Critical Situation Analysis (CSA) of Invasive Alien Species (IAS) Status and Management, Saint Lucia, 2010

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Mitigating the Threats of Invasive Alien Species in the Insular Caribbean

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Executive Summary

This Critical Situation Analysis (CSA) provides an overview of occurrence, trends in distribution of most problematic Invasive Alien Species (IAS), in Saint Lucia, including an assessment of pathways and on-going management approaches. It assesses gaps in existing institutional, legislative and policy frameworks, building on earlier studies, and should be read together with several cited reports prepared in parallel as inputs into the National Invasive Species Strategy (NISS). Early sections describe Saint Lucia's environmental profile, including protected areas, marine reserves, and other sites of high conservation value. Both biodiversity baselines assessments and IAS inventories are discussed regarding their merits and limitations. Generally terrestrial ecosystems are better understood than aquatic ones, where baseline studies are scarce, poorly documented where they exist, and the origin of species is often unknown.

As early as 1998, Saint Lucia published a biodiversity baseline study that formally recognized 13 agricultural and livestock pests as IAS. The first review of regional scope that followed in 2003, only rated four of 37 exotics in Saint Lucia as invasive. In the current CSA, total of 124 IAS present in Saint Lucia are collated and presented with a status assessment: 104 in terrestrial, six in marine and 16 in freshwater ecosystems, with two species occurring on more than one ecosystem Twelve species belong to the "100 of the World's Worst Invasive Alien Species" list. Twenty-one invasive species (IS) present in Saint Lucia are flagged as potential risk to other countries where they may still be absent, nine of which belong to the "100 World's Worst IAS". However, there is no evidence of species originating from Saint Lucia have become invasive elsewhere and most of the species listed are of pantropical distribution already. A total of 40 IAS absent from Saint Lucia are flagged as priority for prevention and/or monitoring: 17 terrestrial, 18 marine and five freshwater IAS; three belong to the "100 World's Worst IAS".

Projects since the 1990s have been concerned primarily with human and animal health as well as agricultural pests. Management focussed on disrupting pathways and relevant reviews on these efforts are cited. The need for a strategic approach and an IAS policy was expressed as early as 2006. By that time, IAS were rated as top threat to invertebrates, mammals, reptiles and birds, and as second most important threat (following habitat loss) for plants. The initial phase of the current GEF-funded project

commenced in 2006. It concentrated on IAS threats to native biodiversity in terrestrial and aquatic ecosystems for the first time and also stressed the need for a broad stakeholder base as well as regional collaboration. The Full Size Project (FSP) has five common components in five pilot countries; the Bahamas, the Dominican Republic, Jamaica, Saint Lucia and Trinidad & Tobago:

1. **Development of National Invasive Species Strategies (NISS).**
2. **Caribbean-wide Cooperation and Regional IAS Strategy (RISS)**
3. **Information and Knowledge Generation, Management, and Dissemination**
4. **Prevention of IAS in Terrestrial, Freshwater and Marine Systems. A pilot project in Saint Lucia addresses the protection of the unique biodiversity of Maria Islands Nature Reserve and the surrounding Point Sables Environmental Protected Area (PSEPA).**
5. **Early Detection, Rapid Response and Control of IAS Impacts in Terrestrial, Freshwater and Marine Systems. In Saint Lucia the pilot project aims to eradicate an alien species of iguana that was introduced into the Soufriere area and thereby threatens the uniqueness of the native iguana.**

IAS managers need to acknowledge evolution as a dynamic process. When deciding whether or not to manage a species, its invasive behaviour, not its origin (alien, native or uncertain) should be the main criterion. The focus is on populations of IS, with priority being given to devastating pathogens, particularly vulnerable (e.g. disturbed) sites and habitats of high conservation value (e.g. because of endemism). The study recognizes that the distinction between natural range expansion of a species – often at the expense of other species – and invasive behaviour mediated directly or indirectly by human action, is a delicate decision that requires good judgement and is best taken by a committee of expert, i.e. an IAS working group. Nevertheless, this CSA concentrates mainly on species that are both invasive and alien and that affect native biodiversity.

The CSA reviews the relevance of existing and drafted legislation and policy as well as the institutional framework responsible and/or available for IAS management. While no Saint Lucian law is dedicated specifically to IAS, of the 40 enacted laws revised, 14 were somewhat relevant to prevention, 36 to IAS control; five and two were rated highly relevant, respectively: the Animals (National and International Movement and Disease Prevention) Act, the Control of Importation of Live Fish Act, the Importation of Bees Act, the Plant Protection Act, the Quarantine Act, and the Waste Management Act. Major gaps were identified concerning the pet and aquarium trade, as well as the disposal of animal faeces from boats. Of the laws being drafted, the CITES Management Act may be best suited to fill the former gap. Further discussion will have to determine whether to develop an Invasive Species Act or whether IAS legislation should be incorporated into existing legislation.

The need for a NISS to harmonize presently fragmented IAS management efforts is beyond doubt. The National Influenza Plan of the Ministry of Health sticks out as the

most modern and comprehensive relevant policy. The associated Influenza Response Plan could serve as model for similar IAS Action Plans. The Ministry of Agriculture, Lands, Forestry and Fisheries (MALFF) is the primary entity responsible for a coordinated and holistic approach to IAS management, in collaboration with a range of other Ministries, governmental and non-governmental agencies, including regional and global organizations, as well as civil society. Saint Lucia is a member of 18 of the 21 relevant organisations and their subsidiaries, the most pertinent being the Caribbean Environmental Programme of (CEP/UNEP), the Caribbean Invasive Species Working Group (CISWG), Caribbean Plant Protection Commission (CPPC), the Inter-American Institute for Cooperation in Agriculture (IICA), the International Maritime Organization (IMO), the Organisation of Eastern Caribbean States (OECS), World Health Organization (WHO) and the World Trade Organization (WTO). Saint Lucia is not a member of the highly relevant Centre for Agricultural Bioscience International (CABI) or World Organization for Animal Health (OIE).

Saint Lucia is party to 16 of 21 relevant Multilateral Environmental Agreements (MEAs) and both related Protocols reviewed here. Nine were rated highly relevant: the Convention on Biological Diversity, the Cartagena Convention, the Protocol Concerning Specially Protected Areas and Wildlife (SPAW), the Ramsar Convention, the International Health Regulations, the International Plant Protection Convention, the Agreement on the Application of Sanitary and Phytosanitary Measures, the Convention on the Control of Harmful Anti-fouling Systems on Ships, and the International Convention for the Control and Management of Ships' Ballast Water and Sediments. Saint Lucia is a member of these highly MEAs, except the latter two. This distribution is typical for the Caribbean region. However, Saint Lucia has recently made concrete plans to join the Ballast Water Convention, which has yet to come into force.

Novel IAS management tools and approaches discussed in this CSA are the establishment of metapopulations of critical species on off-shore islands that are freed/kept free of IAS and adaptive measures to climate change. The background to and rationale of Saint Lucia's two pilot project in the GEF project are described. Risk and economic impact assessments, other than for pathogens and agricultural pests, are in their infancy. Most public awareness, education and capacity-building also have their roots in safeguarding agricultural production. Related studies offering concrete recommendations are highlighted. Baseline biodiversity evaluations suggest a total use benefit of EC$132 million. Cost recovery mechanisms include taxes, levies, and user fees , which can provide a powerful mechanism for protecting biodiversity.

Context, Scope and Objectives

Invasive Alien Species (IAS) are organisms whose introduction and/or spread impacts human health and well being, disrupts trade and threatens biological diversity (Caribbean Invasive Alien Species Network (CIASNET, 2010). IAS are recognised as one of the leading threats to biodiversity and also impose enormous costs on agriculture, forestry, fisheries, and other

enterprises, on human and animal health as well as ecosystem services. Rapidly accelerating trade, tourism, transport, and travel – the infamous "four Ts" - over the past century have dramatically enhanced the spread of IAS, allowing them to surmount natural geographic barriers.

If a species' new habitat is similar enough to its native range, it may survive and reproduce. However, it must first subsist at low densities, when it may be difficult to find mates to reproduce. For a species to become invasive, it must successfully out-compete native organisms, spread through its new environment, increase in population density and harm ecosystems in its introduced range. Ecosystems that have been invaded by an alien species may not have the natural predators and competitors present in its native environment that would normally control population levels. To summarize, for an alien species to become invasive, it must arrive, survive and thrive.

Not all non-indigenous species are harmful. In fact the majority of species used in agriculture, forestry and fisheries are alien species. Thus, the initial step in a national IAS management programme must be to distinguish the harmful from the harmless alien species and identify the impacts of the former on native biodiversity. This decision is not always straightforward and conflicts of interest may arise – and therefore need to be considered in management plans. For the purpose of this treatise, only species introduced into Saint Lucia after colonization by Europeans (after *ca* 1500), will be regarded "alien".

Native ecosystems that have undergone human-induced disturbance are often more prone to alien invasions because there is less competition from native species. For example, imported red fire ants (*Solenopsis invicta*) are more successful in establishing themselves in disturbed areas such as roadsides and agricultural fields and rarely colonize intact closed forests. Therefore, not all invasive species are aliens. Habitat disturbance can give the competitive edge to an indigenous organism that subsequently becomes invasive. Saint Lucian examples are the shiny cowbird, which is a nest parasite similar to a cuckoo, and the soapbush (*Clidemia hirta*, Kaka mèl), which tends to cover cleared areas close to the forest to the extent that it inhibits forest regrowth (Graveson, undated). Internationally *C. hirta* is on the "100 of the World's Worst Invasive Alien Species"[1] list prepared by the World Conservation Union (IUCN) (Global Invasive Species Database (GISD), 2010).

A species introduction is usually vectored by human activity, such as the "four Ts". However, it is not always clear to which extent human action is involved and to which extent natural range expansion occurs. For example, iguanas may drift onto another island on a fallen local forest tree after a hurricane, thereby naturally expanding their range. The arriving iguanas may negatively impact the previously present ones, as has happened in Anguilla. The availability of many broken up wooden houses after the hurricane - maybe combined with faster river flow due to watershed modifications - may significantly increase their number and thus represent indirect human involvement. Thus, deciding whether or not the new arrivals should be managed to

[1] The "100 of the World's Worst Invasive Alien Species" was prepared to raise awareness of IAS, using 100 species as case studies. The list has often been misinterpreted to represent a ranking. Nevertheless, these species are considered of major importance because of their impact.

protect the original inhabitant or whether this is interference in a natural range expansion (and thus evolution) is a delicate matter that requires balanced decisions based on good judgement, especially in cases where solid scientific or economic data may be scarce – which, unfortunately, is frequently the case for IAS in the Caribbean. (Natural) evolution is dynamic and involves also the replacement (and sometimes extinction) of species.

By the same token, there may be situations where we wish to manage an only marginally invasive species, whether alien or not, if it threatens a particular sensitive site of high conservation value. For example cultivated and now naturalized Commelinaceae are replacing native herb species on the Gros Piton, as unique habitat for some endemic plant species. The same Commelinaceae species in secondary dry forest are of no concern.

A particularly critical case is the emergence of a new strain of a pathogen, be it through natural evolution or at least partly human-mediated. If, for example, a new strain of influenza virus emerges (habitually originating from animal influenza viruses) among human populations, mortality rates can be much higher than usual (generally from severe respiratory disease); spread can be nearly universal, sometimes within a matter of months, and disrupt all sectors of the society. Such a situation is called a "pandemic." Major influenza pandemics have occurred three times during the last century: the 1918 Spanish flu, 1957 Asian flu and 1968 Hong Kong flu, respectively. The 1918 pandemic was especially dramatic, causing at least 20 million deaths worldwide (GOSL, 2009b). Clearly, in the face of such tragedy and devastation, urgent interventions are required and any delay due to debates on the origin of the pathogen would be tactless.

IAS occur in all taxonomic groups, including animals, plants, fungi and microorganisms, and can affect all types of ecosystems. Common characteristics of IAS include rapid reproduction and growth, high dispersal ability, phenotypic plasticity (ability to adapt physiologically to new conditions), and ability to survive on various food types and in a wide range of environmental conditions. A good predictor of invasiveness is whether a species has successfully or unsuccessfully invaded elsewhere. Saint Lucia, to date, has been relatively unaffected by numerous plants that proved invasive elsewhere.

Nevertheless, IAS pose a particular risk to Small Island Developing States (SIDS) by threatening the ecosystems, livelihoods, economies and public health of inhabitants. Islands are especially vulnerable to IAS because of the lack of natural competitors and predators that control populations in the aliens' native ecosystems. The geographic isolation of islands limits immigration of new species, with two main consequences. Firstly, islands often have ecological niches that have not been filled because of the distance from colonizing populations; secondly, the isolation allowed established species to evolve with few strong competitors and predators. IAS introduced by human activity thus have a dramatic effect on such isolated ecosystems and are a leading cause of species extinctions. Many islands, such as Saint Lucia, have a high proportion of endemic and specialized flora and fauna with relatively low breeding populations.

This document is a Critical Situation Analysis, intended to:

Provide an overview of occurrence, distribution and trends in distribution of most problematic IAS, in Saint Lucia, including an assessment of pathways and vectors for IAS.

Review efforts to prevent, eradicate, control/mitigate IAS in the country to date. If known, highlight what worked and what did not work. If possible include cost estimates.

Re-assess gaps in existing institutional, legislative and policy frameworks, including Multilateral Environmental Agreement (MEA) obligations and their fulfilment, to prevent IAS introduction to (and where appropriate, dissemination from) the country as baseline for strategic review under the Full Size Project (FSP) in line with Global Invasive Species Programme (GISP), Convention in Biological Diversity (CBD) and Food and Agriculture Organization (FAO) guidance, *inter alia*.

Be read together with the stand-alone IAS awareness baseline study (Krauss, 2010a), which has the objectives to identify knowledge gaps and inform the public education campaigns on the most promising and cost-effective approach to chose.

Build on efforts during the previous phase of the Global Environment Facility (GEF) project, the Project Preparation Grant (PPG), most notably the report presented by Jn. Pierre (2008) and Polar & Krauss (2008 a & b).

This Critical Situation Analysis CSA concentrates on species that are both invasive and alien. The impact of native species that turn invasive, e.g. as a result of habitat modification, is, however, acknowledged. Conversely, non-invasive aliens were not the centre of attention, except where potential invasiveness was viewed as a risk. Living Modified Organisms (LMOs) may be a sub-set of IAS, but are not discussed in their own right here. Future amendments may want to include one or more of these (for more detail on these, see Shine *et al.*, 2000).

The main emphasis will be on managing species that negatively impact native biodiversity, but this does not categorically disqualify introduced biodiversity from being conserved, such as the blue mahoe-dominated forests that are crucial to maintain a forested habitat and protect watersheds, livelihoods and health. Again prudent and balanced judgement is required to set management priorities.

Historic Overview

IAS have been formally recognized as a threat to Saint Lucian biodiversity since at least 1998 (Government of Saint Lucia (GOSL, 1998). This substantial report, which is a team effort of several consultants, makes reference to a number of earlier events that alerted officials to introductions, but without a unifying terminology. Thirteen IAS are listed; these are all agricultural and livestock pests. The report features an impressive list of organisms present in Saint Lucia that also covers many microbes, including biocontrol agent deliberately introduced into Saint Lucia.

Past and ongoing IAS projects in Saint Lucia have been concerned primarily with three sectors:

- Agricultural pests, such as the Giant African Snail (GAS) (*Achatina fulica)*, the Pink Hibiscus Mealy Bug (PHMB) (*Maconellicoccus hirsutus*), the coconut mite (*Aceria guerreronis)*, and the red palm mite (RPM) (*Raoiella indica*)
- Human health, e.g. control of schistosomiasis
- Animal health, again with a livestock focus, e.g. the prevention of foot and mouth disease, the eradication of the Tropical Bont Tick (*Amblyomma variegatum*), and the varroa mite (*Varroa destructor*) that affects honey bees.

A first major step towards the formal recognition of IAS as a threat to livelihoods as well as the environment in the Caribbean was taken by Kairo *et al.* (2003). Their ground-preparing treatise coincided with the founding of the Caribbean Invasive Species Working Group (CISWG) at the annual meeting of the Caribbean Food Crop Society (CFCS) in Guadeloupe in 2003. To date, CISWG remains focused on trade with agricultural commodities as guided by the Caribbean Community (CARICOM) via a chairperson provided by a subsidiary, the Caribbean Agricultural Research and Development Institute (CARDI). Its commitment to the management of environmental IAS, as stated in its Caribbean Regional Invasive Species Intervention Strategy (CRISIS) has largely remained a lip service without funding or action. Saint Lucia is a CISWG member (Appendix 3).

Kairo *et al.* (2003) described 37 exotic species for Saint Lucia, four of which – all agricultural pests - were rated invasive. This report has now to be regarded as largely outdated. The authors admit that detection and recognition of marine invasives, in particular, are in their infancy and list 18 species for the Wider Caribbean Region (WCR). A regional follow-up study encountered a minimum of 118 marine IAS (Lopez & Krauss, 2006). Thus, the current CSA can only be interpreted as a snapshot in time and does not claim completeness.

By 2006, the Saint Lucian Government was well aware of the threat posed by IAS. While the focus was on agricultural pests, which were deemed most amenable to pathway management, the Third National Report to CBD explicitly stated the need for an IAS strategy and policy (GOSL, 2006a). It also recommended continued alertness for the appearance of any invasive species in freshwater, forest and mountain habitats. Vertebrate predators (mongoose, feral dogs and cats) are considered IAS that reduce the population of the native iguana and other fauna on drylands. Main management bottlenecks are also flagged: insufficient personnel, financial and material to address IAS effectively. It is noteworthy that this report already mentioned community involvement as instrumental in IAS monitoring and management. In the Fourth National Report, increasing IAS incidences are highlighted as a main threat to forests and terrestrial wildlife, with feral pigs and escapees from the pet trade singled out as becoming problematic (GOSL, 2009a). Agricultural, coastal and marine ecosystems are also threatened by IAS. Overall, IAS were rated as top threat to invertebrates (followed by habitat loss), they tied with habitat loss as main threat to mammals, reptiles and birds, and came second (following habitat loss) for plants.

Because IAS pose a major threat to the vulnerable marine, freshwater and terrestrial biodiversity of Caribbean islands and to people depending on this biodiversity for their

livelihoods, Caribbean states have recognized the need for a regional strategy and expressed strong interest in linking up their national efforts in implementing Article 8 (h) of the CBD to mitigate the threats of IAS in the Caribbean. The Centre for Agricultural Bioscience International (CABI), in collaboration with a wide range of national, regional and international partners and stakeholders, has led the development of the project entitled "*Mitigating the Threats of Invasive Alien Species in the Insular Caribbean*" for funding by the GEF through the United Nations Environmental Program (UNEP).

In July 2006, the first funding cycle, Project Development Facility-A (PDF-A), was granted by GEF, supported by national co-financing in six countries: the Bahamas, Cuba, the Dominican Republic, Jamaica, Saint Lucia and Trinidad & Tobago. During the PDF-A, the pilot countries began to define their current state of capacity regarding IAS. The PDF-A phase was completed with an international workshop in January 2007. A final report was prepared (Lopez *et al.*, 2007). Cuba withdrew its engagement after completing PDF-A.

The PPG phase was implemented in the remaining five countries between April 2008 and January 2009. Activities carried out during the PPG phase were designed to provide essential information and data for the preparation of the FSP proposal. Regional outcomes were summarized by Krauss *et al.* (2008) and Krauss (2009). Saint Lucia's achievements during this phase are listed in Table 1.

At the end of the PPG phase, the proposal for the FSP proposal was submitted to the GEF in January and approved in July 2009. The FSP has five components:

- Development of National Invasive Species Strategies (NISS): At the end of the four-year project, each country is expected to have a NISS (policy document) and a permanent IAS working group to address IAS issues officially and in a sustainable manner.
- Caribbean-wide Cooperation and Regional IAS Strategy (RISS): At the end of the project a regional IAS strategy for marine, terrestrial and aquatic IAS will complement the national efforts described under Component 1. The regional strategy aims to expand the draft CRISIS document, which is currently primarily focused on agricultural pests and diseases, to cover also environmental IAS.
- Information and Knowledge Generation, Management, and Dissemination: The threat posed by IAS is a cross-cutting issue. A multi-sectoral approach to knowledge management and dissemination is key to successful uptake of the project outputs. Public awareness campaigns will be implemented for each of the pilot projects, including the exchange of lessons learnt among the participating countries. The project will establish and strengthen several electronic networking initiatives that would be sustained after the project concludes.
- Prevention of IAS in Terrestrial, Freshwater and Marine Systems: Prevention is the most cost effective measure for managing IAS and is a key component of the CBD Guiding Principles. A pilot project in Saint Lucia will address the protection of the unique biodiversity of Maria Islands Nature Reserve and the surrounding Savannes Bay Environmental Management Area. This terrestrial and marine reserve contains the most threatened, endangered and endemic reptile species of all of Saint Lucia's protected areas, the Saint

Lucian racer (*Liophis ornatus*) and Saint Lucia whiptail lizard (*Cnemidophorus vanzoi*). The pilot project will build capacity among local field staff in biodiversity monitoring and inventory techniques; raise awareness among both local community stakeholders and the general public (including tourists) of the dangers posed by IAS. It will establish a monitoring and rapid response plan in case IAS are detected in the reserve or the neighbouring air- and sea-ports.

Table 1: Saint Lucia's achievements during the Project Preparation Grant (PPG) of the GEF-funded project "Mitigating the Threat of Invasive Alien Species in the Insular Caribbean"

Activities in Saint Lucia during PPG	Output Achieved during PPG
Desk study on existing inventories for terrestrial, marine and aquatic organisms, with respect to (1) preserving native species and (2) invasive alien species threatening native biodiversity Review MEA obligations and their fulfilment so far to prioritise next steps on strategic level	Country is aware of the IAS data and information available in their country and formulated research needs based on this data available Country identified gaps, inconsistencies and conflicts in their national policies and legislation of relevance to IAS
Draft training plan for implementation under FSP Draft communications plan for dissemination of project up-dates and lessons learnt	Key stakeholders regarding IAS are identified and aware of their potential roles Target groups for public awareness activities in FSP identified; draft communication plan circulated for feedback Tentative training needs identified and capacity-building strategy drafted for fine-tuning and subsequent implementation under FSP
Finalize selection criteria, if appropriate in consultation with additional stakeholders Select pilot projects based on all the information and criteria (international workshop and PPG)	A confirmed list of species and/or sites for pilot projects agreed by key national stakeholders Preliminary list of measures for prevention, early detection, rapid response and eradication compiled and budgeted for each pilot project Equipment and personnel needs assessed and budgeted

- Early Detection, Rapid Response and Control of IAS Impacts in Terrestrial, Freshwater and Marine Systems: Pilot projects under Component 5 addresses options for the management of IAS that are already present, at four levels: early detection and rapid response; eradication of incipient invasions or contained (island) populations; management of established IAS invasions for which eradication is not feasible; and protection measures for sites of high conservation value. The restoration of ecosystems during and after removing an IAS is of major importance in preventing new invasions. In Saint Lucia the Component 5 pilot project aims to eradicate an alien species of iguana that was introduced into the Soufriere area. The alien iguana threatens the uniqueness of the Saint Lucia iguana with

which it might hybridize and/or compete for food and habitat once their two ranges meet. It is therefore imperative to act quickly, while the two populations are geographically separated. This will be achieved through capture and euthanasia of the alien iguana as well as a public awareness campaign.

Saint Lucia's Environmental Profile

For a comprehensive, but now somewhat dated, review, the reader is referred to the Caribbean Conservation Association *et al.* (1991). Saint Lucia is located at a North latitude of 13º55' and a West longitude of 60º59', between the islands of Martinique to the North and Saint Vincent to the South (Anthony *et al*., 2007). It has a size of 661 km^2 (Anthony *et al*. 2007). The main island is approximately 620 km^2, most of which are terrestrial systems and only 1.6% water. The coastline has a length of 158 km. The landmass is surrounded by 15,617 km^2 of national Exclusive Economic Zone (EEZ), of which 522 km^2 are coastal shelf areas. The biodiversity sub-index of 4.62 is relatively high; its Environmental Vulnerability Index (EVI) of 393 classifies Saint Lucia as "extremely vulnerable"
(http://www.vulnerabilityindex.net/EVI_Country_Profiles.htm; GOSL, 2001).

The terrain is volcanic and mountainous with some broad, fertile valleys. The topography of Saint Lucia is characterized by a north-south axial ridge. The Island's tallest mountain, Mount Gimie, is 3117 feet high. The spectacular two Pitons (Gros Piton 2619ft and Petit Piton 2461ft in the south west of the island) are an UNESCO World Heritage Site. Accentuated hills of the main island are incised with steep valleys and many streams (Anthony *et al.*, 2007).

The climate is tropical, moderated by trade winds from the north-east. The dry season lasts from December/January to April/May, the rainy season from May/June to August/November. Annual rainfall depends largely on topography and ranges from ca 1500 mm to over 6000 mm. The temperatures range from 22ºC to 32ºC, with an annual mean of 27ºC.

Principal natural resources are forests, sandy beaches, marine resources, minerals (pumice), mineral springs, and geothermal potential. Eight percent of the land area are considered arable. Of these, 20% are under permanent crops, 5% under meadows and pastures, 13% forests and woodlands, and 54% with other uses. The forested lands in the interior comprise mainly of natural forest with a few exotic species in small plantations. Agriculture is practiced both in lowlands and on steep slopes with banana cultivation as the major cash crop. Main environmental threats are (Anthony *et al.*, 2007; GOSL, 2001):

- Climate change
- Hurricanes
- Volcanic activity
- Deforestation and other habitat loss, particularly of wetlands, for banana cultivation, hotel development and housing. However earlier, Heileman (2007) reported no significant change in mangrove area from 1980 to 1990.

- Soil erosion
- Pollution (solid and liquid waste) and
- Invasive species, such as non-native predators (especially the small Indian mongoose, rats, feral pigs, and GAS) and introduced competitors (sheep, goats, cattle).

Water flows into the Caribbean Sea from the Atlantic Ocean mostly through the Grenada, Saint Vincent, and Saint Lucia Passages. It then continues westward as the Caribbean Current, the main surface circulation in the Caribbean Sea. Significant amounts of water are transported northwestwards by the Caribbean Current through the Caribbean Sea and into the Gulf of Mexico. The circulation in the Caribbean Sea experiences much variation in both space and time. The Caribbean Sea is also influenced by freshwater discharge from both the Orinoco and Amazon Rivers of South America. In addition to freshwater, the Orinoco River also contributes significant quantities of sediments and suspended organic matter. The influence of river runoff is strongly seasonal, with the strongest flow occurring during the wet season (June to November) (Heileman, 2007).

All of Saint Lucia's coral reefs are at high (39%) or very high (61%) risk from overfishing, sedimentation pollution from inland sources and coastal development. A high risk also emanated from shipping and marine-based sources of pollution (Burke & Maidens, 2004). Poorly understood coral diseases have spread across the region, devastating some of the main reef-building corals (staghorn and elkhorn) due to white band disease and white plague. The latter has been reported from Saint Lucia, as has black band disease (Global Coral Disease Database, 2006). The reasons for this sudden emergence of reef diseases throughout the Caribbean are not well understood. Aspergillosis is a fungal disease that attacks some species of gorgonians (sea fans). This pathogen seems related to desertification in Africa, blown with dust across the Atlantic (Garrison *et al.*, 2003), while the pathogen responsible for the die-off of the long-spined sea urchin (*Diadema antillarum*) may have been transported into the region via the Panama Canal in ballast water from ships. More research and integrated environmental monitoring are needed to better understand and help predict this major, widespread threat to coral reefs (Burke & Maidens, 2004)

Protected Areas and Other Areas of High Conservation Value

There are 20 protected areas, covering 14.7% of surface area, including two Ramsar sites: Mankoté mangrove (60ha) and Savannes Bay (20ha) – the Component 4 pilot site. However, there are no IUCN category I or II sites. A total of 357 animals are on the IUCN Red List, 38 of which are threatened. Furthermore, six of eight plants on the IUCN Red List are threatened.

The Mankoté Wetland is Crown Land, but falls under the jurisdiction of the Department of Fisheries for active management, due to the fact that Mankoté is a declared Marine Reserve under the Fisheries Act (No. 10 of 1986). The Aupicon Charcoal and Agricultural Producers Group (ACAPG) formed as an informal cooperative of about 15 individuals who harvest mangrove wood to produce charcoal. Historically, since the early 1980s, the Caribbean Natural Resource Institute (CANARI), then known as Eastern Caribbean Natural Area Management Programme (ECNAMP), pioneered organizing the harvesters into the informal cooperative.

Subsequently, this activity has been carried out in consultation with the Forestry Department, which is responsible for forest and wildlife management on government lands. Mankoté is adjacent to Vieux Fort, the country's second town, which hosts the major international airport, major docking facilities for both container boats and small cruise ships, a number of hotels, and an industrial complex.

As for some other protected areas, institutional responsibilities are not clear-cut for Mankoté or the adjacent Savannes Bay (see also p. 47) Both reserves have also been vested into the care of the Saint Lucia National Trust (SLNT), the country's lead organization in the conservation of natural and cultural heritage and the National Development Corporation (NDC), the agency responsible for Government's lands slated for eventual development and legal owner of Mankoté. Saint Lucia is party to several relevant MEAs, most notably Ramsar, and several laws under the jurisdiction of different Ministries are applicable (see also p. 33 and p. 40):

- Forest, Soil and Water Conservation Ordinance of 1946, amended in 1956 and 1983.
- Wildlife Protection Act of 1980 and proposed amendments, which are presently in the Attorney general's office
- Crown Lands Ordinance of 1946 establishes the position of Commissioner of Crown Lands and sets the conditions for the management of Crown Lands
- Land Conservation and Improvement Act of 1992 provides the legal framework for the establishment of a Land Conservation Board and gives it a broad mandate with respect to the management of land and water resources.

Figure 1: Important bird areas of Saint Lucia

Anthony and Dornelly (2008) describe the five important bird areas of Saint Lucia, which total 155 km^2 or 25% of the island's land area (Figure 1). Most (70%) of these habitats are formally protected. Of the 162 bird species recorded in Saint Lucia, 97 breed there. Twenty-three have a restricted range and six are threatened (Table 2).

Key breeding sites for waterbirds on Saint Lucia include Grande Anse Ponds, Esperance mangrove, Bois D'orange swamp, Auberge Seraphine swamp, Praslin mangrove, Fregate Islands, Maria Islands and Point Sables. Those sites are used by migratory species such as ducks, herons, waders, and other fowl. Some of the water birds that breed on the island include Masked Duck, Common Gallinule, Little Blue Heron, Green Heron, and Yellow-crowned Night Heron.

There are 24 marine reserves comprising turtle nesting beaches, coral reef areas, artificial reefs, and mangrove habitats. Of these, 19 were declared in 1986 and a further six in 1990. A revised list of 24 marine reserves (including the reserves from the two previous listings) was declared in 2000.

Over the years, enforcement of laws governing marine reserves has proven to be a difficult task due to the remoteness of some of these areas, low enforcement capacity, the fact that some of these areas are privately owned and boundaries for many reserves have never been declared. Marine reserves within the Fond D'Or Mangrove and the Mankoté Mangrove are being managed to some degree, and marine reserves within the Soufriere Marine Management (SMM) Area and the Canaries/Anse la Raye Marine Management Area have the most comprehensive management system in place on the island (GOSL, 2001).

Table 2: Internationally important bird areas on Saint Lucia with associated biodiversity and key IAS threats (for more details see Anthony et al. (2007) and Anthony & Dornelly, 2008).

Important Bird Area (IBA)	Habitat	Size (ha)	Threatened birds	Other biodiversity, incl. IAS threat
LC001 North East Coast Terrestrial: unprotected Six marine reserves	Shrubland, dry forest 1-156 m.a.s.l.	4,313	White-breasted Thrasher (*Ramphocinclus brachyurus*) St Lucia Black Finch (*Melanospiza richardsoni*) Rufous Nightjar (*Caprimulgus rufus otiosus*)	15 Restricted-range birds The endemic St Lucia boa constrictor (*Constrictor orophias*) St Lucia viper (*Bothrops caribbaeus*) St Lucian green iguana (*Iguana iguana*) The Grand Anse beach is important nesting ground for three globally threatened turtle species. The St Lucia muskrat (*Megalomys luciae*), thought to be extinct, could still be present in this area. **IAS threats**: small Indian mongoose, rats (brown and black, semi-feral dog and cats.
LC002 Government Forest Reserve Forest Reserve	Tropical moist forest with introduced, exotic vegetation 0-950 m.a.s.l.	7,974	St Lucia Amazon (*Amazona versicolor*) St Lucia Black Finch (*Melanospiza richardsoni*) Forest Thrush (*Cichlherminia lherminieri*) Semper's Warbler (*Leucopeza semperi*)	22 restricted range bird C. orophias and B. caribbaeus St Lucia anole (*Anolis luceae*) St Lucia pygmy gecko (*Sphaerodactylus microlepis*) At least nine endemic plants **IAS threats**: feral pigs, introduced parrots (escaped pets), several cultivated plants
LC003 Pitons Management Area UNESCO World Heritage Site	Forest with some shrubland 0-777 m.a.s.l.	1,617	*M. richardsoni* St Lucia Oriole (*Icterus laudabilis*)	14 restricted-range birds *C. orophias, B. caribbaeus*, and *A. luceae* Many endemic plants **IAS threats**: mongoose, rats, several exotic plants

Important Bird Area (IBA)	Habitat	Size (ha)	Threatened birds	Other biodiversity, incl. IAS threat
LC004 Mandele Dry Forest Terrestrial unprotected, except for some Crown Land status Marine Reserves (1986)	Shrubland, dry forest, mangrove 0-200 m.a.s.l.	826	*R. brachyurus* *M. richardsoni* *A. versicolor*	15 restricted-range birds St Lucia whiptail (*Cnemidophorus vanzoi*) C. orophias, B. caribbaeus **IAS threats**: small Indian mongoose and rats (brown and black)
LC005 Pointe Sable National Park Maria Islands Nature Reserve and four marine reserves	Dry tropical forest, scrubland, mangrove, wetland, sea 0-223 m.a.s.l	774	*M. richardsoni*	Over 20,000 Sooty Terns (*Sterna fuscata*) breed, as do 250–500 Bridled Terns (*S. anaethetus).* Roseate Tern (*S. dougallii*), Royal Tern (*S. maxima*) and Red-billed Tropicbird (*Phaethon aethereus*) breed in regionally important numbers. Important herpetofauna: five endemics, two of which are globally threatened. The endangered St Lucia racer (*Liophis ornatus*) and Vulnerable *C. vanzoi* are endemic to the Maria Islands **IAS threats:** Maria Major is rat- and mongoose-free. Maintaining this status must be a priority.

The SMM Area remains the portion of coast between Anse l'Ivrogne in the south and Anse Mamin in the north, from the shore to a depth of seventy-five meters. The SMM Area is a marine management area comprising of 11km of coastline with a contour depth of 75 metres and adjacent marine area, to include marine reserves, fishing priority areas, multiple use areas, recreational areas and yacht moorings. In fact the SMM Area has four main marine reserves all of which contain a rich coral resource and they include: Anse Chastanet, Rachette Point, Petit Piton and Gros Piton.

The SMM Area is a marine protected area, officially declared in 1995. It was declared a Local Fisheries Management Area in 2001 under the Fisheries Act No. 10 of 1984. It comprises several zones, including Marine Reserves (no take areas), Fishing Priority Areas, Yacht Mooring Areas, Recreational Areas and Multiple Use Areas. Four marine reserves are found in the SMM Area. It overlaps with the Pitons Management Area, which has been declared as an Environmental Protection Area under the Physical Development Plan Act of 2001. In addition, it was declared a World Heritage Site in 2004, including its terrestrial and marine components.

Maria Islands is another designated Reserve with a marine component. It is an important nesting site for sea turtles and white sea-urchins. Seagrasses comprise several families of underwater marine flowering plants. Seagrass is usually found in close physical proximity to mangroves and coral reefs and grows in dense beds. These provide home, food and shelter for a variety of marine animal taxa and are particularly important as grazing grounds for turtles and nursery habitats for coral reef fishes, because they help the fish to avoid predators and contain an abundant food supply. As the tidal range in the Caribbean is very small, the seagrass beds are never exposed to the open air, but remain covered by water. Moreover, seagrass beds provide habitat for transient fish that migrate between mangrove and coral reefs and thus contribute invaluable ecosystem services to fisheries and hence the livelihood of those in the fishing industry.

The surrounding areas, Savannes Bay and Mankoté Mangroves, were declared Ramsar sites in 2002. Together with the Maria Islands, they form part of a wider Pointe Sable Environmental Protection Area (PSEPA), so declared in 2007, under the Physical Development Plan Act of 2001. This initiative is part of an Organisation of Eastern Caribbean States (OECS) Protected Areas and Associated Livelihoods (OPAAL) Project. The Saint Lucia component of the OPAAL Project is spearheaded by the Saint Lucia National Trust (SLNT).

Biodiversity Baseline Assessments

International databases, such as the Global Biodiversity Information Facility (GBIF), are assumed to be known to the informed reader and shall not be reviewed here. The GOSL (1998) report series constitutes an impressive biodiversity baseline assessment across all taxa, including a large number of invertebrates and microorganisms, which are considered beyond the taxonomic scope of most comparable studies in the region. Threatened species are flagged in an ecosystem context. The social section covers land tenure and practices regarding harvesting of wild resources, and could thus also be relevant to IAS management, as may be the chapter on tourism, which lists most visited sites on land and in the sea. It was intended to form the basis of Saint Lucia's National Biodiversity Strategy and Acton Plan (NBSAP) (GOSL, 2000), which outlines some high-level recommendations, but does not even once mention IAS explicitly, because these were not a priority concern for the country. Much of Saint Lucia's subsequent biodiversity-related reports are available on
http://www.slubiodiv.org/biodiversity_papers.php and
http://www.bananatrustslu.com/index.php?link=doccentre&project=sfa2003
and none of these shall be reviewed here in detail. A recent species and distribution surveys of the bats of St. Lucia is also available (Kwiecinski *et al.*, 2009). Table 3 provides a summary of indigenous and exotic species that have established themselves in the wild.

The Biodiversity Unit of MALFF is developing a web-based database of Saint Lucia's biodiversity (Figure 2a). It was developed to provide an easily accessible source of information for persons interested in Saint Lucia's Biodiversity. However, to date, data entry is incomplete, limiting its usefulness. In contrast, Roger Graveson's plant database is gradually developing into a one-stop shop for both flowering and non-flowering plants (Figure 2b). It is possible to search by "wild flowering plants", "wild non-flowering vascular plants". In addition to scientific

names, common names are given in English and Kwéyòl. A section on endemic species distinguishes between “Saint Lucia”, “Lesser Antilles excluding Saint Lucia” and “Caribbean islands, excluding the Lesser Antilles”. The numbers of endemic species listed in 2010 were 11, 95, and 84, respectively. A key to plant families is also offered. Risk of invasiveness is now being included (Graveson, undated). The Herbarium in the Forestry Department at Union is in the process of being digitalized. However, specimen storage conditions are sub-optimal.

Table 3: Number of native and alien species recorded in Saint Lucia according to Daltry (2009a), Dornelly (pers. comm., 2010) and Morton (2009a).

Taxonomic group	**Indigenous**		**Exotic**
	Total	**Of which are endemic**	Total
Mammals	10	1 (extict)	7
Birds	132	6	2
Reptiles	13	7	6
Amphibian	2	1	3
Beetles	> 777	Ca. 144	> 39
Other insects	> 1000		> 160
Higher plants	945	9	289
Ferns and mosses	137		

On-line Biodiversity Database

Example of a potentially invasive plant on http://www.saintlucianplants.com/

Figure 2: Examples of national databases in Saint Lucia

Terrestrial Ecosystems

This section should be read in conjunction with the report by Andrew & John (2010), which was prepared simultaneously, during the last two month of the preparation of this CSA, as a specific input towards the preparation of the NISS. Their report had the goal to assess the capacity of Saint Lucia to manage invasive alien species in terrestrial ecosystems. This was achieved by identifying legislative, informational and institutional gaps, inadequacies and conflicts that serve as barriers to effective control of IAS in Saint Lucia along four intervention approaches.

The Forestry Department of MALFF is the main government department responsible for the management of forests, soil, water and wildlife of Saint Lucia. The Wildlife Protection Act (revised version of 2001) provides a list of protected species, which is in the process of being up-dated in the 2008 Amendment.

Graveson (2009) classified Saint Lucia's vegetation types as follows:

- Littoral Evergreen Forest and Shrubland
- Mangrove
- Freshwater Swamp Forest
- Deciduous Seasonal Forest
- Semi-natural Forest
- Tree Plantations
- Elfin Shrublands
- Herbaceous Swamp (seasonal or permanent)
- Semi-evergreen Seasonal Forest
- Lower Montane Rainforest
- Montane Rainforest
- Cloud Montane Rainforest
- Littoral Unconsolidated Sand Vegetation
- Littoral Scrub, including Cacti
- Fumarole Vegetation
- Aquatic Herbaceous Vegetation
- Grassland, with or without a few trees or shrubs
- Littoral Rock and Cliff Vegetation

Aquatic Ecosystems

COASTAL AND MARINE ECOSYSTEMS

Coastal and marine ecosystems were assessed by Scott (1998) as part of the larger national biodiversity assessment (GOSL, 1998). She described beaches, mangals, coral reefs, and seagrass beds. A number of threats to marine and coastal biodiversity are discussed, but none relates directly to IAS. It is possibly the most comprehensive documented overview of marine mammals and several taxa of limited commercial interest, e.g. sponges, in Saint Lucian waters. Knowledge gaps are flagged as far as marine algae and coral reef distribution are concerned. The Fisheries Department of MALFF has done most of the inventory up-dates, e.g. reef-checks, and has established the Fish Management Plan (GOSL, 2001), which lists main commercial species categorized by:

- Shallow-shelf and reef fishes
- Deep-slope fishes
- Large pelagic
- Coastal pelagic
- Lobster
- Conch
- Sea urchins
- Sea moss
- Flyingfish
- Turtles
- Freshwater shrimps

Unfortunately, throughout the preparation of this report, the library at the Fisheries Department was undergoing remodelling, rendering the actual library non-functional. This would have been

one location where some key historic baseline surveys should have been kept, e.g. the ODA-funded Environment Research Programme Project R5936 entitled "*The Development and Integration of Biotic and Chemical Monitoring with Land Use Assessment*". It was completed by Felix, Maharaj and Lloyd around 1995 and included a freshwater component under the subtitle "*River Surveillance in the Caribbean"*, or the subsequent article: Thorpe T & Lloyd B (1999). The macroinvertabrate fauna of St Lucia elucidated by canonical correspondence analysis. *Hydrobiologia* 400, 195-203.

The most comprehensive fish list for Saint Lucia can be found on-line (http://www.fishbase.org/home.htm), while the 25 most common coral fishes are listed on http://www.eoearth.org/article/Common_coral_reef_fishes_of_St._Lucia. No sea-grasses are mentioned for Saint Lucia in the Flora of the Lesser Antilles, but Scott (1998) mentioned turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*) and shoal grass (*Halodule wrightii*). Graveson (undated) also lists the indigenous *Najas guadalupensis,* and the naturalized *Ruppia maritime*. The native *Halophila decipiens* has also been found (Roger Graveson and Demian Willette, pers. comm., 2010).

FRESHWATER AND BRACKISH ECOSYSTEMS

Good groundwork was done by Felix (1998) covering freshwater as well as brackish habitats again as part of the above-cited national biodiversity assessment (GOSL, 1998). Saint Lucia has 37 rivers in addition to temporary and permanent streams, marshes, swamps, underground springs, flood plains, and inland mangroves. In addition to these natural ecosystems, man-made freshwater habitats include the John Compton Dam, the Rodney Bay Sewerage Treatment Ponds and several ponds for irrigation and aquaculture. On the other hand, increasing populations have led to unsustainable extraction of water for household use as well as for construction and land reclamation. Inappropriate hillside agriculture and unplanned development cause erosion. This creates high sediment loads in rivers and downstream aquatic systems (estuaries, river mouths). Agro-chemicals also contaminate freshwater resources. The biological quality of freshwater resources is affected by effluent disposal by sewage treatment plants and domestic septic tanks.

Microbes may lead to disease outbreaks in aquatic plants and animals and/or may infect secondary and tertiary users of the ecosystems. The agency responsible for the protection of the water resources on the island and ensuring adequate supplies for use by residents is the Water and Sewerage Company (WASCO) and the Ministry of Health, Human Services, Family Affairs and Gender Relations is responsible for monitoring the quality of water in the rivers, especially those being used by WASCO as intakes. Additionally, water quality is being monitored by the Caribbean Environmental Health Institute (www.cehi.org.lc) for coliforms and parasites. Dysentery, gastroenteritis, typhoid fever, but no cholera, as well as dengue fever and schistosomiasis have been reported on past occasions (Felix, 1998).

The main freshwater taxa in Saint Lucia are birds (resident as well as migratory), fish, shrimp, insects and molluscs. Felix (1998) listed 13 species of freshwater shrimp, which are found in every type of wetland system that has a link with the sea, so that these pollution-sensitive

animals can re-colonize promptly. In contrast, insects and snails are found island-wide but their distribution patterns are reported to be linked with pollution levels. While macroinvertebrates are listed, often to species level, in her report, less is known about the fresh and brackish water fish and their lifecycles. As a result, indigenous fish are underutilized, unduly encouraging the importation and cultivation of exotic fish, such as tilapia.

As mentioned above, reports on a substantial ODA-funded study could no longer be sourced. Bass up-dated Felix's groundwork and compared Saint Lucia's marcoinvertebrate fauna with that of other Caribbean islands, but did not include a list in his paper (Bass, 2003). Notwithstanding, he kept raw data and contact could be made. Thus, a collated list is appended here as Appendix 2.

In contrast to biodiversity assessment, remarkably solid baseline information is available on physical factors. A Riverbank Assessment Consultancy [44] for Saint Lucia, conducted in 2008 with EU funding, gives an overview of the river systems, followed by detailed profiling of watersheds, including assessments of the rivers and riverbanks (GOSL, 2008a). It also touched on forest trees and traditional medicinal plants.

IAS Inventories

The first question a donor agency will ask when a country requests funds to managing IAS is whether or not there is an IAS inventory. However, there are several principal challenges to the establishment and meaningful use of IAS inventories:

- Frequently it cannot be determined with certainty whether a species is indigenous or naturalized. This is particularly true for marine organisms, many of which are of pan-tropical distribution, and those aliens that got established a long time ago.
- In order to be classified as an IAS, the organism has to impact human health and well being, disrupt trade and/or threaten biological diversity (p. 4). However, historically the recognition of damage was largely limited to agricultural pests and pathogens. With agriculture heavily dependent on alien crop and animal species impact estimates exhibit much bias.
- Reasonably comprehensive IAS inventories require tremendous taxonomic inputs across all life forms. These skills are expensive and/or not available with the required swiftness to meet the demand of early detection and rapid response.
- As a result, even the best available IAS inventories tend to be notoriously out of date.
- Because of the economic implications (trade, travel/tourism, animal and human health) the presence of certain IAS can have on a country, there tends to be reluctance to providing public access to accurate up-to-date information in most countries. Saint Lucia's candour has been above average in recent years, which is commendable for the regional public good.

Having spelled out the limitation, Table 4 is an attempt at summarizing confirmed IAS present in Saint Lucia for terrestrial, marine and freshwater ecosystems. A total of 124 IAS are identified;

104 in terrestrial, six in marine and 16 in freshwater ecosystems. One species of tilapia occurs in marine, brackish and freshwater habitats. The tiger mosquito that vectors Dengue fever inhabits terrestrial and freshwater ecosystems as adult and larva, respectively (Table 4). "Trends in IAS distribution" is one of the provisional CBD indicators for assessing progress towards the 2010 Biodiversity Target. "Reduction in invasive species" is an indicator for monitoring stress reduction for integrated watershed and coastal areas management. In 2008, Saint Lucia did not report making use of this tool yet (Heileman & Walling, 2008).

Table 4: Invasive Alien Species present in Saint Lucia and their current status

Common name	Scientific name	Status	Source
Terrestrial: 104, one of which is shared with Freshwater			
Vertebrates: 25			
Orange winged parrot	*Amazona amazonica*	Recent escape from captivity? Potentially competing with endemic parrot	This report
Barbados anole	*Anolis extremus*	Apparently expanding range; Possibly displacing the native *Anolis luciae*	This report
Cuban brown anole	*Anolis sagrei*	First sighted in 2002; established in La Toc; reported invasive on several Caribbean islands	This report
Watts' anole	*Anolis wattsi*	Displacing the native *Anolis luciae*	[16]
Cane toad	*Bufo marinus*	Widespread; severely impacting biodiversity; "100 World's Worst IAS"	[16], [25], [55]
Cattle Egret	*Bubulcus ibis*	Cosmopolitan of Old World origin; implicated in spread of tick-borne diseases; Safety hazard at Hewanorra Airport due to bird strike risk	This report
Feral dogs	*Canis lupus familiaris*	Widespread; severely impacting biodiversity	[10], [82]
Feral goats	*Capra aegagrus hircus*	Invasive on Dennery island; impacts on vegetation and animal habitat	[16]
Rock pigeon	*Columba livia*	Widespread; severely impacting biodiversity; air-strike hazard at SLU airport	[55], this report
Opossum	*Didelphis marsupialis marsupialis*	Widespread; severely impacting biodiversity	[10]
Whistling frog	*Eleutherodactylus martinicensis*	May have displaced native *Eleutherodactylus johnstonei*	[16]
Feral cats	*Felis catus*	Widespread; severely impacting biodiversity; one of "100 World's Worst IAS"	[10], [25]
Antilles Leaf-toed	*Hemidactylus*	Present in Maria Major; competing with	[16]

Common name	Scientific name	Status	Source
Gecko	*palaichthus*	endangered reptiles?	
Indian mongoose	*Herpestes javanicus*	Widespread; severely impacting biodiversity, one of "100 World's Worst IAS"	[10], [25], [31], [55]
Alien iguana	*Iguana iguana*	Localized, expanding in Soufriere area; threat to endemic iguana if two populations meet	[55]
Mouse	*Mus musculus*	Widespread	[16]
Feral sheep	*Ovis aries*	Invasive on Dennery island; impacts on vegetation and animal habitat	[16]
Indian peafowl	*Pavo cristatus*	Held in captivity; noise nuisance has been reported	This report
Brown rat	*Rattus norvegicus*	Widespread; severely impacting biodiversity, but one of "100 World's Worst IAS"	[10], [25]
Black rat	*Rattus rattus*		
Red-snouted tree frog	*Scinax ruber*	Invasive	[16], [55]
Eurasian collared-dove	*Streptopelia decaocto*	Escaped from captivity	This report
Feral pigs	*Sus scrofa*	Widespread and invasive in forest; threatening some rare bird and the endemic fer-de-lance; control efforts would require simultaneous stop to re-supply through continued escapes; one of "100 World's Worst IAS"	[10], [25], [82]
Monkeys	Unknown species	Localized in Desrameaux, Monchy	[55]
Invertebrates:30, one of which is shared with Freshwater			
Coconut mite	*Aceria guerreronis*	Present	[55]
Giant African snail	*Achatina fulica*	Invasive; impacting native molluscs and vegetation through forage	[55]
Tiger mosquito	*Aedes aegypti*	Widespread with on-going severe impact. adults are aerial/terrestrial and vector Dengue fever, larvae are aquatic; control attempts by cultural and chemical means	[31], [89]
Citrus Blackfly	*Aleurocanthus woglumi*	Agricultural pest	[51]
Tropical Bont Tick	*Amblyomma variegatum*	Livestock pest of African origin	[31]
Fruit fly	*Anestrepha obliqua*	Agricultural pest	[31]
Gliricidia moth	*Azeta repugnalis*	Present since 2001	[75]
Sweet potato whitefly	*Bemisia tabaci*	IAS of environmental importance or agricultural pests only?	[51]

Common name	Scientific name	Status	Source
Tick savaan	*Boophilus microplus*	Livestock pest; vector of tick fever complex	[31]
Sweet potato weevil	*Cylas formicarius*	Agricultural pest of Asian origin	[31]
White cedar thrips	*Holopothrips iniquilnus*	Present since 2007	[55], [75]
[terrestrial snail]	*Huttonella bicolour*	Introduced, of peninsular Malaysian origin; impact on Saint Lucia poorly documented	[91], [92]
Florida leatherleaf	*Leidyula floridana*	Introduced slug; impact on Saint Lucia poorly documented	[91], [92]
Pink Hibiscus mealybug	*Macronellicoccus hirsutus*	Invasive, successfully controlled by classical biocontrol	[55]
African dung beetle	*Ontophagus gazellae*	Invasive; threatening endemic dung beetle species	[15]
Papaya mealybug	*Paracoccus marginatus*	Invasive	[55]
Crazy ant	*Paratrechina longicornis*	Commensal of Old World origin	[29]
Citrus leaf miner	*Phyllocnistis citrella stainton*	IAS of environmental importance or citrus pests only?	[51], [75]
Red palm mite	*Raoiella indica*	Invasive	[55]
Chilli thrips	*Scirtothrips dorsalis*	Agricultural pest, present since 2004	[75]
Mango seed weevil	*Sternochetus mangiferae*	IAS of environmental importance or mango pests only?	[51]
[terrestrial snail]	*Streptostele musaecola*	Introduced molluscivore; impact on Saint Lucia poorly documented	[91], [92]
Oleander moth	*Syntomeida epilais*	Present since 1982	[75]
Tramp ant	*Tapinoma melanocephalum*	Commensal of Old World origin	[29]
Melon thrips	*Thrips palmi*	Agricultural pest	[75]
Brown Citrus Aphid	*Toxoptera citricida*	Environmental importance or citrus pests only? Vector of CTV	[31], [51]
Varroa mite	*Varroa destructor*	Present; invasive	[55]
Pancake slug	*Veronicella sloanei*	Native to Jamaica; introduced in Eastern Caribbean; pest status	[91], [92]
Unidentified sandfly	*Leptoconops bequaerti* ?	Recent expansion into in-land areas and intensification of nuisance throughout day. Several sandfly species can vector leishmaniasis	This report
Plants: 44			
Red sandalwood tree; Dalmawi	*Adenanthera pavonina*	Exotic, but not naturalized; Invasive;	[1], [25]

Common name	Scientific name	Status	Source
		Present	[49],
Woman's tongue	*Albizia lebbeck*	Present; reported invasive in Caribbean	[25]
Popgun tree	*Ardisia elliptica*	Common ornamental (of Asian origin - tropical Japan) in Castries area. Reported as invasive in many countries. Favours river floodplains in sun or shade	[49]
Giant cane	*Arundo donax*	Probably extirpated in Saint Lucia; belongs to GISD "100 World's Worst IAS"	[25][49]
Neem	*Azadirachta indica*	Escaped from cultivation, Asian origin; Risk in disturbed and burnt habitats	[49], [64]
Desert date	*Balanites aegyptica*	Present; reported invasive in Caribbean; of African origin Not listed as present	[25]; [49]
Common bamboo	*Bambusa vulgaris*	Very common and invasive	[15]
Pitted beardgrass	*Bothriochlo pertusa*	Native to the Indian subcontinent, southeastern Asia; can cover large areas of xeric areas at low elevation: coastal grasslands and savanna	[49]
Basket plant	*Callisia fragrans*	Recent arrival? Escapes from cultivation, thrives in deciduous seasonal forest; serious potential threat on Pitons	[49]
Ylang-ylang	*Cananga odorata*	Common on Piton Springs –Pacience road; potential threat in lower montane rainforest and riparian systems	[49]
Casuarine	*Casuarina equisetifolia*	Reported invasive on many Caribbean islands, but still localized where planted in Saint Lucia	[16], [25], [49]
Jack in the bush; Fléwi Nwèl	*Chromolaena odorata*	Present; listed as invasive in Caribbean; Listed as indigenous	[25] [49]
Ivy gourd	*Coccinia grandis*	Invasive of African and Asian origin; Covering indigenous vegetation in mesic areas of Babonneau; risk in disturbed and burnt habitats	[49], [64]
Glue; Sip	*Cordia obliqua*	Invasive of Indian origin; Tree of secondary coastal woodlands, savannas and seasonal swamps. Very common in Vieux Fort Beach area; risk in disturbed and burnt habitats	[49], [64]
Spiked spiralflag ginger	*Costus spicatus*	Present; potential threat in lower montane rainforest	[49]
Rubber vine; Lèt makak, Zong makak	*Cryptostegia madagascariensis*	Invasive from Madagascar; Common in Laborie, Micoud and Vieux Fort; Risk in disturbed and burnt habitats; Potential	[49], [64]

Common name	Scientific name	Status	Source
		threat to xeric savanna	
Lemongrass; Sitonnèl	*Cymbopogon citrates*	Naturalized of Old World origin; quite rare, but presenting a fire & IAS hazard in critical areas, e.g. Pigeon Island;	[49]
Golden pothos	*Epipremnum pinnatum*	Vine of S.E. Asia; cultivated ornamental; naturalized and replacing native *Monstera adansonii* in some river valleys	[49]
Lavender; Lavann	*Hedychium coronarium*	Invasive of Asian origin; Common; Preference for very wet semi-open spots, especially roadsides and forest rivers; possibly replacing indigenous and very rare orchid *Habenaria monorrhiza*	[49]
Heliconia	*Heliconia wagneriana*	Planted along forest edge from where it could invade disturbed, burnt habitats and lower montane rainforest	[49], [64]
Busy-lizzie	*Impatiens balsamina*	Present; potential threat in lower montane rainforest	[49]
Busy-lizzie	*Impatiens walleriana*	Present; potential threat in lower montane rainforest	[49]
Stalkleaf murainagrass	*Ischaemum timorense*	Naturalized of Asian origin, common in open and semi-open wet areas at lower and middle elevations; Appears to be invasive in Choiseul ravines	[49]
Jatropha Medsinnyè beni	*Jatropha curcas*	Imported for biofuel nursery in Plateau. Several batches were distributed prior to abandonment of project. Plant of tropical American origin has proven invasive elsewhere	This report
Leucaena	*Leucaena leucocephala*	Exotic, but not naturalized in Saint Lucia; Invasive; Planted for charcoal production to protect mangrove	[16], [25] [22]
Swordfern	*Macrothelypteris torresiana*	Naturalized from Africa, Asia and/or Pacific; Probably becoming more common; Terrestrial fern of dark shady roadsides and ravines	[49]
Mazapan	*Malvaviscus penduliflorus*	Present; potential threat in lower montane rainforest	[49]
Paper bark tree	*Melaleuca quinquenervia*	Exotic, but not invasive; Not listed as present: Invasive	[16], [49], [25]
Catclaw mimosa	*Mimosa pigra*	Naturalized; of African origin; Spreading fast; Assumed to be recent arrival; Risk in disturbed and burnt habitats; one of “100	[25], [49], [64]

Common name	Scientific name	Status	Source
		World's Worst IAS"	
Asian sword fern	*Nephrolepis brownii*	Invasive of African and Asia origin; Replacing indigenous *Nephrolepis rivularis;* Risk in disturbed and burnt habitats	[49], [64]
Patchouli	*Pogostemon cablin*	Present; potential threat in lower montane rainforest	[49]
MacArthur palm	*Ptychosperma macarthurii*	Present in disturbed forest: Union, Morne Fortune; potential threat to semi-evergreen seasonal forest	[49]
Royal palm; Palmis	*Roystonea oleracea*	Present where planted; potential threat to semi-evergreen seasonal forest and riparian systems	[49]
Roseleaf bramble; Fonbwèz	*Rubus rosifolius*	Mildly invasive in man-made clearings in Saint Lucia; one of "100 World's Worst IAS"	[49]
Mother-in-law's tongue; Lanng bèlmè	*Sansevieria hyacinthoides*	Present; potential threat to dry woodland on Pitons	[49]
Mother-in-law's tongue; Lanng bèlmè	*Sansevieria trifasciata*	Present; potential threat to dry woodland on Pitons	[49]
Saltmeadow cordgrass	*Spartina patens*	Present; potential threat to sandy beach edge	[49]
African tulip tree	*Spathodea campanulata*	Spreading along Union River and elsewhere; potential threat to semi-evergreen seasonal forest; one of "100 World's Worst IAS"	[25], [49]
Phillippine Orchid	*Spathoglottis plicata*	Invasive of Asian origin; Very common and moving into forest	[49]
Arrowhead vine	*Syngonium podophyllum*	Vine still uncommon, present in Millet and Roseau; risk in disturbed and burnt habitats	[49], [64]
Yellow trumpetbush	*Tecoma stans*	Moule a Chique and Petit Piton; cultivated ornamental that is invasive in several countries; West Indian origin, but unlikely Saint Lucian	[49], this report
Maiden fern	*Thelypteris extensa*	Naturalized from SE. Asia and Indonesia; Quite rare but becoming commoner; Terrestrial on moist, shady roadsides	[49]
Moses-in-the-cradle	*Tradescantia spathacea*	Escaped ornamental, naturalized? Present in dry rocky hills in the north, a real danger for the Pitons	[49]
Wandering jew	*Tradescantia zebrina*	Invasive of African origin; Escaped ornamental; Very common around Gros	[49]

Common name	Scientific name	Status	Source
		Piton trail; very rare elsewhere	
Microbes and Viruses: 5			
Fungal blight	*Cercosporidium sequoiae*	Pathogen affecting tree plantations of *Cupressus lusitanica* since 2005	[75]
Citrus Tristeza	*Citrus Tristeza Clausterovirus*	Citrus pest	[31], [51]
Dengue fever virus	*DENV*	Virus fluctuates seasonally; vectored by *Aedes aegypti*	[31]
Witches' broom of cocoa	*Moniliophthora (=Crinipellis) perniciosa*	Early phase of establishment	[59]
Black Sigatoka	*Mycosphaerella fijiensis*	Early phase of establishment	[14]
Marine: 6, one of which is shared with Freshwater			
Green macroalgae	*Chlorophyta* spp.	Present; invasiveness not assessed	[55]
Sea turtle virus	*Fibropapillomatosis (FP)*	Present	[55]
Mediterranean seasgrass	*Halophila stipulacea*	Invasive in Dominica, Probably recent introduction to Saint Lucia: present in Anse La Raye, Marigot and Labrelotte Bays; threat to native seagrasses	[103]
Mozambique tilapia	*Oreochromis mossambicus*	Invasive in fresh and brackish water; one of "100 World's Worst IAS"	[25]
Brown macroalgae	*Phaeophyta* spp.	Present; invasiveness not assessed	[55]
Red macroalgae	*Rhodophyta* spp.	Present; invasiveness not assessed	[55]
Freshwater: 16, one of which is shared with Terrestrial, one with Marine			
Animals: 8, one of which is shared with Terrestrial, one with Marine			
Tiger mosquito	*Aedes aegypti*	Widespread with on-going severe impact. adults are aerial/terrestrial and vector Dengue fever, larvae are aquatic; control attempts by cultural and chemical means	[31], [89]
Marsh snail	*Biomphalaria glabrata*	Present; host/vector of *Schistosoma mansoni;* eradication failed, impact control by focussed molluscicide treatment following survey	[86], [98]
Giant river prawn	*Macrobrachium rosenbergii*	Probably naturalized; introduced for aquaculture form Taiwan; invasiveness unclear	[21]
Malaysian trumpet snail	*Melanoides tuberculata*	Apparently introduced to control *Biomphalaria glabrata*; also impacting non-target species	[83]
Obscure swamp eel	*Ophisternon*	Naturalized; native to North America;	[21]

Common name	Scientific name	Status	Source
	aenigmaticum	invasiveness unclear	
Mozambique tilapia	*Oreochromis mossambicus*	Invasive in fresh and brackish water; introduced for aquaculture in 1970s	[21], [25]
Nile tilapia	*Oreochromis niloticus*	Probably naturalized with ecological impact; introduced for aquaculture in 1970s	[21]
Schistosoma parasite	*Schistosoma mansoni*	Present; eradication failed, impact control by focussed molluscicide treatment following survey	[86], [98]
Red-eared slider	*Trachemys scripta elegans*	Escaped/released from captivity; May impact native terrapins as well as common prey	This report
Plants: 7			
Calathea	*Calathea lutea*	Large stands at Bexon River; potential threat to riparian habitat	[49]
Spiral ginger	*Costus scaber*	Present, potential threat to riparian habitats	[49]
Umbrella sedge	*Cyperus difformis*	Invasive of Asian origin; Detected in Cul de Sac swamp in March 2010	[49]
Water hyacinth	*Eichhornia crassipes*	Naturalized; one of "100 World's Worst IAS"; popular ornamental clogs drainage canals	[25], [49]
Woodrose	*Merremia tuberose*	Expanding into Union River; huge vines; potential threat to riparian systems	[49]
Golden Flamboyant	*Peltophorum pterocarpum*	Few specimen in swampy spots and mangroves; potential threat to swamp forest	[49]
Java plum	*Syzygium cumini*	Common on Piaye River; potential threat to riparian systems	[49]

IAS in Terrestrial Ecosystems

The native terrestrial mammal fauna of the Lesser Antilles comprised only bats and Sigmodontine rodents (rice or musk rats). The Amerindians brought dogs, agoutis (*Dasyprocta leporina*), and the Southern opossum (*Didelphis marsupialis*) (Daltry, 2009b). Some of the most environmentally damaging IAS today were deliberately introduced into Saint Lucia by European settlers, either directly for agriculture, e.g. pigs (*Sus scrofa*) and goats (*Capra hircus*), or to control undesirable biodiversity in sugarcane plantations and farms storage, e.g. the mongoose, domestic cat (*Felis catus*), and the cane toad (*Bufo marinus*). With the exception of goats, these are ferocious predators of indigenous reptiles, birds and insects. Their shipments were accompanied by mice (*Mus musculus*) and rats (*Rattus rattus*). The endemic Semper's warbler (*Leucopeza semperi*) is believed to have been pushed into extinction by IAS predators. The

globally threatened Saint Lucia pygmy gecko (*Sphaerodactylus microlepis*) is being predated on by IAS into declining and increasingly fragmented populations, with Maria Islands remaining a relative safe haven (Daltry, 2009a).

St Lucia most damaging invasive mammals have been mapped recently using modern GIS technology (Clarke, 2009) and examples from his report are shown in Figure 3:

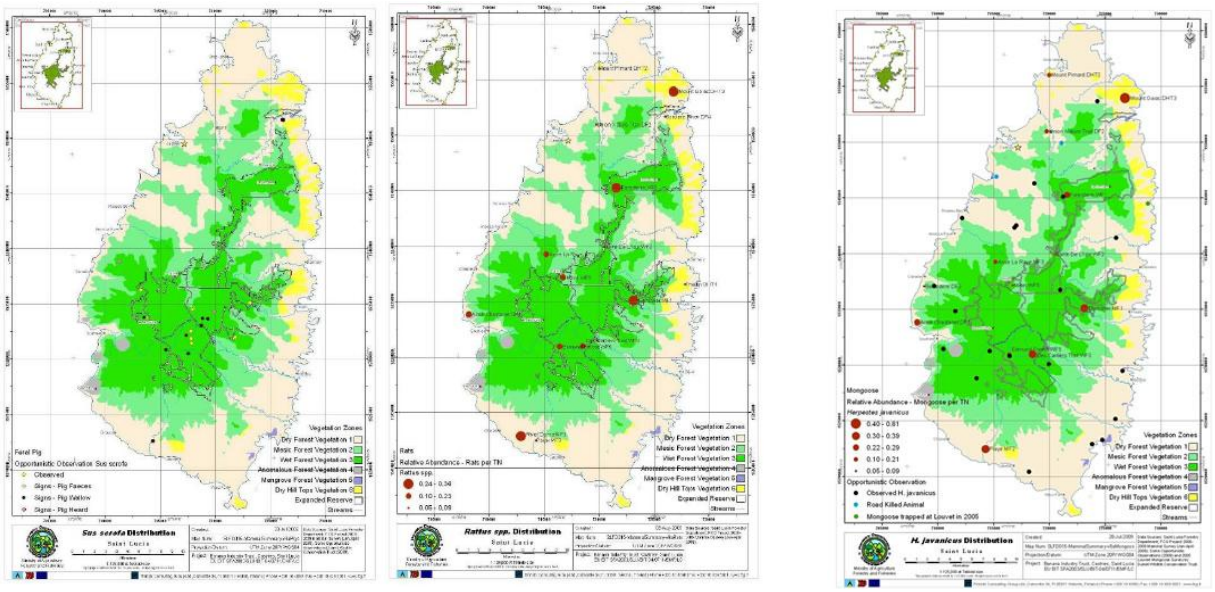


Figure 3: Distribution and abundance of introduced mammals: a) feral pig (*Sus scrofa*), b) rats (*Rattus *spp.) and c) mongooses (*Herpestes javanicus*) among Saint Lucia's native forests (from [13]).

Daltry (2009b) believes IAS (opossum, rats, dogs, cats and feral pigs and, most importantly, the mongoose) to be the greatest threats to Saint Lucia's native forest herpetofauna. Alien invasive reptiles and amphibians also pose a great danger to native species through predation, competition and hybridization, e.g. the introduced green iguanas near Soufriere threatens the uniqueness of the native iguana through competition and hybridization.

Using beetles as biodiversity indicators, Ivie (cited by Daltry, 2009a) found species diversity to decreases with elevation, while the percentage of endemics rose, so that the summits exhibited limited fauna of native, mostly Saint Lucian endemics. At lower elevations, notably in the deciduous seasonal forests, the number of species was very high - Saint Lucian endemics but also more alien species. This indicates that the dry forests are underrated in terms of their biodiversity value, but are also more threatened by IAS than the wetter forests in the Forest Reserves.

Nearly 300 exotic plant species have become established in natural habitats in Saint Lucia (Table 3), although only a fraction has become naturalized. Some of the most invasive plants in Saint Lucia are the common bamboo (*Bambusa vulgaris*), African tulip tree (*Spathdea campanulata*), water hyacinth (*Eichhornia crassipes*) and leucaena (*Leucaena leucocephala*) (Table 4). The majority of alien plants have been observed in degraded forests in lowland

areas: it appears that relatively few have been successful at invading the mature rainforests to date (Daltry, 2009a). No plants are currently classified as invasive in the Millet Range, although the forest has a strong component of exotic species, such as blue mahoe (*Hibiscus elatus*) (Organisation of Eastern Caribbean States, undated). However, open and disturbed habitats are more susceptible. The Lesser Antillean endemic *Paspalum nesiotes* has possibly been pushed into extinction by competing invasive grasses (Graveson, undated).

Pests of agricultural and veterinary interest can be found on the Caribbean Animal & Plant Health Information Network (CARAPHIN) of the Inter-American Institute for Cooperation in Agriculture (IICA) (http://infoagro.net/health/caraphin/). It lists species of regional concern. Their status can be searched by country and is categorized as present, new occurrence, and active surveillance. Unfortunately the site is badly out of date, at least for Saint Lucia; for example the Giant African snail, *Achatina fulica* and the cocoa witches' broom pathogen, *Crinipellis perniciosa* (incidentally both misspelt), are still listed as absent.

Overall, in their assessment of terrestrial ecosystems, Andrew & John (2010) concur with the conclusions of the Fourth National Report (GOSL, 2009a), underscoring IAS as top threat to forest wildlife, particularly to amphibians and invertebrates. IAS tied with habitat loss as main threat to mammals, reptiles and birds, and came second (following habitat loss) for trees and herbaceous plants.

IAS in Aquatic Ecosystems

Far less information is available on IAS in aquatic ecosystems. The freshwater shrimp, *Macrobrachium rosenbergii*, was introduced for pond culture as early as the 1960s and was encouraged in the late 1980s, with the construction of fish and shrimp hatcheries. In 1998, 25 farmers cultivated introduced fish and shrimp on 6.9 hectares. Water used in aquaculture is accessed from upper rivers. Most systems operate as flow through systems, where water enters the pond at one end and flows out at the other end (Felix, 1998). This is a growing industry with 45 farms, comprising a total of 9.7 hectares of land under fish and shrimp cultivation at present (Felix, 2010).

Two species of tilapia have subsequently been introduced in the early 1990s for aquaculture and are cultivated island-wide. Tilapia species have populated all aquatic ecosystems on the island, such as many rivers, the Rodney Bay Sewerage ponds, and the John Compton Dam. The tolerance of tilapia to elevated organic and bacterial levels makes them suitable as biological indicators and WASCO's precursor the Water and Sewage Authority (WASA) has used sudden large-scale mortalities of fish to pin-point where and when oxygen levels have fallen well below recommended standards (Felix, 1998).

Around the same period, the introduction of grass carps for control of aquatic weeds in ponds was being considered by Saint Lucian authorities, as this fish would feed on the weeds and then could be sold as fish food. However, a risk assessment showed that the species had become a serious pest in the United States, where it had escaped from the aquaculture ponds and begun to thrive in southern waterways, consuming all vegetation and thereby wiping out other species that were less competitive. Saint Lucia abandoned plans to import grass carps (Felix 2010).

The importation from within the region and cultivation of seaweed (*Gracilaria* and *Eucheuma* species) since the mid 1980s is not considered an IAS threat, as neither genus thrived in Saint Lucia (Smith ≥1996).

Recently an invasive seagrass, *Halophila stipulacea*, was reported (Willette & Ambrose, 2009) in three out of six Caribbean bays surveyed. It was subsequently detected also in Anse Chastanet (12 May 2010). A photo guide with detailed features of the plant has been obtained from Demian Willettte (Figure 4).

Invasive seagrass *Halophila stipulacea* photographs - Dominica

Dense bed of *H. stipulacea*, depth 5 m, Lamothe Bay, Dominica

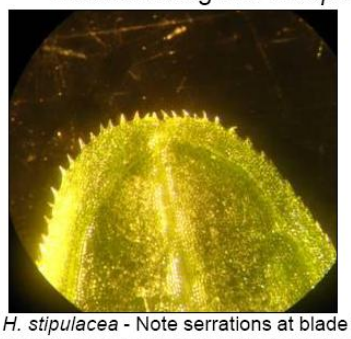
Mixed bed of *H. stipulacea* and *S. filiforme*, depth 7 m Prince Rupert Bay, Dominica

Typical appearance of extending rhizomes at margin of a *H. stipulacea* patch

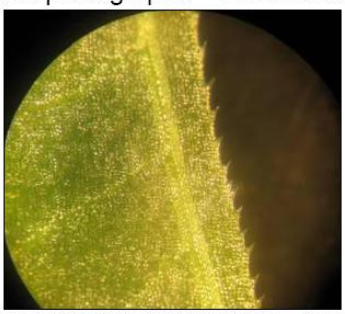
Fragmented section of *H. stipulacea* free-floating above reef

Photos by D. Willettte

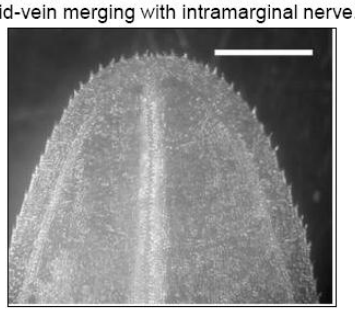
Invasive seagrass *Halophila stipulacea* photographs – Plant features



Apex of *H. stipulacea* - Note serrations at blade tip and mid-vein merging with intramarginal nerve.



Lateral margin of *H. stipulacea* blade – Note serrations and 30-60° cross-veins from mid-rib to nerve.



Apex of *H. stipulacea* – scale bar = 1 mm

Complete shoot and rhizome of *H. stipulacea* with typical blade and sheath numbers

Photos by D. Willettte

Invasive seagrass *Halophila stipulacea* photographs – Marigot Bay, St. Lucia

Marigot Bay, St. Lucia – red arrows indicate "North" & "South" patch of *H. stipulacea* within bay

North patch – foreground shows dark thicket of *H. stipulacea* in ~20 cm of water

South patch – *H. stipulacea* patch in ~20 cm of water just to right of boardwalk

South – patch – close-up of photo to right showing *H. stipulacea* patch

Photos by D. Willettte

Figure 4: The recently detected seagrass, Halophilus stipulaceae, is at early stages of invasion but may compete with the indigenous and less common Halophilus decipiens

Legislation and Policy

National Legislation

None of Saint Lucia's national legislation addresses IAS management explicitly. Several Acts, however, are directly and highly relevant to prevention of IAS entry (Table 5), most foremost, the Animals (National and International Movement and Disease Prevention) Act and its predecessor, the somewhat outdated Control of Importation of Live Fish and the Importation of Bees Acts, the Plant Protection Act with accompanying Instruments, and the Quarantine Act. A noteworthy gap in the law is the fact that the importation of most exotic animals can essentially only be blocked on veterinary grounds. Legislation that addresses the risk of the animal itself becoming invasive is urgently needed. In contrast, the Plant Protection Act recognized the risk posed by exotic plants turning weedy. However, with "weed' not being defined, wording remains weak. In the accompanying Regulation, a long list of plants with import restrictions is provided, almost exclusively on phytosanitary grounds. Only aquatic plants, with the exception of *Nebulium* spp., are restricted due to their invasive nature. Presently, a Biodiversity Bill as well as Biosafety Bill exist in draft form but are not yet enacted. The same applies to the CITES Management Bill, which has been drafted to enable effective implementation of the

Table 5: National legislation relevant to IAS management in Saint Lucia. XXX: highly relevant, XX: relevant, X: somewhat relevant.

National Legislation	Scope in		Comment
	Prevention	Control	
Agriculture Small Tenancy Act (No. 22 of 1983)		X	Enforcement of regulations requiring sound soil and water conservation practices on small land holdings
Air and Seaport Act (1981), Amendment of 1983; Regulations of 1985 Saint Lucia Air and Sea Ports Authority Act No. 10 of 1983	XX		Development and management of the nation's air and seaports
Animal (Disease and Importation) Act (1956); revised to form the Animals (National and International Movement and Disease Prevention) Act, 2004	XXX	XX	The Act (i) regulates the quarantine, treatment and disposal of animals suffering from or suspected to suffering from any disease in country, (ii) controls the importation of animals and (iii) defines offences and penalties for breach of Act. It prohibits the import of birds, reptiles or insects without license and requires quarantine for specified times. It bans the import of monkeys. The Act does not apply to bees.
Beach protection Act (No. 2 of 1967); Amendment No. 9 of 1994		X	Protection of beaches through control of sand mining
Control of Importation of Live	XXX	XXX	The Control of Importation of Live Fish Act

National Legislation	Scope in		Comment
	Prevention	Control	
Fish Act (1952)			prohibits the importation of non-indigenous fish species without a license and makes provisions for penalties and destruction of fish.
Crown Lands Ordinance (1946)		X	Establishment of the Crown Land Committee to review and make recommendations on the allocation/use of Crown Land
Customs (Control and Management) Act No. 23 of 1990	XX		Regulated importation and inspection
Disaster Management Act No. 30 of 2006; replaced Disaster Preparedness and Response Act No. 13 of 2000	X	X	In the absence of specific legislation, probably applicable to Biosafety and GM/LMO
Employers Occupational Health and Safety Act (1985)		X	Provision of inspection of food handling premises
Fisheries Act (No.10 of 1984)		X	Management of the use of fisheries and marine resources, including aquaculture
Forest, Soil and Water Conservation Ordinance (Cap 25 of 1946); Amendments 1957 & 1983 A Draft Forest Act of 2008 is yet to be enacted		X	Management of forests, including visitors and fire management; Establishment of forest reserves and protected forests; Development of soil and water conservation programmes to protect forested areas
Housing and Urban Development Corporation Act (1971)		X	Assistance in Planning and development of housing projects
Importation of Bees Act (1912)	XXX		The Importation of Bees Act regulates the importation of bees, bee products. The Act (i) requires a license to import queen bees and (ii) outlines the procedure for handling the import of queen bees including the destruction of packaging material
Land Conservation and Improvement Act (No.10 of 1992)		X	Provision for better land and drainage conservation
Land Development (Interim Control) (No. 8 of 1971); Amendment of 1990	X	X	Provision of land use planning and development control, including some aspects of use of beaches, parks and protected areas
Litter Act (No. 24 of 1983) (Amendment) Act (No 14, 1993, No. 15, 1985)		XX	Control of litter in public places or private places
Maritime Areas Act No. 6 of		X	Provision for territorial sea continental shelf;

National Legislation	Scope in		Comment
	Prevention	Control	
1984			Establishment of contiguous zone, economic zone and other related purposes; Regulates some aspects of marine pollution; Implementation of various provisions of the United Nations Conservation on the Law of the sea.
Merchant Shipping Act (1981)	X		Introduction of the law of England with regards to Merchant Shipping and matters connected therewith including marine pollution
National Conservation Authority Act (1999)		X	The National Conservation Authority Act provides for the establishment of a National Conservation Authority whose authority is largely restricted to conservation of natural beauty and topographic features, particularly in relation to beaches.
National Development Corporation Act (1971)	X	X	Promotion of economic growth/industrial development, including some aspects of use of beaches, parks and protected areas
Parks and Beaches Commission Act (No. 4 of 1983)		X	Provision for the management of public parks, gardens and beaches Advisory body on coastal erosion
Pesticides Control Act (No. 7 of 1975)	X	X	Establishment of the Pesticide Control Board control of import, use labelling and storage of pesticides
Physical Planning and Development Act No. 29 of 2001		X	Governs Environmental Impact Assessments
Plant Protection Act (No. 21 of 1988) with Statutory Instrument No. 66 of 1995 and Section Instrument (No. 71 of 1995)	XXX	XX	The Plant Protection Act provides for the control of pest and diseases injurious to plants and to prevent the introduction of exotic species. The Act (i) prohibits or restrict the importation of any planting material, fruit vegetable, plant product or soil, or any other non-plant related material which may result in the entry of plant pest (ii) makes provisions for the quarantine of materials (iii) makes provisions for the disinfecting or destruction of plant or associated materials (iv) makes provisions for the issuing of permits for the importation of plant material and (v) provides for the conditions under which such introductions may be deemed a notifiable pest, and outlines measures for control and eradication.
Praedial Larceny Act No. 13 0f 1978		X	

National Legislation	Scope in		Comment
	Prevention	Control	
Public Health Act (No. 8 of 1975)		XX	Regulation of sewage, industrial and solid waste disposal removal of nuisance and unsanitary conditions on premises (rubbish, soil, vermin, etc.
Quarantine Act (1944)	XXX	XXX	The Act aims to minimize the entry and spread of infectious human diseases. The Act allows for regulations to be passed that prevent danger to public health from ships or aircraft or persons or things therein, arriving at or intending to leave from national territory. The Act provides for the establishment of a Quarantine Authority and allows for the destruction of vectors of disease (e.g. mosquitoes, rats).
Rodney Bay Development Act (1970)		X	Authorization of land improvements works at Rodney Bay Limited
Slum Clearance and Housing Ordinance (1946)		X	Deals with housing of persons and acquisition management of slum areas, as well as the re-development and improvement of unhealthy areas, demolition of insanitary areas
Solid Waste Management Authority Act (No. 20 1996). Environmental Levy Order SI (No. 68 of 1996) and Tipping Fee Order SI (No. 69 of 1996)		XX	Establishment of the National Solid Waste Management Authority and penalty system.
Special Development Areas Act No. 2 of 1998		X	
Saint Lucia National Trust Act (No. 16 of 1975)		X	Provision for the preservation of buildings and objects of historical and architectural value and areas of natural or scenic importance
Standards Act No. 14 of 1990	X	X	Defines national standards
Timber Industry Development Act (1984)		XX	Development of timber industry promotions of timber production
Tourist Industry Development Act (1981)	X	X	Promotion and development of tourism industry
Town and Country Planning Ordinance (Cap 175) (1946 and Amendment)		X	Authorization over physical planning and building
Water and Sewerage Authority Act (No. 18 of 1984)		XX	Management of water supply and resources development, and control of sewage systems protection of surface water
Waste Management Act		XXX	Stipulates water management in conformity with

National Legislation	Scope in		Comment
	Prevention	Control	
(2004)			best environmental practices; covers hazardous and bio-medical waste
Wild Birds Protection Act (1885)		X	Prohibits the killing, wounding, capture of any wild birds as identified in the Schedule.
Wildlife Protection Act (No. 9 of 1980) with revision of 2001		X	Provision for conservation of wildlife and recommendations for designation of wildlife reserves enforcement of hunting regulations

CITES Convention in Saint Lucia. With emphasis on monitoring and regulation of importation and exportation of wild flora and fauna, this Bill could fill the above-mentioned gap, as it also restricts the importation of species that are believed to be potentially harmful to local biological diversity. Further, an Environmental Management Bill, a Marine Pollution Bill, a Solid Waste Management Bill and a Returnable Containers Bill are also underway.

Far fewer laws allow the effective management of IAS once they have entered national territory and again largely via legislation mainly focussing on other issues, such as the Disaster Preparedness Response Act, and the Forest, Soil and Water Conservation Ordinance (Table 5). Daltry, 2009b) noted that the Wildlife Protection Act was not designed to, and therefore fails to, address the threat from alien invasive species.

A major gap here surrounds the pet and aquarium trade, which regularly gives rise to potentially invasive escapees. Especially informal breeders are currently largely beyond control measures. However, the revised version of 2001 stipulates that a MALFF licence is needed to keep any wildlife in captivity as well as to import any wildlife into or export from Saint Lucia. In this context, the legal interpretation of “wildlife” is important: all vertebrates and crustaceae, whether resident or migratory, indigenous or alien, found living beyond the control if man. It is questionable, however, if a maximum EC$5,000 fine for offences is sufficient a deterrent for commercial lawbreakers. An amendment dated 2008 foresees the licensing system to become obligatory also to operate a pet trade to sell wildlife (birds, reptiles, mammals or exotic/alien species). This Amendment also proposes to add feral animal to non-protected species; however, it has yet to be enacted. Similarly, the disposal of faeces of pets in yachts is currently not well managed, as excrements enter the normal garbage stream after disposal in marina bins (Mathurin, 2010c).

A principal discussion needs to be held: whether GOSL should develop an Invasive Species Act or whether IAS legislation should be incorporated into existing legislation. There are pros and cons for either decision. While the former would be a compact on-stop shop, implementation and enforcement would invariably remain the responsibility of a range of agencies under different Ministries. Thus, the current problem of fragmentation would possibly not be significantly alleviated. Furthermore, enactment of an entirely new Act could take longer than amendments to existing laws. The development of IAS legislation via either avenue may require some external assistance. Local expertise in drafting environmental legislation exists, but could

not be contracted to contribute to the present gap analysis. IAS-specific legislative training would also be beneficial.

National Policy

As stated above, neither the NBSAP of Saint Lucia, nor the Global Environmental Outlook, mention IAS. However, as a result of preparatory phases of the GEF-funded project on IAS, this topic has by now moved onto the front burner of key stakeholders. A second NBSAP has been drafted (John-Norville, 2008). It foresees controlling the introduction and spread of invasive species that may pose threats to native biological resources. Prevention and emergency response are distinguished, stakeholders defined and targets sets, i.e. development and implementation of management plans for three IAS by 2012. The draft second NBSAP is probably the turning point from which onwards the threat to biodiversity posed by IAS was recognized as priority. Saint Lucia has recognized the need for a specific, stand-alone National Invasive Species Strategy (NISS) and the necessary actions are underway. In the meantime, several policy documents provide some degree of guidance, while others are still in draft form.

The Fisheries Regulations, SI No. 9 of 1994, are to be read in connection with the Fisheries Act. These two instruments relate to fisheries access agreements, local and foreign fishing licensing, fish processing establishments, fisheries research, prohibited fishing gears and methods, marine reserves and fishing priority areas, fisheries enforcement, and specific restrictions for certain utilized resources (conch, lobster, sea urchin, freshwater shrimp, cetaceans, turtles and marine algae). Their relevance to IAS is limited. No regulations yet exist for the Maritime Area Act, 1994, No 6. `

The draft of the Saint Lucia Forest Policy (2008) is directed at conserving the biodiversity of plants and animals life, while minimizing and mitigating the impacts of invasive alien species and climate change on the country's natural resources. Morton (2009c) studied the use of native and invasive wildlife, including hunting. He recommends the establishment of a regulatory framework for the control of feral pigs as well as impact assessment of both the pigs and the control measures. Suggestions are also made to reduce resupply via escapes of domestic pigs. The report recommends an impact assessment of the opossum; in the meantime, their removal from sensitive sites is suggested, despite the species being protected under Schedule 1 of the Wildlife Protection Act.

The primary objective of the draft National Action Programme to Combat Desertification/Land Degradation in Saint Lucia (NAPSAP) is to stem the continued loss of the productivity of land and reverse the declining trend in the availability and quality of the island's water resources, to ensure a sustainable quality of life for the people of Saint Lucia (GOSL, 2008b). If up-dated accordingly, it could provide a vehicle to address IAS and climate change.

The Medical Waste and Other Bio-Hazardous Wastes Management Plan is a proposal to regulate waste streams for bio-hazardous general, industrial and medical wastes, including pesticides, condemned meats, and quarantined foods (GOSL, $\geq$2000). Gaps in current practices and weaknesses in infrastructure are presented together with partly costed solutions.

A prioritized list of hazardous organisms is also presented. To date, this remains largely a strategic wish list.

The National Communicable Disease Surveillance Manual of 2006 revises the national communicable disease surveillance system. It offers guidance for the development or amendment of national communicable disease surveillance guidelines and includes an outline of the rationale and process for the revision of the national communicable disease surveillance system. The declared aim is to provide information for action. The purpose of surveillance is not just to detect communicable diseases, but rather to respond to any communicable diseases with the appropriate disease control measure in a timely manner.

Related to the above are several volumes of National Influenza Plan (NIP) (GOSL, 2009b). The purpose of this modern policy on human and animals influenza viruses is:

- To reduce transmission of the pandemic virus strain, to decrease cases, hospitalizations and deaths, to maintain essential services and to reduce the economic and social impact of a pandemic
- Ensure that victims of a pandemic have access to the necessary available care.
- To define the context for the establishment, maintenance and provision of an emergency response to a pandemic within the national emergency management system and available resources.
- Establish a mechanism for the provision of services.
- Link pandemic management with the national relief and welfare programmes.
- Where possible to respect the cultural and religious needs of victims.

All responses are described in relation to the alert level, which is clearly defined (Figure 5). Exemplary in this policy is the explicit provision for the destruction of all back yard birds, where the influenza virus is confirmed. In that case, an appraisal team is to be deployed to value the birds, products and materials destroyed because of infection or exposure to avian influenza. Compensation will be given to owners, whose birds are caged or who can show proof of ownership for loose birds. This section could serve as model for other response plans.

The policy also includes a ventilator policy, which, in the event of a severe pandemic, regulates the prioritization of access to ventilators.

The policy also recognizes that vaccine development cannot commence until the pandemic virus has been isolated and that no specific pandemic influenza strain vaccine will be available initially. If it becomes available, it will likely be difficult to obtain sufficient doses for the entire population. A priority plan for vaccination is presented.

A travel section of the NIP regulates travel into, out of and within Saint Lucia, depending on the severity of the disease outbreak.

General Alert Levels	World Health Organisation Alert Levels	Saint Lucia Alert Levels
PREPARE Phase One and Two Prepare for influenza now	Phase 1 Low risk of human case Phase 2 Higher risk of human case	GREEN ALERT
PREVENT Phase Three and Four Influenza in Community/Country	Phase 3 No or very limited human-to-human transmission Phase 4 Evidence of increased human-to-human transmission	YELLOW ALERT Evidence of human to human transmission, but spread is highly localized
RESPONSE Phase Five and Six EMS affected by influenza	Phase 5 Evidence of significant human-to-human transmission	ORANGE ALERT Not fully transmitted but human to human is s till localized RED ALERT Large cluster but human to human spread is still localized
	Phase 6 Efficient and sustained human-to-human transmission	BLACK ALERT High severe diseases and death rates. Situation beyond control. Healthcare system overwhelmed Panic sweeps through Community/Country

Figure 5: Pandemic phases in Saint Lucia's NIP in comparison to WHO and general alert levels (GOSL, 2009b)

The Donations and Importation of Relief Supplies Policies and Guidelines in Saint Lucia after Disasters (GOSL, 2005) and the Hazard Mitigation Policy (GOSL, 2006b) regulate national responses to a wide range of disasters and hazards, respectively. Relevant to IAS management is a clear preference expressed in the former for local foodstuff, which, as stated in this policy, tends to be available for purchase and distributions somewhere on national territory, even during famines.

To a varying extent, biodiversity conservation priorities and activities are also incorporated into the Forest Management Plan (1992-2002), the new Forest Sector and Wildlife Policy, the Agriculture Policy, the National Climate Change Policy and Adaptation Plan in (2003), the Coastal Zone Management Policy (2004), the Fisheries Policy/Fisheries Management Plan, the National Land Policy (2007), the Physical Development Plans and the Tourism Policy.

Multilateral Environmental Agreements (MEAs) and International Instruments

IAS introductions are international in character. Prevention of IAS introductions and provision of mechanisms for control or eradication, therefore, require an international legislative framework through global, regional or bilateral agreements. Internationally agreed instruments may be binding or non-binding. Binding agreements are agreements between states (treaties, conventions) which have a mandatory character in that they must be observed and their obligations carried out in good faith. Non-binding agreements or "soft law" are resolutions adopted by intergovernmental fora, in the form of recommendations, guidelines, programmes of action, declaration of principles etc., which are accepted by states as guidance for future action and are not mandatory. However, they may become included at a latter stage in a binding instrument and become "hard law".

A range of terms is used to describe treaty actions and varies with respect to the extent to which a state has committed itself to a treaty. "Signature" is a term which must be interpreted in context of the nature of the treaty. For example, when a treaty is not subject to ratification, acceptance or approval, definite signature establishes consent to be bound by a treaty, i.e. the state becomes a party to the treaty. Signature - subject to ratification, acceptance or approval -

does not establish consent to be bound; however, it is a means of authentication and expresses the willingness of the signatory state to continue the treaty-making process. In a similar manner, a representative may sign a treaty "*ad referendum*" which requires confirmation by the state to become definite. "Ratification", "accession", "approval" and "acceptance" all signify the state has consented to be bound by a treaty and is hence a party. The differences in terminology has historic reasons and guidance on this matter can be found at http://untreaty.un.org/english/guide.pdf.

Legal and institutional frameworks in most countries treat IAS in a fragmented manner, because they have been developed in separate thematic areas; this sectoral pattern is reflected in the current institutional arrangements and processes. Historically, the agricultural sector has the most developed mechanisms for controlling IAS due to the potential economic impacts. Legal measures in other sectors have been adopted reactively as new problems and pathways have become apparent. This subheading groups international instruments relevant to the WCR by subject matter, looking at global and where applicable regional instruments in each category guided by the approach of Shine *et al.* (2000).

A range of international instruments relating to IAS in the context of biological diversity conservation have participation by countries of the WCR. These include: Convention of Biological Diversity (CBD), Barbados Plan of Action, Johannesburg Plan of Action, Mauritius Strategy, Convention on the Conservation of Migratory Species of Wild Animals (CMS), Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), United Nations Convention on the Law of the Sea (UNCLOS), Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (Cartagena Convention), including the Protocol Concerning Specially Protected Areas and Wildlife (SPAW), Convention on Wetlands of International Importance Especially as Waterfowl Habitat and the FAO Code of Conduct for Responsible Fisheries. For a more detailed treatise with the geographic scope covering the entire WCR, the reader is referred to Polar & Krauss (2008b). Saint Lucia's participation in relevant MEAs is summarized in Table 6, with the relevance to IAS management quantified in three categories.

Trade is one of the major pathways for the spread of IAS (Waugh, 2009). The WTO Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) is the major international instrument relating to trade globally and in the WCR. The CARICOM Single Market (CSM), which allows for free movement of goods and services through measures such as eliminating all barriers to intra-regional movement, is likely to impact on the movement of IAS. The Caribbean Invasive Species Working Group (CISWG) has developed a Caribbean Regional Invasive Species Intervention Strategy (CRISIS) for the management of agricultural IAS in the Caribbean region.

The key objective of sanitary and phytosanitary (quarantine) measures is to protect humans, animals and plants (wild and cultivated) from damage due to pest and disease. This is often achieved through the use of import and export control measures. The international regime with respect to human health and plant protection relevant to the WCR is discussed in more detail below. There is currently no global convention for the protection of animals; however, the World

Organization for Animal Health (OIE) adopts international standards related to animal health to restrict the movement of live animals and fish to minimize the transfer of zoonotic diseases. Saint Lucia is not a member of the OIE.

Table 6: International legal instruments relevant to IAS management in and by Saint Lucia.

International Legal Instrument	Saint Lucia's Status	Relevance Rating[1]	Focus of Relevant Intervention
Convention on Biological Diversity (CBD)	Party	XXX	Only globally applicable, legally binding instrument to generally address IAS introduction, control and eradication across all biological taxa and ecosystems. Specifically Article 8(h) requires parties "to prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species". The CBD's Conference of Parties (COP) designated IAS as a cross-cutting issue to be taken into account in the convention's thematic work programmes, which has lead to a range of Decisions being passed.
Convention on the Conservation of Migratory Species of Wild Animals (CMS) (*Bonn Convention)*	-	XX	Aims to conserve terrestrial, marine and avian migratory species throughout their ranges. Article III (4) requires parties to prevent, reduce and control factors endangering migratory species, including "strictly controlling the introduction of, or controlling or eliminating already introduced exotic species".
Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES)	Party	XX	Aims to ensure that the international trade in specimen and wild animals and plants do not threaten their survival by using a permit system to regulate the import and export of species. Decision 10.54 recognizes that non-indigenous species can pose significant threats to biodiversity, and that fauna and flora species in commercial trade are likely to be introduced to new habitat as a result of international trade.
United Nations Convention of the Law of the Sea (UNCLOS) and its	Party	XX	Article 196 requires parties to "take all measures to prevent, reduce and control the intentional and accidental introduction of species, alien or new, to a particular part of the marine environment, which may cause significant and harmful changes thereto".
Agreement for the Implementation of Provisions of the Convention Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks	Party	X	Does not directly address the issue of IAS, but is concerned with all factors which may impact transboundary fish species.

International Legal Instrument	Saint Lucia's Status	Relevance Rating[1]	Focus of Relevant Intervention
Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (Cartagena Convention) and its	Party	XXX	Only regional environmental legal agreement addressing biodiversity conservation issues of the WCR. The Convention and its protocols constitute a legal commitment by the participating governments to protect, develop and manage their common waters individually or jointly.
Protocol Concerning Specially Protected Areas and Wildlife (SPAW)	Party	XXX	The objective of the SPAW Protocol is to protect rare and fragile ecosystems and habitats, thereby protecting the endangered and threatened species residing therein. Under Article 12, each party must "take all appropriate measures to regulate the intentional or accidental introduction of non-indigenous or genetically altered species into the wild that may cause harmful impacts to the natural fauna and other features of the Wider Caribbean Region".
Protocol Concerning Pollution from Land-Based Sources (LBS Protocol)	Party	XX	The LBS Protocol is concerned with pollutants, including pathogenic microorganisms, being released from land into the sea.
Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention)	Party	XXX	Resolution VII/14 (*Invasive Species and Wetlands*, of 1999) emphasizes the threat of IAS to wetland species and requested the preparation of guidance material for parties on legislation and best practice management approaches that incorporate risk assessment, in order to minimize the introduction of new and environmentally dangerous alien species into a jurisdiction.
FAO Code of Conduct for Responsible Fisheries	Member	XX	A voluntary code. Article 9.3.1 states that "efforts should be undertaken to minimize the harmful effects of introducing non-native species or genetically altered stocks used for aquaculture including culture-based fisheries into waters, especially where there is a significant potential for the spread of such non-native species or genetically altered stocks into waters under the jurisdiction of other states as well as waters under the jurisdiction of the state of origin. States should, whenever possible, promote steps to minimize adverse genetic, disease and other effects of escaped farmed fish on wild stocks"
Cartagena Protocol on Biosafety	Party	XX	Aims to ensure safe transfer, handling and use of living modified organisms (LMOs) resulting from modern

International Legal Instrument	Saint Lucia's Status	Relevance Rating[1]	Focus of Relevant Intervention
(Cartagena Protocol)			biotechnology. The major focus of the protocol is the transboundary movement of the LMOs.
WHO International Health Regulations	Member	XXX	Intended to prevent international spread of infectious diseases to humans. Inadvertently these regulations are perhaps the most stringent with respect to controlling the introduction and spread of invasive disease organisms.
International Plant Protection Convention (IPPC)	Party	XXX	International framework to prevent the spread of plant pest; also promotes appropriate measures for their control. Facilitates the development of *International Standards for Phytosanitary Measures (ISPMs)*
World Trade Organization (WTO) Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement)	Member	XXX	Provides binding rules for international trade in goods, services and intellectual property, which are enforced by a compulsory dispute settlement mechanism. Also provides a set of basic rules on how WTO members can apply those measures to manage IAS that are pests or diseases. Focus is on prevention.
Convention on the Control of Harmful Anti-fouling Systems on Ships	-	XXX	Promote safe and effective anti-fouling systems to impede the spread of harmful aquatic organisms, including IAS.
International Convention for the Control and Management of Ships' Ballast Water and Sediments (GloBallast)	Princi-pally agreed to join in 2010	XXX	The Convention aims to reduce the transfer of harmful aquatic organisms and pathogens in ships' ballast water. It was adopted in 2004, but has yet to come into force as a quorum of 30 countries has not yet been met.
Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention)	Party	XX	Promotes the effective control of all sources of marine pollution and to take all practicable steps to prevent pollution of the sea by dumping of wastes and other matter.
World Heritage Convention (WHC)	Member	X	Aimed to protect the world cultural and natural heritage. IAS have been recognized as a threat to the specific natural heritage sites, i.e. the Galapagos World Heritage Site.
Food Aid Convention	-	X	While the convention does not explicitly mention IAS, grains, rice and seeds eligible as food aid could provide a

International Legal Instrument	Saint Lucia's Status	Relevance Rating[1]	Focus of Relevant Intervention
			vehicle for IAS transfer. Measures are outlined to minimize this risk. All products must meet international quality standards and, with the exception of seeds, be suitable for human consumption.
Agreement on the Importation of Educational, Scientific and Cultural Materials	-	X	Aims to encourage the free exchange of ideas and knowledge. While this interchange is primarily via printed and electronic materials, articles covered include scientific collections which could harbour IAS.
Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction	Party	XX	Commits states to never develop, produce, stockpile or otherwise acquire or retain microbial or other biological agents or toxins of types and in quantities that have no justification for prophylactic, protective or other peaceful purposes.
Convention on the Prohibition of Military or any Hostile use of Environmental Modification Techniques	Party	XX	Urges states not to engage hostile use of environmental modification techniques, including biotic agents.
United Nations Framework Convention on Climate Change	Party	X	Aims to reduce the emission of greenhouse gases. Although IAS are not specifically mentioned, they are embraced under the definition of "adverse effects of climate change".
Convention to Combat Desertification/ Land Degradation	Party	X	Aims to halt the continued loss of the productivity of land and availability and quality of the water resources. Could be adapted to address effects of IAS and climate change.

[1] XXX: highly relevant, XX: relevant, X: somewhat relevant.

The International Plant Protection Convention (IPPC) is an international framework to prevent the spread of plant pests; it also promotes appropriate measures for their control. Parties are required to adopt legislative, technical and administrative procedures and standards to identify pests that threaten plant health. Parties may prohibit the introduction of certain plants and restrict the import of plant products and related articles, execute inspections and detain particular consignments. Parties are also required to distribute information regarding plant pest

and means of prevention and control. Each party is required to establish a National Plant Protection Organization (NPPO). One of the key components of many national phytosanitary systems is the three stage pest risk analysis (PRA).

The IPPC Secretariat facilitates the development of *International Standards for Phytosanitary Measures* (ISPMs). These are designed to prevent the introduction or spread of plant pests of potential economic importance while encouraging the international harmonization of phytosanitary measures to facilitate safe trade and avoid unjustified barriers. The most important ones in the IAS context are:

- ISPM No. 01 (2006) Phytosanitary principles for the protection of plants and the application of phytosanitary measures in international trade
- ISPM No. 3 The Code of Conduct for the Import and Release of Exotic Biological Control Agents: Regulates classical biological control, which involves the introduction of specific natural enemies from the homeland of a pest of foreign origin. The code address the importation of exotic biological control agents capable of self replication (parasitism, predators, parasites, phytophagous arthropods and pathogens)
- ISPM No. 07 (1997) Export Certification System
- ISPM No. 11 Pest Risk Analysis for Quarantine Pests Including Analysis of Environmental Risks and Living Modified Organisms (2004) is most suited to control the introduction and spread of IAS.
- ISPM No. 12 (2001) Guidelines for Phytosanitary Certificates
- ISPM No. 15 (2002) Guidelines for Regulating Wood Packaging Material in International Trade
- ISPM No. 20 (2004) Guidelines for a Phytosanitary Import Regulatory System
- ISPM No. 25 (2006) Consignments in Transit

International instruments relating to IAS in the context of transport include Guidelines for the Control and Management of Ships' Ballast Water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogens, the Convention on the Control of Harmful Anti-fouling Systems on Ships and the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter for marine pathways. Civil aviation is an important pathway for the movement of IAS; hence the International Civil Aviation Organization (ICAO) has adopted a resolution A33-18, "Preventing the Introduction of Invasive Alien Species" but leaves the responsibility of control measures up to individual counties.

Military activities could lead to the introduction and spread of IAS. However, little can be done to regulate military operations. Mathurin (2010c) issued recommendations for military and other heavy duty vehicles that are transported internationally to prevent IAS spread into and out of Saint Lucia. The Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on their Destruction and the Convention on the Prohibition of Military or any Hostile Use of Environmental Modification Techniques may also include IAS.

Polar and Krauss (2008b) analysed the membership of Caribbean countries in relevant agreements. They reported that no country in the WCR is party to or a member of all 28 international conventions/organizations reviewed. Saint Lucia was above average: the country participates in 16 of the 21 relevant conventions, with one further signature in the pipeline, and is also party to the three related Protocols (Table 6). Almost all countries in the WCR are parties to the major conventions (CBD, CITES, UNCLOS, Cartagena Convention, Ramsar Convention, IPPC) or members of the key organizations (FAO, WHO, IMO, IPPC, WTO) which suggest that there is a fair level of harmonization in the mechanisms for the control of IAS in the WCR, particularly along the pathways trade, travel, transport and tourism. However, the limited participation in GloBallast and the Convention on the Control of Harmful Anti-fouling Systems on Ships indicate that the marine pathway for IAS requires further harmonization. The authors issued the following recommendations:

- Individual countries should investigate conventions and organization of which they are not currently parties or members to determine if the benefits of participation are appropriate in their developmental context.
- Participation in conventions which control specific marine IAS pathways such as GloBallast and the Anti-fouling Convention needs to be improved
- In conventions and organization of which there is maximum participation of WCR members, *ad hoc* groups should be established to fine tune mechanisms for the control of IAS pathways through regional or bi-lateral agreements under advice from CISWG.
- At COP meetings, WCR countries need to lobby for greater emphasis to be placed on developing specific mechanisms for the control of IAS beyond general guidelines.

Sectoral Involvement

National Stakeholder Mapping

In the Fourth National Biodiversity Report, responsibility for IAS management is placed with MALFF (GOSL, 2009a). The Government agency responsible for the development of a coordinated, integrated, holistic approach to national development planning that takes into account economic, social and environmental issues, has been restructured and renamed several times and is currently the mandate of the Ministry of Physical Development and the Environment, which also accommodates Crown Lands and a Geographic Information Systems Unit. The Land Development (Interim) Control Act (1971) established a Development Control Authority (DCA), whose role is to review and determine development plans. Coastal infrastructure and control of sand mining on beaches is the mandate of the Ministry of Communications, Works, Transport and Public Utilities. The Ministry of Tourism and Civil Aviation oversees sport fishing, ecotourism, dive establishments and submarine operations. It needs to liaise closely with the Saint Lucia Air and Sea Ports Authority (SLASPA), who is in charge of the day-to-day management of air- and seaports, including the marinas. The nation's Meteorological Services fall under the Ministry of Communications, Works, Transport and Public Utilities. The Ministry of Finance was only recently detached from Planning and Sustainable Development. The former is responsible for the Customs and Excise Department, which

controls imports/exports and carries out surveillance activities around the island. The National Emergency Management Unit (NEMO) falls under the Office of the Prime Minister. With technical inputs from the above-mentioned departments, legislation and legal advice on biodiversity issues is the responsibility of the Attorney General's Chambers.

The National Development Corporation (NDC) is a non-governmental agency that manages the Saint Lucia Fish Marketing Corporation and development of vested lands, thereby overlapping n mandate with the DCA. The Saint Lucia National Trust (SLNT) manages certain protected areas. The SMM Association, which manages the SMM Area[2], was declared a not-for-profit Organisation under the Companies Act of Saint Lucia in 2003. The mission of the SMM Association is to contribute to national and local development, particularly in the fisheries and tourism sectors, through the management of the coastal zone of Soufriere, based on the principles of sustainable use, cooperation among resource users, institutional collaboration, active and enlightened local participation, and equitable sharing of benefits and responsibilities among stakeholders.

The Fisheries Department of MALFF is the lead agency responsible for the development and management of marine resources. In 1998 it possessed a small fleet of five research/fishing vessels and four 4X4 vehicles as well as staff for research, aquaculture and extension (Scott, 1998). In recent years, both the transportation and human resource situation has declined dramatically, limiting the effective implementation of activities by the Department.

As can be seen, natural resource management remains dispersed among several Government Ministries, statutory bodies and quasi-agencies. Scott (1998) noted that, while responsibilities fall within the jurisdiction of certain agencies, limitations regarding adequate facilities and human resources do not always facilitate their mandated duties and this situation has not fundamentally changed since her assessment. Nevertheless, it has long been understood that a multi-stakeholder approach to IAS management is required, with the following sectors being targeted for active involvement as early as the Third National Report (GOSL, 2006a): Local Government, Ministry of Physical Planning, Customs Officials, Ministry of Health, Saint Lucia Police Force, Ministry of Finance, Ministry of Communication, CARDI, the Banana Emergency Recovery Unit (BERU), plant retail outlets, pet and aquarium dealers, Windward Island Banana Development and Export Company (WIBDECO) and the individual community or communities.

Having said all that, Prip *et al.* (2010) used the highly efficient implementation of Saint Lucia's 1st NBSAP as an example to illustrate that ultimately the success in implementation is more dependent on strong and devoted individuals than the institutions themselves. Furthermore, Saint Lucia owed part of its implementation success to having a team of officials across ministries who have worked for many years on biodiversity-related issues.

Active Involvement in Regional and International Initiatives, Including Databases

SAINT LUCIAN MEMBERSHIP IN RELEVANT REGIONAL AND INTERNATIONAL ORGANIZATIONS

[2] both entities are acronymed "SMMA" in many reports

Table 7 summarizes Saint Lucia's membership in relevant regional and international organizations. Saint Lucia is a member of 18 of the 21 relevant organisations and subsidiaries. For starred entries (*) additional background is provided in the narrative. Involvement in highly relevant less formal networks is covered under the subsequent subheading.

Table 7: Saint Lucian membership in relevant regional and international organizations.

Organization	Saint Lucia's Status	Relevance Rating[1]	Scope
Association of Caribbean States (ACS)	Member	X	Coordination and cooperation of Caribbean states beyond CARICOM borders; includes responses to natural disasters *
Alliance of Small Island States (AOSIS)	Member	XX	Lobby for SIDs *
Centre for Agricultural Bioscience International (CABI)	-	XXX	Regional Executing agency for GEF-funded IAS project *
Caribbean Community (CARICOM)	Member	XX	Coordination and cooperation among member countries; relevant bodies include CEHI, CISWG, CMO and COTED (all *)
Caribbean Environmental Health Institute (CEHI)	Member	XX	
Caribbean Invasive Species Working Group (CISWG)	Member	XXX	
Caribbean Meteorological Organization (CMO)	Member	XX	
Caribbean Conservation Association (CCA)	Member	XX	Conservation interest group to facilitate the sustainable management of the region's natural and cultural resources. The GOSL is represented by Michael Andrew
Caribbean Disaster Emergency Management Agency (CDEMA)	Member	XX	Regional emergency management: networks independent emergency units throughout the WCR.
Caribbean Environmental Programme (CEP)/UNEP	Member	XXX	Responsible for Cartagena Convention, LBS and SPAW Protocols *
Caribbean Plant Protection Commission (CPPC)	Member	XXX	Key role in WTO/SPS standard setting
Caribbean Tourism Organization (CTO)	Member	X	Could play a greater role in future, particularly in prevention, if made aware of relevance; 32 member countries/ territories (English, French, Spanish and Dutch-speaking), as well as private sector allied members.
International Civil Aviation Organization (ICAO)	Member	XX	Resolution A33-18 *Preventing the Introduction of Invasive Alien Species* of 1998 requests

Organization	Saint Lucia's Status	Relevance Rating[1]	Scope
			members to work with other UN organizations to identify approaches ICAO may take and support efforts to minimize risk of introducing potential IAS through civial aviation.
Inter-American Institute for Cooperation in Agriculture (IICA)	Member	XXX	Relevant to information management, with emphasis on agriculture. Technical assistance can be obtained for management of agricultural IAS
International Maritime Organization (IMO)	Member	XXX	Relevant to marine pathway management; leads GloBallast Partnership and Ballast Water Convention *
Organisation of American States (OAS)	Member	X	May support punctual environmental programmes
Organisation of Eastern Caribbean States (OECS)	Member	XXX	Environment and Sustainable Development Unit is harmonising sub-regional environmental legislation and implementing OPAAL project. Relevant to sourcing of funding for sub-regional projects on IAS. Can source technical assistance on IAS management *
United Nations World Tourism Organization (UNWTO)	-	X	Could provide greater lobby for pathway management
World Organization for Animal Health (OIE)	-	XXX	Various standards for prevention of spread of animal pathogens. Published review series on IAS in 2010 *
World Health Organization (WHO)	Member	XXX	Adopted International Health Regulations *
World Trade Organization (WTO)	Member	XXX	Responsible for SPS Agreement *

[1] XXX: highly relevant, XX: relevant, X: somewhat relevant.

The Association of Caribbean States (ACS) was formed with the aim of promoting consultation, cooperation, and concerted action among all the countries of the Caribbean. Responding to a proposal by the USA for a Free Trade Area of the Americas (FTAA), existing Caribbean-area trading blocs joined forces in 1995 to strengthen their economic position and ease future integration into the FTAA. Today it constitutes a trading bloc, composed of 25 member countries of the Caribbean basin and four associate members.

The Alliance of Small Island States (AOSIS) is a coalition of SIDS and low-lying coastal countries. Founded in 1991, it is the *ad hoc* lobby and negotiating voice for SIDS within the United Nations system. To date, AOSIS's involvement focussed on Climate Change, Agenda 21, BPOA, and the Mauritius Strategy, but there has been no participation in CBD meetings. In

the WCR, these include Antigua & Barbuda, Bahamas, Barbados, Belize, Cuba, Dominica, Dominican Republic, Grenada, Guyana, Haiti, Jamaica, St. Kitts & Nevis, Saint Lucia, Saint Vincent & The Grenadines, Suriname and Trinidad & Tobago. The Netherland Antilles and USVI have observer status.

CABI is an international, intergovernmental, not-for-profit organization established by a UN treaty level agreement between its member countries. CABI's mission is to improve people's lives worldwide by providing information and applying scientific expertise to solve problems in agriculture and the environment. "Invasive Species" is one of CABI's three priority themes, with involvement in IAS prevention by provision of technical support to the IPPC and the SPS Agreement under the WTO, and in IAS control using integrated pest management, especially biological control. CABI developed the proposal Mitigating the Threats of Invasive Alien Species in the Insular Caribbean (MTIASIC) for GEF funding and is now the Executing Agency for this regional project. Three participating countries (the Bahamas, Jamaica and Trinidad & Tobago) are CABI members within the WCR; the Dominican Republic and Saint Lucia are not.

CARICOM coordinates cooperation among member countries. The CARICOM Single Market (CSM) allows for free movement of goods and services through elimination of barriers to intra-regional movement. Since this is likely to impact on the movement of IAS, CISWG was formed and charged to develop a Caribbean Regional Invasive Species Intervention Strategy (CRISIS) for the management of IAS in the Caribbean region. CISWG submitted the CRISIS document to CARICOM member states at the 19th meeting of the CARICOM Council for Trade and Economic Development (COTED). The COTED endorsed the membership of CISWG and charged the working group with developing a fundable proposal for strengthening the region's ability to safeguard itself against IAS. Thus CISWG developed a proposal for a Caribbean Invasive Species Surveillance and Information Program (CISSIP). CARICOM superseded its precursor, the Caribbean Free Trade Association (CARIFTA), in 1973. Saint Lucia had been part of the process as a CARIFTA and now CARICOM member since 1968, even prior to independence.

The Caribbean Meteorological Organization (CMO) is a specialized agency of CARICOM that coordinates the joint scientific and technical activities in weather-, climate- and water-related sciences in 16 English-speaking Caribbean countries. Another relevant body of CARICOM is CEHI. Its headquarters are located in Saint Lucia. All CEHI members are also CARICOM members, but not the other way round. In contrast, CISWG has country representatives as well as organisational members. CABI as well as all participating countries of the GEF project are CISWG members. Ulrike Krauss (Invasive Species Coordinator) is Saint Lucia's CISWG representative.

The Caribbean Environmental Programme (CEP) of UNEP promotes regional co-operation for the protection and sustainable development of the marine environment of the Wider Caribbean Region. CEP/UNEP is leading the development of the Cartagena Convention, the Protocol Concerning Pollution from Land-Based Sources and Activities to the Convention for the Protection and Development of the Marine Environment of the WCR (LBS Protocol) and the SPAW protocol. CEP manages four GEF projects and collaborates with several more.

The Caribbean Plant Protection Commission (CPPC) is an inter-governmental organization functioning as a coordinating body for National Plant Protection Organizations (NPPOs) on a regional level and operates under the IPPC. In recent years, the CPPC's role has been limited to facilitating the participation of NPPOs in the WTO/SPS standard setting process. As part of harmonization efforts in the region, the Caribbean Agricultural, Health and Food Safety Agency (CAHFSA) will be created to cover food safety, animal health and plant health matters for CARICOM and would eventually replace the CPPC.

The International Maritime Organization (IMO) is the driving force behind UNCLOS, the Ballast Water Convention (GloBallast), and the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter. The IMO adopted the Guidelines for the Control and Management of Ships' Ballast Water to Minimize the Transfer of Harmful Aquatic Organisms and Pathogens. These guidelines were intended to assist Governments and appropriate authorities in minimizing the risk of introducing harmful aquatic organisms and pathogens from ship's ballast water and associated sediments while protecting the ship's safety. SLASPA Marine Affairs section is the focal point for the IMO in Saint Lucia.

The Organisation of Eastern Caribbean States (OECS), created in 1981, is an inter-governmental organisation dedicated to economic harmonisation and integration, protection of human and legal rights, and the encouragement of good governance between countries and dependencies in the Eastern Caribbean. It also performs the role of spreading responsibility and liability in the event of natural disaster, such as a hurricane. The OECS Secretariat is based in Castries, Saint Lucia. Saint Lucia is the only OECS country participating in MTIASIC. Countries of the OECS have taken a harmonised approach to environmental legislation using model legislation developed by the Environment and Sustainable Development Unit (ESDU). ESDU is also implementing the OPAAL project, which will come to an end in June 2011. Under OPAAL, the development of a site-specific IAS strategy and management plan for the PSEPA was foreseen; however, this plan has now been discarded. In accordance with its guidelines ESDU also assists countries with general aspects of environmental management; i.e. the St. Georges Declaration of Environmental Principles has resulted in a regional followed by national environmental management policies and strategies. Environmental management within the OECS has to date been focused along some broad priority themes. These themes include: (i) integrated watershed management; (ii) integrated development planning; (iii) adaptation to climate change; (iv) protection/enhancement of biodiversity, in both marine and terrestrial contexts; (v) environmental assessment; and (vi) the application of sustainable practices to fishing, forestry, tourism, agriculture and other sectors.

The World Organization for Animal Health (OIE) is one of the most relevant organisations for IAS management in which Saint Lucia is not a member. It developed various standards to minimize the transfer of zoonotic diseases by restricting the movement of live animals and fish. In 2010, the OIE published a substantial review on animals as invasive species that goes far beyond the OIE's original veterinary mandate (Eds. P.-P. Pastoret & F. Moutou; Invasive Species, Part 1: General Aspects and Biodiversity, Part 2: Concrete Examples, *Scientific and Technical Review* 29). Some chapters deal with movement of livestock and with exotic pet trade.

The World Health Organization (WHO), together with the FAO, was instrumental in the development and promotion of the FAO/WHO Codex Alimentarius. The WHO adopted the International Health Regulations (IHR) that are designed to ensure maximum security against the international spread of infectious diseases to humans. The IHR were revised and updated in 2005, in response to changes in disease epidemiology and control, and to the increase in international traffic. The IHR are applicable to all member states.

The World Trade Organization (WTO) governs international trade in goods, services and intellectual property with binding rules, which are enforced by a compulsory dispute settlement mechanism. The WTO agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) is a set of basic rules on how WTO members can apply those measures and is relevant to IAS that are pests or diseases, in that it helps members to (1) protect human, animal and plant life or health from the risks arising from the entry, establishment or spread of pest, diseases, or disease carrying organisms and (2) prevent or limit damage from the entry, establishment or spread of a pest.

Recent Involvement in Regional Biodiversity Initiatives

Saint Lucia is involved in several sub-regional projects, including Integrating Watershed and Coastal Area Management (IWCAM), the OECS Protected Areas and Associated Livelihoods (OPAAL) and Protecting the Eastern Caribbean Region's Biodiversity (PERB). The overall objective of the GEF-funded IWCAM project is to strengthen the commitment and capacity of the participating countries to implement an integrated approach to the management of watersheds and coastal areas. The long-term goal is to enhance the capacity of the countries to plan and manage their aquatic resources and ecosystems on a sustainable basis (Prip *et al.*, 2010).

Saint Lucia's IWCAM pilot project is Protecting and Valuing Watershed Services and Developing Management Incentives in the Fond d'Or Watershed Area of St Lucia. Fond d'Or is the second-largest watershed in the country and faces threats related to water quality and to reliable access to and production of freshwater as a resource for both the human population and the biodiversity of the watershed/coastal ecosystem. The project successfully used native plants to help clean up sewage water in the constructed wetland. The project also supports the implementation of the CBD, the Ramsar Convention, the Cartagena Convention and Protocols, the UNCCD, MARPOL, the UNFCC and the Society of Garden Designers (SGD).

The OPAAL project is the first five-year phase of a fifteen-year programme which seeks to create an integrated system of protected areas in OECS member states, strengthen existing protected areas and create new protected areas while providing environmentally sustainable economic opportunities for communities associated with the surrounding protected areas. Saint Lucia's PSEPA is one of six demonstration sites in the OECS region. Outputs include the Pointe Sable Environmental Protection Area Management Plan (2009-2014), an Interpretation and Education Plan for the Pointe Sable Environmental Protection Area, and a Social Assessment. Other outputs at the sub-regional level include the report of a Knowledge, Attitude and Practice (KAP) survey conducted in six OECS member states, a Regional Awareness

Strategy on Protected Areas, and a policy, legal and institutional review. In late 2009, as part of the OPAAL project, Saint Lucia drafted a Systems Plan for Protected Areas.

The PERB project is funded by USAID and executed by the OECS Secretariat through the ESDU. It seeks to improve biodiversity protection, management and conservation through interventions in selected sites. Under the project, countries have looked at the legal framework for biodiversity management and consistency with MEAs and other OECS member states, biodiversity awareness and education, biodiversity areas management and training, biodiversity and tourism, and information management systems for protected areas. Saint Lucia developed a Millet Nature Trail Management Plan and Interpretive Centre under the PERB project. Regulations to accompany the draft Biodiversity Conservation and Sustainable Use Bill were also produced. Finally, a database for protected areas was developed under PERB, and Saint Lucia was used as the pilot country to test the database, housed at the OECS headquarters (Prip *et al.*, 2010).

Active Involvement in Regional IAS Management Initiatives

In the late 1980's, the USDA sponsored a project to identify fruit fly species on Saint Lucia. The only economically important species found was *Anestrepha obliqua*, the West Indian Fruit Fly. It was decided that the major ports of entry would be monitored for the possible introduction of exotic fruit fly species. During subsequent monitoring, which had to be partially suspended from 2005 to 2009 for the lack of reliable transportation, no new fruit fly species were trapped (Mathurin, 2010a). Another USDA-funded project investigated the Red Palm Mite (*Raoiella indica*) of coconuts and other palms and crops in several CARICOM countries: the host range, life history, and evolved into a search for natural enemies and tolerant germplasm.

A classical biocontrol project of the Pink Hibiscus Mealy Bug (PHMB), *Maconellicoccus hirsutus*, has been well-documented in the 1990s. Subsequent occasional rapid surveys have also been done not only for PHMB, but also chilli thrips (*Scirtothrips dorsalis*), parasitoids of the citrus weevil borer (*Diaprepes abbreviatus*), the Giant African Snail (GAS) - *Achatina fulica*, and Anthurium bacterial blight (*Xanthomonas axonopodis* pv. *dieffenbachiae*); however, Mathurin (2010a) questioned their frequency and scientific rigour. GAS was introduced into Saint Lucia in 2000 and has since spread island-wide. Again, it is a CARICOM priority.

The Third National Report (GOSL, 2006a) states that collaboration to address threats of plant and animal health concerns occur with Saint Lucia's CARICOM and OECS partners through CARINET and CARIPESTNET, which provide taxonomic support and information on the management of plant, and animal pests through the electronic medium.

For the International Cricket Council World Cup in 2006, the Saint Lucia Air & Seaports Authority (SLASPA) constructed a "port health facility" at the George F.L. Charles Airport in Castries. This facility was designed to accommodate officers and inspection facilities for personnel from the Ministry of Health and the Veterinary and Livestock Services and Crop Protection & Quarantine Unit of the MALFF (Mathurin, 2010a). In early 2010, only the section allocated to the Ministry of Health was occupied fulltime, quite likely driven by the swine flu pandemic, which also resulted in a few cases in Saint Lucia.

In 2007, the Veterinary Department, in collaboration with the Forestry Department of MALFF, was working on a schedule of surveillance for detection of the Avian Influenza Virus at various wetlands island-wide. This programme was being funded by the GOSL (Anthony *et al.*, 2007). With the decline of avian influenza, active monitoring is no longer carried out.

Several rapid surveys for the presence/absence of Black Sigatoka (*Mycosphaerella fijiensis*) and Moko (*Ralstonia solanacearum*) diseases of banana and plantain have been carried out at least since the early 1990, led by WinFresh, then known as the Windward Islands Banana Development and Export Company (WIBDECO) and before as the Windward Island Banana Growers' Association (WINBAN), by MALFF, and the Banana Production Management Unit (formerly: Banana Emergency Recovery Unit, BERU). In 2010, this host-specific pathogen was confirmed in Saint Lucia. Emergency management plans are being developed with the help of the EU, particularly CIRAD, who have a vested interest to keep the pathogen out of neighbouring Martinique[3].

Abadie *et al.* (2008) presented several CIRAD initiatives on invasive plant pests and pathogens that are present in the Caribbean. These are primarily focused on *Ralstonia solanacearum* (causal agent of Moko disease of banana), Black Sigatoka, coconut lethal yellowing and viral diseases of sugarcane and banana. They include research activities, transfer of diagnosis techniques to plant protection and quarantine services and participation to surveillance networks, either existing or under construction. Surveys were carried out in Grenada and in Saint Lucia on banana Moko disease. Diagnosis and monitoring tools and techniques are one of the major outputs of CIRAD's research activities. Transfer of these tools and techniques towards plant protection and quarantine services of Caribbean countries is achieved through collaborative projects and courses, e.g. training in Black Sigatoka diagnosis and surveillance in Saint Lucia, as part of the above-mentioned management assistance that aims to prevent introduction of the pathogen into the French West Indies. CIRAD also plays an active role in several projects and global surveillance networks such as PANDOeR and the current USDA / CARICOM joint initiative for promoting plant health in the region through existing networks (CISWG, CISSIP).

Public Awareness, Education and Capacity Building

Early training activities also had their roots in safeguarding agricultural production. Quarantine Awareness Day has been observed since the varroa mite was introduced, presumably by smuggling bees into the country from the UK (GOSL, 1999). In 2004, MALFF conducted the first ever National Quarantine Course, supported by European Union (EU) funding. Officers of both the CPU and the Veterinary and Livestock Division were "cross-trained" to ameliorate the effect of staff turnover. Several subsequent events were held over the years, with various donors supporting specific priorities, e.g. the FAO-supported Phytosanitary Training Workshop, 16-20 Nov. 2009 and a National Plant Quarantine Workshop, 26-30 July 2010.

[3] By November 2010, the pathogen was also confirmed in Martinique, underlining the difficulty of prevention the spread of microfungi.

Every June, the CPU together with the Livestock Services and Veterinary Unit of the MALFF observes Quarantine Awareness Week. Normally, the activities include an address by the Minister, panel discussions and a film documentary on national television. A quarantine information supplement is also included in a national newspaper with sponsorship by agribusiness companies and non-governmental organizations. Apart from this annual event, plant pest and disease films, produced in English and Kwéyòl with the assistance of MALFF's Communications Unit, are occasionally shown on national television (Mathurin, 2010a). Posters are placed at official entry points, such as sea- and airports (Figure 6).

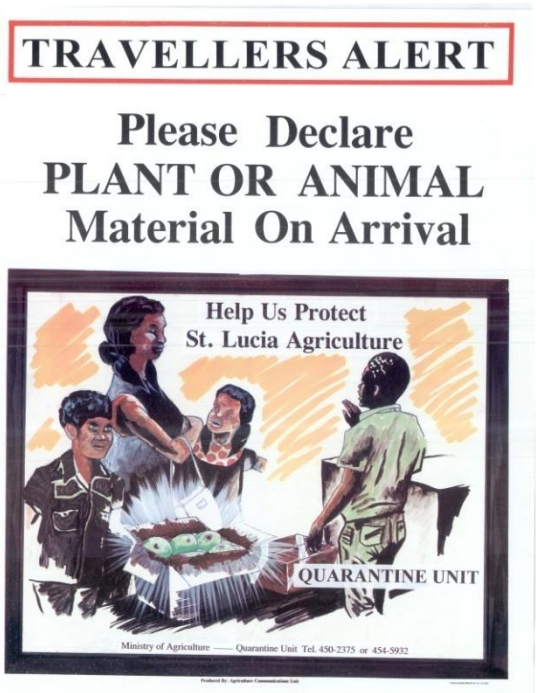


Figure 6: Quarantine awareness posters produced by MALFF and SLASPA.

A recently concluded project on RPM employed two persons at Associate Degree (A.S.) level, who acquired excellent field survey and plant sampling skills, including the use of Global Positioning Satellite (GPS) technology. Due to the termination of the project, they are no longer employed within the CPU (Mathurin, 2010a).

Baseline awareness on wildlife issues and on biodiversity was established by John (2001) and St. Marthe (2003), respectively. A recent OECS-wide KAP assessment, also highlight many findings at the national level and thus update these earlier studies (Chambers & Smith, 2007). Although exotic and invasive species are mentioned by John (2001) and by Chamber & Smith (2007), an analysis specifically for awareness on IAS has been overdue until 2010. This has now been conducted in conjunction with this CSA document (Krauss, 2010b). It aims to establish a baseline that could inform the methodological approach of a public awareness campaign as well as provide a basis against which the success of such interventions could be assessed. Strategic recommendations for environmental education as well as methodological recommendations for follow-up surveys are presented and shall not be repeated here.

As flagged earlier (p. 18), older reports on relevant topics were not always stored and maintained in a desired manner. Even where hard copies of reports still exist, they are not always easy to find and/or access by the general public. Several libraries in Saint Lucia cover natural history and/or agricultural and natural biodiversity. These are fragmented, with no common cataloguing system, and – at least partly as a result of both – are tedious to consult and gradually drop(ped) below critic mass readership. Some have become defunct, such as the former library at WINBAN's Research and Development Station in Roseau (destroyed by Tropical Storm Debbie in 1994) and CARDI's Agriculture Library in the Mabouya Valley. Others are small departmental collections, that are not regularly frequented by the general public other than school children, such as MALFF's agricultural library at Waterfront, Castries, the library at the Forestry Department, Union, the CEHI and OECS libraries on the Morne. In practice, an interested party is far more likely to encounter copies of a particular report in the private collection of a fellow researcher than in a public library. With the inevitable gradual passing of the elders, the future accessibility of historic records is even less certain, as is the case with the "Allan Smith collection", until family and last wishes will have been taken into due consideration.

Prevention

Prevention is the most-cost-effective IAS management approach. However, prioritizing exotic and still absent species to be kept out from a country is a nearly insurmountable task, as it requires a rare combination of knowledge to assess risks:

- Local condition that may favour invasiveness (generally available in Saint Lucia)
- Risk of arrival or introduction (largely available in Saint Lucia)
- Potential for invasiveness under conducive conditions. This item is generally unavailable locally in most countries, including Saint Lucia. External sourcing of information requires a good idea where to start, i.e. a pre-prioritization of organisms, leading to a circular task that can only partly be fulfilled by intuition and very careful iteration.

Having spelled out the limitation of species lists for IAS prevention, Table 8 is an attempt to prioritize IAS still absent from in Saint Lucia for proactive preventative measures, including public awareness and education, and/or for continuous (or at least regular) monitoring. A total of 40 species were selected either because of the feared severity of impact should these IAS arrive in Saint Lucia and/or because of their proximity to Saint Lucian territory. Seventeen are terrestrial, 18 marine and five freshwater aquatics.

Traditionally prevention of IAS referred exclusively to the introduction of IAS from outside national territory. Agricultural pests and diseases (of humans and animals) received almost all the attention. There is currently no legal basis to exclude a potentially invasive exotic animal from importation if veterinary regulations are fulfilled and the animal is not listed in CITES. The keeping of wildlife in captivity, however, requires a permit from the Forestry department – a regulation that has not been implemented consistently to date. If this gap was closed, major progress towards efficient prevention could be made.

Table 8: Invasive alien species (IAS) still absent from, whose introduction needs to be prevented as a matter of priority and/or that should be monitored because of their proximity to Saint Lucian territory.

Common name	Scientific name	Status	Source
Terrestrial: 17			
Foot and mouth disease	*Aphtae epizooticae*	Prevention of this viral disease has been a GOSL priority for years	[35]
Red Ring Disease	*Bursaphelenchus (=Rhadinaphelenchus) cocophilus*	Internationally regulated pest for Saint Lucia; Vector *Rhynchophorus palmarum* present in Saint Lucia	[16], [54]
Citrus greening (Huanglong-bing)	Candidatus *Liberibacter asiaticus*	Absent from Saint Lucia; present in Florida, including Keys. Vectored by Asian citrus psyllid, *Diaphorina citri*. Both have quarantine pest status for Puerto Rico Identified in St. Croix April 2010; present in Puerto Rico	[100] [30]
Cannibal snail	*Euglandina rosea*	Predatory snail, native to the US; introduced in Bahamas; caused extinctions of endemic snails on Pacific islands; risk of deliberate, illegal introduction for GAS biocontrol	[29]
Underwood's Spectacled Tegu	*Gymnophthalmus underwoodi*	Native to Guyana; invasive in much of Eastern Caribbean	[16]
Avian influenza	Influenza A Virus	Absent from New World; Potential threat to wild and domestic birds as well as public health	[55]
Swine flu	Influenza virus H1N1	Successfully eradicated in early phase in 2010; public health risk	This report
Leishmaniasis	*Leishmania* spp.	Parasites are vectored by sandflies, which are widespread. Cases have need reported occasionally throughout much of Caribbean island chain, including neighbouring Martinique.	[104]
Miconia	*Miconia calvescens*	Evergreen tree from Central and South America. Highly invasive on Pacific islands, where it was introduces as ornamental; "100 World's Worst IAS"	[49]
Frosty Pod Rot	*Moniliophthora roreri*	Absent from insular Caribbean; present in Mesoamerica and Western Venezuela; severe threat to cocoa (*Theobroma cacao*) industry	[61]
American palm cixiid	*Myndus crudus*	Absent from Saint Lucia; vector for internationally regulated Lethal Yellowing	This report
Cuban tree frog	*Osteopilus septentrionalis*	Native to Cuba, Bahamas and Cayman Islands. An IAS in large parts of WCR	[29]
Malaria	*Plasmodium* spp.	Parasite eradicated from most of insular Caribbean, incl. Saint Lucia after 14 reported cases between 1980 and 2005. Re-introduced	[89]

		occasionally into insular Caribbean. Three vector species (*Anopheles* spp.) are present in Saint Lucia, with larvae developing in fresh water.	
Strawberry guava	*Psidium cattleianum*	Native to Brazil; one of the "100 World's Worst IAS"	[49]
Rabies	Rabies virus	Prevented by quarantine regulation for pet importation	[33]
Moko Disease	*Ralstonia solanacearum*	Absent; widespread in Grenada; potential threat to Musaceae (banana, plantain, ornamentals)	[55]
Citrus Canker	*Xanthomonas axonopodis*	Internationally regulated pest for Saint Lucia; present in Cuba and Florida, including Keys.	[54], [72], [100]
Lethal Yellowing	16SrIV Phytoplasma	Internationally regulated pest for Saint Lucia	[54]
Marine: 18			
Clown fish	*Amphiprion* spp.	Widely introduced as aquarium fish; naturalized escapees can turn invasive	[24]
Brine shrimp	*Artemia* spp.	Widely introduced for aquaculture; invasive in several Caribbean islands, e.g. Bahamas	[24]
Blue Crab	*Callinectes sapidus*	Naturalized and invasive in several Caribbean islands, e.g. Bahamas.	[24]
Sea Nettle	*Chrysoara quinquechirra*	Naturalized and invasive in several Caribbean islands, e.g. Bahamas. Probably arrived via ballast water	[24]
American Oyster	*Crassostrea virginica*	Native to Eastern US and Gulf; introduced widely for mariculture, naturalized and invasive in several Caribbean islands, e.g. Bahamas, Jamaica	[24]
Killer shrimp	*Dikerogammarus villosus*	Transported by ballast water; very adaptable to a wide range of environmental conditions, voracious predator	[81]
Queensland grouper	*Epinephelus lanceolatus*	Large predator of Indo-Pacific origin	[24]
Zebra bullhead shark	*Heterodontus zebra*	Large predator of Indo-Pacific origin	[24]
American comb jelly	*Mnemiopsis leidyi*	Presently living in temperate to subtropical estuaries along the Atlantic coast of North and South America, but highly adaptable; spread by ballast water; capable of self-fertilization; natural enemy: *Beroe ovate.* Associated with complete fisheries crashes in Old World seas; one of the "100 World's Worst IAS"	[29]
Microalga	*Nannochloropsis*	Used as an energy-rich food source for fish	[24]

	oculata	larvae and rotifers. Naturalized and invasive in several Caribbean islands, e.g. Bahamas.	
Adam's dwarf triton	*Oenebra muricoides*	Mollusc naturalised and invasive in several islands, e.g. Curacao	[24]
Green Mussel	*Perna viridis*	Native of New Zeeland; naturalized and invasive in several islands, e.g. Jamaica and Trinidad	[24]
Blue-Girdled Angelfish	*Pomacanthus navarchus*	Widely introduced as aquarium fish on mostly Indo-Pacific origin; naturalized escapees can turn invasive	[24]
Lionfish	*Pterois volitans* and *P. miles*	Ferocious and highly invasive predator from Indo-Pacific; aquarium escape; rapidly expanding range in Caribbean; top priority marine threat	[24], [55]
Sea anemone	*Radianthus* sp.	Naturalized and invasive in several Caribbean islands, e.g. Bahamas.	[24]
Tunicate	*Trididemnum solidum*	Naturalised and invasive with rapid population growth (>900% in 30 year) in several islands, e.g. Bonaire, Curacao	[24]
Bamboo shark	*Chiloscyllium* spp. & *Hemiscyllium* spp.	Widely introduced as aquarium fish of Indo-Pacific origin; naturalized escapees can turn invasive	[24]
Dragonet	Several genera in the family *Callionymidae*	Widely introduced as aquarium fish of mostly Indo-Pacific origin; naturalized escapees can turn invasive	[24]
Freshwater: 5			
Chytrid fungus	*Batrachochytrium dendrobatidis*	Invasive (of African origin) extinguished ca. 70% of critically endangered Mountain Chicken (*Leptodactylus fallax*) in Dominica. Has caused extinctions around globe; benefits from global warming; co-transported in amphibian trade; one of the "100 World's Worst IAS"	[16], [71]
Nile perch	*Lates niloticus*	Voracious predatory fish; Its value as a commercial species rendering deliberate introduction a risk	[81]
North American bullfrog	*Lithobates (=Rana) catesbeianus*	Adaptable to wide range of aquatic habitats, including brackish; highly competitive and voracious predator of aquatic and terrestrial species; edible frog introduced to over 40 countries for aquaculture, aquarium trade and pest control. Present in Cuba and Jamaica; one of the "100 World's Worst IAS"	[29], [81]
Largemouth bass	*Micropterus salmoides*	Tasty fish, popular with sport fishers of North American origin; deliberately introduced to many countries, including Cuba and the	[29], [81]

		Dominican Republic, where it is invasive; accidental introduction unlikely; adaptable predator of local species; one of the "100 World's Worst IAS"	
Banded shark	*Myxocyprinus asiaticus*	Omnivorous and popular aquarium fish of Asian (China) origin; naturalized escapees can turn invasive	[24]
Cholera	*Vibrio cholerae*	Alert in effect since 1 Dec 2010, in response to epidemic in Haiti. Last outbreak in Saint Lucia was 1854	This report

Another novel step would be to take measures that prevent an already present species from turning invasive, e.g. if its behaviour can be manipulated by habitat management.

In the same manner that IAS in other parts of the Caribbean (and world) constitute a potential threat to Saint Lucia, species native to Saint Lucia but absent elsewhere could turn into IAS if introduced to countries with conducive conditions. Table 9 shows 20 such species, 19 of which are terrestrial and nine of which belong to the "100 World's Worst IAS".

To date, there is no evidence of species originating from Saint Lucia becoming invasive elsewhere. However, Lovette *et al*. (1999) suspect four birds species of entering Barbados from Saint Lucia and influencing the local gene pool of Barbadian birds: the common ground dove (Zotolan; *Columbina passerine*), bananaquit (*Coereba flaveola*), the Caribbean Elaenia (Piole; *Elaenia martinica*), and the Lesser Antillean Bullfinch (Pere Noir = male, Maisson = female; *Loxigilla noctis*). Such natural range expansion and subsequent evolution should not be confused with the type of invasion discussed here in the context of preventative management.

Pathways

IAS pathways for the WCR have recently been reviewed by Meissner *et al.* (2009) and Waugh (2009), whose finding will not be repeated here. The Saint Lucia situation, specifically, was elucidated by Mathurin (2010c), who also presented import/export statistics available from SLASPA and MALFF websites, as well as boat (incl. yachts and cruise ships) and visitor statistics from the Caribbean Tourism Association and SLASPA. His report analyses both, the regulatory framework, i.e. the theory, - and the reality on the ground. Thus, it should be read together with this CSA.

Pathway management in Saint Lucia, as in most other countries, was developed to protect the nation's crops and livestock as well as export markets, and is thus driven by agriculture, particularly MALFF's CPU, whose key tasks are (Mathurin, 2010a):

- Issue plant import permits and phytosanitary certificates: For the one-year period of April 2007 to March 2008, a total of 907 plant import permits and 1,200 phytosanitary certificates were issued. The main plant products imported were onions, potato, garlic, cassava,

pineapples, vegetables, copra and cut flowers. The leading countries of origin were (in decreasing order): Canada, USA, Guyana, and Belgium

Table 9: Species native to Saint Lucia that could turn invasive and threaten biodiversity in other countries

Common name	Scientific name	Threatens	Source
Terrestrial: 19			
Shiny cowbird; Merle de Barbade	*Molothrus bonariensis*	Common throughout much of West Indies, with range expanding; Invasive in North America	[88] [25]
Antillean Crested Hummingbird; Fou-fou	*Orthorhyncus cristatus*	Flagged as threat to native birds in Barbados Also rated as common throughout West Indies	[70] [88]
Carib Grackle; Merle	*Quiscalus lugubris*	Flagged as threat to native birds in Barbados; Also rated as common in Lesser Antilles, from Anguilla to Grenada; possible introduced to Lesser Antilles north of Montserrat; Common in Trinidad	[70] [88] This report
	Q. lugubris inflexirostris	Subspecies endemic to Saint Lucia	[99]
Black-faced Grassquit	*Tiaris bicolour*	Flagged as threat to native birds in Barbados Also rated as common throughout West Indies	[70] [88]
Black-whiskered Vireo	*Vireo altiloquus*	Flagged as threat to native birds in Barbados Also rated as common throughout much of the West Indies	[70] [88]
Fire ant	*Solenopsis geminate*	Tropical plantations; threat to butterflies; already widespread globally	[25]
Little fire ant	*Wasmannia auropunctata*	Reduces arthropod diversity; painful stings. On the Galapagos, it impacts tortoises. Already widely spread, but great threat in the Pacific region. One of "100 World's Worst IAS"	[29]
Pumpwood; bwa kannon	*Cecropia schreberiana*	Fast-growing pioneer species; useful to reforest landslides and other disturbed areas; also used for building rafts and musical instruments. One of "100 World's Worst IAS"	[49]
West Indian cedar; Acajou	*Cedrela odorata*	Threatened due to overexploitation in native range. Planted exotic on several Pacific islands. Risk of invasiveness in	[25]

		disturbed areas	
Bitter bush; Fléwi Nwèl	*Chromolaena odorata*	Indigenous and very common; one of "100 World's Worst IAS"	[25], [49]
Soap bush; Kaka mèl	*Clidemia hirta*	Very common; covers clearings to extent that prevent forest regrowth; one of "100 World's Worst IAS"	[25], [49]
Blacksage; Jiwòf flè, Bwa wa tou, Pis a bed	*Lantana camara* and *L. strigocamara*	Indigenous and very common; one of "100 World's Worst IAS"; already of pantropical distribution	[25], [49]
Leucaena	*Leucaena leucocephala*	Indigenous and introduced germplasm, common; one of "100 World's Worst IAS"; already of pantropical distribution	[25], [49]
Cat's claw vine	*Macfadyena unguis-cati*	Tropical forests outside its origin (Central and South America, West Indies)	[25]
American rope; Kacho	*Mikania micrantha*	Indigenous and introduced germplasm, common; one of "100 World's Worst IAS"; already widespread globally	[25], [49]
Guava; Gwiyav	*Psidium guajava*	Some pastures and field in tropics; already widespread globally	[25]
Singapore daisy; Venvenn kawayib	*Sphagneticola trilobata*	Indigenous and common; one of "100 World's Worst IAS"	[25], [49]
Shrubby false buttonwood; Ti makònèt	*Spermacoce verticillata*	Threat to Pacific ecosystems	[25]
White cedar; Pòwyé	*Tabebuia heterophylla*	Threat to Pacific ecosystems, dry coastal woodlands and secondary forest	[25]
Freshwater: 1			
Guppy	*Poecilia reticulate*	Popular, fast-breeding aquarium fish. Invasive in wide range of aquatic habitats; threatening cyprinids and killifishes; can carry exotic parasites; already widespread globally	[25]

- Export certification; major crops certified for export for the same one-year period were bananas, plantain, mangoes, coconut and avocados, mainly to Barbados, Trinidad & Tobago and St. Maarten.
- Import inspections at official ports of entry or on consignee premises
- Diagnostics of farm pests and diseases
- Occasional surveys/surveillance activities for plant pests/diseases
- Issuance of pesticides import licenses, including benefit:risk assessments for potential classical biocontrol agents
- Farmer and Extension Officer training

Presently there is no Entomologist, Plant Pathologist, Nematologist or Weed Scientist employed with the CPU and funds to call on independent local experts are usually not available quickly enough to assist in IAS prevention. Nevertheless, quarantine is a relative strength of the CPU and only area of specialist training. Much training is on-the-job. The effectiveness of both formal and informal training is limited by staff turnover and retirements (Mathurin, 2010a).

As a mismatch to staff expertise, laboratory equipment, although fairly basic, is best for the fields of Entomology, Nematology and Plant Pathology. Thus, the actual diagnostic capability of the CPU is limited, forcing it to source outside assistance, e.g. from CABI's Plant Clinic, which can provide identifications free of charge but then takes a long time, or from CariPestNet and PestNet, two email networks. Mathurin (2010a) also judged the infrastructure at the CPU as inadequate. Monitoring ports of entry for exotic fruit flies is a work plan priority, but has been severely hampered by the lack of transportation; two pick-up trucks purchased in 2010 should alleviate transportation issues.

Two plant quarantine officers are stationed at the Hewanorra International Airport and Port Castries, respectively, where facilities, which are under the control of SLASPA, also leave room for improvement. For example, there are no incinerators, nor areas specifically earmarked for inspection of plant product consignments, vessels, containers or vehicles. This applies to imports as well as exports (Mathurin, 2010a). The author recommends that all future development plans for Saint Lucia ports of entry, including marinas, should include facilities for plant quarantine services, such as office spaces, secure inspection rooms, inspection and basic laboratory equipment. Areas at the sea ports need to be designated for inspection and/or treatment of lumber, container cargo, wood packing materials, used vehicles and heavy equipment. Furthermore, incinerators and fumigation chamber are needed nearby, also to handle disposal of waste from yachts and schooners. Concrete recommendations for the establishment of a centralized database are provided. Finally, Mathurin (2010a) stressed the importance of cooperation between agencies, including the CPU, the Customs & Excise Department, SLASPA, shipping agencies and the tourism sector in fulfilling their role in protecting Saint Lucia from IAS. The three major gaps – in theory and practice – highlighted in Mathurin's (2010c) report fall into this category:

- Organic waste from most ships other than cruise ships, incl. yachts, enters the normal garbage stream, i.e. is disposed in local landfills without treatment
- Heavy construction and military vehicles are occasionally brought to Saint Lucia from other countries without inspection for soil and other contaminants
- Equipment used during international and regional event, e.g. sports championships, are not inspected with the same due diligence as other imports.
- Accidental escape and deliberate release of pets, including aquarium species

Recently, the pet trade has grown in importance as an avenue of arrival and spread for invasive animals into terrestrial and aquatic ecosystems. Informal breeders are particularly worrisome, as they are neither registered, nor regulated, nor controlled. Their facilities tend to be less secure and no meaningful records of who receives animals can be reconstructed. It is believed

that monkeys, alien iguanas, alien parrots and doves have escaped captivity of non-licensed holders. The Eurasian collared-dove (*Streptopelia decaocto*) is an extremely successful invader that competes with endemic birds and may transmit disease [25]. Prevention of animal diseases entering and leaving country is regulated (GOSL, undated b and c), but the laws addressing the risk of the vector becoming invasive is a legislative gap.

Not all IAS are introduced by human action. Locusts were found on the island after the passage of Hurricane Allen in 1980 but soon disappeared (GOSL, 1998), presumably through predation by birds. It can be argued that hurricanes are natural, albeit catastrophic, events that mediate natural spread. However, climate change – which is accelerated by human action – is forecast to increase hurricane strength and frequency. Thus, and also because of the severe effect these IAS can have, management of IAS spread by storms should be considered. Mathurin (2010c) considered both man-made and natural pathways in his analysis and the reader is referred to that detailed document for further information.

Risk Assessment

With the exception of pest risk analyses and animal/human health assessment, very little systematic risk assessment is carried out in Saint Lucia. For example, the import of an animal species depends almost exclusively on the risk of co-introducing animal pathogens, but not on the risk of the animal species itself becoming invasive. Keeping wild animals furthermore requires a permit of the Forestry Division, but with the objective to protect wildlife from capture and removal from wild stocks. The Fisheries Department is a bit farther, stipulating import permits for all aquarium fish. Subsequent breeding of fish and other animals, however, is not regulated.

Off-shore Islands Management for the Establishment of Metapopulation of Critical Species

The concept of metapopulations as management approach to critical species could be dealt with under the headings “prevention” as well as “early detection, rapid response and control”, as frequently selected sites - in this case off-shore islands (Figure 7a) - first need to be freed from IAS. Subsequently, critical species can be re-introduced there to establish metapopulations. As part of on-going management, these sites need to be maintained IAS-free. Since the long-term management (hopefully) falls under “prevention” it is presented in this section and picked up later as appropriate.

The off-shore islands of potential significance for threatened endemic vertebrates and predatory IAS are: Dennery Island, the Maria islands, Praslin Islands and Rat Island. The latter two are only 1 ha each; other off-shore islands are even smaller and thus too small to sustain viable vertebrate populations. The exceptions are Rouche Island (about 1 ha), which is too close to shore, and Scorpion Island, which is similar size but regularly flooded with seawater.

The Forestry Department, together with DWCT, cleared the following islands of IAS predators: Praslin Island in 1993 and 1995, Dennery Island in 2005 (but livestock reappeared – Figure 7b), and Rat Island in 2005. Both the Maria Islands appear to have been rat-free in recent history,

but others (Rouche and Frigate) require a survey.

St Lucian Off-shore Islands

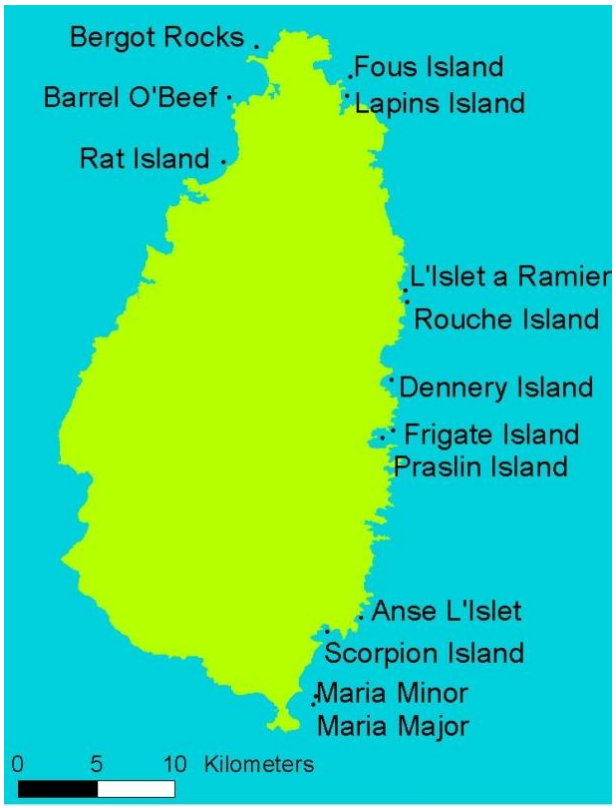


Figure 7a (left): Saint Lucia's off-shore island can provide a safe haven from IAS predators for metapopulations of several endemic species if they can be kept IAS-free.

Figure 7b (right, from top): Feral sheep and goats on Dennery island seem to survive on moisture in vegetation when the rainfed waterhole (below) dries out (Photos: Matthew Morton, Durrell Wildlife Conservation Trust)

Background to Component 4 Pilot Project Site and Activities

Maria Islands and the Pointe Sable Environmental Protection Area (PSEPA)

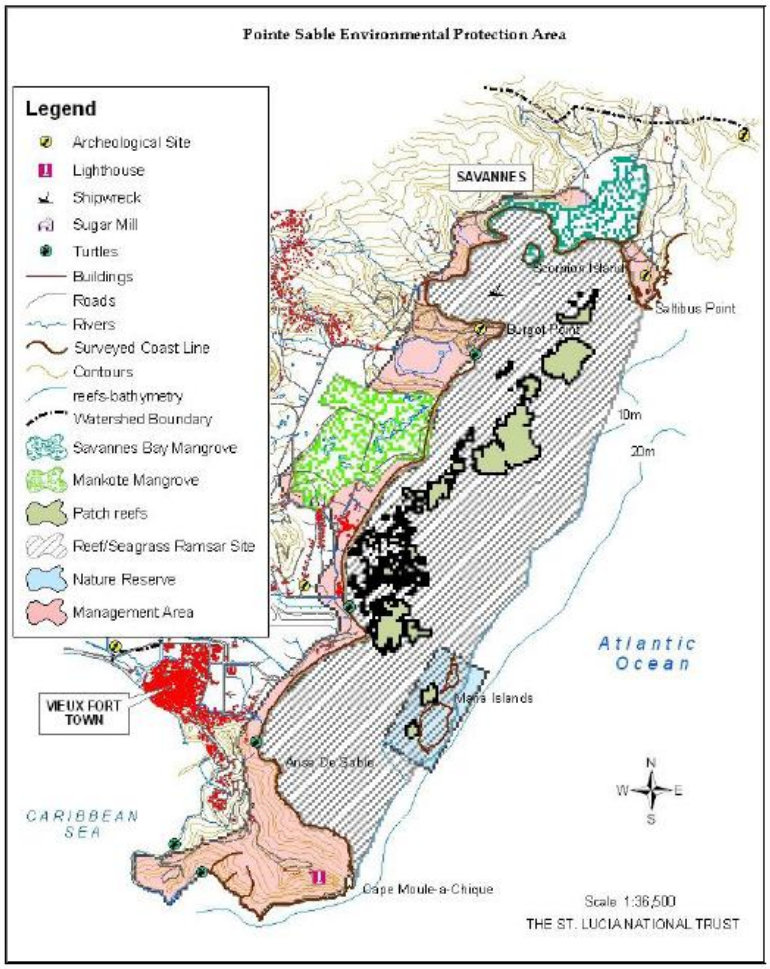


Figure 8: Pointe Sable Environmental Protection Area

The Pointe Sable Environmental Protection Area (PSEPA; Figure 8) was gazetted in August 2007. It is defined as reaching from Pointe De Caille to Moule A Chique, including Savannes Bay and Pointe Sable in the quarter of Vieux Fort. The designated area consists of a narrow coastal strip of Queen's Chain, the Savannes Bay Mangroves and Mankoté Mangroves, as well as the offshore islands Scorpion Island and Maria Islands. Thus, both of Saint Lucia's Ramsar sites lie within the PSEPA. Its seaward boundary follows the 20-metre depth contour, running from Pointe De Caille southwards to Moule A Chique. The total area encompasses approximately 1,038 hectares of land and sea (Gardener, 2009). Physical demarcation of the marine boundaries is foreseen under the GEF-funded IAS project.

The two Maria Islands, Maria Minor and Maria Major together are about 25 acres in size and form part of the PSEPA (Figure 8). Of all the protected areas of Saint Lucia, Maria Island (Major) contains the most threatened, endangered and endemic reptile species. The island is located 1000 yards off the southeastern coast of Saint Lucia. There are eight reptile species of which five are endemics: the tree lizard (*Anolis trinitatis luciae*), the Saint Lucian fer-de-lance snake (*Bothrops caribbaeus*), the Saint Lucia pigmy gecko (*Sphaerodactylus microlepis microlepis*), the Saint Lucian racer, and the Saint Lucia whiptail lizard. This high rate of endemism on such a vulnerable small fragile area/ecosystem is of serious concern, more so since the area is both a marine reserve and a bird sanctuary, which make it vulnerable to IAS that could be carried there from land, sea or air via natural or human means, such as avian influenza or rats, respectively. The original CSA [55] specifically recommended the

establishment of an Invasive Species Coordination Agency. National stakeholders prioritised Maria Island as the pilot site for preventative measures because of high endemism and its importance for nesting seabirds. IAS constitute a significant potential threat for this unique and relatively intact ecosystem, with possibly the biggest threat coming from the Pacific lionfish (Figure 9).

Scott (1998) cited a number of earlier studies describing the marine ecology of the Maria Islands' area, particularly the coral reefs. She also laments that there has been no efficient attempt to accurately determine and map the extent of reef habitats around Saint Lucia. Due to the global significance of the biodiversity resources on the Maria Islands, some stakeholders consider these islands to be the single most important location within PSEPA for biodiversity conservation. While the islands are currently free from mammalian IAS, they have to be actively managed to maintain this status (Gardener, 2009).

Figure 9: Pacific lionfish (*Pterois volitans*) is one of the regional IAS still absent in Saint Lucia. Awareness about this threat will be raised and island-wide monitoring initiated, involving public and private sector.

The only IAS currently believed to be present on Maria Major is the Antilles Leaf-toed Gecko, *Hemidactylus palaichthus*, which was first described in 1969. While it is common and widespread in Central America and occurs on Trinidad & Tobago, in the Antilles, it is known to occur only on Saint Lucia. *H. palaichthus* could have been accidentally introduced by Amerindians or more recent travellers from Latin America, or may have reached Saint Lucia on natural rafts a long time ago (Daltry, 2009b). Its distribution pattern on Saint Lucia is unusual, as it neither seems to be very commensal (thriving in urban, agricultural or other disturbed areas) nor spreading from possible entry points; instead, the main stronghold of this lizard is Maria Major, which is otherwise remarkably free of alien species. It is unclear to which extent this species may be competing with vulnerable endemic reptiles, such as the St Lucia whiptail, *Cnemidophorus vanzoi*.

Metapopulation Management of the Vulnerable Saint Lucia Whiptail Lizard on Four of Saint Lucia's Off-Shore Islands

Historically, *C. vanzoi* is assumed to have occurred across Saint Lucia. However, when it was first described to science in the 1960s, this species was known only from the two Maria Islands. This species is presumed extirpated from the mainland by introduced predators, such as cats, dogs, rats, mongooses, as well as damage to native vegetation from goats. These predators have never been introduced to the Maria Islands.

The Saint Lucia whiptail is one of the highest priority reptile species for conservation globally. It is endemic to Saint Lucia and no other species in this genus is found in the Eastern Caribbean. Its global threat status is "Vulnerable" but needs updating and could be justifiably increased to "Endangered" (Daltry, 2009a).

Morton (2009b) summarized additional detail on the biology and management of the Saint Lucia whiptail. Daltry (2009b) believes this species to be an important, possibly essential, prey species for the Saint Lucia racer. This harmless snake, also an endemic, was probably once widespread across Saint Lucia, but is now restricted to Maria Major (12ha), an island that has fortuitously remained free of alien invasive mammals, but represents only 0.02% of its former range and even there, its population size remains very low, so that its global threat status of "Endangered" should probably be increased to "Critically Endangered" (Daltry, 2009b).

The DWCT and the Saint Lucia Forestry Department eradicated rats on two other off-shore islands to allow the lizard population to grow through translocations. The way for survival of the Saint Lucia whiptail was paved with the establishment of metapopulation of this rare species on Praslin Island (1995) and on Rat Island (2008) (Morton, 2009b). The rat-free status of these islands is maintained though a network of rat bait stations that provide an early warning mechanism in case of re-invasion. This work has been funded by the Balcombe Trust and Syngenta, with support from Sandals Hotel.

With the world's entire population of the Saint Lucian whiptail restricted to three isolated sites, collectively of just 14 hectares, the threat from stochastic events such as storms remains high. For animal populations on off-shore islands, the threats from global climate change, with a predicted increase in storm surges and hurricanes, as well as sea-level rise, exacerbate the direct danger, as they are likely to reduce the size and quality of Maria Islands. The xeric vegetation found on Saint Lucia's off-shore islands is very prone to wildfires, which could have a devastating impact on the fauna of these isolated sites (Morton, 2009b). Thus, the islands remain open and vulnerable to anthropogenic and natural activities from land, sea and air. Specifically, IAS and fire are considered to be critical threats.

While the Maria Islands were gazetted as a Nature Reserve in 1988 and vested in the SLNT, Rat Island, which is Crown Land, was vested in the Rat Island Foundation (an initiative of Nobel Laureate Derek Walcott), but its current protection status is unclear. Praslin Island belonged to the Dennehy Estate and was acquired by the developer of Le Paradis, who has yet to fulfil conservation promises made to authorities. Key recommendations for the conservation of the whiptail include: (Daltry, 2009b, Morton, 2009b):

- 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).

- 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

A management plan covering 2009-2014 has recently been developed under another GEF-funded project, commissioned by the Environment and Sustainable Development Unit (ESDU) of the OECS and is an output of the OECS Protected Areas and Associated Livelihoods (OPAAL) Project. The plan presents detail for institutional involvement and responsibilities. Issues related to invasive species management within the PSEPA are vested in the Forestry Department of MALFF, which also functions as the National Focal Point for the Ramsar Convention. IAS are listed among the eight critical threats to the PSEPA. Cats, dogs, mongoose, and rats are considered the most immediate threats. The development and implementation of a site-specific invasive species management strategy and plan is a foreseen activity for the PSEPA under the OPAAL project (Gardener, 2009).

Early Detection, Rapid Response and IAS Control:

Agricultural Pests and Diseases

Acknowledging a problem is the first step on the road to a solution. Mathurin (2010a) judged MALFF as historically very open and forthright with respect to reporting agricultural pests and diseases. As soon as a new pest's identification had been confirmed by the relevant taxonomic authority, the presence of the pest was reported to the FAO Sub Regional Office in Barbados. Communication and information exchange with other NPPO's is done as required and to the FAO Regional Plant Protection Officer either directly, or through the Permanent Secretary of the MALFF. Recent examples of introductions in Saint Lucia mentioned are: Eriophyid Coconut Mite (*Aceria guerreronis*) – 1980; Oleander moth (*Syntomeida epilais*) – 1982; Desert African locust (*Schistocerca gregaria*) – 1988; Melon thrips (*Thrips palmi*) – 1994; PHMB – 1996; Varroa mite (*Varroa destructor*) – 1998(?); GAS – 2000; Citrus leafminer (*Phyllocnistis citrella*) – 2000; Gliricidia moth (*Azeta repugnalis*) – 2001; Red Palm Mite (*Raoiella indica*) – 2004; Chili thrips (*Scirtothrips dorsalis*) – 2004; Fungal blight in *Cupressus lusitanica* (*Cercosporidium sequoiae) – 2005;* White cedar thrips *(Holopothrips iniquilinus)* – 2007. In the era of the internet, the 2010 detection of Black Sigatoka in Saint Lucia seems to have been first circulated on the (Pacific-focussed) PestNet on 10 Feb., 2010, even before the official Government release was issued.

Morton (2009c) investigated the use of wildlife in Saint Lucia. Hunting for game meat of native and alien wildlife was assessed. The questionnaire also included questions on the perceived trend of population levels. The mannikou or opossum (*Didelphis marsupialis*) and the agouti (*Dasyprocta leporina*) are believed to have been introduced by Amerindians and thus, according to the definition used in this report, count as native. Despite being protected under Schedule One of the 1980 Wildlife Protection Act, prohibiting all except licensed (Section 10) hunting of these species, they are widely harvested. There is little doubt that the mannikou is a predator that affects populations of rare and threatened Saint Lucian wildlife. It is possible that the protection enjoyed by the mannikou in the Forest reserve negatively affects other species of

higher conservation priority. Feral pigs are IAS and not protected as a species. Hunting them in the Forest Reserve, where they thrive, however, is illegal, albeit largely tolerated by authorities. It would be advantageous to regulate licences hunting of feral pigs given their devastating impact on wildlife, forest tree recruitment and livelihoods (largely by destruction of home gardens). This should be accompanied by impact assessment and monitoring of control efforts as well as success (Morton, 2009c).

Impact Assessment

Quantitative assessment of IAS impact in the Caribbean is in its infancy. The Caribbean Regional Agriculture Policy Network (CaRAPN) estimated that the total economic loss due to PHBM amounted to US$138 million. It biological control in Trinidad & Tobago during a six-year period had a net benefit of nearly US$35 million and a benefit:cost ratio of 8:1 [10]. CaRAPN predicts the Carambola fruit fly (*Bactrocera carambolae*) to cost as much US$212 million per year should is spread from its current range in Guyana and Suriname throughout the WCR. Annual losses due to livestock infestation by the New World Screwworm in Jamaica were estimated at between US$5.5 million and US$8.8 million in 1998 [10]. While no comparable data were found for Saint Lucia, a few economic assessments of natural resources and associated biodiversity in Saint Lucia are available to form the cornerstone for subsequent elaboration.

Biodiversity is an economic resource and its services produce a wide range of economic benefits. They are broadly described as “use” and “non-use” benefits. These are further broken down into direct and indirect use benefits. Direct use benefits are generally the end products of an ecosystem: timber, fish, or tourism. Indirect benefits are the services or functions provided by an ecosystem: water retention and flood control provided by forests; beach protection and nursery grounds provided by coral reefs. Non-use benefits are the intangible values that individuals or societies may derive from simply knowing that a certain ecosystem exists, whether they actually use it or not (Ruitenbeek & Cartier, 2000). Box 1 provides a summary to relevant terminology economists use to convert natural resources into quantifiable monetary units.

Invasive species may cause major economic losses to society, whether in the form of direct economic impacts, such as loss of agricultural or fishery production, or secondary economic impacts caused, for example, by human health issues. IAS also have negative impacts on ecosystem services upon which humans depend. They change ecosystems in ways that affect flooding, erosion and silt accumulation, water and air quality. These are not easily quantified and are often excluded from the analysis of costs associated with IAS.

While the costs of prevention, control and mitigation measures to avoid biodiversity impacts can be measured, assessing the impacts of IAS on biodiversity is not as straightforward: what is the value of an extinct species or a change to the ecosystem? Economists tend to quantify costs on an annual basis, while impacts due to IAS tend to increase in severity, as IAS population increases over time. Most importantly, the impacts of IAS on natural ecosystems are usually irreversible.

Box 1: The Economic Value of Natural Resources - Terminology [4]

Natural and biological resources:

- Natural resources are natural assets (raw materials) occurring in nature that can be used for economic production or consumption.
- Biological resources can be timber resources, crop and plant resources, aquatic resources, and terrestrial animal resources that bring use benefits today or that may do so in the future. Each category of biological resource in the System of Integrated Environmental and Economic Accounting (SEEA) asset classification is subdivided into cultivated and non cultivated ones.

Benefits:

- Use benefits include both direct and indirect benefits. Use benefits also include option and bequest benefits.
- Direct use benefits include the use of environmental assets as sources of materials, energy or space for input into human activities.
- Indirect use benefits do not change the physical characteristics of the environment and are sometimes described as being "non-consumptive". The amenity benefit of landscape is one example.
- Option benefits are those derived from the continued existence of elements of the environment that may one day provide benefits for those currently living.
- Bequest benefits are derived from the continued existence of elements of the environment because they may one day provide benefits for those yet to be born.
- Non-use benefits are the benefits provided by an environmental entity, the existence of which is considered desirable to be maintained, although it has no prospect of being of use to humans now or in the future.

Economic Assessment of Saint Lucia's Natural Resources and Related Benefits

In preparation for the development of the NBSAP, Ruitenbeek & Cartier (2000) conducted several case studies to assess the economic value of the terrestrial and marine biodiversity and aimed to demonstrate how economic policy mechanisms can be beneficially used to protect biodiversity. Their biodiversity valuations focussed on use values (Box 1). The authors recognised the importance of biodiversity (genes, species, ecosystems) both in terms of its end products (fish, timber, fresh water, *etc.*), and in its functional values (erosion control, storm protection, nursery, etc.). However, only the economic values for those biological resources that pass through formal markets were estimated.

In 1997, Agriculture contributed 6.93% of GDP in Saint Lucia, tourism 44% and hotel and restaurants 13% (Ruitenbeek and Cartier 2000). These authors estimated the proportion of traditional natural resource extraction activities across OECS countries as representing about 6% of GDP. They distinguished this figure from tourism, which they estimated at 43% of GDP,

[4] Source: Organisation for Economic Co-operation and Development (OECD) Glossary of Statistical Terms, http://stats.oecd.org/glossary/index.htm

with just over 13% depending directly on maintaining a healthy environment. On the other hand, terrestrial and coastal/marine biodiversity accounted for 15% and 49%, respectively (Figure 10).

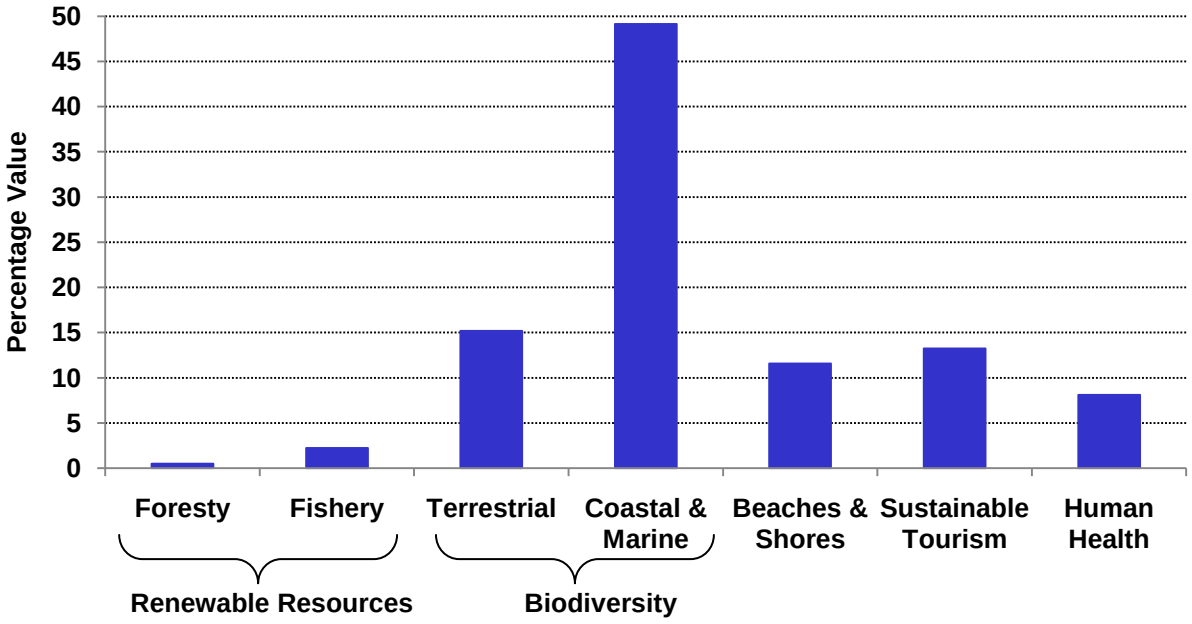


Figure 10: Estimated economic benefits of maintaining environmental quality in OECS member states (adapted from Ruitenbeek & Cartier, 2000; total value for OECS: EC$1,614 million).

Table 10 provides valuations for the use benefits of terrestrial and marine ecosystems of Saint Lucia. The direct use benefits of food production, raw materials, and tourism are estimated for the rainforest, mangrove, and marine protected area (MPA) classifications. Only food production was estimated for open oceans; calculation was based on a per-ha-and-year value of the potential marine catch at average market prices, applied to the EEZ area of each country. Other benefits of the open ocean, such as gas regulation and nutrient recycling, were omitted. About 44% of Saint Lucian shoreline depends on coral reefs for protection. Burke *et al.*, (2008) estimated that this ecosystem service was worth between US$28 million and US$50 million in 2007.

Indirect benefits estimated include: water supply regulation, erosion control, soil formation, waste treatment (for rainforest and scrub forest); storm protection and nursery function (for mangrove), waste treatment, disturbance regulation, habitat/refugia (for MPA). Base values were derived for 1994 and escalated by 3.5 per cent a year to arrive at representative values for the year 2000. According to this approach, the total annual biodiversity use benefit for Saint Lucia amounts to EC$132 million (Table 10).

Several case studies homed in on specific areas and quantified their value in greater detail (Figure 11). For example, in Saint Lucia's Mabouya Valley, Ruitenbeek & Cartier (2000) found ecosystem services to surpass the net value of agricultural production; the study did not

consider the watershed's recreational value, e.g. through tourism in Fond d'Or. The annual value of water quality was estimated at EC$4 million, costal land protection at EC$3-6 million, while agriculture accounted for EC$2-5 million per year.

Table 10: Annual use benefits of Saint Lucia's natural resources in million EC$ (Ruitenbeek & Cartier, 2000).

Natural Resource	**Use Benefit in EC$[5] million yr^{-1}**
Terrestrial	
Rainforest	33
Mangroves	4
Grassland/Rangeland	<1
Scrub and Plantation Forest	2
Total Terrestrial Use Benefit	**39**
Marine	
Marine Protected Areas	13
Open Ocean	80
Total Marine Use Benefit	**93**
Total Biodiversity Use Benefit	***132***

A recent analysis of goods and services provided by the SMM Area is available (Anonymous, 2010). The users of the area include fishers, yachtspersons, recreational divers and the wider community for other recreational purposes. Reef related tourism as well as fishing activities are critical components of this management area as there are resources which provide opportunities for a variety of economic and livelihood activities. Reef related tourism in the SMM Area refers specifically to scuba diving, snorkelling, operation of day charters and the operation of glass bottom boats. The author applied the valuation methodologies of the World Resource Institute (WRI). The coral reef valuation involved the estimation of the economic benefits that are gained from the presence of reefs. However, some of the less tangible benefits such as future use and existence value are much more difficult to quantify. As such, the WRI Valuation Tools only accounted for estimates of revenue generated (direct use value) from the reefs and not other values such as those derived from primary production and shoreline protection. The total economic value of US$21.7 million (Table 11) is therefore believed to be an underestimate of the overall value of the goods and services provided by these reefs. For the whole of Saint Lucia and also using the WRI methodology, Burke *et al.* (2008) estimated coral reef-related direct and indirect impacts to have amounted to US$160-194 million in 2006.

[5] US$ 1.00 is equivalent to EC$ 2.70

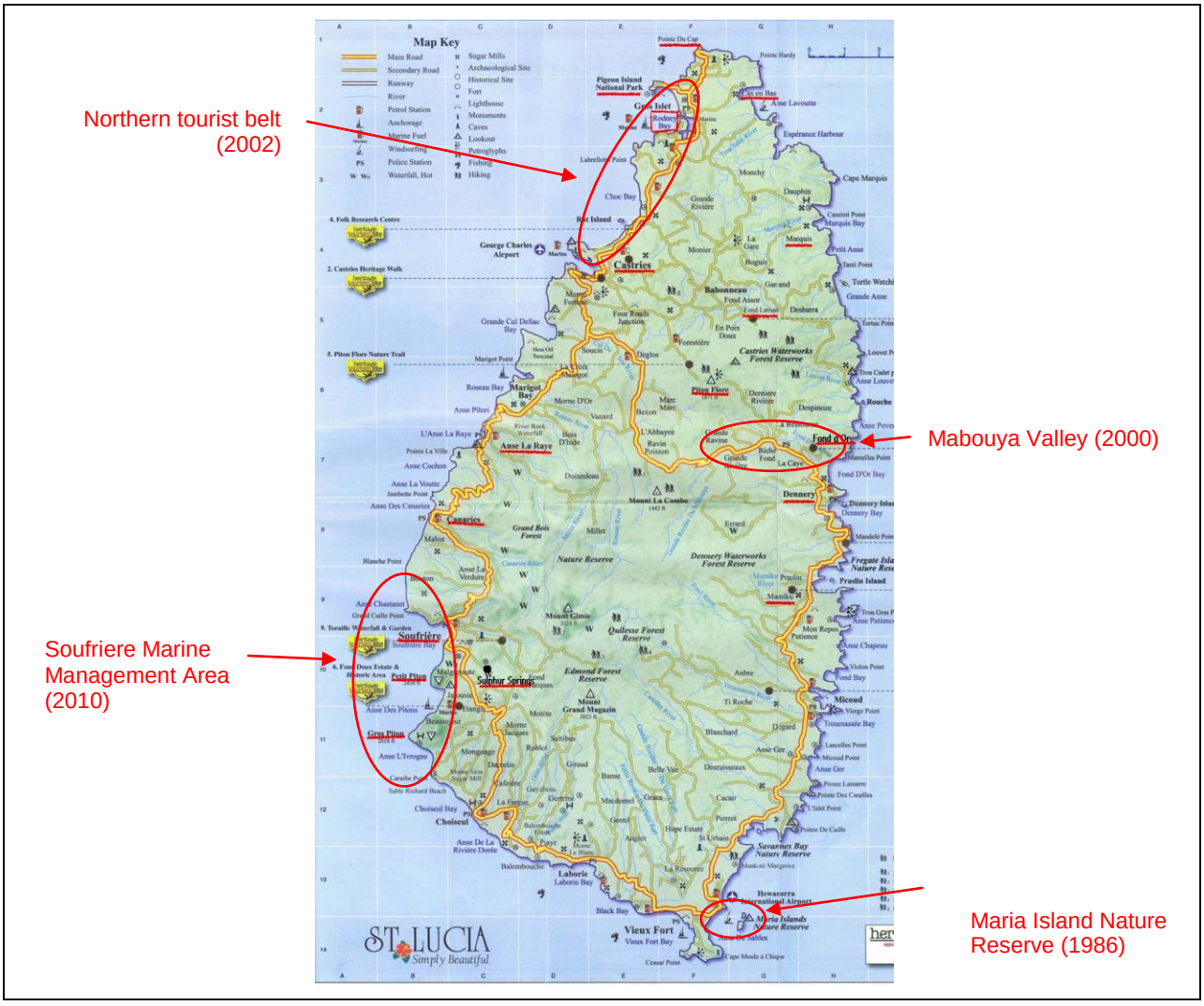


Figure 11: Overview of locations of detailed case studies on environmental economics carried out in Saint Lucia

Key environment/economy linkages for beach areas relate to their function as critical buffer zone, e.g. against storm surges, their use as recreational land and as a resource for road and building construction, although sand mining is regarded a problem. On Saint Lucia, the land asset value of the coastal areas of the country, taken as a minimum 20 meter setback, was estimated to be approximately EC$300 million (Ruitenbeek & Cartier, 2000). Dharmaratne & Strand (2002) quantified the economic value of beaches along the prime tourist belt of Saint Lucia, running north of Castries to Pigeon Point. The use value of beaches for local residents during a six-month period ranged from US$3.9 to 4.9 million.

Saint Lucia's experience with economic valuation of natural resources remains relatively incomplete. One of the difficulties encountered is the lack of data to undertake the economic valuation using market based techniques, possibly with the exception of certain pests of agricultural products. In order to enable Government officials to take informed decisions on

investment for IAS management, an economic assessment of IAS impacts is urgently needed. Only then can meaningful cost-recovery mechanisms be put in place.

Table 11: Summary of total economic impact of reef-related tourism and recreation in the Soufriere Marine Management Area as estimated by the World Resource Institute Valuation Tools (Anonymous, 2010).

Source of Revenue	Total Value (net, inclusive of amounts transferred to economy) in US$
Value captured by tool	
Accommodation	8,409,942
Diving	8,837,339
Snorkeling and Boating	1,010,342
Marine Parks	432,741
Other Direct Expenditures	440
Total Captured Economic Impact	**18,690,804**
Uncaptured Value	
Local Use of Coralline Beaches	0
Local Use from reef recreation	0
Diving Consumer Surplus	2,661,849
Snorkeling Consumer Surplus	304,320
Total Estimated Economic Impact	**21,656,973**

Conservation Cost Recovery

The management objective associated with sustainable management of a renewable resource is to maximise economic returns without threatening the ability or opportunity for future generations to enjoy similar returns. A key indicator of sustainability is "rent capture". Rent capture refers to the amount of economic rent that is captured by existing management mechanisms. The few documented interventions have been regulatory in nature and have not substantially used fee or royalty structures to extract resource rents. One outstanding policy issue throughout OECS relates to national property rights associated with biological resources. Bioprospecting, particularly in marine ecosystems, is of growing importance, and mechanisms for capturing rents from such activities, such as joint-venture agreements, royalties, or prospecting fees, are rarely in place (Ruitenbeek and Cartier 2000).

The few documented examples of cost recovery for biodiversity conservation efforts are clearly understudied. Direct taxation is the simplest approach, but not always feeds back into conservation of biodiversity. A Forestry Tax contributed EC$60,000 to Saint Lucia's central budget in 2000 and nature trail fees another EC$233,000 for the Forestry Department in 1999. The Fisheries Department made EC$5,000 from scuba licenses. A number of environmental levies on vehicles (EC$300-400), tyres (EC$5-10), used refrigerators and freezers (EC$20), and batteries (EC$10), empty containers and goods in containers made of plastic, glass, metal or

paperboard (1.5% c.i.f.) as well as imported goods regarded “non-essential” (1% c.i.f.) are estimated to have amounted to EC$ 4.6 million Government revenue for the budget year 2000. (Ruitenbeek & Cartier, 2000).

As early as 1986, the GOSL commissioned the OAS to quantify the economic value and cost-recovery potential via sustainable eco-tourism for the Maria Islands Nature Reserve (Kolcuoglu, 1986). While the general principles still apply, the actual figures are now out of date. However, an implementation attempt was abandoned after a few years, presently it covers, at best, direct cost.

An instructive example of an attempt to introduce economic incentive policies for conservation is the SMM Area management plan. Based on an extensive public process, involving all users, 11 kilometres of coastline were divided into five zones to accommodate all biodiversity uses. The management plan was presented to the community in 1994; by 1997 resource use conflicts had escalated to the point that a review of the SMM Area was undertaken. The review recommended institutional reforms and a restructuring to permit collected revenues to be recycled within the project area. Experience to date suggests that regulatory mechanisms by themselves are inadequate to promote biodiversity. Subsequent to the implementation of reforms at the SMM Area, greater success is being realised as revenues are now being recycled within a strengthened decentralised authority. The types of fees being collected in the SMM Area include a marine reserve dive fee (US$12 annual or US$4 daily) and a Coral Conservation Permit for mooring that ranges from US$10 to US$25, depending on the size of vessel and duration of stay; these amount to over EC$200,000 annually. This is a positive example of how biodiversity rents can be captured and used beneficially for promoting protection of the asset (Ruitenbeek and Cartier 2000).

Such direct mechanisms are relatively simple to implement and surveys worldwide indicate that those paying such fees are quite willing to do so, if the charges directly support conservation and protection efforts. Resource rents include profits to industry and individuals, as well as returns to government in the form of licenses, fees or royalties. GOSL revenue from forestry management was given as 25% of total resource value and 21% of management expenditure. As such, it was flagged as a positive example within the OECS for adequate pricing. The major source of income here was associated with forest tours, indicating that fees from this recreational activity are being used positively as a sustainable means for rent collection (Ruitenbeek and Cartier 2000).

Ruitenbeek & Cartier (2000) concluded that policy interventions are likely to have both a revenue impact and an incentive effect. The use of earmarked revenues creates an important focal point for decentralising decision-making authority and provides greater incentives to local resource users to manage resources sustainably. It can also fund capacity building: institutional strengthening is viewed as a co-requisite to the successful implementation of any policy intervention and should go hand-in-hand with the implementation.

With respect to IAS, the cost of correcting environmental damage is many times higher than preventing damage and maintaining adequate levels of environmental quality in the first place.

Moreover, in some instances restorative costs are effectively infinite where damages are irreversible. The application of economic instruments is an important cost-saving tool in this regard. The "user pays" principle needs to be applied to requests for permits to introduce a new species. The user, or 'responsible party,' is the entity which seeks to conduct the activity that may result in an IAS introduction, and who will benefit from it. Therefore any costs associated with the process, and the burden of proof for demonstrating compliance with regulations, should fall upon the user. Permits for intentional introductions should involve a fee structure that not only covers administration costs of management, including risk analysis, but which also addresses the issue of liability, should the species in question become invasive. There is also a need to introduce financial penalties for non-compliance with regulatory requirements in the case of both intentional and unintentional introductions. Furthermore, the risks associated with operating various known pathways (such as cargo handling or international flights) should be assessed, costed and paid for by the users of the pathways. For example, airport departure taxes are a way of making those who travel pay for the procedures of screening for propagules at customs checks.

The implementation of mechanisms for financial sustainability has become a routine conditionality of loans and grants for protected areas. Saint Lucia's draft Second NBSAP proposes a three-year project "Biodiversity and Tourism" for mainstreaming biodiversity management into sectoral policies, plans, regulations and procedures, at a cost of EC$486,000. The recently established protected areas within the SMM Area are working towards full or partial financial self-sufficiency.

Another success story is presented by Geoghegan (1998): Saint Lucia's Pigeon Island National Landmark. Entrance and visitor fees are supplemented by souvenir shop sales in many locations. At Pigeon Islands, the process was facilitated by a major infrastructure project, with Canadian funding, in the early 1990s. Subsequently, the entrance fee was increased and revenue rose from around US$34,000 in 1992 to over US$175,000 in 1997. Additionally, fees for cruise ships anchoring off Pigeon Island amounted to US$12,000. However, special events staged at Pigeon Island make all the difference. They range from regular weddings (grossing about $25,000 in 1997) to annual events, such as the SLNT's International Food Fair and Saint Lucia's renowned International Jazz Festival. In relation to IAS, it is noteworthy that, alien invasive lemongrass (*Cymbopogon citrates*) is considered a significant fire hazard at this popular park (Graveson undated, Lewis & Gustave, 2010; Figure 12). It is also an excellent pioneer on burnt land, creating potentially a vicious circle with hazard risk proportional to visitor numbers. Smoking is not permitted in the park as a preventative measure.

Climate Change and IAS Management

Excessive greenhouse gas emissions and increased greenhouse effect result in a distinct warming of the earth. This global warming is causing climate change: melting ice caps, changing weather patterns and ocean currents, increasing extreme weather events and spread of disease. Climate change, therefore, is causing overwhelming changes to ecosystems and their services. For example, Hurricane Andrew, in 1992, had multiple effects: it facilitated a population explosion in large feral iguanas and invasive vines in Florida (Masters & Norgrove,

2010) and damaged an aquarium that led to an escape of lionfish (US National Park Service, undated). The cactus moth (*Cactoblastis cactorum*) is believed to have been blown from the Caribbean, where it had been introduced as a biocontrol agent of invasive *Opuntia* cacti, to Mexico during the 2005 hurricane season, where it poses a significant ecological and economic threat to over 104 *Opuntia* spp., 38 of which are endemic (Mafokoane, cited in Burgiel & Muir, 2010). Tropical regions are forecast to receive even more precipitation (Masters & Norgrove, 2010). Riverbanks are particularly vulnerable to severe rain and flooding. Such disturbed habitats subsequently provide an opportunity for invasion by pioneer plants. Furthermore, inundation helps spread certain propagules.

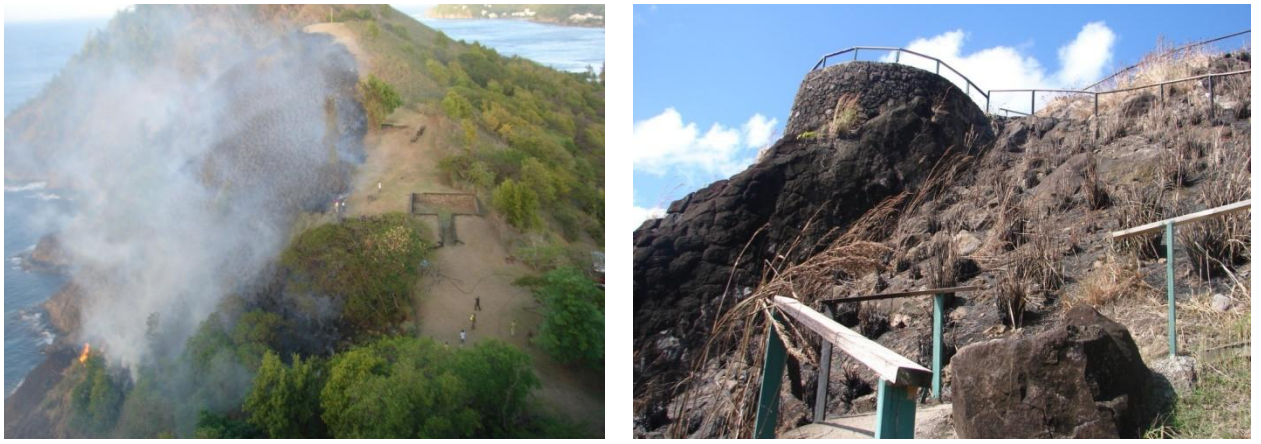


Figure 12: Highly flammable lemongrass (*Cymbopogon citrates*) and human activity create a very real wildfire risk at Pigeon Island National Landmark. Burn slopes are quickly re-invaded by pioneer species, such as lemongrass, closing a vicious circle (Photos from Lewis & Gustave, 2010).

Loss of genetic diversity, stochastic effects and climate change are serious impending threats to the species and subspecies that are scarce or confined to Saint Lucia's offshore islands (Daltry, 2009b). Thus, adaptation to climate change in Saint Lucia should start also considering the effect of climate change on IAS. The Saint Lucia National Climate Change Policy and Adaptation Plan (GOSL, undated d) has this aim. The document stressed that the wetlands of Saint Lucia are relatively small. In recent years, their area has been reduced from 320 hectares to 193 hectares, with some wetlands being under considerable stress. Some of Saint Lucia's most critical species inhabit coastal areas and the already very limited high-altitude forests. These habitats, including off-shore islands, are at most risk from climate change.

Unfortunately, global cumulative knowledge on IAS and climate change almost exclusively focuses on range expansion of tropical organisms into temperate regions as a result of global warming. Close to nothing is known in the effect of climate change on IAS dynamics on SIDs, except that increased hurricane frequency and intensity are foreseen to spread potential IAS more widely. Another mechanism influencing IAS distribution could be predicted changes in water regimes. Both higher rainfall and more severe droughts are foreseen in some models.

The latter could foster wildfires, which in turn interact with the flora, particularly pioneer species – and most IAS are excellent pioneers.

The plant species considered to be at highest risk from climate change today are the endemic Saint Lucia lobelia (*Lobelia santa-luciae*), the pencil cedar (*Juniperus barbadensis*) and *Bernardia laurentii*. The Saint Lucia lobelia is confined to highest elevation vegetation types; although currently well protected, it is at highest risk to be among the first species to be lost to climate change. The latter two species occur only on the summit of Petit Piton, where they are at risk from fire and invasive ornamentals (Daltry, 2009a).

Saint Lucia joined the Florida-Caribbean Fire & Invasive species (FL-CR) Learning Network in November of 2008. The focal point for the network in Saint Lucia is Davis Lewis, with involvement of additional representatives from Forestry, Agricultural Research, the Fire Department, the Coastal Zone Management Unit, and the SLNT. The network seeks to collaborate with practitioners across the region in order to assess the state of knowledge about the interactions of fire and invasive plants, including:

- fire management practices related to control and susceptibility
- influence of invasive species on fire regimes
- influence of fire on invasive species dynamics
- influence of land use and land management practices on invasive species and fire.

It then hopes to:

- Identify and prioritize management information needs and related research needs;
- Identify critical barriers to the prevention of invasion and successful implementation of restoration projects and fire, and develop strategies to overcome these barriers;
- Develop integrated fire and invasive species management plans that appropriately coordinate the management of fire and the control of invasive species;
- Utilize case study templates, after action reviews, and other tools to capture practitioners results;
- Transfer knowledge and lessons learned throughout the Network to facilitate ecological objective setting, effective stakeholder engagement, efficient on-the-ground efforts, and successful funding of ecological fire/invasive species projects;
- Achieve tangible and measureable progress in increasing or maintaining the health of fire-dependent and fire-sensitive habitats throughout the network by increasing on-the-ground abatement of fire/invasive species threats; and
- Build a peer-to-peer network of practitioners and experts that can share information and experiences, build capacity and develop appropriate tools and methodologies to address fire and invasive threats.

Saint Lucia's objective is to mitigate the threats posed by climate change with respect to wildfires and invasive species. The country has benefitted from the exposure to experts in the

field of invasive species and wildfire management. This exposure has facilitated the development and implementation of work programs and even the evaluation of activities by members of the learning network. Saint Lucia has also benefited in terms of information gathering on IAS through access to international databases such as FEIS (Fire Effects Information System).

One activity of the Florida/Caribbean Fire and IAS Learning Network regarding early detection and rapid eradication of invasive plants was the identification of at least five of the most critical plants per country in need of eradication in relation to invasiveness and fire risk. Saint Lucia first defined the selection criteria:

- Recently introduced species to allow to early response
- Species that alter ecosystem processes, such as fire frequency, sedimentation, nutrient cycling or other ecological processes.
- Species that out-compete natives and otherwise dominate undisturbed native communities
- Species that are fast growing and most disruptive
- Species that occur in the most highly valued habitats, especially habitats that contain rare or highly valued species or communities and, at that, provide vital resources.
- Species likely to be controlled or eliminated with available technology and resources and which desirable native species will replace with little further input

This prioritization resulted in selection of the following IAS plant species: *Mimosa pigra, Cordia oblique, Coccinea grandis, Spathodea campanulata, Nephrolepis brownii, Chriptostegia madagasteriensis, Syngonium podophyllum, Heliconia wagneriana*, and neem.

Saint Lucia, like all MTIASIC project countries, has submitted its Initial National Communication on United Nations Framework Convention on Climate Change (UNFCCC). All these communications mention biodiversity and adaptation, but it is only the Bahamas that makes direct reference to IAS. In Saint Lucia, the Forestry Department and the Biodiversity Coordinator are both represented on the active National Climate Change Committee, which is an oversight committee for national climate change activities on the island. A recent vulnerability assessment and adaptation for biodiversity to Climate Change was carried out for Saint Lucia. Coordination with UNFCCC at the national level is facilitated by the fact that this framework is implemented by the same agency as the GEF Operational Focal Point. At the regional level, the Caribbean Community Climate Change Centre (CCCCC) (http://caribbeanclimate.bz/) in Belize is leading UNFCCC implementation with UNDP GEF support.

Background to Component 5 Pilot Project Site and Activities

Saint Lucia's Native Iguana

Saint Lucia was known to the Arawak Amerindian inhabitants as *Iouanalao* (pronounced iyanola) – "*The Land of the Iguana*". The Saint Lucian iguana is the largest native land animal

on the island. Incipient DNA studies suggest that the native iguanas on Saint Lucia form a unique population, quite distinct from all other green iguanas common throughout the WCR, despite carrying the same scientific name: *Iguana iguana.* Reptile taxonomists concerned with Caribbean iguanas have recognized that several species should be distinguished. Some experts have chosen to call the Saint Lucian iguana *Iguana cf. iguana* until a better alternative becomes available. There is sufficient phenological (Figure 13 b & c) and genetic evidence already to conclude that the Saint Lucian iguana is found in the wild only on this island. Thus, the Component 5 pilot's goal is preserving this unique heritage and genetic resource.

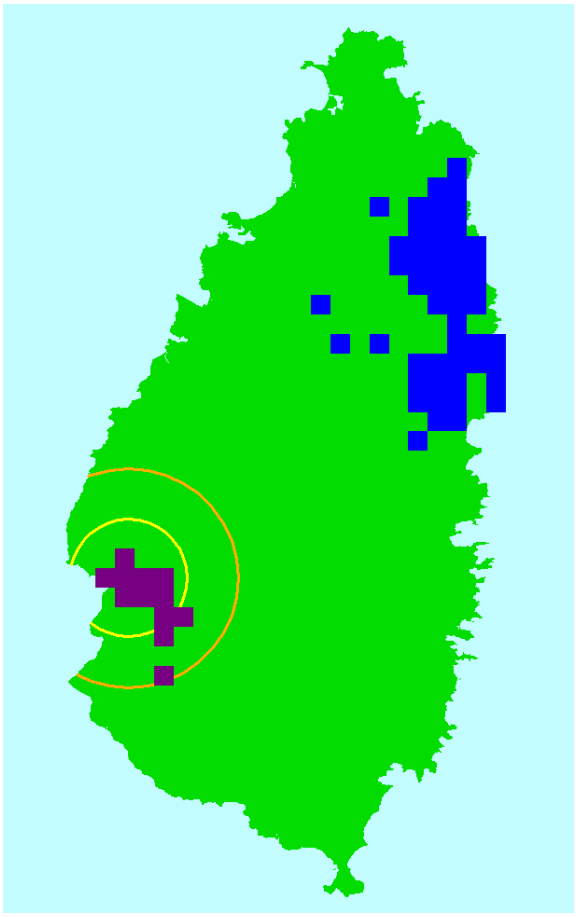
The main population of the Saint Lucia Iguana is found on the north east coast of the island. Populations levels are critically low, due to a combination of habitat loss, predation by IAS, and hunting, although the latter has declined (Morton, 2009c). Thus, one avenue to preserve the Saint Lucian iguana is to control its IAS predators. The DWCT and Forestry Department conducted mongoose control research at sensitive iguana nesting site, as mongooses prey on iguana hatchlings. The researchers found that live-trapping and euthanasia, even at a relatively low trapping and removal effort around nest areas, can effect a sharp decline in numbers of mongooses that persisted for several months, essentially the entire window of hatchling emergence. This work was funded by the Balcombe Trust prior to the current GEF-funded project.

Arrival of the Alien Iguana in Saint Lucia

Observations of the exotic iguana (Figure 13) in the wild were first reported to the Forestry Department in 2006. Its country of origin is unknown, because these specimen are believed to have been bought from a pet shop in Canada and smuggled into Saint Lucia for a mini zoo at the Still in Soufriere. At least two, but possibly more individuals, escaped and subsequently naturalized. In the light of local observations collated by a recent awareness survey (Krauss, 2010b), it seems likely that first escapes occurred before 2000 and that there were probably several escapes from one or more source(s).

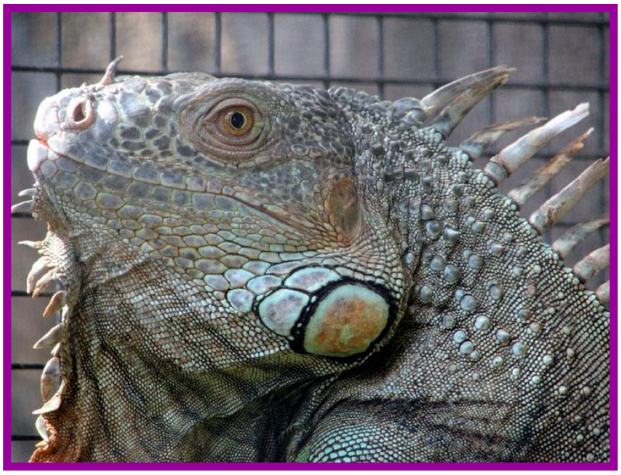
Since 2008 the spread of the alien iguana within the Soufriere basin (Figure 13) is considered invasive. The alien iguana has a high reproductive potential. Its clutch size is 40 to 80 eggs, whereas the clutch size of the native iguana is only 20 to 25. The alien iguana is also very mobile locally and adaptable to different environments. Especially on the mountains surrounding Soufriere, its control will become increasingly difficult (Figure 13d). Several factors contribute to its damaging impact [55]:

- It can compete with indigenous species for food and habitat, causing a reduction in numbers or even extinction of the local species
- It may breed with the indigenous species, causing the latter to lose its uniqueness. This, in turn, would destroy the iyanola concept, with negative consequences for national pride as well as marketing it to tourists
- It may vector pests and diseases to the local iguana populations, especially if imported illegally without veterinary certification or inspection
- It may cause an imbalance to local ecosystems



(a) Native and alien ranges

(b) Native iguana



(c) Alien invasive iguana

(d) Topography of range of alien iguana in the Soufriere area

Figure 13: (a) Distribution of the Saint Lucian native iguana (blue on map; b) and the alien invasive iguana (purple on map; c). Purple squares represent actual observations, yellow and orange rings the predicted natural spread in two years. The topography of the Soufriere area (d) poses a challenge to control efforts.

- It could become an agricultural pest that would cause a direct economic loss

Control of the Alien Invasive Iguana

For the control of the alien invasive iguana, early detection and rapid response is very important, as control is only realistically possible as long as the ranges of the two types of iguanas remain separate (Figure 13a). The main approach here is the removal and euthanasia of the alien invasive iguana from South West Saint Lucia. This is an ongoing collaboration between DWCT and the Forestry Department, initiated by questionnaires and field surveys in 2008, prior to the main phase of the GEF project. The DWCT has been involved with Forestry in the implementation of removal methods since they were first deployed in 2009, and are supported by the Balcombe Trust in this work. This activity is now being continued with the support of the GEF-funded project. One aim is to identify more cost-effective search and capture methods. Captured iguanas are put down by a veterinarian.

The legal framework for euthanizing the alien iguana has one major weakness, which has not affected control efforts to date, but should nevertheless be resolved. *Iguana iguana* is a CITES-listed species. As long as the native and alien iguanas are not taxonomically distinguished, control effort of the alien iguana could be misinterpreted. In the meantime, national legislation needs to set the iguanas apart, with the native one remaining Schedule 1-protected. The alien iguana should be more explicitly named as unprotected and efforts are underway to amend the Forestry Act and Regulations in a way that any species declared invasive may be controlled by legal means and authorized persons.

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Appendices

Appendix 1: List of Acronyms

Acronym	*Organization*
ACAPG	Aupicon Charcoal and Agricultural Producers Group
ANBAGLO	Saint Lucia Dive Association
BERU	Banana Emergency Recovery Unit
CABI	Centre for Agricultural Bioscience International
CARAPHIN	Caribbean Animal & Plant Health Information Network
CaRAPN	Caribbean Regional Agriculture Policy Network
CARICOM	Caribbean Community
CARDI	Caribbean Agricultural Research and Development Institute
CBD	Convention of Biological Diversity
CFCS	Caribbean Food Crop Society
CERMES	Centre for Resource Management and Environmental Studies
CIASNET	Caribbean Invasive Alien Species Network
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement
CISWG	Caribbean Invasive Species Working Group of CARICOM
CITES	Convention on the International Trade in Endangered Species of Wild Fauna and Flora
CMO	Caribbean Meteorological Organization
CMS	Conservation of Migratory Species of Wild Animals
COP	Conference of Parties of the CBD
CPPC	Caribbean Plant Protection Commission
CPU	Crop Protection Unit
CRISIS	Caribbean Regional Invasive Species Intervention Strategy
CSA	Critical Situation Analysis
DCA	Development Control Authority
DWCT	Durrell Wildlife Conservation Trust
EEZ	Exclusive Economic Zone
ESDU	Environment and Sustainable Development Unit
EU	European Union
EVI	Environmental Vulnerability Index
FAO	Food and Agriculture Organization of the United Nations
FSP	Full Size Project
GAS	Giant African Snail
GBIF	Global Biodiversity Information Facility
GDP	Gross Domestic Product

GEF	Global Environment Facility
GIS	Geographic Information Systems
GISP	Global Invasive Species Programme
GM/LMO	Genetically modified/living modified organisms
GOSL	Government of Saint Lucia
IAS	Invasive Alien Species
ICAO	International Civil Aviation Organization
IHR	International Health Regulations
IICA	Inter-American Institute for Cooperation in Agriculture
IMO	International Maritime Organization
IPPC	International Plant Protection Convention
ISPM	International Standards for Phytosanitary Measure
IUCN	World Conservation Union
IWCAM	Integrating Watershed & Coastal Areas Management in Caribbean Small Island Developing States
KAP	Knowledge, awareness and practices
MALFF	Ministry of Agriculture, Lands, Forestry and Fisheries
MARPOL	International Convention for the Prevention of Pollution from Ships ("Marpol" is short for “marine pollution”)
MEA	Multilateral Environmental Agreement
MPA	Marine Protected Area
MTIASIC	Mitigating the Threats of Invasive Alien Species in the Insular Caribbean
NAPSAP	National Action Plan and Strategic Action Plan to Combat Desertification and Drought in Saint Lucia
NBSAP	National Biodiversity Strategy and Acton Plan
NDC	National Development Corporation
NEMO	National Emergency Management Unit
NIP	National Influenza Plan
NISS	National Invasive Species Strategy
NPPO	National Plant Protection Organization
OAS	Organization of American States
OECD	Organisation for Economic Co-operation and Development
OECS	Organisation of Eastern Caribbean States
OIE	World Organization for Animal Health
OPAAL	OECS Protected Areas and Associated Livelihoods
PDF	Project Development Facility
PERB	Protecting the Eastern Caribbean Region’s Biodiversity
PHD	Plant Heath Directors of CARICOM
PHMB	Pink Hibiscus Mealy Bug

PPG	Project Preparation Grant
SEEA	System of Integrated Environmental and Economic Accounting
SIDS	Small Island Developing States
SGD	Society of Garden Designers
SLASPA	Saint Lucia Air & Seaports Authority
SLNT	Saint Lucia National Trust
SMM	Soufriere Marine Management
UNCCD	United Nations Convention to Combat Desertification
UNCLOS	United Nations Convention of the Law of the Sea
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme
UNFCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
UWI	University of the West Indies
WCR	Wider Caribbean Region
WHC	World Heritage Convention
WHO	World Health Organization
WIBDECO	Windward Islands Banana Development and Export Company (predecessor of WinFresh)
WINBAN	Windward Island Banana Growers' Association (predecessor of WIBDECO, now WinFresh)
WRI	World Resource Institute
WTO	World Trade Organization

Appendix 2: List of freshwater macroinvetebrates from Saint Lucia

From personal communication, David Bass (2010)

Taxa	***Collection***
Platyhelminthes	
Dugesia arimana	6
Micromidae	6
Turbellaria	5
Oligochaeta	
Alluriodes americana	6
Dero digitata	6
Lumbriculus sp.	4
Lumbriculidae	5
Tubifex newaensis	6
Hirudinea	
Hellobdella lineata	6
Hirudinea sp.	5
Polychaeta	
Polychaeta sp.	5
Gastropoda	
Ampullaria glauca	6
Biomphalaria glabrata	6
Drepanotrema lucidum	6
Drepanotrema surinamense	
Gundlachia radiata	5, 6
Lymnaea cubensis	6
Melanoides tuberculata	1, 2, 3, 5
Neritidae sp.	5
Neritilia succinea	6
Neritina punctulata	6
Neritina virginia	6
Physa marmorata	6
Physella cubensis cubensis	4
Physidae sp.	5

Taxa	***Collection***
Planorbidae sp.	5
Potamopyrgygus coronatus	6
Pygophorus parvulus ?	5
Bivalvia	
Pisidium punctiferum	6
Sphaeriidae sp.	5
Decapoda	
Atya innocuous	5, 6
Atya lanipes ?	5, 6
Atya scabra	5, 6
Callinectes danae	6
Callinectes sp.	5
Geograpsus lividus	6
Grapsidae spp.	5
Grapsus grapsus	6
Guenotia (G) dentata	5, 6
Jonga serrei	5, 6
Macrobrachium acanthurus	5, 6
Macrobrachium carcinus	5, 6
Macrobrachium crenulatum	5, 6
Macrobrachium faustinum	5, 6
Macrobrachium heterochirus	5
Micratya poeyi	5, 6
Palaemon pandaliformes	6
Penaeu aztecus subtilis	6
Potimirim glabra	5, 6
Plagusia depressa	6
Sesarma (H.) roberti	6
Troglocubanus sp.?	5
Xiphocaris elongata	5, 6
Hydracarina	

Taxa	***Collection***
Hydracarinidae	5
Collembola	
Entomobryiidae	5
Ephemeroptera	
Baetidae	5, 6
Baetis sp.	5
Borinquena travera	5, 6
Caenis sp.	5, 6
Centroptilum sp.	5
Cleodes sp.	5
Leptohyphes sp.	5
Nigrobaetis sp.	5
Tricorythodes sp.	5
Odonata	
Brachymesia herbida ?	1
Ceratura capreola	6
Coenagrionidae sp.	5
Gynacantha nervosa	6
Ischnura ramburii	4
Lestes tenuatus	6
Libellulidae	5
Orthemis ferrugunea	4
Triacanthagyna trifida	6
Orthoptera	
Orthoptera sp.	5
Hemiptera	
Belostoma subspinosum	4
Branchymetra albinervis	2, 4, 5
Branchymetra shawi	5
Buenoa sp.	4
Centrocorisa nigripennis	4

Taxa	***Collection***
Gerridae spp.	5
Limnogonus franciscanus	1, 3, 4
Mesovelia mulsanti	1, 2, 3, 4, 5
Mesoveliidae spp.	5
Microvelia sp.	1
Ochterus aenifrons	5
Rhagovelia angustipes	1, 2, 3, 5
Rhagovelia insularis	5
Saldula sp.	2
Trepobates taylori	5
Trochopus plumbeus	6
Veliidae spp.	5
Megaloptera	
Chloronia antilliensis	5
Trichoptera	
Alisotrichia orophila	6
Alisotrichia sp.	5
Atanatolica dominicana	5
Cernodina cadeti	5, 6
Chimarra antillina	5,6
Chimarra diannae	6
Helicopsyche guadeloupensis	5, 6
Hydroptila antilliarum	6
Neotrichia iridescens	5, 6
Neotrichia tauricornis	6
Oxyethira janella	5, 6
Phylloicus sp.	5
Polycentropus insularis	5
Polyplectropus bredini	5, 6
Polyplectropus simmonsi	5
Smicridea simmonsi	6
Xiphocentron fuscum	5, 6
Zumatrichia antilliensis	6
Zumatrichia anomaloptera	6

Taxa	*Collection*
Lepidoptera	
Cosmopterygidae sp.	5
Cossidae sp.	5
Crambus sp.	5
Nymphula sp.	5
Petrophila sp.	5
Coleoptera	
Carpelimus sp.	5
Dytiscidae sp.	5
Hexanchorus caraibus	5, 6
Hexacylloepus smithi	5
Hydrophilidae sp.	5
Lampyridae sp.	5
Pseudodiserus sp.*?*	5
Diptera	
Anthericidae sp.	5
Anthomyiidae sp.	5
Atrichopogon sp.?	5
Bezzia sp.	5
Blephariceridae sp.	5
Ceratopogonidae sp.	5
Chironomidae spp.	5

Taxa	*Collection*
Coelotanypus sp.	4
Culicidae sp.	5
Culicoides ? sp.	4
Dasyhelea sp.?	5
Dixidae sp.	5
Dolichopodidae sp.	5
Empididae sp.	5
Ephydridae sp.	5
Heleidae sp.	5
Maruina sp.?	5
Pericoma sp.?	5
Polypedilum halterale group	1
Psychoda sp.?	5
Psychodidae sp.	5
Sciomyzidae sp.	5
Simuliidae sp.	5
Stratiomyidae sp.	5
Syrpidae sp.	5
Tabanidae sp.	5
Tipulidae sp.	5

Collections: 1. D. Bass, Vieux Fort River, Beausejour Agricultural Station, Saint Lucia, 3 April 1996; 2. D. Bass, Vieux Fort River, Coulie Town, Saint Lucia, 3 April 1996; 3. D. Bass, Vieux Fort River, Joyeux Carriere, Saint Lucia, 3 April 1996; 4. D. Bass, Fort Rodney Pond, Pigeon Island, Saint Lucia, 5 April 1996; 5. Reported by Felix, Maharaj, and Lloyd from streams in Saint Lucia, ODA project,1995; 6. Reported by other investigators.

Appendix 3: Contact list of IAS experts in Saint Lucia in August, 2010.

List of Saint Lucia's IAS Working Group and GEF Project Steering Committee

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