi* per hour on Saint Lucia), the Grenada study found very few ground lizards, boas, large geckos or microteiid lizards (only one *Ameiva ameiva*, one *Thecadactylus rapicaudus*, one *Corallus,* and one *Bachia heteropa* were sighted), and no *Sphaerodactylus, Mabuya, Iguana, Clelia, Liophis, Mastigodryas* or *Typhlops,* during more than 15 hours of intensive searches during the day and 15 hours at night.

To conclude, while there are some differences between the islands in terms of species composition, these comparisons indicate that the herpetofauna populations on Saint Lucia are severely depleted in comparison to Montserrat, Dominica and other mongoose-free islands in the Lesser Antilles, but still perceptibly healthier than Grenada.

3.1.5 The interaction between native and non-native anoles

As discussed above, the native **Saint Lucia anole, *Anolis luciae,*** is the most abundant and widespread reptile on Saint Lucia. It was recorded in 51 of the 55 plots and had a high mean encounter rate of 9.22 individuals per hour across all forest classes. The smaller, non-native **Watts' anole, *Anolis wattsi,*** was much less widespread (14 out of 55 plots), but its range appears to be increasing rapidly (see Section 5.9). The fact this species has now reached Vieux Fort shows a significant increase in range since the 1960s[5] and even since the mid 1990s, when this species was reported to be still confined to the Northwest of Saint Lucia, around Castries (Giannasi *et al*. 1997).

The survey data showed a weak inverse correlation (r =-0.166) between the relative abundance of *A. luciae* and *A. wattsi*. It was striking that the forest site with the greatest number of *A. wattsi* sightings (72 individuals, plot

[5] Lazell (1972) remarked: "one might expect the small rupicolous [living in or among rocks] *A. wattsi* to do well on St. Lucia in sympatry with *A. luciae*; it does not, however, seem to spread from the original collection site: the Botanical Garden in Castries." Gorman (1976) wrote: "In 1965 and 1966 I noted *A. wattsi* in the Castries Botanical Garden, but I did not see it in subsequent visits in 1972 and 1973. A. S. Rand and A. R. Kiester (personal communication) did find *A. wattsi* in one set of hedges along a deep damp shady ravine in Castries just below the Villa Hotel, in November 1970."

37, Semi-Evergreen Seasonal Forest, Anse La Raye) had no *A. luciae*, despite appearing to provide the sort of habitat that *A. luciae* would normally thrive in. Conversely, sites with very high densities of *A. luciae* (more than 30 individuals seen per hour in plots 24, 44, 48) had no *A. wattsi*. Although this pattern is not statistically significant, it corroborates my impression from travelling around Saint Lucia that wherever *A. wattsi* has gained a foothold, *A. luciae* is less abundant, irrespective of forest class.

It may also be important that the number of sightings of *A. wattsi* were strongly positively correlated with the proximity of the plot to man-made features such as walls, buildings and culverts (Wilcoxon-Mann-Whitney test, z=1.957; p=<0.026). *Anolis luciae*, on the other hand, shows neither a positive nor negative association with man-made features (Wilcoxon-Mann-Whitney test, z=-0.414; p=0.341).

These findings suggest that *A. wattsi* is displacing the larger *A. luciae* from disturbed forest areas, especially where buildings have been constructed (but not necessarily still occupied). The mechanism for such displacement is unclear: *Anolis wattsi* is smaller, but could it be competing for prey, or even preying on juvenile *A. luciae*? *Anolis wattsi* breed very rapidly and may simply be quicker at filling vacant territories: and the walls of buildings may provide its optimal habitat for growth and survival. In the northern Lesser Antilles, *A. wattsi* has been observed winning territorial battles with the much larger *A. bimaculatus* (Schwartz & Henderson, 1991). This small, invasive lizard is still spreading across Saint Lucia, but it remains to be seen whether it will confine itself to disturbed areas, or penetrate deeper into more intact forests. White & Hailey (2006) observed that the introduced *A. wattsi* population on Trinidad naturally enlarge their range at the rate of 100 metres per year, but occasionally 'jump' many kilometres, presumably when carried via human transport of plants or building materials.

The other introduced anole, the **Barbadian anole, *Anolis extremus,*** appeared in only of the 55 standard forest plots (plot 10, near Vigie airport). This large species has been observed to chase *A. luciae*, but it currently appears too highly localized to pose any serious threat to the island's native anole population. Giannasi *et al.* (1997) used detailed morphological measurements to investigate whether *A. extremus* was hybridizing with *A. luciae*, and found no evidence of this occurring.

3.2 Opportunistic Field Records

While travelling to survey plots, or accompanying other members of the project team on field surveys, the author recorded more than 200 additional sightings of reptiles and amphibians. While the majority were anole lizards, whistling frogs and other species that were recorded in the standardized survey, they included records of Saint Lucia fer-de-lance, *Bothrops caribbaeus*, and nesting green turtles *Chelonia mydas*.

Other members of the project team - mammalogist Dr Frank Clarke, botanist Roger Graveson and his assistant Melvin Smith - kindly provided some records and photographs of reptiles and amphibians they encountered in 2009. In addition, the project entomological team accidentally caught and killed a small number of small reptiles and amphibians in their insect traps. These specimens were preserved in ethanol and used to verify the field identifications of the *Anolis*, *Gymnophthalmus*, *Sphaerodactylus* and *Eleutherodactylus*. Their locality data were added to the survey database.

3.3 Literature Review and Consultations

One of the most striking things about the existing, published literature on the herpetofauna of Saint Lucia is how little there is. Most of the available literature focuses on taxonomy, and there have been very few in-depth studies of the ecology, population biology, status or distribution of these reptiles and amphibians. The most notable exception being the work carried out by the Durrell Wildlife Conservation Trust and Saint Lucia Forestry Department on the Saint Lucia whiptail *Cnemidophorus vanzoi* (see Section 5.10) during the past 15 years.

For most species, the best available published distribution maps are in Schwartz & Henderson (1991), which show the locations where museum specimens have been collected. Even these maps are rather crude with only a handful of locations marked for most species. On a more local scale, detailed distribution maps have been prepared for a variety of species of reptiles and amphibians in Northeast Saint Lucia by the Durrell Wildlife Conservation Trust and Saint Lucia Forestry Department, based on intensive surveys (unpublished data). These data have been incorporated into the species distribution maps shown in Section 5.

Despite its small size, the available literature for Saint Lucia show a surprisingly large number of contradictions and confusion, especially concerning which species are truly native to the island, versus those that have been introduced more recently by humans. Some of these cases are discussed further in Section 4.1.

More than half of the species that are currently found on Saint Lucia also occur in other countries. The discussion below will therefore draw on observations from overseas, where applicable, to examine the biology, impacts and needs of these animals. All of the written references used in this report are listed in Section 7.

4 Discussion

4.1 Who are the true Saint Lucians?

Knowing which species truly belong to Saint Lucia is very important. For the country to uphold its responsibilities to the Convention on Biological Diversity, it must place greater priority on conserving species that reached the island by natural means and have been present for thousands if not millions of years. True native species tend to be better adapted to their ecosystem, and the other native species will, in turn, be adapted to live with them. Non-native species (those deliberately or accidentally transported to the island by humans), on the other hand, can threaten to destabilize the natural ecosystem and may need to be controlled and even eradicated.

There are doubts over the origin of some of the species recorded on Saint Lucia. Table 2 shows Saint Lucia's herpetofauna into four categories: Native, Probably Native, Non-Native and Probably Non-Native. In this report, the conservation management recommendations will tend to focus on maintaining and conserving the first two groups, while treating the second pair as neutral or undesirable. Some of the decisions may puzzle or surprise some readers and deserve an explanation:-

Saint Lucia fer-de-lance *Bothrops caribbaeus* – It is often claimed that fer-de-lances were introduced to Saint Lucia to control runaway slaves (without specifying where the snakes had come from), or that Carib indians brought the snakes as a form of biological warfare to gain control of the island from resident Arawaks (Dowling, 1965). In fact, the Saint Lucia fer-de-lance occurs nowhere else in the world. Genetic studies have proved this fer-de-lance evolved on Saint Lucia during the late Miocene or early Pliocene, between 4.2 and 8.9 million years ago (Wüster *et al.* 2002). This snake is indisputably a Saint Lucian endemic. It is also the direct ancestor or sister-species of the Martinique fer-de-lance, *Bothrops lanceolatus* (Wüster *et al.* 2002).

Rough-scaled worm lizard, *Gymnophthalmus pleii* – Malhotra & Thorpe (1999) record this lizard as occurring in Guadeloupe, Dominica, Martinique and Saint Lucia, and inferred that this species is native to all four islands. The populations on the main island of Saint Lucia and Maria Major are recognised as distinct, endemic subspecies: *G. p. luetkeni* and *G. p. nesydrion* (a third subspecies, *G. p. pleii*, is confined to Martinique). Their physical differences suggest that these populations were isolated on Saint Lucia long before humans arrived. (Note this is a different species to *G. underwoodi* from Guyana, which is highly invasive and has become established on many islands in the Caribbean in recent years, including Martinique, Saint Vincent, Antigua and Guadeloupe, but not, to the best of my knowledge, Saint Lucia).

The whistling frogs *Eleutherodactylus johnstonei* and *E. martinicensis* – These frogs are similar in appearance, easily confused with one another, and very effective colonizers. Censky & Kaiser (1999) considered that *E johnstonei* and *E. martinicensis* are native to Saint Lucia and Martinique respectively, and introduced everywhere else. Lescure (2000) proposed the Antigua and Barbuda Bank as the native place for *E. johnstonei* (see also Kaiser, 1997), however, and Saint Lucia, Martinique and Dominica for *E. martinicensis*. Consequently, it is unclear whether the abundant population of *E. johnstonei* on Saint Lucia originated here naturally, or is an alien invasive species that has replaced *E. martinicensis* (see Breuil, 1997a,b). No *E. martinicensis* were seen or heard during the present survey, and it is likely that only *E. johnstonei* is present. This report follows Censky & Kaiser (1999) in treating *E. johnstonei* as probably native (and endemic), and *E. martinicensis* as probably non-native, with the caveat that future genetic or sub-fossil research may prove otherwise.

Mountain chicken, *Leptodactylus fallax* – The mountain chicken is considered native to Dominica, Montserrat, Guadeloupe, Martinique, and Saint Kitts and there are unconfirmed historical records from Antigua and Saint Lucia (Fa *et al.* 2004). Referring to Dominica, Saint Kitts, Guadeloupe and Saint Lucia, Barbour

(1937) asserted "*it has been exterminated by the mongoose*" The origins of this large frog are uncertain, however, because they may well have been moved around the Lesser Antilles by Amerindians for food. (The same might of course be inferred of the boa and iguana, but Saint Lucia's iguanas and boas are morphologically distinct from other populations in the West Indies, which suggests they have been isolated on Saint Lucia for millennia, long before humans could have introduced them). A genetics study by Hedges (1996) demonstrated this species has been in the Lesser Antilles for between three and seven million years.

Table 2. Classifying Saint Lucia herpetofauna into native and non-native (alien) species

	Scientific Name	*Common Name (English)*	*Present or Extinct on Saint Lucia*
Native	***Caretta caretta***	Loggerhead	Present
	Chelonia mydas	Green turtle	Present
	Dermochelys coriacea	Leatherback turtle	Present
	Eretmochelys imbricate	Hawksbill turtle	Present
	Anolis luciae	Saint Lucia anole	Present
	Cnemidophorus vanzoi	Saint Lucia whiptail	Present
	Gymnophthalmus pleii	Rough-scaled worm lizard	Present
	Iguana cf iguana	Saint Lucia iguana	Present
	Mabuya mabouya	Southern Antillean skink	Extinct
	Sphaerodactylus microlepis	Saint Lucia pygmy gecko	Present
	Boa constrictor	Boa constrictor	Present
	Bothrops caribbaeus	Saint Lucia fer-de-lance	Present
	Clelia errabunda	Saint Lucia cribo	Extinct
	Leptotyphlops bruilei	Saint Lucia thread snake	Present
	Liophis ornatus	Saint Lucia racer	Present
Probably Native	***Eleutherodactylus johnstonei***	Johnstone's whistling frog	Present
	Leptodactylus fallax	Mountain chicken (see Barbour 1937)	Extinct
	Hemidactylus palaichthus	Antilles leaf-toed gecko	Present
	Thecadactylus rapicaudus	Forest gecko	Present
Probably Non Native	***Eleutherodactylus martinicensis***	Martinique whistling frog (see Hedges *et al.*, 2004)	Extinct
	Sphaerodactylus elegantulus	Antiguan pygmy gecko (Barbour, 1937)	Extinct
	Sphaerodactylus vincenti	Central Lesser Antillean pygmy gecko (see Schwartz, 1965a)	Extinct
	Hemidactylus mabouia	House gecko (present before the 1930s: Barbour, 1937)	Present
Non Native	***Bufo marinus***	Cane toad (introduced c. 1870s)	Present
	Scinax ruber	Red-snouted tree frog (introduced c. 1891: Barbour, 1937)	Present
	Anolis extremus	Barbados anole [introduced c. 1956: Gorman, 1976)	Present
	Anolis wattsi	Watts' anole (introduced to Castries Botanic Gardens c. 1962: Lazell 1972)	Present
	Iguana iguana	Green iguana (introduced c. 2004: M. Morton pers. comm.)	Present

Forest gecko, *Thecadactylus rapicaudus* – There is some doubt as to how the forest gecko reached the Lesser Antilles. According to Hedges (1996), the Lesser Antillean populations of this species are morphologically

very similar to the continental populations, which suggests the species colonized the Lesser Antilles relatively recently (probably accidentally introduced by humans). Genetic studies, on the other hand, have revealed that the Lesser Antilles forest geckos belong to a distinct, monophyletic group (Kronauer *et al.* 2005). Their unique genetics suggest that *T. rapicaudus* reached the Lesser Antilles long before humans, and this species is therefore probably native to Saint Lucia.

Antilles Leaf-toed Gecko, *Hemidactylus palaichthus* – First described in 1969, the presence of this species in Saint Lucia is rather puzzling. It is common and widespread in Central America and occurs on Trinidad and Tobago (Schwartz & Henderson 1991), but in the Antilles, it is known to occur only on Saint Lucia. This anomaly could indicate this species was introduced, possibly accidentally transported by Amerindians or more recent travellers from Latin America. On Saint Lucia, however, its pattern of distribution is unlike that of other known invasive species, which tend to be highly commensal (thriving in urban, agricultural or other disturbed areas) and whose ranges fan out from major ports and other obvious entry points. Within Saint Lucia, the main stronghold of this lizard is Maria Major, which is otherwise remarkably free of alien species. With no genetic, sub-fossil or other evidence to the contrary, it seems safe to assume that this species has been in Saint Lucia for a very long time. It could feasibly have reached Saint Lucia on natural rafts (Censky *et al.* 1998; Vidal *et al.* 2008).

House gecko, *Hemidactylus mabouia* – Most authors considered that this gecko was introduced in the New World from West Africa during the Triangular Trade (Lescure, 1983; Malhotra & Thorpe, 1999). Kluge (1969) suggested this species reached the Caribbean by natural means long ago, however, based on their distribution and differences between the Old World and New World geckos. Whether this species is native or non-native, however, will not carry much weight in the forest management recommendations (Chapter 6, Management Priorities for Forest Reptiles and Amphibians) because this is a highly urban reptile.

Antiguan pygmy gecko – *Sphaerodactylus elegantulus* – Recorded by Barbour (1937) on "Saint Lucia, perhaps introduced". Although King (1962) never saw the specimen(s) that Barbour examined, he assumed this was a mistake on Barbour's part, and that he had misidentified *S. vincenti* (see below). Other authors, including Schwartz & Henderson (1991) have accepted King's assumption. Barbour was an expert taxonomist - and was in fact the first person to formally describe *S. elegantulus* - so his record should not be dismissed so lightly. His comment "probably introduced" tells us that he was fully aware this was a surprising record, outside of the species' normal range in Antigua and Barbuda. It *is* entirely possible that *S. elegantulus* was introduced from Antigua to Saint Lucia (bearing in mind both Saint Lucia and Antigua were under common British rule for many years), but the species may not have persisted for long. There have been no further records of this species since the early 20th century.

Central Lesser Antillean pygmy gecko, *Sphaerodactylus vincenti diamesus* – Parker (1933) appears to have been the first to record *Sphaerodactylus vincenti*, from a single individual on Saint Lucia. Schwartz (1965a) later described this as an endemic subspecies, closely allied to a subspecies he described on southern Martinique. Only six individuals were found, all on Vigie beach. While Albert Schwartz was a reputable taxonomist, it is questionable whether this species or subspecies is genuinely native to Saint Lucia, because there are no records of it occurring outside of Vigie. Having an international airport and being close to the ports of Castries, Vigie is an obvious hub for invasions by alien species. (Vigie coast was included in survey plot no. 10 and, while no *Sphaerodactylus vincenti* were seen, this plot had the highest number of alien invasive species of any site!). This is more likely an introduction that did not penetrate very far into the island. Whether this species is native or not, however, is a moot point given that it has not been recorded on Saint Lucia since the 1960s.

4.2 Which species are the highest conservation priorities?

4.2.1 Prioritizing species

Species can be identified as conservation priorities according to the criteria shown in Table 3. The following sections will attempt to apply these criteria in turn to Saint Lucia's herpetofauna, with special attention to the native species. See: Section 4.2.2, for reptiles and amphibians currently recognised as globally threatened (criterion 1); Section 4.2.3, for species endemic to a restricted area (criterion 2i); Section 4.2.4 for species perceived to be scarce and/or declining (criteria 2ii and 2iii); Section 4.2.5, for species prone to hybridization with introduced species (criterion 2iv); Section 4.2.6, for species of economic or subsistence use (criterion 3); Section 4.2.7, for species of cultural significance (criterion 4); and Section 4.2.8, for species of ecological importance (criterion 5).

Table 3. Criteria for prioritizing species for conservation

(Modified from Appleton & Daltry, in prep.)

	Justification
1	Native species and subspecies currently listed as globally threatened with extinction by IUCN (2009)
2	Native species and subspecies that are nationally threatened with extinction:
	i Endemic to a restricted area
	ii Scarce
	iii Declining in population size or distribution range
	vi At risk of hybridization with introduced species
3	Species of actual or potential economic or subsistence use
4	Species of cultural significance (including species that can serve as flagships for conservation)
5	Indigenous species that have a ecological keystone role (i.e. help to create or maintain a habitat)

Section 4.2.9 will then rank the native species in order of conservation priority, taking all of these criteria into account. From a conservation standpoint, species that meet criteria 1 and 2 are the most critical, however, because these species could potentially disappear without good management.

4.2.2 Species already recognised as globally threatened

Table 4 shows the current conservation threat status of Saint Lucia's herpetofauna, according to IUCN (2009). Only three species are currently recognised as **CRITICALLY ENDANGERED**: the hawksbill turtle, leatherback turtle and the mountain chicken (which is extinct on Saint Lucia). This is the highest category of threat and indicates that the species is facing an extremely high risk of extinction in the wild. Three species are classified as **ENDANGERED**: the loggerhead turtle, green turtle and, importantly, the Saint Lucia racer. The Endangered classification denotes species that are at very high risk of extinction. Only one species, the Saint Lucia whiptail, is **VULNERABLE**, which signifies is at high risk of extinction in the wild, albeit less imminently than for the previous categories.

What is most striking about Table 4 is the large number of reptiles that are Not Evaluated. These are species that have not yet been formally evaluated against the IUCN categories of threat (2001) to determine which category they belong to.

It is a common mistake to assume that any species not on the IUCN red list is not threatened with extinction. Apart from birds, amphibians and mammals, for which a concerted effort has been made to evaluate almost every known species, few other major taxonomic groups have been thoroughly assessed yet. As IUCN (2001)

warned, "*Listing in the categories of Not Evaluated and Data Deficient indicates that no assessment of extinction risk has been made…Until such time as an assessment is made, taxa listed in these categories should not be treated as if they were non-threatened. It may be appropriate (especially for Data Deficient forms) to give them the same degree of attention as threatened taxa, at least until their status can be assessed*."

Table 4. IUCN (2009) Red List status of Saint Lucia's reptiles and amphibians

Shaded boxes indicate species considered non-native or probably non-native: see Table 2)

	Scientific Name	*Common Name (English)*	*IUCN (2009) category of threat*
1	***Bufo marinus (as Rhinella marina)***	Cane toad	Not Threatened: Least Concern
2	***Eleutherodactylus johnstonei***	Johnstone's whistling frog	Not Threatened: Least Concern
3	***Eleutherodactylus martinicensis***	Martinique whistling frog	Near Threatened
4	***Scinax ruber***	Red-snouted tree frog	Not Threatened: Least Concern
5	***Leptodactylus fallax***	Mountain chicken	Globally Threatened: **CRITICALLY ENDANGERED**
6	***Caretta caretta***	Loggerhead	Globally Threatened: **ENDANGERED**
7	***Chelonia mydas***	Green turtle	Globally Threatened: **ENDANGERED**
8	***Dermochelys coriacea***	Leatherback turtle	Globally Threatened: **CRITICALLY ENDANGERED**
9	***Eretmochelys imbricata***	Hawksbill turtle	Globally Threatened: **CRITICALLY ENDANGERED**
10	***Anolis extremus***	Barbados anole	Not Evaluated
11	***Anolis luciae***	Saint Lucia anole	Not Evaluated
12	***Anolis wattsi wattsi***	Watts' anole	Not Evaluated
13	***Cnemidophorus vanzoi***	Saint Lucia whiptail	Globally Threatened: **VULNERABLE**
14	***Gymnophthalmus pleii***	Rough-scaled worm lizard	Not Evaluated
15	***Hemidactylus mabouia***	House gecko	Not Evaluated
16	***Hemidactylus palaichthus***	Antilles leaf-toed gecko	Not Evaluated
17	***Iguana cf iguana***	Saint Lucia iguana	Not Evaluated
18	***Iguana iguana***	Green iguana	Not Evaluated
19	***Mabuya mabouya***	Southern Antillean skink	Not Evaluated
20	***Sphaerodactylus microlepis***	Saint Lucia pygmy gecko	Not Evaluated
21	***Sphaerodactylus vincenti***	Central Lesser Antillean pygmy gecko	Not Evaluated
22	***Thecadactylus rapicaudus***	Forest gecko	Not Evaluated
23	***Boa constrictor orophias***	Saint Lucia boa	Not Evaluated
24	***Bothrops caribbaeus***	Saint Lucia fer-de-lance	Not Evaluated
25	***Clelia errabunda***	Saint Lucia cribo	Not Evaluated
26	***Leptotyphlops bruilei***	Saint Lucia thread snake	Not Evaluated
27	***Liophis ornatus***	Saint Lucia racer	Globally Threatened: **ENDANGERED**

Even for species that *have* been assessed, many were assessed a decade or more ago, and their classification may need to be revised based on more recent data and using the new criteria. IUCN (2001) urge that such species should be uplisted "without delay" if there is evidence that they now qualify for a more threatened category.

Section 4.2.4 therefore considers whether the categories of threat for the evaluated species still hold true, and which of the 'Not Evaluated' species could qualify as threatened.

4.2.3 Endemic species and subspecies

Saint Lucia has eight endemic species and at least five endemic subspecies - indigenous taxa that naturally occur nowhere else in the world. All things being equal, Saint Lucia should give priority to conserving endemic taxa because if they disappear from Saint Lucia, they are lost forever. Sadly, at least one of the following animals, the **Saint Lucia cribo *Clelia errabunda*** is already probably extinct.

Table 5. Endemic species and subspecies of Saint Lucia

		Scientific Name	*Common Name*	*Natural Range*	*Current range*
I		***Eleutherodactylus johnstonei***	Johnstone's whistling frog	Main island	Main island, Praslin (Kaiser 1997)
Ii		***Anolis luciae***	Saint Lucia anole	Main island and offshore islands	Main island and offshore islands
Iii		***Cnemidophorus vanzoi***	Saint Lucia whiptail	Main island and offshore islands	Maria, Rat and Praslin islands
Iv	a	***Gymnophthalmus pleii luetkeni***	Saint Lucia worm lizard	Main island only†	Main island (localised)
	b	***Gymnophthalmus pleii nesydrion***	Maria Islands worm lizard	Maria Islands only†	Unknown
v	a	***Sphaerodactylus microlepis microlepis***	Saint Lucia pygmy gecko	Main island only	Main island (localised)
	b	***Sphaerodactylus microlepis thomasi***	Maria Islands pygmy gecko	Maria Islands only‡	Maria Islands
vi	a	***Boa constrictor orophias***	Saint Lucia boa	Main island	Main island (localised)
vii		***Bothrops caribbaeus***	Saint Lucia fer-de-lance	Main island	Main island (localised)
viii		***Clelia errabunda***	Saint Lucia cribo	Main island	Extinct
ix		***Leptotyphlops bruilei***	Saint Lucia thread snake	Main island and offshore islands	Main island and Maria Islands
x		***Liophis ornatus***	Saint Lucia racer	Main island and offshore islands	Maria Major

† Murton (2008) reported rough-scaled worm lizard *Gymnophthalmus pleii* on Praslin Island, but did not record which, if indeed either, of the two subspecies it belongs to.

‡ Schwartz (1965) found *Sphaerodactylus microlepis* on the main island near Vieux Fort, opposite Maria islands, that appeared to resemble *thomasi* more than *microlepis*, and speculated that this subspecies may be present in the south of Saint Lucia.

The endemic status of **Johnstone's whistling frog, *Eleutherodactylus johnstonei***, is contestable. Kaiser (1997), a specialist on this species, considered it to have most likely originated on Saint Lucia, but at least one other author has placed its origin in the northern Lesser Antilles. This report treats this species as native, and probably endemic to Saint Lucia, partly due to Kaiser's (1997) research, and also due to the lack of evidence that Saint Lucia had any other native *Eleutherodactylus* in the past.

Of the endemic species, it should be noted that the **Saint Lucia pygmy gecko *Sphaerodactylus microlepis*** has been recorded on Dominica. According to Schwartz (1965b), however, only a single male was found on Dominica, and this species should therefore be presumed strictly endemic to Saint Lucia. Of the endemic subspecies, the **Saint Lucia boa, *Boa constrictor orophias*** was also considered native to Dominica until Lazell (1964) designated the Dominica population as a separate subspecies, *nebulosus*.

A subspecies of the **Central Lesser Antillean pygmy gecko, *Sphaerodactylus vincenti diamesus***, was described from six specimens collected from Vigie and is sometimes called an endemic subspecies. This may be in error however, however, because there is circumstantial evidence to suggest this species was a short-lived introduction (see Section 4.1).

The native **Saint Lucia iguana, *Iguana cf iguana***, is not shown on this table because its taxonomic status is unclear. While there have been human-assisted introductions of **green iguanas *Iguana iguana*** from Central America throughout the West Indies, Anon (1998) reported that "genetic analyses carried out by Scott Davis indicate that five of the Saint Lucia captives [at Union zoo] are genetically identical and distinct from mainland green iguanas, showing divergence levels of 2% (equivalent to subspecies or higher in *Cyclura* [another iguana genus in the West Indies])". A few years later, unpublished genetic studies by Catherine Malone, Purdue University, Indiana, indicated Saint Lucia's population may belong to an indigenous, ancient lineage of *I. iguana*-type West Indian iguanas, which occurs on several islands in the Lesser Antilles. Until the taxonomic status of this West Indian group is resolved, we cannot confidently call the Saint Lucia form an endemic species or subspecies.

4.2.4 Status and distribution of native species (and suggested IUCN listings)

Below is a short appraisal of the status, range and population trends of every native forest species. Where possible, I have attempted to apply IUCN (2001) criteria for determining which category of threat the species belongs too (Table 6). The available data for many Saint Lucian species are imperfect, yet still better than for many other species that have been successfully evaluated.

Table 6. Summary of recommended IUCN categories of threat for native Saint Lucian forest reptiles and amphibians

Native and probably native species are taken from Table 2. [Square brackets indicate species considered extinct on Saint Lucia]. Explanations follow below.

Scientific Name	*Common Name*	*Current IUCN status - international*	*Recommended IUCN status - international*	*Recommended IUCN status – National*
Eleutherodactylus johnstonei	Johnstone's whistling frog	Not Threatened: Least Concern	Not Threatened: Least Concern	Not Threatened: Least Concern
[Leptodactylus fallax]	[Mountain chicken]	[Globally Threatened: **CRITICALLY ENDANGERED**]	[Globally Threatened: **CRITICALLY ENDANGERED**]	[Nationally Threatened: **EXTINCT**]
Anolis luciae	Saint Lucia anole	N/A	Not Threatened: Least Concern	Not Threatened: Least Concern
Cnemidophorus vanzoi	Saint Lucia whiptail	Globally Threatened: **VULNERABLE**	Globally Threatened: **ENDANGERED**	Nationally Threatened: **ENDANGERED**
Gymnophthalmus pleii	Rough-scaled worm lizard	N/A	Near Threatened	Near Threatened

Scientific Name	*Common Name*	*Current IUCN status - international*	*Recommended IUCN status - international*	*Recommended IUCN status – National*
G. p. luetkeni	Saint Lucia worm lizard	N/A	Near Threatened	Near Threatened
G. p. nesydrion	Maria Islands worm lizard	N/A	**Data Deficient**	**Data Deficient**
Hemidactylus palaichthus	Antilles leaf-toed gecko	N/A	Not Threatened: Least Concern	Nationally Threatened: **VULNERABLE**
Iguana cf iguana	Saint Lucia iguana	N/A	N/A (Cannot be assessed until taxonomic status confirmed)	Nationally Threatened: **CRITICALLY ENDANGERED**
Mabuya mabouya	Southern Antillean skink	N/A	Near Threatened	[Nationally Threatened: **EXTINCT**]
Sphaerodactylus microlepis	Saint Lucia pygmy gecko	N/A	Globally Threatened: **VULNERABLE**	Nationally Threatened: **VULNERABLE**
S. m. microlepis	Saint Lucia pygmy gecko	N/A	Globally Threatened: **VULNERABLE**	Nationally Threatened: **VULNERABLE**
S. m. thomasi	Maria Islands pygmy gecko	N/A	Globally Threatened: **VULNERABLE**	Nationally Threatened: **VULNERABLE**
Thecadactylus rapicaudus	Forest gecko	N/A	Not Threatened: Least Concern	Not Threatened: Least Concern
Boa constrictor	Boa constrictor	N/A	Not Threatened: Least Concern	**N/A**
B. c. orophias	Saint Lucia boa	N/A	Globally Threatened: **VULNERABLE**	Nationally Threatened: **VULNERABLE**
Bothrops caribbaeus	Saint Lucia fer-de-lance	N/A	Globally Threatened: **VULNERABLE**	Nationally Threatened: **VULNERABLE**
[Clelia errabunda]	[Saint Lucia cribo]	[N/A]	[Globally Threatened: **EXTINCT**]	[Nationally Threatened: **EXTINCT**]
Leptotyphlops bruilei	Saint Lucia thread snake	N/A	Globally Threatened: **VULNERABLE**	Globally Threatened: **VULNERABLE**
Liophis ornatus	Saint Lucia racer	Globally Threatened: **ENDANGERED**	Globally Threatened: **CRITICALLY ENDANGERED**	Nationally Threatened: **CRITICALLY ENDANGERED**

When evaluating whether species are <u>globally</u> threatened under the IUCN (2001) criteria, it is important to look at Saint Lucia from a global perspective, and bear in mind that what might seem like a large area or multiple areas on Saint Lucia are in fact tiny or form a single site on a global scale. It is also important to heed IUCN's advice "*Assessors should resist an evidentiary attitude* [classifying a taxon as threatened only when there is strong evidence to support a threatened classification] a*nd adopt a precautionary but realistic attitude to*

uncertainty when applying the criteria, for example, by using plausible lower bounds, rather than best estimates, in determining population size, especially if it is fluctuating." To put it another way, it is better to risk listing a non-threatened species as threatened, than to risk failing to recognise a species that is in danger of extinction.

***Johnstone's whistling frog, Eleutherodactylus johnstonei* –** Being widespread and abundant throughout Saint Lucia (Sections 3.1.2 and 5.3), there is no evidence to suggest this frog has been extirpated from any part of its presumed-natural range on Saint Lucia. On both a national and international scale, it is correct to classify this species as Least Concern using the IUCN categories of threat (IUCN, 2001). Like all Least Concern species, however, this status could change if the population is subject to a new threat, such as an alien invasive competitor or disease (e.g. if this species proved to be more susceptible to chytridiomycosis than recent evidence from Dominica and Montserrat would suggest).

Mountain chicken, *Leptodactylus fallax* – This species was reported to be on Saint Lucia, but the record is historical and unconfirmed (Fa *et al.* 2004) and it is no longer present (Section 5.6). Considering their large size and extremely loud, yelping call, it is improbable that any mountain chicken frogs could have remained on Saint Lucia without being noticed.

This species was correctly listed as Critically Endangered by IUCN due to a drastic population decline (estimated to be more than 80% over the last ten years, inferred from the apparent disappearance of most of the population on Dominica and Montserrat due to chytridiomycosis and volcanic eruptions: Fa *et al.* 2004). This species should not only be considered extinct on Saint Lucia, but held up as warning of how swiftly even a likeable, abundant island animal can be driven towards extinction.

Saint Lucia anole, *Anolis luciae* – Through restricted to Saint Lucia and its offshore islands (including Maria Major, Praslin, Rat and Dennery), this is one of the most abundant and widespread animals in the nation (Sections 3.1.2 and 5.8). Barbour (1937) commented that this species was "*much less common than formerly*" and the present study found evidence that this species is less common where natural forest habitat has been cleared or degraded by human activity (Section 3.1.3). It also appears to be suffering from the relatively recent invasion of *Anolis wattsi* (Section 3.1.5), but not at the rate or scale that will qualify it as threatened with extinction. Gorman (1976) observed that the Barbados anole, *Anolis extremus*, had eliminated the Saint Lucia anole from localized areas, but this alien anole has not spread very far despite being on the island for more than thirty years. The conservative mean estimate in Section 3.1.4 of just under 1,000 *Anolis luciae* per hectare of forest (all classes) translates into a total island population in the tens of millions.

This species currently qualifies as Least Concern because it is still abundant and widespread, but its status could change, especially if another non-native, invasive *Anolis* species threatens to displace it.

Saint Lucia whiptail, *Cnemidophorus vanzoi* – This endemic species is believed to have been formally widespread throughout Saint Lucia, but was until recently confined to two offshore islands, Maria Major and Maria Minor, with a combined area of 12.2 hectares (= 0.02% of the species' historical range). Following the eradication of rats (Johnston *et al.* 1994) this lizard was successfully reintroduced to Praslin Island (1.1ha) in 1995 (John, 1999) and has since been released on Rat Island (1.3ha), raising its current distribution range to 14.6 hectares and its total estimated population to 2,349 (Durrell Wildlife Conservation Trust & Saint Lucia Ministry of Agriculture Forestry Department, 2008; Morton, 2009a). It was listed as Vulnerable in 1996 under criterion D2: *population is characterised by an acute restriction in its area of occupancy (typically less than 100 km^2) or in the number of locations (typically less than five). Such a taxon would thus be prone to the effects of human activities (or stochastic events whose impact is increased by human activities) within a very short period of time in an unforeseeable future, and is thus capable of becoming Critically Endangered or even Extinct in a very short period* (Gibson, 1996).

Despite these recent modest increases, it would be premature to down-list this species from Vulnerable because it still satisfies the IUCN (2001) criterion D2: *Population with a very restricted area of occupancy (typically*

less than 20 km^2) or number of locations (typically five or fewer) such that it is prone to the effects of human activities or stochastic events within a very short time period in an uncertain future, and is thus capable of becoming Critically Endangered or even Extinct in a very short time period [the Saint Lucia whiptail occupies an area of no more than 0.16km^2, on four islands].

Taking a more precautionary approach, this lizard may well qualify as Endangered under criteria B1ab (i,ii,iii) and B2ab(i,ii,iii): *Extent of occurrence estimated to be less than 5,000km^2* and *Area of occupancy estimated to be less than 500 km^2* [both the extent of occurrence and area of occupancy are 0.16km^2], *and estimates indicating it is severely fragmented or known to exist at no more than five locations* [the species is confined to four small offshore islands] *and estimates indicating continuing decline, observed, inferred or projected, in the (i) extent of occurrence, (ii) area of occupancy* and *(iii) area, extent and/or quality of habitat* [these changes can be predicted due to the projected rise in sea level and increased hurricanes and storm surges due to climate change].

These categories could be raised even higher if the Maria Major and Maria Minor populations are recognised separate 'evolutionary significant units' or subspecies: a possibility raised by Funk & Fa (2006) and Young *et al.* (2006) due to morphological and genetic differences between them. The Maria Minor population is much smaller than the Maria Major population, and the reintroductions to Praslin and Rat islands have used a mixture of stock from both islands.

Rough-scaled worm lizard, *Gymnophthalmus pleii* – The rough-scaled worm lizard is still secure in Dominica (Malhotra & Thorpe, 1999: although Malhotra *et al.*, 2007, question the identity of the species on Dominica), which is mercifully free of mongooses and cane toads. It has largely disappeared from islands that have mongooses and cane toads, however, including Guadeloupe (Breuil 2002). Barbour (1937) described is as "*Extinct on Martinique. Excessively rare on St. Lucia…. found on these two islands by Garman, who took a good series before it was exterminated*". Although the rough-scaled worm lizard is still locally abundant in some areas (e.g., Grande Anse, Praslin Island[6]), its patchy distribution on Saint Lucia indicates that this species has been reduced both in number and area of distribution. While it may not yet qualify as Vulnerable, the regional decline of this species means it ought to be considered Near Threatened: *A taxon is Near Threatened when it has been evaluated against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable now, but is close to qualifying for or is likely to qualify for a threatened category in the near future* (IUCN, 2005).

At the subspecies level, *G. p. luetkeni* should also be classed as Near Threatened, but could be a candidate for Vulnerable because its range (area of occupancy) is considerably less than 100km^2, it appears to be fragmented, and the area, extent and quality of its habitat are declining.

The other subspecies, *G. p. nesydrion* must be listed as Data Deficient, owing to dearth of records of this endemic subspecies on Maria Major. If we extrapolate the known population density of rough-scaled worm lizard on Praslin Island (65.5/ha: Murton, 2008), this would give a total population size of 694 on Maria Major. Such a small world population and tiny area of occupancy (10.6ha) suggest that this species could qualify for one of the globally threatened categories.

Antilles leaf-toed gecko, *Hemidactylus palaichthus* – This species is infrequently seen, with most sightings confined to the islands of Maria Major (10.6ha) and Dennery (1.6ha). One specimen was reportedly found by Allwin Dornelly near Vieux Fort (Matthew Morton, pers. comm.). Although Barbour (1937) was unaware of its presence on Saint Lucia, it is tempting to assume this species was formerly more widespread. Like Saint

[6] The rough-scaled worm lizard has been confirmed to be present on Praslin Island (Murton, 2008) and Rat Island (M. Morton, pers. comm.), but it is not known whether these populations belong to the subspecies *G. p. luetkeni* or *G. p. nesydrion*.

Lucia's whiptail lizard and racer, this largely ground-living species could have become largely restricted to the offshore islands where there are fewer predatory mammals.

On a global scale, this species is unlikely to qualify as threatened: probably Least Concern. If Saint Lucia were to produce a National Red List based on the IUCN criteria, however, this species would be rated as Vulnerable for the same reasons as the pygmy gecko.

Saint Lucia iguana, *Iguana cf iguana* – The green iguana *Iguana iguana* is very widespread and successful lizard that would qualify as Least Concern. The Saint Lucia iguana, on the other hand, is scarce, with fewer than a thousand mature individuals remaining in a total area of less than 30km^2 (M. Morton, pers. comm.). Breen (1844) was aware of the iguanas and observed that they provided "*excellent sport for the native chasseurs*". By the 1930s, Barbour (1937) considered it so rare on Saint Lucia that he questioned whether any remained.

If Saint Lucia were to produce its own National Red List or the iguana were recognised as an endemic species or subspecies, it should be designated as Critically Endangered under criteria B1a,b(i,ii,iii): *Extent of occurrence estimated to be less than 100km^2* [the extent of occurrence is approximately 30km^2], *and estimates indicating it is severely fragmented or known to exist at only a single location* [one location -Northeast Saint Lucia] *and estimates indicating continuing decline, observed, inferred or projected, in the (i) extent of occurrence, (ii) area of occupancy* and *(iii) area, extent and/or quality of habitat* [due to tourism developments, sand-mining, livestock grazing and other documented threats that are known to reduce the quality and extent of suitable habitats].

Southern Antillean skink, *Mabuya mabouya* – This species has not been confirmed on Saint Lucia since the 1800s, and Barbour (1930) listed the species as extinct on Saint Lucia. It is still common on Dominica (Bullock & Evans, 1990) and was recently confirmed on islands off Guadeloupe (Lorvelec *et al*, 2008). Elsewhere, however, it has declined and disappeared from most of its range in the southern Lesser Antilles, seemingly wherever mongooses were introduced (much of Guadeloupe, Saint Lucia, Saint Vincent, Grenada, Martinique: Barbour, 1937; Lorvelec *et al.* 2008), but also, mysteriously from mongoose-free Montserrat (pers. obs.). It would clearly be erroneous to regard this species as Least Concern, and it should be considered Near Threatened, if not Vulnerable.

This assessment follows Miralles (2005) in regarding *M. mabouya* as a regional endemic of the Southern Lesser Antilles, and *Mabuya sloanii* to belong to the northern Lesser Antilles and Greater Antilles. There is little consensus in the literature on the taxonomy of the '*Mabuya mabouya* species complex', however, which may be an obstacle to Saint Lucia's species being assigned a place on the IUCN Red List.

Saint Lucia pygmy gecko, *Sphaerodactylus microlepis* – While it is still locally abundant in some areas, sightings of the Saint Lucia pygmy gecko are worryingly infrequent and patchy in comparison to related species on other islands. During taxonomic collections, Schwartz (1965), an expert on West Indian pygmy geckos, found this species '*distinctly difficult to secure*'. Given that it can occur in a wide range of habitats, from coastal Deciduous Seasonal Forests a few metres above sea level to at least 634m in the Lower Montane Rainforest (see Figure 2 and Section 5.18), this species ought to be naturally widespread and more common throughout Saint Lucia. The current pattern of sightings indicates that this species has declined both in number and area of occupancy. The fact that Breen (1844) put the 'annulated lizard' high on his list of 'insects' from the island also suggests that the pygmy gecko was more common and conspicuous in the nineteenth century.

This species qualifies as Vulnerable under B1ab(ii) and B2ab(ii): *Extent of occurrence estimated to be less than 20,000km^2* and *Area of occupancy estimated to be less than 2,000 km^2* [Saint Lucia is only 161km^2, and the area where geckos have been found is less than 50km^2 and probably not more than 10 km^2], *and estimates indicating it is severely fragmented or known to exist at no more than 10 locations* [the Maria Major forms one location and the mainland population another, within which the species is highly fragmented into four or five restricted patches] *and estimates indicating continuing decline, observed, inferred or projected, in the (ii) area*

of occupancy and *(iii) area, extent and/or quality of habitat* [this decline is inferred from the patchy distribution range, and is projected to continue due to threats to forests outside of the reserves, and predicted sea level rises and increased hurricanes which will reduce the surface area and quality of Maria Major].

At the subspecies level, *Sphaerodactylus microlepis microlepis* and *S. m. thomasi* qualify as Vulnerable for largely same reasons, with the caveat that there is currently no evidence to suggest that *thomasi* - which is endemic to Maria Major (10.6ha) - has declined in number or area of occupancy yet.

Forest gecko*, Thecadactylus rapicaudus* – This species has a wide distribution throughout Central and South America and the West Indies, occurring in a variety of habitats (especially mature xeric forest), and it is not known to have become extinct on any island. It is therefore unlikely to qualify as globally threatened or even Near Threatened, and IUCN may class it as Least Concern.

This species is only infrequently reported on Saint Lucia, and indeed other Caribbean islands. This is not necessarily a cause for concern because these lizards are largely nocturnal and are frequently well hidden or high above the ground in large trees (pers. obs.). The fact that as many as three specimens were found during the present survey without extensive night searches, suggests they are not uncommon on Saint Lucia. Additional, targeted studies will be necessary to confirm this, however.[7]

Saint Lucia boa, *Boa constrictor orophias* – The Saint Lucia boa is still locally common in some areas, e.g. La Sorciere up to 350 metres above sea level (Lazell, 1964), and Quilesse Forest Reserve, Louvet Estate and Grand Anse Estate (M. Morton, pers. comm.). Recent interview reports indicate it has declined in many parts of the island, however: 66% of interviewees who expressed an opinion considered the boa had declined in Saint Lucia. This snake was already considered rare by the 1930s (Barbour, 1937). Even allowing for the fact that these snakes are well camouflaged and easily overlooked in spite of their large size, the Saint Lucia population is relatively infrequently seen compared to populations of boa constrictors on other islands (e.g. Vandeventer, undated, found 15 adults in just eight days on Dominica), which suggests their numbers and range have been suppressed by human activities.

At the species level, the boa constrictor is a very successful, widespread and abundant species that probably qualifies as Least Concern. As a subspecies, however, *B. c. orophias* might qualify as Vulnerable, under criteria B1ab(ii,iii) and B2ab(ii,iii): *Extent of occurrence estimated to be less than 20,000km^2* and *Area of occupancy estimated to be less than 2,000 km^2* [Saint Lucia is only 161km^2, and the area where boas have been found is less than 50km^2], *and estimates indicating it is severely fragmented or known to exist at no more than 10 locations* [the mainland population forms a single location, within which the species is fragmented] *and estimates indicating continuing decline, observed, inferred or projected, in the (ii) area of occupancy* and *(iii) area, extent and/or quality of habitat* [this decline is inferred from interview reports and projected to continue due human persecution and the clearance and degradation of forests outside of the reserves].

The available data are weak, admittedly, and further research (both field status assessments and research into historical literature) are required to confirm its distribution and place on the IUCN Red List.

Saint Lucia fer-de-lance, *Bothrops caribbaeus* – Though still locally common-to-abundant in some areas (e.g. Millet Forest Reserve), the distribution range of this endemic snake has contracted to approximately half of its former range (see Figure 7). Historical records of bounties indicate that this species was collected in large numbers in most parts of the country, as far north as Monchy and Cape Marquis, and south to Savannes Estate and Gayabois. Breen (1844), a methodical historian, described it as present in "*every part of the island*."

[7] Researchers from Durrell Wildlife Conservation Trust and the Forestry Department caught three specimens in Northeast Saint Lucia with the aid of coverboards on the ground, but this species is largely arboeal. Probably the best way to find this species is to use spotlights at night, paying special attention to the trunks and larger branches of old trees.

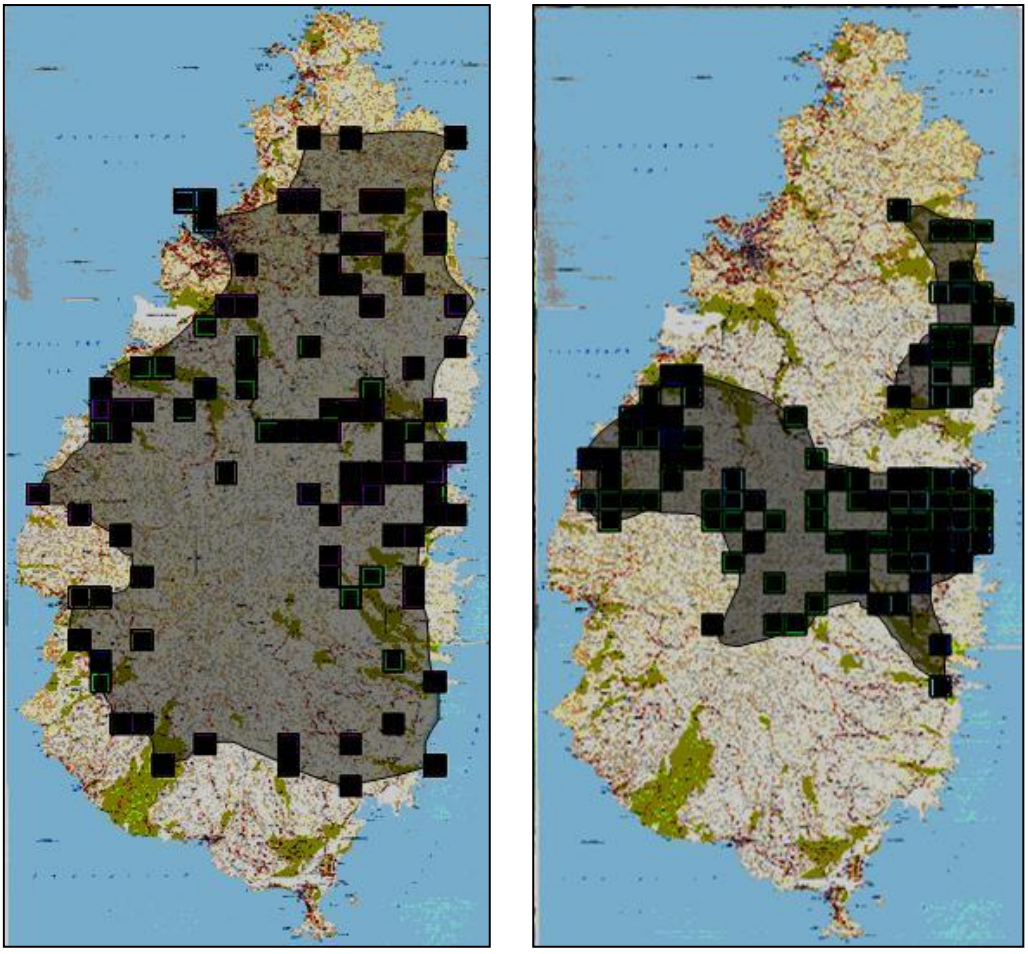
Governor Des Voeux, in his memoirs of late 1870s, claimed that there were fer-de-lances around his house on the Morne in Castries (Robert Devaux, pers. comm.), a statement supported by Figure 7.

This species qualifies as globally Vulnerable under B1ab(ii,iii) and B2ab(ii,iii): *Extent of occurrence estimated to be less than 20,000km^2* and *Area of occupancy estimated to be less than 2,000 km^2* [Saint Lucia is only 161km^2, and the area where fer-de-lances have been found is less than 50km^2], *and estimates indicating it is severely fragmented or known to exist at no more than 10 locations* [the mainland population forms a single location, within which the distribution range may be fragmented] *and estimates indicating continuing decline, observed, inferred or projected, in the (ii) area of occupancy* and *(iii) area, extent and/or quality of habitat* [this decline is inferred from interview reports and projected to continue due human persecution and the clearance and degradation of forests outside of the reserves].

To a large extent, the status of the Saint Lucia fer-de-lance mirrors the Martinique fer-de-lance, *B. lanceolatus*, which has been very heavily persecuted and is now endangered, according to Breuil (2004).

Figure 7. Changes in the distribution range of the Saint Lucia fer-de-lance since 1900.

Historical range (c. 1900), left, and contemporary records (right). Black squares indicated confirmed locations (courtesy of Katherine Breach) and shading indicates the approximate distribution range. Note that occasional, vagrant individuals may be found outside of this range.



Saint Lucia cribo, *Clelia errabunda* – Breen (1844) was familiar with the cribo, and provided remarkably detailed accounts of its behaviour. No confirmed sightings of this endemic snake have been made for at least 100 years, however, in spite of the fact it is large and active species and Saint Lucia is a small country where many experienced naturalists have spent long periods in the field.

The Saint Lucia cribo should be classed as Extinct. IUCN (2001) will not apply this category to a species until "*exhaustive surveys in known and/or expected habitat, at appropriate times (diurnal, seasonal, annual), throughout its historic range have failed to record an individual.*" Saint Lucia has seen many thousands of man-hours spent by forestry staff, biologists and conservation volunteers over the past ten years, all keenly looking out for snakes and including the most remote parts of the forest, without any cribo-like snakes being reported.

Underwoood (1993) attributed the decline and extinction of the Saint Lucia cribo to the bounty-driven collection of snakes to control the Saint Lucia fer-de-lance. This might not be the whole story, however, because the similar endemic cribo, *Clelia clelia groomei*, of Grenada (where there are no fer-de-lances) has also disappeared and is feared to be extinct. Germano *et al.* (2003) noted that some people have attributed its decline to the use of toxic pesticides, but added that they believe direct predation by mongooses is more likely. A fourth contributing factor could be added: both cribos could have suffered from reduced availability of prey, notably through the mongoose-driven decline of ground lizards (*Cnemidophorus vanzoi* on Saint Lucia; *Ameiva ameiva* on Grenada) and small snakes (*Liophis ornatus* on Saint Lucia; *Mastigodryas bruesi* and possibly *Liophis melanotus* on Grenada). Large 'top predator' snakes require an abundance of prey in order to forage successfully.

Saint Lucia thread snake, *Leptotyphlops bruilei* – Though their exact number and distribution is unknown, the infrequency with which thread snakes are found on the main island of Saint Lucia indicate they may be uncommon. Hedges (2008) was aware of only three sites: Maria Major, Anse Galet and "near Praslin" (although his map appears to have misdirected the Praslin record to the Louvet estate). Archaeologist and naturalist Robert Devaux has reported seeing thread snakes in only a handful of scattered locations during many decades working outdoors, all of which were in coastal areas (pers. comm.).

Taking a precautionary approach (IUCN, 2001), this species qualifies as Vulnerable, under criteria B2ab(ii): *Area of occupancy estimated to be less than 2,000 km*^{2} [Saint Lucia is only 161km^2, and the area where thread snakes have been found is less than 50km^2], *and estimates indicating it is severely fragmented or known to exist at no more than 10 locations* [the mainland population forms one location, within which the species may be fragmented, and Maria Major forms the second location] *and estimates indicating continuing decline, observed, inferred or projected, in the (ii) area of occupancy* and *(iii) area, extent and/or quality of habitat* [this decline is projected to continue due to the persistence of alien invasive predators, the clearance and degradation of forests outside of reserves, and predicted loss of habitat on offshore islands due to sea level rises and increased storm surges].

Saint Lucia racer, *Liophis ornatus* – This endemic species was probably formerly widespread across Saint Lucia, but is now restricted to Maria Major (12ha), an island that has fortuitously remained free of alien invasive mammals, but represents only 0.02% of its former range. Barbour (1937) and even Henderson (2004) considered it extinct, but between one and three individuals are seen each year by Forestry Department staff and other visitors to the island.

The current population size is unknown, but can safely be assumed to be very small. The highest published density estimate for any species of *Liophis* (50/ha *Liophis* [=*Alsophis*] *portoricensis* on Guana Island: Rodda *et al.* 2001), and there is no reason to suppose that *L. ornatus* could achieve a higher density. This suggests a maximum conceivable population size of 600 individuals. Based on the known population density of the Antiguan racer (*Alsophis antiguae),* a lizard-eating snake of comparable size on similar offshore islands (Daltry *et al.* 2001), a population estimate of 100-200 would be more plausible. The Saint Lucia racer is much less frequently seen than its Antiguan counterpart, however, so even these figures could be too high. We can also

confidently predict that this population will fluctuate according to prey abundance, stochastic effects, and climate (the Antiguan racer population density, for example, naturally fluctuates between 8 and 16 adults and subadults per hectare, seemingly linked to hurricanes and cyclical fluctuations in lizard abundance).

Another important consideration is that projected sea level rises and increased hurricanes and storm surges due to climate change will measurably reduce the size and quality of Maria Major and could reduce the number of animals the island can support (sea level rises of between 19 and 58cm by 2100 were predicted by Nicholls *et al.* 2007, and some scientists place the estimate at more than a metre).

The Saint Lucia racer's current listing as Endangered is defendable, based on criterion D: *population size estimated to number fewer than 250 mature individuals* [the Saint Lucia racer is unlikely to exceed 150, based on data on comparable island snakes, notably *Alsophis antiguae* which fluctuates between 50 and 120 mature individuals on a 9.9ha island]. Not even the Endangered category, however, does justice to the precarious state of a top predator that is entirely confined to a 12 hectare island and that is, moreover, rarely seen in spite of being an active diurnal snake. Species of the genus *Liophis* have suffered exceptionally high rates of extirpation and extinction, and there is no evidence to suggest that this species *doesn't* qualify as critically endangered. Indeed, its disappearance from the main island of Saint Lucia shows how readily it can be wiped out.

Taking into account IUCN's (2001) advice to take a precautionary approach where appropriate, it is reasonable to upgrade this species to Critically Endangered under criterion C2(ii): *population size estimated to number fewer than 250 mature individuals* [unlikely to exceed 150, based on *Alsophis antiguae* data], and *a continuing decline, observed, projected, or inferred, in numbers of mature individuals* [decline projected due to loss of genetic diversity and climate change] and *(ii) at least 90% of mature individuals in one subpopulation* [100% are in the single population]; and/or D: *population size estimated to number fewer than 50 mature individuals* [the population feasibly could fluctuate below 50 mature individuals, based on *Alsophis antiguae* data].

4.2.5 Species prone to hybridization with introduced species

The reptile of greatest concern in this regard is the **Saint Lucia iguana, *Iguana cf iguana***. The recent accidental introduction of green iguanas (*Iguana iguana*) from a captive facility in Southwest Saint Lucia could lead to this species invading the Saint Lucia iguana's habitat in the Northeast. While the taxonomic status of the Saint Lucia iguana is unresolved, hybridization between the two is likely. There is strong evidence that *Iguana iguana* hybridizes with the Lesser Antillean iguana *Iguana delicatissima* even under wild conditions (Day & Thorpe, 1996; Breuil & Sastre, 1993) so its hybridization with the putatively more closely related Saint Lucia iguana should be even easier. Over time, this would result in the disappearance of the pure-bred native iguana in the wild.

The introduction of other species that are closely related to Saint Lucia's native herpetofauna could threaten the native species through hybridization. The **Saint Lucia anole *Anolis luciae*** is potentially at risk, for example, because there are well-documented cases of different species of *Anolis* hybridizing in the wild (Gorman & Atkins, 1968). Giannasi *et al.* (1997) investigated whether there was hybridization between *A. luciae* and the Barbados anole, *A. extremus*, on Saint Lucia, but found no evidence for this (and inferred that hybridization with the introduced *A. wattsi* would be even less likely). The risk of hybridisation could be higher with more closely related species, such as the Bonaire anole, *A. bonairensis.*

4.2.6 Economically important species

The ecological roles of reptiles and amphibians outlines above can also have economic impacts where, for example, they control pests of food crops and food stores. **Anole lizards (*Anolis* spp.)** and **whistling frogs (*Eleutherodactylus* sp.)** prey on many insects that plague vegetable gardens and fruit trees, for example, but there are no published calculations of how much their services are worth to farmers.

The invasive **cane toad**, ***Bufo marinus*,** was deliberately introduced to Saint Lucia and other parts of the West Indies in the nineteenth century to control pests, specifically the beetles in sugar cane crops (Lever, 2001). Hinkley (1962) concluded that the invasive cane toad is "economically neutral", however, because it consumes both "harmful" and "beneficial" invertebrates.

Boa constrictors, *Boa constrictor*, have a reputation for being effective at controlling unwanted small mammals. According to Plough *et al.* (2004), boa constrictors are effective at controlling opossums (and have indeed been observed eating opossums in Saint Lucia, according to Matthew Morton, pers. comm.), thereby reducing the potential transmission of leishmaniasis to humans. Barbour (1937) reported Saint Lucia's boas "*occasionally at least, eat a mongoose*". In many parts of South America, boa constrictors are kept as house pets to control rats and mice. If the boas on Saint Lucia were permitted to become abundant near most human settlements and farms, they could play a more significant role in controlling vermin. From his experiences in Saint Lucia in the 1960s, Lazell (1964) observed "*Most estate owners and managers protect the Tet'chien, sometimes even fining workers for killing one; this practice is based on the belief that the Tet'chien destroys rats - which it certainly does - though probably not with anything like the efficiency of the Serpent.*" (The Serpent refers to the **Saint Lucia fer-de-lance, *Bothrops caribbaeus***).

The boa constrictor is also prized as an exotic pet or collectors item, and has become one of the most heavily traded live reptiles in the New World. Between 1989 and 2000, for example, 115,131 live boa constrictors were imported into the United States alone (Reed, 2005). While it is not known whether Saint Lucia's boas were ever harvested and exported on a large, commercial scale, small numbers continue to be caught and demonstrated to tourists for tips.

In the West Indies, boa constrictors are exploited for their fat, which is sometimes extracted from live boas that are subsequently sewn up and released (M. Morton, pers. comm.). These individuals are unlikely to survive for long after such drastic surgery. The fat is rendered into oil, which is used to treat arthritis and other joint ailments (Malhotra & Thorpe 1999). Such oil is currently being exported from Saint Lucia, especially to Martinique (M. Morton, pers. comm.). The boas and **Saint Lucia iguanas** are also hunted for meat, although this practice appears to be declining due to stricter law enforcement, reduced availability, more convenient alternatives and/or changing attitudes (Morton, 2009b). Consumption of these animals probably dates back to the first Amerindian occupants of Saint Lucia. Arawak middens on Antigua have been found to contain the bones of boa constrictors and iguanas (Steadman *et al.* 1984). The Amerindians also hunted **mountain chickens, *Leptodactylus fallax***, and smaller lizards, even *Anolis* sp. (Pregill *et al.* 1994; Grouard, 2001).

4.2.7 Culturally important species

The cultural values of reptiles and amphibians are equally broad, but special note should be made of two species, the ***Saint Lucia iguana*** and ***Saint Lucia whiptail.*** Both species have been greatly popularized through awareness campaigns and, in the minds of many people, have become icons for Northeast Saint Lucia's dry forests and the Maria islands respectively. Such flagship species can have a very powerful role in securing interest in conserving the areas they inhabit (e.g. Bowen-Jones & Entwistle, 2002), and can become lucrative tourist attractions in their own right. The Amerindian name for Saint Lucia, Iouanalao (pronounced "Iyanola") means 'place where the iguana is found', although it has been speculated that this was a code name for the fer-de-lance. Martinique (which also has fer-de-lances and iguanas) was given a very similar name.

The **Saint Lucia fer-de-lance, *Bothrops caribbaeus***, has probably never been popular, but has nonetheless has had a significant part in Saint Lucia's culture. So strongly was Saint Lucia identified with this impressive snake that it featured in battle insignia: both Martinique (which has *Bothrops lanceolatus*) and Saint Lucia fought together under the flag of the four serpents (Figure 8). Even in recent decades, it was a common practice to collect heads of these fer-de-lances and use the oil as a weapon or threat to enemies (Melvin Smith, pers. comm.). Love them or hate them, the fer-de-lances are an important part of Saint Lucia's ancient and modern history.

While most of Saint Lucia's reptiles and amphibians are harmless, inoffensive animals that pose no danger to humans. The fer-de-lance is considered one of the most dangerous snakes in the Caribbean, owing to its exceptionally potent venom. Its medical significance is heightened by the fact that many people are unaware of the correct first aid measures for fer-de-lance bites (David Warrell, pers. comm.).

Figure 8. Saint Lucia and Martinique's flag of four serpents (courtesy of Robert Devaux)

No more than a dozen people are bitten by the fer-de-lance each year, and very few individuals die (Breach, 2009). To put this low figure in context, traffic accidents account for more than 60 deaths in Saint Lucia every year. Nevertheless, it is entirely understandable that most people fear this snake, and are reluctant to venture into the forest, especially at night or in areas where they cannot easily see what they are stepping on. Fear of the fer-de-lance also spills over into fear of the non-venomous snakes, such as the Saint Lucia boa and Saint Lucia racer. The boa is not venomous, but can inflict a painful bite if provoked.

Of the other species, only the non-native **cane toad*, Bufo marinus,*** is capable of killing humans, and only then if someone is foolish enough to consume the toads or their eggs (Lever, 2001). When threatened, they are able to squirt the toxic secretion over a metre, causing extreme pain if rubbed into the eyes. Studies on Grenada have implicated *Bufo marinus* as being reservoirs for the bacteria *Leptospira interrogans*, which causes Weil's disease (infectious jaundice) in humans.

4.2.8 Ecologically important species

Native reptiles and amphibians as predators and prey

In the islands of the West Indies, where native terrestrial mammals are uncommon or absent and even the number of insectivorous birds is far lower than on continental areas, reptiles and amphibians can comprise an incredibly high percentage of the forest vertebrate biomass and take on a more significant role in the food chain. They are extraordinarily important as the leading predators of insects and other invertebrates. Studies from rainforests on Puerto Rico have demonstrated that the resident reptiles and amphibians consume 50,000-340,000 prey items/ha/day (Reagan, 1996). Bennett & Gorman (1979) produced a similar estimate of 20,000-100,000 insects/ha/day consumed by only three species of lizards on Bonaire.

The most important forest insectivores are **anole lizards (genus *Anolis*)** and **whistling frogs (genus *Eleutherodactylus*)**, which this study found to comprise the most abundant members of Saint Lucia forest herpetofauna. Though small, their sheer numbers mean they can have a major impact on invertebrate populations. One whistling frogs consumes, on average, 5.7 invertebrates per night and a density of 1,000 whistling frogs per hectare (a plausible, if conservative, estimate for *Eleutherodactylus johnstonei* in Saint Lucia) could therefore consume 5,700 prey items per hectare per night. These frogs feed chiefly on ants, spiders, leafhoppers and springtails (Schwartz & Henderson, 1991). The conservatively-estimated mean density of 922 *Anolis luciae* per hectare, with peaks of 3,900/ha (Section 3.1.4) could consume more than 20,000 insects, spiders and other invertebrates per hectare per day.

Experimental studies on other islands have proved how effective these animals are at controlling invertebrate populations. Roughgarden (1995) concluded that the removal of anole lizards results in at least a doubling in the number of arthropods on the forest floor, and a 10- to 30-fold increase in the number of spiders. Significantly increased insect damage to leaves was observed after removing anoles from forest plots on Puerto

Rico and the Bahamas. In short, if the anole lizards or whistling frogs were lost, the forest trees and other plants would suffer far more insect damage.

The power of Saint Lucia's herpetofauna to control forest invertebrates has been compromised, however, by the fact that a number of species appear rarer than would naturally be expected. **Pygmy geckos (genus *Sphaerodactylus*)** are now scarce or absent from much of Saint Lucia's forests, for example, and healthy populations of pygmy geckos are surprisingly important in the forest food web. Though each individual may weigh less than one gram, entire *S. macrolepis* populations on Guana Island, British Virgin Islands, represented 15.26 kg/ha. As Rodda *et al*. (2001) pointed out, this is higher than the estimated biomass of African elephants *Loxodonta africanus* of 10kg/ha (Fa & Purvis, 1997)!

Sadly, the **Saint Lucia whiptail lizard, *Cnemidophorus vanzoi,*** has vanished from the main island of Saint Lucia, and we must look to the offshore islands for an indication of how abundant and ecologically important they used to be. The analogous *Ameiva* lizards on other islands prey on small anole lizards and have a measurable impact on forest invertebrates: e.g. the experimental removal of *A. exsul* from forest plots on Puerto Rico resulted in increased snail populations (Lewis, 1989). The unfortunate loss of whiptail lizards from the main island of Saint Lucia would have profoundly affected the forest ecosystem, especially the invertebrates.

Saint Lucia's herpetofauna also includes several top predators, notably the **Saint Lucia racer *Liophis ornatus***, which probably preys mainly on anole and whiptail lizards, **Saint Lucia fer-de-lance, *Bothrops caribbaeus,*** which is likely to prey mainly on lizards, birds and mammals, and the **Saint Lucia boa, *Boa constrictor***, which probably preys mainly on lizards, birds and mammals (Schwartz & Henderson, 1991). The fer-de-lance and boa in particular could have a significant and beneficial role in preying on non-native mammals, including rats and opossums (see Clarke, 2009).

The largely insectivorous reptiles and amphibians in turn feed a variety of other animals, including the larger reptiles and amphibians, birds and bats. The introduced mongoose and, probably, opossum also prey heavily on reptiles and amphibians (Section 4.3.1).

The roles of non-native reptiles and amphibians

Not all of Saint Lucia's reptiles and amphibians are native, however, and it is important to consider the aliens, both as predators and prey. These can include pest species, that threaten to upset the natural balance of native species, but others may be beneficial, e.g. controlling other more harmful alien species or fulfilling the functions of species that have gone extinct.

The most notorious of the island's introduced herps is the **cane toad, *Bufo marinus,*** ranked among the world's 100 worst invasive species (Lowe *et al*, 2000). The toad has a formidable appetite and can reproduce and grow incredible quickly. They feed on almost any terrestrial animal that are small enough to fit into their mouths, and compete very strongly with native invertebrates for food (Lever, 2001; Greenlees *et al.* 2006). Their toxic secretions are known to cause illness and death in animals that attempt to eat them, including domestic dogs and cats, and native wildlife, such as snakes and lizards. Cane toads are toxic to most snakes (Phillips *et al.* 2003), but I have not found any evidence to suggest whether Saint Lucia's boa is susceptible. As on Montserrat (pers. obs.), Saint Lucia's cane toads appear to be more successful in suburban, agricultural and degraded xeric areas, and uncommon in mature forests. In the Caribbean, this species has been implicated in decline of the Critically Endangered Bermudian skink (Varnham, 2006), and it is therefore possible that this toad may be partly to blame for the apparently low numbers of skinks on both Saint Lucia and Montserrat.

The other invasive amphibian, the **red-snouted tree frog, *Scinax ruber,*** is primarily an insectivore, feeding on a wide range of crickets, caterpillars, moths, beetles, flies and bugs (Schwartz & Henderson, 1991). With specific reference to Saint Lucia, Lever (2003) suggested that *S. ruber* may compete with the whistling frog *Eleutherodactylus johnstonei*, but qualified this remark with Kaiser & Henderson's (1994) comment that the whistling frog is "a formidable competitor in its own right". While the invasive tree frog is probably still

spreading and increasing in number, it currently appears unlikely to seriously threaten the abundant and widespread whistling frogs.

The two introduced anole lizards, **Barbados anole *Anolis extremus*** and **Watts' anole *A. wattsi***, are also bound to affect invertebrate populations in the areas they occupy. The estimated high density of 7,200/ha for *Anolis wattsi* (Anse La Raye) could not fail to have an impact on the number of invertebrates in this area. In this case, however, the invader may to a large extent be merely substituting the role of the native *A. luciae*. As noted earlier, there appears to be a trade off between the two species, whereby *A. luciae* is scarcer in areas where *A. wattsi* thrives (Section 3.1.5). Both species are known to consume a wide range of species. Further research is required to understand whether both species differ in terms of their diet.

The largest invader, the **green iguana *Iguana iguana*,** has only recently become established in Southwest Saint Lucia and poses a direct threat to the native Saint Lucia iguana, as described in Section 4.2.5).

4.2.9 Conclusions – Priority species for conservation

Drawing on Table 3 (page 23) and the discussions above, Saint Lucia's native species are ranked below in order of priority for conservation.

The number of ticks in each column indicates how strongly the species or subspecies meets the criterion. Under the column "Listed as globally threatened with extinction (IUCN, 2009[8])", for example, a species that is Vulnerable or Data Deficient would score one tick (✓), an Endangered species two ticks (✓✓), and a Critically Endangered species scores three ticks (✓✓✓). Under "Endemic to a restricted area", a Lesser Antilles endemic would score one tick (✓), a Saint Lucia endemic two ticks (✓✓), and a Maria Islands endemic scores three ticks (✓✓✓).

The animals that stand out most strongly on this table are the Saint Lucia iguana *Iguana cf iguana*, Saint Lucia racer, *Liophis ornatus*, and Saint Lucia whiptail lizard *Cnemidophorus vanzoi*. Crucially, the iguana and whiptail lizard are already the focus of conservation programmes. Clearly the Saint Lucia racer warrants more attention too, followed by the Saint Lucia boa. Every native species and subspecies scored at least one point, however, which signifies that even the species at the bottom of the table are important too.

[8] If the current, published IUCN (2009) threat classes were updated with the proposed classes (Table 6), many of the total scores would increase, but the overal rankings would not change significantly.

Table 7. Conservation priority ranking of Saint Lucia's extant (still present) native reptile and amphibian species and subspecies

Scientific Name	*Common Name*	*Listed as globally threatened with extinction (IUCN, 2009)*	*Endemic to a restricted area*	*Scarce*	*Declining in population size or distribution range*	*Prone to hybridization with introduced species*	*Species of actual or potential economic or subsistence use*	*Species of cultural significance*	*Indigenous species that have a ecological keystone role*	*TOTAL SCORE*	*RANK*
Iguana cf iguana	Saint Lucia iguana		✓✓	✓✓	✓✓✓	✓✓✓	✓	✓✓	✓	14	1
Liophis ornatus	Saint Lucia racer	✓✓	✓✓	✓✓✓	✓✓✓				✓	11	2
Cnemidophorus vanzoi	Saint Lucia whiptail	✓	✓✓	✓✓	✓✓✓				✓✓	10	3
Boa constrictor orophias	Saint Lucia boa		✓✓	✓	✓		✓	✓✓	✓	8	4
Gymnophthalmus pleii nesydrion	Maria Islands worm lizard		✓✓✓	✓✓✓					✓	7	6.5
Sphaerodactylus microlepis thomasi	Maria Islands pygmy gecko		✓✓✓	✓✓✓					✓	7	6.5
Bothrops caribbaeus	Saint Lucia fer-de-lance		✓✓		✓			✓✓	✓✓	7	6.5
Anolis luciae	Saint Lucia anole		✓✓		✓				✓✓	6	6.5
Gymnophthalmus pleii luetkeni	Saint Lucia worm lizard		✓✓		✓✓				✓	5	10.5
Hemidactylus palaichthus	Antillean leaf-toed gecko			✓✓	✓✓				✓	5	10.5
Sphaerodactylus microlepis microlepis	Saint Lucia pygmy gecko		✓✓	✓	✓				✓	5	10.5
Leptotyphlops bruilei	Saint Lucia thread snake		✓✓	✓	✓				✓	5	10.5
Eleutherodactylus johnstonei	Johnstone's whistling frog		✓✓						✓✓✓	5	10.5
Thecadactylus rapicaudus	Forest gecko								✓	1	14

4.3 What are the main threats to reptiles and amphibians?

4.3.1 Alien invasive species

Alien mammals

The native terrestrial mammal fauna of the Lesser Antilles comprised only bats and Sigmodontine rodents (rice or musk rats), which rarely if ever consumed reptiles or amphibians. While the native rodents have disappeared during the course of human settlement of these islands (Lorvelac *et al.* 2007), other, alien mammals have been introduced. Amerindians brought dogs, agoutis *Dasyprocta leporina*, and the Southern opossum *Didelphis marsupialis* (Lorvelec *et al.* 2001). Europeans brought cats, pigs, goat, sheep and other domestic mammals, and at least four other mammal species. Three are commensal murine rodents: the ship rat or roof rat, *Rattus rattus*, and the house mouse, *Mus musculus*, were introduced to the Lesser Antilles hundreds of years ago, and the Norway rat, *Rattus norvegicus*, would have been introduced at the end of the 18th century (Pinchon, 1967).

The fourth non-domestic mammal, and arguably the most devastating, is the **small Asian mongoose, *Herpestes javanicus***, which reached Saint Lucia around 1888 (Clarke, 2009). Mongooses were introduced to control rats in sugar cane plantations and, perhaps, to control the venomous *Bothrops caribbaeus*. The mongoose has had a catastrophic impact on other animal throughout the West Indies including: Jamaica (terrestrial crabs, insects, amphibians, snakes, lizards, ground-nesting birds: Espeut, 1882; Allen, 1911); Puerto Rico (arthropods, amphibians, reptiles and mammals: Pimentel, 1955) and US Virgin Islands (iguanas, Ameiva ground lizards, Alsophis snakes, marine turtle eggs, and birds (Seaman, 1952; Seaman and Randall, 1962). Westermann (1953) reported its impact on the mountain chicken *Leptodactylus fallax* in the Lesser Antilles.

Barbour (1930, 1937) concluded the mongoose has been responsible for major changes in the fauna distribution in the Antilles, leading to extinction of many ground-nesting birds and reptiles. Honegger (1981) attributed the fact that Saint Lucia racers *Liophis ornatus* in Saint Lucia are now confined to Maria Major mostly to mongoose predation on the main island. There is compelling circumstantial evidence that such non-venomous ground snakes and mongooses cannot coexist in the West Indies. Lazell (1967) and Powell & Henderson (1996) implicated the mongoose in the extinction of the snakes *Alsophis ater* in Jamaica, *Alsophis sanctaecrucis* in Saint Croix, *Liophis cursor* in Martinique. Like the Saint Lucia racer, the Antiguan racer *Alsophis antiguae*, now survives only on mongoose-free offshore islands (Daltry *et al.* 2001).

Having noted the declines of many snakes in particular, Barbour (1930) predicted that the Saint Lucia fer-de-lance *Bothrops caribbaeus* would become rare in Saint Lucia, and *B. lanceolatus* very rare in Martinique as a result of the mongoose. The ability of the mongoose to 'control' such large, venomous snakes appears to be weak, however. Mongooses find it difficult to detect a motionless snake by day, and even a medium-sized fer-de-lance would be physically capable of killing and swallowing a mongoose: the closely related *Bothrops atrox* of Central and South America has been recorded eating animals up to 1.56 times their own weight (Greene, 1983).

When Baskin & Williams (1966) first described the Saint Lucia whiptail *Cnemidophorus vanzoi*, they too hypothesized that its absence from the main island of Saint Lucia was due to mongoose introduction. Ground lizards are also very vulnerable to mongoose predation, and, on other islands, many species of *Ameiva* (which are similar to *Cnemidophorus* in size and behaviour) have become scarce or absent where mongooses have been introduced. On Antigua, for example, the ground lizard *Ameiva griswoldi* is thriving on mongoose-free offshore islands and in the largest towns, but is more difficult to find in the countryside where the mongooses are at large (Smith *et al.* 2002; pers. obs.).

According to Henderson (1992), most of the local extirpations and extinctions among the amphibians and reptiles of the Lesser Antilles can be explained by the introductions of mongooses, dogs and cats, with ground lizards (*Ameiva* and similar species) and medium-sized snakes (*Alsophis* and *Liophis*) being the most

susceptible to such predators. The impact of mongooses on smaller ground-living reptiles, such as the pygmy geckos, skinks and rough-scaled worm lizards, are less well documented, but mongooses captured at Louvet were found to contain Saint Lucia anoles, rough-scaled worm lizards, Johnstone's whistling frogs, and young Saint Lucia iguanas (M. Morton, pers. comm.). In my experience, small ground-dwelling reptiles are scarcer on islands with mongooses than those without. The data presented in Section 3.1.4 from this study and comparable studies on Montserrat (no mongooses), Dominica (no mongooses), Guana Island, BVI (no mongooses) and Grenada (has mongooses) support this view. Corke (1992) also observed that ground lizards and skinks were abundant only on mongoose-free islands in the Windwards.

Of the other introduced carnivores, feral and domestic **cats, *Felis catus,*** seem less widespread on Saint Lucia than the mongoose, but can also be devastating in their impact on native wildlife, including herps. Cats are also listed on the "world's 100 worst invasive species" (Lowe *et al.* 2000). Breuil (1997a) reported cat faeces containing remains of juvenile iguanas and anoles in Martinique, and cats were identified as the main cause of *Brachylophus* population declines in Fiji (Gibbons, 1984). Both cats and **domestic dogs, *Canis domesticus***, pose an especially acute threat to iguanas, and, in only three years, almost eradicated the population of 5,500 *Cyclura carinata carinata* on Pine Cay Island (390ha) in the Caicos Islands (Iverson, 1978). Dogs, together with mongooses, are also major predators of turtle nests in the French West Indies (Lorvelec *et al.* 2007).

Southern opossums, *Didelphis marsupialis,* are very abundant and widespread on Saint Lucia (Clarke, 2009), despite having been introduced little more than one hundred years (R. Devaux, pers. comm.). Being omnivores, opossums do not hesitate to consume small reptiles and amphibians or their eggs. I am not aware of any study of their impact as predators on island reptiles and amphibians, but I predict they are responsible for consuming a very large number of individuals every night. In 2009, an opossum or 'manicou' was observed preying on a hatchling Saint Lucia iguana (M. Morton, pers. comm.).

Another of the "world's 100 worst invasive species" (Lowe *et al.* 2000), the free-ranging and feral **pigs, *Sus scrofa,*** are also common on Saint Lucia (Clarke, 2009). Breen (1844) referred to 'wild hog' in the forests. Pigs are omnivores and frequently eat small animals. Jolly (2007) found reptiles and amphibians in more than 17% of the stomach samples of feral pigs in the southern USA, and inferred the pigs would have a significant impact on reptile and amphibian populations, consuming 3,872 individuals per km^2 per year, especially *Anolis*. It is conceivable this figure would be higher in Saint Lucia due to the lower availability of other vertebrates. A number of Saint Lucians informed the author that pigs, and cattle, can clear areas of fer-de-lances (although all three species coexist in some sites, for example, Grande Anse: M. Morton, pers. comm.). It is possible that pigs will eat even large venomous fer-de-lances (feral wild pigs in the USA have been reported to kill rattlesnakes), and their trampling could flush the snakes out of the undergrowth.

Rats and mice present a very high risk to reptiles and amphibians, especially the black rat, roof rat, or **ship rat, *Rattus rattus***, which is also among the "world's 100 worst invasive species" (Lowe *et al.* 2000). A growing number of rat eradications have been carried out on small islands to conserve West Indian terrestrial reptiles, including several islands (from two to 43 hectares) around Antigua between 1995 and 2006 to conserve the Antiguan racer *Alsophis antiguae* (Daltry, 2007) and Monito Island (15ha) in 1998 to conserve the endemic pygmy gecko *Sphaerodactylus micropithecus* (García *et al.* 2002). In fact Saint Lucia was the first country in the West Indies to control black rats for the purposes of conserving reptiles, with the eradication of rats from Praslin Island in 1994, to allow the successful reintroduction of Saint Lucia whiptail lizards (Johnston *et al.* 1994; John, 1999). Evidence of the severe impact that rats have on native reptiles can be seen in the population increases that follow such eradications. In Antigua, for example, the world population of Antiguan racers, *Alsophis antiguae*, doubled within 18 months of eradicating black rats and showed a significant improvement in physical condition (Daltry *et al.* 2001; Daltry & Abernethy, 2006). In New Zealand, Towns *et al.* (2001) showed that seven geckos and ten skinks from New Zealand increased their population levels, following the eradication of rats (*Rattus exulans*, a similar species to *R. rattus*).

While most of the examples concern mammals that directly threaten reptiles and amphibians through predation, it should be added that mammals may also compete for their food and severely damage their habitat. On

Anegada in the British Virgin Islands, for example, grazing by **domestic goats** and other large herbivores is considered the main threat to the critically endangered Anegada rock iguana *Cyclura pinguis* (Mitchell, 1999).

Alien reptiles and amphibians

The introduction of non-native reptiles and amphibians threatens the native species in a variety of ways, including predation, competition and hybridization. There are a large number of examples to illustrate this point, including the following relevant to Saint Lucia:

- **Whistling frogs:** *Eleutherodactylus johnstonei* and *E. martinicensis* have been blamed for the decline of native *Eleutherodactylus* on several islands, including Grenada, Guadeloupe and Saint Vincent (Kaiser & Henderson, 1994; Breuil, 2002).
- **Cane toads:** On Bermuda, these toads have been implicated in the decline of the critically endangered Bermudan skink (Varnham, 2006).
- **Green iguanas:** On Guadeloupe, hybridization and competition between introduced green iguanas *Iguana iguana* and native Lesser Antillean iguanas, *I. delicatissima*, were responsible for the near disappearance of *I. delicatissima* from Les Saintes during the second part of the 20th century (e.g. Breuil & Sastre, 1993).
- **Microteiid lizards:** On Guadeloupe, the invasion of the fast-breeding *Gymnophthalmus underwoodi* has corresponded with the near-disappearance of the native *G. pleii.* Competition for a similar niche may be to blame. *Gymnophthalmus underwoodi* is parthenogenic (females can reproduce by cloning themselves, without males), so only one individual would need to reach Saint Lucia to establish a population.
- **Anoles:** On Dominica, the recently introduced *Anolis cristatellus* appears to be displacing the native *A. oculatus*, at least in coastal areas (Malhotra *et al.*, 2007). On Saint Lucia, Gorman (1976) found *A. extremus* from Barbados displaced *A. luciae* from localized areas between Castries and Vigie, and there is mounting evidence that *A. wattsi* from Antigua has spread widely and is displacing *A. luciae* in urban and disturbed habitats (see Section 3.1.5).
- **Thread snakes:** The recent introduction to Barbados of the flowerpot blindsnake, *Ramphotyphlops braminus*, an Asian parthenogenic species (females reproduce without being fertilized by males), is considered a potentially dangerous competitor of the native *Leptotyphlops carlae* (Hedges, 2008).
- **Other lizards:** In the Bahamas, the introduced lizard *Leiocephalus carinatus* competed with the native *Anolis sagrei* for prey and drove it to extinction in the Great Abaco Islets (Schoener *et al.* 2001).

Interestingly, the invasion of non-native anoles - which has already happened at least twice on Saint Lucia - does not always cause the extinction of the native species, but can lead to significant changes in its form and behaviour so as to reduce competition (Roughgarden, 1995).

Sometimes the effects of an introduced reptile or amphibian can be difficult to predict. For example, Cole *et al.* (2005) observed when the non-native gecko *Hemidactylus frenatus* was introduced in islets off Mauritius (Mascarene Islands), the endemic gecko populations (*Nactus coindemirensis, N. durrelli* and *N. serpensinsula*) decreased drastically due to competition for refuges.

The introduction of new, exotic reptiles and especially amphibians is evidently most likely to be aided by human transport, either deliberately or inadvertently. During the mid 2000s, for example, an agamid lizard was discovered in cargo at Castries port, and was promptly shot (M. Morton, pers. comm.). There could be occasional invasions by individuals transported on flotsam from Latin America or from the northern Lesser Antilles during hurricanes (Censky *et al.* 1998; Hedges, 2006). Such events are likely to be extremely rare in Saint Lucia, however.

Alien parasites

No review of the threats from alien invasive species to Caribbean herpetofauna would be complete without mentioning the **chytrid fungus, *Batrachochytrium dendrobatidis.*** This water-borne parasitic fungus causes the amphibian disease chytridiomycosis. Thought to have originated in southern Africa, it has spread worldwide and was first recorded in the Caribbean in 2002 (Dominica) and has since spread. During outbreaks, some species of amphibians are wiped out while others survive. Some species are naturally resilient to chytridiomycosis and can carry the fungus without necessarily being killed, including the cane toad *Bufo marinus*. Of the presumed-native amphibians, the mountain chicken *Leptodactylus fallax* is known to be highly susceptible (Magin, 2004; Martin *et al.* 2007), but is already extinct on Saint Lucia. Johnstone's whistling frog *Eleutherodactylus johnstonei* appears to be resilient, according to tests carried out in Montserrat and Dominica, perhaps partly because it does not have a tadpole stage. The introduced red-snouted tree frog, *Scinax ruber*, could be at risk, because other species of this genus are susceptible (Toledo *et al*. 2006).

Saint Lucia's reptiles are also at risk from other alien parasites. Millennia of isolation can result in island species losing immunity to parasites that are harmless to continental species. The Saint Lucia whiptail lizard, for example, has been found to be fatally susceptible to a protozoan parasite (Buley & Gibson, 2001). Other studies by the Durrell Wildlife Conservation Trust found that Antigua's endemic racer, *Alsophis antiguae*, can die within hours from exposure to the **common snake mite, *Ophionyssus natricis*** (Daltry *et al.* 2001). It is plausible the Saint Lucia racer and the other rare island endemics would have a similar lack of immunity to this or other parasites. In light of the ever-growing human-assisted transportation of reptiles around the world, there is increasing danger of such parasites being introduced to Caribbean islands like Saint Lucia. This is yet another reason for tightening controls on the deliberate or accidental importation of alien reptiles and amphibians (see above).

4.3.2 Habitat alteration and fragmentation

Saint Lucia has a fairly high human population density of 1,036 per km^2 (compared to Martinique and Guadeloupe with 348 and 260 inhabitants per km^2 respectively), with most of the population concentrated in lowland areas. Increasing urbanisation, roads, and tourism developments mean more destruction, fragmentation and pollution of primary and secondary forest habitats.

Mature Deciduous Seasonal Forests appear to be disproportionately important for reptiles and amphibians (see Figure 2, Section 3.1.3), having a significant greatest diversity and density of species than any other forest types. Unfortunately, these forests are at greatest risk, chiefly due to the demand for tourism and recreation facilities by the sea. The new Le Paradis Beach Golf and Marine Resort development near Praslin, for example, has incurred the clearance of c. 200 hectares of mature Deciduous Seasonal Forest (pers. obs.). A similar-sized, beach resort development has been approved on the Marquis Estate in Northeast Saint Lucia, an area that is currently largely covered with Deciduous Seasonal Forest. In a press release in July 2009, the president of the development company said the "site offers tremendous opportunity to take golf to nature".

Some Lesser Antillean species are very adaptable and will readily move in to new ornamental grounds, buildings and even the 'roughs' of golf courses, such as *Anolis luciae*, *Eleutherodactylus johnstonei*, and the introduced *Anolis wattsi* and *Hemidactylus mabouia*, as long as there is limited use of heavy insecticides and other pesticides. Inevitably many others are less tolerant, especially if the new residents object to their presence (e.g. the Saint Lucia fer-de-lance, see below). Hedges (2008) regards Saint Lucia's thread snake as an obligate forest species.

Fragmentation of forests can lead to such forest species becoming marooned in small pockets of forest, unable to disperse and interbreed. This phenomenon is well known to accelerate the loss of reptiles and amphibians (e.g. Driscoll, 2004; Cushman, 2006). Wherever roads are created or upgraded, iguanas, large snakes and other animals are vulnerable to being run over in significant numbers (Rodda, 2005). Improved infrastructure and

growing populations also increase the likelihood of new alien invasive species being introduced (see Section 4.3.1).

On a more local scale, the 'tidying' up of leaf litter and undergrowth from sandy, coastal recreational areas makes these areas uninhabitable for Saint Lucia's smallest lizards: the pygmy geckos and rough-scaled worm lizards. Some of the earliest records of these species on Saint Lucia came from such coastal areas, before the practice of sweeping them was introduced. Based on field surveys during the 1960s, Schwartz & Henderson (1991) for example, noted that rough-scaled worm lizards occupy sandy areas where they have a cover of *Coccoloba* and *Terminalia* leaves. Similarly, Schwartz (1965a) found Saint Lucia's only known colony of the Central Antillean pygmy gecko *Sphaerodactylus vincenti* under *Coccoloba* and *Terminalia* leaves on Vigie Beach – a colony that appears to have disappeared.

It is not all bad news for Saint Lucia's reptiles and amphibians, however. In the Semi-Evergreen Seasonal Forest zone, the abandonment of large areas of plantations and gardens in recent years could lead to forests regenerating and improved habitat for reptiles and amphibians. There are very few examples of mature Semi-Evergreen Seasonal Forest on the island, but my study found this to be one of the richest habitats in terms of species diversity and abundance (see Figure 2, Section 3.1.3). Indeed, Saint Lucia has a higher forest cover today than it did 100 or even 200 years ago: the great sugar plantation of Grande Anse, for example, is now covered in a mature, secondary Deciduous Seasonal Forest that is of outstanding important for the Saint Lucia iguana and other rare species.

4.3.3 Hunting, persecution and collection

Historically, hunting of terrestrial herpetofauna by Amerindians was implicated in the decline and local extinction of a number of medium-sized to large species in the Lesser Antilles, including the mountain chicken *Leptodactylus fallax*, and iguanas (Lorvelac, 2007). The Saint Lucia iguana is currently restricted to a remote area far from paved roads and human settlements, which may be evidence that this species was hunted out from more accessible areas (M. Morton, pers. comm.).

Although the hunting of reptiles for bushmeat has declined in Saint Lucia (Morton, 2009b), there are still frequent cases of deliberate killing, especially of the pit viper and Saint Lucia boa. During the recent clearance of coastal Deciduous Seasonal Forests to develop a resort near Praslin, more than 80 *Bothrops caribbaeus* were reportedly killed by workers: M. Morton, pers. comm.). Adult Saint Lucia boas are particularly vulnerable owing to their habit of frequently the same site for weeks if not years (Lazell, 1964). Even if the finder does not kill or catch the snake, he or she may report the snake's position to another person who will.

The persecution of pit vipers has a long history in Saint Lucia, with bounties offered for killing these snakes. This has been implicated in the extinction of one of Saint Lucia's endemic snakes, the cribo, *Clelia errabunda* (Underwood, 1995). On Martinique, the endemic fer-de-lance *Bothrops lanceolatus* has been killed in such large numbers that it now qualifies as endangered, according to Breuil (2004).

Another form of hunting is the collection of animals for the pet trade. The 'herpetocultural' industry is enormous, especially in the USA, Czech Republic, Germany, Great Britain and other parts of Europe: the retail trade in live reptiles and amphibians is reportedly worth more than two billion dollars a year in the US alone, with several million individuals imported annually (Schlaepfer *et al.* 2005). There is especially strong demand for snakes – especially large constrictors – iguanas, anole lizards and geckos, in particular colourful and unusual species. A quick online search reveals interest among specialist collectors in purchasing Saint Lucia's boa constrictor and pygmy geckos, with indications that even the Maria Islands subspecies of pygmy gecko has been traded.

For most species, the collection of a few individuals for the pet trade is unlikely to do much harm. For very restricted populations, however, this represents a serious threat. Even the Saint Lucia racer, *Liophis ornatus* – surely the island's rarest reptile - could be at risk. Collectors have been observed taking members of the

Alsophis genus in the Lesser Antilles, including endangered and critically endangered species. The Saint Lucia racer's rarity and attractive colours would undoubtedly appeal to some snake collectors. Reptile pet keepers or collectors who live on Saint Lucia, on the other hand, also represent a risk to native herpetofauna if their exotic pets escape (as has already happened with the accidental release of green iguanas near Soufriere since 2004) or if their pets bring deadly new parasites and diseases (see Section 4.3.1).

Collecting specimens for scientific purposes also belongs in this category, because it still represents a loss of individuals from the wild populations. Of particular concern are taxonomists who demand a large 'series' of several hundred individuals in order to show the full range of variation within the species. In practice, this usually means the collectors taking every individual they can find during several days of searching. The more common and widespread species, such as the Saint Lucia anole, could withstand such heavy collecting, but this practice, if permitted, could be catastrophic for the rarer endemics, especially those restricted to a small area like Maria Major.

4.3.4 Pollution and pesticides

Reptiles and especially amphibians are sensitive to environmental pollution. Many dangerous persistent organic pollutants, including Aldrin, Chlordane, DDT, Dieldrin, Endrin, Heptachlor, Hexachlorobenzene, Mirex and Toxaphene, were banned in Saint Lucia in the 1970s and 1980s. Nevertheless, there is still a heavy use of toxic agrochemicals, which could harm reptiles and amphibians through direct poisoning, secondary poisoning and/or depletion of insect populations and other prey.

A survey by Simpson (2003) found more than 95% of Saint Lucian farmers use chemical fertilizers, typically without first conducting soil tests, and nearly 90% use pesticides. He also found more than 70% of farmers thought that the use of pesticides was having an adverse effect on the environment, and more than 40% considered the use of fertilizers harmful.

While use of agrochemicals is very common on farms both small and large, the greatest consumers are the banana plantations. Approximately 80% the 700 tonnes of chemicals imported annually to Saint Lucia consist of insecticides, herbicides, and nematicides for the banana industry. Banana monocultures in Saint Lucia are especially prone to pests and quickly deplete natural nutrients, necessitating heavy use of fertilizers and pesticides. The steep slopes also encourage soil erosion and thus the downhill movement of paraquat, glyphosate and other pesticides towards ravines. This frequent and intense use of chemicals, combined with inappropriate handling, storage and disposal, has contributed to environmental pollution in Saint Lucia on a scale hazardous to humans. In recent studies, for example, more than 75% of water samples were found to contain pesticide residues higher than the acceptable limits set by the European Community for drinking water (http://mrag.org/Documents/r7668/R7668Brief2.pdf).

While my study focused on the herpetofauna of the forests rather than agricultural areas, I frequently walked through banana monocultures and was struck by the scarcity of reptiles and amphibians: even the anoles (*Anolis* spp.) and whistling frogs (*Eleutherodactylus johnstonei*) are rare. In some of the larger plantations, the encounter rate of *Anolis luciae* dropped to as low as two or three per hour – lower than any of the forest classes apart from Elfin Shrubland. While there may be a number of factors that would make a plantation less convivial for such animals, it is logical to expect such heavy use of agrochemicals to deplete the herpetofauna.

4.4 Are the current legal mechanisms sufficient?

4.4.1 Wildlife Protection Act

The Wildlife Protection Act of 1980, revised 2001, was formulated to "make provision for the protection, conservation and management of wildlife in Saint Lucia". The Act makes provision to establish hunting

licenses and create wildlife reserves, and makes it an offence to import or export any wildlife without a license. The Act also divides wildlife into three categories, protected, partially protected and unprotected.

Of the reptiles and amphibians, four species are Protected:

- **Saint Lucia racer, *Liophis ornatus*** - listed as the Couresse or Meadow Snake, *Leimadophis ornatus.*
- **Saint Lucia whiptail lizard, *Cnemidophorus vanzoi*** - listed as the Zandoli terre or Ground Lizard, *Cnemidophorus vanzoi.*
- **Saint Lucia iguana *Iguana cf iguana*** - listed as Zandoli Bois or Iguana, *Iguana iguana*
- **Saint Lucia boa *Boa constrictor orophias*** - listed as the Tete Chien or Boa Constrictor, *Constrictor Constrictor Orphius* [sic].

None are Partially Protected. This category is designed for species that may be hunted during specified open seasons.

One species is Unprotected. These species may be kept in captivity, with a license, and hunted, trapped or traded all year round:

- **Saint Lucia fer-de-lance, *Bothrops caribbaeus*** - listed as the Fer-de-lance or Serpent *Bothrops caribbaeus.*

Four points are immediately striking about the list above. First, and most importantly, the majority of species of reptiles and amphibians known to occur on Saint Lucia (15 extant species, excluding the marine turtles) do not appear on any of the three lists. In practice, these non-listed species might automatically be treated as unprotected unless they are found within a reserve. However, the Act also states that "Wildlife, resident or migratory, indigenous or alien, found in Saint Lucia, except fish, frogs or crustaceans in private ponds, are the property of the Crown and may be taken or hunted only at such times, in such places and in such manner as is provided by this Act." This suggests that the non-listed reptiles at least may not be taken or hunted without permission from the Forestry Department. Nevertheless, the omission of most species creates a grey area of uncertainty.

Second, while the Act correctly uses scientific names to clarify exactly which species the Creole and common names refer to (many species have the same common name or have multiple names), some of the scientific names are misspelled or out of date. In theory, a well informed defendant could use this as a loophole to escape prosecution. This is a sticky problem in wildlife legislation the world over.

Third, the list of protected species includes *Iguana iguana*. While the likely intent was to protect the native Saint Lucia iguana (*Iguana cf iguana*), this scientific name also applies to the alien green iguana, which escaped on Saint Lucia around 2004, shortly after the Wildlife Protection Act was revised. This would be interpreted by a lawyer as meaning *both* types of iguana are equally protected and people, by law, cannot take or kill the green iguanas without a permit from the Ministry of Agriculture. This legal complexity should be borne in mind when planning how to control the alien green iguanas.

Fourth, the Saint Lucia fer-de-lance is classed in the same category as the alien mongoose, rats and mice. This implies that this venomous snake is too abundant, or too undesirable, to warrant any form of protection. This is at odds with the growing evidence that this endemic reptile has declined and qualifies as a globally threatened species in the same category as the Saint Lucia parrot (Section 4.2.4).

Another important observation is that the overall tone and intent of the Wildlife Protection Act addresses the *hunting* and *trade* of wildlife. The act was in fact originally conceived to safeguard species that are at risk from over-hunting. In this regard, the act has been very successful. According to John (2001) "The Act laid the ground for a vibrant public conservation programme that continues today, with an underlying message of absolute protection of all species. Changes in cultural practices and public attitudes in recent years have

reduced the demand for 'wild meat' and this has dovetailed with conservation efforts. In addition, the rise to prominence of nature-oriented tourism has helped in promotion of non-exploitive management of forest and wildlife resources. Today, Saint Lucia is a model for forest and wildlife conservation and hunting of wildlife is currently minimal… Hunting pressure on Saint Lucia is at an all time low."

Hunting is only one of the many threats facing Saint Lucia's reptiles and amphibians (Section 4.3.3). The Wildlife Protection Act was *not* designed to, and therefore fails to, address the threat from alien invasive species, accidental killing and - apart from the creation of wildlife reserves - measures to protect the animals' habitats. For example, the Saint Lucia boa is a protected species, but this act does not appear to prohibit any landowner from destroying a boa's den if it is on private land. In many countries, the Wildlife Protection Act or its equivalent *does* address critical habitat too: e.g. making it an offence to destroy a breeding site or other essential habitat of a protected species, even on private land. It is possible this aspect could be covered under other national legislation.[9]

The provision to create wildlife reserves is potentially one of the strengths of the Wildlife Protection Act, however, because it allows the complete protection of all wildlife and their habitat within a defined area for a conservation purpose (not necessarily merely to prevent hunting). This act enabled the creation of the Maria Islands reserve (see below), a protected area of inestimable importance for the conservation of Saint Lucia's herpetofauna. Saint Lucia's other wildlife reserve, the Saint Lucia parrot reserve, is embedded within the forest reserves in the mountains.

The requirement for licenses to import or export any species of wildlife is also significant, partly because this could be used as a mechanism to prevent the introduction of alien invasive species (Section 4.3.1), which pose the single greatest threat to the herpetofauna of Saint Lucia and other countries in the Lesser Antilles.

To sum up, the Wildlife Protection Act does contain some useful and important tools to protect wildlife, especially insofar as hunting and trade are concerned. It fails, however, in explicitly categorizing most of the known reptiles and amphibians of Saint Lucia, places the endemic fer-de-lance in potentially perilous position, and does not appear suited for addressing some of the greatest threats to native wildlife, including alien invasive species, and the loss of important habitats on private land.

4.4.2 The protected area system

Saint Lucia's forest reserve system covers 9,196 hectares, or 15.3% of the country, to which should be added the nature reserves, national landmarks, protected landscapes and other protected areas. This is clearly well above the 10% coverage set as a target by the Convention on Biological Diversity, and also higher than the world's national average of 12.2% coverage for terrestrial protected areas (Coad *et al.*, 2009).

Of the forest classes (Graveson, 2009), the reserves are dominated by Elfin Woodland, Cloud Montane Rainforest and, especially, Lower Montane Rainforest. According to Figure 2 (Section 3.1.3), however, these forest types have the lowest diversity and density of reptiles and amphibians. Based on the findings of this survey, the species that occur in these forest reserves areas are the least threatened. Semi-Evergreen Seasonal Forests, Freshwater Swamp Forests and especially the Deciduous Seasonal Forests – the forest classes with the greatest diversity of species, and the most threatened species – are sorely underrepresented.

Importantly, the Maria Islands have been protected as a nature reserve since 1988 under the Wildlife Protection Act 1980. This is the single most important site for herpetological conservation, owing to the presence of the Saint Lucia racer (the world's only population), Saint Lucia whiptail lizard (86% of the world population: M. Morton, pers. comm.), an endemic subspecies of Saint Lucia pygmy gecko, an endemic subspecies of rough-

[9] There appears to be a great reluctance on the part of the Saint Lucia government to protect private land or impose other economic restrictions on landowners, possibly because the owners may claim financial componsation (M. Morton, pers. comm.).

scaled worm lizard, and importants population of Saint Lucia thread snake and the nationally rare leaf-toed gecko.

Legal protection is not enough for the dry coastal herpetofauna, however. The Maria Islands are small and inherently vulnerable, and their small reptile populations are at great risk from inbreeding and stochastic effects, as well as the long term effects of climate change. Furthermore, not all of the dry forest species occur here. Notably, the Saint Lucia iguana, one of the country's most endangered species, inhabits the dry forests of Northeast Saint Lucia, none of which are protected. The endemic subspecies of rough-scaled worm lizard also lives on the mainland, and most if not all of its range is outside of the protected reserves.

Consequently, despite being relatively large in area, the current reserve system does *not* adequately represent the full range of vegetation types and areas that are crucial to support Saint Lucia's full diversity of reptiles and amphibians.

4.4.3 CITES

Saint Lucia has been a Party of the Convention on International Trade in Endangered Species of Wild Fauna and Flora since 1983. CITES is an international agreement among government that aims to ensure that international trade in specimens of wild animals and plants does not threaten their survival.

Under CITES, a number of animals and plants have been placed on different lists (appendices) which denote how the Party countries should treat their export and import. Contrary to how the convention is often perceived, many wildlife species on these lists are *not* actually endangered in the wild. For these species, the agreement is intended to ensure their trade is conducted within sustainable levels.

Of Saint Lucia's herpetofauna, only the marine turtles and iguana are affected by this agreement:

- All marine turtles are on CITES Appendix I. This Appendix is dedicated to species threatened with extinction. Commercial trade in these species is permitted only in exceptional circumstances.
- All species in the genus *Iguana*, and all members of the family Boiidae (which includes *Boa constrictor*) are on CITES Appendix II. This includes species that are not necessarily threatened with extinction, but for which commercial trade must be controlled and monitored to prevent over-exploitation.

The Appendices apply not only to whole, live animals, but also their parts and processed goods, such as marine turtle shell jewellery. CITES-listed species may be imported into or exported (or re-exported) from a State Party to the Convention only if the appropriate document has been obtained and presented for clearance at the port of entry or exit.

To trade an Appendix I species, the owner will, in most cases, first require an export permit from the country of origin and import permit from the country of destination. These will be issued only if the specimen was obtained legally, is not to be used for primarily commercial purposes and if its movement will not detrimental to the survival of the species. In the case of a live animal or plant, the government authorities must be satisfied that the recipient can house and care for it properly.

To trade an Appendix II specimen, the owner must have an export permit from the country of origin. This will be issued only if the specimen was legally obtained and if the export will not be detrimental to the survival of the species. No import permit is needed unless it is transported by sea or required by the national law of the country concerned.

Given the explicit purpose of the convention, there is no need to add any other Saint Lucian reptiles or amphibians to the appendices yet. Apart from marine turtles, iguanas and boas, which are correctly covered, the other reptiles and amphibians are not known to be threatened by unregulated, unsustainable trade. Some species

are *potentially* at risk from the international pet trade (see Section 4.3.3), but Saint Lucia can use the Wildlife Protection Act to prohibit or regulate their collection and export.

4.5 What are the constraints to the management of reptiles and amphibians?

4.5.1 Legal mechanisms for protecting species and habitats

Some of the main legal mechanisms for conserving these animals and their habitats were discussed in the previous section. Despite being excellent in many respects, the Wildlife Protection Act contains some notable weaknesses that, in its current form, make it ill-suited for protecting species against some of the major threats to their survival, including alien invasive species and the loss of critical breeding habitats outside of reserves. It is not clear how feasible it would be to adjust this Act to encompass these wider issues.

4.5.2 Public attitudes towards reptiles and amphibians

Throughout the developed and developing world alike, most people dislike or are indifferent to reptiles and amphibians. Many simply do not see the point in conserving them, especially species they find repulsive or frightening.

This appears to be the case in Saint Lucia. Building on the successes of the Saint Lucia parrot conservation programme, however, excellent and important groundwork has already been done by the Forestry Department, Durrell and RARE, among others, to raise public understanding and appreciation of the handsome Saint Lucia iguana and the colourful Saint Lucia whiptail lizard. Most people comply with their protection, and some individuals, including a number of Forestry Department staff, have become rather fond of and even proud of these beasts. The iguana and whiptail lizard awareness campaigns have benefited from the fact that the target animals are harmless, easily recognised, unique to Saint Lucia, and restricted to small areas where they do not inconvenience many people.

As this report has highlighted, a number of other species in Saint Lucia also require, or could soon require, more concerted conservation efforts. The success of such initiatives will depend on the understanding and support of the public, especially landowners, and policy makers. This in turn will require education and promotion of the need and reasons to manage these animals sustainably. Given that alien invasive species are the single greatest threat to native herpetofauna, it important that more people understand the dangers of releasing non-native species on Saint Lucia. John (2001) highlighted the impressive level of public awareness of the problems of hunting and habitat loss, but indicated little awareness of which species are alien or the harm they cause.

Conserving the Saint Lucia racer will be particularly challenging, given the widespread dislike of snakes and our human tendency to perceive snakes as being very abundant even if only one or two are seen. The experiences and methods of the Antiguan Racer Conservation Project in popularising the critically endangered Antiguan racer *Alsophis antiguae* could be useful here (Daltry *et al*. 2001). This project demonstrated that the attitudes of the public and politicians can, over time, be turned in favour of conserving such snakes.

Undoubtedly, the greatest challenge ahead will be in convincing the public that the Saint Lucia fer-de-lance is (a) a truly indigenous species that belongs in Saint Lucia and, having accepted this, (b) worthy of conserving in spite of it being potentially dangerous. Even within the Forestry Department, many employees do not hesitate to kill the fer-de-lances on sight, including snakes in remote areas where they pose no real danger to anyone. It would therefore be wise to begin by addressing message ‘a’, beginning within the Forestry Department itself, while at the same time improving first aid and professional medical treatments to reduce the threat to human life posed by this snake. It is not impossible to conserve even potentially dangerous animals – as many

countries that conserve big cats, bears, wolves and crocodiles can attest – but it is crucial to gain the support of the local law enforcement agencies and other stakeholders first.

For the smaller reptiles, the first step will be to teach people that they even exist. Most members of the public and visitors do not differentiate between the pygmy geckos, or other forest lizards, and the common house geckos they see on the walls of their houses every evening. It would be very worthwhile to educate the people that there are a variety of species on Saint Lucia, and some of them rare, interesting and even quite attractive when examined closely.

4.5.3 Understanding of species' status, needs and threats

This constraint should not be overstated. Politicians and wildlife managers often point to a lack of scientific information as an excuse for not taking any action. Many of the needs of, and threats to, Saint Lucia's reptiles and amphibians are in fact very clear. Even where local data are scarce, sensible management decisions can be informed by studies and experiences in other countries in the Lesser Antilles (Section 4.3).

Nevertheless, there are *some* critical information gaps that make it difficult to know how best to manage certain species on Saint Lucia. For example, there have been no recent reports of the Maria Islands worm lizard *Gymnophthalmus pleii nesydrion* (an endemic to the Maria islands): does this unique animal still exist? The status and ecology of the Saint Lucia racer *Liophis ornatus*, is so poorly known that we cannot even judge whether it would be safe and feasible to transfer any individuals to another island or to a captive breeding programme. Some of the most pressing research priorities are outlined in Section 6.

4.5.4 Human and financial resources

This constraint has become a cliché because few countries or organisations consider themselves to have all the funding and skilled human resources they would like to manage wildlife. Saint Lucia is no exception, and it is therefore necessary to prioritise which actions to take, based on conservation need, public and political interest, cost-effectiveness, probability of success, and other important considerations.

Importantly, the Forestry Department – the authority with the mandate for managing terrestrial wildlife and their forest habitats – is one of the best resourced and staffed in the region. Its staff include a number of highly trained, experienced, motivated and capable wildlife managers, and the department is widely respected by the public. The department also benefits from partnerships with a number of external organisations that bring additional human and financial resources, notably the Durrell Wildlife Conservation Trust. Nevertheless, the department must focus on what it can do within the constraints of its finite resources, and, where possible, try to engage the assistance of other actors - e.g. the port authority, the Saint Lucia National Trust, schools, and private landowners - to support its management objectives.

The recommendations in chapter 6 are therefore not intended to be a complete list of all that can be done to conserve and manage, but a pragmatic shortlist of some of the most important and feasible actions that the department and its partners can address during the next five-to-ten years.

4.5.5 Technical limitations

Some of the needs of, and threats to, Saint Lucia's herpetofauna may be impossible to address even with the best technology currently available.

For example, the eradication of certain alien invasive species is impractical over a large area. To eradicate the mongoose from the whole island of Saint Lucia would be the single greatest action this country could take to benefit its native wildlife, but mongoose eradications have never been attempted on such a scale before, and I am not aware of any safe method that is likely to succeed. Other countries are studying and experimenting with

different ways of controlling mongooses, mink, stoats and related mammals, however, so it is possible that an effective technology will emerge in the future.

There appear to be even fewer options to contain, let alone reverse, the spread of Watts' anole *Anolis wattsi*, without inadvertently harming the native Saint Lucia anole, *A. luciae* and other lizards. For such alien invasive species, it is easier to prevent them from invading the country in the first place than to eliminate them afterwards. Preventing invasion should be especially easy to implement for the offshore islands, which make excellent natural sanctuaries for threatened reptiles.

5 Forest Species Profiles

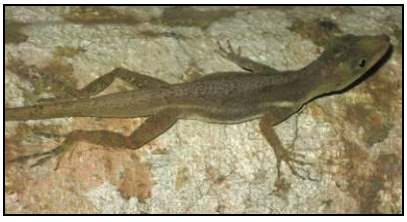
5.1 Preamble

This section is intended to provide a snap-shot of the biology, distribution and management issues of every species of reptiles and amphibian that has been recorded on Saint Lucia. It draws upon the findings and discussions in the previous chapters. Although the use of citations will be minimized in this section in order to save space, the statements are supported by either the findings of my field survey (chapter 3) or references cited in chapters 3 and 4. Exceptionally useful sources are given at the end of each profile. Management recommendations for each species are indicated on each profile, the most important of which are detailed in chapter 6.

This is *not* intended to be a definitive identification guide: some species would be difficult to identify with 100% accuracy using this chapter alone. For example, the two whistling frogs (*Eleutherodactylus johnstonei* and *E. martinicensis*) are easily confused with one another, as are the three anole lizards (*Anolis extremus*, *A. luciae* and *A. wattsi*), especially when young. In fact most species of reptiles and amphibians are extremely variable in appearance, and do not always look exactly like these photographs of 'typical' specimens. (To illustrate this point, Figure 9 shows different colour varieties of the Saint Lucia anole, one of the *least* variable species in its genus!). Nor can this report cover all of the species that might *potentially* invade and breed on Saint Lucia in the future. There are, after all, many other similar species of *Anolis*, *Eleutherodactylus* (a vast genus with more than 400 species), *Sphaerodactylus*, *Leptotyphlops*, etc., in the Caribbean that could reach Saint Lucia by human transport.

Anyone seriously interested in conducting further herpetological surveys or other research on Saint Lucia should therefore consult the sources recommended below, especially Schwartz & Henderson's (1991) *Amphibians and Reptiles of the West Indies. Descriptions, Distributions, and Natural History*, published by University of Florida Press. There are several copies of this book on Saint Lucia, and limited previews of the book can also be found online at <www.books.google.com>. For electronic copies of the pages describing Saint Lucian species, send a request to <jenny.daltry(AT)fauna-flora.org>. For a handy, illustrated introduction to some Saint Lucia species, Malhotra & Thorpe's (1999) *Reptiles & Amphibians of the Eastern Caribbean*, published by Macmillan Education Ltd, is readily available on Saint Lucia.

Figure 9. Natural variation in the Saint Lucia anole, *Anolis luciae.*



Maria Major (offshore island)

Cas En Bas (North-East coast)

Millet (West-Central)

Woodlands (South-Central)

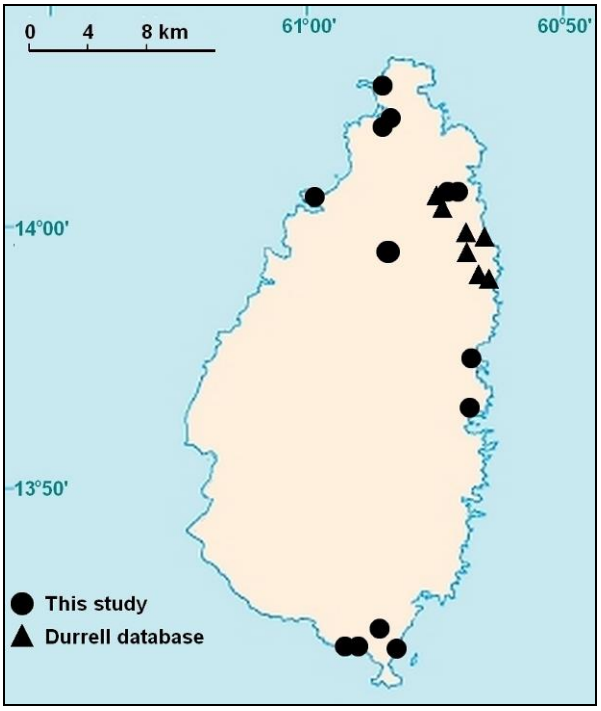
Praslin (East)

Morne Beausejour (South)

5.2 Cane Toad

Scientific Name	***Bufo marinus***
Creole Name	Kwapo, Kwapo-Lad
Alternative Names	Marine toad
Native status on Saint Lucia:	Non Native
Endemicity:	Latin America and Central America
IUCN (2009) Category of Threat (International):	Least Concern
Recommended Category of Threat (International):	Least Concern
Recommended Category of Threat (National):	N/A (Alien Species)
CITES	Not listed
Wildlife Protection Act 1980 (amended 2001)	Not specified

Figure 10. Adult female cane toad in La Sorciere (J. Daltry, FCG-FFI)



Identification

A heavily built toad with short legs, growing up to 15cm long. Fingers lack webs, but the toes are heavily webbed. Adults have a rough, warty skin, coloured tan, brown or dark brown, dull green or black. The ear drum (tympanum) is distinct, about one half to two thirds the size of the eye. Venom glands are widely distributed around the surface of the skin and aggregated together to form large parotoid glands, found on each shoulder. These glands are able to ooze or squirt a white toxic secretion. Eggs are laid in long strands. Tadpoles are between 10 and 25mm in length. The body and tail of the tadpole is dark brown or black (unlike the red-snouted tree frog tadpole, which is almost white). The male's mating call is a high pitched 'brrrr' resembling the dial tone of a telephone or a small outboard motor engine.

Population status and distribution

Common and widespread at lower elevations. Likely to increase wherever new water bodies are constructed or forests cleared.

Habitat

In Saint Lucia, typically occurs in agricultural areas, lakes, natural forests, ravines, urban and suburban areas, and wetlands. Uncommon in rainforest. Incapable of reproducing on the offshore islands due to the absence of standing water. Toads and tadpoles are able to tolerate high levels of salinity.

Diet

Cane toads will eat almost any terrestrial animal, but especially those active at ground level at night, but also feed on carrion and dog food, including rice. Often seen beneath street lamps at night, feeding on insects attracted to the artificial light.

Reproduction

Cane toads usually stay on dry land and reproduce in any shallow water nearby. Cane toads breed between the months of April and September, and males can be heard calling in late March. Every year, the female cane toad produces two strings of 8,000 to 35,000 eggs, which can be seen floating on the surface of water in a jelly-like string or wrapped around vegetation and other debris in the water. Eggs hatch within 24 to 72 hours into tiny, shiny black tadpoles. Approximately 0.5% survive to maturity, which takes a year, by which time the toads are about 75mm long.

Threats

Probably affected by heavy use of pesticides on banana plantations and other agricultural areas. Rats have been recorded preying on cane toads, but not at a large enough scale to impact populations.

Other Issues

The cane toad was introduced to Saint Lucia as a biological control for insect pests. The toad secretes a white toxic liquid from it parotid glands when provoked or pressure is applied, such as a predator grasping the toad in its mouth. The toxic secretions are known to cause illness and death in both domestic and wild animals that come into contact with toads, such as dogs, cats, snakes and lizards. Cane toads are able to squirt the toxic secretion over a metre when threatened, causing extreme pain if rubbed into the eyes. Human fatalities have been recorded from the cane toad, following ingestion of the eggs or adults. Cane toads are considered a nuisance in urban areas because their calls can keep people awake. This species is a carrier of the amphibian fungal disease chytridiomycosis.

Management Recommendations

- List the cane toad as Unprotected under the Wildlife Protection Act.
- Investigate whether cane toads have a significant negative impact by preying on native fauna, specifically pygmy geckos and rough-scaled worm lizards.
- Island-wide eradication is unlikely to be successful, but hand-collecting and exclusion fences could usefully remove cane toads from localized areas to benefit small native fauna.
- Assist amphibian conservation in other tropical countries by prohibiting, screening and removing toads from exported cargo.

Important References

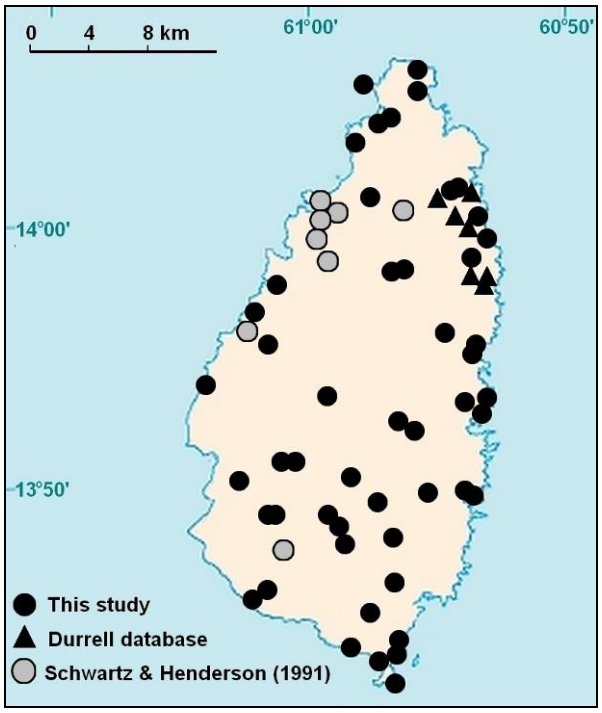
Lever, C. (2001) *The Cane Toad: the History and Ecology of a Successful Colonist*. Westbury Publishing, West Yorkshire.

ISSG website: http://www.issg.org/database/species/distribution.asp?si=113&fr=1&sts=sss&lang=EN

5.3 Johnstone's Whistling Frog

Scientific Name	***Eleutherodactylus johnstonei***
Creole Name	Ti tolin
Alternative Names	Robber frog, tink frog
Native status on Saint Lucia:	Native
Endemicity:	Saint Lucia
IUCN (2009) Category of Threat (International):	Least Concern
Recommended Category of Threat (International):	Least Concern (see page 28)
Recommended Category of Threat (National):	Least Concern
CITES	Not listed
Wildlife Protection Act 1980 (amended 2001)	Not specified

Figure 11. Adult Johnstone's whistling frog in Forestiere. NB Colour pattern is highly variable. (J. Daltry, FCG-FFI)



Identification

[Also see the description for the very-similar Martinique whistling frog]. A very small frog: adult males 17-25mm long and adult females 17-35mm. Back is brown to grey-tan with usually at least one, often two darker chevrons. Often a pale narrow pinstripe down the spine or a broad pair of pale dorsal stripes. Backs of thighs are marbled, stippled, or blotched on a dark brown to grey-tan ground colour. No red on hindlegs or in groin. Creamy underside, often with dark stippling on the throat. Large eyes, with iris gold above and brownish below. Round finger and toe disks, without webbing. Adult males have paired vocal slits and lack nuptial thumb pads.

Eggs laid beneath logs and other damp places on land. Each clutch contains 10-30 pale, unmarked eggs covered in a thin layer of viscous mucus. Newly laid eggs average around 3mm in diameter. There is no tadpole stage. The male's call is a two-note whistle that can be repeated up to 60 times per minute. First note, frequency about 2 kHz for 70-90 milliseconds. Longer second note, lasting 180-270 milliseconds, that rises sharply from about 3 to 4 kHz.

Habitat

In Saint Lucia, occurs in agricultural and urban areas, and all major forest classes. Usually spend the day in moist crevices, including beneath logs, rocks, coconut husks and other objects on the ground.

Population status and distribution

Abundant and widespread, from sea level to mountain peaks. Probably naturally absent from offshore islands.

Diet

Small live invertebrates: mostly ants, but also spiders, leafhoppers, and springtails. Mainly forages at night.

Reproduction

Capable of breeding all year, peaking during the rainy season. Female approaches a calling male to initiate courtship and follows the male to a damp place to lay eggs. Froglets with stumpy tails hatch from the eggs, about 4mm long. The tails disappear within a day, and the froglets reach sexual maturity in about one year.

Threats

Probably adversely affected by the use of pesticides on banana plantations and other agricultural areas. Potentially threatened by introductions of other non-native *Eleutherodactylus*.

Other Issues

Appears to be resistant to the amphibian disease chytridiomycosis. Johnstone's whistling frog is often introduced as a stowaway via trade among the islands and out-competes local frog species, especially in urban and agricultural environments. It is easily confused with the Martinique whistling frog, *E. martinicensis*, which has also been reported on Saint Lucia.

Management Recommendations

- No special management measures required to conserve this species on Saint Lucia.
- Support amphibian conservation in other tropical countries by prohibiting, screening and removing frogs from exported cargo.

Important References

Breuil, M. (1997) *L'herpétofaune de la Réserve Biologique Domaniale de la Montagne Peléé*. Office National des Forêts de Martinique, Fort-de-France, Martinique, and Association des Amis du Laboratoire des Reptiles et Amphibiens du MNHN, Paris. [In French].

Kaiser, H. (1997) Origins and introductions of the Caribbean frog *Eleutherodactylus johnstonei* (Leptodactylidae): management and conservation concerns. *Biodiversity Conservation* 6, 1391-1407.

Kaiser, H., & Hardy, J.D. (1994) *Eleutherodactylus johnstonei* Barbour, Johnstone's Whistling Frog, Rainette de Johnstone. *Catalogue of American Amphibians and Reptiles*, No. 581, 1-5.

Hedges, B., Ibéné, B., Koenig, S., La Marca, E., Ibáñez, R., & Hardy, J. (2004) *Eleutherodactylus johnstonei.* In *2009 IUCN Red List of Threatened Species. Version 2009.1*. <www.iucnredlist.org>.

For illustrations of this highly variable species, see:
http://calphotos.berkeley.edu/cgi/img_query?query_src=aw_maps_geo-noam&where-taxon=
Eleutherodactylus+johnstonei&rel-taxon=begins+with&where-lifeform=specimen_tag&rel-lifeform=ne

5.4 Martinique Whistling Frog

Scientific Name	***Eleutherodactylus martinicensis***
Creole Name	Gounouy (Martinique)
Alternative Names	Martinique Robber Frog
Native status on Saint Lucia:	Probably Non Native. [Probably Extinct on Saint Lucia]
Endemicity:	Martinique
IUCN (2009) Category of Threat (International):	Near Threatened
Recommended Category of Threat (International):	Near Threatened
Recommended Category of Threat (National):	N/A (Alien Species)
CITES	Not listed
Wildlife Protection Act 1980 (amended 2001)	Not specified

Figure 12. Adult Martinique whistling frog on Dominica (© J. Daltry, FFI, above)

Identification

The Martinique frog is very similar in appearance and behaviour to Johnstone's whistling frog, and often confused even by specialists. It is a small frog, but typically larger (and with proportionally longer legs) than *E. johnstonei*: adult males average 32mm long and adult females 47mm. The back is normally dark brown with usually one or two darker chevrons. Usually a narrow dark band between the eyes. Often a pale, broad stripe down the spine or a broad pair of pale dorsal stripes (as seen in *E. johnstonei*). Frequently with red on the hindlegs or in the groin (unlike *E. johnstonei*). White or pale yellow underside, often heavily stippled with dark brown (unlike *E. johnstonei*). Large eyes with silvery, golden or bronze iris. Round finger and toe disks, without webbing. The vocal sac of the male has many glands.

Pale, unmarked eggs, covered in a thick layer of jelly, are laid beneath logs and other damp places on land. Newly laid eggs average around 4mm in diameter (slightly larger than *E. johnstonei*). There is no tadpole stage. The male's call is a two-note whistle approximately 0.35 seconds long. The first note is at 2kHz, and the second, longer note starts at 3.2kHz and rises to 4.2kHz.

Habitat

Prefers lush tropical habitats near water, but will use other habitats, including dry forests, and urban areas. When introduced, they typically remain in lowland agricultural areas and are absent from rainforests. Often enter houses and may be seen near artificial lights at night, feeding on insects. Remain hidden under rocks and logs during the daylight hours.

Population status and distribution

Absent from Saint Lucia (no recent confirmed records). Usually inferred to have originated on either Martinique or Guadeloupe.

Diet

Small live invertebrates. Forage mainly at night.

Reproduction

Capable of breeding all year, peaking during the rainy season. Males perch in vegetation about a metre above the ground to call and are typically found on agaves, broad-leafed grasses, etc. This species breeds in sites with abundant ground cover and high moisture in the soil, such as decaying plant foliage or compost heaps. Froglets hatch from the eggs about 5mm long.

Threats

N/A. In its native range, this species is affected by introduced predators, such as cats, rats and mongooses, by forest loss, and possibly also by pesticides. *Eleutherodactylus johnstonei* appears to be a competitor, and capable of replacing this species in open areas.

Other Issues

The Martinique whistling frog is often introduced as a stowaway via trade among the islands and out-competes local frog species, especially in agricultural environments. It is apparently unable to out-compete Johnstone's whistling frog, however.

Management Recommendations

- Remove whistling frogs from imported cargo to prevent invasions by this or other non native species.

Important References

Breuil, M. (1997) *L'herpétofaune de la Réserve Biologique Domaniale de la Montagne Peléé*. Office National des Forêts de Martinique, Fort-de-France, Martinique, and Association des Amis du Laboratoire des Reptiles et Amphibiens du MNHN, Paris. [In French].

Kaiser, H. (1992) The trade-mediated introduction of *Eleutherodactylus martinicensis* (Anura, Leptodactylidae) on St-Barthélémy, French-Antilles, and its implications for Lesser Antillean biogeography. *Journal of Herpetology*, 26, 264-273.

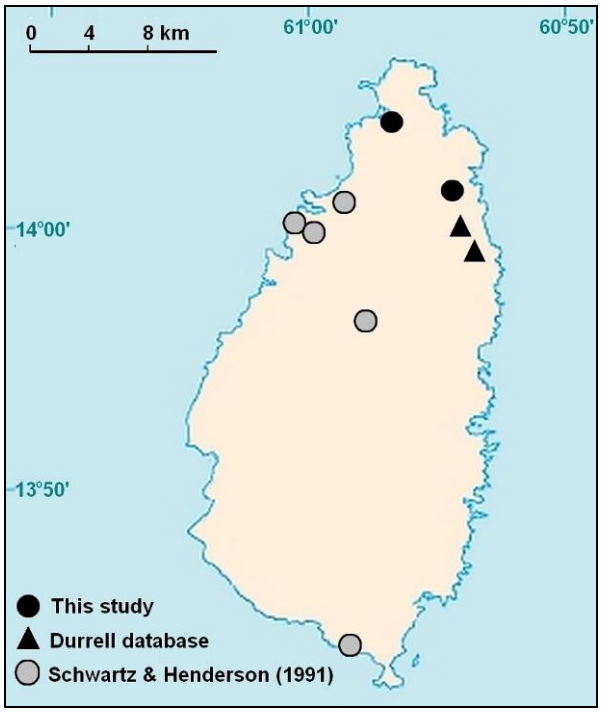
Kaiser, H., & Hardy, J.D. (1994) *Eleutherodactylus martinicensis* (Tschudi). Brown Whistling Frog, Rainette brun [sic]. *Catalogue of American Amphibians and Reptiles*, No. 582, 1-4.

Hedges, B., Ibéné, B., Breuil, M., & Powell, R. (2004) *Eleutherodactylus martinicensis*. In: *2009 IUCN Red List of Threatened Species. Version 2009.1.* <www.iucnredlist.org>.

5.5 Red-Snouted Tree Frog

Scientific Name	***Scinax ruber***
Creole Name	Unknown
Alternative Names	Unknown
Native status on Saint Lucia:	Non Native (Introduced)
Endemicity:	Mesoamerica, including Trinidad and Tobago
IUCN (2009) Category of Threat (International):	Least Concern
Recommended Category of Threat (International):	Least Concern
Recommended Category of Threat (National):	N/A
CITES	Not listed
Wildlife Protection Act 1980 (amended 2001)	Not specified

Figure 13. Adult red-snouted tree frog, Desbarra (©M. Morton, Durrell Wildlife Conservation Trust)



Identification

A medium-sized tree frog: adult males 31-37mm long and adult females 40-42mm. Back is normally yellow or cream (males) of brown to grey (females) with dark brown longitudinal spots. Thighs dark with yellow or orange spots. Underside yellow or white (males) or cream (females). Iris bronze to grey.

Egg clutches comprise approximately 590 eggs that adhere to vegetation on edges of temporary ponds. Tadpoles fall into ponds at hatching. The tadpoles are pale, almost white (unlike cane toad tadpoles, which are jet black).

Habitat

Prefers open areas, borders and clearings.

Population status and distribution

Established on Saint Lucia since 1891, but still localized and often associated with disturbed habitats. Most abundant near Castries and Desbarra, but the recent development of a Club Mediterranee complex near the Hewanorro International Airport had reportedly brought tree frogs to the southern end of the island. Further developments may enable the species to extend its range.

Diet

Small live invertebrates. Forages mainly at night.

Reproduction

Capable of breeding all year, peaking during the rainy season. Males call from branches at the edge of or over water. Typically breeds in roadside ditches and shallow, temporary ponds.

Threats

Likely to be adversely affected by the use of pesticides and preyed on by alien mammals. Probably susceptible to the amphibian disease chytridiomycosis (not yet recorded in Saint Lucia, but present elsewhere in the Lesser Antilles).

Other Issues

The red-snouted tree frog is sometimes introduced as a stowaway via trade among the islands (including Saint Martin in 1990s, Puerto Rico in 1988, Martinique in 1997 and Guadeloupe in 2003). Although it will prey on smaller frogs and has therefore been considered a threat to whistling frogs on the French islands, it appears to have had negligible impact on Saint Lucia's abundant populations of Johnstone's whistling frog.

Management Recommendations

- Support amphibian conservation in other tropical countries by prohibiting, screening and removing frogs from exported cargo.

Important References

Solís, F., Ibáñez, R., Jaramillo, C., Fuenmayor, Q., Azevedo-Ramos, C., La Marca, E., Coloma, L.A., Ron, S., Hardy, J., Hedges, B., Ibéné, B., Breuil, M., & Powell, R. (2004) *Scinax ruber*. In *2009 IUCN Red List of Threatened Species. Version 2009.1.* <www.iucnredlist.org>.

5.6 Mountain Chicken

Scientific Name	***Leptodactylus fallax***
Creole Name	Kwapo
Alternative Names	Giant ditch frog
Native status on Saint Lucia:	Probably Native. Extinct on Saint Lucia.
Endemicity:	Lesser Antilles
IUCN (2009) Category of Threat (International):	**Critically Endangered**
Recommended Category of Threat (International):	**Critically Endangered**
Recommended Category of Threat (National):	**Extinct** (see page 28)
CITES	Not listed
Wildlife Protection Act 1980 (amended 2001)	Not specified

Figure 14. Adult mountain chickens, photographed on Montserrat in 1998 (© J. Daltry, FFI).

Identification

One of the world's largest frogs, with adults reaching up to 210mm long. Back colouration is either uniform chestnut-brown or spotted and barred, and more orange-yellow on the side. Underside is pale yellow. The thighs usually have broad, dark bands on their upper surface. Males have hard spurs on each hand. This can be distinguished from other members of its genus by the following characteristics: folds of skin running from eye to groin; lack of breast spines; lack of light striping on upper lip; elongated hind limbs; small tubercles on the back and sides of the body; small fold present over the ear drum, curving sharply towards the angle of the jaw.

Eggs are rarely seen because they are laid in a foam nest in a burrow away from water. Tadpoles, also raised in the burrow, can reach 110mm in length, of which 80% is tail. Males make a loud whooping call at 500-1500kHz during the breeding season that can be heard up to a kilometre away.

Habitat

Moist to wet woodland and forests. Can tolerate some disturbance. On Dominica and Montserrat it occurs from close to sea level up to 430 metres above sea level, usually in dense secondary forests and ravines.

Population status and distribution

Historical presence on Saint Lucia reported, but unverified.

Diet

Small live animals, including crickets, beetles, snails, millipedes, woodlice, small reptiles, amphibians and mammals. Ambushes prey at night.

Reproduction

Mountain chickens breed during the rainy season. Males dig burrows and make a whooping call to attract females, followed by a "trilling bark" (100-120 calls/min) to direct the female into the burrow. The mating pair creates a foam nest in which the eggs are laid. Males remain outside the burrow, within a metre of the entrance, and defend the burrow if intruders approach. Females rarely leave the nest, apparently doing so only to feed. Once larvae hatch, females provide the tadpoles with unfertilized eggs to feed on roughly once every three days (range 1-11 days). Larval development is complete within 45 days, with 26-43 young froglets emerging from the burrow.

Threats

In Montserrat and Dominica, the mountain chicken is threatened by the amphibian fungal disease chytridiomycosis (primary threat), hunting, loss of mesic forests, and alien invasive predators. Chytridiomycosis broke out on Dominica in 2002 and was first reported in Montserrat in 2009.

Other Issues

Originally found on Dominica, Guadeloupe, Martinique, Montserrat, and Saint Kitts and Nevis, records from Saint Lucia and Antigua are historical and unconfirmed. The mountain chicken is now found only to Dominica and Montserrat where populations have crashed due to chytridiomycosis. Captive populations from both islands are in UK and USA. Any attempt to reintroduce it to Saint Lucia is unlikely to succeed without addressing the risk of chytridiomycosis and alien invasive predators.

Management Recommendations

- None.

Important References

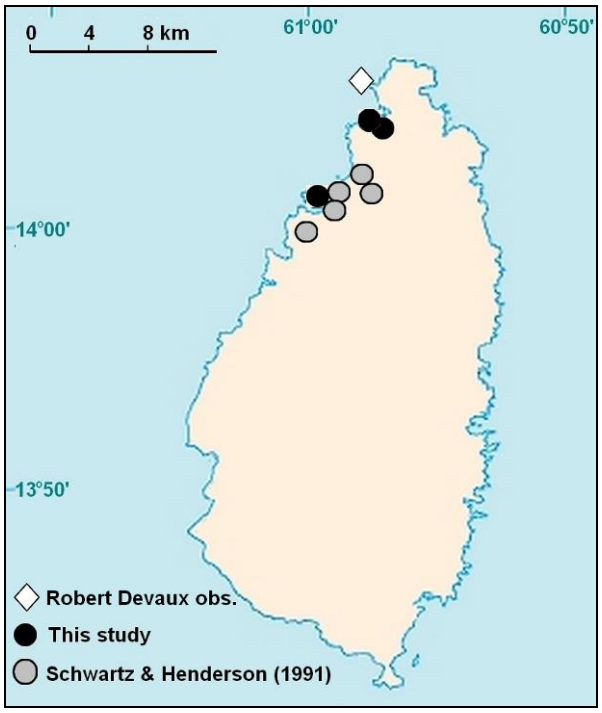
Fa, J., Hedges, B., Ibéné, B., Breuil, M., Powell, R., & Magin, C. (2004) *Leptodactylus fallax*. In *2009 IUCN Red List of Threatened Species. Version 2009.1*. <www.iucnredlist.org>.

Martin, L., Morton, M.N., Hilton, G.M., Young, R.P., Garcia, G., Cunningham, A.A., James, A., Gray, G., & Mendes, S. (eds) (2007) *A Species Action Plan for the Montserrat Mountain Chicken* Leptodactylus fallax. Department of Environment, Montserrat.

5.7 Barbados Anole

Scientific Name	***Anolis extremus***
Creole Name	Zanndoli
Alternative Names	Extreme anole
Native status on Saint Lucia:	Non Native
Endemicity:	Barbados
IUCN (2009) Category of Threat (International):	Not Evaluated
Recommended Category of Threat (International):	Least Concern
Recommended Category of Threat (National):	N/A (Alien Species)
CITES	Not listed
Wildlife Protection Act	Not specified

Figure 15. Adult male Barbados anole on Vigie Beach (J. Daltry, FCG-FFI)



Identification

A fairly large, arboreal anole, similar in size to the Saint Lucia anole. Males: Up to 85mm from snout to tail-base. Mossy green with dark brown or black markings and sometimes pale spots, mainly in the front half of the body. The front half may also have a lavender or grey hue. Head blue grey or lavender. Dark ring around eye. Dewlap yellow or orange with greenish scales. Females: Up to 60mm from snout to tail-base. Similar colour to males but duller, and may have a striped or obsolete pattern down the spine.

Habitat

On Saint Lucia, mainly in gardens, urban areas and adjoining patches of forest. Not recorded in deep forest.

Population status and distribution

First recorded on Saint Lucia in 1976, by which time there was already a well established, abundant population between Castries and Vigie, with scattered individuals elsewhere. It appears to have extended its range to at least as far north as Rodney Bay, but is still localised and apparently confined to urban and suburban areas.

Common and widespread on its native Barbados, with introduced populations on Bermuda, Trinidad and elsewhere.

Diet

Very varied, including ants, spiders, crickets, cockroaches, grasshoppers, insect larvae, and occasionally fruit. Barbados anoles are "sit and wait" predators that perch on tree trunks, branches and bushes, scanning the ground and undergrowth for prey.

Reproduction

The female lays and buries one or two eggs in a shallow nest in the soil.

Threats

N/A. Preyed on by mongooses, but apparently not enough to have a significant impact on their numbers.

Other Issues

This anole is capable of displacing the Saint Lucia anole *A. luciae*, at least from localized areas, and thus might seriously endanger the endemic anole if it spreads more widely. It has not spread very far during the past thirty years, however, which suggests it may be unable to compete with *A. luciae* outside of the urban and suburban environment. An island-wide eradication is unlikely to be either necessary or feasible, but removal by hand could be effective on a local scale.

Management Recommendations

- List the Barbados anole as Unprotected under the Wildlife Protection Act.
- Monitor the distribution of the Barbados anole and be vigilant for it invading the forest.
- Support reptile conservation in other tropical countries by prohibiting, screening and removing anole lizards from exported cargo.

Important References

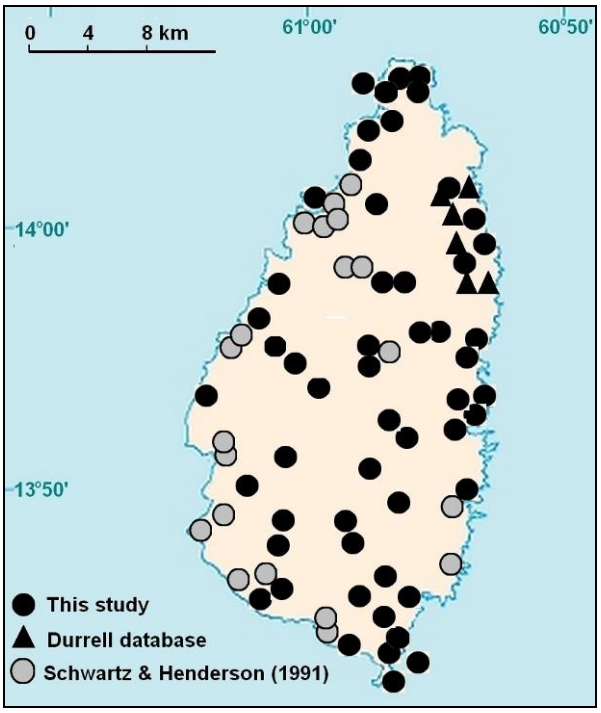
Gorman, G.C. (1976) Observations on the distribution of *Anolis extremus* (Sauria: Iguanidae) on St. Lucia, West Indies - A "colonizing" species. *Herpetologica* 32, 184-188.

Lever, C. (2003) *Naturalized Reptiles and Amphibians of the World*. Oxford University Press, Oxford.

5.8 Saint Lucia Anole

Scientific Name	***Anolis luciae***
Creole Name	Zanndoli
Alternative Names	Saint Lucia tree lizard
Native status on Saint Lucia:	Native
Endemicity:	Endemic to Saint Lucia
IUCN (2009) Category of Threat (International):	Not Evaluated
Recommended Category of Threat (International):	Least Concern (see page 28)
Recommended Category of Threat (National):	Least Concern
CITES	Not listed
Wildlife Protection Act 1980 (amended 2001)	Not specified

Figure 16. Adult male, Barre de Lisle (top) and female, Cas en Bas (J. Daltry, FCG-FFI)



Identification

A fairly large, anole, slightly bigger than the Barbados anole. Males: Up to 91mm from snout to tail-base. Very variable ground colour, from pale apple-green to dark brown, with the back patternless or marked with chevrons or mottling. Creamy white to blue flank stripe, sometimes obscure but usually paler and conspicuous above the forelimb. No dark ring around eye (unlike *A. extremus*). Underside tan-white or with a yellow wash. Dewlap greyish yellow or dull orange with white scales, or plain grey to brick red with green scales. Females: Up to 63mm from snout to tail-base. Back colour is duller and browner than males. Dark chevrons with white posterior borders, with or without a pale stripe down the spine. Pale stripe down the side, whiter and more clearly defined over the forearm, but not quite touching the pale throat. Iris turquoise, blue or dark brown.

Habitat

All forest classes from sea level to the mountain peaks, with the possible exception of Elfin Shrubland. Also common in suburban and recreational areas, and present throughout agricultural areas. Most abundant in

mature Semi-Evergreen Seasonal Forest and Deciduous Seasonal Forest. Males perch 1-4 metres above the ground; females and juveniles tend to be lower, frequently on the ground.

Population status and distribution

Abundant and widespread on the main island of Saint Lucia and the offshore islands. The Saint Lucia anole is less common on plantations or other areas where natural forest habitat has been cleared or degraded by human activity, and it appears to be suffering from competition from the invasive anoles *A. wattsi* and *A. extremus*, but not at severe rate or scale. There are estimated to be just under 1,000 Saint Lucia anoles per hectare of forest (all classes), which translates into a total population in the tens of millions. In some lowland and coastal forests, almost every tree has a pair of anoles.

Diet

Varied, including ants, spiders, crickets, cockroaches, grasshoppers, and insect larvae, often caught on the ground. They are "sit and wait" predators that perch on trees, walls and other vantage points, scanning the ground and undergrowth for prey.

Reproduction

Female lays and buries one or two eggs in a shallow nest in the soil.

Threats

N/A. Preyed on by mongooses, but apparently not enough to have a significant impact on their numbers. There is mounting evidence that this species has been displaced from localized areas (mainly urban/ suburban areas) by the introduced Barbados anole *A. extremus*, and Watts' anole, *A. wattsi*.

Management Recommendations

- Protect the Saint Lucia anole under the Wildlife Protection Act.
- Monitor the spread of the alien invasive *Anolis wattis* and *Anolis extremus*, and prevent them from being transported to the offshore islands.
- Prohibit the import of any non-native *Anolis* species, and screen incoming cargo for *Anolis* stowaways
- Support reptile conservation in other tropical countries by prohibiting, screening and removing anole lizards from exported cargo.

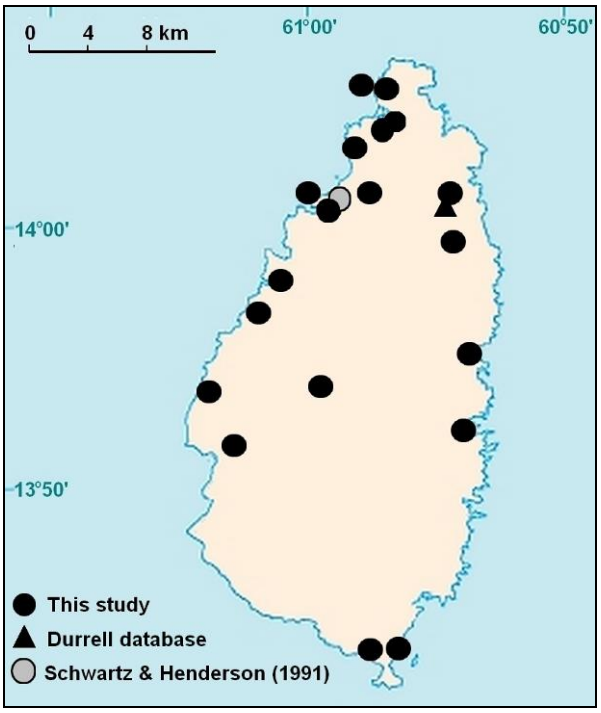
Important References

Schwartz, A., & Henderson, R.W. (1991) *Amphibians and Reptiles of the West Indies. Descriptions, Distributions, and Natural History*. Gainesville, Florida, University of Florida Press.

5.9 Watts' Anole

Scientific Name	***Anolis wattsi wattsi***
Creole Name	Zanndoli
Alternative Names	None
Native status on Saint Lucia:	Non Native
Endemicity:	Subspecies endemic to Antigua
IUCN (2009) Category of Threat (International):	Not Evaluated
Recommended Category of Threat (International):	Least Concern
Recommended Category of Threat (National):	N/A (Alien Species)
CITES	Not listed
Wildlife Protection Act 1980 (amended 2001)	Not specified

Figure 17. Adult male (top) and female Watts' anole (J. Daltry, FCG-FFI)



Identification

Moderate sized anole, generally smaller than the Saint Lucia anole. Males: Up to 58mm from snout to tail-base. Variable ground colour, including tan, brown, grey-brown, olive or blue-green, with or without faint dark bands. Snout often has an orange hue and the rest of the head may have a sky-blue hue. Chin cream, orange or yellow, sometimes with black dots. Underside dirty white, yellow-brown or yellow. Dewlap white, yellow or orange, with pale blue or white scales. Females: Up to 46mm from snout to tail-base. Back rich brown or grey-brown, usually with a pale grey stripe down the spine, often bordered with a darker colour. Head may have a slightly red, green or blue hue, but less colourful than mature males. Underside dirty white, cream, or yellow. Often have a white stripe down the side, continuous with the white throat.

Habitat

Usually on or near buildings, bridges or other man-made structures. Typically in lowland areas (urban, suburban, disturbed seasonal forests), but have been recorded up to 259 metres above sea level (Millet, on the

edge of the rainforest). Males perch up to 60cm above the ground, but females and juveniles tend to be lower, frequently on the ground.

Population status and distribution

This lizard was accidentally introduced to the botanic garden in Castries in or by 1962 and, after a slow start, is now spreading rapidly, especially down the coastlines. Densities on Saint Lucia are as high as 7,200/ha, and this species is capable of reaching densities of more than 9,900/ha.

Diet

Varied, including ants, spiders, crickets, cockroaches, grasshoppers, and insect larvae, usually caught on the ground. Also eat soft fruits, including mangoes. They often perch close to the ground on tree, walls and other vantage points, scanning the ground for prey.

Reproduction

The female lays and buries one or two eggs in a shallow nest in the soil.

Threats

N/A. Preyed on by mongooses and probably other invasive predators, but apparently not enough to have a significant impact on their numbers. Likely to be adversely affected by use of pesticides.

Other Issues

This species is displacing the endemic Saint Lucia anole *Anolis luciae* from urban, suburban and some localized, disturbed, secondary forest sites. It is unlikely to invade the rainforest or other mature, natural forest, but, if it does, it could lead to a reduction in the Saint Lucia anole nationwide. An island-wide eradication is unlikely to be either necessary or feasible, but removal by hand could succeed on a local scale.

Management Recommendations

- List the Watts' anole as Unprotected under the Wildlife Protection Act.
- Monitor the spread of this species and be vigilant for signs that it is invading mature, natural forests.
- Prevent this species from invading the offshore islands, especially Maria islands, by screening all boats and baggage.
- Support reptile conservation in other tropical countries by prohibiting, screening and removing anole lizards from exported cargo.

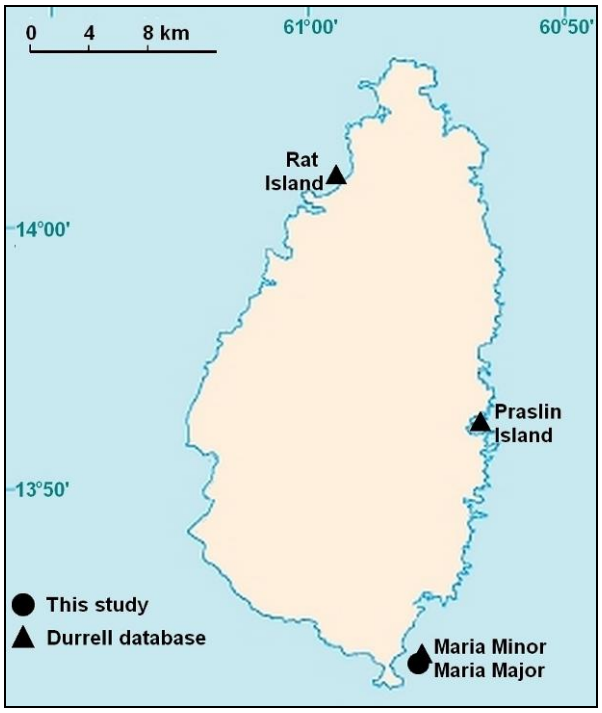
Important References

Schwartz, A., & Henderson, R.W. (1991) *Amphibians and Reptiles of the West Indies. Descriptions, Distributions, and Natural History*. Gainesville, Florida, University of Florida Press.

5.10 Saint Lucia Whiptail

Scientific Name	***Cnemidophorus vanzoi***
Creole Name	Zando
Alternative Names	None
Native status on Saint Lucia:	Native
Endemicity:	Endemic to Saint Lucia
IUCN (2009) Category of Threat (International):	**Vulnerable**
Recommended Category of Threat (International):	**Endangered** (see page 28)
Recommended Category of Threat (National):	**Endangered**
CITES	Not listed
Wildlife Protection Act 1980 (amended 2001)	Protected

Figure 18. Adult male (top) and juvenile Saint Lucia whiptail on Maria Major (J. Daltry, FCG-FFI)



Identification

A fairly large, very active ground lizard. Males: Up to 121mm from snout to tail-base. In typical adult males, the back is dull greenish brown, with very faint tannish stripes, and the snout is blue-grey; light bluish-grey spots on the sides; chin is pale blue and the throat black; underside bright yellow to orange; tail bright green to sea-blue, patched with turquoise. However, some adult males closely resemble females in colour hue and pattern. Females: Up to 95mm from snout to tail-base. Back is paler and browner, becoming dark on the sides; dull ochre stripes down the sides of the body (no yellow or blue); pale, often bluish grey, dots on the sides; had brown; belly and throat clear grey with a rusty wash; white or pale buff spots on thighs. Juveniles of both sexes are similar in appearance to, but smaller than, adult females.

Habitat

Uses all parts of the offshore islands, but especially clearings. Lives mainly on the ground, but occasionally climbs trees.

Population status and distribution

This endemic species is believed to have been formally widespread throughout Saint Lucia (or at least at lower elevations) before becoming confined to two offshore islands, Maria Major and Maria Minor, with a combined area of 12.3 hectares (= 0.02% of the species' historical range). This species was successfully reintroduced to Praslin Island (1.1ha) in 1995 and has since been released on Rat Island (1.3ha), raising its 2009 distribution range to 16.4 hectares and its total population to 2,349. In spite of recent increases, however, this lizard is still in danger of extinction.

Diet

Small live animals, including termites (not ants), scorpions, and springtails, carrion (e.g. dead sea birds) and fruits (e.g. figs, column cactus fruits). Activity forages mostly on the ground.

Reproduction

Not documented, but eggs likely to be from this species were found under rocks on Maria Major in July.

Threats

Unable to coexist with mongooses and other major alien predators. Every population is at risk of problems associated with 'inbreeding depression' (e.g. reduced fertility, reduced resistance to disease) and stochastic factors because of their small sizes. Predicted sea level rises and increased hurricanes and storm surges could reduce the number of whiptail lizards that each offshore island can support.

Other Issues

Probably an important, even essential, prey species for the Saint Lucia racer, *Liophis ornatus*. The Saint Lucia whiptail has been promoted as a flagship species for the Maria Islands.

Management Recommendations

- Retain Saint Lucia whiptail as Protected under the Wildlife Protection Act.
- Translocate whiptail lizards regularly to Praslin and Rat island to enhance genetic diversity, but avoid transferring whiptail lizards from Maria Major to Maria Minor and vice versa.
- Ensure all occupied islands are kept free of rats, mongooses, Watts' anole and other alien species.
- Explore the possibility of creating permanent alien predator-free enclaves on the main island of Saint Lucia to which whiptail lizards could be re-introduced.

Important References

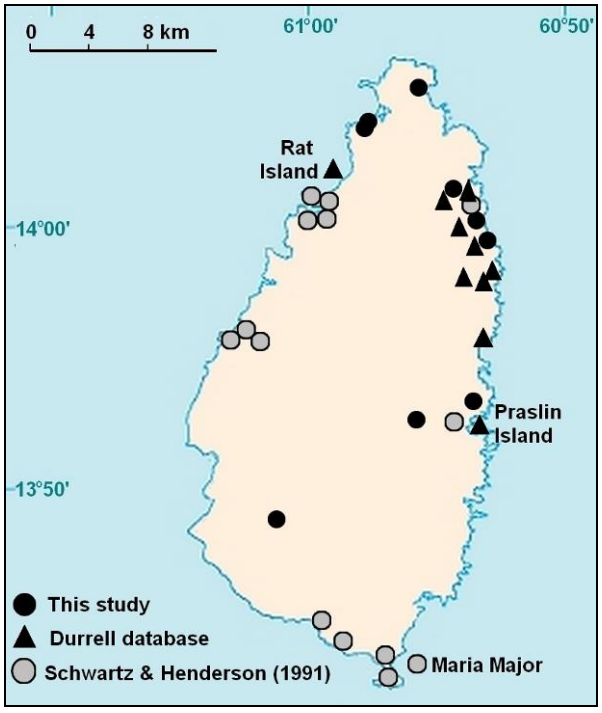
John, C.L. (1999) *Population and Habitat of the St. Lucia Whiptail Lizard (*Cnemidophorus vanzoi*) on Praslin Island, St. Lucia*. Unpublished report, Forestry Department, Ministry of Agriculture, Forestry & Fisheries, Castries, St. Lucia, West Indies (http://www.slumaffe.org/slu_whiptail.pdf).

Young, R.P., Fa, J.E., Ogrodowczyk, A., Morton, M., Lesmond, S., & Funk, S.M. (2006) The Saint Lucia whiptail lizard *Cnemidophorus vanzoi*: a conservation dilemma? *Oryx*, 40, 358-361.

5.11 Rough-Scaled Worm Lizard

Scientific Name	***Gymnophthalmus pleii*** (two subspecies: ***luetkeni*** and ***nesydrion***)
Creole Name	Zanndoli tè, Chofèy solèy, Koylèv-tè (Martinique)
Alternative Names	Pygmy skink, spectacled lizard, Pléei's worm lizard
Native status on Saint Lucia:	Native
Endemicity:	Southern Lesser Antilles. ***G. p. luetkeni*** is endemic to the main island; *G. p.* ***nesydrion*** to Maria Major
IUCN (2009) Category of Threat (International):	Not Evaluated
Recommended Category of Threat (International):	Near Threatened as ***Gymnophthalmus pleii*** (page 29) Near Threatened as ***G. p. luetkeni*** Data Deficient as ***G. p. nesydrion***
Recommended Category of Threat (National):	As above
CITES	Not listed
Wildlife Protection Act 1980 (amended 2001)	Not specified

Figure 19. Adult rough-scaled worm lizard at Grande Anse (J. Daltry, FCG-FFI)



Identification

A small, active, lizard, most easily seen on sunny days, slipping in and out of the leaf litter. Both sexes are up to 48mm long from the tip of the snout to the base of the long tail, and 129mm total length. Shiny, metallic brown, with two golden yellow stripes running from the snout, above the eyes and down each side of the body, usually with a black border below and sometimes above. Sides dark grey-brown or reddish brown. Tail often paler than the body. Underside black to metallic greenish, sometimes pink in mature males. Dark eyes. Could be confused with a young Southern Antillean skink, *Mabuya mabouya*, but has only four toes on the front feet (unlike the skink, with five). This genus is sometimes referred to as the spectacled lizards because their lower eyelids are transparent, which allows them to see with eyes closed.

Underwood's worm lizard *Gymnophthalmus underwoodi*, has not been recorded on Saint Lucia yet, but has invaded several countries nearby, including Saint Vincent and Barbados. This alien can be distinguished from the native *G. pleii* by its smaller size (maximum 44mm from the tip of the snout to the base of the tail), the scales on its back are without keels (whereas the scales on the back of *G. pleii* have keels, albeit weak keels in the subspecies *G. p. nesydrion*) and low number of body scales (only 13 dorsal scales around the middle of the body in *G. underwoodi*, whereas *G. pleii* has more than 15, sometimes as many as 19). Furthermore, *G. pleii* has a dark stripe running down its spine (which is absent in *G. underwoodi)*, its pale dorsal stripes are more conspicuous, and the central five rows of scales on its back are bronze-coloured (only three rows in *G. underwoodi*). Nevertheless, the two species are easily confused even by specialists.

Habitat

Prefers areas with plenty of moist leaf litter and sunny clearings. Appears to be most abundant at lower elevations, in Deciduous Seasonal Forest or drier forms of Freshwater Swamp Forest, but can occur in disturbed areas, such as road embankments.

Population status and distribution

Locally abundant, but very patchy on the main island of Saint Lucia (*G. p. luetkeni*). There are no recent records from Maria Major (*G. p. nesydrion*). An undetermined subspecies is on Praslin and Rat islands.

Diet

Probably preys on small, live invertebrates that live among leaf litter.

Reproduction

Lay small clutches of oval eggs, approximately 6.4mm long.

Threats

Alien invasive predators, including the mongoose and cane toad, could be responsible for eliminating this species from many areas. These lizards are also likely to be adversely affected by use of pesticides on plantations and farms. The endemic subspecies on Maria Major has not been reported for some time, and assuming the population is small, could be at severe risk from 'inbreeding depression' (e.g. reduced fertility, reduced resistance to disease) and stochastic factors. The highly invasive, fast-breeding *Gymnophthalmus underwoodi* might out-compete this species, if it were introduced to Saint Lucia.

Management Recommendations

- Prohibit and screen the importation of alien invasive lizards, specifically including Underwood's worm lizard *Gymnophthalmus underwoodi*.
- Ensure the offshore islands are kept free of alien invasive mammals and reptiles.
- Determine whether the cane toad, mongoose, opossum or other alien species have a significant impact on worm lizard densities on the mainland.
- Assess the status of *G. p. nesydrion* on Maria Major as a matter of urgency and determine whether Praslin, Rat or any other offshore islands hold this subspecies.

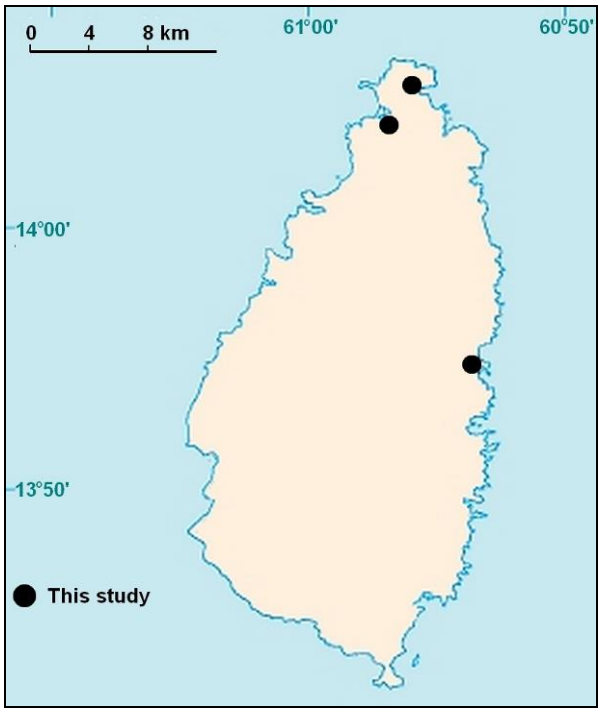
Important References

Breuil, M. (1997) *L'herpétofaune de la Réserve Biologique Domaniale de la Montagne Peléé*. Office National des Forêts de Martinique, Fort-de-France, Martinique, and Association des Amis du Laboratoire des Reptiles et Amphibiens du MNHN, Paris. [In French].

5.12 House Gecko

Scientific Name	***Hemidactylus mabouia***
Creole Name	Mabouya
Alternative Names	Common woodslave, Afro-American house gecko
Native status on Saint Lucia:	Non Native
Endemicity:	Sub-Saharan Africa
IUCN (2009) Category of Threat (International):	Not Evaluated
Recommended Category of Threat (International):	Least Concern
Recommended Category of Threat (National):	N/A (Alien Species)
CITES	Not listed
Wildlife Protection Act 1980 (amended 2001)	Not specified

Figure 20. Adult (top) and juvenile house geckos in Dennery (J. Daltry, FCG-FFI)



Identification

A nocturnal lizard, usually seen on the walls and ceilings of porches, warehouses and houses at night. Males are up to 68mm long from the tip of the snout to the base of the long tail; females are slightly smaller. Both sexes are greyish white or pale brown above, with a light or dark brown pattern of three-to-six V-shaped bands. Upper surface of tail has 10-13 faint or conspicuous dark bands. Six rows of spine around the base of the tail. Underside white with few markings. Adults seen during the day, and juveniles, are darker and more heavily marked. Eggs slightly elongated, about 8x9mm. Males make a chattering call and often fight.

Habitat

Typically associated with buildings, especially occupied houses. Can occur in forests, but is normally restricted to the edges, close to buildings. During the day, house geckos hide in crevices, including beneath loose concrete slabs and other objects on the ground.

Population status and distribution

This African species was probably accidentally introduced to Saint Lucia at least two hundred years ago from introduced populations on other Caribbean islands. It is present almost wherever people live on Saint Lucia and throughout the West Indies.

Diet

Mainly nocturnal, flying invertebrates, such as moths and mosquitoes. Often seen on walls and ceilings, feeding on insects attracted to artificial lights.

Reproduction

Capable of breeding all year. Eggs are laid in crevices e.g. by door hinges and behind bookcases. Hatchlings measure 4cm total length. Males call from branches at the edge of or over water.

Threats

None significant. Preyed on by domestic cats and other animals. Potential, if slight, risk of being depleted if the invasive tokay gecko *Gecko gecko* were to be introduced to Saint Lucia (this very large Asian house gecko has become well established on Martinique via the pet trade and will kill and eat even adult house geckos).

Other Issues

This species has not been implicated as a threat to any native reptiles, amphibians or other wildlife.

Management Recommendations

- List house gecko as Unprotected under the Wildlife Protection Act.
- No other management actions necessary.

Important References

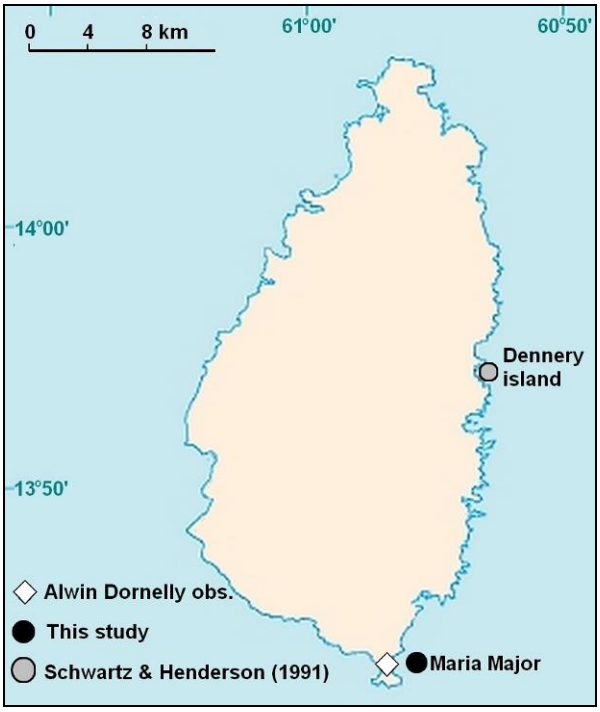
Kluge, A.G. (1969) The evolution and geographical origin of the New World *Hemidactylus mabouia-brookii* complex (Gekkonidae, Sauria). *Miscellaneous Publications of the Museum of Zoology, University of Michigan*, 138, 1-78.

Powell, R., Crombie, R.I., & Boos, H.E.A. (1998) *Hemidactylus mabouia*. Reptilia: Squamata: Sauria: Gekkonidae. *Catalogue of American Amphibians and Reptiles*, No. 674, 1-11.

5.13 Antilles Leaf-Toed Gecko

Scientific Name	***Hemidactylus palaichthus***
Creole Name	Unknown
Alternative Names	Rock gecko
Native status on Saint Lucia:	Probably Native
Endemicity:	Northern South America and Saint Lucia
IUCN (2009) Category of Threat (International):	Not Evaluated
Recommended Category of Threat (International):	Least Concern
Recommended Category of Threat (National):	**Vulnerable** (see page 29)
CITES	Not listed
Wildlife Protection Act 1980 (amended 2001)	Not specified

Figure 21. Adult Antilles leaf-toed gecko on Maria Major (J. Daltry, FCG-FFI)



Identification

[Compare with the similar house gecko *H. mabouia*] A nocturnal lizard, usually found by turning rocks over on the offshore islands. Purportedly up to 63mm long from the tip of the snout to the base of the long tail (but the specimen pictured above was around 70mm). Both sexes are light to dark brown or grey above, with a dark brown or black pattern. The pattern often appears as a complex latticework down the back and sides. The tail has about 10 faint or conspicuous bands and numerous irregular spots, and has rows of spines at the base. The body has spiky scales (more pronounced than the house gecko) that make the gecko feel very rough when handled. Eggs slightly elongated, about 7mm diameter. Calls, if any, have not been documented.

Habitat

Not associated with buildings (unlike the house gecko). On Saint Lucia, it is mainly found under rocks and in cliff crevices on Maria Major and Dennery islands in coastal xeric vegetation (e.g. Deciduous Seasonal Forest).

Population status and distribution

Infrequently seen, with most sightings confined to Maria Major (12 ha) and Dennery island. One specimen was reportedly found near Vieux Fort. This species may have formerly been more widespread, but is now largely restricted to the offshore islands.

Diet

Not documented, but probably include small nocturnal invertebrates, especially on the ground.

Reproduction

Not documented, but eggs likely to belong to this species were found under rocks on Maria Major in July.

Threats

The current distribution range (largely restricted to offshore islands) indicates this species is susceptible to alien invasive mammals, such as mongooses. The offshore island populations must be small and therefore are risk of problems associated with 'inbreeding depression' (e.g. reduced fertility, reduced resistance to disease) and stochastic factors. Predicted sea level rises and increased hurricanes and storm surges could reduce the number of Antilles leaf-toed geckos that each offshore island can support.

Management Recommendations

- Protect the Antilles leaf-toed gecko under national law.
- Ensure the offshore islands are kept free of alien invasive mammals.
- Explore the possibility of creating alien predator-free enclaves on the main island of Saint Lucia to which Antilles leaf-toed geckos could be (re-)introduced.

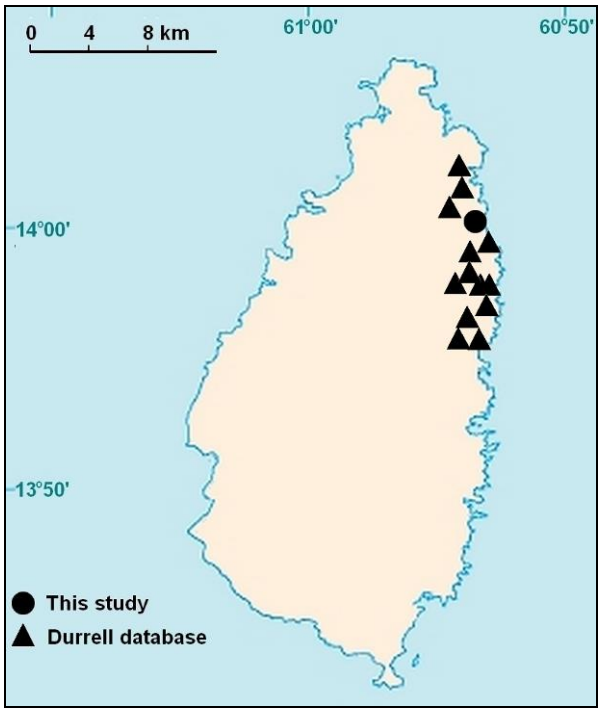
Important References

Schwartz, A., & Henderson, R.W. (1991) *Amphibians and Reptiles of the West Indies. Descriptions, Distributions, and Natural History*. University of Florida Press, Gainesville, Florida.

5.14 Saint Lucia Iguana

Scientific Name	***Iguana cf iguana***
Creole Name	Léza, gwo zandoli
Alternative Names	None
Native status on Saint Lucia:	Native
Endemicity:	?
IUCN (2009) Category of Threat (International):	Not Evaluated
Recommended Category of Threat (International):	**Critically Endangered** (see page 30)
Recommended Category of Threat (National)	**Critically Endangered**
CITES	II
Wildlife Protection Act 1980 (amended 2001)	Protected

Figure 22. Adult male Saint Lucia iguana (© M. Morton, DWCT).



Identification

Saint Lucia's largest native lizard. Up to 50cm from snout to the base of the tail. Mature adults of both sexes have broad black 'tiger stripes'. Males: Background colour ranges from green to black and pale silvery grey. Tall crest of scales from head to tail; the tallest, on the neck, may have a pinky-orange wash. Head part of body may also have a golden yellow wash in males. Elongated scales on the snout form prominent 'horns'. Dewlap green or almost black. Females: Background colour usually green or brown, with shorter crest and horns than the males. Juveniles emerald green with transverse bands across the back.

Habitat

Currently occurs only in Deciduous Seasonal Forest and adjoining Freshwater Swamp Forest. Requires warm sandy areas above the high tide mark for nesting.

Population status and distribution

Scarce, with fewer than a thousand mature individuals remaining in a total area of less than 2.5km^2. Published and verbal accounts suggest it used to be much more widespread and abundant: its current range implies hunting may be a primary driver of this supposed range contraction, but alien invasive predators are also implicated.

Diet

Strictly herbivorous in the wild, feeding predominantly on leaves (with the soft foliage of lyenn dous being a notable favourite), but also flowers and soft fruits.

Reproduction

Breeds once a year: nesting takes place from February to May, with eggs incubating for about three months and hatching from May to August, most likely triggered by the onset of the rainy season. Almost all the known nest sites on Saint Lucia are on sandy beaches in sunny patches surrounded by thick vegetation. There are approximately 25 eggs in a clutch.

Threats

Hunting; loss of habitat (notably mature Deciduous Seasonal Forest); predation on eggs, young and adults by mongooses, cats, dogs and other animals; hybridization and competition from the newly introduced green iguanas.

Other Issues

This species is being popularized as a flagship species for Saint Lucia's threatened dry forests. It has been the subjected of a concerted research and conservation programme by the Forestry Department and Durrell since 2002.

Management Recommendations

- Retain Saint Lucia iguana as Protected under the Wildlife Protection Act to maintain the ban on hunting.
- Eradicate the introduced green iguanas as a matter of urgency; and prohibit and enforce the importation and keeping of green iguanas in captivity.
- Resolve the taxonomic status of the Saint Lucia iguana – this will require a regional examination of the morphology and/or genetics of green iguanas.
- Ensure the iguana's core habitat in northeast Saint Lucia, including known and suspected nesting areas, is protected as a nature reserve.
- Study whether local removal of mongooses and other predators increase egg and juvenile survival.
- Seek other suitable, 'protectable' lowland forest sites where iguanas could be reintroduced by first removing known threats, ideally contiguous with the existing range.
- Educate the public not to take unleashed dogs into iguana habitat, and remove any feral dogs and cats.

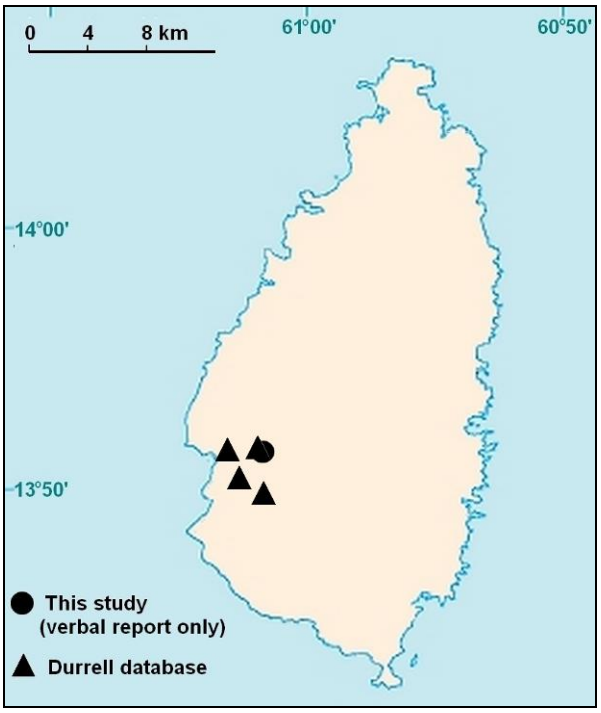
References

Morton, M. (2007) *Saint Lucia Iguana: Report 2002-06.* Unpublished report to Durrell Wildlife Conservation Trust, Jersey, and Saint Lucia Ministry of Agriculture Forestry Department, Union, Saint Lucia.

5.15 Green Iguana

Scientific Name	***Iguana iguana***
Creole Name	Léza, igwàn (Guadeloupe)
Alternative Names	Common iguana
Native status on Saint Lucia:	Non Native (Introduced)
Endemicity:	?
IUCN (2009) Category of Threat (International):	Not Evaluated
Recommended Category of Threat (International):	Least Concern
Recommended Category of Threat (National):	N/A (Alien Species)
CITES	II
Wildlife Protection Act 1980 (amended 2001)	Protected

Figure 23. Adult male green iguana (© M. Morton, DWCT).



Identification

Saint Lucia's largest alien invasive reptile. Up to 50cm from snout to the base of the tail. Both sexes lack 'tiger stripes' on body (unlike Saint Lucia iguana), but have conspicuous bands on the tail. Males: Usually green, olive or dark grey. Head may be pale, in old individuals. Crest of scales from head to tail, but generally not as tall as male Saint Lucia iguana, and horns on the snout are usually much reduced compared with the Saint Lucia iguana. Dewlap typically grey or green, but may have distinctive rust-orange colour. Females: Usually green or brown, with a less pronounced crest than the males. Juveniles of this species (like Saint Lucia iguana) are emerald green with transverse bands across the back.

The alien iguanas on Saint Lucia have more spiny scales on the sides of the neck, arranged in lines (this character is found in Saint Lucia iguanas, but the spines are fewer and more scattered). This character is found in both adults and hatchlings. Hatchlings otherwise resemble Saint Lucia iguanas, but adults (of this population) appear to develop a darker grey-green or grey colouration, with stripes only prominent on the tail; the dewlap is sometimes a rusty-orange colour. The head shape, seen in profile, also different in mature adults, being somewhat less massive and more pointed (toward the snout) in the alien iguana.

Habitat

Usually xeric or mesic habitats, including cliff faces, mangrove edges, gardens and fruit orchards. In Saint Lucia, a colony has become established in Semi-Evergreen Seasonal Forest in ravines inland from Soufriere.

Population status and distribution

Founded from three to six captive individuals (accounts vary) that escaped from the Ruby area of Soufriere, this population is confirmed to be breeding in the wild, with hatchlings having been found. Based on numerous reported sightings, the population is expanding.

Diet

Largely plants, but bird eggs are also eaten.

Reproduction

This alien species appears to nest from February to May, with eggs hatching from May to August. Clutches may be significantly larger (30-40 eggs) than those of the Saint Lucia iguana.

Threats

Lack or loss of suitable habitat does not appear to be a limiting factor for this alien species: the lush mesic vegetation around Soufriere seems to suit it very well. It is not known whether the iguanas are being hunted, but other non-human predators may impact this population to some degree.

Other Issues

The need to control and, if at all possible, eradicate this alien population is complicated by the need to conserve the Saint Lucia iguana. Sustained and carefully designed education of local communities is vital to raise local support for its eradication.

Management Recommendations

- Eradicate the introduced green iguanas as a matter of urgency; and prohibit, and enforce, the importation and keeping of green iguanas in captivity.
- The green iguana should be retained as Protected under the Wildlife Protection Act because the eggs, young and even adults look similar to the Saint Lucia iguana.

Important References

Morton, M.N. (2008) *The Urgent Problem of Alien Green Iguanas Around Soufriere*. Unpublished report to Durrell Wildlife Conservation Trust, Jersey, and Saint Lucia Ministry of Agriculture Forestry Department, Union, Saint Lucia.

Sementelli, A., Smith, H.T., Meshaka, Jr., W.E., & Engeman, R.M. (2008) Just green iguanas? The associated costs and policy implications of exotic invasive wildlife in South Florida. *Public Works Management & Policy*, 12: 599-606. Abstract available at: http://pwm.sagepub.com/cgi/content/abstract/12/4/599

ISSG website: http://www.issg.org/database/species/impact_info.asp?si=1022&fr=1&sts=&lang=EN

5.16 Southern Antillean Skink

Scientific Name	***Mabuya mabouya***
Creole Name	Mabouya
Alternative Names	Slippery back skink
Native status on Saint Lucia:	Native
Endemicity:	Southern Lesser Antilles:
IUCN (2009) Category of Threat (International):	Not Evaluated
Recommended Category of Threat (International):	Near Threatened
Recommended Category of Threat (National):	**Extinct** (see page 30)
CITES	Not listed
Wildlife Protection Act 1980 (amended 2001)	Not specified

Figure 24. Adult Southern Antillean skink on Montserrat (© Q. Bloxam, Durrell, right).

Identification

Small, active ground-dwelling lizard, similar in size to Saint Lucia anole and substantially larger than the rough-scaled worm lizard, which it otherwise resembles. Males: Up to 87mm from snout to tail-base. Females: Up to 93mm from snout to tail-base. The backs of both sexes are metallic bronzy brown, copper, dark brown or pale brow. Broad dark brown stripe down each side, often bordered above and below with narrow cream lines. Back may be spotted or speckled. Underside whitish or cream, becoming grey of brown towards the tail. Limbs of both sexes are relatively long (compared to the rough-scaled worm lizard). Lower eyelid transparent.

Habitat

Usually xeric habitats, including Deciduous Seasonal Forests and Littoral Shrubland, even among detritus on the beach. Typically on the ground, where it hides in crevices during the night and cool weather, but has been found in trees up to 2.3 metres above the ground.

Population status and distribution

This species has not been confirmed on Saint Lucia since the 1800s, and should be considered extinct. This regional endemic is still common on Dominica and was recently confirmed on islands off Guadeloupe, but has declined and disappeared from most of Guadeloupe, Saint Vincent, Grenada and Martinique.

Diet

Small live invertebrates, including crickets and cockroaches. Forages during the day.

Reproduction

Ovoviviparous – the female carries the fertilized eggs until they hatch, reportedly around January. Four young have been recorded, with 36-48 hour intervals between births.

Threats

Probably wiped out from Saint Lucia and other islands by introduced mongoose, cats, cane toads and other alien predators (this diurnal lizard is relatively easy to catch and slow-breeding).

Other Issues

None.

Management Recommendations

- Protect the Southern Antillean under national law.
- Sightings of Southern Antillean skinks reported by credible sources should be investigated.
- In the future, it may be possible to create predator-free enclaves on main island of Saint Lucia to which this native species could be re-introduced (e.g. from Dominican stock).

Important References

Miralles, A. (2005) The identity of *Lacertus mabouya* Lacepède, 1788, with description of a neotype: an approach toward the taxonomy of new world *Mabuya. Herpetologica*, 61, 46-53.

Schwartz, A., & Henderson, R.W. (1991) *Amphibians and Reptiles of the West Indies. Descriptions, Distributions, and Natural History*. Gainesville, Florida, University of Florida Press.

5.17 Antiguan Pygmy Gecko

Scientific Name	***Sphaerodactylus elegantulus***
Creole Name	Unknown
Alternative Names	Antiguan dwarf gecko
Native status on Saint Lucia:	Non Native
Endemicity:	Antigua and Barbuda
IUCN (2009) Category of Threat (International):	Not Evaluated
Recommended Category of Threat (International):	Near Threatened
Recommended Category of Threat (National):	N/A (Alien Species/ Extinct)
CITES	Not listed
Wildlife Protection Act 1980 (amended 2001)	Not specified

Figure 25. Adult Antiguan pygmy gecko from Antigua (©J. Daltry, FFI, left; C. Pratt, above)

Identification

Small lizard, up to 29mm from snout to base of the tail (both sexes). Back is light or dark brown, and, in adults, uniform or speckled with dark scales, which may form squiggly markings especially on the head. Underside of head and body is white to light brown. Iris yellow. Eggs 5.5x7.0mm.

Habitat

Habitat in Saint Lucia was not recorded. In Antigua and Barbuda, this species is usually found in dry, rocky habitats in the lowlands, including rocky cliffs, gardens, Littoral Shrubland and Deciduous Seasonal Forest.

Population status and distribution

Probably Extinct on Saint Lucia (no record since the 1930s), but it possibly never established a colony on the island. In its native range, it is not common.

Diet

Mainly ants and other very small invertebrates in leaf litter.

Reproduction

Females with well developed eggs have been found in Barbuda in June-July.

Threats

Include mongooses and other alien invasive predators

Management Recommendations

- If any more Antiguan pygmy geckos are discovered on Saint Lucia, they should be humanely destroyed. Specimens should be preserved to confirm their identity and origin.

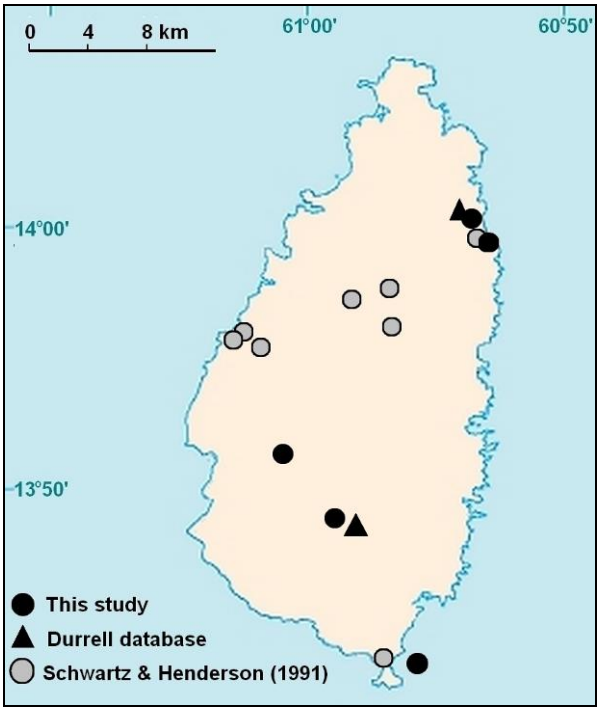
Important References

Schwartz, A., & Henderson, R.W. (1991) *Amphibians and Reptiles of the West Indies. Descriptions, Distributions, and Natural History*. Gainesville, Florida, University of Florida Press.

5.18 Saint Lucia Pygmy Gecko

Scientific Name	***Sphaerodactylus microlepis*** (two subspecies: ***microlepis*** and ***thomasi***)
Creole Name	Unknown
Alternative Names	Saint Lucia dwarf gecko
Native status on Saint Lucia:	Native
Endemicity:	Endemic to Saint Lucia (***S. m. microlepis*** endemic to main island; ***S. m. thomasi*** endemic to Maria Major)
IUCN (2009) Category of Threat (International):	Not Evaluated
Recommended Category of Threat (International):	**Vulnerable**
Recommended Category of Threat (National):	**Vulnerable** as ***Sphaerodactylus microlepis*** (page 30) **Vulnerable** as ***S. m. microlepis*** **Vulnerable** as ***S. m. thomasi***
CITES	Not listed
Wildlife Protection Act	Not specified

Figure 26. Adult Saint Lucia pygmy gecko from Grande Anse (top) and Maria Major (J. Daltry, FCG-FFI)



Identification

Small lizard, up to 34mm from snout to base of the tail (both sexes). Usually light brown to grey above with a series of 6-7 faint or conspicuous, often broken dark crossbands (between arms and legs). Neck with a brown or black collar which is usually followed with a light border (not in all *S. m. thomasi*). Sometimes a pair of white or grey 'eye spots' in front of the dark collar (rarely if ever in *S. m. thomasi*). Top of head light brown to yellow with dark brown markings (the markings may be less apparent in older individuals). Dark stripe extends from behind each eye, joining at the nape of the neck. Top and sides of the tail may be brown, coral (Anse Galet) or pale orange (Maria Major), and the underside of the tail is dull orange. Underside of head and body is white or yellow, and the throat has dark brown or black stripes. Iris bright green to blue-grey. Eggs elongated, approximately 5.5x7.0mm. (The two subspecies are distinguished by colour pattern and the number and shape of their scales: see Schwartz, 1965, for details).

This species differ from *S. vincenti* in having two scales behind each nostril (difficult to see without microscope) and the central row of scales under the tail is not enlarged. It also differs from *S. v. diamesus* in commonly having white eyespots, a distinct, dark neck band, and dark stripes on the throat.

Habitat

Can occur in a wide range of habitats, from coastal Deciduous Seasonal Forests a few metres above sea level to at least 634m in the Lower Montane Rainforest, and has been reported in pastures. It is scarce or absent from most parts of the country, however, including urban areas.

Population status and distribution

Locally common (e.g. Maria Major, Grande Anse, La Porte), but very patchy. This lizard probably used to be more abundant and widespread.

Diet

Probably mainly ants and other very small invertebrates in leaf litter.

Reproduction

Females with well developed eggs have been found at La Porte in April. Eggs have been found on Maria Major in April, hatching in May. Incubation time is at least 5.5 weeks.

Threats

The cause of this species' apparently low numbers and patchy distribution is unknown, but is likely to be alien invasive predators, especially mongooses, rats, cane toads and probably opossums. Pygmy geckos may be affected by agrochemicals in plantation areas, and loss of habitat where leaf litter has been removed from coastal recreational areas. Due to the population's restricted size, the endemic subspecies on Maria Major could be at risk from 'inbreeding depression' (e.g. reduced fertility, reduced resistance to disease) and stochastic factors.

Management Recommendations

- Protect the Saint Lucia pygmy gecko under national law.
- Ensure the other offshore islands are kept free of alien invasive mammals, especially the Maria Islands.
- Prohibit and screen the importation of alien invasive lizards, especially including non-native pygmy geckos (i.e. all other members of the genus *Sphaerodactylus*).
- Investigate genetic diversity and gene flow between populations, and develop a genetic management plan if found to be at risk.

Important References

Schwartz, A. (1965) A new subspecies of the gecko *Sphaerodactylus microlepis. Herpetologica*, 21, 261-269.

Schwartz, A., & Henderson, R.W. (1991) *Amphibians and Reptiles of the West Indies. Descriptions, Distributions, and Natural History*. Gainesville, Florida, University of Florida Press.

5.19 Central Antillean Pygmy Gecko

Scientific Name	***Sphaerodactylus vincenti*** (one subspecies: ***diamesus***)
Creole Name	Unknown
Alternative Names	Central Antillean dwarf gecko, small-scaled least gecko
Native status on Saint Lucia:	Probably Non Native [Probably Extinct on Saint Lucia]
Endemicity:	Southern Lesser Antilles [Subsp. ***diamesus*** attributed to Saint Lucia in error?]
IUCN (2009) Category of Threat (International):	Not Evaluated
Recommended Category of Threat (International):	Least Concern (at species level)
Recommended Category of Threat (National):	N/A (Alien Species/ Extinct)
CITES	Not listed
Wildlife Protection Act 1980 (amended 2001)	Not specified

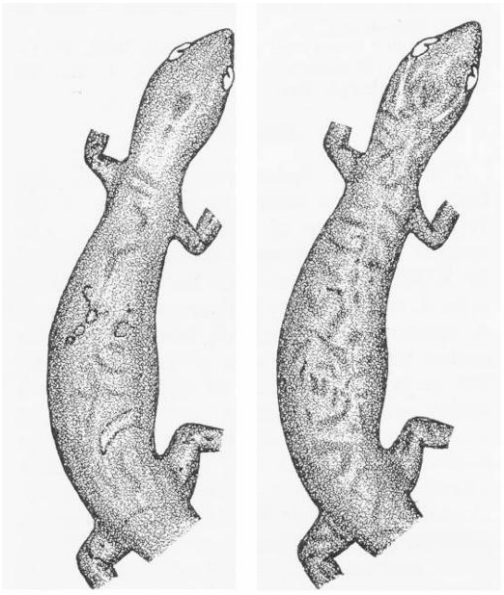
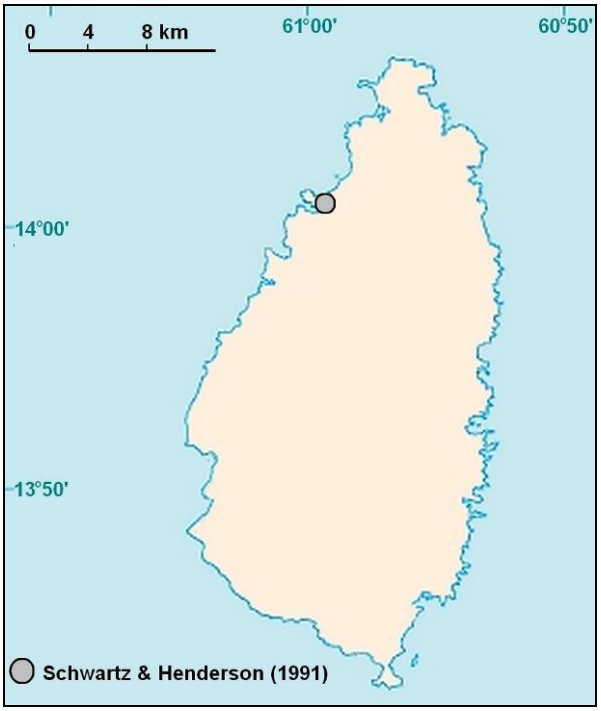


Figure 27. Adult Saint Vincent pygmy gecko: male (left) and female specimens of the subspecies *diamesus* from Vigie (Schwartz 1965a)



Identification

Small lizard: both sexes up to 40mm from snout to base of the tail (but maximum length of *S. v. diamesus* is 29mm). Very variable in colour and pattern. Usually brown or dirty yellow above with brown flecking (*diamesus*), spots or bands. This species usually has a dark bar across the neck (but very faint or absent in adult *diamesus*) or conspicuous pair of black-edged white 'eye spots' (but never in *diamesus*). Top of head light brown to yellow. Faint light stripes may extend from above each eye and may join at the neck or further down. Upper side of the tail may have dark-edged white spots or white crossbars and the underside is light brown to dull orange. Underside of head and body is uniform light brown, pinkish, orange, white or yellow, usually without markings. Iris brown, blue, blue-grey or blue green (pale blue in *diamesus*).

This species differs from the endemic *S. microlepis* in being generally bigger, having only one scale behind each nostril (difficult to see without microscope) and the central row of scales under the tail is enlarged. More

importantly, the subspecies *diamesus* that was recorded on Saint Lucia never has white eyespots (unlike most *S. m. microlepis*), the neck band is faint or absent in adults, and there are no dark stripes on the throat.

Habitat

On Saint Lucia, this species was recorded only among *Coccoloba* and *Terminalia* leaves on Vigie Beach in the 1960s. On other islands, this species inhabits dry and especially mesic and wet habitats from sea level to the higher mountains (from sea level to at least 550m on Martinique), including mangrove edges, coconut plantations, Deciduous Seasonal Forest, and Lower Montane Rainforest. Hides under stones, logs and other debris by day.

Population status and distribution

Extinct on Saint Lucia? This species is common on Martinique (where densities can reach 10,000/ha), and also present on Saint Vincent and Dominica.

Diet

Probably mainly ants and other very small invertebrates in leaf litter.

Reproduction

The female lays a single egg.

Threats

Having been recorded only among *Coccoloba* and *Terminalia* leaves on Vigie Beach, it is possible this colony was eliminated by increased development and the practice of removing undergrowth and sweeping up fallen leaves.

Other Issues

This species does not appear to pose a threat to the Saint Lucia pygmy gecko *S. microlepis.*

Management Recommendations

- Conduct further surveys in the Vigie area to determine whether any Central Antillean pygmy geckos remain.
- If any are found, conduct genetic analysis to determine whether this is a long-established native species or a recent introduction (Durrell Wildlife Conservation Trust could assist with this analysis) to determine whether to conserve or eradicate them.

Important References

Breuil, M. (1997) *L'herpétofaune de la Réserve Biologique Domaniale de la Montagne Peléé*. Office National des Forêts de Martinique, Fort-de-France, Martinique, and Association des Amis du Laboratoire des Reptiles et Amphibiens du MNHN, Paris. [In French].

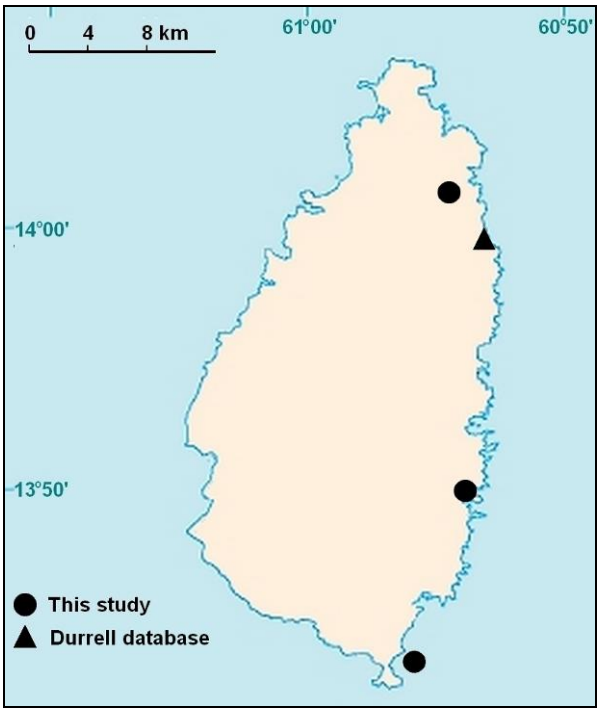
Schwartz, A. (1965) A review of *Sphaerodactylus vincenti* on the southern Windward Islands. *Caribbean Journal of Science*, 4, 391-409.

Schwartz, A., & Henderson, R.W. (1991) *Amphibians and Reptiles of the West Indies. Descriptions, Distributions, and Natural History*. Gainesville, Florida, University of Florida Press.

5.20 Forest Gecko

Scientific Name	***Thecadactylus rapicaudus***
Creole Name	Unknown
Alternative Names	Turnip-tailed gecko
Native status on Saint Lucia:	Native
Endemicity:	Widespread throughout Neotropics.
IUCN (2009) Category of Threat (International):	Not Evaluated
Recommended Category of Threat (International):	Least Concern (see page 31)
Recommended Category of Threat (National):	Least Concern?
CITES	Not listed
Wildlife Protection Act 1980 (amended 2001)	Not specified

Figure 28. Adult forest gecko on Maria Major (above) and Escap estate (J. Daltry, FCG-FFI)



Identification

Medium sized lizard, up to 121mm from snout to base of the tail. Sepia, light grey, smoky-grey or olive-brown above, often with conspicuous bands and spots. A white stripe runs from the eye to ear. Lips white, often with black margins to the scales. Underside pale beige. Often scarred from fighting. If the tail is broken, the new tail will be conspicuously thicker at the base. Retractable claws. Largely nocturnal, hiding in crevices by day, but occasionally seen basking in full sunlight. Its call comprises a series of 15 to 20 "tchack-tchak-tchak" or "tchick-tchick-tchick".

Habitat

On Saint Lucia, recorded in rock piles (including Maria Major) and on large trees in lowland and coastal woodlands. On other islands, it has been recorded in a wide range of habitats, including houses, coconut groves, and rainforests, but appears to be most abundant in mature xeric forests.

Population status and distribution

This species is only infrequently reported on Saint Lucia, probably because they are highly nocturnal and frequently well hidden or high above the ground. This species has a wide distribution throughout Central and South America and the West Indies, and it is not known to have become extinct on any island.

Diet

Live prey up to 5cm long, including grasshoppers, crickets, cockroaches, butterflies, scorpions, spiders and juvenile whistling frogs and house geckos.

Reproduction

Eggs laid singly, reportedly on the ground in July and August.

Threats

May include opossums and other alien invasive predators.

Management Recommendations

- Partially protect the gecko under the Wildlife Protection Act.
- Include the forest gecko in future night surveys to determine its status and distribution.

Important References

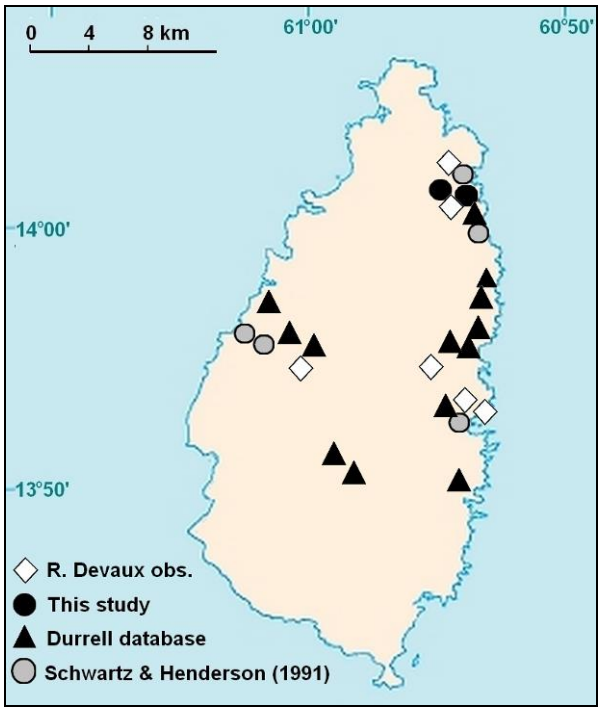
Breuil, M. (1997) *L'herpétofaune de la Réserve Biologique Domaniale de la Montagne Peléé*. Office National des Forêts de Martinique, Fort-de-France, Martinique, and Association des Amis du Laboratoire des Reptiles et Amphibiens du MNHN, Paris. [In French].

Kronauer, D.J.C., Bergmann, P.J., Mercer, J.M., & Russell, A.P. (2005) A phylogeographically distinct and deed divergence in the widespread Neotropical turnip-tailed gecko, *Thecadactylus rapicauda*. *Molecular Phylogenetics and Evolution* 34, 431-437.

5.21 Saint Lucia Boa

Scientific Name	***Boa constrictor*** (one subspecies ***orophias***)
Creole Name	Tet chyenn
Alternative Names	None
Native status on Saint Lucia:	Native
Endemicity:	Subspecies endemic to Saint Lucia
IUCN (2009) Category of Threat (International):	Not Evaluated
Recommended Category of Threat (International):	Least Concern as ***Boa constrictor*** **Vulnerable** as ***B. c. orophias*** (see page 31)
Recommended Category of Threat (National):	**Vulnerable**
CITES	II
Wildlife Protection Act 1980 (amended 2001)	Protected

Figure 29. J. Daltry holding an adult female Saint Lucia boa from La Sorciere (F. Clarke, FCG)



Identification

Very large snake, with a maximum recorded total length of 2.4 metres (and probably capable of growing larger). Glossy in appearance. Pale brown to very dark brown above with 23-35 rectangular or irregular dark blotches. White underside with black or grey spotting, or grey with black blotches and mottling. Dark stripe from nostril to eye, which may continue to the neck. Dark streak on the middle of the head. All of the body scales are smooth, without keels (unlike the fer-de-lance which has rougher-looking, keeled scales).

Habitat

Riparian forest and ravines through dry forest areas, forest gardens and even banana plantations. It is usually found on the ground or in trees up to 12 metres above the ground.

Population status and distribution

The endemic Saint Lucia subspecies of boa constrictor is still locally common in some areas, e.g. La Sorciere, but interview reports indicate it has declined in many parts of the island. It was already considered rare by the 1930s. While these snakes are well camouflaged and easily overlooked, the Saint Lucia population is relatively infrequently seen compared to populations of boa constrictors on uninhabited islands. This suggests their numbers and range have been suppressed. At the species level, however, the boa constrictor is a very successful, widespread and abundant species in the New World.

Diet

Birds, reptiles (including iguanas) and mammals, including rats, agoutis, opossums and bats.

Reproduction

Female gives birth to a dozen or more live young around April and May.

Threats

Persecution by humans and probably predation on young boas by mongooses, cats and other alien predators. There is ongoing demand for this species from the international pet trade.

Management Recommendations

- Retain Saint Lucia boa as Protected under the Wildlife Protection Act.
- Licenses to collect boas for oil extraction or other purposes should be withheld until a proper evaluation has been conducted into the status of the population and conservative quotas established for sustainable offtake. If boa fat is to be harvested, humane methods of euthanasia should be established: the practice of extracting oil from live boas is inhumane and bound to be fatal.
- Prohibit the importation of boa constrictors from other countries.
- If illegal trade escalates, seek CITES support to upgrade this subspecies to Appendix I.

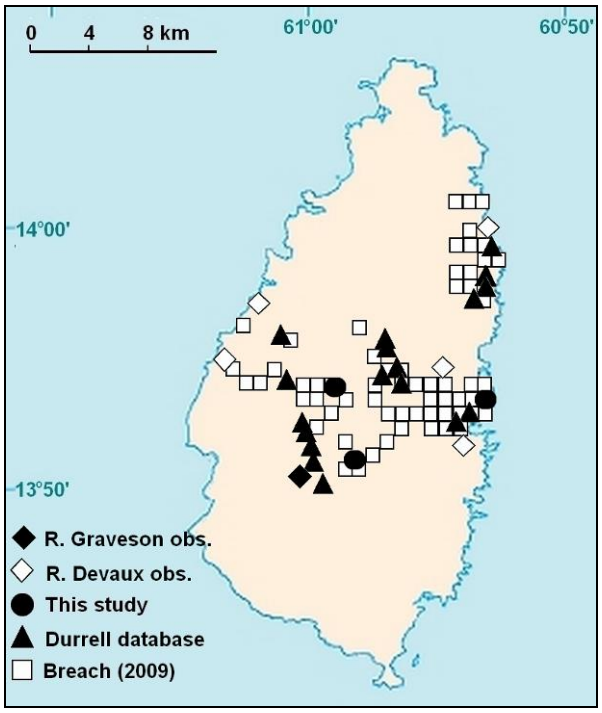
Important References

Lazell, J.D., Jr. (1964) The Lesser Antillean representatives of *Bothrops* and *Constrictor*. *Bulletin of the Museum of Comparative Zoology, Harvard University*, 132, 245-273.

5.22 Saint Lucia Fer-de-lance

Scientific Name	***Bothrops caribbaeus***
Creole Name	Sepan
Alternative Names	Saint Lucia pitviper, lancehead, serpent
Native status on Saint Lucia:	Native
Endemicity:	Endemic to Saint Lucia
IUCN (2009) Category of Threat (International):	Not Evaluated
Recommended Category of Threat (International):	**Vulnerable** (see page 31)
Recommended Category of Threat (National):	**Vulnerable**
CITES	Not listed
Wildlife Protection Act 1980 (amended 2001)	Unprotected

Figure 30. Adult female Saint Lucia fer-de-lance at Millet (J. Daltry, FCG-FFI). This specimen was about to shed its skin, hence its dull colour and blue eyes.



Identification

A large snake, with measured specimens reaching up to 1.5 metres from snout to base of the tail (with a maximum known total length of 2.13 meters). Usually grey, sandy-yellow, reddish-brown or brown above, with slate-grey to chocolate markings. A dark stripe runs from the eye to the neck. Underside yellow to cream, sometimes finely specked with grey on the sides. Every scale on the upper side of the body has a keel (ridge) running down the centre, which gives the snake a rougher texture than the boa or cribo.

Habitat

Occurs in a wide range of habitats from ravines in Deciduous Seasonal Forest almost at sea level to Lower Montane Rainforest. It is usually found on the ground, but occasionally in trees.

Population status and distribution

Locally common-to-abundant in some areas (e.g. Millet Forest Reserve), but the distribution range of this endemic snake has contracted to half its former size. Historical records of bounties indicate that this species used to be abundant in most parts of the country, even Castries.

Diet

Confirmed to eat rats and mice, and reported to eat mongooses, opossums and birds. Juveniles probably feed on lizards, frogs and large insects.

Reproduction

Mating takes place around March or April, and the female gives birth to 30-40 live young around August and September.

Threats

Human persecution; alien invasive predators (may include pigs); loss of forest habitat especially Deciduous Seasonal Forest.

Other Issues

A much feared and potentially dangerous snake to humans. It is widely, but wrongly, believed to have been introduced to Saint Lucia. It will be difficult to persuade people to accept this as being endemic and worth conserving. To prohibit the killing of fer-de-lances nationwide would be unenforceable, and is arguably not necessary yet. The only known natural predator of the fer-de-lance, the Saint Lucia cribo, is extinct.

Management Recommendations

- Educate the public, beginning with the forestry department employees, that this is a native species.
- Remove the Saint Lucia fer-de-lance from the Unprotected list on the Wildlife Protection Act, and
    - Permit killing or relocation only where the snake presents a danger to people (e.g. in villages or on a frequently-used forest trail), OR
    - Identify uninhabited, rarely visited forest areas as safe refuges for fer-de-lances, where killing them will be strictly forbidden.
- Conduct baseline field research on the species' status, distribution and ecological requirements.
- Review and improve the standard of snake bite treatment in Saint Lucia's hospitals, in particular sourcing more effective antivenom and training the medical professionals in its application.
- Educate the public on practical steps to avoid being bitten and first aid measures.

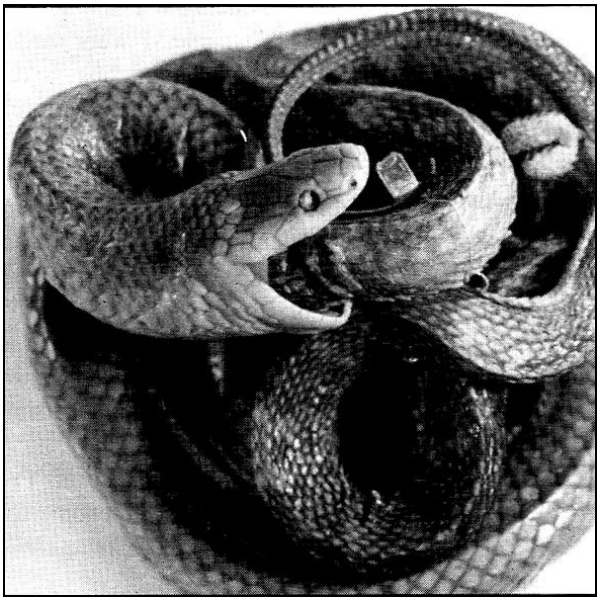
Important References

Breach, K. (2009) *Quantifying the Interactions Between Humans and Endemic Pitvipers (*Bothrops caribbaeus*) in Saint Lucia.* A thesis submitted in partial fulfilment of the requirements for the degree of Master of Science, University of London.

Wüster, W., Thorpe, R.S., Salomão, M.G., Thomas, L., Puorto, G., Theakston, R.D.G., & Warrell, D.A. (2002) Origin and phylogenetic position of the Lesser Antillean species of *Bothrops* (Serpentes, Viperidae): biogeographical and medical implications. *Bulletin of the Natural History Museum: Zoology*, 68, 101-106.

5.23 Saint Lucia Cribo

Scientific Name	***Clelia errabunda***
Creole Name	Cribo
Alternative Names	Black snake, Underwood's massurana
Native status on Saint Lucia:	Native
Endemicity:	Endemic to Saint Lucia
IUCN (2009) Category of Threat (International):	Not Evaluated
Recommended Category of Threat (International):	**Extinct** (see page 33)
Recommended Category of Threat (National):	**Extinct**
CITES	Not listed
Wildlife Protection Act 1980 (amended 2001)	Not specified



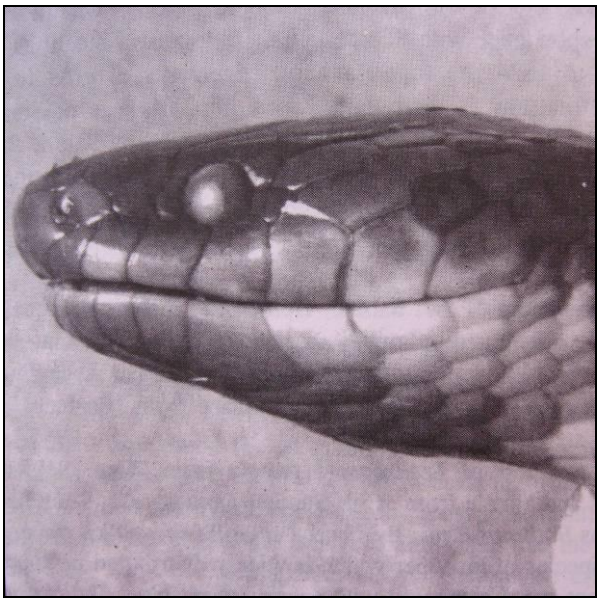


Figure 31. Saint Lucia cribo museum specimen at the Philadelphia Academy of Natural Sciences, swallowing a fer-de-lance.

Identification

A large snake, up to 1.38 metres from the snout to the base of the tail. Large adults are dark grey to black above. Juveniles have a black snout, dark brown head, a yellow band on the neck followed by a wider black band, and the rest of the body is red. Underside is cream, without markings. The yellow collar may still be visible in individuals up to a metre long, which also have a reddish hue to the body. All of the body scales are smooth, without ridges (unlike the fer-de-lance, which has keeled scales).

Habitat

Riparian forest and ravines through dry forest areas, forest gardens and even banana plantations. It was usually found on the ground or in trees up to 12 metres above the ground.

Population status and distribution

No confirmed sightings of this endemic snake have been made since the 19th century, despite the fact that it is large and active species, and Saint Lucia is a relatively small country where many experienced naturalists have spent long periods in the field, watching out for snakes. This snake is most likely extinct.

Diet

Confirmed to eat the Saint Lucia fer-de-lance *Bothrops caribbaeus*, and probably naturally eat other reptiles. West Indian cribos are also known to prey on non-native rats (*Rattus*). Prey animals are killed using venom and constriction.

Reproduction

No data on this species, but the related *Clelia clelia* lays clutches of 10 to 20 eggs, which hatch after four months. Hatchling *Clelia clelia* are approximately 6cm in length.

Threats

Its decline has been attributed to over-harvesting or killing by people in error during attempts to control the Saint Lucia fer-de-lance, but there may be other contributing factors such as predation by mongoose or reduced abundance of its prey.

Other Issues

There are occasional reports of very large black snakes in the forest. Although this description might as easily apply to the Saint Lucia boa, there is a very slim chance that Saint Lucia cribo might yet be rediscovered. It would be possible to identify this species from shed skin. The introduction of other species of cribo, as an ecological surrogate, is *not* advisable because it is unlikely to survive and may endanger the now-reduced population of Saint Lucia fer-de-lance. Note that even though this genus (*Clelia*) has venom fangs, bites are rare and not fatal to humans.

Management Recommendations

- Any sightings of cribos reported by credible sources should be investigated and, as a precautionary measure, this species should be protected under the Wildlife Protection Act.

Important References

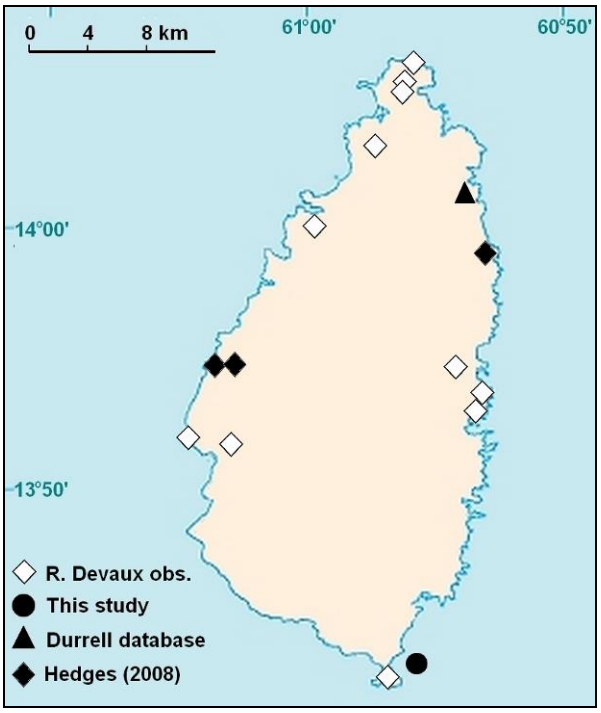
Underwood, G. (1993) A new snake from Saint Lucia, West Indies. *Bulletin of the Natural History Museum (Zool.)*, 59, 1-9.

Underwood, G. (1995) *A Tale of Old Serpents*. Saint Lucia National Trust, Castries, Saint Lucia, West Indies.

5.24 Saint Lucia Thread Snake

Scientific Name	***Leptotyphlops bruilei***
Creole Name	Unknown
Alternative Names	Breuil's thread snake, worm snake
Native status on Saint Lucia:	Native
Endemicity:	Endemic to Saint Lucia
IUCN (2009) Category of Threat (International):	Not Evaluated
Recommended Category of Threat (International):	**Vulnerable** (see page 33)
Recommended Category of Threat (National):	**Vulnerable**
CITES	Not listed
Wildlife Protection Act 1980 (amended 2001)	Not specified

Figure 32. Adult Saint Lucia thread snake on Maria Major (J. Daltry, FCG-FFI)



Identification

Probably the second smallest snake in the world (after the Barbados thread snake), reaching only 108mm from snout to the base of its short tail. Brown, with a pair cream or yellow lines running down the length of the body. Snout and tail are short and blunt. Easily mistaken for a dark worm.

Habitat

Confirmed habitat in Saint Lucia is Deciduous Seasonal Forest and Littoral Shrubland (on Maria Major and the coastal main island), less than 100 metres above sea level. Typically found in soil beneath leaf-litter and under rocks.

Population status and distribution

Though their exact number and distribution is unknown, the infrequency with which thread snakes are found on the main island of Saint Lucia indicates they are uncommon and very patchily distributed. Published records

confirm only three locations, Maria Major, Anse Galet and Praslin, and it has also been confirmed on Marquis estate.

Diet

Thread snakes usually feed on the adults and larvae of ants and termites.

Reproduction

Not documented. Other species of *Leptotyphlops* lay between 1 and 12 slender, thin-shelled eggs (1.5–2.5cm in length, and 2–4mm in width), which typically hatch after three months.

Threats

Probably alien invasive predators, loss of coastal dry forests, use of insecticides, and, potentially, competition from alien invasive worm snakes e.g. *L. bilineatus* of Martinique, *L. carlae* of Barbados, or the highly invasive flowerpot blindsnake, *Ramphotyphlops braminus* (which is already widespread in the Caribbean having been introduced via the horticultural industry).

Other Issues

This species was first described in 2008, having previously been misidentified as *Leptotyphlops bilineatus*. Being a species that probably spends most of its life underground, it could be more abundant and widespread than recent studies suggest.

Management Recommendations

- List the Saint Lucia thread snake as Protected under the Wildlife Protection Act.
- Ensure the offshore islands are kept free of alien invasive mammals, especially Maria Major.
- Conduct targeted surveys to determine the actual distribution range of this species.
- Endeavour to prevent the importation of alien species of thread snakes or worm snakes (genera *Typhlops, Leptotyphlops* and *Ramphotyphlops*). These are most likely to be transported in the soil of potted plants and top soil imported from other tropical countries landscaping purposes.

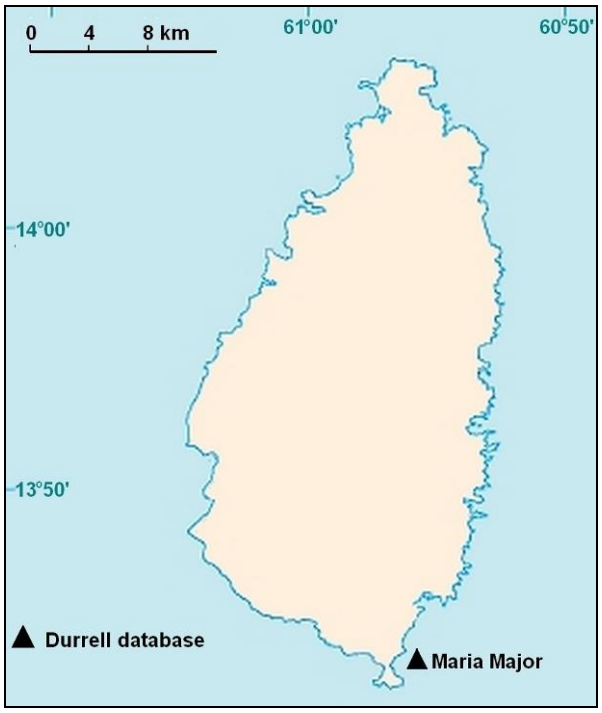
Important References

Hedges, S.B. (2008) At the lower size limit in snakes: two new species of threadsnakes (Squamata: Leptotyphlopidae: *Leptotyphlops*) from the Lesser Antilles. *Zootaxa*, 1841, 1–30

5.25 Saint Lucia Racer

Scientific Name	***Liophis ornatus***
Creole Name	Kouwès
Alternative Names	Ornate snake, Saint Lucia grass snake
Native status on Saint Lucia:	Native
Endemicity:	Endemic to Saint Lucia
IUCN (2009) Category of Threat (International):	**Endangered**
Recommended Category of Threat (International):	**Critically Endangered** (see page 33)
Recommended Category of Threat (National):	**Critically Endangered**
CITES	Not listed
Wildlife Protection Act 1980 (amended 2001)	Protected

Figure 33. Adult Saint Lucia racer on Maria Major (© M. Morton, DWCT)



Identification

A medium sized snake, reaching 1.24 metres from the tip of its snout to the base of its tail. Two basic colour varieties recognised (1) Alternating yellow and black diagonal spots on the first quarter of the body, forming diagonal streaks towards the rear of the body, with the black streaks tending to enclose the yellow ones. On the last quarter of the body, a pale line appears on each side of the body and continues to the tip of the tail. Head black with yellow streaks on snout. Yellow band on each side of the nape of the neck. Underside white or yellow, with some belly scales edged with black. (2) Broad, brownish stripe along the back, with yellowish spots on the edges. Sides yellowish, with flecks of brown. Underside more heavily marked with black.

Habitat

Deciduous Seasonal Forest on Maria Major. Historically, this snake may have occupied most forest types on Saint Lucia.

Population status and distribution

This endemic species was probably formerly widespread across Saint Lucia, but is now restricted to Maria Major (12ha), an island that has fortuitously remained free of alien invasive mammals, but represents only 0.02% of its (presumed) former range. Typically, between one and three individuals are seen each year by Forestry Department staff and other visitors to the island. The current population size is unknown, but can safely be assumed to be small, probably significantly fewer than 200 individuals.

Diet

Not known, but probably mainly lizards (probably mainly diurnal species i.e. Saint Lucia whiptail and Saint Lucia anole). Juveniles may also eat large insects.

Reproduction

Unknown. *Liophis juliae* (Dominica) has been recorded using communal nests, with 20 to 30 females laying 101 eggs in an underground nest chamber. Each clutch numbers two to four elongated eggs, approximately 27mm in length.

Threats

Alien invasive predators, especially mongooses, are the most likely cause of the snake's disappearance from most of Saint Lucia. Unless the population is increased, the species could be at very severe risk from 'inbreeding depression' (e.g. reduced fertility, reduced resistance to disease) and stochastic factors that could lead to its extinction.

Other Issues

It is likely that the Saint Lucia racer is the major predator of the Saint Lucia whiptail. The conservation of the racer may hinge on the conservation of this rare lizard.

Management Recommendations

- Retain Saint Lucia racer as Protected under the Wildlife Protection Act.
- Ensure the Maria Major is permanently kept free of alien invasive species, especially mammals.
- Conduct a thorough assessment of the population status and ecological needs of the racer and develop a species conservation action plan.
- As part of the action plan, explore the option of reintroducing racers to other offshore islands or even mainland enclaves, if these have sufficient prey and can permanently cleared of alien predators.
- As part of the action plan, explore the option of establishing a breeding colony of Saint Lucia racers in captivity.

Important References

Henderson, R.W. (2004) Lesser Antillean snake faunas: distribution, ecology, and conservation concerns. *Oryx,* 38, 311-320.

Schwartz, A., & Henderson, R.W. (1991) *Amphibians and Reptiles of the West Indies. Descriptions, Distributions, and Natural History*. University of Florida Press, Gainesville, Florida.

6 Management Priorities for Forest Reptiles and Amphibians

6.1 ALIEN INVASIVE SPECIES

Control the introduction and spread of alien invasive species that endanger forest herpetofauna

6.1.1 Keep the offshore islands free of alien invasive species [TOP PRIORITY]

1. Prevent rats, opossums, mongooses, Watts' anoles, and other alien organisms from (re)invading the Maria, Praslin, Dennery and Rat islands:
    a) Educate boat users on why and how to check their boats and any baggage for stowaways before they leave the mainland, and ensure no food or litter is left on the island;
    b) Visiting researchers especially should ensure their clothes, boots, research equipment and camping equipment are thoroughly cleaned, and preferably disinfected, before landing on the island;
    c) Trained staff should visually monitor the islands at least once every six weeks, and especially after major storms, for signs of rat activity (use permanent bait stations or similar methods to assist detection) and other alien animals;
    d) Develop a contingency plan and ensure resources (trained staff, rodenticide) are ready at all times to eradicate any rats or other animals that are detected.
    e) Where possible, regulate the number of boats that are permitted to land on these islands and prohibit overnight camping without authorization.
2. Eradicate goats from Dennery island to improve the quality of habitat, and hence the island's capacity to support native reptiles:
    a) Conduct a feasibility study to identify the best options for removing the goats, and seek the owner's consent.
    b) Mobilize the human resources to catch or kill the island's entire goat population.

6.1.2 Eradicate the introduced green iguanas to conserve the Saint Lucia iguana [TOP PRIORITY]

1. Eradicate the introduced green iguanas as a matter of urgency
2. Prohibit, and enforce, the importation and keeping of green iguanas in captivity.

6.1.3 Control harmful alien invasive mammals from priority sites on the main island

1. Reduce the density of mongooses and other carnivores in the "the North East Corridor" (Grande Anse, Caille Des and Louvet), which is a critical area for nesting iguanas, nesting sea turtles and important populations of pygmy geckos and rough-scaled worm lizard.

a) Using a large number of live traps baited with chicken or other appropriate food, trap and euthanize mongooses, cats and opossums, especially during the iguana breeding season (February to August). Keep careful records of the numbers of animals caught.

b) Prohibit, or at least discourage, people from taking dogs into the North East Corridor area.

c) Monitor the survival and recruitment of juvenile iguanas, turtles and other threatened biodiversity, in the target area.

2. Reduce the population of feral and free-ranging pigs on Saint Lucia (see Clarke, 2009). Approaches may include:-

a) Require all owners to mark their pigs and keep them in enclosures at all times.

b) Permit the shooting or capture of pigs outside of forest reserves.

c) Review the effectiveness, feasibility and benefits-risks of other options suitable for state forest areas, including trapping, poisoning and oral contraception.

6.1.4 Minimise the probability of non-native species invading Saint Lucia [TOP PRIORITY]

1. Prohibit the importation and keeping of alien species that present a risk to native wildlife.

a) Employ the Wildlife Protection Act and relevant trade or health legislation to prevent the deliberate importation of, in particular, non-native reptiles, amphibians and non-agricultural mammals.

b) No new permits should be issued to allow residents to keep animals perceived to be a threat to native wildlife if they escape. The long list of potentially destructive alien species includes green iguanas *Iguana iguana*, and other lizards, boa constrictors and other large snakes, raccoons and monkeys.

c) If such animals are already in captivity, they should be euthanized or, if that is not an option, be castrated or spayed to prevent breeding.

d) Illegally imported alien wildlife should be destroyed immediately.

e) Nominate at least one Forestry officer to liaise with the authorities at Vigie, Castries docks, Hewannora and other important ports of entry, and provide prompt technical advice should any alien animals be detected.

f) Review the current capacity of customs/ port authority staff to screen incoming baggage and cargo for wildlife, and provide training and resources as required.

g) Offenders who illegally import animals should be penalized and held up as an example to others.

6.1.5 Minimise the probability of species from Saint Lucia invading other countries

1. Linked to 6.1.4 above, assist reptile and amphibian conservation in other tropical countries by prohibiting, screening and removing reptiles and amphibians from exported cargo.

6.2 NATIONAL LEGISLATION

Revise the national legislation to reflect the current needs of Saint Lucia's herpetofauna

6.2.1 Revise the next edition of the Wildlife Protection Act [TOP PRIORITY]

1. With reference to Section 4.4.1, ensure the Act is brought closer into line with the main threats facing Saint Lucia's herpetofauna, and clarifies the status of every species. Key points to consider during the revision are:-

    a) Ensure all species common names, Creole names, and scientific names are up to date, and include synonyms where appropriate.

    b) Retain the Saint Lucia whiptail, Saint Lucia racer, Saint Lucia boa and Saint Lucia iguana as Protected species (Schedule 1), together with any species that resemble them (i.e., green iguana).

    c) Determine whether the essential breeding sites and dens of species that are protected or partially protected can also be afforded protection, irrespective of whether they are on state or private land.

    d) Remove the Saint Lucia fer-de-lance from the Unprotected list (Schedule 3), but permit it to be killed or relocated where the snake presents a danger to people (e.g. in villages, farms or on often-used forest trails).

    e) Ensure all species of reptiles and amphibians are named on the Act and assigned to a protected or unprotected status:

        i) Species to Protect should be species threatened by human activities *and species that look like them*, e.g. (in addition to b) all pygmy geckos, Saint Lucia thread snake, Southern Antillean skink, Antilles leaf-toed gecko, and, potentially, rough-scaled worm lizard.

        ii) Native species that appear to be widespread, abundant and/or adaptable do not need protection, e.g. Johnstone's whistling frog, Saint Lucia anole, forest gecko.

        iii) Alien species should be Unprotected *unless they closely resemble a protected species*. Ideally, the Act would place all alien and undesirable species in a separate category: e.g. cane toad, red-snouted tree frog, Barbados anole, Watts' anole, house gecko.

        iv) Native species thought to be extinct in Saint Lucia may be listed as Protected as a precautionary measure in case they are rediscovered: e.g. cribo.

    f) Expand or add to the clause that requires permits for the import and export of wildlife to make clear that the importation of alien invasive species is prohibited under any but the most exceptional circumstances.

6.3 FOREST PROTECTION

Secure the protection and regeneration of important dry and mesic forest sites on Saint Lucia

6.3.1 Establish at least one new nature reserve to protect dry forest wildlife communities on the main island of Saint Lucia [TOP PRIORITY]

1. Create a nature reserve to ensure the protection of native herpetofauna and their habitat.
    a) Conduct baseline field surveys to identify sites that are important and can be feasibly protected.
        i) Priority should be given to sites with well developed dry forests, preferably with ravines
        ii) Priority should be given to areas containing Saint Lucia iguanas and which have important populations of pygmy geckos, rough-scaled worm lizard, Saint Lucia fer-de-lances and other endemics (e.g. Grande Anse).
        iii) Preference should be given to a large site versus one or several small sites, and to areas that are contiguous with existing reserves.
    b) Explore mechanisms for obtaining private land or, if that is not practical, forming landscape protection agreements with landowners and other key stakeholders (see Section 6.3.2).
    c) In parallel with designating a new protected area, develop a costed management plan that prescribes the area's objectives and how these will be achieved and monitored. It is important to consider the management of alien invasive species and what human activities can be permitted in the area (e.g. recreational uses).

6.3.2 Formulate local agreements to preserve important wildlife habitats and forest corridors

1. Encourage landowners and other stakeholders to safeguard specific sites of known importance to threatened reptiles.
    a) Map the location of important sites (including Saint Lucia iguana nesting sites, Saint Lucia boa dens, significant colonies of Saint Lucia pygmy geckos, and important forested ravines through dry forest) and identify the owners and other stakeholders that use these areas.
    b) Develop a dialogue with the owners and, as applicable, other stakeholders regarding what steps to take or avoid to ensure the long term security of these sites. It may be necessary to negotiate some form of compensation to dedicate these sites to conservation purposes, such as tax relief or tourism concessions.
    c) Management agreements should be put in writing in the form of a contract or covenant, signed by the landowner, the government and, as applicable, authorized representatives of other stakeholder groups. These may be indefinite or cover a fixed period, e.g. 30 years.
2. Facilitate the regeneration and conservation of mesic (Semi-Evergreen Seasonal) forests on Saint Lucia.
    a) Identify plantations and other sites in the mesic zone where farming appears to have been abandoned and which are of low suitability for farming (e.g. steep slopes, close to ravines).

b) Identify the current owners and determine their plans for these sites. Encourage or negotiate with then owners for such areas to be allowed to revert to mesic forest in order to conserve wildlife and protect the watershed.

c) Mesic forests can be allowed to regenerate naturally or, resources permitting, native saplings planted and non-native trees felled.

6.4 RED-LISTING AND CONSERVATION ACTION PLANS

Update and use the Red List system to guide and support improved management

6.4.1 Enable IUCN to list all native Saint Lucia reptiles[10] with appropriate categories of threat on the international Red List [TOP PRIORITY]

1. Ensure all native species are shown on the IUCN Red List [http://www.iucnredlist.org/] with appropriate categories of threat.

   a) Ask IUCN for contact details of the specialist group or other organisation currently responsible for the listing of Caribbean snakes, iguanas and lizards (different taxa may be handled by different groups).

   b) Using the information presented in this report and others sources, prepare proposals for each endemic species to justify their categories of threat, using the most up to date criteria (currently IUCN, 2001). Recommended international listings are:-

      i) Extinct: Saint Lucia cribo, *Clelia errabunda.*

      ii) Critically Endangered: Saint Lucia racer, *Liophis ornatus* (upgrade from Endangered).

      iii) Endangered: Saint Lucia whiptail, *Cnemidophorus vanzoi* (upgrade from Vulnerable).

      iv) Vulnerable: Saint Lucia pygmy gecko, *Sphaerodactylus microlepis* (both subspecies, *microlepis* and *thomasi*); Saint Lucia boa, *Boa constrictor orophias*; Saint Lucia thread snake, *Leptotyphlops bruilei*; Saint Lucia fer-de-lance, *Bothrops caribbaeus.*

      v) Near Threatened: Saint Lucia worm lizard, *Gymnophthalmus pleii luetkeni.*

      vi) Least Concern: Saint Lucia anole, *Anolis luciae.*

      vii) Data Deficient: Maria Major worm lizard, *Gymnophthalmus pleii nesydrion.*

   c) For reptile species and subspecies that are native to Saint Lucia but also occur in other countries, supply IUCN with information on the status and distribution of the Saint Lucia population to support their international assessment. These species include the Southern Antillean skink, *Mabuya mabouya*, Antilles leaf-toed gecko, *Hemidactylus palaichthus*, and forest gecko, *Thecadactylus rapicaudus* (see Section 6.4.2 below).

[10] Saint Lucia's native and alien amphibians are already included on the IUCN red list with appropriate categories of threat. These do not need to be changed.

6.4.2 Develop a National Red List

1. Apply the IUCN criteria at a national scale to Saint Lucia's native reptiles and amphibians to recognise their national status. The national red list would serve to inform national policy making, including protective legislation and environmental impact assessments.

   a) Using the information presented in this report and others sources, prepare proposals for each native species to justify their national categories of threat, using the most up to date criteria (currently IUCN, 2001). Recommended national listings are:-

      i) Extinct: Saint Lucia cribo, *Clelia errabunda*; mountain chicken, *Leptodactylus fallax*; Southern Antillean skink, *Mabuya mabouya.*

      ii) Critically Endangered: Saint Lucia racer, *Liophis ornatus*; Saint Lucia iguana, *Iguana cf iguana.*

      iii) Endangered: Saint Lucia whiptail, *Cnemidophorus vanzoi*.

      iv) Vulnerable: Antilles leaf-toed gecko *Hemidactylus palaichthus;* Saint Lucia pygmy gecko, *Sphaerodactylus microlepis* (both subspecies, *microlepis* and *thomasi*); Saint Lucia boa, *Boa constrictor orophias*; Saint Lucia thread snake, *Leptotyphlops bruilei*; Saint Lucia fer-de-lance, *Bothrops caribbaeus.*

      v) Near Threatened: Saint Lucia worm lizard, *Gymnophthalmus pleii luetkeni.*

      vi) Least Concern: Saint Lucia anole, *Anolis luciae*; Johnstone's whistling frog *Eleutherodactylus johnstonei*; and probably forest gecko, *Thecadactylus rapicaudus.*

      vii) Data Deficient: Maria Major worm lizard, *Gymnophthalmus pleii nesydrion.*

   b) For clarity, add the category of Alien Species to the national red list. This group would include the cane toad, *Bufo marinus,* Barbados anole, *Anolis extremus,* Watts' anole, *Anolis wattsi*, house gecko, *Hemidactylus mabouia*, and green iguana, *Iguana iguana.*

6.4.3 Prepare and implement species conservation action plans for Saint Lucia's most threatened herpetofauna

1. For all species identified as globally threatened and nationally threatened, i.e., listed in categories Vulnerable, Endangered or Critically Endangered, there should be a clear and concise conservation action plan to prevent extinction. Some points to consider are:

   a) Focus first on species that are in most urgent need of attention i.e. those that qualify as Critically Endangered and Endangered (Saint Lucia racer, Saint Lucia whiptail lizard and Saint Lucia iguana).

   b) Track down all sources of information concerning the status, distribution, ecological needs and likely threat(s) to the species. Sources may include published reports, unpublished reports, local experts, and experts on related taxa in other countries. If necessary, conduct rapid surveys to fill important gaps.

   c) Based on a reasonable understanding of the species' needs and threats, identify the management options to halt and even reverse the species' decline. These may range from 'do nothing' to restoring habitats and even conducting reintroductions. Annex III shows a decision-making matrix designed to guide the choice of recovery actions.

   d) The most successful conservation action plans are those that are developed through a process of consultation with local experts and other stakeholders, especially the individuals who will be expected to implement the plan.

e) Conservation action plans should be working documents, revised and updated every few years as more information and experience accumulates. It is crucial to monitor the wildlife population and threats to evaluate which management actions are working and adjust the conservation action plan as necessary.

6.5 APPLIED RESEARCH

Conduct applied research to inform and monitor the management of Saint Lucia's herpetofauna

Short term and long term research and monitoring may be carried out by Forestry Department staff, university staff or Masters students, or biologists from other collaborating institutions. The list of potentially useful studies is very long, so the following is a shortlist of topics that could help to inform improved conservation management of these species and the forests they inhabit.

6.5.1 Assess the status and ecological needs of, and threats to, the least-known species [TOP PRIORITY]

1. Evaluate the approximate population size, habitat associations, and diet of the Saint Lucia racer *Liophis ornatus*, Maria Major rough-scaled worm lizard *Gymnophthalmus pleii nesydrion*, Saint Lucia thread snake, *Leptotyphlops bruilei,* and Maria Islands Saint Lucia pygmy gecko *Sphaerodactylus microlepis thomasi.*

   a) In the case of the racer, such a study is likely to take several months, with skilled researchers based on the island. Safe methods of trapping may increase the chances of detecting these rare snakes. Methods for estimating population size using mark-recapture and recording the snake's habitat requirements and diet could follow Daltry (1999).

   b) Survey methods for the lizards could entail distance sampling or mark-recapture during the course of one or two weeks on Maria Major, with a comparative study of *Gymnophthalmus pleii luetkeni* and Maria Islands Saint Lucia pygmy gecko *Sphaerodactylus microlepis microlepis* in selected sites on the mainland.

   c) Surveys for the Saint Lucia thread snake should include digging enclosed quadrats to assess population densities both on Maria Major and selected sites on the mainland.

2. Conduct advanced research to guide the conservation management of the Saint Lucia iguana *Iguana cf iguana*.[11]

   a) Resolve the taxonomic status of the Saint Lucia iguana, with the aid of an examination of the morphology and genetics of green iguanas throughout their New World distribution range.

   b) Determine the relationship between iguana distribution and the age and quality of Deciduous Seasonal Forest.

   c) Monitor the nuclear DNA of Saint Lucia iguanas for evidence of hybridization with alien iguanas.

   d) Prepare a contingency plan for dealing with hybridization with alien green iguanas, e.g. ex situ conservation and/or establishment of purebred Saint Lucia iguanas on secure (offshore?) sites.

   e) Conduct habitat suitability modelling to guide future reintroductions.

[11] Studies recommended by Matthew Morton, Durrell Wildlife Conservation Trust.

See also Applied Research Recommendation 6.5.2 (1).

3. Conduct advanced research to guide the conservation management of the Saint Lucia whiptail *Cnemidophorus vanzoi*.[12]

    a) Assess the success of the current "genetic rescue" on Rat Island (to conserve genes from the source populations of both Maria Major and Maria Minor).

    b) Monitor all source and reintroduced populations (Maria Major, Maria Minor, Praslin and Rat)

    c) Conduct baseline vegetation and biodiversity studies on Dennery Island, and assess the feasibility of (re-)introducing whiptail lizards.

4. Include forest gecko in future night surveys to determine its status and distribution.

5. Conduct further surveys in the Vigie area to determine whether any Central Antillean pygmy geckos remain. If any are found, conduct genetic analysis to determine whether this is a long-established native species or a recent introduction before deciding on whether to conserve (native) or eradicate (alien) them. Durrell Wildlife Conservation Trust could assist with the genetic analysis.

6. Conduct an in-depth study of the status, distribution, habitat requirements, diet and threats to the Saint Lucia fer-de-lance. This would have a duel purpose in informing conservation management and identifying ways to reduce human-snake conflict. Methods could include:

    a) Radiotrack at least five male and five female fer-de-lances of various sizes to determine home range sizes, activity patterns, macro- and microhabitat associations. The study should be carried out for at least two months, ideally different times of year to accommodate seasonal variation.

    b) Armed with knowledge acquired from interviews (including Breach, 2009) and, ideally, the aforementioned radiotracking study, survey likely sites throughout the country for the presence of fer-de-lances and map their distribution.

    c) Capture a large sample of fer-de-lances to measure the population structure (sex ratio, age-size distribution) and diet (faeces can be palpated from live snakes under anaesthetic): the snakes should be released unharmed afterwards.

    d) Obtain, preserve and dissect specimens killed by cars or people to obtain information on diet and reproductive biology.

6.5.2 Elucidate the impacts of different alien invasive animals on native reptiles and amphibians

1. Study the population density and diet of selected invasive species, and determine which species have the most significant affect on native reptiles and amphibians. Of particular concern are the cane toad, mongoose, feral pigs and opossum.

    a) Study the diet of the alien species and determine their consumption of reptiles and amphibians, including Saint Lucia iguana eggs and other eggs.

    b) Study the distribution and habitat associations of the alien species, and pinpoint the factors that explain why they are more abundant in some areas than others.

    c) Study the impact of removing alien invasive mammals on the hatching success and survival of Saint Lucia iguanas (see recommendation 6.1.3 [1]).

[12] Studies recommended by Matthew Morton, Durrell Wildlife Conservation Trust.

d) Conduct exclosure experiments (whereby the invasive species is excluded from a certain area) to monitor and compare the populations of reptiles and amphibians living with or without the invasive species present.

2. Monitor the geographic distribution of the invasive Watts' anole *Anolis wattsi*[13] and assess whether it presents a significant threat to the native Saint Lucia anole *A. luciae* or other lizards.

   a) Compile and update maps showing the distribution of Watt's anole every two years.

   b) Monitor the abundance of Saint Lucia anoles in sites before, during and after Watts' anole invasion, or conduct enclosure/ exclosure experiments to compare the impact of *A wattis* presence on the density, growth rates and reproductive success of *A. luciae.*

   c) Conduct direct observations to determine how the two species interact, and the mechanisms by which the smaller Watts' anole displace the Saint Lucia anole.

6.5.3 Monitor selected populations and forest habitats to evaluate and guide management decisions

1. Conduct routine monitoring of managed threatened reptile populations,

   a) Develop methods to monitor iguana nests and hatching success.

   b) Monitor the population sizes of Saint Lucia whiptail lizards on all occupied islands using distance sampling methods.

2. Include reptile and amphibians in routine monitoring of selected forests to measure forest ecological health and provide an early warning of changes.

6.5.4 Conduct applied research on improved medical treatment for snakebite

1. Review and improve the standard of snake bite treatment on Saint Lucia, so as to minimise mortality or injury.

   a) Educate the public (especially farmers and forest workers) and emergency services personnel on the correct first aid treatment for bites by the Saint Lucia fer-de-lance. Annex IV contains advice on appropriate first aid for this species.

   b) With counsel from Prof. David Warrell, conduct clinical trials of alternative antivenoms to determine which are most effective in treating severe cases of *Bothrops caribbaeus* envenomation. BothroFav, produced by Aventis-Pasteur, should be included in these trials (this antivenom is currently available in Martinique, but not Saint Lucia).

   c) If a more effective antivenom or other treatment is identified, stocks should be purchased and local medical professionals trained in its application.

[13] Because it is spreading rapidly, the alien Watts' anole (*Anolis wattsi*) is perceived to present a greater threat than the alien Barbados anole (*A. extremus*) to the native Saint Lucia anole (*A. luciae*). The same suite of recommendations could be applied to the Barbados anole, however, especially if there is any evidence of it dispersing outside of its current Northwest range. (There has been an unconfirmed report of Barbados anoles living in an agricultural area, some distance inland from Praslin: Stephen Lesmond, pers. comm.)

6.6 EDUCATION

Strengthen local and national understanding and support for conservation

6.6.1 Increase public interest in and awareness of Saint Lucia's reptiles and amphibians

1. Develop an awareness programme to increase public knowledge of the diversity and importance of reptiles and amphibians in Saint Lucia. This need not entail an expensive campaign, but instead could make opportunistic use of existing resources (e.g. Union Zoo) and connections to the media. To support this:
   a) Create a 'toolbox' of materials that Forestry staff, collaborating organisations and the media can use to obtain and pass on information about reptiles and amphibians. This should include fact sheets on each species (the profiles in chapter could be a basis for these), photographs and video footage.
   b) Encourage local papers, radio, television to run features on reptile and amphibians, focusing on species that are threatened and endemic.
   c) Integrate reptiles and amphibians into outreach materials and activities for Saint Lucia's forests, e.g. trail guides and interpretation signs.
   d) Work with the Ministry of Tourism to address the natural curiosity of many tourists in Saint Lucia's wildlife, including showing labelled images of native species on brochures and promotional materials.
2. Engage local students and other members of the public in research activities where possible, including interviews, population surveys and monitoring.
3. Conduct a special awareness programme focusing on the Saint Lucia fer-de-lance, using television, posters and other media. Key messages to convey are the fact the fer-de-lance is a native species, ways to avoid being bitten, and the correct first aid techniques (see Annex IV).

6.6.2 Heighten public understanding of the impact of alien invasive species

1. Drawing on examples from Saint Lucia and comparable island nations, explain what alien invasive species are and the impact that they have. This theme could be incorporated into environmental education in schools, as well as through media articles, posters, public talks, etc.

7 References

Allen, G.M. (1911) Mammals of the West Indies. *Bulletin of the Museum of Comparative Zoology,* 54, 175-263.

Anon (1998) Common iguana (*Iguana iguana*). *West Indian Iguana Specialist Group Newsletter,* 1, 6.

Appleton, M.A., & Daltry, J.C. (in prep.) *Protected Area Management: a Practical Guide*. In preparation.

Barbour, T. (1930) Some faunistic changes in the Lesser Antilles. *Proceedings of the New England Zoological Club,* 11, 73-85.

Barbour, T. (1937) Third list of Antillean reptiles and amphibians. *Bulletin of the Museum of Comparative Zoology,* 82, 77-166.

Baskin, J.N., & Williams, E.E. (1966) The Lesser Antillean *Ameiva* (Sauria, Teiidae): re-evaluation, zoogeography, and the effects of predation. *Studies of the Fauna of Curaçao and Other Caribbean Islands,* 23, 144-176.

Bennett, A.F., & Gorman, G.C. (1979) Population density and energetics of lizards on a tropical island. *Oecologia,* 42, 339-358.

Boback, S.M. (2005) Natural history and conservation of island boas (*Boa constrictor*) in Belize. *Copeia*, 2005, 879-884.

Bowen-Jones, E., & Entwistle, A. (2002) Identifying appropriate flagship species: the importance of culture and local contexts. *Oyrx,* 36, 189-195.

Breach, K. (2009) *Quantifying the Interactions Between Humans and Endemic Pitvipers (*Bothrops caribbaeus*) in Saint Lucia*. A thesis submitted in partial fulfilment of the requirements for the degree of Master of Science, University of London.

Breen, H.H. (1844) *St. Lucia: Historical, Statistical and Descriptive*. Longman, Brown, Green and Longmans, London.

Breuil, M. (1997a) *Les Reptiles, les Amphibiens et les Chauves-Souris de l'Îlet Chancel (Martinique)*. Report, Direction Régionale de l'Environnement, Fort-de-France, Martinique, and Association des Amis du Laboratoire des Reptiles et Amphibiens du MNHN, Paris.

Breuil, M. (1997b) *L'herpétofaune de la Réserve Biologique Domaniale de la Montagne Pelée*. Office National des Forêts de Martinique, Fort-de-France, Martinique, and Association des Amis du Laboratoire des Reptiles et Amphibiens du MNHN, Paris. [In French].

Breuil, M. (2002) *Histoire Naturelle des Amphibiens et Reptiles Terrestres de l'Archipel Guadeloupéen: Guadeloupe, Saint-Martin, Saint-Barthélemy*. Patrimoines Naturels No. 54, MNHN, Institut d'Écologie et de Gestion de la Biodiversité and Service du Patrimoine Naturel, Paris.

Breuil, M. (2004) *À la Découverte des Amphibiens & Reptiles des Antilles*. PLB (Thierry Petit Le Brun) Éditions, Le Gosier, Guadeloupe.

Breuil, M., & Sastre, C. (1993) *Inventaire Ecologique de l'Archipel des Saintes (Guadeloupe): Végétation et Vertébrés (sauf Oiseaux)*. Report, Parc National de la Guadeloupe, Basse-Terre, Guadeloupe, and MNHN, Paris.

Brice, S. & Bloxam, Q. (1995). *Understanding Translocation Possibilities for a Teiid Lizard in St. Lucia: Distribution, Density of the Source Population and Ecological Aspects of the Target Habitat.* Unpublished internal report, Jersey Wildlife Preservation Trust, Jersey, Channel Islands.

Brown, H. (2008) *Assessing the Translocation of the Saint Lucia Whiptail Lizard* Cnemidophorus vanzoi*: A Retrospective Analysis of Abundance, Demographics and Habitat Utilization.* A thesis submitted in partial fulfilment of the requirements for the degree of Master of Science and the Diploma of Imperial College London.

Buley, K.R., & Gibson, R. (2001) Whiptail, Saint Lucia. In (ed. Bell, C.) *Encyclopedia of the World's Zoos. Volume 3*, Fitzroy Dearborn Publishers, Chicago.

Bullock, D.J., & Evans, P. (1990) The distribution, density and biomass of terrestrial reptiles in Dominica, West Indies. *Journal of Zoology*, 222, 421-443.

Campell, J.A., & Lamar, W.W. (2004) *The Venomous Reptiles of the Western Hemisphere*. Comstock Publishing Associates, Ithaca, New York.

Censky, E.J., & Kaiser, H. (1999) The Lesser Antillean fauna. In (ed. Crother, B.I.) *Caribbean Amphibians and Reptiles*, p. 181-221. Academic Press, San Diego and London.

Censky, E.J., Hodge, K. & Dudley, J. (1998) Over-water dispersal of lizards due to hurricanes. *Nature*, 395, 556.

Clarke, F.M (2009) *The Mammals of Saint Lucia: Species Accounts, Distribution, Abundance, Ecology, Conservation and Management of Saint Lucia's Native and Introduced Wild Mammals*. Technical Report to the National Forest Demarcation and Bio-Physical Resource Inventory Project, FCG International Ltd, Helsinki, Finland.

Coad, L., Burgess, N., Fish, L., Ravillious, C., Corrigan, C., Pavese, H., Granziera, A., & Besançon, C. (2009) Progress towards the Convention on Biological Diversity terrestrial 2010 and marine 2012 targets for protected area coverage. *Parks*, 17, 35-42.

Cole, N.C., Jones, C.G., & Harris, S. (2005) The need for enemy-free space: the impact of an invasive gecko on island endemics. *Biological Conservation*, 125, 467-474.

Corke, D. (1987) Reptile conservation on the Maria Islands (St. Lucia, West Indies). *Biological Conservation* 40, 263–280.

Cushman, S.A. (2006) Effects of habitat loss and fragmentation on amphibians: a review and prospectus. *Biological Conservation*, 128, 231-240.

Daltry, J.C. (1995a) *Report on the Findings of the Amphibians and Reptiles Team Part A: Species and Habitat Associations.* Report to Montserrat Biodiversity Project, Fauna & Flora International, Montserrat National Trust and Division of Forestry and Environment, Montserrat.

Daltry, J.C. (1995b) *Report on the Findings of the Amphibians and Reptiles Team Part B: Special Site Surveys.* Report to Montserrat Biodiversity Project, Fauna & Flora International, Montserrat National Trust and Division of Forestry and Environment, Montserrat.

Daltry, J.C. (1999) *Status, Distribution and Natural History of the Antiguan Racer (*Alsophis antiguae*): Field Research and Conservation Technical Report*. Antiguan Racer Conservation Project, Report No. 4. Fauna & Flora International, Cambridge.

Daltry, J.C. (2000) *Preliminary Assessment of the Saint Lucia Iguana, August-September 2000*. A report to the Saint Lucia Forest & Lands Department, Union, and the Durrell Wildlife Conservation Trust, Jersey.

Daltry, J.C. (2007) An introduction to the herpetofauna of Antigua, Barbuda and Redonda, with some conservation recommendations. *Journal of Applied Herpetology* 4, 97-130.

Daltry J.C. & Abernethy K.E. (2006). The effect of black rat *Rattus rattus* control on the population of the Antiguan racer snake Alsophis antiguae on Great Bird Island, Antigua. Case 367. www.ConservationEvidence.com

Daltry, J.C., Ross, T., Wüster, W. & Thorpe, R.S. (1998) Evidence that humidity influences snake activity: a radio telemetry study of the Malayan pit viper *Calloselasma rhodostoma*. *Ecography*, 21, 25-34.

Daltry, J.C., Bloxam, Q., Cooper, G., Day, M.L., Hartley, J., Henry, M., Lindsay, K. & Smith, B.E. (2001) Five years of conserving the 'world's rarest snake', the Antiguan racer *Alsophis antiguae. Oryx*, 35, 119-127.

Day, M.L., & Thorpe, R.S. (1996) Population differentiation of *Iguana delicatissima* and *I. iguana* in the Lesser Antilles. In (eds Powell, R., & Henderson, R.W.) *Contributions to the West Indian Herpetology. A Tribute to Albert Schwartz*, p. 436-437. Contributions to Herpetology, Volume 12, Society for the Study of the Amphibians and Reptiles, Ithaca, New York.

Dickinson, H.C., & Fa, J.E. (2000) Abundance, demographics and body condition of a translocated population of Saint Lucia whiptail lizards (*Cnemidophorus vanzoi*). *Journal of Zoology*, 251, 187-197.

Dickinson. H., Fa. J.E. & Lenton, S (2001) Microhabitat use by a translocated population of Saint Lucia whiptail lizards (*Cnemidophorus vanzoi*). *Animal Conservation* 4, 143-156.

Dowling, H.G. (1965) The puzzle of *Bothrops*; or, a tangle of serpents. *Animal Kingdom*, 68, 18-21.

Driscoll, D.A. (2004) Extinction and Outbreaks Accompany Fragmentation of a Reptile Community. *Ecological Applications*, 14, 220-240.

Durrell Wildlife Conservation Trust & Saint Lucia Ministry of Agriculture Forestry Department (2008) *The St Lucia Whiptail Lizard: Maximizing Survival Potential. An Action Plan for Genetic Management*. Unpublished report. Durrell Wildlife Conservation Trust, Jersey, and Saint Lucia Ministry of Agriculture Forestry Department, Union, Saint Lucia.

Espeut, W.B. (1882) On the acclimatization of the Indian mungoos in Jamaica. *Proceedings of the Zoological Society of London*, 1882, 712-714.

Fa, J.E. & Purvis, A. (1997) Body size, diet and population density in Afrotropical forest mammals: a comparison with Neotropical species. *Journal of Animal Ecology*, 66, 98-112.

Fa, J., Hedges, B., Ibéné, B., Breuil, M., Powell, R., & Magin, C. (2004) *Leptodactylus fallax*. In *2009 IUCN Red List of Threatened Species. Version 2009.1*. <www.iucnredlist.org>. [Downloaded on 2 September 2009].

Funk, S.M. & Fa, J.E. (2006) Phylogeography of the endemic St. Lucia whiptail lizard *Cnemidophorus vanzoi:* Conservation genetics at the species boundary. *Conservation Genetics*, 7: 651-663.

García, M.A., Diez, C.E., & Alvarez, A.O. (2002) The eradication of *Rattus rattus* from Monito Island, West Indies. In (eds Veitch, C.R., & Clout, M.N.) *Turning the Tide: the Eradication of Invasive Species*, p. 116-119. Occasional Paper of the IUCN Species Survival Commission No. 27. Auckland University.

Germano, J.M., Sander, J.M., Henderson, R.W., & Powell, R. (2003) Herpetofaunal communities in Grenada: a comparison of altered sites, with an annotated checklist of Grenadian amphibians and reptiles. *Caribbean Journal of Science*, 39, 68-76.

Giannasi, N., Thorpe, R.S., & Malhotra, A. (1997) Introductions of *Anolis* species to the island of St. Lucia, West Indies: testing for hybrids using multivariate morphometrics. *Journal of Herpetology*, 31, 586-589.

Gibbons, J.R.H. (1984) Iguanas of the South Pacific. *Oryx.* 18, 82-91.

Gibson, R. (1996) *Cnemidophorus vanzoi*. In *2009 IUCN Red List of Threatened Species. Version 2009.1.* <www.iucnredlist.org>. [Downloaded on 2 September 2009].

Goldwasser, L., & Roughgarden, J. (1993) Construction and analysis of a large Caribbean food web. *Ecology*, 74, 1216-1233.

Gorman, G.C. (1976) Observations on the distribution of *Anolis extremus* (Sauria: Iguanidae) on St. Lucia, West Indies - a "colonizing" species. *Herpetologica*, 32, 184-188.

Gorman, G.C., & Atkins, L. (1968) Natural hybridization between two sibling species of *Anolis* lizards: chromosome cytology. *Science*, 159, 1358–1360.

Graveson, R. (2009) *The Classification of the Vegetation of Saint Lucia*. Technical Report to the National Forest Demarcation and Bio-Physical Resource Inventory Project, FCG International Ltd, Helsinki, Finland.

Greene, H.W. (1983) Dietary correlates of the origin and radiation of snakes. *American Zoology*, 23: 431 441.

Greenlees, M.J., Brown, G.P., Webb, J.K., Phillips, B.L. & Shine, R. (2006) Effects of an invasive anuran [the cane toad (*Bufo marinus*)] on the invertebrate fauna of a tropical Australian floodplain. *Animal Conservation,* 9, 431–438.

Grouard, S. (2001) Faunal remains associated with late Saladoïd and post-Saladoïd occupations at Anse à la Gourde, Guadeloupe, West Indies: Preliminary results. *Archaeofauna.* 10, 71-98.

Gutiérrez, J.M., Sanz, L., Escolano, J., Fernández, J., Lomonte, B., Angulo, Y., Rucavado, A., Warrell, D.A., & Calvete, J.J, (2008) Snake venomics of the Lesser Antillean pit vipers *Bothrops caribbaeus* and *Bothrops lanceolatus*: correlation with toxicological activities and immunoreactivity of a heterologous antivenom. *Journal of Proteome Research* 7, 4396-408.

Hedges, S.B. (1996) The origin of West Indian amphibians and reptiles. In (eds Powell, R., & Henderson, R.W.) *Contributions to the West Indian Herpetology. A Tribute to Albert Schwartz*, p. 95-128. Contributions to Herpetology, Volume 12, Society for the Study of the Amphibians and Reptiles, Ithaca, New York.

Hedges, S.B. (2006) Paleogeography of the Antilles and origin of West Indian terrestrial vertebrates. *Annals of the Missouri Botanical Garden* 93, 231–244.

Hedges, S.B. (2008) At the lower size limit in snakes: two new species of threadsnakes (Squamata: Leptotyphlopidae: *Leptotyphlops*) from the Lesser Antilles. *Zootaxa*, 1841, 1–30.

Hedges, B., Ibéné, B., Breuil, M., & Powell, R. (2004a) *Eleutherodactylus martinicensis*. In: *2009 IUCN Red List of Threatened Species. Version 2009.1.* <www.iucnredlist.org>. [Downloaded on 11 September 2009].

Hedges, B., Ibéné, B., Koenig, S., La Marca, E., Ibáñez, R., & Hardy, J. (2004b) *Eleutherodactylus johnstonei*. In *2009 IUCN Red List of Threatened Species. Version 2009.1*. <www.iucnredlist.org>. [Downloaded on 11 September 2009].

Henderson, R.W. (1992) Consequences of predator introductions and habitat destruction on amphibians and reptiles in the post-Columbus West Indies. *Caribbean Journal of Science* 28, 1-10.

Henderson, R.W. (2004) Lesser Antillean snake faunas: distribution, ecology, and conservation concerns. *Oryx,* 38, 311-320.

Henderson, R.W., & Powell, R. (1999) West Indian herpetoecology. In (ed. Crowther, B.I.) *Caribbean Amphibians and Reptiles*, p. 223-268. Academic Press, San Diego.

Hensley, R.L., Wissmann, S.M., Powell, R., & Parmalee Jr, J.S. (2004) Habitat preferences and abundance of dwarf geckos (*Sphaerodactylus*) on St. Eustatius, Netherlands Antilles. *Caribbean Journal of Science*, 40, 427-429.

Heyer, W.R., Donnelly, M.A., McDiarmid, R.W., Hayek, L.C., & Foster, M.S. (eds) (1994) *Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians.* Smithsonian Institution Press, Washington, DC.

Hinkley, A.D. (1962) Diet of the giant toad, *Bufo marinus* (L.), in Fiji. *Herpetologica*, 18, 253–259.

Honegger, R.E. (1981) List of amphibians and reptiles either known or thought to have become extinct since 1600. *Biological Conservation*, 19, 141-158.

IUCN (2001) *IUCN Red List Categories and Criteria: Version 3.1*. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK.

Iverson, J.B. (1978) The impact of feral cats and dogs on populations of the West Indian rock iguana, *Cyclura carinata. Biological Conservation,* 14, 63-73.

John, C.L. (1999) *Population and Habitat of the St. Lucia Whiptail Lizard (*Cnemidophorus vanzoi*) on Praslin Island, St. Lucia*. Unpublished report, Forestry Department, Ministry of Agriculture, Forestry & Fisheries, Castries, St. Lucia, West Indies (http://www.slumaffe.org/slu_whiptail.pdf).

John, L. (2001) *Attitudes Towards Hunting and the Development of a National Wildlife Policy in St. Lucia.* Forestry Department, Union, Saint Lucia.

Johnston, J. P., Anthony, D. & Bloxam, Q. (1994) Eradication of rats from Praslin Island, St. Lucia. *Dodo (Jersey Wildlife Preservation Trust)* 30, 114–118.

Jolly, D.B. (2007) *Reproduction and Herpetofauna Depredation of Feral Pigs at Fort Benning, Georgia.* A Thesis Submitted to the Graduate Faculty of Auburn University in Partial Fulfillment of the Requirements for the Degree of Master of Science, Auburn, Alabama.

Kaiser, H. (1992) The trade-mediated introduction of *Eleutherodactylus martinicensis* (Anura, Leptodactylidae) on St-Barthélémy, French-Antilles, and its implications for Lesser Antillean biogeography. *Journal of Herpetology*, 26, 264-273.

Kaiser, H. (1997) Origins and introductions of the Caribbean frog *Eleutherodactylus johnstonei* (Leptodactylidae): management and conservation concerns. *Biodiversity Conservation* 6, 1391-1407.

Kaiser, H., & Hardy, J.D. (1994a) *Eleutherodactylus johnstonei* Barbour, Johnstone's Whistling Frog, Rainette de Johnstone. *Catalogue of American Amphibians and Reptiles* , No. 581, 1-5.

Kaiser, H., & Hardy, J.D. (1994b) *Eleutherodactylus martinicensis* (Tschudi). Brown Whistling Frog, Rainette brun [sic]. *Catalogue of American Amphibians and Reptiles*, No. 582, 1-4.

Kaiser, H., & Henderson, R.W. (1994) The conservation status of Lesser Antillean frogs. *Herpetological Natural History*, 2, 41-56.

King, W. (1962) Systematic of Lesser Antillean lizards of the genus *Sphaerodactylus*. *Bulletin of the Florida State Museum*, 7, 1-52.

Kluge, A.G. (1969) The evolution and geographical origin of the New World *Hemidactylus mabouia-brookii* complex (Gekkonidae, Sauria). *Miscellaneous Publications of the Museum of Zoology, University of Michigan*, 138, 1-78.

Kronauer, D.J.C., Bergmann, P.J., Mercer, J.M., & Russell, A.P. (2005) A phylogeographically distinct and deep divergence in the widespread Neotropical turnip-tailed gecko, *Thecadactylus rapicauda. Molecular Phylogenetic Evolution*, 34, 431-437.

Lazell, J.D., Jr. (1964) The Lesser Antillean representatives of *Bothrops* and *Constrictor*. *Bulletin of the Museum of Comparative Zoology, Harvard University*, 132, 245-273.

Lazell, J.D., Jr. (1967) Wiederentdeckung von zwei angeblich ausgestorbenen Schlangenarten der westindischen Inseln. *Salamandra*, 3, 91-97.

Lazell, J.D., Jr. (1991) The herpetofauna of Guana island: diversity, abundance, rarity, and conservation. In (ed. Moreno, J.A.) *Status y Distribucion de los Reptiles y Amfibios de la Region de Puerto Rico*, p. 28-33. Departamento de Recursos Naturales, Puerto Rico.

Lescure, J. (2000) Répartition passée de *Leptodactylus fallax* Müller, 1923 et d'*Eleutherodactylus johnstonei* Barbour, 1914 (Anoures, Leptodactylidés). *Bulletin de la Société Herpetologique de France*, 94, 13-23.

Lever, C. (2001) *The Cane Toad: the History and Ecology of a Successful Colonist*. Westbury Publishing, West Yorkshire.

Lever, C. (2003) *Naturalized Reptiles and Amphibians of the World*. Oxford University Press, Oxford.

Lewis, A.R. (1989) Diet selection and depression of prey abundance by an intensively foraging lizard. *Journal of Herpetology*, 23, 164-170.

Lorvelec, O., Delloue, X., Pascal, M., & Mège, S. (2004) Impacts des mammifères allochtones sur quelques espèces autochtones de l'îlet Fajou (réserve naturelle du grand cul-de-sac marin, Guadeloupe), établis à l'issue d'une tentative d'éradication. *Revue d'Ecologie (la Terre et la Vie)*, 59, 293-307.

Lorvelec, O, Pascal, M., Pavis, P., & Feldmann, P. (2007) Amphibians and reptiles of the French West Indies: inventory, threats and conservation. *Applied Herpetology*, 4, 131-161.

Lowe, S., Browne, M., Boudjelas, S., & De Poorter, M. (2000) *100 of the World's Worst Invasive Alien Species: A Selection from the Global Invasive Species Database*. Invasive Species Specialist Group (ISSG), a specialist group of the Species Survival Commission (SSC) of the World Conservation Union (IUCN). [Available online from: Invasive Species Specialist Group http://www.issg.org].

Magin, C. (2004) *Wildlife Survey Report.* Fauna and Flora International, Cambridge, and the Forestry and Wildlife Division, Dominica.

Malhotra, A., & Thorpe, R.S. (1999) *Reptiles & Amphibians of the Eastern Caribbean*. Macmillan Education Ltd, London and Oxford.

Malhotra, A., Thorpe, R.S., Hypolite, E., & James, A. (2007) A report on the status of the herpetofauna of the Commonwealth of Dominica, West Indies. *Applied Herpetology*, 4, 177-194.

Martin, L., Morton, M.N., Hilton, G.M., Young, R.P., Garcia, G., Cunningham, A.A., James, A., Gray, G., & Mendes, S. (eds) (2007) *A Species Action Plan for the Montserrat Mountain Chicken* Leptodactylus fallax. Department of Environment, Montserrat.

Miralles, A. (2005) The identity of *Lacertus mabouya* Lacepède, 1788, with description of a neotype: an approach toward the taxonomy of new world *Mabuya. Herpetologica*, 61, 46-53.

Mitchell, N.C. (1999) Effect of introduced ungulates on density, dietary preferences, home range, and physical condition of the iguana (*Cyclura pinguis*) on Anegada. *Herpetologica*, 55, 7-17.

Morton, M.N. (2007) *Saint Lucia Iguana: Report 2002-06*. Unpublished report to Durrell Wildlife Conservation Trust, Jersey, and Saint Lucia Ministry of Agriculture Forestry Department, Union, Saint Lucia.

Morton, M.N. (2008) *The Urgent Problem of Alien Green Iguanas Around Soufriere*. Unpublished report to Durrell Wildlife Conservation Trust, Jersey, and Saint Lucia Ministry of Agriculture Forestry Department, Union, Saint Lucia.

Morton, M.N. (2009a) *A Genetic Rescue for the Saint Lucia Whiptail Lizard*. Unpublished report to Durrell Wildlife Conservation Trust, Jersey, and Saint Lucia Ministry of Agriculture Forestry Department, Union, Saint Lucia.

Morton, M.N. (2009b) *A Survey of Wildlife Use on Saint Lucia.* Technical Report No. 7 to the National Forest Demarcation and Bio-Physical Resource Inventory Project, FCG International Ltd, Helsinki, Finland.

Murton, E.M. (2008) *The Abundance and Distribution of Reptiles on a Small Tropical Island: Implications for the Conservation of Reptile Communities.* A thesis submitted in partial fulfilment of the requirements for the degree of Master of Science and the Diploma of Imperial College London.

Nava, S.S., Lindsay, C.R., Henderson, R.W., & Powell, R. (2001) Microhabitat, activity, and density of a dwarf gecko (*Sphaerodactylus parvus*) on Anguilla, West Indies. *Amphibia-Reptilia*, 22, 455-464.

Nicholls, R.J., Wong, P.P. Burkett, V.R. Codignotto, J.O. Hay, J.E. McLean, R.F. Ragoonaden S. & Woodroffe, C.D. (2007) Coastal systems and low-lying areas. In (eds Parry, M.L. Canziani, O.F. Palutikof, J.P. van der Linden P.J. & Hanson, C.E.) *Climate Change 2007: Impacts, Adaptation and Vulnerability*, p.315-356. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, UK

Numeric, P., Moravie, V., Didier, M., Chatot-Henry, D., Cirille, S., Bucher, B., & Thomas, L. (2002) Multiple cerebral infarctions following a snakebite by *Bothrops caribbaeus. American Journal of Tropical Medicine and Hygiene*, 67, 287–288.

Parker, H.W. (1933) Some amphibians and reptiles from the Lesser Antilles. *Annals and Magazine of Natural History*, 10, 151-158.

Phillips, B.L., Brown, G.P. & Shine, R (2003) Assessing the potential impact of cane toads on Australian snakes. *Conservation Biology*, 17, 1738-1747.

Pimentel, D. (1955) Biology of the Indian mongoose in Puerto Rico. *Journal of Mammalogy* 36, 62-68.

Pinchon, R. (1967) *Quelques Aspects de la Nature aux Antilles*. Imprimerie Ozanne et Cie, Fort-de-France, Martinique, et Caen, France.

Pough, F.H., Andrews, R.M., Cadle, J.E., Crump, M.L., Savitsky, A.H., & Wells, K.D. (2004) *Herpetology: Third Edition.* Prentice-Hall, Inc. Upper Saddle River, New Jersey

Powell, R., & Henderson, R.W. (1996) A brief history of West Indian herpetology. In (eds Powell, R., & Henderson, R.W.) *Contributions to the West Indian Herpetology. A Tribute to Albert Schwartz*, p. 29-50. Contributions to Herpetology, Volume 12, Society for the Study of the Amphibians and Reptiles, Ithaca, New York.

Powell, R., & Henderson, R.W. (2005) Conservation status of Lesser Antillean reptiles. *Iguana*, 12, 63-77.

Powell, R., Crombie, R.I., & Boos, H.E.A. (1998) *Hemidactylus mabouia*. Reptilia: Squamata: Sauria: Gekkonidae. *Catalogue of American Amphibians and Reptiles*, No. 674, 1-11.

Pregill, G.K., Steadman, D.W., & Watters, D.R. (1994) Late Quaternary vertebrate faunas of the Lesser Antilles: historical components of Caribbean biogeography. *Bulletin of the Carnegie Museum of Natural History,* 30, 1-51.

Reagan, D.P. (1992) Congeneric species distribution and abundance in a three-dimensional habitat: the rain forest anoles of Puerto Rico. *Copeia*, 1992, 392-403.

Reagan, D.P. (1996) The role of amphibians and reptiles in a West Indian rain forest food web. In (eds Powell, R., & Henderson, R.W.) *Contributions to West Indian Herpetology,* p. 217-227. Society for the Study of Amphibians and Reptiles, Ithaca, NY.

Reed, R.N. (2005) An ecological risk assessment of nonnative boas and pythons as potentially invasive species in the United States. *Risk Analysis*, 25, 753-766.

Rodda, G.H. (1990) Highway madness revisited: roadkilled *Iguana iguana* in the Llanos of Venezuela. *Journal of Herpetology*, 24, 209-211.

Rodda, G.H., Perry, G., Rondeau, R.J., & Lazell, J. (2001) The densest terrestrial vertebrate. *Journal of Tropical Ecology* 17, 331-338.

Roughgarden, J. (1995) *Anolis Lizards of the Caribbean: Ecology, Evolution, and Plate Tectonics.* Oxford University Press, New York, US, and Oxford. UK.

Seaman, G.A. (1952) The mongoose and Caribbean wildlife In (ed. Quee, E.M.) *Transactions of the Seventeenth North American Wildlife Conference*, p. 188-197. Wildlife Management Institute, Washington.

Seaman, G.A., & Randall, J.E. (1962) The mongoose as a predator in the Virgin Islands. *Journal of Mammalogy*, 43, 544-546.

Schlaepfer, M.A., Hoover, C., & Dodd, K.C., Jr. (2005) Challenges in evaluating the impact of the trade in amphibians and reptiles on wild populations. *Bioscience*, 55, 256–264. [Available online at www.caliber.ucpress.net]

Schoener, T.W., Spiller, D.A., & Losos, J.B. (2001) Predators increase the risk of catastrophic extinction of prey populations. *Nature*, 412, 183-186.

Schwartz, A. (1965a) A review of *Sphaerodactylus vincenti* on the southern Windward Islands. *Caribbean Journal of Science*, 4, 391-409.

Schwartz, A. (1965b) A new subspecies of the gecko *Sphaerodactylus microlepis. Herpetologica,* 21, 261-269.

Schwartz, A., & Henderson, R.W. (1991) *Amphibians and Reptiles of the West Indies. Descriptions, Distributions, and Natural History*. University of Florida Press, Gainesville, Florida.

Sementelli, A., Smith, H.T., Meshaka, Jr., W.E., & Engeman, R.M. (2008) Just green iguanas? The associated costs and policy implications of exotic invasive wildlife in South Florida. *Public Works Management & Policy*, 12: 599-606. Abstract available at: http://pwm.sagepub.com/cgi/content/abstract/12/4/599

Siegel, S., & Castellan, N.J. (1988) *Non-Parametric Statistics for the Behavioral Sciences* (second edition). McGraw Hill, New York.

Simpson, L.A. (2003) *Review of Soil Management and Farming Practices, Including the Use of Agro-chemicals in the Caribbean, with Particular Reference to Saint Lucia and Jamaica.* Caribbean Agricultural Research and Development Institute (CARDI), Kingston, Jamaica.

Smith, B. E., Davis, O., & Bartscher, N.S. (2002) Surveys *of the Lizard* Ameiva griswoldi *on Antiguan Offshore Islands III: Summer 2001*. Antiguan Racer Conservation Project Report No. 8. Black Hills State University, Spearfish, South Dakota.

Solís, F., Ibáñez, R., Jaramillo, C., Fuenmayor, Q., Azevedo-Ramos, C., La Marca, E., Coloma, L.A., Ron, S., Hardy, J., Hedges, B., Ibéné, B., Breuil, M., & Powell, R. (2004) *Scinax ruber*. In *2009 IUCN Red List of Threatened Species. Version 2009.1*. <www.iucnredlist.org>. [Downloaded on 11 September 2009].

Steadman, D.W., Pregill, G.K., & Olson, S.L. (1984) Fossil vertebrates from Antigua, Lesser Antilles: evidence for Late Holocene human-caused extinctions in the West Indies. *Proceedings of the National Academy of Sciences, USA,* 81, 4448-4451.

Stewart, M.M., & Rand, A.S. (1991) Vocalizations and the defense of retreat sites by male and female frogs, *Eleutherodactylus coqui. Copeia,* 1991, 1013-1024.

Toledo, L.F., Britto, F.B., Araújo, O.G.S., Giasson, L.M.O., & Haddad, C.F.B. (2006) The occurrence of *Batrachochytrium dendrobatidis* in Brazil. *South American Journal of Herpetology*, 1, 185-191.

Towns, D.R., Daugherty, C.H., Cree, A. (2001) Raising the prospects for a forgotten fauna: a review of 10 years of conservation effort for New Zealand reptiles. *Biological Conservation*, 99, 3-16.

Underwood, G. (1993) A new snake from Saint Lucia, West Indies. *Bulletin of the Natural History Museum (Zoology)*, 59, 1-9.

Underwood, G. (1995) *A Tale of Old Serpents*. Saint Lucia National Trust, Castries, Saint Lucia, West Indies.

Vandeventer, (undated) In Search of the tete'chein: observations on the natural history of *Boa constrictor nebulosus*. In *The Boa Constrictors*, [http://www.boa-subspecies.com/subspecies/nebulosus.htm]

Varnham, K. (2006) *Non-native Species in UK Overseas Territories: A Review*. JNCC Report 372. Peterborough, United Kingdom.

Vidal, N., Azvolinsky, A., Cruaud, C., & Hedges, S.B. (2008) Origin of tropical American burrowing reptiles by transatlantic rafting. *Biology Letters,* 4, 115–118.

Waide, R.B., & Reagan, D. (1993) *The Food Web of a Tropical Rain Forest.* University of Chicago Press, Chicago.

Westermann, J.H. (1953) Natural preservation in the Caribbean: a review of literature on the destruction and preservation of flora and fauna in the Caribbean area. *Foundation for Scientific Research in Surinam and the Netherlands Antilles*, 9, 1-106.

White, G.L., & Hailey, A. (2006) The establishment of *Anolis wattsi* as a naturalized exotic lizard in Trinidad. *Applied Herpetology* 3, 11-26.

Wüster, W., Thorpe, R.S., Salomão, M.G., Thomas, L., Puorto, G., Theakston, R.D.G., & Warrell, D.A. (2002) Origin and phylogenetic position of the Lesser Antillean species of *Bothrops* (Serpentes, Viperidae): biogeographical and medical implications. *Bulletin of the Natural History Museum: Zoology*, 68, 101-106.

Young, R.P., Fa, J.E., Ogrodowczyk, A., Morton, M., Lesmond, S., & Funk, S.M. (2006) The Saint Lucia whiptail lizard *Cnemidophorus vanzoi*: a conservation dilemma? *Oryx*, 40, 358-361.

8 Acknowledgements

This study was carried out as part of the National Forest Demarcation and Bio-Physical Resource Inventory Project, funded by the European Union. Under the auspices of the Banana Industry Trust, this project was implemented by the Finnish Consulting Group International in collaboration with the Saint Lucia Forestry Department. I am grateful to Mr Jorma Peltonen, FCG International, for engaging myself, via Fauna & Flora International, in this project; and the Project Leader Dr Bob Tennent, for his tireless hard work and support for more than a year.

Many of my colleagues in the conservation biology team - Dr Frank Clarke, Roger Graveson, Prof. Mike Ivie, Mr Eli Ivie, Mr Ross Winton, Dr Justin Runyon, Dr Casey Delphia, Prof. David Warrell and, most of all, Mr Matthew Morton – contributed invaluable information and ideas to this study. Mr Morton (Durrell Wildlife Conservation Trust) also kindly provided reference materials and survey equipment, and reviewed earlier drafts of this report. Mr Vijay Datadin produced the map shown in Fig. 1. Mr Robert Deveaux was a wealth of information, especially regarding the Saint Lucia fer-de-lance. Any errors that remain, however, are entirely my responsibility.

I would also like to thank the Saint Lucia Forestry Department for their support of this study. Many staff contributed observations and ideas to this report. Mr Adams Toussaint guided me on my first trip around the island and provided excellent background information on the island's ecology. Mr Stephen Lesmond must be singled out for arranging and hosting two visits to Maria Major, the jewel in Saint Lucia's herpetological crown. Mr Melvin Smith accompanied me on several field trips and shared his extensive knowledge of Saint Lucia wildlife.

Finally, my involvement in this project would not have been possible without the support of my organisation Fauna & Flora International. I thank my colleagues Mr Mark Blake, Ms Kathie Alban, Dr Rosalind Aveling, Dr Robert Bensted-Smith, Ms Alison Gunn, Mr Berry Mulligan, Ms Heather Jolley and Ms Eleanor Bell for facilitating this assignment in various ways.

Annex I Survey plot characteristics

Plot No.	*Northing*	*Easting*	*Elevation (m)*	*Place name*	*Within 10m of ravine?*	*Manmade structures?*	*Forest Class (Graveson, 2009)*	*Quality*	*Date of survey*	*Time start*	*Time end*	*Mean ambient RH (%)*	*Mean ambient temp (°C)*	*Notes*
1	727557	1536442	160	Praslin Forest	No	No	Deciduous seasonal forest	High	02/02/2009	9.45	10.45	63	27.6	Adjacent to La Paradis development. Some disturbance (litter)
2	725668	1551490	32	La Sorciere	Yes	No	Deciduous seasonal forest	Medium	02/02/2009	14.05	15.05	64	27.6	Stream (gallery forest)
3	725624	1551553	30	La Sorciere	No	Yes	Deciduous seasonal forest	Low	02/02/2009	15:15	16:15	65	27.1	Disused buildings on forest edge/ field
4	727560	1547186	115	Louver	No	No	Deciduous seasonal forest	Medium	03/02/2009	08:30	09:30	71	32.1	South facing hillside. Scrubby. Evidence of cattle grazing, litter
5	727686	1547054	100	Louvet	No	No	Deciduous seasonal forest	Medium	03/02/2009	08:30	09:30	71	32.1	South facing hillside and stream. Scrubby. Evidence of cattle grazing
6	725990	1551540	20	La Sorciere	No	No	Deciduous seasonal forest	Low	03/02/2009	16:30	17:30	79	26.3	Acacia scrub, remains of cobbled road.
7	720050	1551027	37	Union	Yes	Yes	Deciduous seasonal forest	Medium	04/02/2009	08:45	09:45	84	25.6	On Union Forest trail, near stream
8	720508	1540330	310	Barre de lisle	No	No	Lower Montane Rainforest	Medium	04/02/2009	13:45	14:45	79	24.0	Windy day
9	720512	1539559	280	Barre de lisle	No	Yes	Lower Montane Rainforest	Medium	04/02/2009	15:15	16:15	78	24.5	Windy day
10	716393	1550973	3	Vigie	No	Yes	Littoral Evergreen Forest and Shrubland	Low	04/02/2009	17:05	18:05	74	26.1	Incl coconuts and mangrove, open, sandy
11	718461	1530984	398	Des Cartiers	Yes	No	Lower Montane Rainforest		05/02/2009	16:30	17:30	72	24.3	Along trail, crossed with very small streams.

Plot No.	*Northing*	*Easting*	*Elevation (m)*	*Place name*	*Within 10m of ravine?*	*Manmade structures?*	*Forest Class (Graveson, 2009)*	*Quality*	*Date of survey*	*Time start*	*Time end*	*Mean ambient RH (%)*	*Mean ambient temp (°C)*	*Notes*
12	719823	1558997	16	Pigeon Island National Park	No	Yes	Littoral Evergreen Forest and Shrubland	Low	06/02/2009	11:05	12:05	66	29.5	Incl ruins and lawns
13	720926	1558862	8	Near Pigeon Island causeway (on mainland)	No	No	Deciduous seasonal forest	Low	06/02/2009	12:30	13:30	61	29.6	Acacia scrub, grazed by horses, pigs, lot of litter, small muddy pond.
14	715021	1532570	824	Mont Troumassée	No	No	Elfin Shrubland	High	07/02/2009	10:00	11:00	66	22.6	Windy side, facing Atlantic
15	714452	1532522	633	Mont Troumassée	No	No	Lower Montane Rainforest	High	07/02/2009	11:10	12:10	78	25.0	Leeward side, densely forested (tall trees)
16	714225	1532547	634	Mont Troumassée	No	No	Lower Montane Rainforest	High	07/02/2009	12:10	13:10	78	27.4	Rainforest boundary with cattle pasture
17	713765	1544800	2	Marigot Bay	No	Yes	Mangrove	Low	08/02/2009	12:00	13:00	61	28.7	Includes beach restaurant and parking
18	715479	1538852	286	Millet road	No	Yes	Semi-evergreen Seasonal Forest	Low	08/02/2009	13:45	14:45	61	28.1	cattle pasture
19	721189	1545330	345	Forestiere trail	Yes	No	Lower Montane Rainforest	High	09/02/2009	10:45	11:45	74	25.5	Some blue mahoe
20	721947	1545250	390	Forestiere trail	Yes	No	Lower Montane Rainforest	High	09/02/2009	11:55	12:55	73	25.4	Rainforest
21	723168	1534365	251	Mamiku	No	Yes	Semi-evergreen Seasonal Forest	Low	10/02/2009	09:00	10:00	67	26.8	Mixed forest/ banana plantation
22	722826	1534903	265	Mamiku	No	No	Lower Montane Rainforest	High	10/02/2009	10:30	11:30	73	24.5	Rainforest (lower elevation)
23	722503	1535133	389	Mamiku	No	No	Lower Montane Rainforest	High	10/02/2009	12:15	13:15	74	23.6	Rainforest (lower elevation)

Plot No.	*Northing*	*Easting*	*Elevation (m)*	*Place name*	*Within 10m of ravine?*	*Manmade structures?*	*Forest Class (Graveson, 2009)*	*Quality*	*Date of survey*	*Time start*	*Time end*	*Mean ambient RH (%)*	*Mean ambient temp (°C)*	*Notes*
24	713332	1540630	13	Millet river	Yes	Yes	Semi-evergreen Seasonal Forest	Medium	11/02/2009	12:45	13:45	66	28.4	Beside river (name unknown)
25	708708	1537773	36	Canaries	No	Yes	Deciduous seasonal forest	Low	11/02/2009	14:30	15:30	62	28.4	Includes small cemetery
26	716725	1537682	259	Millet reserve	No	Yes	Lower Montane Rainforest	Medium	03/05/2009	10:00	11:00	78	25.5	Includes forest buildings
27	718965	1554655	33	East Winds Inn	No	Yes	Littoral Evergreen Forest and Shrubland	Low	03/05/2009	12:30	13:30	64	27.6	Landscapes hotel gardens
28	722338	1516753	222		No	No	Deciduous seasonal forest	Medium	03/05/2009	15:45	16:45	77	27.1	Roadside to communications tower. Feral cat seen
29	722704	1519500	9	Chak chak	No	Yes	Littoral Evergreen Forest and Shrubland	Low	03/05/2009	17:15	18:15	74	27.2	Cottage buildings, gardens, dry forest
30	727366	1529992	54	Escap	No	No	Deciduous seasonal forest	Medium	04/05/2009	17:15	18:15	74	27.1	Dry forest near residential area
31	728845	1536918	65	Bordelais	Yes	Yes	Deciduous seasonal forest	Medium	05/05/2009	13:00	14:00	79	28.4	Near Bordelais prison. Dry forest, some disturbed, some intact.
32	722207	1518716	10	Hewanorra	No	No	Littoral Evergreen Forest and Shrubland	Low	05/05/2009	15:30	16:30	77	27.1	Coccoloba trees and pasture. Leafliter is being removed (recreational area)
33	721837	1523374	235	Morne Caillandre	No	No	Semi-evergreen Seasonal Forest	Low	05/05/2009	17:00	18:00	74	27.1	Mixed moist forest and agriculture (coconuts, bananas, fruit trees)
34	727633	1539800	60	Fond'Or	No	Yes	Littoral Evergreen Forest and Shrubland	Low	21/07/2009	16:45	17:45	80	28.0	Dry forest

Plot No.	*Northing*	*Easting*	*Elevation (m)*	*Place name*	*Within 10m of ravine?*	*Manmade structures?*	*Forest Class (Graveson, 2009)*	*Quality*	*Date of survey*	*Time start*	*Time end*	*Mean ambient RH (%)*	*Mean ambient temp (°C)*	*Notes*
35	727786	1540162	1	Fond'Or	Yes	No	Freshwater Swamp Forest	Low	21/07/2009	17:45	18:45	80	27.0	Swamp forest/ coconut plantation
36	712495	1542678	152	Anse La Raye	No	Yes	Deciduous seasonal forest	Medium	22/07/2009	14:00	15:00	65	27.4	Dry forest/ residential
37	712140	1542714	90	Anse La Raye	No	Yes	Semi-evergreen Seasonal Forest	Low	22/07/2009	15:15	16:15	67	27.5	Beside stream, mixed with mangoes and coconuts. Charcoal pit (recent use)
38	711238	1530601	256	Soufriere sulphur springs	Yes	Yes	Fumarole vegetation	Low	22/07/2009	16:45	17:45	70	26.8	Sulphur springs, some Pinus.
39	722758	1518982	6	The Reef, Vieux Fort	No	Yes	Littoral Evergreen Forest and Shrubland	Low	23/07/2009	12:15	12:45	63	27.6	Grounds of beachside restaurants
40	718890	1519245	14	Georgie Point	No	Yes	Deciduous seasonal forest	Low	23/07/2009	14:10	14:40	60	28.4	Acacia scrub, grazed by horses, cattle, lot of litter
41	718118	1527115	277	Woodlands	No	Yes	Semi-evergreen Seasonal Forest	Low	23/07/2009	15:30	16:30	78	26.8	Old building at interface between mesic and banana plantation
42	720727	1521472	173	Morne Beausejour	No	Yes	Deciduous seasonal forest	Medium	23/07/2009	16:45	17:45	72	27.5	Dry forest patches between residences
43	728105	1549554	15	Grande Anse	No	No	Deciduous seasonal forest	High	24/07/2009	10:15	11:15	75	29.3	Dry forest, minor disturbance (litter, crab digging, grazing near edges)
44	728453	1548526	7	Grande Anse	Yes	No	Freshwater Swamp Forest	Medium	24/07/2009	12:00	13:00	75	29.7	Dry forest beside river, minor disturbance (litter, grazing on edges)
45	713141	1528292	362	Choiseul	No	No	Semi-evergreen Seasonal Forest	High	25/07/2009	11:10	12:10	75	25.6	Mesic forest - secondary but mature. Mosaic landscape with gardens.

Plot No.	*Northing*	*Easting*	*Elevation (m)*	*Place name*	*Within 10m of ravine?*	*Manmade structures?*	*Forest Class (Graveson, 2009)*	*Quality*	*Date of survey*	*Time start*	*Time end*	*Mean ambient RH (%)*	*Mean ambient temp (°C)*	*Notes*
46	713133	1528066	345	Choiseul	Yes	No	Semi-evergreen Seasonal Forest	Medium	25/07/2009	12:30	13:30	75	26.6	Mesic forest - secondary but mature. Mosaic landscape with gardens.
47	712356	1522202	19	River Dore	Yes	Yes	Deciduous seasonal forest	Medium	25/07/2009	13:45	14:45	74	29.9	Riparian through dry forest, secondary
48	723681	1518362	50	Maria Major	No	No	Deciduous seasonal forest	High	26/07/2009	10:05	11:05	69	28.5	Dry forest
49	723701	1518182	104	Maria Major	No	No	Deciduous seasonal forest	High	26/07/2009	11:25	12:25	65	30.9	Dry forest - dominated by cacti.
50	723724	1558909	5	Cas En Bas	No	No	Littoral Evergreen Forest and Shrubland	Medium	27/07/2009	10:20	11:20	67	31.9	Coastal forest, swampy in parts
51	723663	155879	7	Cas En Bas	No	No	Freshwater Swamp Forest	Medium	27/07/2009	11:30	12:30	72	31.0	Coastal forest, swampy in parts
52	723697	1559846	111	Cap (North)	No	Yes	Deciduous seasonal forest	Medium	27/07/2009	13:00	14:00	65	31.3	Dry forest
53	724879	1540900	57	Mabuya valley	No	Yes	Semi-evergreen Seasonal Forest	Low	27/07/2009	15:30	16:30	76	30.6	Mesic forest
54	714558	1548452	26	Cul de Sac	No	Yes	Deciduous seasonal forest	Low	27/07/2009	07:30	08:30	73	24.5	Patch of secondary forest among housing
55	721646	1556391	17	Rodney Bay	Yes	Yes	Deciduous seasonal forest	Low	27/07/2009	16:45	17:45	77	30.5	Mixed dry forest

Annex II Species recorded in every plot

Plot No.	*Anolis extremus*	*Anolis luciae*	*Anolis wattsi*	*Boa constrictor*	*Bufo marinus*	*Cnemidophorus vanzoi*	*Eleutherodactylus johnstonei*	*Gymnophthalmus pleii*	*Hemidactylus mabouia*	*Hemidactylus palaichthus*	*Leptotyphlops bruilei*	*Scinax rubra*	*Sphaerodactylus microlepis*	*Thecadactylus rapicaudus*	*Total number of individuals*
1		17					13								30
2		7	4		1		3								15
3		5	7	1											13
4		5													5
5		3					2								5
6		4			1		1					1			7
7		15	3												18
8		5													5
9		4													4
10	3	2	3		4										12
11		2					2								4
12		12	4				2								18
13		9	2		1										12
14							2								2
15															0
16		1					2						1		4
17		4	10				1								15
18		4													4
19		3					2								5
20		5					1								6
21		4					10	1							15
22		12													12
23		8					1								9
24		37					4								41
25		3	5				2								10
26		8	12				4								24
27		4	12				2								18

Plot No.	*Anolis extremus*	*Anolis luciae*	*Anolis wattsi*	*Boa constrictor*	*Bufo marinus*	*Cnemidophorus vanzoi*	*Eleutherodactylus johnstonei*	*Gymnophthalmus pleii*	*Hemidactylus mabouia*	*Hemidactylus palaichthus*	*Leptotyphlops bruilei*	*Scinax rubra*	*Sphaerodactylus microlepis*	*Thecadactylus rapicaudus*	*Total number of individuals*
28		15					4								19
29		14					4								18
30		12					6							1	19
31		13					7								20
32		10													10
33		6					7								13
34		13	5				5								23
35		10					12								22
36		5					10								15
37			72				10								82
38		8					3								11
39		24	4		1		6								35
40		5			1		4								10
41		4					20						1		25
42		6					15								21
43		11					5	9					15		40
44		34					7	8					7		56
45		14					8								22
46		11					6								17
47		13					12								25
48		39								2	2		7		50
49		15				10					1		1		27
50		21					2	1	1						25
51		7					1								8
52		5					2								7
53		4					3								7
54															0
55		5	40		1		21		1			1			69
TOTAL	3	507	183	1	10	10	234	19	2	2	3	2	32	1	1,009

Annex III Decision Matrix for Species Recovery Planning

After Appleton & Daltry (in prep.). See Section 6.4.3.

		Recovery Management Actions: Mostly In Situ ← → Mostly Ex Situ																
	Current Situation	Baseline field surveys to identify cause(s)	Monitoring of wild population	Monitoring of known and or probable threats in the area	Targeted protection and enforcement	Habitat improvement or expansion	Artificial habitat enhancement/ supplementary feeding	Alien invasive / feral species control	Control other native species.	Horticultural/ veterinary care to treat disease or injuries	Population re-enforcement or Translocation	Re-introduction	Awareness and education to improve human behaviour	Head-starting	Fostering (for species that lay multiple clutches of eggs)	Captive breeding/ propagation	Seed banks and cryopreservation	Benign Introduction (outside natural range)
Status critical, but cause uncertain	Population locally extinct	●	n/a	○	n/a	·	·	·	·	n/a	n/a	●	○	n/a	n/a	○	·	○
	Population shows:																	
	Severely reduced population size	●	●	○	○	·	·	·	·	·	○	n/a	·	·	·	·	·	n/a
	Slow rate of reproduction or regeneration	●	●	○	○	·	·	·	·	·	○	n/a	·	·	●	·	·	n/a
	High juvenile mortality	●	●	○	·	·	·	·	·	·	○	n/a	·	●	○	·	·	n/a
	Severely reduced genetic variation or gene flow between groups	●	●	○	·	·	·	·	·	·	○	n/a	·	●	○	·	·	n/a
Threat(s) is known	'Habitat loss' (reduced area, fragmented area, degraded quality)	·	●	●	○	●	○	·	·	·	·	Identify and remove threats before re-introduction	○	·	·	·	·	Avoid introduction into areas with these threats
	Competition/ predation/ hybridization with alien species	·	●	●	·	·	·	●	·	·	·		○	·	·	○	·	
	Competition, predation, hybridization with feral or domestic animals or plants	·	●	●	●	·	·	●	·	·	·		●	·	·	○	·	
	Abnormal imbalance with other native species	·	●	●	·	·	·	○	○	·	·		·	·	·	○	·	
	Pathogenic disease (native)	·	●	●	·	·	·	·	○	●	·		·	·	·	○	·	
	Pathogenic disease (introduced)	·	●	●	·	·	·	●	·	●	·		·	·	·	○	·	
	Intentional killing/ collection by humans	·	●	●	●	·	·	·	·	·	·		●	·	·	○	·	
	Unintentional killing/ collection by humans	·	●	●	○	·	·	·	·	·	·		●	·	·	○	·	
	Direct contamination from pollutants	·	●	●	●	○	·	·	·	·	·		●	·	·	○	·	
	Inbreeding depression (small population size)	·	●	·	·	·	·	·	·	·	●		·	·	○	○	·	

● Probably essential; ○ Probably useful; · May be useful; n/a Not applicable or appropriate

Annex IV Snakebite Recommendations

Adapted from:

Anon (2008) *Health & Safety Guidelines For Field Work in Saint Lucia.* Internal document for field researchers, National Forest Demarcation and Bio-Physical Resource Inventory Project, Union and Castries, Saint Lucia.

Venomous snakes

Snakes are not naturally aggressive, but may strike if they feel threatened. Take care even with supposedly dead specimens - people have received fatal reflex bites from dead and decapitated snakes. Snakes carry enough venom to bite more than once.

The best way to avoid a bite from a venomous snake is to stay away from it and not attempt to pick it up or kill it (many people get bitten while trying to kill snakes). The risk can also be greatly reduced with proper clothing: long trousers and tall *leather* boots or snake gaiters will help protect against being bitten after treading on a snake. Watch out for snakes when brushing against vegetation, climbing trees, turning over logs and stones, collecting firewood, or examining holes and crevices. Pit vipers are most active at night, so it is important to be extra-vigilant and carry good torches when hiking at night.

It has been calculated that only 7% of Saint Lucia fer-de-lance bites are fatal without treatment, and the death rate can be reduced to nearly 0% with use of antivenom. If a person is bitten and shows signs of envenomation, the hospital will therefore give them a course of antivenom (antivenin) injections. Antivenom treatment is most effective when given promptly after the bite, but can still work even several days later. Antivenom should be administered only by trained medical practitioners.

Actions on Snakebite

The person who is bitten

- Move away from the snake. Make no attempt to catch or kill the snake.
- Alert your colleagues immediately, but do not panic. Remember that snake bites are treatable, and that venomous snakes frequently inflict ‘dry’ bites with little or no venom is injected.
- If your colleagues are out of sight, use your telephone or the international distress signal: SIX long blasts on the whistle every minute. Sit still and let your colleagues come to your assistance.

The other team members

- On hearing the distress signal, other survey participants should respond (THREE long blasts per minute) and decide the safest means of reaching the stricken individual.
- Keep away from the snake. Make no attempt to catch or kill the snake unless that is the only way to avoid a second bite.
- Gently wash the bitten area to remove any venom from the surface of the skin.
- You must get the victim to hospital by the quickest route possible: you may use a project vehicle, ambulance (dial 911) or flag down a passing vehicle. Keep the patient as calm and still as possible, and prevent excited onlookers crowding around. Even if he/she feels able to walk, it is best to carry them on a makeshift stretcher or vehicle.
- Watch the patient closely for any signs of cardiac (heart) or pulmonary (breathing) arrest, and be prepared to administer cardio-pulmonary resuscitation. If they vomit, lay the patient on one side so that fluid does not block breathing passages.
- Allow the patient to drink plenty of water. You may provide Paracetamol (0.1-1.0g for an adult).

- Do not give alcohol or aspirin. Do not apply a tourniquet. Do not attempt to cut, burn, apply ice, or suck the area around the bite wound (these methods promote infection and shock, and tourniquets can dangerously concentrate the venom's tissue-destroying enzymes, leading to the loss of the leg or arm).
- If possible, either you or your seniors should phone the hospital in advance to warn them that a snake bite patient will be arriving, and give the estimated time of arrival.

Note that Snake Venom Kits (including suction devices) are ineffective and not recommended.

DISCLAIMER:

This document has been compiled from various sources and is believed to be the best advice available. Nevertheless, FCG and its employees cannot take responsibility for deaths or injury resulting from following these guidelines.