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Management of Critical Species on Saint Lucia

SPECIES PROFILES AND MANAGEMENT RECOMMENDATIONS

By

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Executive Summary

A suite of 16 forest species and subspecies of the highest priority for conservation action on Saint Lucia were selected from four of the groups covered by the National Forest Demarcation and Bio-Physical Resource Inventory Project: plants, reptiles, birds, and mammals. The criteria used to make this selection were endemism (irreplaceability), declining or very restricted populations and/or ranges, and the severity of threats to their continued survival. In addition, other criteria were the keystone roles that these species and subspecies play within forest ecosystems on Saint Lucia, along with their uses and cultural significance to people.

It was decided, in consultation with the Saint Lucia Forestry Department, to include endemic subspecies as well as species for a number of reasons. Firstly, on precautionary grounds: the taxonomy of a number of animals and plant remains uncertain and some subspecies may eventually be recognised as full species; secondly, even as subspecies, many of the choices here represent globally distinct levels of biodiversity; and thirdly, many of the subspecies also fulfil one or more important roles on Saint Lucia.

The following 16 critical species were selected:

Four trees: *Zanthoxylum flavum* (arkokwa), *Guaiacum officinale* (gayak), *Juniperus barbadensis* var. *barbadensis* (pencil cedar) and *Carapa guianensis* (akajou gwan bwa).

Five reptiles: *Liophis ornatus* (Saint Lucia racer), *Iguana cf iguana* (Saint Lucia iguana), *Cnemidophorus vanzoi* (Saint Lucia whiptail lizard), *Sphaerodactylus microlepis* (Saint Lucia pygmy gecko) and *Bothrops caribbaeus* (Saint Lucia fer de lance).

Five birds: *Amazona versicolor* (Saint Lucia amazon), *Melanospiza richardsoni* (Saint Lucia black finch), *Camprimulgus rufus otiosus* (Saint Lucia nightjar), *Troglodytes aedon mesoleucus* (Saint Lucia wren) and *Ramphocinclus brachyurus sanctaeluciae* (white-breasted thrasher)

Two mammals: *Sturnira lilium luciae* (Saint Lucia yellow-shouldered bat) and *Brachyphylla cavernarum* (Antillean fruit bat).

For each critical species or subspecies, a profile is presented to provide an evidence base and a guide for wildlife managers conserving these native animals and plants. Each species profile includes a justification for why the species was selected, along with information on identification, habitat use, distribution, population status, diet (for animals only), reproduction, uses and threats to the species on Saint Lucia. This information is followed by species-specific management recommendations. Each profile also lists references and an email contact for someone working on Saint Lucia and with expert knowledge of the species in question.

Detailed information on insect species was not available at the time of writing this report, but a preliminary outline of some example priority species and conservation management issues is appended.

Critical Species

Background

The Saint Lucia Forestry Department (SLFD), Ministry of Agriculture, Lands, Fisheries and Forestry, has a long and successful history of managing species of high conservation priority on Saint Lucia. The diverse and intensive efforts to save the Saint Lucia amazon (*Amazona versicolor*) have been conspicuously successful (Young *et al.*, in prep.). Ongoing management of the Saint Lucia whiptail lizard (*Cnemidophorus vanzoi*) continues to achieve successes (Morton, 2009). Other notable programmes on the Saint Lucia iguana (*Iguana cf iguana*) and the white-breasted thrasher (*Ramphocinclus brachyurus*) have amassed an impressive evidence base for the management of these species (Morton, 2007; White, 2009; Young *et al.*, in press). This report focuses on a small number of ‘critical species’, including those just mentioned, that have been identified as of especial importance for conservation action on Saint Lucia.

Scope and purpose

The purpose of this report is to provide an evidence base and a guide for wildlife managers conserving Saint Lucia’s native species. It aims to collate existing knowledge and sources to assist management planning, and to identify management recommendations for each of the critical species identified. Given Saint Lucia’s impressively high biodiversity (Clarke, 2009; Daltry, 2009; Graveson, 2009; Toussaint *et al.*, 2009; Ivie, in prep), this report has necessarily had to focus on a small number of species, selected from some of the groups covered by the National Forest Demarcation and Bio-Physical Resource Inventory Project: plants, reptiles, birds, and mammals. A report on another taxonomic group – insects – is still in preparation and species from this group are only covered briefly (Annex I) in this report.

The concept of focal species

Focal species attempt to bridge the gap between single species approaches to conservation and the need to conserve whole assemblages of species and their ecosystems (Mills, 2007). Ideally, a focus on a small suite of species will provide information on, and guide the management of, whole ecosystems. Mills (2007) describes four types of focal species:

- *Flagship species* are not intended to explain or represent the functioning of whole ecosystems. They are strategic concepts to raise support and awareness of these systems.
- *Umbrella species* are chosen so that their conservation also conserves a wide range of other species that co-exist with them.
- *Indicator species* are intended to signpost the presence of additional species or to be sensitive to impacts on the wider ecosystem.
- *Keystone species* are species thought to be essential for ecosystems to function; their loss could lead to the collapse of those ecosystems.

Critical species for Saint Lucia

As with many of the plants and animals on Saint Lucia, most of the critical species selected in this report qualify as one or more of these types of focal species. Some have been promoted as flagship species such as the Saint Lucia amazon and the Saint Lucia iguana. These are also umbrella species

for their respective forest ecosystems: the parrot is found in lower montane rain forest and the iguana in one of the most biodiverse areas of deciduous seasonal forest on Saint Lucia. Species restricted to the offshore islands appear very sensitive to the impacts of introduced predators and are indicators for these small ecosystems that are important for many other species on Saint Lucia. Examples are the Saint Lucia racer (*Liophis ornatus*) and the Saint Lucia whiptail, the latter also a flagship for the offshore islands as promoted by SLFD. Although found on the mainland of Saint Lucia, the supposed remnant populations of the Saint Lucia wren (*Troglodytes aedon mesoleucus*) and the Saint Lucia nightjar (*Camprimulgus rufus otiosus*) suggest they are also very sensitive to habitat modification and introduced predators and their presence may indicate the value of certain small areas for a range of other species impacted by these pressures. A number of Saint Lucia's only extant native mammals – its nine species of bat – provide the keystone ecological services of pollination and seed dispersal for a wide range of forest trees and other plants. The two bat species selected were chosen as umbrella species for other bats on Saint Lucia. The Antillean fruit bat (*Brachyphylla cavernarum*) depends on large caves (a rare and fragile resource on Saint Lucia) for roosting, but so do a number of other bat species. The Saint Lucia yellow-shouldered bat (*Sturnira lilium luciae*) represents a number of bat species using cavities in large trees as roosts.

Selection of critical species for Saint Lucia

The following 16 critical species were selected:

Four trees: *Zanthoxylum flavum* (arkokwa), *Guaiacum officinale* (gayak), *Juniperus barbadensis* var. *barbadensis* (pencil cedar) and *Carapa guianensis* (akajou gwan bwa).

Five reptiles: *Liophis ornatus* (Saint Lucia racer), *Iguana cf iguana* (Saint Lucia iguana), *Cnemidophorus vanzoi* (Saint Lucia whiptail lizard), *Sphaerodactylus microlepis* (Saint Lucia pygmy gecko) and *Bothrops caribbaeus* (Saint Lucia fer de lance).

Five birds: *Amazona versicolor* (Saint Lucia amazon), *Melanospiza richardsoni* (Saint Lucia black finch), *Camprimulgus rufus otiosus* (Saint Lucia nightjar), *Troglodytes aedon mesoleucus* (Saint Lucia wren) and *Ramphocinclus brachyurus sanctaeluciae* (white-breasted thrasher)

Two mammals: *Sturnira lilium luciae* (Saint Lucia yellow-shouldered bat) and *Brachyphylla cavernarum* (Antillean fruit bat).

A number of criteria were used to select these 16 critical species, including focal roles, as outlined above, and taxonomic coverage across the multiple taxa considered by the Bio-Physical Resource Inventory Project. The main criteria though were endemism (irreplaceability), declining or very restricted populations and/or ranges, and the severity of threats to their continued survival. These are among the criteria used to assess the status of species (IUCN, 2001), as used on the IUCN Red List (IUCN, 2009) and have been applied at a national level for Saint Lucia. Considering these factors combined, all but two of the species and subspecies identified here as critical have a high to extremely high risk of extinction on Saint Lucia in the near future. In the case of species or subspecies endemic to Saint Lucia alone this is, of course, also a high to extremely high risk of extinction globally.

The two exceptions to this are the two bat species. None of the bats on Saint Lucia currently appear to be at high risk of extinction. These two bat species chosen were selected on the basis of key ecosystem roles, plus subspecific endemism in the case of one, and a dependence on a rare habitat type (caves)

in the case of the other. Other criteria were also considered in selecting these 16 critical species including uses and cultural significance of species.

Daltry (2009a) and Toussaint *et al.*, (2009) formalize the prioritization for conservation action of herptiles and birds respectively using these multiple criteria. This report closely follows their findings, though given the limited time available not all could be included. Additionally, two birds of very high priority for Saint Lucia – Semper’s warbler (*Leucopeza semperi*) and the forest thrush (*Cichlherminia lherminieri sanctaeluciae*) – were omitted from the 16 critical species presented here because of the great, and ongoing, difficulties in locating any populations of them on Saint Lucia. It is recommended that if this changes – and there have been some recent sightings of the forest thrush (Toussaint *et al.*, 2009) that might presage such a change – that detailed management profiles are developed for these species too. The plant species were selected by Roger Graveson and the bat species by the author of this report.

The decision to include endemic subspecies as well as species was made for a number of reasons. Firstly, on precautionary grounds it is noted that the taxonomy of a number of species remains uncertain: the wren and the iguana are examples, and possibly the nightjar and pygmy gecko (*Sphaerodactylus microlepis*) as well. Secondly, even as subspecies, many of the choices here represent globally distinct levels of biodiversity. Thirdly, many also fulfil one or more focal roles (as outlined above) on Saint Lucia.

Species profiles and recommendations

For each critical species or subspecies, a profile is presented to summarize existing knowledge about the species that may be of use in making, and evaluating the outcomes of, conservation management decisions. Each profile is followed by a series of recommendations, specific to the critical species in question, for conservation action on Saint Lucia. For certain species, especially those that are already the focus of conservation efforts on Saint Lucia, longer profiles reflect the larger body of information from Saint Lucia that is available.

The profiles are made up of the following sections:

Justification. An explanation of why each species was selected as a critical species for Saint Lucia. Any taxonomic uncertainties are noted here (and in some cases elaborated on in the following section). In the case of the Saint Lucia iguana, for which the taxonomy appears completely unresolved, a boxed section at the end of the profile reviews evidence and thinking on this matter.

Identification. A brief physical description with guidelines on identifying each species on Saint Lucia. Any taxonomic uncertainties are noted here or in the following section.

Habitat. A summary of what is known of the habitat preferences and requirements of each species. For some species, different habitat types are used at different points in the organism’s life, for example bat roost and bat foraging habitats, iguana nesting areas and their normal home range.

Distribution. An outline of each species international distribution outside Saint Lucia (for those species to which it is applicable) and its national range on Saint Lucia. A distribution map shows the locations of confirmed records.

Population status. A summary of what is estimated, or believed, to be the size of each species population on Saint Lucia, and whether there is any information available, or able to be inferred, on population trends.

Diet. (Animal species only). A summary of the species' requirements in terms of dietary items and feeding behaviour. When examples of specific food items are available, these are briefly noted.

Reproduction. For plants, a summary of what is known of the mechanisms of, and times of year when they occur, for flowering, pollination, fruiting and seed dispersal, along with information on growth. For animals, the timing of mating, egg laying or pregnancy, and births and the number of offspring.

Uses. Any known uses that the animals serve people. These may be economic or cultural uses, or ecosystem services.

Threats. A summary of the main pressures (current) and threats (likely in the immediate future) facing each species.

Management Recommendations. Actions recommended to be implemented in Saint Lucia to increase the chances of survival of each of the critical species considered here.

References. A comprehensive literature review was beyond the scope of this report, but an attempt has been made to identify all the most useful works referring to each critical species on Saint Lucia. Each profile attempts to back up all its factual claims with references whenever possible.

Contact. Email contacts for someone working on Saint Lucia and with expert knowledge of the species in question (substitute @ for [AT] to complete each address).

Each profile is intended to function as a standalone piece with its own references; hence there is some repetition across profiles and references. Each profile is, however, intended to be used in the broader context of, and recommendations from, other technical reports under this project: Clarke (2009), Daltry (2009a), Graveson (2009), Toussaint *et al.*, (2009), and Ivie (in prep.).

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Arkokwa

Scientific Name

Zanthoxylum flavum Vahl

Kweyol Name

Arkokwa

Alternative Names

Yellow sanders, West Indian satinwood, Tembetaria, Bois Noyer, Espinillo

Native status on Saint Lucia:

Native

Endemicity:

West Indies + Honduras (single specimen)

IUCN (2009) Category of Threat (International):

Vulnerable (VU A1c ver 2.3, 1998. Needs updating)

Recommended Category of Threat

To be evaluated

(International):

Recommended Category of Threat (National):

Critically Endangered B2b(i, ii, iii); C2a(i); D

CITES

Not listed

Wildlife Protection Act 1980 (amended 2001)

Not applicable to plants



Figure 1: Arkokwa – trunk (top); compound leaves and immature fruits (bottom). Photos © R. Graveson



Map 1: Confirmed current records of arkokwa on Saint Lucia (R. Graveson, pers. comm.)

Justification

A globally threatened (Vulnerable) species, very rare in Saint Lucia and throughout its range. Essentially endemic to the West Indies (though with a few specimens in the Florida Keys and Honduras). Of potential value for timber and non-timber products, if managed sustainably.

Identification

A medium-sized tree, growing up to 15m (Chudnoff, 1984) with a straight trunk and very hard bark (Fig. 1). The heartwood is yellow or creamy with a high oil content and described as having “a lasting, fragrant odour of spicy coconut” (Francis, 1997). There is a small amount of foliage on the narrow crown and the leaves are compound (once odd pinnate; Fig. 1).

Habitat

In Saint Lucia, arkokwa is restricted to deciduous seasonal forest on the east coast (R. Graveson, pers. comm.). Across its range it is reported as growing from 0–800m above sea level, on well drained soils in dry forests, though sometimes also in wet forests on rocky serpentine ridges (Francis, 1997).

Distribution

In Saint Lucia, known only at a few locations: below Mon Repos; the Louvet Estate area; and above Latitanse in the Marquis 2 Reserve (Graveson, pers. comm.). Internationally, it is found primarily in Bermuda, the Bahamas, Cuba, Jamaica, Hispaniola, Lower Florida Keys, Bermuda, Bahamas, Cuba, Jamaica, Hispaniola, Puerto Rico, and Lesser Antilles from Anguilla to Saint Lucia (Chudnoff, 1984). In Central America the species is represented by a single collection from Swan Island, Honduras (Areces-Mallea, 1998).

Population status

On Saint Lucia, it is known only from a handful of specimens (R. Graveson, pers. comm.). Across the whole of its range, this species is “reduced to rare, scattered individual trees” (Francis, 1997). Areces-Mallea (1998) reports the timber to be extremely rare in international trade, with stands now largely depleted of mature trees. In 1998, IUCN classified this species as Vulnerable (Areces-Mallea, 1998) based on an at least 20% decline in area of occupancy, extent of occurrence and/or quality of habitat (though the criteria used [IUCN, 1994] are now out of date and this classification needs updating). Seeds are not currently held at the Millennium Seed Bank (Liu *et al.*, 2009).

Reproduction

Arkokwa is a honey tree, attracting large numbers of bees (Francis, 1997); pollinators other than bees are not recorded. In Puerto Rico it flowers from ‘winter to summer’ (Little & Wadsworth, 1964); on Saint Lucia, early on in the wet season, often in a leafless condition (R. Graveson, pers. comm.). The heavily scented yellow blossoms (Forbes, 2009), and the small seed pods, are clustered into multi-branched ‘panicles’ (Fig. 1). Each pod contains one shiny black seed about 3 mm across, with fruiting during ‘spring to fall’ (Little & Wadsworth, 1964). Bats and birds are assumed to disperse the seeds, as in *Z. martinicense* (Francis, 1997). Tree growth is slow (Little & Wadsworth, 1964, report trees reaching less than 8 cm in diameter after 15 years), with mature trees only reaching medium size (up to 15m) and in some cases remaining as shrubs (Francis, 1997). Francis (1997) provides more detailed information on germination, growth and yield.

Uses

Up until the 1920s, Arkokwa was one of Puerto Rico's most valuable timbers (Little & Wadsworth, 1964), the wood being prized for cabinet-making, fine furniture, inlays, turnery, fancy veneers, specialty item such as hand mirrors and hairbrushes (Chudnoff, 1984), but then became vary scarce due to over-exploitation (Little & Wadsworth, 1964). It is also a honey tree, attracting bees, and is planted for as an ornamental and for shade (Little & Wadsworth, 1964).

Threats

IUCN records logging and wood harvesting as the major threats to this species (Areces-Mallea, 1998), although the global threat status of seasonal deciduous forest (McGinley, 2007), the habitat of this species, means it is subject to the other threats facing that habitat too. Conversion to agricultural land use (facilitated by improved road infrastructure), extractive uses and limited enforcement of wildlife and environmental legislation are all cited by McGinley (2007). The elevated incidence of fires in Caribbean dry forests compared to other types (Robbins *et al.*, 2008) presumably is an additional threat.

Management Recommendations

- Conservation management of seasonal deciduous forest in the North East Corridor.
- Replanting (and protection) of this species in SLFD's Forest Reserves within seasonal deciduous forest (primarily the Marquis Forest Reserves; also around La Sorcière).
- Review and if necessary amend legislation and ensure trees are afforded protection from logging outside the Forest Reserves.
- Encourage planting for ornamental purposes or by apiarists to attract honey bees.
- Applied ecological research (e.g. into possible pests in Saint Lucia that could hinder replanting efforts).
- Deposit seeds in a seed bank (e.g. Millennium Seed Bank Project, 2009)

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Gayak

Scientific Name

Guaiacum officinale Linnaeus

Kweyol Name

Gayak

Alternative Names

Lignum Vitae, Guaiac, Guayacán, Palo De Vida, Palo Santo

Native status on Saint Lucia:

Native

Endemicity:

West Indies, Venezuela, Colombia, Panama

IUCN (2009) Category of Threat (International):

Endangered (EN C2a ver 2.3, 1998. Needs updating)

Recommended Category of Threat

To be evaluated

(International):

Recommended Category of Threat (National):

Critically Endangered B2b(i, ii, iii); C2a(i); D Appendix II (1992; all parts, derivatives except seeds, pollen, cultures)

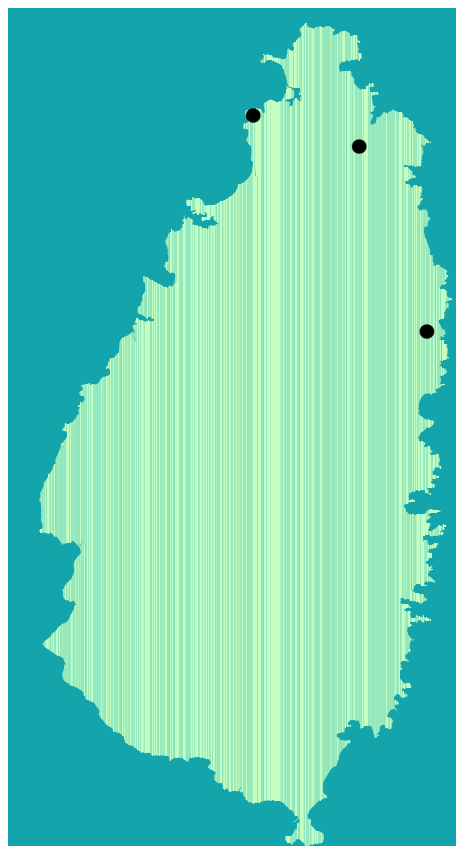
CITES

Not applicable to plants

Wildlife Protection Act 1980 (amended 2001)



Figure 2: Gayak – trunk (top); compound leaves and seed pods (bottom). Photos © R. Graveson



Map 2: Confirmed current records of gayak on Saint Lucia (R. Graveson, pers. comm.)

Justification

A globally threatened (Endangered) species, very rare in Saint Lucia and throughout its range.

Identification

A small to medium-sized tree (5-10m) with a dense, rounded crown of dark green foliage. The leaves are compound (opposite even pinnate; Fig. 2, bottom). Key identifying features (Little & Wadsworth, 1964; Francis, 2002) are mottled light brown or green bark, peeling in scales (Fig. 2, top); distinctive orange seed pods (Fig. 2, bottom) and deep to pale blue flowers in umbel-like clusters (Francis, 1993).

Habitat

Found in seasonal deciduous forest, typically near the coast but up to 400m above sea level (Francis, 1993). It prefers well-drained soils and grows best in deep rich soils, but only if protected from competition by other tree species; in practice it normally only survives in poor soils in dry conditions where competition does not hinder its very slow growth (Francis, 1993). It can occur as small thickets and is also sometimes planted as an ornamental in tropical North America.

Distribution

The native range of gayak is the West Indies (though it may be introduced in Trinidad and Tobago), plus coastal areas of Panama, Venezuela and Colombia (Francis, 2002). Writing in 1993, Francis noted it was near extinction on several Lesser Antillean islands. In Saint Lucia, gayak is known from only a few scattered locations, at Ti Trouya, the La Bourne area on a ridge close to beach (Graveson pers. comm.), and above Louvet Estate (A. Toussaint, pers. comm.).

Population status

In Saint Lucia, only a few specimens (up to 20 in one location) are known (Graveson, 2009). Throughout its range, populations are severely reduced (Americas Regional Workshop, 1998). In 1998, IUCN classified this species as Endangered (Americas Regional Workshop, 1998) based on a population estimated to number less than 10,000 mature individuals and severely fragmented (i.e. no subpopulation estimated to contain more than 1,000 mature individuals), though the criteria used (IUCN, 1994) are now out of date and this classification needs updating. This species is also listed on Appendix II of CITES; the latest listing (in 1992) “designates all parts and derivatives, except: (a) seeds, spores and pollen (including pollinia); and (b) tissue cultures and flaked seedling cultures” (UNEP-WCMC, 2009). Seeds are held at the Millennium Seed Bank (Liu *et al.*, 2009).

Reproduction

In Puerto Rico, gayak flowers from ‘early spring to fall’ (Little & Wadsworth, 1964), and in Cuba from March to May (Francis, 1993). There is no specific information on the flowering period in Saint Lucia, but it is believed to be during the wet season (R. Graveson, pers. comm.). Flowering is not synchronous, and the abundant blue blossoms remain on the tree for about a month, visited by bees. The distinctive fruits, orange when mature, each contain two seeds surrounded by a fleshy red aril, the latter maybe to attract birds for seed dispersal (Francis, 1993). Pigs and goats also disperse the seeds (Francis, 1993). Seeds are produced in large numbers and germinate well, but growth is very slow: trees may not start fruiting and flowering until they reach 25 years old (Francis, 2002). Saplings will coppice when cut but grafting and rooting of cuttings has not been shown. Francis (1993, 2002) provides more details on germination and cultivation.

Uses

Gayak produces an extremely dense, durable and self-lubricating wood, so valuable that it used to be sold by weight (Little & Wadsworth, 1964), though it is now so rare that there is little trade. Francis

(2002) records that the “wood was used historically for bushings, bearings, and pulleys for steam and sailing ships; today, it is principally used for carving, cutting boards, mortars, pestles, and charcoal”. *Lignum vitae* (“wood of life”, referring to the resin and/or an extract of the wood; Francis, 1993) has a long history of medicinal uses for treating toothache pain, gout, venereal diseases and skin infections (Honeychurch, 1980). In the Eastern Caribbean, the leaves have been used as an abortifacient (ibid.), though Francis (1993) reported? it is fatal to humans in overdose. The tree is also planted as an ornamental for its foliage and blossoms (though its popularity for this purpose is reduced by its very slow growth), the latter being the national flower of Jamaica (Francis, 1993).

Threats

Historically, over-exploitation – for timber and resin – combined with *gayak*’s very low recovery rate have lead to its globally threatened status (Americas Regional Workshop, 1998). Francis (2002) notes conversion of forests (for development and agriculture) and forest fires as additional threats.

Management Recommendations

- Conservation management of seasonal deciduous forest in the North East Corridor.
- Replanting (and protection) of this species in SLFD’s Forest Reserves within seasonal deciduous forest (primarily the Marquis Forest Reserves; also around La Sorcière).
- Review and if necessary amend legislation and ensure trees are afforded protection from logging outside the Forest Reserves.
- Encourage more use of this species in ornamental plantings.

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Pencil cedar

Scientific Name	<i>Juniperus barbadensis</i> L. var. <i>barbadensis</i>
Kweyol Name	(no Kwéyòl name found)
Alternative Names	Pencil cedar
Native status on Saint Lucia:	Native
Endemicity:	<i>Species</i> : Bahamas; Cuba; Jamaica; Saint Lucia. <i>Variety</i> : Saint Lucia
IUCN (2009) Category of Threat (International):	<i>Species</i> : Vulnerable B1+2c ver 2.3 <i>Variety</i> : Critically Endangered D ver 2.3 (1998) Needs updating
Recommended Category of Threat (International):	Critically Endangered B2b(i, ii, iii); C2a(i); D
Recommended Category of Threat (National):	Critically Endangered B2b(i, ii, iii); C2a(i); D
CITES	Not listed
Wildlife Protection Act 1980 (amended 2001)	Not applicable to plants



Figure 3: Tree (top); leaves and seed cones (bottom). Photos © R. Graveson

Map 3: Confirmed current records of pencil cedar on Saint Lucia

Justification

This species is assessed as Vulnerable (Conifer Specialist Group, 2000) but the variety found only on Saint Lucia (*Juniperus barbadensis* var. *barbadensis*) is assessed as Critically Endangered (Conifer Specialist Group, 1998). This variety is the taxon reviewed in this profile. It is now extremely rare and found in the wild only at a single location: the summit of Petit Piton.

Identification

Trees can reach 10m (Adams, 2009), though normally only to 6m (R. Graveson, pers. comm.), and are pyramidal in shape on the north and west sides of Petit Piton's summit (Fig. 3, top), but rounded and leaning on the windward east side (Adams, 2009). The bark is thin, cracking into strips. The pale green leaves take the form of small scales about 1mm in length (Fig. 3, bottom) and the seed cones ("berries") are reddish-blue with a noticeable bloom (Fig. 3, bottom). The name 'pencil cedar' is misleading, as this species is unrelated to true cedars (genus *Cedrus*).

Habitat

The sole remaining location of the Saint Lucian variety is in deciduous seasonal forest (Graveson, 2009). Another variety of the same species, the Bahaman juniper (*Juniperus barbadensis* L. var. *lucayana*) is found in coastal areas of swamp and limestone coppice on Jamaica, Cuba and the Bahamas (Adams, 2009).

Distribution

Now only found in the wild on inaccessible steep rocky slopes within 30m of the summit of Petit Piton. Historically, it is believed to have been common in the parishes of Choiseul and Laborie (Graveson, pers. comm.). Adams *et al.* (1987) cite an extract from the Agricultural Report for Saint Lucia from 1921 (published in *The Voice*, April 29, 1922, p. 6): "The Pencil Cedar used to grow wild all along the South Western coast of the island, but has been nearly all destroyed with the exception of a few trees situated at the top of the small Piton".

The species' Latin name, meaning Barbados juniper, is ironic given the species is extinct on Barbados, and is believed to have been so since the early 18th century as a result of clearance for sugar cane cultivation (Adams *et al.*, 1987). The variety on Barbados was the same as Saint Lucia's.

Population status

The global population of this species is tiny. In 1986, Adams (2009) reports collecting 5 individuals and observing a total of about 30 on Petit Piton. More recent visits by Graveson (pers. comm.) confirm this still to be the case. A few planted specimens are growing at the SLFD headquarters car park at Union (R. Graveson, pers. comm.) and Noblick (2009) reports taking "15 cuttings from three specimens of *Juniperus barbadensis* ... into protective cultivation at Montgomery Botanical Center in Miami, Florida and at the forestry department in St. Lucia". Seeds are not currently held at the Millennium Seed Bank (Liu *et al.*, 2009).

Reproduction

The pencil cedar is dioecious – i.e. having separate male and female trees and cones. Pollen is shed from January to March (Adams, 2009) and presumably is spread by wind as in most *Juniperus* species, although Lyons *et al.*, (2009) note that some *Juniperus* species in Texas also produce volatile oils to attract insect pollinators. Adams *et al.*, (1987) report that the related *J. bermudiana* reaches sexual maturity at four to five years old. It is proposed that the genus *Juniperus* was originally

dispersed into the West Indies, as seeds carried by birds (Adams, 1989; Adams *et al.*, 2008). It is unknown whether birds still disperse seeds of the Petit Piton population. In other *Juniperus* species, seeds remain viable for up to 18 months (Lyons *et al.*, 2009). Juniper species can be propagated from cuttings (e.g. Berhea & Negashb, 1998), although propagation from seeds will increase the genetic diversity conserved (Broome, 2003).

Uses

No uses are recorded for the pencil cedar. Internationally, junipers are well known for the use of the aromatic juniper “berries” to flavour gin and various dishes. These berries are primarily the cones from the European *J. communis*, although FAO (1998) note that berries of other juniper species are sometimes used for this purpose. No information was found on whether pencil cedar berries are safe to eat. FAO (1998) also record other uses of various juniper species. The Bahaman juniper is used for wood carving (Adams, 2009).

Threats

IUCN record over-grazing and over-cutting as the main threats facing this variety (Conifer Specialist Group, 1980), although given its current very restricted range, at the top of a steep mountain, these seem a less immediate threat to the remaining population than wildfires, as have occurred on Petit Piton in the recent past (R. Graveson, pers. comm.).

Management Recommendations

- Minimize the risk of wildfires by regulating access to Petit Piton and sensitizing unofficial tour guides (who currently take tourists to the summit; R. Graveson, pers. comm.) to the dangers of fire.
- Cultivation by SLFD, ideally by propagation from seed to maximize genetic diversity captured.
- Encourage cultivation for use and sale as an endemic Christmas tree.
- Replanting (and protection) of this species in SLFD’s Forest Reserves within seasonal deciduous forest (primarily the Marquis Forest Reserves; also around La Sorcière).
- Review and if necessary amend legislation and ensure planted trees are afforded protection from logging outside the Forest Reserves.
- Deposit seeds in a seed bank (e.g. Millennium Seed Bank, 2009)

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Akajou gwan bwa

Scientific Name

Carapa guianensis Aublet

Kweyol Name

Akajou gwan bwa

Alternative Names

Bastard mahogany, crabwood, cabirma de Guinea, bois rouge, andiroba, cedro macho, tangaré

Native status on Saint Lucia:

Native

Endemicity:

West Indies, Central and South America

IUCN (2009) Category of Threat (International):

Not evaluated

Recommended Category of Threat

To be evaluated

(International):

Recommended Category of Threat (National):

Endangered D

CITES

Not listed

Wildlife Protection Act 1980 (amended 2001)

Not applicable to plants



Figure 4: Akajou gwan bwa – trunk (top); seeds (bottom). Photos © R. Graveson

Map 4: Confirmed current records of akajou gwan bwa on Saint Lucia (R. Graveson, pers. comm.)

Justification

In Saint Lucia, extremely rare and declining (R. Graveson, pers. comm.). Provides important food and nesting opportunities for many Neotropical birds, including *Amazona* parrots and agouti (*Dasyprocta* species) (Fournier, 2002). Potential as a valuable timber species (Chudnoff, 1984; Fournier, 2002); much sought after by sawmills throughout its range (R. Graveson, pers. comm.). This species can be dominant in some forest areas, suggesting it may serve key ecological roles.

Identification

A large tree (up to 60m tall and 2m in diameter) with buttresses and no branches in the lower half to two-thirds of its trunk (Fournier, 2002); the bark is greyish, flaking into squares or strips (Orwa *et al.*, 2009). The wood is pink or reddish. The leaves are elliptic and compound (even alternate pinnate), and may be gigantic in juvenile plants (Orwa *et al.*, 2009). The blossom is borne in large inflorescences of white or pale pink flowers with a musky fragrance (Fournier, 2002). The fruit is a four-lobed woody capsule, with 2-4 smooth angular seeds per lobe (Fig. 4).

Habitat

Akajou gwan bwa is a canopy tree of moist forests, though it is also found in swampy or marshy areas or periodically inundated flood plains. Orwa *et al.*, (2009) report it occurring at elevations of 0-1,200m above sea level, although Fournier notes it is unusual to find it above 700m. Chudnoff (1984) report it to be “a lowland species but also at high altitudes along rivers”. Orwa *et al.* (2009) report that South American foresters regard “red” or “hill crabwood”, grown at higher elevations, as superior to the timber from “white crabwood” growing in lower, swampy areas. It may be the dominant tree species in an area and can form pure stands. In Saint Lucia, it is found in remnants of semi-evergreen seasonal forest.

Distribution

This species is widespread throughout Central and South America. In Saint Lucia, akajou gwan bwa is extremely rare and known from only a few scattered locations (Map 4) in the north and east of the island.

Population status

Globally, this species is widespread and locally common (Orwa *et al.*, 2009) or even locally abundant (Fournier, 2002). In the Eastern Caribbean it is known from Dominica, Grenada, Guadeloupe, Marie Galante, Martinique, Saint Lucia, and St. Vincent (Carrington, 2009), although no information on its status in the region was found. However, Cock *et al.*, (1985; cited in FAO, 2009) state that “attempts to establish plantations of mahogany and other forest trees such as cedar (*Cedrela odorata*) and crabwood (*Carapa guianensis*) have failed in Belize, Dominica, Grenada, Saint Lucia and St. Vincent because of the damage caused by ... the mahogany shoot borer”, the caterpillar of a native species of moth *Hypsipyla grandella* (FAO, 2009), which Orwa *et al.*, (2009) report tunnels into the leading shoots causing malformation of the stem. Seeds are not currently held at the Millennium Seed Bank (Liu *et al.*, 2009).

Reproduction

Akajou gwan bwa flowers from January to April (Fournier, 2002) and pollination is believed to be by insects: Orwa *et al.*, (2009) report ants swarming over extrafloral nectarines. Orwa *et al.*, (2009) also report that normally only 1-2 fruits per inflorescence mature, over a period of 8-12 months. There is

some seed dispersal by agouti and pigs, though the floating seeds of this species are adapted for water dispersal during seasonal flooding (Scarano *et al.*, 2003). Orwa *et al.*, (2009) report that “in swamp forest, trees reach felling size in 20-25 years; at higher elevations probably in 40-60 years. [It] is moderately tolerant of shade, but full overhead light is required for fast growth. It coppices freely and is resistant to fire.”

Uses

Timber is the most valuable use of this species (Fournier, 2002), with Orwa *et al.*, (2009) noting that “its main attraction is for high-quality furniture and cabinetwork, stairs and flooring, and as veneer for furniture, interior work and plywood. It is used for masts, building material and as a substitute for okoumé (*Aucoumea klineana*) and walnut (*Juglans regia*)”. “Andiroba” or “crab oil” from the seeds is used for making soap, candles, lamp oil and insecticides; the bark for tanning; and the wood fibre for paper production. Medicinally, many parts of the tree are used: boiled leaves used to treat itchy skin; carapina (an alkaloid in the bark) used for reducing fever, as is the fruit rind which is also used to treat intestinal worms. Seed oil is taken orally for hepatitis and tetanus and topically for skin diseases and ringworm. The tree can also be planted ornamentally or to enrich soil (Orwa *et al.*, 2009).

Threats

This species has not been assessed by IUCN but seems likely to be classed globally as being of Least Concern. However, over-exploitation may occur locally: Sulser (1998), for example, notes that “high-value wood species, such as Tangaré (*Carapa guianensis*) ... are being harvested from [the Mache Mountains of Ecuador] at an alarming rate without sufficient reforestation to compensate for the loss”. In Saint Lucia, the semi-evergreen seasonal forest type where akajou gwan bwa is found has largely been lost and only remnants remain (Graveson, 2009). Also in Saint Lucia, and regionally, the mahogany shoot borer appears to be a serious threat (FAO, 2009), although Valera (1997) reports work on cultivating resistance to this pest in mahogany (*Swietenia*) and red cedar (*Cedrela*).

Management Recommendations

- Investigate the potential for cultivation as a native timber tree in plantations (e.g. Fournier, 2002, and Orwa *et al.*, 2009, provide reviews of cultivation)
- Conserve its remaining semi-evergreen seasonal forest habitat around Chassin.

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Saint Lucia racer

Scientific Name

Creole Name

Alternative Names

Native status on Saint Lucia:

Endemicity:

IUCN (2009) Category of Threat (International):

Recommended Category of Threat (International):

Recommended Category of Threat (National):

CITES

Wildlife Protection Act 1980 (amended 2001)

Liophis ornatus

Kouwès

ornate snake, meadow snake, Saint Lucia grass snake

Native

Saint Lucia

Endangered D ver 2.3, (1996) Needs updating

Critically Endangered (C2a(ii), D)

Critically Endangered (C2a(ii), D)

Not listed

Schedule 1 – Protected Wildlife (Reptiles; listed under synonym *Leimadophis ornatus*)

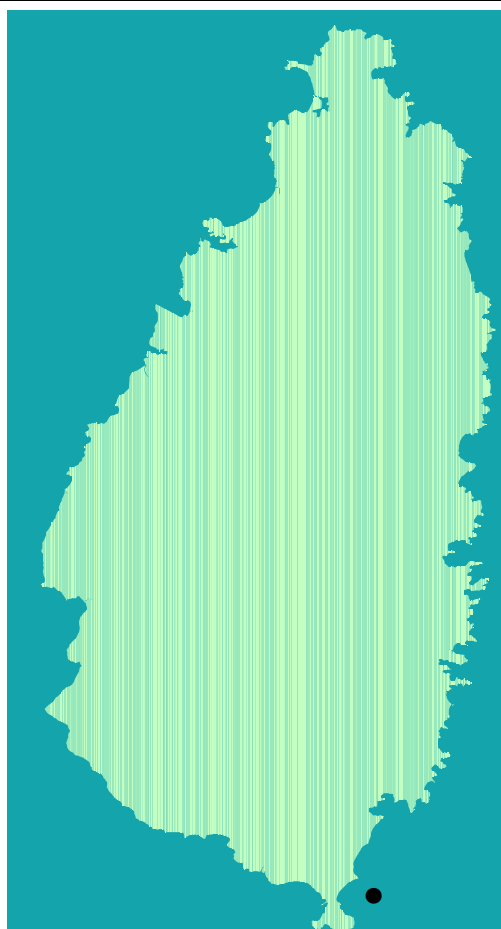


Figure 5: Saint Lucia racer. Photos © M. Morton/Durrell (top); © A. Ogrodowczyk/Durrell (bottom).

Map 5: Confirmed records of Saint Lucia racer (Maria Major is the sole site it is recorded from).

Justification

Daltry (2009a) identifies the Saint Lucia racer as one of the highest priority reptile species for conservation on Saint Lucia. It has a global threat status of Endangered that needs updating (Gibson, 1996) and could be justifiably increased to Critically Endangered: Daltry (2009a) comments: “Not even the Endangered category... 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 easily it can be wiped out”. It is endemic to Saint Lucia and restricted to a tiny area (12 hectares) at a single site (Maria Major island).

Identification

A medium sized snake, up to 1.24 metres from the tip of its snout to the base of its tail, with smooth (not keeled as in the fer de lance) glossy scales. The head shape is quite distinct from Saint Lucia's other three species of snake, lacking the large venom sacs that give the fer de lance its lance-head shape, and with a much less distinct neck and “snout” than the boa. The Saint Lucia thread snake is much smaller, with almost no distinct neck.

Dixon (1981) describes two basic colour varieties: (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. A pale line appears on each side of last quarter of the body, continuing to the tip of the tail. Head black with yellow streaks on snout. There is a 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. The two individuals photographed in Fig. 5, however, had features of both these types: the white belly of the first type not marked with black (pers. obs., not visible in Fig. 5) and the longitudinal brown stripe of the second. Neither had yellow markings (pers. obs.). Geoghegan, & Renard (1985) also note that “snakes that have been seen in recent years have not been so brightly coloured as those that once existed on St. Lucia's mainland”.

Habitat

Littoral evergreen forest and shrubland and littoral scrub with cacti (*sensu* Graveson, 2009) on Maria Major. This offshore island is notable for the presence of dense impenetrable thickets of *Pilosocereus royenii* (Royen's tree cactus). Loose rocks and scree are abundant on the island's steep slopes (pers. obs.). Sightings of snakes and shed skins indicate this species uses all habitats on the island, although there are more sightings from the areas with more leaf litter and shade in the littoral evergreen forest. A preference for areas of high leaf litter was found for the ecologically similar Antiguan racer (*Alsophis antiguae*) and corresponded to higher densities of anole lizards (a prey item). A number sightings have been of snakes coiled in rainwater trapped by hollow trees as they prepare to slough their skin (pers. obs.). On Dominica, free of introduced mongooses, the related grove snake *L. juliae* is found in a wide range of habitats including moist and dry forests, and disturbed areas. The grove snake on Guadeloupe, to which mongooses have been introduced, is more associated with agricultural habitats (Breuil, 2002), but is considered very rare (Lorvelec *et al.*, 2007).

Distribution

Historically, this species is assumed to have occurred across Saint Lucia. Today it is restricted to the single offshore island of Maria Major, being rediscovered there in 1973 by Gregor Williams and Robert Devaux after having been believed extinct (Geoghegan & Renard, 1985). The Maria Islands were gazetted as a Nature Reserve in 1988 and vested in the Saint Lucia National Trust; they are also included within the Point Sable Environmental Protection Area, PSEPA (Gardner, 2009).

Population status

Daltry (2009a) comments on the status of this species:

“The current population size is unknown, but can safely be assumed to be small. The highest published density estimate for any species of *Liophis* (50/ha *Liophis* [=*Alsophis*] *portoricensis* on Guiana 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 antiquae*), 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 this range may be far 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).”

Several authors (e.g. Geoghegan & Renard, 1985; Malhotra & Thorpe, 1999) have commented that the Saint Lucia racer may qualify as the rarest snake in the world.

Diet

It seems nothing has been published on the diet of the Saint Lucia racer, but the ecologically similar Antiguan racer is known to be diurnal and to feed primarily on ground lizards (*Ameiva griswoldi*, very similar in size, behaviour and ecology to the Saint Lucia whiptail, *Cnemidophorus vanzoi*) and anoles (Daltry *et al.*, 2001). It seems very likely that the Saint Lucia racer feeds on these ecological equivalents: *C. vanzoi* and *Anolis luciae*. Juvenile Antiguan racers feed on dwarf geckos *Sphaerodactylus elegantulus* (Daltry *et al.*, 2001), and the related *S. microlepis* is also common on Maria Major. The Antiguan racer is a sit-and-wait, or ambush, hunter, a behaviour that is unusual in colubrid snakes (Daltry *et al.*, 2001), but one that has recently been described in another West Indian racer, *Alsophis sibonius* in Dominica (White *et al.*, 2008). Both these racers sit in ambush, and also actively forage, in the early morning and late afternoon, and it may be that the Saint Lucia racer follows a similar pattern. Other West Indian *Liophis* species commonly eat frogs and also fish, tadpoles and insects (Schwartz & Henderson, 1991), although, of these, only insects are available to the Saint Lucia racer on Maria Major.

Reproduction

As with diet, it seems nothing has been published on the reproduction of the Saint Lucia racer. The Saint Lucia fer de lance and boa give birth to live young, but the Saint Lucia racer presumably lays a small clutch (3-6) of eggs, as other *Liophis* species do (James & Henderson, 2004). On Dominica, James & Henderson (2004) reported the grove snake *L. juliae* using a communal nest site, with 20 or more females depositing eggs in a chamber below rotted roots. Subadult Saint Lucia racers have been seen on Maria Major as recently as 2009 (pers. obs.).

Uses

There are no reported uses of the Saint Lucia racer. On Antigua, the Antiguan racer has been effectively promoted as a flagship species for the country's offshore islands, although in Saint Lucia, this role has already been bestowed upon the Saint Lucia whiptail lizard. It is however a harmless snake, posing no threat to humans.

Threats

Given its apparent extirpation from the mainland of Saint Lucia, introduced predators – most especially the small Asian mongoose, but also rats – seem to be the greatest threat to this species, as with most West Indian racers on islands with mongooses (Henderson, 2004). The risk of inbreeding depression must also be considered severe given the very small size of the remaining population of this species (Daltry, 2009a). With the world's entire population of this species restricted to a single site of just 12 hectares, the threat from stochastic events such as storms is also high. And with the site being an offshore island, the threat from global climate change of predicted increases in storm surges and hurricanes, as well as sea-level rises, further exacerbates these risks. The xeric vegetation found on Saint Lucia's offshore islands is also especially prone to wildfires, which could have a devastating impact on the fauna of these isolated sites. Finally, Daltry (2009a) notes that this species appears to depend upon another endangered species, itself also facing all of these same threats: the Saint Lucia whiptail lizard.

Management Recommendations

The following recommendations are taken from Daltry (2009a)

- 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.

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Saint Lucia iguana

Scientific Name

Iguana cf. iguana

Creole Name

Léza, gwo zandoli

Alternative Names

Iyanola; green iguana (internationally)

Native status on Saint Lucia:

Native

Endemicity:

Unresolved

IUCN (2009) Category of Threat (International):

Not evaluated

Recommended Category of Threat

To be assessed (as *Iguana cf iguana*)

(International):

Recommended Category of Threat (National):

Critically Endangered B1a,b(i,ii,iii)

CITES

Appendix II

Wildlife Protection Act 1980 (amended 2001)

Schedule 1 – Protected Wildlife (Reptiles)



Figure 6: Saint Lucia iguana © M. Morton/Durrell.



Map 6: Confirmed records of Saint Lucia iguana (partial, showing extent; see text).

Justification

The Saint Lucia iguana is currently classified as *Iguana iguana* (e.g. Crother, 2001, following Lazell, 1973 and Etheridge, 1982). This classification however remains unresolved and, as it has been an ongoing source of confusion in Saint Lucia, current thinking on the matter is reviewed in the box below. For the purposes of this profile, the species is regarded as *Iguana cf iguana* – i.e. similar to, but not confirmed as, *Iguana iguana* – and the iguana on Saint Lucia is treated as a separate population in its own right for the purpose of conservation management. The term Saint Lucia iguana applies only to this population. Whatever species or subspecies status this population may eventually be assigned, it remains a species of national importance to Saint Lucia. It is restricted to a single very small area on Saint Lucia and is facing multiple severe threats. Concerns about its survival were expressed by SLFD and J. Gilardi in the 1990s (Anon, 1996), leading to work in the 2000s by Durrell and SLFD (Morton, 2007). More recently, SLFD has promoted the Saint Lucia iguana as a flagship for the island's endangered deciduous seasonal forest, and in particular the deciduous seasonal forests of the North East Corridor (Narcisse, 2009). Both the pride campaign's iguana mascot and the North East Corridor were given the name Iyanola, a phonetic version of Iouanalao, the Amerindian name for Saint Lucia, meaning "the land of the iguana" (Jesse, 1960).

Daltry (2009a) advises "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 100km²* (both the extent of occurrence and area of occupancy are approximately 30km²), *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...and other documented threats that are known to reduce the quality and extent of suitable habitats)".

Identification

A large arboreal lizard, with a very long tail. The body is green, grey-green, or pale grey with thick black stripes. Adults have single row of upright, spine-like scales runs from the base of the head down the midline of the back and onto the tail. These soft 'spines' are tallest on the neck and often pinky-orange in colour towards their tips. Also in adults, several scales between the nostrils are elongated to form 'horns' in both males and females and there are pointed scales on the margin of the black and green dewlap that hangs under the throat (Fig. 6). The length of 'horns' and 'spines' varies between individuals of both sexes. Spines in females in particular are often shorter and may be damaged, perhaps as a result of digging nest tunnels, as is found in other *I. iguana* populations (unpubl. data cited in Zug & Rand, 1987). However, the only reliable way to sex adults based on external characters is to examine the line of femoral pores running down the underside of each thigh; these are much more pronounced in males.

The Saint Lucia iguana is the largest native terrestrial animal on Saint Lucia. A large adult male at Union minizoo measured 1.6m long (1.1m being tail) and weighed over 5kg. In practice, most adult Saint Lucia iguanas seen in the wild are smaller than this: a sample of 30 adults averaged 1.1m (0.3m snout to vent length, SVL) and 1.5 kg. Hatchlings are green or yellowish-green with 'cloudy' (not solid) black bands. As they mature, the black bands may come narrower and less solid. In what seem to be the most mature individuals (the largest), the black bands become more solid and the green

background fades to a pale grey or, especially on the head, white (see Fig. 7). All adults have solid black bands on the tail. Few of these ‘black and white’ Saint Lucia iguanas are seen in the wild and, in recent years at least, all have been male (pers. obs.) which may indicate higher mortality in females. In captivity, older ‘black and white’ females are found.

Iguanas can also be identified from the tail drags they leave in sand, and the empty eggshells they disinter when digging at traditional nest sites. Morton (2005) provides detailed guidance on recognizing these signs. *Ipomoea tiliacea* browsed by iguanas is recognizable by the removal of the leaves with the leaf stalk left intact and attached to the vine.



Figure 7: Saint Lucia iguana hatchlings (leftmost photo) and adults (remaining three photos). These photos are not to the same scale; the iguanas they show were of increasing size from left to right. © M. Morton / Durrell.

Recently, alien (non-Saint Lucian) green iguanas have escaped and bred in the south west of Saint Lucia (Morton, 2008). The origin of these aliens is reportedly a pet shop in Canada; the part of *I. iguana*'s range that they ultimately originated from is not known. At the time of writing, the alien population remains geographically separate from the Saint Lucia iguana population in the North East Corridor, but it is useful to be able to distinguish the two from specimens. Colour varies in both populations and whilst some alien individuals have a marked rusty-orange colouration, others are shades of green or grey; both have black stripes on the tails. A consistent difference seems to be in the low, circular, pointed scales on the sides of the neck (not the row of elongated spines running down the neck and back). In the alien iguanas, these are relatively well developed and conspicuous, even at some distance, running in lines down the sides of the neck. In Saint Lucia iguanas, they are present, but less developed, fewer in number and more scattered (Fig. 8).



Figure 8: Alien iguana in Saint Lucia (left) and Saint Lucia iguana (right) showing neck scales. © M. Morton/ Durrell.

Habitat

Across the whole of its international range, the green iguana *I. iguana* is found primarily in lowland tropical forest, typically in the vicinity of water into which it can escape, but also in desert, semi-desert and steppe areas (Rodda, 2003). The Saint Lucia iguana is found exclusively in deciduous seasonal forest and some areas that may have been semi-evergreen seasonal forest (*sensu* Graveson, 2009). As with other *I. iguana*, it appears to favour ravines which typically have running water, at least seasonally, and taller trees. A preference for cliffs was also found (Morton, 2003). It also seems to favour trees covered with thick mats of vines of various species. The Saint Lucia iguana is not reported from any of the higher elevation montane rain forest types but is known to climb into trees in agricultural or rural community areas that border these habitats. All nesting activity has been observed at only five beaches on Saint Lucia (Morton, 2007). Radiotracking of female Saint Lucia iguanas supports the theory that they are not using other non-beach sites to nest, although there is one report of eggs laid in freshly tilled and another of eggs in a hollow tree stump (Morton, 2007). Nesting habitat on Saint Lucia is typically well-drained sand, open to the sun but at least partly surrounded by thick, low vegetation such as sea grape (*Coccoloba uvifera*). Studies in several other countries indicate that juvenile *I. iguana* show different habitat preferences, occurring more in lower thickets of thorny vegetation, often further from water than adults. Radiotracking a small sample of hatchling Saint Lucia iguanas supports the idea that they select areas 1-3m above the ground (unpubl. data).

Distribution

The Saint Lucia iguana appears to be restricted to the North East Corridor within an area of about 30km² between the northern slopes of Mabouya Valley to the south and Dauphin ravine to the north. This range extends in from the coast about 3km to the settlements of Aux Lyon and Bougis and the foothills of Mt. La Sorcière. Extensive field searches and an island-wide questionnaire in 2004-05 convincingly confirmed this range (Morton, 2007).

Population status

No historical data on the abundance or range of the Saint Lucia iguana has been found, although in the 19th century, the historian Breen (1844) observed that iguanas on Saint Lucia provided “*excellent sport for the native chasseurs*”. But by the 1930s, Barbour (1937) considered them so rare on the island that he questioned whether any remained. Its very restricted range now corresponds closely with one of the two areas on Saint Lucia (the other being Mt. Gimie, including the island’s highest elevation) that are furthest from paved roads (in other words, the hardest for people to access). This strongly suggests that the supposed severe range contraction has been due to direct anthropogenic factors such as hunting or introduced predators (Morton, 2007). Estimates of clutch size and counts of emerging hatchlings in 2004-05 suggest a plausible adult population of less than 1,000 individuals (Morton, 2007). Signs including iguana tail drags have been monitored as indices of nesting activity. These indicated a further decline over the period 2004-06, although this is somewhat confounded by an apparent decline in the detectability of signs too (Morton, 2007).

Diet

All observations suggest the diet of the Saint Lucia iguana is the same as for other *I. iguana* (Baer, 2003): herbivorous, made up primarily of leaves but also including soft fruits and flowers. Several

studies (reviewed by Rodda, 2003) found *I. iguana* to spend only approximately 30 minutes a day feeding. Baer (2003) and van Marken Lichtenbelt (1993) listed plant species known to be eaten by *I. iguana*, including a number found on Saint Lucia such as *Spondias mombin* (mouben), *Tecoma stans* (flambo blan), *Bourreria succulenta* (pis a cheval), *Bursera simaruba* (gonmyé modi), *Momordica charantia* (konmonm kouli), *Lonchocarpus heptaphyllus* (savonnèt gwan fey), *Gouania lupuloides* (lyenn savon), *Laportea aestuans* (zoti), *Coccoloba swartzii* (bwa lanmowi), *Randia aculeate* (bwa lans), *Capparis flexuosa* (kas mawon) and *Guapira* sp (mapou). It is also known to eat *Myrcia citrifolia* (bwa gwiyé; pers. obs.) and *Hippomane mancinella* (medsinnyé modi) apples (M. Day, pers. comm.) which are lethally toxic to humans. The Saint Lucia iguana is believed to have an especial fondness for the bindweed *Ipomoea tiliacea* (lyenn dous), a common vine of open areas (pers obs.; A. Johnny, pers. comm.). There are very few reports of any crop damage by Saint Lucia iguanas, although A. Johnny (pers. comm.) notes it occasionally eats sweet potato greens (*Ipomea batatas*). There are no reports of the Saint Lucia iguana eating birds' eggs as has been (very rarely) reported in *I. iguana* (Arendt, 1982).

Reproduction

Saint Lucia iguanas mate at the end of the year. Dugan (1982) recorded a mating season from October to December, with males courting individual females for up to four weeks prior to mating. Saint Lucia iguanas nest during the last three months of the dry season, from the start of February to the start of May. They migrate from their normal home ranges (typically a few hundred metres in width) for distances of up to three kilometres or more to reach nest sites (Morton, 2007). The beaches at Louvet and Grand Anse appear to account for the vast majority of nesting by this population, although a few individuals nest at Fond d'Or, Caille Des and possibly La Ti Tanse beaches (Morton, 2007). The nest is a chamber at least 0.5m below the surface of the sand and often built under woody roots that support its roof (pers. obs). It is accessed via a tunnel, up to several metres long that the female digs then backfills after laying her eggs (Morton, 2007). Females congregate annually at traditional nesting spots, each creating their own nesting chamber or using existing chambers from previous years (Morton, 2007; see also Rand, 1968; Rand & Dugan, 1983). Empty eggs shells from previous years often reveal nest sites when they are disinterred by female iguanas digging. Clutch size varies greatly in *I. iguana* – from 9 to 71 eggs (Rodda, 2003) – but in Saint Lucia females lay about 25 eggs per clutch (Morton, 2007). Eggs incubate for about 90 days and hatch from the start of the wet season in May through to the start of August. Rainfall appears to trigger egg hatching (pers. obs.). Hatchlings disperse varying distances from the site, from a less than a hundred metres to over two kilometres in the first few weeks of life (Morton, 2007). The age at first breeding is not known for the Saint Lucia iguana, but it varies in different populations of *I. iguana* from 18 months to three years (Alberts *et al.*, 2003).

Uses

Hunting Saint Lucia iguanas for food is one of the most likely causes of their decline to current levels. It still occurs in the North East Corridor at a low level, but sufficient to have a predicted ongoing negative impact on the adult iguana population (Morton, 2007, Morton, 2009). The Saint Lucia iguana has been adopted by SLFD as a flagship – Iyanola – for the deciduous seasonal forests of the North East Corridor as part of a RARE pride campaign (Narcisse, 2009). Ironically, the international popularity of *I. iguana* as a pet has led to the introduction of alien green iguanas into Saint Lucia.

Threats

Habitat conversion for development (particularly tourist development at the three large estates of the North East Corridor: Louvet, Grand Anse and Marquis and the proposed North East Corridor highway) currently appears to be the most severe threat facing the Saint Lucia iguana. Impacts from development are also likely to include exacerbating other more longstanding and severe threat, that of introduced mammalian predators. Feral cats (*Felis catus*), mannikou (*Didelphis marsupialis*) and the small Asian mongoose (*Herpestes javanicus*) are all known to kill hatchling iguanas in Saint Lucia (Morton, 2007, and J. Carr, pers. obs.). Mongooses also take iguana eggs and rats (*Rattus* spp.) are a suspect in the mutilation of hatchlings whilst still in the nest chamber (pers. obs.). Dogs (*Canis familiaris*), both feral and domestic, predate adult Saint Lucia iguanas, especially nesting females that are particularly vulnerable whilst on the ground (Morton, 2007). Although killing Saint Lucia iguanas contravenes the Wildlife Protection Act of 1980, humans also hunt and eat iguanas at a low – but predicted to be significant – level. It seems likely that hunting is, historically, the main cause of the decline in the Saint Lucia iguana population. Another alien invasive species on Saint Lucia – the alien green iguanas breeding in the environs of Soufrière – threaten the genetic uniqueness of the Saint Lucia iguana through hybridization. Illegal sand mining at beaches threatens Saint Lucia iguana nesting habitat and its seasonal deciduous forest habitat is also especially prone to the threat of wildfires (Robbins *et al.*, 2008).

Management Recommendations

The detailed and specific recommendations of Toussaint *et al.* (2009) and Daltry (2009a) are relevant to the conservation of the Saint Lucia iguana, namely:

- Securing the management and restoration of critical deciduous seasonal and semi-evergreen forest areas on Saint Lucia: see recommendations 5.1 in Toussaint *et al.* (2009) and 6.3 in Daltry (2009a). These authors recommend both protection and restoration of habitat in selected critical areas.
- Control the introduction and spread of alien invasive species: see recommendations 5.2 in Toussaint *et al.* (2009) and 6.1 in Daltry (2009a). The recommendation here is to focus strongly on mongooses, rats mannikou (opossums), cats and dogs. Impacts are predicted to increase with further development and are likely to depend on one another (e.g. removing rats alone could increase mongoose predation on native species).

Morton (2007) provides a long list of detailed recommendations for conserving this species. The following summarizes the main points made by Morton (2007) and adds two more to address the recent developments of alien green iguanas breeding in the Soufrière area and touristic development proposals for the North East Corridor. These recommendations largely overlap with those of Daltry (2009a). A number of these recommendations are already being implemented by SLFD and Durrell.

- Encourage the use of mitigation measures in planning permission granted for iguana sites: maintenance of migration corridors (especially riparian) and beachside vegetation strips used for nesting; aggressive control of alien invasive species, including strict regulation of pets; signage and culverts to minimize road kills; trial use of artificial nesting sites.
- If development sites are zoned in this manner, actively manage these zones to improve nesting and normal home range habitats.

- Continue to monitor the Saint Lucia iguana population in the North East Corridor and pressures on this population: habitat loss, alien invasive species impacts, hunting, sand mining. If possible, develop more reliable, and more feasible, monitoring methodologies. This will be especially important to assess impacts of pending developments. Also monitor genetic integrity of North East Corridor population (e.g. using hatchling DNA).
- Identify potential iguana translocation sites. The need for secure nesting sites and the need to avoid hybridization with free-living alien green iguanas will need to be considered.
- Prevent the spread of alien green iguanas and eradicate them. Prevent future introductions into Saint Lucia.
- Develop a contingency plan for if hybrid Saint Lucia / alien iguanas are detected. Contingency responses may need to include an ex situ intervention.
- Continue awareness-raising efforts addressing both the needs of the Saint Lucia iguana and the threat from alien green iguanas.
- Daltry (2009a) recommends resolving the taxonomy of the Saint Lucia iguana. Whilst certainly desirable, the amount of time and money needed for this should not be underestimated, nor should it detract from ongoing conservation efforts on Saint Lucia.

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Box 0. The classification of the Saint Lucia iguana

The species status of the iguana on Saint Lucia has been a cause for confusion in Saint Lucia for some while and at the time of writing has not been resolved. What follows is a brief review of findings and opinions reported on this subject so far.

To summarize: Recent evidence (Malone & Davis, 2004) suggests that the green iguana, *Iguana iguana*, should probably be reclassified as more than one species. It is not clear yet how many species, or what the range of each of these new species would be. At least three groupings have been suggested from preliminary analyses – Central American, South American, and South American [Caribbean] + Lesser Antillean – but more work is needed. It is also not clear whether any subspecies would be supported. This is the case, for example, with Greater Antillean rock iguanas (genus *Cyclura*) where several species are divided into subspecies, each subspecies a single island endemic, assessed separately (Alberts, 1999) and assigned its own red list category. Where the Saint Lucia iguana will fall in any new classification is unknown, but it seems justified to at least regard its current classification as *Iguana cf iguana* – i.e. similar to, but not confirmed as, *Iguana iguana*. Malone & Davis' (2004) findings suggest it is a more ancient lineage within the Eastern Caribbean than at least the other two Eastern Caribbean populations they examined. These authors recommend preventing hybridization of iguanas from different parts of the current species' range.

In more detail:

Lazell (1973) regarded *I. iguana* as a single species with no subspecies. Within the Eastern Caribbean he distinguished three groups based on various morphological features: Northern (on Saint Croix, Saba and Montserrat), Guadeloupéen (on Guadeloupe and offshore islands), and Southern (on Saint Lucia, Saint Vincent and the Grenadines, and Grenada). However, Lazell (1973) described these groups as “useful” but stressed he regarded these differences in appearance as sufficiently variable as to not warrant any taxonomic divisions (such as species or subspecies). Lazell (1973) dismisses the contention that *I. iguana* is a recent introduction (e.g. by the Carib peoples) to the Eastern Caribbean, although *I. iguana* on Martinique (not considered by Lazell) was introduced in the 1960s (Breuil, 2009). Breuil (2002) also rejects Lazell's argument that *I. iguana* is native to Guadeloupe where it occurs together with the Lesser Antillean iguana *I. delicatissima*. Both *Iguana* species are also now

found together on Anguilla, following *I. iguana*'s arrival there on rafts of vegetation following Hurricanes Luis and Marilyn in 1995 (Censky *et al.*, 2003).

The West Indian Iguana Specialist Group (now the Iguana Specialist Group) of IUCN reported in 1998 that “genetic analyses carried out by Scott Davis indicate that five of the Saint Lucia captives [iguanas at Union minizoo] are genetically identical and distinct from mainland green iguanas, showing divergence levels of 2% (equivalent to subspecies or higher in *Cyclura* [West Indian rock iguanas in the Greater Antilles]) (Anon, 1998). Gerber (1999) refers to “the recent finding that common iguanas on Saint Lucia, which also differ in coloration from other populations, are genetically distinct from other sampled populations (S. K. Davis and C. Malone, unpublished data)”.

Following further analyses, Malone and Davis (2004) revised this assessment, with a phylogeny (‘family tree’) of the genus *Iguana*, showing relationships inferred from molecular genetic data within the two species found in this genus, *I. iguana* and *I. delicatissima*. This phylogeny incorporated DNA from iguana populations on three Eastern Caribbean islands: the DNA from Saba and Montserrat grouped with samples from Venezuela and separately from the DNA from Saint Lucia. Further down the tree (‘further back in time’), the DNA from Venezuela, Saba, Montserrat and Saint Lucia grouped with samples from Suriname. Malone and Davis (2004) comment “these data suggests that the taxonomy of *I. iguana* is not hierarchically comparable with other genera and call for a more comprehensive study” and: “the molecular phylogeny reveals that at least two *I. iguana* radiations in the Lesser Antilles have taken place, first onto Saint Lucia and more recently onto Saba and Montserrat.” Noting the need for more data, Malone & Davis (2004) conclude “currently, the...data imply that *at least* three cryptic species may exist under the evolutionary and phylogenetic species concepts (Central American, South American, [and] South American [Caribbean] + Lesser Antillean)” (M. Morton’s emphasis).

More recently, Stephen (née Malone) confirmed this position, writing “it seems highly unlikely that *I. iguana* represents a single interbreeding population” and: “results from both data sets [nuclear and mitochondrial DNA] show a congruent, deep lineage divergence between the Central American populations and the South American plus Lesser Antillean populations of green iguana” (Stephen, 2005).

S. Funk (conservation geneticist, Durrell; pers. comm.) notes (as do Davis & Malone, 2004) that the data set is incomplete, and he advises that further divisions may – or may not – be apparent as DNA samples from more sites are analysed.

Malone & Davis (2005) recommend that “all translocation of [green] iguanas between South America, central America, and the Caribbean Islands should cease, as hybridization between disparate lineages may lead to the loss of unique genetic variation and disintegration of locally adaptive gene complexes”.

Saint Lucia whiptail lizard

Scientific Name	<i>Cnemidophorus vanzoi</i>
Creole Name	Zando, zandoli tè
Alternative Names	Saint Lucia whiptail
Native status on Saint Lucia:	Native
Endemicity:	Saint Lucia
IUCN (2009) Category of Threat (International):	Vulnerable D2 ver 2.3
Recommended Category of Threat (International):	Endangered B1ab(ii,iii), B2ab(ii,iii):
Recommended Category of Threat (National):	Endangered B1ab(ii,iii), B2ab(ii,iii):
CITES	Not listed
Wildlife Protection Act 1980 (amended 2001)	Schedule 1 – Protected Wildlife (Reptiles)

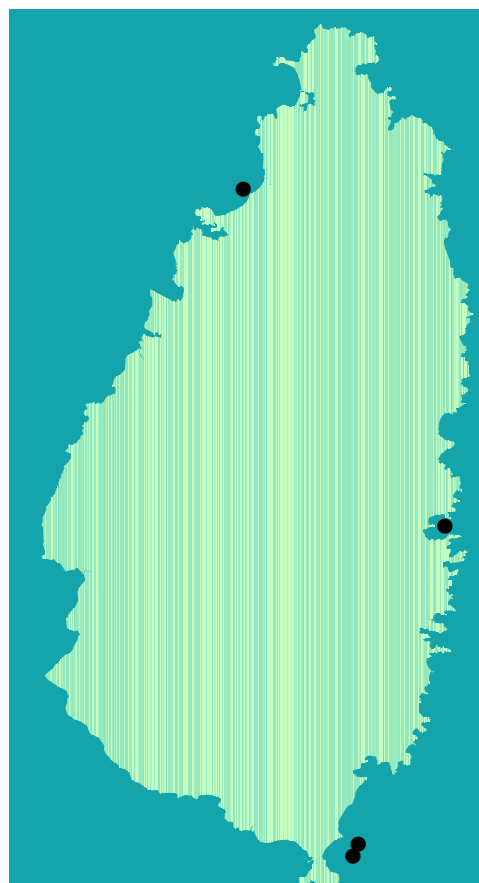


Figure 9: Saint Lucia whiptail lizard. Top: female (left) and male (right); photo © M. Morton/Durrell. Bottom: males from Maria Major (left) and Maria Minor (right); photo © E. Holt/Durrell.)

Map 7: Confirmed records of Saint Lucia whiptail lizard

Justification

Daltry (2009a) identifies the Saint Lucia whiptail lizard, or simply whiptail, as one of the highest priority reptile species for conservation on Saint Lucia. It is endemic to Saint Lucia and no other species in this genus is found in the Eastern Caribbean. It has a global threat status of Vulnerable that needs updating (Gibson, 1996) and could be justifiably increased to Endangered (Daltry, 2009a) triggered by red list criteria B1ab(ii,iii) and B2ab(ii,iii): extent of occurrence estimated to be less than 500km² and area of occupancy estimated to be less than 500 km² (Saint Lucia being 161km², and the area where the Saint Lucia whiptail is found less than 0.16km²); 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 area of occupancy and area, extent and/or quality of habitat (these changes predicted from the projected rise in sea level and increased hurricanes and storm surges due to climate change).

The Saint Lucia whiptail has also been promoted by SLFD as a flagship species – zando – for the country's critical offshore island habitats, helped by the adult males of the species having the same colours as the Saint Lucian flag: blue, black, white and yellow.

Identification

A large lizard, males reaching up to 12cm from snout to reproductive vent, females up to 10cm. Adult females are a coppery brown colour with longitudinal stripes along the back and sides of the body, cream-coloured spots along the sides and a whitish belly. Males have a bluish-black back, with faint longitudinal stripes, fading to grey on the flanks with white spots that extend to the sides of the head. The belly is an intense yellow and the tail colour a bright mosaic of turquoise and black. A proportion of males have female colouration and markings; on capture, these can be distinguished from females by the pattern of belly scales immediately above (anterior to) the reproductive vent: Males have three large scales forming a triangle, females four or five large scales (Fig. 10). Brown (2008), working on Praslin Island, found these female-looking males to be predominantly smaller individuals. Juveniles of both sexes are similar in appearance to, but smaller than, adult females.

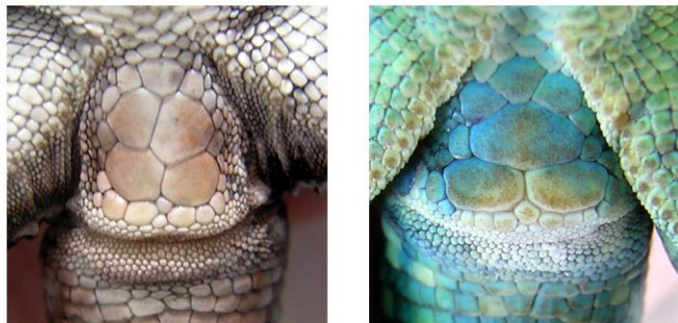


Figure 10: Appearance of scales above the reproductive vent on the underside of the body in female (left) and male (right) Saint Lucia whiptail lizards.

Saint Lucia whiptails from Maria Minor are significantly smaller than those on Maria Major (Fig. 9; Funk & Fa, 2006) and the males appear less intensely coloured (the tail appears more of a powder blue, for example). There may be differences in head shape too (S. Lesmond, pers. comm.).

Habitat

Littoral evergreen forest and shrubland and littoral scrub with cacti (*sensu* Graveson, 2009) on Maria Major. On Maria Minor, littoral scrub dominated by grass, with a single tiny patch of littoral evergreen shrubland. Maria Major is notable for the presence of dense impenetrable thickets of *Pilosocereus royerii* (Royer's tree cactus) and abundant loose rocks and scree on the island's steep slopes (pers. obs.). The vegetation on Praslin and Rat Islands is similar, though with cacti dominant on neither and a number of mesic plant species found on Rat Island (Graveson, 2005). Both Praslin and Rat Islands are flat and lack the conspicuous quantity of loose rocks found on Maria Major, though it appears that broken concrete from ruined buildings on the latter may act as a substitute, with founder whiptails being seen predominantly in these areas (pers. obs.).

Distribution

Historically, this species is assumed to have occurred across Saint Lucia. When it was first described to science (Baskin & Williams, 1966), this species was known only from the two Maria Islands. In 1995, SLFD and Durrell established a satellite population on Praslin Island (Dickinson & Fa, 2000); and another in 2008 on Rat Island (Morton, 2009). The Maria Islands were gazetted as a Nature Reserve in 1988 and vested in the Saint Lucia National Trust; they are also included within the PSEPA (Gardner, 2009). Rat Island was vested in the Rat Island Foundation, but its current status is unclear. Praslin Island belonged to the Dennehy Estate and was acquired by the developer of Le Paradis, who has offered (K. Dolby, Design Construction Group, pers. comm.) to vest it in a Saint Lucian entity such as the Saint Lucia National Trust or SLFD to help maintain its status as a de facto nature reserve.

Population status

A population survey using distance sampling on the Maria Islands in 2005 estimated 1,985 whiptails (between 1,449–2,719 with 95% confidence limits) on Maria Major, and 29 (16–52) on Maria Minor (Young *et al.*, 2006). Maria Minor was surveyed by the same method in 2008, producing an estimate of 20 (6–66); Morton (2008). The most recent estimate from Praslin Island is from 2008: 185 (142 – 286) whiptails (Brown, 2008), down from 335 (249–452) in 2005 (Young *et al.*, 2006), although it is likely that numbers fluctuate widely on such a small island.

Diet

Invertebrates, lizards (*Anolis luciae*), fruit (*Ficus citrifolia* and *Pilosocereus royerii*) and carrion (dead birds) have been recorded as food items for this species (Brice & Bloxam, 1998; Schwartz & Henderson, 1991; Daltry, 2009a). Brice & Bloxam found faecal samples to consist predominantly of invertebrate remains. Saint Lucia whiptails have been observed subduing scorpions (*Tityus insignis*) half their own body length on Maria Major, and catching and eating bees (*Apis* sp.) on Praslin Island (pers. obs.). They will also scavenge food, such as banana or watermelon, discarded by people.

They forage primarily on the ground, scratching in leaf litter and soil, but have limited climbing activity as well and have been observed lying along the lower branches of small trees (Schwartz & Henderson, 1991).

Reproduction

In captivity, female Saint Lucia whiptails laid two eggs under pieces of bark on the ground and did not dig holes to lay eggs as other lizard species do. Females in a captive population of *C. vanzoi* produced

eggs year round (every three weeks) but this is likely due to food availability in captivity (Q. Bloxam, pers. comm.). Corke (1990), cited in Brice & Bloxam, 1998) reported seasonal peaks in whiptail activity on Maria Major which he suggested coincided with mating in March-April and the appearance of juveniles in August-October. Q. Bloxam (pers. comm.) observed female guarding by males, and ‘sneaky’ matings by female-looking males, on Praslin in May and June. It seems likely that breeding in the Saint Lucia whiptail is seasonal with births coinciding with higher food availability in the wet season. Mesquita & Colli (2003) studied reproduction in five other neotropical species of *Cnemidophorus* and found clutch sizes of 1-4, with an average of two. In *C. ocellifer*, breeding was seasonal (dry season) in areas with marked seasons, and continuous in areas with unpredictable climate (Mesquita & Colli, 2003).

Uses

The colours of the male Saint Lucia whiptail, fortuitously the same as the flag of Saint Lucia, lend it special value in a national pride campaign, an opportunity that has already been capitalized on by SLFD with their zando campaign in the 1990s. This species is not shy and is easily seen on the offshore islands it is found on, making it an obvious potential attraction for ecotourists. Daltry (2009a) points out that the Saint Lucia whiptail is also “probably an important, even essential, prey species for the Saint Lucia racer, *Liophis ornatus*”.

Threats

Given its apparent extirpation from the mainland of Saint Lucia, introduced predators – most especially the small Asian mongoose, but also rats – seem to be the greatest threat to this species, as with most West Indian racers on islands with mongooses (Henderson, 2004). With the world’s entire population of this species restricted to three isolated sites, collectively of just 14 hectares, the threat from stochastic events such as storms is also high. And with these sites being offshore islands, the threat from global climate change of predicted increases in storm surges and hurricanes, as well as sea-level rises, further exacerbates these risks. The xeric vegetation found on Saint Lucia’s offshore islands is also especially prone to wildfires, which could have a devastating impact on the fauna of these isolated sites.

The risk of inbreeding depression must also be considered severe given the very low genetic diversity of the remaining population of this species. Funk & Fa (2006) report this is true of the Maria Major population, but especially of the tiny Maria Minor population, which has essentially no genetic variation left (S. Funk, pers. comm.) and consequently is at very high risk of extinction. These authors also report that there is marked genetic and phenotypic variation between the populations on Maria Minor and Maria Major, leading to a quandary over what genetic variation should be conserved (Young *et al.*, 2006). Durrell Wildlife Conservation Trust & Saint Lucia Ministry of Agriculture Forestry Department (2008) have developed an action plan for genetic management of these two populations. This plan aims to both conserve these each of these diverging lineages separately *and* to attempt a ‘genetic rescue’ (e.g. Madsen *et al.*, 2004; Waite *et al.*, 2005) to capture the genes of both populations in a separate mixed population, founded on Rat Island.

Management Recommendations

- Continue to implement and monitor the action plan for genetic management of this species (see Durrell Wildlife Conservation Trust & Saint Lucia Ministry of Agriculture Forestry Department,

2008), maintaining Maria Minor and Maria lineages as distinct *and* establishing a separate mixed lineage population (a genetic rescue).

- Maintain rat-free status of the Maria Islands, plus Rat, Praslin and Dennery Islands. Prevent other invasive species from establishing at these sites.
- Continue ecosystem restoration on satellite islands (Rat, Praslin and Dennery) by establishing additional native species.
- Gazette Rat, Praslin and Dennery Islands as Nature Reserves.
- Raise public awareness of importance of offshore islands to conservation on Saint Lucia, and of risks to these fragile habitats (fire, rats, etc).
- Encourage and carefully manage tourism (local and international) to offshore islands. The experience of the Antiguan Racer Conservation Project (Daltry *et al.*, 2001) shows that excessive visitor numbers can be a severe pressure on offshore islands; capacities of Saint Lucia's offshore islands will need to be carefully evaluated.

Daltry (2009a) also adds the following prudent recommendation:

- 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.

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Saint Lucia pygmy gecko

Scientific Name

Creole Name

Alternative Names

Native status on Saint Lucia:

Endemicity:

IUCN (2009) Category of Threat (International):

Recommended Category of Threat

(International):

Recommended Category of Threat (National):

CITES

Wildlife Protection Act 1980 (amended 2001)

Sphaerodactylus microlepis thomasi and

Sphaerodactylus microlepis microlepis

Ti mabouya, mabouya fèy (Martinique)

(mabwiya is another variant of mabouya)

Saint Lucia dwarf gecko

Native

Mainland of Saint Lucia (*S. m. microlepis*)

Maria Major, Saint Lucia (*S. m. thomasi*)

Not evaluated

Vulnerable B1ab(ii,iii), B2ab(ii,iii)

(as *S. microlepis*)

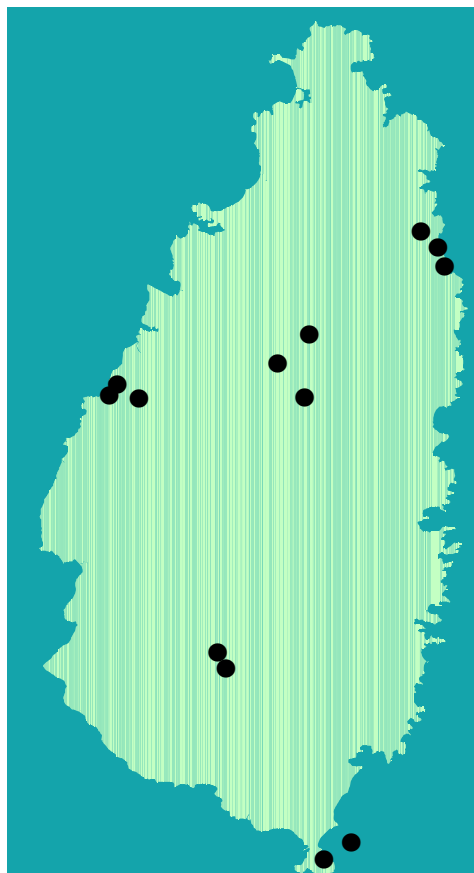
Vulnerable B1ab(ii,iii), B2ab(ii,iii) (as *S. microlepis* and as each subspecies)

Not listed

Not listed on Schedules 1, 2 or 3



Figure 11: Saint Lucia pygmy geckos from Quillesse (top, © E. Holt) and Maria Major (middle, © S. Brooker; bottom, © M. Morton/Durrell (bottom).



Map 8: Confirmed records of the Saint Lucia pygmy gecko (both subspecies).

Justification

Daltry (2009a) identifies the Saint Lucia pygmy gecko as one of the highest priority reptile species for conservation on Saint Lucia. It is endemic to Saint Lucia as a species and so, therefore, are both of the two subspecies. The *S. m. thomasi* subspecies has an extremely restricted range (Maria Major) and the *S. m. microlepis* subspecies appears to have a very fragmented distribution (Daltry, 2009a). The species has not yet been assessed and assigned a red list category, but it qualifies as Vulnerable (Daltry, 2009a), triggered by red list criteria B1ab(ii,iii) and B2ab(ii,iii): extent of occurrence estimated to be less than 5,000km² and area of occupancy estimated to be less than 500 km² (Saint Lucia being 161km², and the area where the Saint Lucia whiptail is found less than 50km² and probably not more than 10 km²); and estimates indicating it is severely fragmented or known to exist at no more than five locations (the mainland population forms one location, within which the species is highly fragmented into a small number of restricted patches, and the Maria Major population another); and estimates indicating continuing decline, observed, inferred or projected, in the area of occupancy and area, extent and/or quality of habitat (these changes predicted from the projected rise in sea level and increased hurricanes and storm surges due to climate change).

There may be some uncertainty about the validity of the two subspecies (see below), but it does not affect the threatened status of the species. Taking a precautionary approach, it is recommended to treat them as separate for management purposes until this uncertainty is resolved. Daltry (2009a) notes that each of the two subspecies both also qualify as Vulnerable for largely same reasons as the full species, with the caveat that there is currently no evidence to suggest that *S. m. thomasi* – purportedly endemic to Maria Major (10.6ha) – has declined in number or area of occupancy. For the purposes of this profile, the name Saint Lucia pygmy gecko refers equally to both putative subspecies unless otherwise noted.

Identification

A tiny gecko, about 4-5cm total length (snout to vent length, SVL, 3 cm), active in leaf litter. Fig. 11 shows some of the variation in colour and pattern found in this species on Saint Lucia. Both subspecies appear to be equally variable. The background colour can vary from a pale sandy brown to a dark chocolaty brown, with white speckles and dark bands of varying intensity. Sometimes parts of the body are distinctly orange. The head may be whitish with thick longitudinal stripes or a more uniform brown. The iris of the eye can be green, pale blue, golden or orange. There is often a dark collar behind the head. Saint Lucia worm lizards (*Gymnophthalmus pleei*) and juvenile *Anolis* spp. are similar in size to adult Saint Lucia pygmy geckos and, like them, are typically seen in leaf litter. Worm lizards have a more sinuous, somewhat serpentine movement, whilst *Anolis* move more 'jerkily', often jumping. Saint Lucia pygmy geckos tend to dart through leaf litter, frequently ducking out of site under dead leaves. Schwartz (1965) reports that individuals with stripey heads are younger than those with plain heads and that the unpatterned heads of older males have a more vivid background colour (yellow or yellow-orange) than the unpatterned heads of older females (dull yellow and brownish-yellow).

Schwartz (1965) distinguishes the subspecies *S. m. thomasi* (on Maria Major) from *S. m. microlepis* (on the mainland of Saint Lucia) by having smooth (or only weakly keeled) ventral (belly) scales, differing scale counts, a pale blue iris and a smaller size (SVL ca. 2.5cm). However individuals matching this description (with the exception of scale counts that were not made) have been observed at Grand Anse, near to where Scharzt (1965) collected *S. m. microlepis*; a pygmy gecko with weakly

keeled ventrals (i.e. “the most trenchant difference” distinguishing *S. m. thomasi*; Schwartz, 1995) photographed at Quillesse; and individuals with distinctly keeled ventrals photographed on Maria Major (pers. obs.). Schwartz (1965) himself reports an individual with intermediate characters collected at Anse de Sables. Orange irises have, however, only been noted in mainland pygmy geckos, although other iris colours are found in these populations too (E. Holt and K. Statham, pers. comm.) These apparent contradictions may mean that *S. m. microlepis* has a wider range than just Maria Major,. Or they may mean that mainland and Maria Island populations cannot be separated into distinct subspecies. Or the casual observations of the author (and others) may be clarified with further data (e.g. scale counts).

Habitat

Schwartz (1965) describes the habitat of the Saint Lucia pygmy gecko as typically moist and shaded. Most of the mainland records of this species (Schwartz, 1965; Daltry, 2009; Durrell, unpubl. data) are from lower montane rain forest (*sensu* Graveson, 2009). In addition to the Maria Major population, however, exceptions in more xeric habitats are a small population in littoral evergreen forest and shrubland at Grand Anse, and Schwartz’s (1965) specimens from Anse Galet and Anse de Sables. Thomas *et al.* (1992) propose that pygmy geckos species can be classified into two ecomorphs: xeric forest ecomorphs and mesic forest ecomorphs, the latter being larger and more darkly coloured. Thomas *et al.* (1992) apply the ecomorph concept to separate species, but the division into these two types is reminiscent of the two rather distinct niches occupied by the same species, *S. microlepis*, in Saint Lucia. Pygmy geckos are poor at regulating water loss and various xeric ecomorphs select mesic microhabitats within xeric areas (Lopez-Ortiz & Lewis, 2004). They typically prefer well shaded areas with abundant leaf litter, often associated with rocks (e.g. Hedges & Thomas, 2001; Hensley *et al.*, 2004), as also appears to be the case on Saint Lucia (Schwartz, 1965). The Saint Lucia pygmy gecko appears to be very largely terrestrial, unlike the other three gecko species on Saint Lucia, but has about a metre off the ground under rotting bark on a few occasions (M. Smith, pers. comm.).

Distribution

Schwartz (1965) describes the species’ distribution as widespread but, at the time of writing this report, it also appears distinctly patchy. During an island-wide survey, Daltry (2009a) only found it at four locations and, although Schwartz (1965) notes it can be “extremely difficult” to find, more intensive repeat searches using multiple detection methods within the North East Corridor (Morton, 2007) only located it at a single site (unpubl. data). This suggests rarity rather than elusiveness explains the scarcity of records. Other than Maria Major, it has not been found on offshore islands (Dennerly, Praslin and Rat Islands and Maria Minor). Daltry’s (2009) survey failed to locate the species at Anse de Sables during a brief search, and Schwartz (1965) reported it difficult to locate many individuals at this site over 40 years ago.

Population status

No population estimates are available for this species. Although it seems abundant in places (E. Holt and K. Statham, pers. comm.; and pers. obs) this appears to be only within extremely restricted areas. Daltry (2009a) notes that “the current pattern of sightings indicates that this species has declined both in number and area of occupancy”. She also observes that the historian “Breen (1844) put the ‘annulated lizard’ [i.e. ‘ringed lizard’ presumably a reference to the pygmy gecko’s ‘collar’] high on his list of ‘insects’ from the island, also [suggesting] that the pygmy gecko was more common and conspicuous in the nineteenth century”. The apparent rarity of the Saint Lucia pygmy gecko contrasts

sharply with Rodda *et al.* (2001)'s estimate of 67,600 *S. macrolepis* pygmy geckos per hectare(!) on the mongoose-free offshore island of Guana, British Virgin Islands.

Diet

No information on the diet of the Saint Lucia pygmy gecko was found, but it is expected to consist primarily or entirely of invertebrates, limited in size by the small size of the gecko. Steinberg *et al.* (2007) found *S. vincenti* on Saint Vincent to be a dietary generalist feeding on a wide range of small diurnal arthropods. Thomas & Kessler (1996) studied two pygmy gecko species in Puerto Rico: *S. klauberi* fed on a wide variety of insects and other arthropods and also snails and an *Eleutherodactylus* frog, whilst *S. macrolepis* specialized in Collembolans (springtails). Both these latter two species are about the same size as the Saint Lucia pygmy gecko (Schwartz & Henderson, 1991).

Reproduction

Pygmy geckos of the genus *Sphaerodactylus* produce a single hard-shelled egg per clutch, with the developing egg visible through the thin skin of the female's belly. Schwartz (1965) reports the eggs of the Saint Lucia pygmy gecko are about 7 x 6mm in size and the hatchlings 1.3-1.5 cm from snout to vent. Lopez-Ortiz & Lewis (2002) found hatchlings of *S. nicholsi*, a xeric ecomorph on Puerto Rico, in nearly every month of the year, but found peak numbers of gravid (pregnant) females in the dry season and of hatchlings during the wet season. Gaa-Ojeda (1983, cited in Lopez-Ortiz & Lewis, 2002) found a similar pattern in *S. townsendi* on the same island. These authors suggest this pattern "allows the eggs, which are considered highly resistant to desiccation (Dunson & Bramham, 1981), to incubate during hot, dry summer months". Gaa-Ojeda (1983, cited in Lopez-Ortiz & Lewis, 2002) reports an incubation period of nearly four months in *S. townsendi*.

Uses

No reports of uses of the Saint Lucia pygmy gecko by people were found. This species is easily found by a knowledgeable tour guide on Maria Major, giving it some potential as an attraction for ecotourists, although any unnecessary handling of pygmy geckos should be discouraged as their tiny bodies are very delicate. It is likely they form part of the diet of juvenile Saint Lucia racers and Saint Lucia whiptails.

Threats

Pygmy geckos appear to be dependant on fairly strict microhabitat requirements: deep leaf litter, rocks and good shade. For example, 'tidying up' (removing leaf litter from) a beach was followed by the disappearance of *S. fantasticus* from one of the few sites it was known from in Dominica (R. Thorpe, pers. comm.). Introduced small mammalian predators – small Asian mongooses, rats and mannikou – that forage on the ground are likely to have a heavy impact on this species. Removal of rats from offshore islands in Mauritius was followed by increases in the populations of *Nactus* geckos similar in size to pygmy geckos (Cole *et al.*, 2004). Maria Major is notably free of such alien species, but the threat of it being invaded by them – especially rats – is ever present. For pygmy gecko populations in the lower montane rainforest, ground-foraging feral pigs may be another predator and one that also causes microhabitat disturbance and destruction.

Threats from global climate change – predicted increases in storm surges and hurricanes, as well as sea-level rises – are likely to be especially severe for littoral and offshore island populations of this species. The xeric vegetation found at these sites is also especially prone to wildfires, which could have a devastating impact on isolated populations.

Management Recommendations

Daltry (2009a) makes the following useful 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*). Other non-native genera of lizards could also act as predators or competitors.
- Investigate genetic diversity and gene flow between populations, and develop a genetic management plan if found to be at risk. This investigation may also shed further light on the subspecies division proposed by Schwartz (1965).

Two additional recommendations are made here:

- Translocate Saint Lucia pygmy geckos to other offshore islands free (or cleared of) introduced predators. Some resolution of the subspecies division proposed by Schwartz (1965) may be necessary to ensure genetic diversity is maximized without compromising divergent lineages. As a precaution in lieu of this, it is recommended that the Maria Major population is used to source founders.
- Investigate the use of artificial refugia (e.g. Webb & Shine, 2000; Cole *et al.*, 2005) to increase the survival of Saint Lucia pygmy geckos in areas where introduced predator eradication is not feasible.

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Saint Lucia fer-de-lance

Scientific Name

Creole Name

Alternative Names

Native status on Saint Lucia:

Endemicity:

IUCN (2009) Category of Threat (International):

Recommended Category of Threat (International):

Recommended Category of Threat (National):

CITES

Wildlife Protection Act 1980 (amended 2001)

Bothrops caribbaeus

Sèpan

Saint Lucia fer-de-lance, Saint Lucia pitviper, lance-head, serpent

Native

Saint Lucia

Not evaluated

Vulnerable B1ab(ii,iii), B2ab(ii,iii)

Vulnerable B1ab(ii,iii), B2ab(ii,iii)

Not listed

No protected: Schedule 3 (Unprotected Wildlife)



Figure 12: Saint Lucia fer de lance. Photos © G. Young/Durrell (top) © K. Breach (bottom).



Map 9: Confirmed records of fer de lance since the 1970s; not including additional reported sightings from the general public (see Breach 2009).

Justification

The Saint Lucia fer de lance is a highly venomous snake. Envenomation by this species produces an unpredictable pathology atypical of other snake bites (Numeric *et al.*, 2002; Wüster *et al.*, 2002; Campbell & Lamar, 2004; Gutiérrez *et al.*, 2008). Although human deaths from snake bite are now rare on Saint Lucia, a number of non-lethal bites still occur annually (Breach, 2009). As such, antipathy, even enmity, towards this species is widespread amongst the Saint Lucian public (Breach, 2009) and so it may seem an incongruous choice to recommend priority conservation action for. However, conservation management and reducing human-snake interactions with negative outcomes (i.e. bites) need not be two conflicting goals. The same actions can work towards achieving both.

Despite common misconception in Saint Lucia, the fer de lance *is* an endemic species, and *not* an introduced species. It was not introduced by colonial plantation owners to terrorize slaves, nor introduced earlier by Amerindian peoples as a form of biological warfare, two beliefs documented by Breach (2009). The evidence that these beliefs are simply myths is the observation that the Saint Lucia fer de lance is found nowhere else in the world, together with molecular genetic evidence that this species has been resident on Saint Lucia for 4-9 million years (Wüster *et al.*, 2002), long before any humans colonized the island.

The threat of extinction faced by the Saint Lucia fer de lance has yet to be formally assessed by IUCN, but Breach (2009) and R. Devaux (pers. comm.) have amassed a large body of archival evidence indicating a severe contraction in the species' range on Saint Lucia over the last century. It is still widely persecuted (Breach, 2009). Daltry (2009a) recommends a global threat level of Vulnerable be assigned, triggered by red list criteria B1ab(ii,iii) and B2ab(ii,iii): extent of occurrence estimated to be less than 20,000km² and area of occupancy estimated to be less than 2,000 km² (Saint Lucia being 161km², and the area where fer de lance are found less than 50km²); and estimates indicating it is severely fragmented or known to exist at no more than 10 locations (the mainland of Saint Lucia forms a single location, within which the species' range may be fragmented); and estimates indicating continuing decline, observed, inferred or projected, in the area of occupancy and area, extent and/or quality of habitat.

Identification

Daltry (2009a) describes the species: “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 to 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 (Fig. 12, bottom), which gives the snake a rougher texture than the boa” or kouwès. The head is characteristically shaped like the head of a spear or lance (Fig. 12, bottom) because of the large venom glands on either side of it. A number of respondents to Breach's (2009) questionnaire surveys indicated they distinguished between red fer de lance (sépan wouj) and yellow fer de lance (sépan jòn) on Saint Lucia (Breach, pers. comm.), a distinction also made for the closely related Martinique fer de lance, *Bothrops lanceolatus* (D. Warrell, pers. comm.).

Habitat

The Saint Lucia fer de lance is found in a wide range of habitats, including all the main forest types: deciduous seasonal, semi-evergreen seasonal and lower montane rain forest. It also occurs in

agricultural areas and sometimes on the edges of human settlements. Some SLFD Range workers (C. Bissette, T. Eugene, pers. comm.) report they perceive this species shows a preference for wetter microhabitats such as the bottom of ravines. The Saint Lucia fer de lance is reported to be predominantly terrestrial, although is also found in shrubs (pers. obs.) and sometimes in taller trees (Lazell, 1964; R. Graveson, pers. comm.).

Distribution

Daltry (2009a) reports this species to be locally common-to-abundant in some areas on Saint Lucia, such as Millet, near the Roseau dam. Other areas widely reported to have high fer de lance densities are in the environs of Praslin on the east coast and Anse La Raye on the west coast. Together, these three locations form a band across the middle of Saint Lucia that characterizes the fer de lance's distribution, with extensions north up the east coast and to the south as far as the Quillesse Reserve in the centre of the island. Evidence collated by K. Breach and R. Devaux (pers. comm.), and presented in Breach (2009) and Daltry (2009a) indicates that in recent history, this species' range was much more extensive, almost island-wide, with records from as far north as the Marquis, Monchy and Grand Riviere areas and as far south as the Dugard, Belle Vue and Anse Ger areas. It is even recorded from Castries. Breach (2009) comments that "even in the 1930s, the species appears to be found island wide. Despite this, there is documented evidence that *B. caribbaeus* was decreasing in abundance, and was even considered a rarity".

Population status

Writing over 40 years ago, Lazell (1964) opines "in some areas (e.g. Grande Anse) the Serpent is abundant almost beyond belief". The current and historical distributions presented by Breach (2009), however, suggests an approximately 50% contraction of the fer de lance's range over the last century. Although locally common-to-abundant in a few areas, it is rarely seen in most parts of its currently known range. As an example, in 2009, ten teams of surveyors (counting parrots; Young *et al.*, in prep.) spent six weeks moving throughout almost the whole of this range, living working and sleeping there five days a week. Only seven fer de lance were encountered, in total, during this period.

Diet

Schwartz & Henderson (1991) found mice and rats in stomach contents of Saint Lucia fer de lance. Lazell (1964) reports that they eat birds, rats and mongooses and that the Martinique fer de lance also eats mongooses. Lazell (1964) remarks that "in areas [of Saint Lucia] where *Bothrops* are plentiful there is said to virtually no rat damage to such crops as cocoa; in parts of the island where there are no *Bothrops*, crop damage is said to run as high as 70 per cent".

The Saint Lucia fer de lance is believed to be predominantly nocturnal and is likely to be a sit-and-wait, or ambush predator, like many pit vipers. In what they describe as the first detailed study of the spatial ecology of a *Bothrops* species, Wasko & Sasa (2009) found *B. asper*, in Costa Rica, to be highly nocturnal, with small home ranges of a few hectares. This species was inactive by day, sleeping coiled in leaf litter or shelter, but at night moving often just a few metres to ambush spots where they would wait for prey. This species showed a preference for swampy areas, sheltering by day along wooded banks and ambushing at night within a few metres of the water's edge.

Reproduction

The Saint Lucia fer de lance does not lay eggs but gives birth to live young. Mating takes place around March or April, and the female gives birth to 30-40 young around August and September (Schwartz & Henderson, 1991; Daltry, 2009a).

Uses

There are reports of the decapitated heads of fer de lance being retained as weapons (Breach pers. comm.), though this does not appear to be a common practice nowadays. M. Smith (pers. comm.) reports a fer-de-lance head would be boiled down and the residue was kept in butterdish as a weapon, the idea (quite possibly fanciful) being that a single smear could kill someone. It has been suggested (e.g. D. Anthony, D. Warrell, pers. comm.) that a small number of captive fer de lance at SLFD's minizoo at Union would provide an exhibit that would galvanize visitor interest and afford rich awareness raising opportunities. The unusual symptoms of Saint Lucia fer de lance bite – including capillary thrombosis (clots) – resemble symptoms of some major forms of heart disease, and may provide a model for future treatments (D. Warrell, pers. comm.).

Threats

Breach (2009) speculates briefly on some of the possible causes for the decline of fer de lance on Saint Lucia, including human persecution, habitat loss, predation by mongooses and poisoning by cane toads taken as prey. Of these, the first seems incontestable. The contraction of the fer de lance's range has followed a parallel increase in the human population on Saint Lucia (Statistics Department, 2009) and a bounty on fer de lance heads from 1870 to the 1940s formalized this persecution (Devaux, 1995). The conversion of land following the expanding human population will inevitably have had an effect: fer de lance are still sometimes found in agricultural areas, but sightings are rare in urban sites. Lazell (1964) dismisses the idea of mongooses controlling the fer de lance population, though does not present evidence for this beyond noting that Saint Lucia fer de lance eat mongooses and that, at the time he was collecting snakes, high densities of fer de lance occurred in areas of Saint Lucia where mongooses were present. In support of this, an analysis of over 70 mongoose stomach contents at Louvet in 2005 (unpubl. data), a site known to have fer de lance present, revealed the presence of a wide range of Saint Lucia's herpetofauna, but no fer de lance remains. The data are lacking, but on balance it appears the fer de lance is more likely to control mongoose populations (as it does rat populations) than vice versa, although Breach (2009) speculates mongooses may predate juvenile fer de lance. Another introduced mammal, the pig, is also reported to kill Saint Lucia fer de lance, especially juvenile snakes. In the past, pigs have been set loose in certain areas to exterminate fer de lance (D. Anthony, pers. comm.).

Management Recommendations

The following recommendations are intended to address both the survival of the Saint Lucia fer de lance *and* the need to minimize the number of negative encounters (i.e. resulting in snake bites) between people and fer de lance. Many of these recommendations are also made by Daltry (2009a).

- Address misconceptions about the Saint Lucia fer de lance: its native, endemic and endangered status and its response to people.

On this note, Wasko & Sasa (2009) who spent over two years radiotracking a related fer de lance at close quarters remark: "Fer-de-lance are frequently described as being highly aggressive, prone to striking with little provocation. While the high incidence of *Bothrops asper* snakebite indicates that

this characterization is not entirely without merit, after more than 4,000 observations of free-ranging snakes, we recorded no defensive strike attempts by resting animals except when they were directly manipulated for capture. During the day, snakes could often be approached to within < 1 m with no visible reaction; during the evening when they were more alert, snakes were more likely to flee if approached.”

- Raise awareness of the factors that are likely to increase negative encounters with fer de lance. Breach (2009) discusses these in some detail. The key determinant of whether people are bitten appears to be whether they noticed the snake before it bit them.
- Raise awareness of best practice in responding to snake bites. Again, Breach (2009) discusses this in some detail and Daltry (2009a) provides detailed guidance. Use of tourniquets was widely cited by Breach’s (2009) interviewees, but is misguided, sometimes with catastrophic effects for the patient (D. Warrell, pers. comm.). Hospital treatment of snake bite in Saint Lucia has greatly improved in the last ten years (M. Didier, pers. comm.) and prompt delivery of the patient to hospital is advised.

Currently, a polyvalent serum using antibodies to a range of South American *Bothrops* species, and produced by Instituto Butantan in Brazil, is used in Saint Lucia. A far superior antivenin for treating the unusual venom of the fer de lance on Saint Lucia and Martinique, Bothrofav, is produced in France but is very expensive (reportedly ca. \$3,000 USD per phial [M. Didier, pers. comm.], with multiple phials needed to treat a severe bite). D. Warrell (pers. comm.) suggests laboratory trials of a less costly antivenin produced in Costa Rica to *B. asper*, a species more closely related to the Saint Lucia and Martinique fer de lances which may therefore be expected to be more effective in smaller doses than the Butantan antivenin.

- Develop a project with snake bite treatment experts (e.g. David Warrell, UK) to harvest Saint Lucia fer de lance venom and test against Costa Rican antivenin.

The single most obvious action for protecting both the Saint Lucia people from snake bite *and* the Saint Lucia fer de lance from persecution, appears to be to minimize the number of encounters between them. The more remote and rarely visited parts of the Government Forest Reserve afford an opportunity to do this.

- Conduct baseline field research on the species’ status, distribution and ecological requirements .
- Designate zones within the Government Forest Reserve as protection areas for fer de lance; Daltry (2009b) offers detailed recommendations for this. Prohibit the killing of fer de lance (by the public and SLFD staff) within these zones. This may require reviewing the fer de lance’s status as Unprotected Wildlife under the 1980 Wildlife Protection Act, or may be achievable by some other means.
- Implement effective feral pig control in the Forest Reserves.

In the past, SLFD translocated boas from areas where residents have considered them a ‘nuisance’. This has not been attempted with fer de lance, but the possibility has been mooted by at least one developer on the island. Reinert & Rupert (1999) report a much higher mortality (over 50%) amongst translocated individuals of a pitviper in North America compared with resident individuals (only 11%), as well as long term negative impacts on those that did survive. Brown *et al.*, (2009) looked at

shorter distance (500m) translocations of another North American pitviper and did not find these negative impacts, but also found the translocations to be only a temporary solution (the snakes returned to their original home ranges). Responses of the Saint Lucia fer de lance have not been determined.

- If fer de lance translocations are proposed for new development sites, seek material assistance from the developers to use radiotracking to follow the fates of translocated individuals, preferably in comparison with fates of resident individuals at translocation sites.

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Saint Lucia amazon

Scientific Name	<i>Amazona versicolor</i>
Creole Name	Jako
Alternative Names	Jacquot, Saint Lucia parrot, blue-faced amazon
Native status on Saint Lucia:	Native
Endemicity:	Saint Lucia
IUCN (2009) Category of Threat (International):	Vulnerable (D1, D2 2008)
Recommended Category of Threat (International):	Vulnerable
Recommended Category of Threat (National):	Vulnerable
CITES	Appendix I
Wildlife Protection Act 1980 (amended 2001)	Schedule 1 – Protected Wildlife (Birds)



Figure 13: Saint Lucia Amazon. Photo © Tseng Chiu-wen Hank.



Map 10: Confirmed records of Saint Lucia Amazon.

Justification

The Saint Lucia amazon was identified as being one of the highest priority birds for conservation efforts on Saint Lucia by Toussaint *et al.* (2009). It is endemic to Saint Lucia at the species level and

has a global threat status of Endangered (BirdLife International, 2008) because of its small population size and small range on a single island. In 1979 Saint Lucia's parrot was made the national bird and now appears on the country's coat of arms as well as on a wide range of materials promoting Saint Lucia and sold to tourists. Following an extensive awareness campaign in the 1980s, led by SLFD and RARE (Butler, 1990), it has become one of Saint Lucia's best known endemic species, both within the country and amongst visitors. Although the range and population size of this species have increased impressively over the last 30 years, it remains endangered. BirdLife International (2008) state "the area of apparently suitable (but unoccupied) habitat may be decreasing. If this begins to affect occupied habitat, the species may immediately qualify for uplisting to Endangered".

Identification

Seen at rest, this species is unmistakable on Saint Lucia with its violet-blue face, red throat and upper chest, and green wings with violet-blue primary feathers (Fig. 13). If flying silently, and seen in silhouette, it may be confused with the scaley-naped pigeon or ramier (*Columba squamosa*) by unfamiliar observers. The Saint Lucia amazon produces 26 different calls, five of them during flight (Kleeman & Gilardi, 2005). These authors also describe different call patterns at different locations on Saint Lucia, possibly corresponding to different dialects. Sound recordings of some of this wide variety of vocalizations are available from Chartier (1994) and Cornell Laboratory of Ornithology, Macaulay Library (2009).

Habitat

The Saint Lucia amazon is primarily found in the canopy of montane rain forest (*sensu* Graveson, 2009), although it is also known to forage in other, lower elevation habitats (Jeggo, 1976, cited in Keith, 1997), more so during the wet season (D. Anthony, M. Bobb, pers. comm.). For nesting, Saint Lucia amazons show a preference for trees of large diameter (Dornelly, 2005)

Distribution

Keith (1997) cites various authors to document a range contraction from the whole of Saint Lucia's montane rain forests into the southern forests over the period from 1850 to the 1970s. Since the 1980s, this contraction has been reversed (e.g. D. Anthony, A. Dornelly, M. Bobb, pers. comm.), a finding confirmed by Young *et al.* (in prep.). The Saint Lucia amazon is known to currently range throughout almost the whole of Saint Lucia's lower montane rain forest, although at still at higher densities in the forests south of the Barre de L'Isle (Young *et al.*, in prep.). Keith (1997) also documents that centres of abundance within this range have varied over time. At present the Saint Lucia amazon appears to be most abundant within the montane rain forests of SLFD's Quillesse Range (the core area to which it contracted by the 1970s). It also appears to be abundant in the montane rain forests of the Millet, Dennery and Soufrière Ranges, with fewer in the montane rain forests of the Northern Range. At the time of writing, these apparent variations in abundance are awaiting confirmation (Young *et al.*, in prep.).

Most of the Saint Lucia amazon's range is covered by the Government Forest Reserve (also Saint Lucia's Important Bird Area LC002) and includes a 4km² area gazetted as a Nature Reserve (Parrot Sanctuary) under the 1980 Wildlife Protection Act. The boundary of this reserve is shown in Jeggo & Taynton (1980).

Population status

Keith (1997) documents from various sources a decline throughout the 20th century up to the 1970s. The estimates prior to the 1970s were made retrospectively from earlier reports of sightings, whilst most of those during the 1970s were in the form of indices. Multiple authors, however, concluded the population was at around 1,000 birds in the 1950s but had declined to within the region of 100-150 birds by the 1970s. The species was not red-listed at this time (before 1994, IUCN used more subjective threatened species categories; IUCN, 2001). Applying current red list criteria retrospectively would lead to an assessment of the Saint Lucia amazon as Critically Endangered by the 1970s, triggered by criteria A2 (IUCN, 2001). Since this period, estimates in the form of counts have documented an increase in the population, with Jeggo & Anthony (1991) estimating 300-350 birds by 1990. This increase led to a threat assessment of Vulnerable by 1994 (BirdLife International, 2008), an impressive downlisting of threatened status by two red list categories. Young *et al.* (in prep.) report on an attempt by SLFD and Durrell to obtain a more rigorous estimate of the current population size in 2009. A final estimate is still pending, but it seems clear that there has been an order of magnitude increase in the numbers of Saint Lucia amazons living in the wild from the 1970s to the present day.

Diet

The Saint Lucia amazon eats a wide variety of fruits. Keith (1997) compiles a partial listing of fruits eaten from various sources that includes (with some name changes following Graveson, 2007): balata chyenn *Manilkara riedleana*, bwa tan wouj *Byrsonima martinicensis*, chatannyé *Sloanea massoni*, dalmawi *Pithecellobium jupunba*, gonmyé *Dacryodes excelsa*, bwa di fè *Cassipourea guianensis*, lansan *Protium attenuatum*, mapou *Pisonia fragrans*, palitivyé *Tovomita plumieri* or *Chrysochlamys caribaea* (unconfirmed), maho kochon *Sterculia caribaea*, awali *Clusia* sp., bwapen mawwon *Talauma dodecapetala*, gwi gwi palm *Acrocomia aculeata*, pennépis *Pouteria* sp., bwa kòt *Miconia mirabilis* and ponm dilyenn *Passiflora laurifolia*. Feeding occurs mainly in the early morning and late afternoon (Jovicich, 1976, cited in Keith, 1997).

Reproduction

Breeding occurs from February to August (Keith, 1997), with tree cavities actively inspected, selected, and defended from early in the season. Dornelly (2006) investigated nest tree selection and concluded that the Saint Lucia amazon prefers trees of large diameter. These include gonmyé, bwapen mawwon, pennépis and la gli *Sapium caribaeum* (Jeggo, 1976, cited in Keith, 1997). This species pairs monogamously and has been recorded using traditional areas for nesting over several decades, with identifiable pairs using the same cavity for nesting each year (D. Jeggo, cited in French, 2000). Jeggo (1976, cited in Keith, 1997) suggested eggs are laid in March. Two eggs are laid in a clutch, occasionally one or three (A. Dornelly, pers. comm.). Mülhaus & Mülhaus (1983, cited in Keith, 1997) suggest that generally only one chick is reared from the two eggs, although A. Dornelly (pers. comm.) confirms it is just as common for two to be successfully fledged. Once fledged, young do not return to the nest cavity, but may remain in the same tree with their parents (D. Anthony, cited in French, 2000). In captivity, Saint Lucia amazons have been recorded as living for over 30 years.

Uses

As Saint Lucia's national bird, the Saint Lucia amazon is an attraction not only for the many birders that visit Saint Lucia (see <http://www.birdinginstlucia.org/>), but also the many tourists visiting the Government Forest Reserves. Its image on a wide range of goods and across multiple media is used

both to attract visitors to Saint Lucia and to sell them tourist goods. As such, this species contributes significantly to the livelihoods of many Saint Lucians, both directly and indirectly.

Threats

BirdLife International (2008) identified habitat loss as the most severe threat to the survival of the Saint Lucia amazon. Hurricanes can have devastating impacts on forest cover with 39% of the trees on Saint Lucia killed by Hurricane Allen in 1980 (Keith, 1997). Jeggo & Taynton (1980) reported at least two deaths of Saint Lucia amazons but found that a parrot count following this hurricane did not indicate a significant decline in the Saint Lucia amazon population. These authors report a rapid recovery of fruiting trees within weeks of the hurricane, but noted that a more serious impact was likely from the loss of trees with nesting cavities. Severe hurricane impacts on Saint Lucia are, however, relatively rare. Conversion of forest, by contrast, has resulted in widespread habitat destruction. Keith (1998) reported a loss of over 73% of the Saint Lucia amazon's habitat in the period 1950 to 1975. Since then, a strengthening of Saint Lucia's Forest, Soil and Water Conservation Act (1986) and strenuous efforts by SLFD have greatly reduced this threat, although minor incursions into the Government Forest Reserve are still reported (pers. obs.).

Historically, hunting has been a threat to this species. Keith (1997) cites several reports of the species being hunted through much of the 20th century, for food and to supply the pet trade. The moratorium on hunting introduced with the 1980 Wildlife Protection Act, combined with a national pride campaign for the Saint Lucia amazon (Butler, 1990) appear to have been effective in almost eliminating the hunting of parrots, although concerns remain over the threat from the extremely high prices paid on the black market for *Amazona* species. SLFD do not publicly divulge the locations of any known nesting trees to reduce the risk of birds or eggs being taken for this trade (D. Anthony, pers. comm.).

Competition with the pearly-eyed thrasher (*Margarops fuscatus*) for nesting cavities has been cited as another threat by, for example, Jeggo & Taynton (1980). A. Dornelly and D. Anthony (unpubl. data cited in Wiley *et al.*, 2004) report "substantial evidence of [pearly-eyed] thrasher involvement determined in the failure of several parrot nests" in 1996 and 1997. Keith (1997) notes that the pearly-eyed thrasher was rare in 1950 but has since become common in the montane rain forest. Jeggo & Taynton (1980) speculate that opening up sunlit areas in forest may favour the pearly-eyed thrasher and loss of parrot nesting trees increase competition between these two species. Impacts of introduced predators are not well known, although there is some evidence of chick predation by mannikou *Didelphis marsupialis* (Jeggo, 1976, cited in Keith, 1997).

In late 2003 a sick parrot with coordination difficulties was found in Edmund Forest Reserve, and later died; a second was found in mid 2004. A post mortem by Durrell revealed "moderate encephalitis suggestive of a viral infection...[and] also chronic, active hepatitis of unclear origin" (J. Lopez, pers. comm.). No causative agent was identified and since that time no further sick individuals have been found. The cause remains undetermined but the Saint Lucia amazon population appears to remain healthy.

Management Recommendations

IUCN note four proposed conservation actions (BirdLife International, 1998) which are commented on below:

- 1) *Maintain the hunting moratorium within all forest reserves.* This moratorium is ongoing. Although there have been calls to lift the moratorium, John (2001) reports that a nationwide survey of the Saint Lucian public in 1999 found a large majority of respondents expressed disapproval of hunting wildlife on Saint Lucia. If the moratorium were to be lifted for certain species, strong safeguards would need to be put in place to prevent collateral damage to protected species such as the Saint Lucia amazon.
- 2) *Conduct a basic study of the feeding and breeding ecology.* The many sources cited here and by Keith (1997) constitute this.
- 3) *Designate remaining habitat as protected areas.* This is done by the Government Forest Reserves which cover a large majority of Saint Lucia's lower montane rainforest and montane rainforest.
- 4) *Reassess the objectives of the captive-breeding programme.* Jeggo *et al.* (2002) provide a review of this programme up to 1998, reporting that "in 1975 a captive-breeding programme was established [from nine wild caught founders] as a safeguard against extinction of *A. versicolor* in the wild... Over 20 offspring have been bred at Jersey and since 1996 all chicks have been parent-reared". Since then, five of the original founders remain alive, all aged over 30 years, and breeding success has declined, with only three births since 1998, only one of which fledged but died at age three (D. Jeggo, pers. comm.). Whilst this programme met its objective of providing an ex situ 'safety net', Jeggo *et al.* (2000) opine: "the recovery [since the 1970s] of the wild population of Saint Lucia amazons lessens the importance of the initial key role of the captive-breeding programme, as a safeguard against extinction".

Some additional recommendations are:

- The fundamental recommendation must be for SLFD to continue to conserve the montane rain forest habitat of this species.
- Monitoring the Saint Lucia amazon population can be expensive (Young *et al.*, in prep.). Modifications of the 2009 survey (Young *et al.*, in prep.), requiring much less effort, should be developed to provide a 'quick-and-dirty' estimate of parrot population trends at regular (5 year) intervals. Additionally, monitoring of pressures on this species should be carried out – especially monitoring loss or degradation of montane rain forest, but possibly also of pearly-eyed thrasher numbers.
- The findings of Dornelly (2006) preferences should be incorporated into any timber extraction activities, leaving large mature trees for nesting.
- Forestry activities should be designed to minimize disturbance during the breeding season (February-August) in the vicinity of known parrot nests.
- As Saint Lucia amazon density increases, SLFD should develop a clear policy on dealing with parrot-human conflicts (some of which have been reported in recent years over the loss of fruit crops; A. Dornelly, pers. comm.).
- Control the levels of introduced predators within the forest reserve. Toussaint *et al.* (2009) provide some more detailed recommendations in this regard.

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Saint Lucia black finch

Scientific Name

Creole Name

Alternative Names

Native status on Saint Lucia:

Endemicity:

IUCN (2009) Category of Threat (International):

Recommended Category of Threat (International):

Recommended Category of Threat (National):

CITES

Wildlife Protection Act 1980 (amended 2001)

Melospiza richardsoni

Mwennson pyé blan

Moisson pied blanc

Native

Saint Lucia

Endangered (C2a(ii) 2008)

Endangered

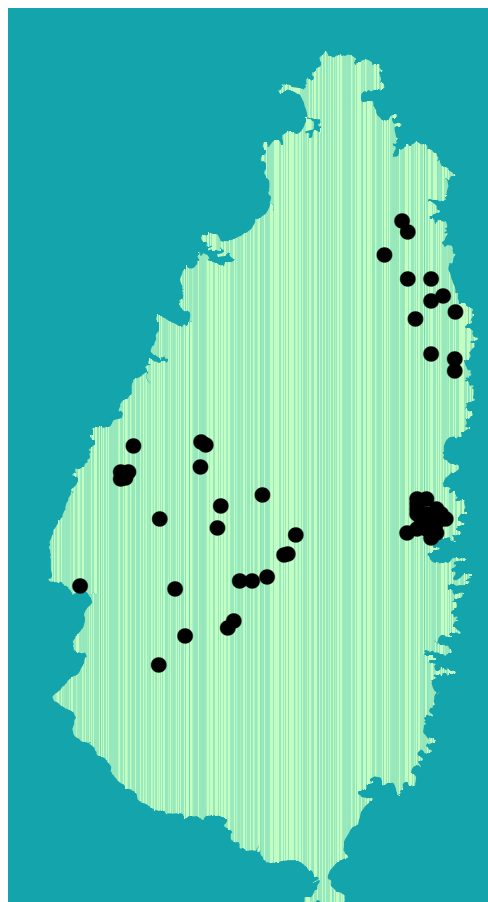
Endangered

Not Listed

Schedule 1 – Protected Wildlife (Birds)



Figure 14: Saint Lucia black finch – male (top); female (bottom) Photos © A. Toussaint.



Map 11: Confirmed records of Saint Lucia black finch

Justification

The Saint Lucia black finch was identified as being one of the highest priority birds for conservation efforts on Saint Lucia by Toussaint *et al.* (2009). It has a global threat status of Endangered (BirdLife

International, 2008) because of its small population size, loss of habitat and the threat of introduced predators. It is endemic to Saint Lucia at the species and genus level.

Identification

A small finch with a heavy bill. The plumage is entirely black in the male (Fig. 14, top) and brown with a contrasting grey head in females and juveniles (Fig. 14, bottom). Superficially, this species looks similar to a number of Emberizids on Saint Lucia, like the Lesser Antillean bullfinch (*Loxigilla noctis sclateri*) or the black-faced grassquit (*Tiaris bicolor*). It is distinguished by its pink legs and its habit of bobbing its tail (Raffaele *et al.*, 1998). Bond (1929) describes the call as “‘Tick- zwee-swisiwis-you’ [with] the accent on the second and last notes...The second note of the song...has a curious buzzing quality”. Sound recordings are available from Chartier (1994).

Habitat

This species is distributed widely, but patchily (Toussaint, *et al.*, 2009; Keith, 1997) across all the main forest types on Saint Lucia: deciduous seasonal, semi-evergreen seasonal and montane rain forest (*sensu* Graveson, 2009). Diamond (1973) opines the species shows a marked preference for secondary growth. Trail and Baptista’s (1989) detailed study of this species suggest a preference for thick undergrowth rather than secondary growth per se. Diamond (1973) and Keith (1997) reported it to be more common at higher elevations, although more recent surveys suggest it is in fact locally common in certain lower elevation areas, notably on the east coast (Toussaint *et al.*, 2009). Bond (1929) reported it “in thick arid scrub country” around Anse La Raye – drawing attention to the fact that fer de lance (*Bothrops caribbaeus*) also occur in some numbers here – a finding repeated in surveys conducted in 2009 by Toussaint (pers. comm.). Other lower elevation areas where Saint Lucia black finches occur at higher densities are also known for thicker understorey and the prevalence of fer de lance; examples are the North East Corridor and Mandalé.

Distribution

Endemic to Saint Lucia. Found in all forest types but not in built up or heavily disturbed areas. Occurs within four of Saint Lucia’s five Important Bird Areas: LC001 (North East Corridor), LC002 (Government Forest Reserve), LC003 (the Pitons) and LC004 Mandalé.

Population status

IUCN report a “density estimate derived from results of surveys in 1987, which recorded 30 individuals in 14 occupied 1-km² map squares” of 2.1 individuals/km², extrapolating this to 131 km² (Extent of Occurrence) to give a population estimate of 275 individuals for the whole of Saint Lucia (BirdLife International, 2008). More recently, surveys in the deciduous seasonal forest of Saint Lucia’s east coast and the montane rain forest of the Forest Reserves (Young *et al.*, 2006; Young *et al.*, in prep.) suggest that in these localized areas densities are higher. Over the whole island, occurrence is patchy (Toussaint *et al.*, 2009). Diamond (1973) also found this species to be “widespread but local”. Anthony & Dornelly (2008) report that Saint Lucia’s Important Bird Area LC001 (the North East Corridor) supports a large percentage of the Saint Lucia black finch population of this species and note that LC003 (the Pitons) is also of importance to the species.

BirdLife International (2008) report the Saint Lucia black finch population to be in decline, inferred from habitat loss (primarily outside of the Forest Reserves) and impacts of introduced predators.

Diet

Various authors have reported the Saint Lucia black finch to be primarily terrestrial (Bond, 1929; Diamond, 1973; Trail & Baptista, 1989), although Bond (1929) also observed it feeding on berries high in trees. Trail & Baptista (1989) provide detailed observations of this species foraging in leaf litter for seeds, but also taking insects by gleaning or ‘fly-catching’ and feeding on fruits and seeds growing close to (up to 4m from) the ground. Fallen seeds, sometimes sprouting, were the predominant food recorded; more rare food items included club mosses and snails (Trail & Baptista, 1989). Diamond states that the Lesser Antillean bullfinch is the Saint Lucia black finch’s main competitor and offers some evidence that these species partition feeding areas vertically, with Saint Lucia black finches feeding closer to the ground.

Reproduction

Nesting occurs primarily from May to August, with a clutch of two eggs being laid, although there are reports of breeding later in the year as well (November; Keith, 1997). Nests are loosely built from twigs, rootlets, ferns and leaves and situated close (1-3m) to the ground. They take the form of a loose ball, with a side entrance. Eggs are white with brownish red spots (Keith, 1997). Trail & Baptista (1989) provide detailed observations of behaviour at the nest during incubation and rearing of the young, including defence of the nest by Saint Lucia black finches against Lesser Antillean bullfinches and bananaquits (*Coereba flaveola*) attempting to steal nesting material.

Uses

As an endemic species, the Saint Lucia black finch is an attraction for the many birders that visit Saint Lucia (see <http://www.birdinginstlucia.org/>) and so contributes to the livelihoods of Saint Lucian birdwatching guides on a regular basis.

Threats

BirdLife International (2008) cite the clearance of undergrowth, particularly in timber plantations, as probably the major threat to this species by rendering areas completely unsuitable for its survival. More generally, habitat loss to development seems the most pressing threat (Toussaint *et al.*, 2009). Introduced mongooses and rats are also cited by BirdLife International (2008) as possible predators of eggs, nestlings and adults which, given this species’ very terrestrial foraging and nesting habits, seems very likely. Other introduced predators may include domestic cats and mannikou (opossum).

Management Recommendations

Given the widespread distribution of this species, site-specific recommendations are made on the basis of existing protected areas that include Saint Lucia black finches and areas outside of existing protected areas that are important to secure for the survival of other critical species, notably the Saint Lucia nightjar, the Saint Lucia wren and the Saint Lucia white-breasted thrasher.

The fundamental recommendations for conservation management coincide with some of the more detailed and specific recommendations of Toussaint *et al.* (2009) and Daltry (2009a), namely:

- Securing the management and restoration of critical deciduous seasonal and semi-evergreen forest areas on Saint Lucia: see recommendations 5.1 in Toussaint *et al.* (2009) and 6.3 in Daltry (2009a). These authors recommend both protection and restoration of habitat in selected critical areas.

- Control the introduction and spread of alien invasive species: see recommendations 5.2 in Toussaint *et al.* (2009) and 6.1 in Daltry (2009a). The recommendation here is to focus strongly on mongooses, rats and mannikou (opossums). Impacts are predicted to increase with further development and are likely to depend on one another (e.g. removing rats alone could increase mongoose predation on native species).

The above recommendations are of relevance to a broad variety of species on Saint Lucia (Daltry, 2009; Toussaint *et al.*, 2009) and should be implemented in a manner that integrates them with the management needs of as broad a range of native species as possible. In addition, two further recommendations specific to the Saint Lucia black finch are made:

- Improve the distribution map for this species across Saint Lucia.
- Conduct more research into the ecology of this species in Saint Lucia (e.g. by facilitating one or more MSc projects). Specifically, elucidate the relationship between black finch survival probability and the density of undergrowth.
- Given that the Lesser Antillean bullfinch is considered a pest in some quarters, the need for awareness raising of the very different statuses of these two species on Saint Lucia should be investigated.

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Saint Lucia nightjar

Scientific Name

Creole Name

Alternative Names

Native status on Saint Lucia:

Endemicity:

IUCN (2009) Category of Threat (International):

Recommended Category of Threat

(International):

Recommended Category of Threat (National):

CITES

Wildlife Protection Act 1980 (amended 2001)

Caprimulgus rufus otiosus

jak papa-pouw; san kou kouto

Saint Lucia nightjar; rufous nightjar; Saint Lucian
whip-poor-will

Native

subspecies: Saint Lucia; species: Trinidad &
Tobago; Panama to north Argentina.

Least Concern (2009)

Species: Least Concern

Subspecies: **Critically Endangered** B1a, B1b(i, ii)

Not Listed

Schedule 1 – Protected Wildlife (Birds)



Figure 15: Saint Lucia nightjar. Photos © B. Kern.



Map 12: Confirmed records of Saint Lucia nightjar. This represents the entire known range of this species on Saint Lucia.

Justification

The Saint Lucia nightjar was identified as being the highest priority bird for conservation efforts on Saint Lucia by Toussaint *et al.* (2009). It is one of five subspecies of the rufous nightjar (*Caprimulgus rufus*) which ranges through South America (Cleere & Nurney, 1998). The species has a global threat status of Least Concern (BirdLife International, 2008) because of its large range. The Saint Lucia nightjar, *C. r. otiosus*, is the taxon reviewed in this profile and is endemic to Saint Lucia. Although IUCN red list criteria can be applied to subspecies (see for example the pencil cedar, profile 0), the Saint Lucia nightjar has yet to be formally assessed. It qualifies as Critically Endangered based on its extremely restricted range (less than 20 km²) at only a single location (the centre of Saint Lucia's North East Corridor. It is also facing severe threats from introduced predators and habitat fragmentation and loss.

Toussaint *et al.* (2009) note that the Saint Lucia nightjar: “has been subject to recent taxonomic revision (AOU, 1998) following the work of Robbins & Parker (1997). However, Robbins & Parker report there is no evidence to believe the Saint Lucia population is migratory and the species is found nowhere else in the Greater or Lesser Antilles (the nearest populations are in Trinidad and Venezuela). Additionally, field notes recorded by Parker in 1989 (ML Audio 51032, Cornell Laboratory of Ornithology Macaulay Library, 2009) indicate that Saint Lucia nightjars are attracted by recordings of other Saint Lucia nightjars, but not by recordings of ostensibly the same species, *Caprimulgus rufus*, recorded elsewhere). Thus interest in this species is partly on account of concerns over its taxonomic status and a resolution of this issue might help clarify priorities for this species on Saint Lucia. Providing DNA from Saint Lucia nightjars to incorporate into a new caprimulgid phylogeny, that currently makes use of *Caprimulgus rufus* DNA from Guyana, but not from Saint Lucia, may be of value here (M. Braun, University of Maryland pers. comm.; see Han, 2006).

Identification

A large bird, 12 inches in length and weighing nearly 100g (Cleere & Nurney, 1998). It has reddish-brown plumage speckled with black and buff. In flight, the Saint Lucia nightjar has short rounded wings which lack the white markings of many nightjar species, but males have a large white spot at the tip of the tail (which is absent in females). Its markings provide effective camouflage against the leaf litter and low undergrowth in which it roosts and this, combined with its nocturnal behaviour, mean that it is not often seen. The males' very distinctive calls – for which the Kweyol names of *jak papa-pouw* and *san kou kouto* are phonetic imitations – however allow them to be easily detected during the breeding season. Sound recordings are available from Chartier (1994) and Cornell Laboratory of Ornithology Macaulay Library (2009).

Habitat

This Saint Lucia nightjar is found only in deciduous seasonal forest, and in drier areas with thick undergrowth and no high canopy. D. Anthony (pers. comm.) notes that it was once found nesting near the Louvet Forest House (in the Castries Waterworks Forest Reserve) but is no longer there, an observation he attributes to the planting and subsequent growth of tall trees like blue maho (*Talipariti elatum*) in this area. It is currently found only in a part of the North East Corridor, although Bond (1929), using the Saint Lucia nightjar's synonym of *Antrostomus rufus otiosus*, reported hearing it in the vicinity of Anse La Raye in an area of dense undergrowth. Both Bond (1929) and Raffaele (1998) draw attention in their accounts to the fact that it was in 1929, and is now, found in areas where fer de lance are prevalent.

This apparent habitat specificity appears at odds with the wide variety of habitats reportedly used by the rufous nightjar, including “gallery forest, second [sic] growth, open woodland, forest edges, scrubland and savannah thickets” (Cleere & Nurney, 1998). This may reflect a real difference in habitat preferences of the Saint Lucia nightjar compared with its sister subspecies in South America. Or it may reflect other factors (e.g. higher introduced predator densities in areas outside the North East Corridor, an area of low human population density on Saint Lucia), forcing the Saint Lucia nightjar into its last remaining retreat on Saint Lucia.

Distribution

Internationally, the rufous njar is found in Central and northern South America (Cleere & Nurney 1998). The Saint Lucia njar is from Povert Ravine to La Ti Tanse, taking in Louvet and Grand Anse Estates, with the highest densities of calling males heard at Caille Des (pers. obs.). Map 12 shows the full (global) extent of the currently known distribution of the Saint Lucia nightjar. This area falls within Saint Lucia’s Important Bird Area LC001.

Population status

Various authors have commented on the rarity of the Saint Lucia nightjar: Bond (1929, 1932), Danforth, 1935 (cited in Keith, 1997), Keith (1997), Anthony & Dornelly (2008), Toussaint *et al.* (2009). Robbins & Parker (1997), who recommended reclassifying the onetime Saint Lucia endemic species *C. otiosus* to the endemic subspecies *C. r. otiosus*, advised: “St. Lucian *otiosus* is certainly vulnerable that its potential habitat is limited to no more than 30 sq. km” (an estimate of habitat availability that, incidentally, appears overly generous at the time of writing the present report; pers. obs.). No estimate of the population size of the Saint Lucia nightjar was found, although ad hoc personal observations from 2002-2008 of the numbers of calling males suggest a density of less than 20 per km² within an area of occupancy (*sensu* IUCN, 2001) of less than 10km². This is only the calling male component of the population, but it suggests a full population size of fewer than 1,000 individuals.

Diet

Nightjars are exclusively insectivorous (Cleere & Nurney, 1998). No data have been published on the insects comprising the diet of the rufous nightjar, but moths and beetles predominate in the diets of many nightjar species (Cleere & Nurney, 1998) and this is likely true for the Saint Lucia nightjar too. Nightjars have a wide gape surrounded by rictal bristles and feed on the wing like swifts, although they are also known to flycatch, making short sallies from a perch. A number of species are known to ingest small stones and grit, believed to help grind food in the stomach (Jenkinson & Mengel, 1970). Many species also drink on the wing (Cleere & Nurney, 1998).

Reproduction

Male Saint Lucia nightjars call from perches at the top of short trees (often the tallest tree nearby in areas with no closed canopy; pers. obs.) The Saint Lucia nightjar does not build a nest but lays its eggs on bare ground or leaf litter, reportedly – for the rufous nightjar – under vegetation or near fallen logs (Cleere & Nurney, 1998). There is a report of Saint Lucia nightjar found nesting in drainage ditch by the side of a rarely used road at Caille Des (A. Johnny, pers. comm.). The eggs – two per clutch – are white with light brown spots (Keith, 1997). Keith (1997) reports breeding by the Saint Lucia nightjar in May and June, and Cleere & Nurney (1998) in late June. The latter authors report longer breeding seasons for sister subspecies (e.g. February-May in *C. r. minimus* in Trinidad) and the territorial calls

of male Saint Lucia nightjars can be heard from as early as February or March (pers. obs.). Distraction displays by parent nightjars – to distract predators away from their nest – are known in many nightjar species but have not been reported in the Saint Lucia nightjar.

Uses

As an endemic, the Saint Lucia nightjar is an attraction for the more adventurous birders that visit Saint Lucia (see <http://www.birdinginlucia.org/>) and so contributes to the livelihoods of some Saint Lucian birdwatching guides.

Threats

Habitat conversion for development (particularly tourist development at the three large estates of the North East Corridor: Louvet, Grand Anse and Marquis and the proposed North East Corridor highway) currently appears to be the most severe threat facing the Saint Lucia nightjar (Toussaint *et al.*, 2009). Impacts from development are also likely to include exacerbating another more longstanding threat, that of the small Asian mongoose (Bond, 1928). Mongooses and other introduced predators such as feral pigs and rats (Clarke, 2009) are predicted to have strong negative impacts on this ground nesting species. The seasonal deciduous forest habitat of the Saint Lucia nightjar is also especially prone to the threat of wildfires (Robbins *et al.*, 2008).

Management Recommendations

The fundamental recommendations for conservation management coincide with some of the more detailed and specific recommendations of Toussaint *et al.* (2009) and Daltry (2009a), namely:

- Securing the management and restoration of critical deciduous seasonal and semi-evergreen forest areas on Saint Lucia: see recommendations 5.1 in Toussaint *et al.* (2009) and 6.3 in Daltry (2009a). These authors recommend both protection and restoration of habitat in selected critical areas.
- Control the introduction and spread of alien invasive species: see recommendations 5.2 in Toussaint *et al.* (2009) and 6.1 in Daltry (2009a). The recommendation here is to focus strongly on mongooses, rats and mannikou (opossums). Impacts are predicted to increase with further development and are likely to depend on one another (e.g. removing rats alone could increase mongoose predation on native species).

The above recommendations are of relevance to a broad variety of species on Saint Lucia (Daltry, 2009; Toussaint *et al.*, 2009) and should be implemented in a manner that integrates them with the management needs of as broad a range of native species as possible. In addition, five further recommendations specific to the Saint Lucia nightjar are made:

- Survey the whole of the Saint Lucia nightjar range to identify centres of abundance or occupancy and the habitat features that best explain this pattern of distribution.
- Establish a monitoring baseline to measure impacts of, and pressures arising from, development within the North East Corridor. Pressures should include loss of habitat and habitat degradation, and abundance of introduced mammalian predators.
- Incorporate these findings into mitigative actions in response to the impact of developments within the North East Corridor.

- Conduct more research into the ecology of this species in Saint Lucia (e.g. by facilitating one or more MSc projects).
- Obtain DNA samples from a few (3-5, M. Braun, pers. comm.) individuals for comparison against related caprimulgid species in a phylogeny constructed using molecular genetic information (Han, 2006).

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Saint Lucia wren

Scientific Name

Creole Name

Alternative Names

Native status on Saint Lucia:

Endemicity:

IUCN (2009) Category of Threat (International):

Recommended Category of Threat

(International):

Recommended Category of Threat (National):

CITES

Wildlife Protection Act 1980 (amended 2001)

Troglodytes aedon mesoleucus

Wòsignòl

Saint Lucia wren; rossignol

Native

Subspecies: Saint Lucia; species: Trinidad & Tobago, Central and South America (Panama to northern Argentina)

Least Concern (2009)

Least Concern (as species)

Critically Endangered B1a, B1b(i, ii) (as subspecies)

Not Listed

Schedule 1 – Protected Wildlife (Birds)

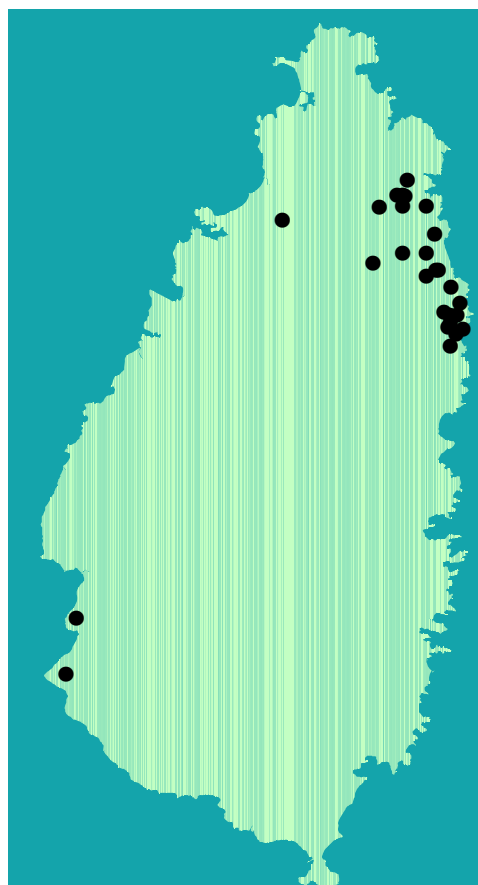


Figure 16. Saint Lucia wren. Photos © A. Toussaint/ Tseng Chiu-wen Hank.

Map 12: Confirmed records of Saint Lucia wren. This represents the entire known range of this species on Saint Lucia.

Justification

The Saint Lucia wren was identified as being one of the highest priority birds for conservation efforts on Saint Lucia by Toussaint *et al.* (2009). It is currently classified as a subspecies of the house wren, *Troglodytes aedon mesoleucus*, by the American Ornithologist's Union, but the most recent AOU checklist notes that “*many or all of the distinctive Caribbean subspecies included within the martinicensis group [which includes the Saint Lucia wren] may each warrant species status*” (AOU, 1998). The house wren, *T. aedon* has a global threat status of Least Concern (BirdLife International, 2008) because of its large range and increasing global population (There is a large body of literature on the house wren: Thompson & Johnson [2006] list over 600 references, but most of them cover North American populations and subspecies). The Saint Lucia wren, *T. a. mesoleucus*, is the taxon reviewed in this profile and is endemic to Saint Lucia. Gilardi & John (1998) opine that “striking morphological variation amongst the Lesser Antillean wren populations strongly suggests that...[they] represent evolutionarily significant units for conservation”. Although IUCN red list criteria can be applied to subspecies (see for example the pencil cedar, profile 0), the Saint Lucia wren has yet to be formally assessed. It qualifies as Critically Endangered based on its extremely restricted range and occurrence at only two (widely separated) locations: the centre of Saint Lucia's North East Corridor, and Gros Piton in the South West of Saint Lucia. It is also facing severe threats from introduced predators and habitat fragmentation and loss.

Identification

A very small, reddish brown bird identified by a pale eyebrow stripe and black barring on the wings and tail. The underparts are pale and the lower mandible of the bill yellow. The head is relatively large (Raffaele *et al.*, 1998; see Fig. 16). The call is described as a “burbling, gurgling warble unlike any other resident landbird” (Raffaele *et al.*, 1998). Sound recordings of the Saint Lucia wren were not located but recordings from Dominica of *T. a. rufescens* (another member of the *martinicensis* group which includes the Saint Lucia wren) are available from the Cornell Laboratory of Ornithology, Macaulay Library (2009).

Habitat

The Saint Lucia wren is found only in deciduous seasonal forest (*sensu* Graveson, 2009). Very little further information appears to have been published on its habitat preferences, although it occupies largely the same areas as the Saint Lucia nightjar. Danforth (1935, cited by Keith, 1997) reports three specimens from a “brackish-water swamp bordering the Marquis River about half a mile back from the point it enters the sea”. Gilardi & John (1998) report the Saint Lucia wren from deciduous seasonal forest and mangrove (at La Ti Tanse). A great deal more information is published on habitat use by the house wren. AOU (1998) report the species occurring in a wide range of habitats from “Arid Lowland (and Montane) Scrub” to “Tropical Lowland Evergreen Forest”. Given the range of this species (the largest of any native songbird in the New World, extending from Canada to virtually the whole of South America, including the Falkland Islands) it is unclear how applicable these observations are to the Saint Lucia wren. Many of the habitats listed by AOU (1998) are described as types of scrub and secondary growth however, which are reminiscent of the habitat in which the Saint Lucia wren (and the Saint Lucia nightjar) is currently found.

Distribution

Like the Saint Lucia nightjar, The Saint Lucia wren is recorded from Louvet to Marquis Estates (the latter including the Mt Gaiac record of Gilardi & John, 1998) in the North East Corridor, but with

scattered sightings extending further West as far as Cacoli. The limits of the records reported by Toussaint *et al.* (2009) encompass all the sightings reviewed by Keith (1997), dating back to Bond (1929), with the exception of an isolated population on the slopes Gros Piton and Petit Piton and isolated sightings at Union and Dauphin (Gilardi & John, 1998). The North East Corridor and the Pitons are within Saint Lucia's Important Bird Areas LC001 and LC003 respectively.

Population status

Bond (1929), Diamond (1973) and Keith (1997) all report the wren to be very rare. Gilardi & John (1998) searched all major drainages in the North East Corridor from Cap Estate to Louvet, throughout Cacoli, at SLFD's Union nature trail and on and around the Pitons and made a total minimum count of 60 individuals. These authors suggest a global population for the Saint Lucia wren of approximately 100 individuals. Gilardi & John (1998) also refer to unpublished data of "substantial song variation" in support of their belief that this tiny population is also highly fragmented.

Diet

The house wren feeds on insects and other invertebrates. Very little information has been published on diet in the Saint Lucia wren, though they are also insectivorous (Gilardi & John, 1998). Graves (1985, cited in Keith, 1997) observed them probing fissures in tree bark at Grand Anse and commented that "the relatively long bills of Lesser Antillean *Troglodytes* and my brief observations of *T. a. mesoleucus* suggest that they probe crevices and fissures more than their continental counterparts". Gilardi & John (1998) report Saint Lucia wrens foraging predominantly within 2m of the ground, "in leaf litter, on the bark of living and dead trees, and especially in the dead ends of broken branches".

Reproduction

Gilardi & John (1998) report details of nesting in tree cavities and in nest boxes constructed from cardboard and bamboo and deployed by the authors. These authors found that nesting started in early June, with nests being situated 1-2m above the ground. Gilardi & John (1998) describe the eggs as "dark and heavily speckled" with a clutch size of two to four eggs, relatively small for temperate house wren subspecies but typical of their tropical subspecies (Young, 1996). Only four out of 16 nests observed by Gilardi & John (1998) had eggs laid in them, and of these four nests, three (one in a natural nest, one in a cardboard nest box and one in a bamboo nest box) fledged chicks. Nest boxes have been used extensively in studies of other house wren subspecies, often in the context of experimental manipulation of reproductive resources. Llambias & Gustavo (2009), for example, report higher nest success and productivity for house wrens in Argentina (*T. a. bonairensis*) using nest boxes compared with those using natural cavities.

Uses

As an endemic, the Saint Lucia wren, and its appealing song, is an attraction for the many birders that visit Saint Lucia (see <http://www.birdinginstlucia.org/>) and so contributes to the livelihoods of Saint Lucian birdwatching guides on a regular basis.

Threats

Habitat conversion for development (particularly tourist development at the three large estates of the North East Corridor: Louvet, Grand Anse and Marquis and the proposed North East Corridor highway) currently appears to be the most severe threat facing the Saint Lucia wren (Toussaint *et al.*, 2009). Mongooses and other introduced predators such as feral pigs and rats (Clarke, 2009) are

predicted to have strong negative impacts on this species that forages and nests near the ground, impacts likely to be only exacerbated by development pressures. The seasonal deciduous forest habitat of the Saint Lucia wren is also especially prone to the threat of wildfires (Robbins *et al.*, 2008). Keith (1997) cites Norton (1990) in support of the contention that the shiny cowbird (*Molothrus bonairensis*) is probably a brood parasite on the Saint Lucia; this species is known to parasitize the house wren elsewhere (e.g. Argentina; Tuero *et al.*, 2007).

Management Recommendations

The fundamental recommendations for conservation management coincide with some of the more detailed and specific recommendations of Toussaint *et al.* (2009) and Daltry (2009a), namely:

- Securing the management and restoration of critical deciduous seasonal and semi-evergreen forest areas on Saint Lucia: see recommendations 5.1 in Toussaint *et al.* (2009) and 6.3 in Daltry (2009a). These authors recommend both protection and restoration of habitat in selected critical areas.
- Control the introduction and spread of alien invasive species: see recommendations 5.2 in Toussaint *et al.* (2009) and 6.1 in Daltry (2009a). The recommendation here is to focus strongly on mongooses, rats and mannikou (opossums). Impacts are predicted to increase with further development and are likely to depend on one another (e.g. removing rats alone could increase mongoose predation on native species).

The above recommendations are of relevance to a broad variety of species on Saint Lucia (Daltry, 2009; Toussaint *et al.*, 2009) and should be implemented in a manner that integrates them with the management needs of as broad a range of native species as possible. In addition, four further recommendations specific to the Saint Lucia wren are made:

- Survey the whole of the Saint Lucia wren range to identify centres of abundance or occupancy and the habitat features that best explain this pattern of distribution.
- Establish a monitoring baseline to measure impacts of, and pressures arising from, development within the North East Corridor. Pressures should include loss of habitat and habitat degradation, and abundance of introduced mammalian predators.
- Incorporate these findings into mitigative actions in response to the impact of developments within the North East Corridor.
- Increase secure nesting opportunities through the deployment of artificial nest boxes and monitor their impacts on fledging success and Saint Lucia wren population abundance or occupancy.
- Assess genetic diversity in disjunct populations and consider using nest boxes and egg fostering (Jones, 2004) as a means of facilitating more gene flow to increase diversity.

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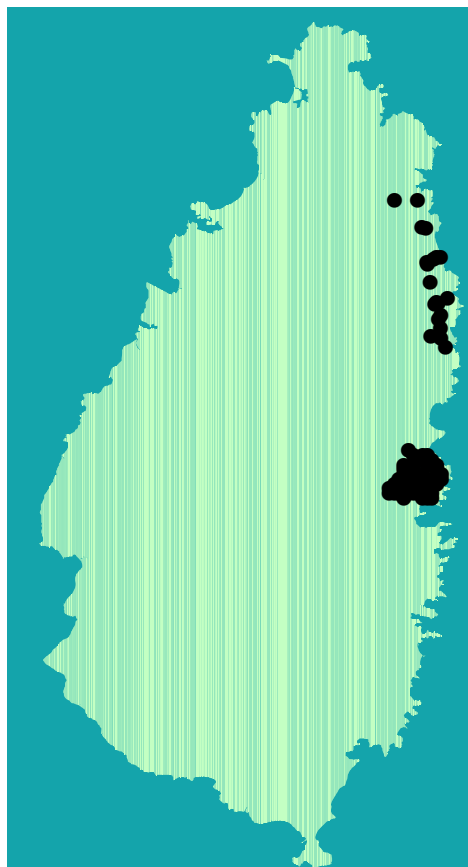
Lyndon John: lynjohn1@yahoo.com

White-breasted thrasher

Scientific Name	<i>Ramphocinclus brachyurus sanctaeluciae</i>
Creole Name	gòj blan
Alternative Names	White-breasted thrasher; gorge blanc; monquer à gorge blanche (Martinique)
Native status on Saint Lucia:	Native
Endemicity:	subspecies: Saint Lucia; species: Saint Lucia, Martinique
IUCN (2009) Category of Threat (International):	Endangered B1ab(i,ii,iii,v 2008)
Recommended Category of Threat (International):	Endangered B1ab(i,ii,iii,v)
Recommended Category of Threat (National):	Critically Endangered B1ab(i,ii,iii,v)
CITES	Not Listed
Wildlife Protection Act 1980 (amended 2001)	Schedule 1 – Protected Wildlife (Birds)



Figure 17: White-breasted thrasher (male displaying). Photos © Tseng Chiu-wen Hank.



Map 14: Confirmed records of the white-breasted thrasher, representing the entire known range of this species on Saint Lucia

Justification

The white-breasted thrasher was identified as being one of the highest priority birds for conservation efforts on Saint Lucia by Toussaint *et al.* (2009). It has a global threat status of Endangered (BirdLife

International, 2008) because of its extremely small range and the continuing loss of its deciduous seasonal forest habitat (BirdLife International, 2008). It is endemic to Saint Lucia at the subspecies level, *Ramphocinclus brachyurus sanctaeluciae*, and at the species (and genus) level to Saint Lucia and Martinique. The Martinique subspecies, *R. b. brachyurus*, is restricted to a tiny population on the Caravelle Peninsula, accounting for less than 20% of the global population of the species (BirdLife International, 2009). The Saint Lucia white-breasted thrasher, *R. b. sanctaeluciae*, is the taxon reviewed in this profile.

Temple (2005) reviews the IUCN red status of the species based partly on area of occurrence which she estimates as “approximately 300 km²” (which is 50% of the total land area of Saint Lucia). Producing an area of *occurrence* by minimum convex polygon (IUCN, 2001) for the Saint Lucia white-breasted thrasher alone – i.e. excluding the sea between Saint Lucia and Martinique as per IUCN’s (2001) guidance that “this measure may exclude discontinuities or disjunctions within the overall distributions of taxa (e.g. large areas of obviously unsuitable habitat)” – gives an estimate 50 km², which the disjunct Martinique range would not inflate greatly. This would trigger criteria B1ab for Critically Endangered. However, area of *occupancy* (IUCN, 2001) does trigger criterion B2 for Endangered, as noted by Temple, 2005. Temple (2005) concludes that the species is “capable of becoming Critically Endangered or Extinct within a very short time period”. For the Saint Lucia white-breasted thrasher, an assessment of Critically Endangered appears warranted based on area of occurrence.

Temple (2005) notes that “*R. b. brachyurus* and *R. b. sanctaeluciae* are well-differentiated at both a genotypic (E. Pasquet & H. Temple unpubl. data) and phenotypic level... are not interbreeding, and constitute two clearly separate evolutionary lineages. There is consequently a strong case for considering each subspecies as an ‘evolutionarily significant unit’ (*sensu* Ryder, 1986) for conservation management.” H. Temple (pers. comm.) reports that further genetic analyses have suggested that each subspecies could be elevated to species level.

Identification

The bright white underparts and a deep red iris distinguish the adult white-breasted thrasher from other birds on Saint Lucia. The upperparts are a dark chocolate brown, the bill long and slightly down-curved. Juveniles are entirely brown but still distinguishable by their red iris. Drooping and twitching the wings (Fig. 17) is common. Bond (1967, cited in Keith, 1997) mentions a report from 1951 of a Saint Lucia white-breasted thrasher song described as “*tee-rou-tit; tee-ou-tee-ou; tee-a-re-tu*”. This is a very rare report, as Bond himself (1957), John (1995), H. Temple (pers. comm.), J. Mortensen (pers. comm.) and others (Keith, 1997) all note the absence of a song in the Saint Lucia white-breasted thrasher. However, alarm cries produced when mobbing predators such as a *Boa constrictor* are commonly heard; a selection recorded by J. Gullede is available from Cornell Laboratory of Ornithology Macaulay Library (2009).

Habitat

The Saint Lucia white-breasted thrasher is found only in deciduous seasonal forest (*sensu* Graveson, 2009). Temple (2005) presents a detailed study of habitat preferences at the landscape and home range levels. She found a strong preference for mature dry forest with a canopy higher than 5m with an aversion to scrubby forest (canopy height below 5m) and a strong aversion to open land. At the level of individual home ranges, higher canopy and tree density were preferred. Home ranges also had higher invertebrate density and were more likely to contain the shrub bwa gwiyé (*Myrcia citrifolia*) –

used to nest in and as food (berries) for adults and chicks – than areas not selected by the birds. Sites selected for nesting showed a preference for denser foliage at nest height than random sites. Temple also notes a difference in habitat use by the Saint Lucia white-breasted thrasher in its northern sub-population compared with its southern sub-population: In the north it seems largely confined to the taller, more lush dry forest found in ravines; whilst in the south it uses both ravines and hillsides in an area with a “more complex and fine-grained mosaic of habitats”. The preference for ravines in the North East Corridor was also noted by Ijsselstein (1992) and John (1995).

Distribution

The white-breasted thrasher on Saint Lucia appears to occur in two disjunct sub-populations: along the North East Corridor (between the Fond d’Or and La Ti Tanse Rivers) in the north; and at Mandelé (between the Praslin and Dennery Rivers) further south. This is a combined area of occupancy of about 24 km². These areas are contained within Saint Lucia’s Important Bird Areas LC001 and LC004 respectively. Temple (2005) collates a long list of sites outside these areas, on both the east and west coasts of Saint Lucia, that have been searched for white-breasted thrashers without finding any. The Martinique subspecies is restricted to approximately 5 km² of the Caravelle Peninsula (Temple, 2005). Diamond (1973) notes that the Saint Lucia white-breasted thrasher’s distribution coincides with high densities of fer de lance.

Population status

Temple (2005) used territory mapping to produce estimates of 108 – 221 birds in the northern sub-population and 1,184 in the southern sub-population. Temple’s (2005) distance sampling estimate for the south of 2,655 birds had very wide 95% confidence limits (35 – 5,273 birds). In 2006, SLFD and Durrell used distance sampling to obtain estimates of these two sub-populations of 80 (33 -197) and 1,121 (696 – 1,807) birds respectively; these latter estimates are very similar to Temple’s (2005) lower estimates despite having been obtained by an alternative method (Young *et al.*, in press).

Temple (2005) compared her data for the northern sub-population with three earlier surveys dating back to 1971 and found a 50% decline in this sub-population over that period. SLFD and Durrell have been monitoring the southern sub-population annually from 2006-2009. Using these data, White (2009) reports there have already been significant declines in encounter rate and occupancy of white-breasted thrashers over this period, most severe, unsurprisingly, at the development site for the Le Paradis hotel and golf course resort at Praslin Bay.

Diet

The Saint Lucia white-breasted thrasher feeds primarily on the ground, ‘thrashing’ through leaf litter, tossing leaves aside, searching for invertebrates and small vertebrates like frogs and lizards (Diamond, 1973; John, 1995; Temple, 2005). They are also known to eat berries (Diamond, 1973) and probe rotting wood for insect larvae (Temple, 2005). John (1995) provides a list of food items including the plants *Tabernaemontana citrifolia* (bwa let), *Inga laurina* (pwa dou), *Cocos nucifera* (coconut; koko), *Myrcia citrifolia* (bwa gwiyé), *Passiflora laurifolia* (ponm dilyenn) *Mamea americana* (mammee apple; zabwiko) and *Guatteria caribaea* (kòsòl mawon); and the animals *Eleutherodactylus johnstonei* (tree frog; ti tolin), *Anolis luciae* (Saint Lucia anole), *Pheretima spp.* (earthworm; vè tè), *Arama spp.* (beetle), Lepidoptera species (moths), *Gryllotalpa spp.* (cricket) and other unidentified insects.

Reproduction

Keith (1997) records breeding in April to July with John (1995) reporting advanced nests in May and Babbs *et al.*, (1988, cited in Keith, 1997) finding nestlings in August. Breeding territories are an average of 70m across (Temple *et al.*, 2006). The nest is a bulky cup of loose twigs, lined with leaves or grass, and built in shrubs or samplings low (2-6m) to the ground (Keith, 1997). Two sky blue eggs are laid in a clutch. Fledglings leave the nest before they can fly and beg for food from their parents on the ground (John, 1995).

Both female and especially male Saint Lucia white-breasted thrashers are philopatric: a large proportion remain within the territory of their birth and help raise one or more clutches of their siblings in future years (Temple *et al.*, 2006). Most do disperse to new territories after their second year, but only very short distances: an average of 103m for males and 360m for females (Temple *et al.*, 2006). This unusual pattern of behaviour is likely to limit this species' ability to colonize new areas. It may mean that the southern and northern sub-populations, although only 6km apart, are reproductively isolated from one another (Temple *et al.*, 2006). It may also help explain the decline over the last 30 years in the apparently fragmented northern sub-population (Temple *et al.*, 2006). Because white-breasted thrashers delay reproduction for one or two years, Temple *et al.* (2009) argue that the effective population size of "mature individuals...capable of reproduction" – used by IUCN (2001) to trigger red list categories – should be considered as smaller than population estimates imply.

Uses

The Saint Lucia white-breasted thrasher's inquisitive nature makes it relatively easy to see in areas where it is present. As an endemic, it is an attraction for the many birders that visit Saint Lucia (see <http://www.birdinginstlucia.org/>) and so contributes to the livelihoods of Saint Lucian birdwatching guides on a regular basis.

Threats

As for Saint Lucia's other endangered deciduous seasonal forest birds that forage and or nest on the ground, the white-breasted thrasher seems threatened primarily by habitat fragmentation and destruction, and introduced predators. Keith (1997) cites habitat loss as the main concern. In recent years this has become a direct pressure at the Le Paradis development site which covers about one third of the southern sub-population's range. The southern sub-population contains about 90% of all Saint Lucia's white-breasted thrashers and 75% of the global population of the species (Temple, 2005). Little evidence of predation by introduced mammals on eggs or nestlings was found by Temple (2005) – with native species such as *Boa constrictor* being the main nest predators – although impacts on fledglings and adults were not investigated. It may be though however white-breasted thrashers are only surviving in areas of relatively low introduced mammal densities, as can be hypothesized from the low human populations in these areas (pers. obs.). Certainly their foraging and nesting habits would appear to make them very vulnerable to terrestrial introduced predators like the small Asian mongoose.

Bond (1982, cited in Keith, 1997) attributes the decline of the Saint Lucia white-breasted thrasher in part to aggressive interactions with the bare-eyed robin (*Turdus nudigens*) which has been expanding its range northwards through the Lesser Antilles and was first recorded from Saint Lucia in 1950 (Keith, 1997). Temple (2005), however, observed no aggressive interactions between these two species over three years of fieldwork, and no other authors seem to have recorded any observations.

One other threat to the Saint Lucia white-breasted thrasher may be its own unusual breeding and dispersal behaviours. As noted above, delaying reproduction to help parents rear siblings in effect reduces the size of the adult breeding population (Temple *et al.*, 2009). Low dispersal reduces the probability of interbreeding between population fragments, especially in the northern sub-population (Temple *et al.*, 2006).

Management Recommendations

Temple (2005) makes a number of recommendations for the conservation management of the Saint Lucia white-breasted thrasher based on her three year study:

1. *Habitat protection.* Temple (2005) describes this as “the single most important form of action that could be taken to protect the White-breasted Thrasher from extinction” and recommends securing protected areas in both the northern and southern ranges of the Saint Lucia white-breasted thrasher, as well as ‘stepping stones’ of habitat that may allow connectivity between these two sub-populations.
2. *Habitat restoration.* Temple (2005) notes that deciduous seasonal forest habitat is “relatively easy to restore” with almost the entire current range of the Saint Lucia white-breasted thrasher being secondary forest. She recommends restoration in land both between the two sub-populations and to the south of the southern one.
3. *Measures to limit the threat posed by invasive predators.* Temple (2005) recommends that in any new developments within the Saint Lucia white-breasted thrasher’s range, cats should be banned, dogs kept fenced in backyards or leashed, and rat numbers actively controlled.
4. *Monitoring.* Temple (2005) describes this as crucial to any management strategy, and it is a recommendation currently being followed by SLFD and Durrell (Young *et al.*, 2009). Temple extends this recommendation to including monitoring pressures on the white-breasted thrasher, notably habitat changes and introduced predator numbers.
5. *Education, awareness-raising and legislation.* Temple (2005) recommends raising the public profile of the Saint Lucia white-breasted thrasher. She recommends new legislation to protect habitats (at present only individual white-breasted thrashers are protected by the 1980 Wildlife Protection Act).

This report endorses all of these recommendations and draws attention to where they coincide with some of the more detailed and specific recommendations of Toussaint *et al.* (2009) and Daltry (2009a), namely:

- Securing the management and restoration of critical deciduous seasonal and semi-evergreen forest areas on Saint Lucia: see recommendations 5.1 in Toussaint *et al.* (2009) and 6.3 in Daltry (2009a). These authors recommend both protection and restoration of habitat in selected critical areas.
- Control the introduction and spread of alien invasive species: see recommendations 5.2 in Toussaint *et al.* (2009) and 6.1 in Daltry (2009a). Although Temple (2009) only mentions cats, dogs and rats specifically, the recommendation here is to focus strongly on mongooses and mannikou (opossums) in addition. Even if these latter species are having low impacts at present

(which remains to be established), these impacts are predicted to increase with further development or even, ironically, with rat control.

The previous two recommendations are of relevance to a broad variety of species on Saint Lucia (Daltry, 2009; Toussaint *et al.*, 2009) and should be implemented in a manner that integrates them with the management needs of as broad a range of native species as possible. In addition, three further recommendations specific to the white-breasted thrasher are made:

- Continue monitoring the southern sub-population with a view to determining impacts of development on this species. This has been started by White (2009) investigating impacts of habitat fragmentation using the data collected by SLFD and Durrell (Young *et al.*, 2009). It should continue (and further incorporate the impacts of additional pressures, e.g. mongooses and rats) with a view to developing mitigative measures for both sub-populations.
- Establish to what extent gene flow exists between the northern and southern sub-populations, and between population fragments within the northern sub-population (also a suggestion in Temple *et al.*, 2009).
- Develop mitigative measures (e.g. egg fostering; Jones, 2004) to increase gene flow if this appears necessary.

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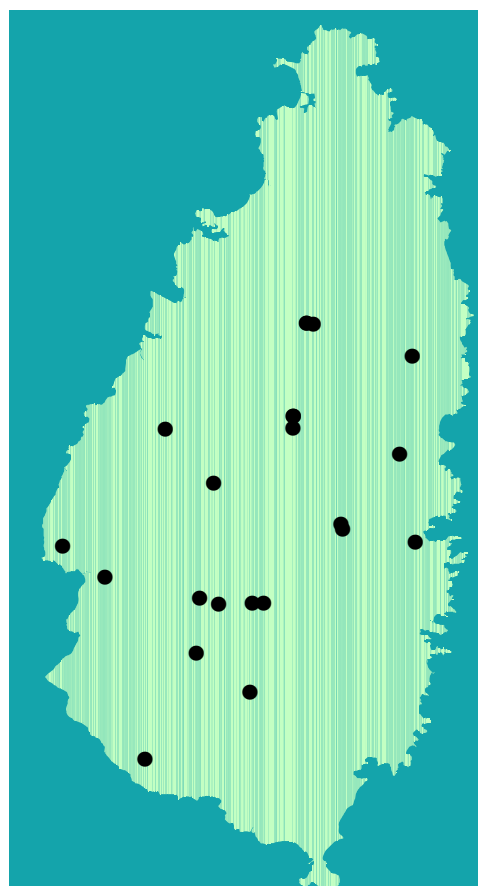
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Saint Lucia yellow-shouldered bat

Scientific Name	<i>Sturnira lilium luciae</i>
Creole Name	Sòlsouwi (generic name meaning 'bat')
Alternative Names	Little yellow-shouldered bat
Native status on Saint Lucia:	Native
Endemicity:	Subspecies: Saint Lucia; species: Central and South America, West Indies
IUCN (2009) Category of Threat (International):	Least Concern (2008)
Recommended Category of Threat (International):	Least Concern
Recommended Category of Threat (National):	Near Threatened
CITES	Not listed
Wildlife Protection Act 1980 (amended 2001)	Not listed on Schedules 1, 2 or 3



Figure 18: The Saint Lucia yellow-shouldered bat. Top: darker reddish shoulder, below and behind ear; bottom: detail of nose leaf and mouth. © M. Morton/ Durrell .



Map 15: Confirmed records of the Saint Lucia yellow-shouldered bat.

Justification

The Saint Lucia yellow-shouldered bat has been selected because it is a single-island endemic subspecies dependent on forest cover. It provides the ecological services of seed dispersal and pollination. The species *Sturnira lilium* has been evaluated as being of Least Concern because “of its wide distribution, presumed large population, it occurs in a number of protected areas, and because it is unlikely to be declining at nearly the rate required to qualify for listing in a threatened category” (Barquez *et al.*, 2008). At the subspecies level, it is endemic to Saint Lucia as *S. l. luciae*. Earlier work for museum collections (e.g. for the description of the subspecies: Jones & Phillips, 1976, cited in Clarke, 2009) does not provide a sufficient baseline against which to assess any declines in abundance or extent (i.e. criteria needed to trigger red list categories). The only recent surveys of bats on Saint Lucia are by Clarke (2009) and G. Kwiecinski, S. Pedersen, H. Genoways and colleagues over the period 2007-09 (in prep.), all of whom found this species to be quite common on Saint Lucia. On many other Eastern Caribbean islands, however, Genoways (1998) considers *S. lilium* to be rare and attributes this to loss of the humid forest it prefers. The Saint Lucia yellow-shouldered bat clearly uses multiple habitat types and conversion of areas of forest would be expected to have negative impacts on the population. With this in mind, a red list classification of Near Threatened (i.e. “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”) is suggested for the subspecies *S. l. luciae*. The term Saint Lucia yellow-shouldered bat in this profile refers to this subspecies.

Identification

A medium to large-sized bat, about 6cm head plus body, with a forearm (a standard measure of bat size) of about 44mm (Clarke, 2009) and weighing 15-20g. Wingspan about 30cm. The genus gets its name from a yellow or orange-brown patch of fur on each shoulder (Fig. 18), stained by the secretions from shoulder glands and more distinct in males. In the hand, this bat can be distinguished from other bats on Saint Lucia by having no tail and a very reduced tail membrane (other bat species on Saint Lucia have a visible tail or a more obvious tail membrane or both); Pedersen & Morton (2008). Like other leaf-nosed bats, it has an upright pointed nose-leaf (Fig. 18).

Habitat

The Saint Lucia yellow-shouldered bat is most abundant in the lower montane rain forest, although it has also been caught in deciduous seasonal and semi-evergreen seasonal forest types, typically near streams (Clarke, 2009). This is consistent with what is known of *S. lilium* on other Eastern Caribbean islands (Genoways *et al.*, 1998; Clarke, 2009 and references cited therein) and in South America (Gannon *et al.*, 1989). Goodwin & Greenhall (1961) working in Trinidad, and Evelyn & Stiles (2003) working in Mexico, report that *S. lilium* normally roosts in hollow trees. Evelyn & Stiles (2003) showed that *S. lilium* showed a marked preference for large trees (mean DBH of 29cm) and species prone to heartwood decay (especially species within the Anacardiaceae, Bombacaceae, Myrtaceae and Verbenaceae). In Belize, Fenton *et al.* (2000) found it roosting in hollow trees, at the base of palm fronds and in tangles of vine. They report it to be inconspicuous in roosts and difficult to flush. They also found this species to be “roost-faithful”, with individuals returning repeatedly to the same roost site. Occasional use of caves or buildings as roosts has also been recorded (Gannon *et al.*, 1989).

Distribution

Sturnira lilium is found throughout much of tropical and subtropical Central and South America (Gannon *et al.*, 1989), including the Eastern Caribbean islands from Dominica southwards

(Genoways, 1998). The subspecies *S. l. luciae* is found only on Saint Lucia. There are records of the Saint Lucia yellow-shouldered bat from most areas of the island that have forest and at all elevations, although it is more abundant in the lower montane rain forests of the Government Forest Reserves (Clarke, 2009; S. Pedersen, pers. comm.).

Population status

Although there is no data on population trends in Saint Lucia, the Saint Lucia yellow-shouldered bat appears to be common. This is in contrast to many Eastern Caribbean populations of *S. lilium* and is likely dependent on the continuing protection of the lower montane rain forests of the Government Forest Reserves (Genoways, 1998).

Diet

No reports of the diet of the Saint Lucia yellow-shouldered bat were found. Gardner (1977) reports that *S. lilium* eats a variety of fruits, including *Ficus* (fijé) and *Cecropia* (bwa kannon). Giannini (1999), in Argentina, and Mello *et al.* (2008), in Brazil, found *S. lilium* to show a strong preference for the fruits of various Solanaceae and Piperaceae (bwa mal) species. Gardner (1977) cites Heithaus *et al.* (1974) as finding *S. lilium* carrying on its fur the pollen of a number of plant species (which it presumably eats, as well, along with nectar). Insects have also been reported in its diet (Gannon *et al.*, 1989).

Reproduction

No reports of the reproductive biology of the Saint Lucia yellow-shouldered bat were found. Like most bats, *S. lilium* is pregnant with one pup at time, but may give birth twice or even three times a year (Gannon *et al.*, 1989; Sanchez Hernandez *et al.*, 1986). Little has been published on the timing of breeding in the Eastern Caribbean, though Genoways *et al.* (1998) reports lactating female *S. l. serotinus* on Grenada in May and a pregnant female of the related *S. thomasi* was found in May on Montserrat. Pregnant females of *S. l. lilium* have been found on Trinidad in August.

Uses

No reports of uses of the Saint Lucia yellow-shouldered bat by people were found, although bats do appear in some Amerindian art, including possibly on Saint Lucia (E. Branford, pers. comm.). Given its abundance and diet, this species is likely to make a significant contribution to the forest ecosystem through pollination and seed dispersal.

Threats

The rarity of yellow-shouldered bats on other Eastern Caribbean islands has been attributed to lack of humid forests (Genoways, 1998). This does not appear to be a current threat on Saint Lucia, though stochastic events such as a severe hurricane could change that. Although lower montane rain forest appears to be the main habitat the Saint Lucia yellow-shouldered bat uses, it does use other forest types and presumably would be negatively impacted by a reduction in their extent.

This species shows high roost faithfulness (Fenton *et al.*, 2000) and a preference for cavity roosting in large trees of species prone to heartwood decay Evelyn & Stiles (2003). Roosts are also difficult to locate (Fenton *et al.*, 2000). Given these observations, indiscriminate removal of large trees may pose a threat.

Bats worldwide are subject to suspicion and animosity from people. The lack of any legislation protecting bat species on Saint Lucia is a concern. As in other countries, legislation to protect bats should offer legal protection to roost sites as well.

Management Recommendations

Habitat protection – of both foraging and roosting habitats – is the fundamental recommendation here. To a large extent, this is already being achieved through the management of the Government Forest Reserves (Clarke, 2009). Some additional specific recommendations are:

- Protect this (and all other bat species on Saint Lucia) with legislation.
- Protect with legislation the roosts of this (and all other bat species on Saint Lucia except *Molossus molossus* when in houses) against destruction or excessive disturbance.
- Do not remove large trees from the Forest Reserves that have cavities and retain some individuals of species that are prone to form cavities.
- Maintain forested riparian corridors, especially along permanent streams, outside of the Forest Reserves, integrating this recommendation with riverbank stabilization and other watershed management activities.
- Raise awareness in the public in general, and pest control agents in particular, of the value of bats and that the majority of bat species on Saint Lucia do not conflict with people (e.g. by roosting in occupied human dwellings or damaging crops).

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Antillean fruit bat

Scientific Name	<i>Brachyphylla cavernarum cavernarum</i>
Creole Name	Sòlsouwi (generic name meaning 'bat')
Alternative Names	Pig-faced bat, Antillean fruit-eating bat
Native status on Saint Lucia:	Native
Endemicity:	Puerto Rico, Virgin Islands; Eastern Caribbean except Grenada
IUCN (2009) Category of Threat (International):	Least Concern (2008)
Recommended Category of Threat (International):	Least Concern
Recommended Category of Threat (National):	Near Threatened
CITES	Not listed
Wildlife Protection Act 1980 (amended 2001)	Not listed on Schedules 1, 2 or 3

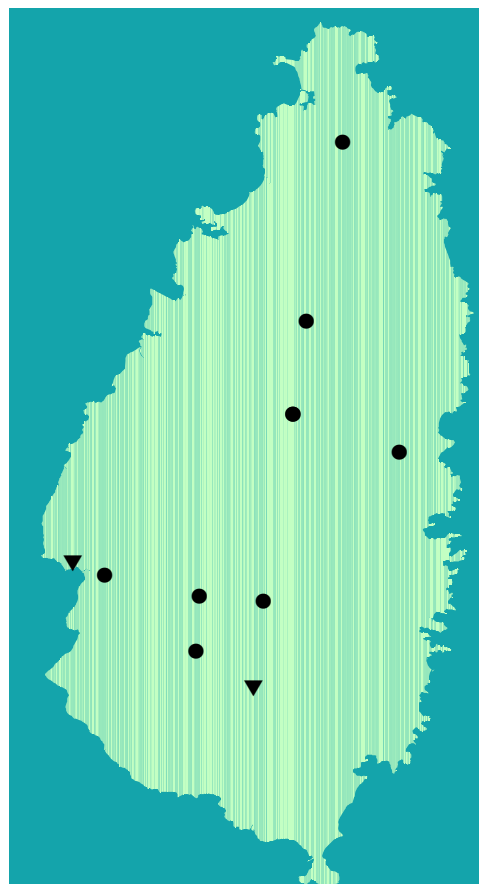


Figure 19: Antillean fruit bat (top); Detail of nose leaf and mouth (bottom). © M. Morton/ Durrell.

Map 16: Confirmed records of Antillean fruit bat on Saint Lucia; inverted triangles show the location of two large roosts.

Justification

The justification in selecting the Antillean fruit bat as a critical species for Saint Lucia is primarily because it typically roosts in caves, a rare resource on islands of volcanic origin in the Eastern Caribbean. These cave roosts often contain a large proportion of an island's population of this species, which is therefore very vulnerable at these focal sites. Typically also, these cave roosts are used by additional species of bats, though that has yet to be confirmed on Saint Lucia.

The Antillean fruit bat is also a regional (Antillean) endemic, and it provides the key ecological services of seed dispersal and pollination. The species has been evaluated by IUCN as being of Least Concern because "its abundance within its restricted distribution, its presumed large population, occurrence in a number of protected areas, tolerance to some degree of habitat modification, and because its habitat is unlikely to be declining fast enough to qualify for listing in a more threatened category." (Rodriguez & Dávalos, 2008). Earlier work for museum collections (e.g. for the description of the subspecies: Jones & Phillips, 1976, cited in Clarke, 2009) does not provide a sufficient baseline against which to assess any declines in abundance or extent (i.e. criteria needed to trigger red list categories). Recent surveys of bats on Saint Lucia by G. Kwiecinski, S. Pedersen, H. Genoways and colleagues over the period 2007-09 (in prep.) netted this species at scattered locations and in lower numbers than for more common bat species on Saint Lucia. The exception to this was the two large cave roosts at Grace and Soufrière. Clarke (2009) did not net any individuals of this species. With rumoured plans to dam the Vieux Fort River at the location of the Grace roost in mind, a red list classification of Near Threatened (i.e. "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") is suggested for the Antillean fruit bat.

Identification

A large, muscular bat, about 7-12cm head plus body, with a forearm (a standard measure of bat size) of about 65mm and weighing 35-50g. Wingspan about 45cm (Pedersen & Morton, 2008). Antillean fruit bats have a fairly short snout ending in a stumpy nose-leaf in the form of a circular pad of flesh around the nostrils, making the face look slightly pig-like (Fig. 19). The eyes are relatively small compared with other kinds of leaf-nosed bat. The fur is long, thick, and ranges from tan-white to brown. The fur is white towards the base, often making this bat appear whitish or grey. The wings are fairly broad and the tail membrane is a relatively thin along thin inner surfaces of the back legs. In the hand, the pad-like nose-leaf (Fig. 19) distinguishes the Antillean fruit bat from any other bat on Saint Lucia. In roosts, this species can often be identified without capture because it forms large clusters that are notable for being quarrelsome and noisy during the day. This is unlike other bat species on Saint Lucia that tend to roost quietly by day, although may become more vocal in the evening and by night.

Habitat

Antillean fruit bats are found in all forest types in the Eastern Caribbean and is found on some very xeric islands such as Barbuda as well as islands such as Saint Lucia with rainforest (Pedersen *et al.*, 1996, 2003, 2005, 2006, 2007). Kwiecinski *et al.* (in prep) caught them in small numbers on Saint Lucia in deciduous seasonal forest, semi-evergreen seasonal forest, and lower montane rainforest. They may 'commute' to foraging sites from roosts many kilometres away; Pedersen *et al.* (2006) recorded one flying more than 60km over two consecutive nights of foraging.

Antillean fruit bats have been reported roosting in a number of different types of structures: caves and their man-made cave-equivalents: deep tarrish pits and large wells; also disused buildings and dense tree tops (Swanepoel & Genoways, 1983). They sometimes roost in fairly well lit situations: the roost in a large rock fissure in the cliffs at Soufrière bay is an example (pers. obs.). But it most commonly found in deep, dark caves, and typically in large numbers, often along with other bat species (Pedersen *et al.*, 2003, 2005, 2006, 2007; Gannon *et al.*, 2005). Pedersen *et al.* (2007) state that on many Eastern Caribbean islands it appears to be an obligate cave dweller, in keeping with its Latin name. Two large roost sites of this species are known on Saint Lucia: the rock fissure at Soufrière bay and a large cave on the walls of the Vieux Fort River ravine near Grace. Unlike many other species, these bats have an aggressive attitude towards members of their own species, thereby making their roosts very active and very noisy throughout the day. These bats seem to be late in leaving their roosts for the night, often waiting until well after sunset. Their populations are quite vulnerable to roost disturbance due to the colony-forming nature of this species (Pedersen & Morton, 2008).

On other islands in the Eastern Caribbean, the importance of large Antillean fruit bat cave roosts is often increased by the presence of additional bat species roosting at the same site (e.g. Pedersen *et al.*, 2006, 2007). It has not yet been confirmed whether other bat species roost at the Soufrière bay and Grace cave roost sites.

Distribution

Antillean fruit bats are endemic to the Antilles, where they are known from Puerto Rico and the Virgin Islands and all the islands of the Eastern Caribbean except Grenada (Swanepoel & Genoways, 1983; Pedersen *et al.*, 2003). The subspecies *B. c. cavernarum* is found from Saint Croix south to Saint Vincent, including Saint Lucia ((Swanepoel & Genoways, 1983). On Saint Lucia, most records are currently from the lower montane rainforest (Map 16), but the sample size of netting locations is small and netting at other times of year may reveal a wider range. Two large roosts are known: at Soufrière bay and a large cave on the walls of the Vieux Fort River ravine near Grace.

Population status

Capture numbers at feeding sites are fairly low for this species: it was one of the least commonly caught of all Saint Lucia's bat species in short surveys in 2007-2009, accounting for only 2% of all captures (Kwiecinski *et al.*, in prep); and Clarke (2009) did not net any individuals. This is in contrast to the more xeric island of Barbuda, for example, where this species made up 60% of all captures (Pedersen *et al.*, 2007). The populations at the two known roost sites on Saint Lucia are, however, large: Clarke (2009) offers an estimate of ca. 5,000 for the Soufrière bay roost and the numbers at the Grace cave probably exceeded 1,000 in 2007 (pers. obs.). It should be borne in mind though, that on other islands, roosting Antillean fruit bats relocate en masse between roosts (Pedersen *et al.*, 1996, 2003) leaving one essentially empty at any one time. Synchronous roost counts at both sites on Saint Lucia would be needed to confirm whether they both held components of the population at the same time. There is no data on population trends in the Antillean fruit bat on Saint Lucia.

Diet

Antillean fruit bats are omnivorous, eating pollen, nectar, fruit, and insects. A range of wild and cultivated fruits (though not citrus) are eaten; the pulp is chewed until dry then spat out (in captivity, insects are dealt with in the same way). Species that Antillean fruit bats have been recorded eating the fruits or flowers of include: *Terminalia catappa* zamann (almond), *Thespesia populnea* maho bòn

lanmè, *Hymenaea courbaril* koubawi, *Ceiba pentandra* fwonmajé, *Roystonea oleracea* royal palm, *Manilkara zapota* chapoti, *Mangifera indica* mango and *Carica papaya*, papay (papaya); Swanepoel & Genoways (1983). This list comes from a study site near the coast on Saint Croix. In Saint Lucia, food trees are likely to include many lower montane rain forest species as well. Unusually for a bat, this species is also known to take pwa angòl (pigeon peas *Cajanus cajan*) on Montserrat (Pedersen *et al.*, 1996).

Like the Jamaican fruit bat *Artibeus jamaicensis*, several hundred Antillean fruit bats will mob fruit trees *en masse*, and have been seen to chase away Jamaican Fruit bats that try to feed close to them. They prefer to feed around the tops of trees, which may be why they are less well represented than other species in mist netting records. But will move lower down a tree as the food runs out and will also take fallen fruits from the ground. They can be noisy feeders, "squabbling" with other bats at trees where they are feeding and dropping blossoms or fruits onto the ground as they eat. Their droppings vary in size and their appearance depends on what they have been eating: they may be dark brown-black, fluid and sticky after a fruit meal, or coarse and crumbly with glistening specks of insect exoskeleton after eating insects. Larger pieces of exoskeleton (like beetle wing covers) may also be found with droppings (Pedersen & Morton, 2008).

Reproduction

In the Eastern Caribbean, the Antillean fruit bat appears to breed once a year, mating in the dry season (February-March), with pregnancies recorded during April-May resulting in births during the dry season (May-July). On some islands it appears breeding may be synchronized at roosts (e.g. Antigua, Pedersen *et al.*, 2006), but on others there appears to be less synchrony and possibly more than one peak in births (e.g. Saint Martin / Sint Maarten, Genoways *et al.*, 2007). As with most other bats, Antillean fruit bats give birth to a single pup at a time.

Uses

The guano of bats is collected and used as a much-valued fertilizer by some small farmers on Saint Lucia (R. Pedley, unpubl. data). The Antillean fruit bat cave roost at Grace is known to be one site that guano is collected from. Bats appear in some Amerindian art, including possibly on Saint Lucia (E. Branford, pers. comm.). Given its abundance and diet, this species is likely to make a significant contribution to the key forest ecosystem roles of pollination and seed dispersal, as well as to controlling insect numbers.

Threats

This species is believed tolerant of some degree of habitat degradation (Rodriguez & Dávalos, 2008) and its varied omnivorous diet probably means it is more resilient to short term habitat destruction (e.g. from hurricanes) as it can switch to other food sources (Pedersen & Morton, 2008).

It is, however, very vulnerable at roosts because of its habit of congregating in very large numbers at single sites (e.g. Pedersen *et al.*, 2003). These congregations may account for a large proportion, or even all, of an island's Antillean fruit bat population (e.g. Pedersen *et al.*, 1996, 2003). Filling-in of caves, dumping of trash and lighting fires in them are all threats to bats using this type of roost. Construction of a dam on the Vieux Fort River near Grace would destroy one of the two known Antillean fruit bat roosts on Saint Lucia.

Management Recommendations

The recommendations for this species focus primarily on roost protection. These recommendations could – and it is recommended are – extended to sites in which large congregations of bats of any species roost on Saint Lucia. This is especially critical for sites that are large, deep caves, as these are likely to be rare.

- Maintain a GIS database of large caves on Saint Lucia, including ones not known to be currently in use by bats. (Some roost sites may not be used by bats all year round; or may act as replacements if other roosts are lost). To populate this database, incorporate the recording of cave site locations, and reports of cave sites, into any survey work or other forest activities carried out by SLFD.
- Survey known cave sites for the presence of bats (of any species). Establish baseline population estimates for each species in any large congregations (> 100 bats) found at roost sites, plus baseline measures of threats to roost sites.
- Assess the impact of guano collection at the Grace cave roost.
- Protect this (and all other bat species on Saint Lucia) with legislation.
- Protect with legislation the roosts of this (and all other bat species on Saint Lucia except *Molossus molossus* when in houses) against destruction or excessive disturbance.
- Raise awareness in the public in general, and pest control agents in particular, of the value of bats and that the majority of bat species on Saint Lucia do not conflict with people (e.g. by roosting in occupied human dwellings or damaging crops).
- The Antillean fruit bat may in fact be one species that does cause damage to fruit crops. In cases of conflict, assess the damage caused and suggest mitigation (e.g. harvest fruit before ripe and allow it to ripen off the tree).
- Raise awareness of the importance of, and threats to, cave habitats on Saint Lucia.

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Annex I: Invertebrate species – preliminary recommendations

The following preliminary information is provided by M. Ivie (in Daltry 2009b). A more comprehensive report by Prof. Ivie is in preparation and will supersede the information below when it is available. For now, the following table provides a few brief examples of some of Saint Lucia's endemic insect species and some of their management needs; (*) indicates species known or expected to be inside Forest Reserves.

Scientific name	Common names	Justification	Comments	Management Needs
(*) <i>Ateuchus luciae</i> and <i>Pseudocanthus iuanalaoi</i>	Dung beetles	National Endemic species	Important in disposing of faeces. Possibly under threat from invasive African dung beetle <i>Onthophagus gazellae</i> .	
(*) <i>Chloronia antillicnsis</i>	Dobsonfly	Only Antillean species of its Order. Known only from Dominica and Saint Lucia.	Larvae inhabit high elevation streams and are sensitive to water quality.	
(*) <i>Dynastes hercules reidi</i>	Saint Lucia hercules beetle, siyé bwa	Local endemic subspecies (shared with Martinique). Economic potential.	Saint Lucia population needs reevaluation (may be upgraded to a full species). Owing to its large size, collectors are interested in buying live or preserved specimens. Could be sold to tourists. Conservation status unknown – none were found during 2009 entomological survey, but adults reported to emerge in December. Larvae feed on rotten wood and take a year or more to develop. Reported to be associated with pwa dou tree	Allow rotten stumps and trees (standing or fallen) to remain. Potential livelihood opportunity (selling beetles to tourists and overseas collectors), if managed sustainably. Evaluate taxonomic status of the Saint Lucia population
<i>Megastylulus pivai</i> and <i>Stylulus isabelae</i>	Ground beetles	National endemic at generic (<i>Megastylulus pivai</i>) or species (<i>S. isabelae</i>) level	Eyeless soil dwellers known only from Ravine Chabot, not recovered in 2009	Biology unknown
(*) <i>Paraclymntemnestra lineata</i>	Longhorn beetle	National endemic at generic level	Large and very rare species Wet Forests Wood borer	
<i>Phyllophaga lackwelderi</i>	May beetle, white grub	National Endemic species	Soil dwelling larvae feed on roots Abundant on eastern coast in deciduous seasonal forest Adults fly to lights. Biomass may exceed that of any native vertebrate species	Larvae may be a pest in sugar cane and even banana, requires study Adults probably important to insectivores during emergences