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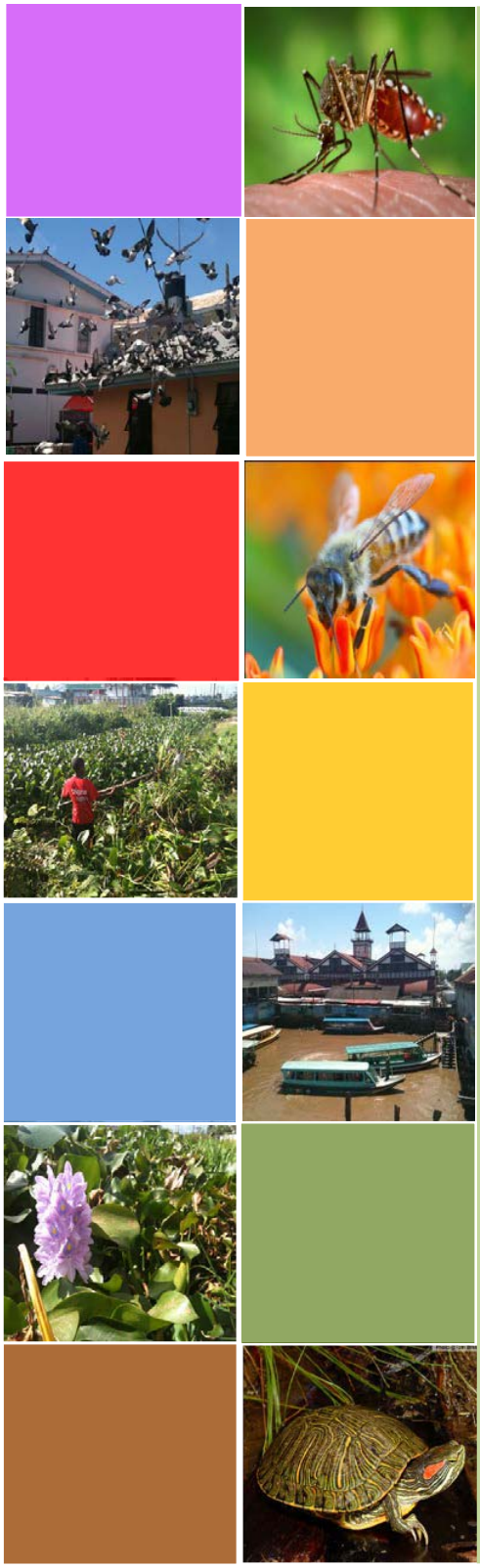

Assessment of Capacity Building Needs for National Biodiversity Priorities

INVASIVE ALIEN SPECIES IN GUYANA: ASSESSMENT REPORT, NATIONAL STRATEGY AND ACTION PLAN

The Environmental Protection Agency (EPA)
GUYANA

BIODIVERSITY ENABLING ACTIVITY PROJECT (BEAP)

ASSESSMENT OF CAPACITY BUILDING NEEDS:

INVASIVE ALIEN SPECIES IN GUYANA

NATIONAL STRATEGY AND ACTION PLAN

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ACKNOWLEDGEMENTS

The Consultancy Team would like to thank all those who contributed to the development of this document.

We wish to thank the Global Environment Facility (GEF) for providing funding; the United Nations Development Programme (UNDP) in Guyana, the Implementing Agency for providing continuous guidance; the Environmental Protection Agency (EPA) for its support and guidance, particularly the Executive Director, Dr. Indarjit Ramdass, and the staff of the Natural Resources Management Division (NRMD). We would like to thank Mr. Damian Fernandes, Director of the NRMD, and in particular Mr. Oumardatt Ramcharran, Ms. Dominique Saheed, Ms. Chuvika Harilal and Ms. Joanne Ford, for their technical guidance and support in realising this present strategy.

Also, the authors wish to extend their sincere thanks to the individual participants and the stakeholders who were actively involved in the First National Workshop on IAS, and subsequent meetings and interviews for their inputs into the Strategy.

We also wish to express our gratitude to many friends and colleagues, who have provided valuable information and inputs for the research. In particular, we would like to thank Alan Saunders, John Parkes, (Landcare Research, New Zealand), Rachel Atkinson (Charles Darwin Foundation, Galapagos), Mat Cottam (Cayman Island Department of Environment), Piero Genovesi (ISPRA, Italy), Shyama Pagad (IUCN SSC Invasive Species Specialist Group), Souad Boudjelas (Pacific Invasives Initiative), Hugo Lòpez Rosas (Department of Ecology, Xalapa, Mexico), and Raffael Ernst (Museum of Zoology, Dresden, Germany).

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ACRONYMS

ACTO	Amazonian Cooperation Treaty Organisation
AINLIM	Associated Industries Limited
BEST	Bahamas Environment, Science and Technology Commission
BWM	Ballast Water Management
CABI	Centre for Agricultural Bioscience International
CARDI	Caribbean Agricultural Research and Development Institute
CARICOM	Caribbean Community
CARINET	Caribbean Taxonomic Network
CARIPESTNET	Caribbean Pest Information Network
CBD	Convention on Biological Diversity
CEP	Caribbean Environment Programme
CI	Conservation International
CISWG	Caribbean Invasive Species Working Group
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
COP	Conference of the Parties
COSALFA	South American Commission for the Control of Foot and Mouth Disease
CPPO	Caribbean Plant Protection Organization
CSBD	Centre for the Study of Biological Diversity
EDRR	Early detection and rapid response system
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
EPPO	European Plant Protection Organisation
FAO	Food and Agriculture Organization
FMD	Foot and Mouth Disease
FSC	Forest Stewardship Council
GEF	Global Environment Facility
GFC	Guyana Forestry Commission
GGMC	Guyana Geology and Mines Commission
GINRIS	Guyana Integrated Natural Resources Information System
GISD	Global Invasive Species Database
GISP	Global Invasive Species Programme
GL&SC	Guyana Lands & Surveys Commission
GLDA	Guyana Livestock Development Authority
GloBallast	Global Ballast Water Management Programme
GMO	Genetically Modified Organism
GoG	Government of Guyana
GRA	Guyana Revenue Authority
GRDB	Guyana Rice Development Board
GuySuCo	Guyana Sugar Corporation
GYD	Guyanese dollar
I3N	IABIN Invasives Information Network
IABIN	Inter-American Biodiversity Information Network
IAS	Invasive Alien Species
IEEP	Institute for European Environmental Policy

IIC	Iwokrama International Centre for Rainforest Conservation and Development
IICA	Inter-American Institute for Cooperation on Agriculture
IMO	International Maritime Organization
IPM	Integrated Pest Management
IPPC	International Plant Protection Convention
ISPM	International Standards for Phytosanitary Measures
ISPRA	Institute for Environmental Protection and Research
ISSG	Invasive Species Specialist Group
IUCN	World Conservation Union
LAN-NPPAW	Latin American Network for Technical Cooperation in National Parks Protected Areas and Wildlife
LCDS	Low Carbon Development Strategy
LMO	Living Modified Organism
MACC	Mainstreaming Adaptation to Climate Change
MOA	Ministry of Agriculture
MOAA	Ministry of Amerindian Affairs
MOFA	Ministry of Foreign Affairs
NAAG	National Aquaculture Association of Guyana
NAREI	National Agriculture Research and Extension Institute
NBAPII	National Biodiversity Action Plan II
NBC	National Biodiversity Committee
NBF	National Biosafety Framework
NBAP	National Biodiversity Action Plan
NCSA	National Capacity Self Assessment
NDDP	National Dairy Development Programme
NISC	National Invasive Species Council
NREAC	Natural Resource and Environment Advisory Committee
NRMD	Natural Resource Management Division
OIE	World Organization for Animal Health
PAHO	Pan American Health Organization
PANAFTOSA	Pan American Foot and Mouth Disease Centre
RAC/ REMPEITC	Regional Activities Centre/ Regional Marine Pollution Emergency Information and Training Centre
SPAW	Specially Protected Areas and Wildlife
UG	University of Guyana
UNCBD	United Nations Convention on Biological Diversity
UNDP	United Nations Development Programme
USA	United States of America
WCR	Wider Caribbean Region
WMA	Wildlife Management Authority
WTO SPS	World Trade Organization – Sanitary and Phytosanitary Agreement
WWF	World Wildlife Fund for Nature

LIST OF ABBREVIATIONS

cm	centimetre
e.g.	exempli gratia
i.e.	id est (that is)
Km	kilometre
Km^2	square kilometre
m	metre
M	million
m^3	cubic metre
MSc	Master of Science
pers. comm.	personal communication

GLOSSARY OF KEY TERMS

Alien species **-** refers to a species, subspecies or lower taxon, introduced outside its natural past or present distribution; includes any part, gametes, seeds, eggs, or propagules of such species that might survive and subsequently reproduce.
NB: some international/regional/national instruments (e.g. Conventions) use the terms '*exotic species*', '*non-indigenous species*' or '*non-native species*' when referring to '*alien species*'. In the report, the term '*alien species*' has been used throughout the text, but where applicable the references used in the original texts have been maintained.
Control **-** means maintaining a given population within certain levels or under a threshold (in terms of the number of individuals in the population and its area of distribution), in which the negative impact on the natural resources or, in particular, on native species is practically eliminated, or considered tolerable or acceptable.
Eradication **-** refers to the operations necessary to obtain the permanent removal of the entire population of a species within a specific time and area.
Establishment **-** refers to the process of an alien species in a new habitat successfully producing viable offspring with the likelihood of continued survival.
Intentional introduction **-** refers to the deliberate movement and/or release by humans of an alien species outside its natural range.
Introduction **-** refers to the movement by human agent, indirect or direct, of an alien species outside of its natural range (past or present). This movement can be either within a country or between countries or areas beyond national jurisdiction.
Invasive alien species **-** means an alien species whose introduction and/or spread threatens biological diversity.
Pathway **-** means, as applicable:

- the geographic route by which a species moves outside its natural range (past or present);
- the corridor of introduction (e.g. road, canal, tunnel); and/or
- the human activity that gives rise to an intentional or unintentional introduction.

Unintentional introduction **-** refers to all other introductions which are not intentional.
Vector **-** means the physical means or agent (i.e. aeroplane, ship) in or on which a species moves outside its natural range (past or present).

The definitions used in this report correspond to those used in the CBD Guiding Principles (UNCBD Decision VI/23), see: http://www.cbd.int/invasive/

1.0 EXECUTIVE SUMMARY

Invasive Alien Species (IAS) are defined as non-native species that have been introduced deliberately or unintentionally outside their natural range as a direct (as food source for cattle, hunting, fishing, ornamental purposes etc.) or indirect result of human activity.

These activities are linked to the increasing worldwide with growing levels of transport, trade, travel and tourism that provide vectors and pathways for their movement. Once IAS have become established, they proliferate and spread in ways that cause damage to biological diversity.

IAS have major impacts globally and represent a serious threat to Guyana's environment and economy, affecting biodiversity, ecosystem functioning, agricultural productivity, economic activities, trade, and human health and well-being.

Some progress has been made in Guyana towards managing IAS in the past. The Carambola fruit fly (*Bactrocera carambolae*), detected in 1993 at Orealla; was eradicated with success in 1998 with the combined use of Integrated Pest Management, quarantine restrictions and public awareness campaigns.

This Consultancy was aimed at undertaking an inventory and an assessment of the impacts of IAS in Guyana (Appendix I). The report documents what is known of the current status of IAS in Guyana as a starting point for developing a National IAS Strategy and Action Plan to address IAS threats and thus contribute to Guyana's long-term sustainable development.

Information was gathered from national and local government authorities and agencies, academic institutions, non-governmental organisations (NGOs) and the private sector through a questionnaire, a literature search, web searches and discussions with experts and interested stakeholders, who were interviewed in country during this project (Appendices II - III).

The first task was to identify sources of available information as a step towards developing a comprehensive IAS database for Guyana. Using information on origins, pathways and dates of introduction, impacts and sectors affected, a preliminary inventory of IAS in Guyana was prepared which provides a useful reference and a tool to support awareness raising.

Guyana can also use this inventory to support regional and global collaboration by helping to update the Inter-American Biodiversity Information Network (IABIN) Invasives Information Network (I3N) database and the Global Invasive Species Database (GISD). The I3N database provides an opportunity for Guyana to join a network covering 19 countries in the Americas that use common regional data standards to facilitate information exchange and to provide a framework for capacity-building and effective implementation of IAS management in Guyana.

Guyana has globally important biodiversity. Its floral diversity is estimated to include over 8000 species (including ferns and mosses), approximately 6500 of those species being identified. There are approximately 1,815 known species of animals (fish, amphibians, birds, reptiles and mammals); some of these species have significant economic value and are endemic to the Guiana Shield.

Based on data collection, stakeholder input from interviews and the Workshop, and databases researches, a summarised list with more than 30 IAS detected in Guyana was prepared, grouped by taxa, broad natural organism type, area of occurrence, with notes on the significance of their impacts, where possible; Some of them have significant documented impacts on the native biodiversity, natural habitats and economic activities. Because of their imminent spreading around the country, particular concerns surround 3 plant species; antelope grass *(Echinochloa pyramidalis*), water hyacinth (*Eichhornia crassipes*) and wattle (*Acacia mangium*).

A wide range of government entities (ministries, departments and agencies), NGOs, stakeholder groups and resource individuals need to become engaged and work together to respond to IAS threats facing Guyana. Reducing the damage caused by existing IAS, and applying robust biosecurity measures to prevent further introductions, is critical for the conservation and sustainable use of the country's unique natural heritage. Other key steps are to help the public become aware of how IAS affect Guyana's ecological and economic well-being, and to educate resource users about biosecurity.

The second task was to assess existing policies for IAS prevention and management within Guyana. Research identified key gaps and the need for specific legislative measures. Effective and coordinated action across relevant sectors will require the development or adjustment of national policies and strategies, additional regulatory measures, and targeted action plans to address existing and potential problems associated with IAS.

The third task was to develop an outline for a National IAS Strategy and Action Plan, building on inputs from the National IAS Workshop in Georgetown on 23 March 2011 (Appendix IV).
For the development of this strategy, an analysis of strengths, weakness, opportunities and threats on the subject of invasive species in the country has been carried out (Appendix X). Three key findings have emerged from the stakeholder consultations and Workshop.

Lack of information on individual IAS, their distribution, ecology and impacts makes it difficult to identify the most serious threats. Priority should be given to improving the quality and availability of information to support decision making and develop effective management responses. Collating existing information and gathering further information on the biggest IAS threats will be necessary to support prioritisation and the most effective allocation of resources.

Guyana's commitments under international and regional agreements to tackle IAS threats need to be fully reflected in its environmental and biosecurity policy framework and in robust implementing legislation. Regulatory measures are an important component for preventing the introduction of potentially invasive alien species and managing their movement. Stronger regional cooperation and capacity-building should be accompanied by domestic instruments to limit further introductions and reduce the impacts of established pests. This approach if understood and accepted by stakeholders and properly enforced will provide a framework to minimise IAS risks to Guyana's economy, environment, and society.

The lack of systematic inter-agency coordination on IAS issues is also a constraint to more effective action. Government-level coordination needs to be complemented by consultation frameworks involving user groups, non-governmental organisations, scientific institutes and other stakeholders. Guyana's Environmental Protection Agency (EPA) should take the lead in implementing a National IAS Strategy and Action Plan.

2.0 BACKGROUND

Guyana signed the United Nations Convention on Biological Diversity (commonly referred to as the CBD) in 1992 and ratified it in 1994. IAS were identified as a cross-cutting issue under the CBD at the fourth meeting of its Conference of the Parties (COP) and Guiding Principles for their prevention and management were adopted by the COP in 2002. As a Party to the CBD, Guyana is required to fulfil obligations under the Convention which stipulates that each contracting party must "prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species". This provision is detailed in the CBD Guiding Principles for the Implementation of Article 8(h) (UNCBD 2002; Decision VI/23).

To assist in implementing these obligations, the Environmental Protection Agency (EPA), acting on behalf of the Government of Guyana (GoG) contracted the services of Mr. Giorgio Muscetta to undertake an inventory and an assessment of the impacts of IAS in Guyana (Terms of Reference: Appendix I).

2.1 Scope/Objectives

Under this Consultancy, it was expected that the Consultant would seek to address the following objectives:

1. To determine the presence and prevalence of IAS in Guyana;
2. To examine the pathways and causes of IAS introduction, and their impacts on local biological diversity; and
3. To identify appropriate mechanisms to prevent further introduction of IAS, and the management or eventual eradication of IAS currently found in Guyana.

2.2 Deliverables

The project was intended to produce the following deliverables/outputs:

1. An Assessment report - with specific focus on the prevalence of IAS to create a better understanding of the pathways and the causes of the introduction of IAS, their impacts on biological diversity, and appropriate mechanisms of control;
2. A Thematic report on IAS in Guyana - according to CBD guidelines;
3. An inventory of IAS – this will include species profiles and geographic distribution at the national level, where possible; and
4. A Strategy and Action Plan to address IAS - including targets for IAS monitoring. The report will entail priorities for legal and regulatory frameworks, institutional roles and coordination.

2.3 Details of the Methodology

The methodology included: A review of published literature and information provided by a wide range of stakeholders in their reports, and from direct interviews and websites. It also included the compilation of responses to a questionnaire sent out to government departments, non-governmental organisations (NGOs), resource personnel, and other relevant institutions across Guyana (List of Stakeholders: Appendix II).

Further information was gathered through consultation and collaboration with stakeholders during and after the national IAS workshop, and follow-up contacts during the preparation of sub-project outputs (Details of the Methodology and the Questionnaire: Appendix III).

3.0 INTRODUCTION

Guyana is the only English speaking country in South America and is located on its Northern Coast, bordered by the Atlantic Ocean to the North, Suriname to the East, Brazil to the South and Venezuela to the West. The country has a total size of 215,000 km^2 with a coastline of approximately 434 km in length and a continental shelf of circa 724 km (EPA, 2010b). The majority of the land area, approximately 85%, is covered by natural forest (figure 1). Guyana, Suriname and French Guiana make up the Guiana Highlands. This region is considered one of the largest continuous and relatively intact tracts of lowland tropical rainforest in the world (EPA, 2010b). Approximately two-thirds of the north-eastern portion of the ancient Precambrian Guianan Shield, the underlying geology of north-eastern South America, consists of moist Guianan forests (EPA, 2010b).

Guyana's relatively rich biological diversity and high endemism rate are due to four factors:

- Its south-western regions are part of the biologically outstanding Amazon drainage basin;
- Its overlying position on the ancient Guiana Shield formation;
- Its position on the Atlantic seaboard of South America, and therefore its marine/coastal environment; and
- Its history of low incidence and intensity of conversion of natural habitats.

Guyana's forests are important for the maintenance of regional biodiversity. Local and regional endemism are high, particularly with regard to plants (EPA, 2010b).

Guyana's floral diversity is estimated to include over 8000 species (inclusive of ferns and mosses) approximately 6500 of these being identified. There are approximately 1,815 known species of fishes, amphibians, birds, reptiles and mammals. Some species have significant economic values and are endemic to the Guiana Shield (EPA, 2010b). The 4th National Report to the Convention on Biological Diversity mentions the discovery of 30 new species and several endemic species that were found during the period 2006-2008 (8 reptiles, 35 amphibians, 40 fishes, 7 insects and 11 vascular plants) (EPA, 2010b).

Guyana, as a signatory party to CBD, has signalled to the international community that it is committed to implementing agreed measures to conserve and sustainably utilize the country's biological resources (EPA, 2010a). The Environmental Protection Agency, established under the Environmental Protection Act, 1996, is the National Focal Point for the CBD.

The Environmental Protection Act sets out the EPA's statutory functions, including:

- *to take such steps as are necessary for the effective management of the natural environment so as to ensure conservation, protection, and sustainable use of its natural resources;*
- *to co-ordinate and maintain a programme for the conservation of biological diversity and its sustainable use; and*
- *to co-ordinate the establishment and maintenance of a national park and protected areas system and a wildlife protection management programme.*

Geopolitically and culturally, Guyana is a member state of the 15-member Caribbean Community

(CARICOM), a regional body working toward regional integration to facilitate the free movement of labour and capital, and the coordination of agricultural, industrial and foreign policies. Guyana, in many ways, is similar to other English-speaking countries within the Caribbean where shared history and language lends to similar cultural heritage and governance systems which are visible today (EPA, 2010b).

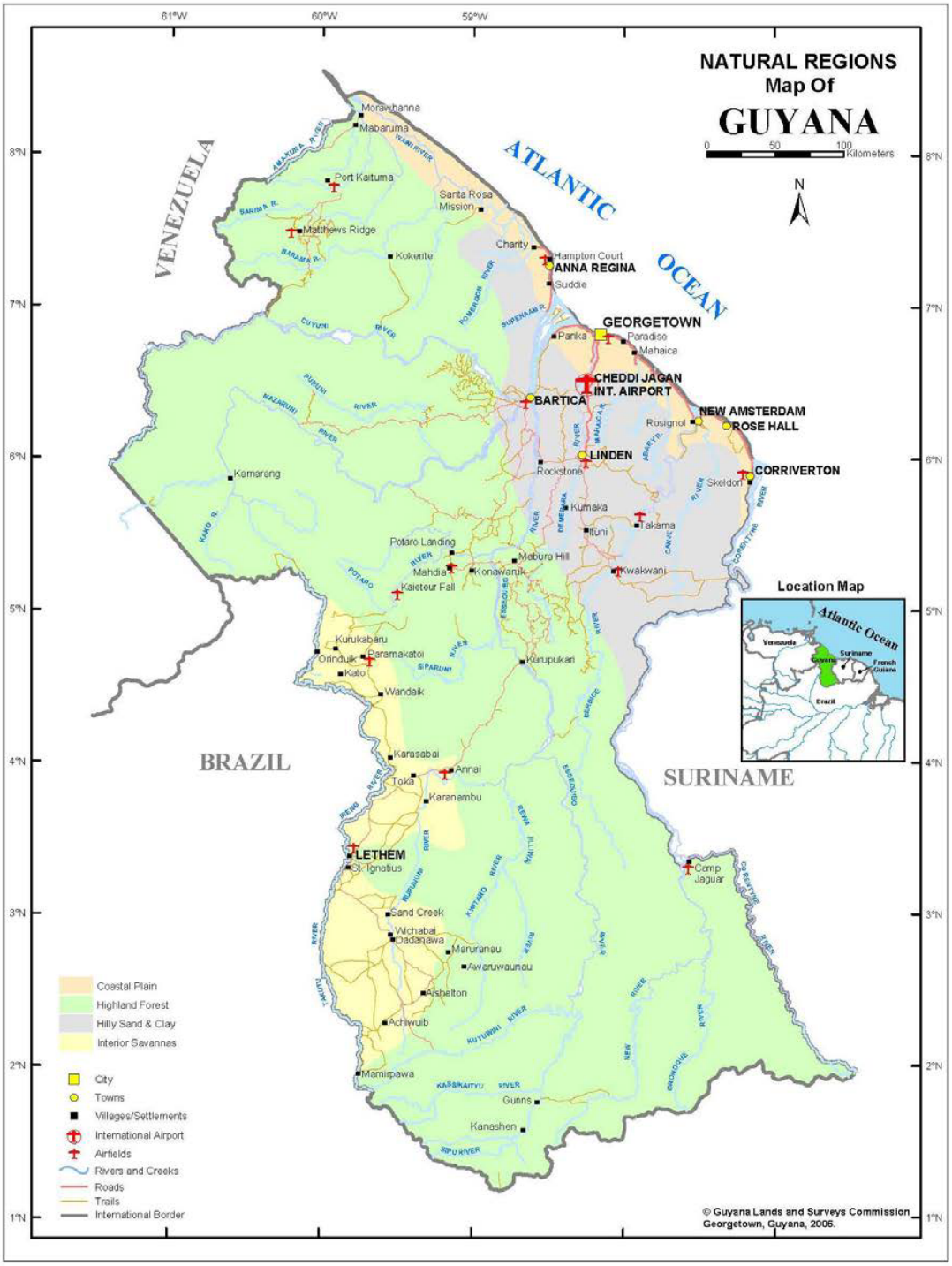

Figure 1: Natural Regions of Guyana.
Source: Guyana Lands & Surveys Commission (GL&SC)

3.1 The Problem of Invasive Alien Species

Invasive alien species (IAS) are introduced plants, animals, and micro-organisms whose establishment and spread threaten ecosystems, habitats or species (including humans). IAS cost the economy of some countries millions of dollars annually.

IAS can include species from all taxa; from mammals and birds, to insects, plants, viruses, and bacteria. They are now recognised as one of the greatest biological threats to the environment, affecting biodiversity and ecosystem functioning, with harmful impacts that are considered second only to those caused by habitat loss. Moreover, they also affect different key sectors of the local economy, such as agricultural productivity, trade, human health and well-being (McNeely, 2001).

Most alien species introduced in a new place do not become invasive or cause problems in their new locations. Some of them bring considerable benefits to society, e.g. in agriculture, horticulture, forestry and the pet industry. However, the subset of alien species that are invasive can have significant environmental, economic, and public health impacts and present a significant risk to native ecosystems (McNeely, 2001).

Social impacts of IAS have not been well documented but can include human health problems, interference with traditional lifestyles, a reduction in property values, tourism, employment, aesthetic values and the enjoyment of natural areas.

The rate of species introductions around the world has grown rapidly and enormously in recent times as a result of increasing globalisation. In addition, climate change affects the abundance and spread of IAS and the vulnerability of ecosystems to invasions. IAS are now a major challenge for biodiversity conservation. Moreover, their negative impacts on food security, plant, animal and human health, and economic development can be extensive and substantial (McNeely, 2001).

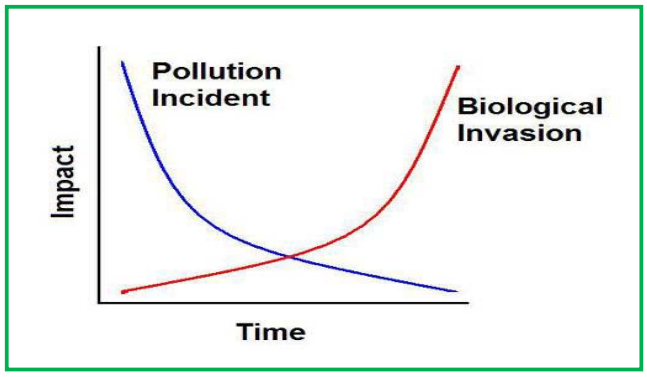

Figure 2: Contrast between the impacts of a typical pollution incident and biological invasion over time.

IAS can be considered as a form of biological pollution. In contrast with non-living pollution (e.g. oil spills), they are by definition capable of replicating and their negative impacts can increase over time unless appropriate management measures are taken (figure 2). Typically, the impacts of physiochemical pollution incidents start at their maximum level and decrease over time. In contrast, the impacts of biological invasions may initially be small, often latent and then grow over time. These impacts have the potential to persist indefinitely if remedial action is not taken (McNeely, 2001).

3.2 The Invasion Process

The problem of IAS is increasing worldwide with growing levels of transport, trade, travel and

tourism (McNeely, 2001). These activities provide vectors and pathways for the movement of live plants, animals, and micro-organisms. Pathways are the *corridors* by which species move between locations (e.g. shipping and air routes) while vectors are the *physical means* by which species move or are transported along pathways (e.g. ship and aeroplane) to areas outside their natural range (Genovesi and Shine, 2003).

Some new populations may spread rapidly across landscapes. Other populations may have a lag phase where the founder population is not initially invasive but remains around the point of establishment for years before changes in the environment, or possibly its genome, allows it to spread. Although a time lag is a common feature of the invasion process, there are some organisms (e.g. vectors of some human, plant, and animal diseases) which have virtually no time lag at all. As such, the large-scale effects of their invasiveness can be seen almost immediately if no remedial action is taken (McNeely, 2001).

In terms of invasive species management, it is generally considered more cost effective to prevent the introduction of IAS, or to deal with newly arrived species before they become established and have any impacts. If left too late, IAS management can become very time consuming and expensive (McNeely, 2001).

Whether an established new species will become invasive is unpredictable, and a precautionary approach (i.e. eradicating the founder population if possible) should be considered as the first option (Genovesi and Shine, 2003).

3.3 The root causes of Invasive Alien Species problems and the need for mainstreaming

All IAS problems are the direct or indirect result of decisions made by individuals or groups of individuals operating within the prevailing economic, political, and social systems. If IAS issues are to be addressed efficiently and effectively, consideration for the impacts of IAS needs to be systematically incorporated into key sectoral policies and practices ('mainstreamed') before problems arise. IAS issues should not be treated as add-ons to be considered only when particular invasions reach emergency proportion (McNeely, 2001).

4.0 ASSESSMENT OF IAS STATUS IN GUYANA

Using currently available information about species present in Guyana, an IAS inventory was compiled from a variety of sources, with additional information collected on the origins, pathways and dates of introduction, as well as impacts and sectors affected by these species.

The main objective of the IAS inventory was to consolidate information that can be used to better understand IAS impacts and to provide a more quantitative picture of the scale of the IAS problem and risks in Guyana to inform the development of a National IAS Strategy and Action Plan.

The inventory was based primarily on information obtained from the Global Invasive Species Database (GISD), by isolating those species reported as invasive and alien in Guyana (GISD, 2011).

Additional information was gathered from key government entities and non-governmental organisations and used to update the GISD and I3N-South American databases.

There is evidence of significant environmental, social and/or economic impacts in Guyana stemming from the introduction of 31 IAS, which are listed in Table 1. These species cover all major biomes, ranging from marine ecosystems to terrestrial areas and inland waters, and represent a range of taxonomic groups including plants, invertebrates and vertebrates.

Although not mentioned in the GISD website, another 14 invasive alien species were identified as alien and invasive in Guyana in this study, and were added to the inventory. In addition, the red lionfish (*Pterois volitans*) was added because it is widespread around the Caribbean and is listed in the European Plant Protection Organisation (EPPO) Alert List. This is not a quarantine list, and does not constitute a recommendation for actions, but it draws the attention to certain pests that present a risk as an early warning before they start to spread.

Among the 31 IAS identified, 4 species are of major concern because they are appear on the list of 100 of the "World's Worst" invaders (Lowe et al, 2000).

Nevertheless, the dynamics of these invasions by alien species in Guyana remain poorly studied. Given a lack of available information, the IAS listed in Table 1 do not form an exhaustive list of IAS with impacts on Guyanese biodiversity and human well-being. There is little detailed information on the ecology of these IAS in Guyana, or of the nature of their impacts on biodiversity or on peoples' livelihoods. This lack of information can underpin IAS management in Guyana which is a key constraint.

The assessment and estimates presented in this report provide one of the first, albeit very general, indications of the extent and significance of overall IAS impacts in Guyana.

Table 1: IAS in Guyana (GISD, 2011).

Species	Common name	Organism type
Acacia mangium	Wattle	Plant - Tree
Antidesma ghaesembilla	Black Currant Tree	Plant - Shrub
Caesalpinia pulcherrima	Barbados pride	Plant - Tree
Calotropis procera	Apple of Sodom	Plant - Shrub
Casuarina equisetifolia	Australian-Pine	Plant - Tree
Echinochloa pyramidalis	Antelope Grass	Plant - Grass
Eichhornia crassipes	Water Hyacinth	Plant - Water Grass
Hedychium gardnerianum	Kahili Ginger	Plant - Herb
Leucaena leucocephala	White Leadtree	Plant - Tree
Melaleuca quinquenervia	Niaouli or Broad-Leaved Paper Bark	Plant - Tree
Terminalia catappa	Alconorque	Plant - Tree
Thunbergia grandiflora	Bengal Clock Vine	Plant - Vine, Climber
Tithonia diversifolia	Japanese Sunflower	Plant - Shrub
Columba livia	Rock Pigeon	Vertebrate - Bird
Eleutherodactylus johnstonei	Johnstone's Whistling frog	Vertebrate - Amphibian
Anolis aeneus	Bronze Anole	Vertebrate - Reptile
Hemidactylus mabouia	Tropical House Gecko	Vertebrate - Reptile
Trachemys scripta elegans	Red-Eared Slider	Vertebrate - Reptile
Herpestes javanicus	Small Asian Mongoose	Vertebrate - Mammal
Clarias batrachus	Walking Catfish	Vertebrate - Fish
Ctenopharyngodon idella	Grass Carp	Vertebrate - Fish
Oreochromis aureus	Gold tilapia	Vertebrate - Fish
Oreochromis mossambicus	Mozambique Tilapia	Vertebrate - Fish
Oreochromis niloticus	Nile Tilapia	Vertebrate - Fish
Pterois volitans *	Red Lionfish	Vertebrate - Fish
Achatina fulica	Giant African Snail	Invertebrate - Snail
Aedes aegypti	Yellow Fever Mosquito	Invertebrate - Insect
Apis mellifera scutellata	Africanised Honey bee	Invertebrate - Insect
Monomorium floricola	Bicoloured Trailing Ant	Invertebrate - Insect
Paratrechina longicornis	Crazy Ant	Invertebrate - Insect
Tapinoma melanocephalum	Tramp Ant	Invertebrate - Insect

*Species of Alert List - (http://www.eppo.org/QUARANTINE/Alert_List/intro.htm)

4.1 Major IAS Threats in Guyana

The information contained in this section has been collated from meetings with stakeholders during the consultancy (March 2011) and from concerns expressed by specialists, all of whom stated that they need better information on individual species and their distribution.

This information can act as a reference and can be used to create awareness about invasive alien species already present in Guyana, but the lack of information needs to be addressed as a matter of priority.

Concerns about IAS impacts focus generally on marine, coastal and lowland terrestrial systems. This is probably a reflection of greater human interest in these areas compared to higher forested areas in the interior. It is also possible that more intact forest systems are more resistant to IAS.

Information on known IAS impacts was compiled for terrestrial, marine and inland water ecosystems and species from all main taxonomic groups (including mammals, plants, reptiles and amphibians, fishes, invertebrates, livestock and human diseases). This represents a first attempt to collate information on the threats posed by IAS in Guyana.

Through the information collected from the stakeholders interviews, carried on March 2011, most concerns were expressed about the following invasive plants: antelope grass *(Echinochloa pyramidalis*), water hyacinth (*Eichhornia crassipes*) and wattle (*Acacia mangium*).

Invasive vertebrates of concern include: the rock pigeon (*Columba livia*), the small Asian mongoose (*Herpestes javanicus*), the red-eared slider (*Trachemys scripta elegans*), and Johnstone's whistling frog (*Eleutherodactylus johnstonei*).

Invasive invertebrates identified have been recognised for the threat posed to the human health carrying viruses and diseases. These species are the giant African snail (*Achatina fulica*) the yellow-fever mosquito (*Aedes aegypti*), and the Africanised bee (*Apis mellifera scutellata*).

4.1.1 Invasive alien plants species

Antelope grass *(Echinochloa pyramidalis*) and water hyacinth (*Eichhornia crassipes*) are the only examples of IAS in Guyana for which detailed distribution, ecology and impacts information are available. These weeds are both notoriously aggressive species. The latter has been nominated by the Invasive Species Specialist Group (ISSG) as being among the top 100 of the world's worst invasive species (Lowe et al., 2000).

Figure 3: Water hyacinth (*Eichhornia crassipes*).

Water hyacinth (*Eichhornia crassipes)* (figure 3) originates from the Amazon basin and the Pantanal area in central Brazil. However the species is not native to the Guiana Shield. Water hyacinth can reproduce from seeds (from the prolific flowers) and from the vegetative extensions from mother plants as well as plant remnants spread by people, wild and domestic animals, water and wind. It can also grow very fast in ideal conditions, doubling its area of occupancy in a matter of days. The success of this plant is associated with high levels of nutrients (eutrophication) in water bodies, principally phosphorus (Neiff et al., 2008).

Its introduction to Africa and India has resulted in major problems such as the blockage of waterways, resulting in the mortality of aquatic fauna and flora, and it has been the subject of a multi-million dollar control project (case study 1). This is a classic example of an intentional introduction followed by the unintentional spread of an alien species which became established and has become invasive with many negative impacts on the development and health people as well as biodiversity.

Figure 4: Mechanical control of water hyacinth (*Eichhornia crassipes)* in Georgetown.

In Guyana, water hyacinth was recently introduced for use in gardens as a popular ornamental plant. It is not invasive at the present, possibly due to its recent introduction, however it is highly recommended to locate all populations and work with communities for its complete elimination. At the present there is no plan for the eradication of this species, only some mechanical interventions for its control (Figure 4).

CASE STUDY 1 - Problems caused by water hyacinth as an invasive species

Water hyacinth (*Eichhornia crassipes*), native to South America, but now an environmental and social menace throughout the Old World tropics, affects the environment and humans in diverse ways. Most of these are detrimental, although some are beneficial or potentially useful. Many of these effects are due to its potential to grow rapidly and produce enormous amounts of biomass, thereby covering extensive areas of naturally open water.

A most striking and little understood effect of water hyacinth is on aquatic plant community structure and succession. Water hyacinth replaces existing aquatic plants, and develops floating mats of interlocked water hyacinth plants, which can be colonized by several semi-aquatic plant species. As succession continues, floating mats dominated by large grasses may drift away or be grounded. This process can lead to rapid and profound changes in wetland ecology, e.g. shallow areas of water will be converted to swamps. In slow-moving water bodies, water hyacinth mats physically slow the flow of water, causing suspended particles to be precipitated, leading to silting. The reduced water flow can also cause flooding and adversely affect irrigation schemes. Water hyacinth acts as a weed in paddy rice by interfering with germination and establishment. Water hyacinth is reported to cause substantially increased loss of water by evapo-transpiration compared to open water, although these findings have recently been challenged. Displacement of water-by-water hyacinth can mean that the effective capacity of water reservoirs is reduced by up to 400 m^3 of water per hectare, causing water levels in reservoirs to fall more rapidly in dry periods. Water displacement, siltation of reservoirs and physical fouling of water intakes can have a major impact on hydroelectric schemes. Water hyacinth mats are difficult or impossible to penetrate with boats, and even small mats regularly foul boat propellers. This can have a severe effect on transport, especially where water transport is the norm. Infestations make access to fishing grounds increasingly time consuming or impossible, while physical interference with nets makes fishing more difficult or impractical. Some fishing communities in West Africa have been abandoned as a direct result of the arrival of water hyacinth.

Water hyacinth has direct effects upon water chemistry. It can absorb large amounts of nitrogen and phosphorus, other nutrients and elements. It is this ability to pick up heavy metals which has led to the suggestion that water hyacinth could be used to help clean industrial effluent in water. By absorbing and using nutrients, water hyacinth deprives phytoplankton of them. This leads to reduced phytoplankton, zooplankton and fish stocks. Conversely, as the large amounts of organic material produced from senescent water hyacinth decompose, this leads to oxygen deficiency and anaerobic conditions under the floating mats. These anaerobic conditions have been the direct cause of fish death, and changes in the fish community by eliminating many species at the expense of air breathing species. Stationary mats of water hyacinth also shade out bottom growing vegetation, thereby depriving some species of fish of food and spawning grounds. The potential impact on fish diversity is enormous. The conditions created by water hyacinth encourage the vectors of several human diseases, including the intermediate snail hosts of bilharzia (schistosomiasis) and most mosquito vectors, including those responsible for transmission of malaria, encephalitis and filariasis. In parts of Africa, water hyacinth mats are reported to provide cover for lurking crocodiles and snakes.

The diversity of impact means that the problems occur in the mandates of diverse ministries. There is considerable scope for delays following a new infestation while the relevant government agencies decide who is responsible for what in order to tackle the problems.

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Antelope grass (*Echinochloa pyramidalis*) was introduced intentionally from South Africa by the National Dairy Development Programme (NDDP) in 1984 as a food source for cattle (Ministry of Agriculture, 2011 *pers. comm*.).

Currently this fast growing fodder grass, is a threat to the agriculture sector affecting drainage and irrigation canals of agricultural land and crop production. It was introduced because of its tolerance to flooding and is now a widespread invasive species.

Figure 5: Antelope grass (*Echinochloa pyramidalis*).

It infests waterways in the coastal areas of Georgetown resulting in clogged drainage and irrigation channels (Figure 5).

In other countries where it has been introduced, it has resulted in significant losses to agricultural production, decimated aquatic wildlife, damaged livelihoods of local people, and created ideal conditions for the spread of diseases and their vectors (Room and Fernando, 1992).

Figure 6: Antelope grass introduced as a food source for cattle**.**

In Mexico, the introduction and expansion of antelope grass, together with grazing practices (figure 6), has caused a decrease in biodiversity and ecosystems services in natural freshwater marshes because it replaces many native plant species (López Rosas et al., 2005).

In Guyana, the economic costs for the management of the antelope grass (*Echinochloa pyramidalis*), as reported by the Honourable Minster of Agriculture, Robert Persaud, was estimated at GYD $700 M per year in 2008 (GINA, 2008). Several farmers expressed concerns about this weed clogging up the waterways and resulting in agriculture losses.

According to the literature, no effective biocontrol agents are available for antelope grass, but one advantage is that the grass does not have a seed bank, but only reproduces through rhizomes.

In a more recent publication, Lopez Rosas et al., (2010) made a case for advancing a freshwater marsh restoration project on an experimental site (in Mexico) invaded by antelope grass. They showed that by inundating the area to a depth of 40 cm for 15 months, it was possible to significantly reduce antelope grass biomass production and significantly increase biomass production of two native species: bull tongue (*Sagittaria lancifolia*) and cat tail (*Typha domingensis*).

During interviews with stakeholders it was mentioned that "some species" of plants had been introduced from Brazil to prevent erosion on the Linden to Lethem trail. One of these species was the wattle (*Acacia mangium*), which was introduced to Guyana in the 1960s and 1970s for reclamation of mined-out sites (Mahadeo S. (GFC), 2011 *pers. comm*.).

Figure 7: The wattle (*Acacia mangium*). Photo: Horace tan

A. mangium (figure 7) is known to have the capacity to spread rapidly and easily. It is a fast-growing tree that produces many seeds. It has naturalized in many cases and it is a threat to the indigenous flora, as evidenced in its history in Mayotte (Pascal, 2002).

Observation of its natural regeneration and its reputation as an invasive species in different tropical regions has encouraged managers to seek native species with which to replace it (Vos, 2004). There is an agreement between the Guyana Geology and Mines Commission and the University of Guyana regarding the use *A. mangium* for replanting purposes in mined out areas (Mahadeo S. (GFC), 2011 *pers. comm*.).

The Guyana Forestry Commission, knowing that *A. mangium* is an invasive alien species, is opposing this project (Mahadeo S. (GFC), 2011 *pers. comm*.). In effect, Guyana should not pursue *A. mangium* for rehabilitation of mined-out areas and should urgently put in place measures to avoid it becoming an invasive species. To help to prevent *A. mangium* from becoming more widespread in the wild and becoming a pest in Guyana, a scientific risk assessment should be conducted to improve the knowledge about its distribution and ecology across the country.

4.1.2 Invasive alien vertebrates species

The rock pigeon (*Columba livia*) is another invasive alien species largely restricted to Georgetown. Normally this species prefers human habitations and is commonly found around farm yards, grain elevators, feed mills, parks, city buildings, bridges, and other structures (Williams and Corrigan, 1994). In Guyana *C. livia* causes considerable damage to buildings and monuments because of its corrosive droppings (figure 8).

Figure 8: Populations of rock pigeons (*Columba livia*) in Georgetown.

These pigeons also pose a health hazard, since they are capable of transmitting a variety of diseases to humans and to domestic poultry and wildlife (Haag and Spiewak, 2004). Elimination of feeding, watering, roosting and nesting sites is important for long-term

pigeon control, together with discouraging people from feeding pigeons in public areas, and cleaning up spilled grain around elevators, feed mills, and railcar clean-out areas. Eliminating pools of standing water that pigeons use for watering, and modifying structures, buildings, and architectural designs to make them less attractive to pigeons can also be useful (Williams and Corrigan, 1994).

In a recent study, Ernst et al., (2011) assessed the invasion status and potential of a mainland population of Johnstone's whistling frog *Eleutherodactylus johnstonei* (figure 9) a decade after its introduction to Western French Guiana.

E. johnstonei, native to the Lesser Antilles, has been referred to as a highly invasive species on the grounds of its wide distribution and its potential to extend its range significantly based on recent climate model assumptions (Ernst et al., 2011).

So far there are no records from neighbouring Suriname, but *E. johnstonei* is known to have been present in Guyana for several decades. Established populations in the capital, Georgetown, appear to be large and the species seems to occur in higher densities compared to French Guiana (Ernst 2011, *pers. comm*.). Further spread is possible, mainly as a result of rapid economic and social changes in the Guiana Shield region.

Figure 9: Johnstone's whistling frog (*Eleutherodactylus johnstonei*) Photo: D. Massemin.

In French Guiana, frogs are restricted to urban garden habitats showing significantly higher abundance in gardens containing ornamental potted plants. In Guyana, frogs are not restricted to gardens but have successfully colonized the vast trench systems that are characteristic of larger towns such as Georgetown. *E. Johnstonei* has also managed to establish populations in Linden, some 300 km South, and there is a chance of further dispersal given new developments (i.e. road constructions) in the region (Ernst et al., 2011).

Despite the common notion that *E. johnstonei* is a rapidly spreading alien species that becomes highly invasive once introduced to novel environments, there is no clear evidence for this proposition in the established mainland populations under study in the Guiana Shield (Ernst et al., 2011). However, the situation in Guyana warrants a comparative systematic analysis of these 'older' mainland populations, because it could foster a sound evaluation of the actual invasion potential of the species in the larger area as a whole. A proactive strategy that involves detailed studies of known populations, and a monitoring system for already established and new populations is highly recommended, as this would allow action to be taken before containment or eradication efforts become either very costly or ultimately impossible (Ernst et al. 2011).

Some alien species identified in Guyana have already demonstrated invasive characteristics in many other parts of the world, some examples include the red-eared slider (*Trachemys scripta elegans*) and the small Asian mongoose (*Herpestes javanicus*) (Cadi et al., 2008; Ramsay et al., 2007; Nellis and Everard, 1983; Coblentz and Coblentz, 1985).

The red-eared slider (*Trachemys scripta elegans)* (figure 10) is a New World species with a natural distribution in eastern United States of America (USA) and adjacent areas of northeastern Mexico.

Although this species is now found on every continent, except Antarctica (Salzberg, 2000) the ecological effects of its introduction have been poorly documented (Platt and Fontenot, 1992).

Figure 10: Red-eared slider (*Trachemys scripta elegans*).

There have been many cases of turtles being released into the wild by their owners when they grow too large, and this has impacted on natural ecosystems where the turtles compete for food, egg-laying sites, or basking places (Cadi et al., 2008). The red-eared slider is listed by the World Conservation Union (IUCN) as one of top 100 of the world's worst invasive alien species (Lowe et al., 2000) and is considered an environmental pest outside its natural range.

Introductions of red-eared sliders into the environment due to releases and/or escapes of pets have been reported also in Guyana (Ernst, 1990; Ramsay et al., 2007) where, due to the lack of information, it is not possible to map the distribution of this species. Because the species is rated as a serious risk to biodiversity, it is important to prevent the establishment of further populations so that it does not become widespread or abundant in Guyana.

To help to prevent the red-eared slider from becoming more widespread in the wild and becoming a pest in Guyana, a scientific risk assessment should be conducted to improve knowledge about its distribution and ecology throughout the country. It is also important to report all sightings to the nearest relevant government department or wildlife authority so that appropriate action can be taken. Pet sliders turtles should be surrendered to the authorities or a responsible organisation and not released into the wild.

Programmes aimed at the eradication or control of these species use a combination of techniques to achieve their objectives. Draining water bodies is the preferred option, while intensive trapping and netting are also used. The novel use of a detection dog to locate turtle nests and eggs allows breeding to be controlled, increasing the likelihood of success (Cash et al., 2005).

Figure 11: Small Asian mongoose (*Herpestes javanicus*). Photo: Miika Silfverberg

The small Asian mongoose (*Herpestes javanicus*) (figure 11) is of immense concern to Guyana. It originates from Asia and was introduced to the West Indies by the British in the late 19th century to control rodent numbers in plantations (Wilson and Reeder, 2005). It is, perhaps wrongly, assumed that the mongoose was introduced to eradicate snakes (Wilson and Reeder, 2005).

The first documented introduction of mongoose to the West Indies was in 1870 when an unknown number of animals from India were introduced to Trinidad (Hoagland et al., 1989). Over the years, mongoose populations have spread throughout local areas and now pose a significant threat to the native biodiversity and the poultry industry (feeding on chicken).

The small Asian mongoose is a voracious predator and has been implicated in the decline or extinction of native animals in the Caribbean, especially on islands where, in most cases, the native animals of the West Indies evolved in the absence of predatory mammals (Nellis and Everard, 1983; Coblentz and Coblentz, 1985).

The small Asian mongoose is also a reservoir of pathogenic forms of the bacterium *Leptospira interrogans,* which is responsible for the disease leptospirosis, and it is a vector of rabies in the West Indies (Lorvelec et al., 2004). Unsurprisingly, the IUCN lists the small Asian mongoose as one of the world's 100 worst invasive alien species (Lowe et al., 2000).

More research is needed because any improvements in control and management of the small Asian mongoose in Guyana requires a greater understanding of its behaviour and ecology, especially of its impact on native and other non-native species, and the efficacy and uptake of poisoned baits in the field (Lorvelec et al., 2004).

Historically, the main methods used to control introduced mongeese were trapping programmes and the use of chemicals (poison). These methods could be used in the short term to control or even eradicate populations of the small Asian mongoose in small, sensitive areas of high conservation value, such as sites where they present a critical threat to endangered birds, reptiles or other wildlife (Lorvelec et al., 2004).

4.1.3 Invasive alien invertebrates species

The giant African snail (*Achatina fulica*) has been a conspicuous invader in Guyana over the past decade and is rapidly spreading across the country with adverse impacts on vegetables, root crops, and garden and native plants.

A. fulica (figure 12) has been nominated by the IUCN Invasive Species Specialist Group (ISSG) in the top 100 of the world's worst invasive species (Lowe et al, 2000). It is a host for *Anigiostrongylus cantonensis*, the rat lungworm, which causes eosinophilic meningitis in human beings.

Figure 12: Giant African snail (*Achatina fulica*). Photo: D.J. Preston

This invasive snail was first found in Trinidad in 2008 in Petit Valley (Joint Press Release, 2009), an eradication programme led by the Research Division of the Ministry of Agriculture, Land and Marine Resources was initiated.

Further research is required to determine the true extent of its distribution and impacts in Guyana. Although formal research has not been undertaken, there is concern that this

indiscriminate predator may cause the extinction of many native snails, as has occurred in Guam (Hopper and Smith, 1992).

Some of the most prevalent IAS in Guyana are those that threaten human health, through the spread of viruses and diseases. Examples include dengue fever and malaria, which are transmitted by the *Aedes aegypti* mosquito, and the Nile virus, where mosquitoes are also the vector.

Other species such as the Africanised bee (*Apis mellifera scutellata)* also constitute a direct threat to human safety, as do species that can cause poisoning or allergic reactions, such as nettles.

The Africanised bees (*Apis mellifera scutellata)* (figure 13) was introduced to Guyana during the 1970s from neighbouring Brazil (Sanford, 2006) (case study 2).

Figure 13: Africanised honey bee (*Apis mellifera scutellata).*

A. mellifera scutellata serves as a source of income for many households through honey production, but its impact on beekeeping in the country included a drastic decline in honey production. Beekeeping in Guyana was a thriving business as far back as the 1930s (Ministry of Agriculture, 2008). There is an high demand of honey in Guyana and the National Association of Beekeepers in Guyana is a registered organization with about 100 members. (Ministry of Agriculture, 2008).

Africanised bees are very aggressive and over the years this caused the death of many local people. However, studies conducted in Africanised honey bee areas indicate that not all colonies of bees become over-defensive (Spivak, 1991).

The management of any system requires some degree of predictability and this certainly is the case for European honey bees which can usually be counted on to take advantage of the same nectar resources, build their population numbers in regular fashion and otherwise behave in a consistent manner. This is especially important for honey production and the commercial pollination (Sanford, 2006).

However, management of the Africanised honey bee is far more challenging because there is often no pattern that can be logically discerned among colonies. Even the same colony can be highly manageable on one occasion, yet completely out of control on the next (Sanford, 2006).

CASE STUDY 2 - How Africanised bees came to America

Africanised honey bees have spread through most of the Americas partly because of their tendency to move more frequently than other honeybees. Their biggest move, however, was to cross the Atlantic from Africa to Brazil, but this was done with human help. By the 20th century, European honeybees had been imported into South America. These honey bees from colder

and drier climates never adapted well to the hot, wet and humid conditions of Brazil. Beekeepers began investigating how they might breed a bee better suited to their environment. Some thought the answer might be found in the tropical zone of Africa. There were reports of beekeepers in South Africa getting remarkable production from indigenous honeybees. African people had been obtaining honey from these wild honeybees for many centuries, and while they knew how furious the insects could get, they had also developed ways to avoid attack.

In 1956 a prominent Brazilian geneticist Warwick Kerr, an expert on Brazil's native stingless bees and familiar with bee breeding and apiculture, was asked by the Brazilian Agriculture Ministry if he could obtain some African honey bee queens and bring them back for breeding experiments. Kerr thought he could utilize African stock to produce a new breed of honey bees, which would be less defensive than the wild African bees but which would be more productive than European honey bees in Brazil's tropical setting. He returned to Brazil with 63 live queens from South Africa, which were taken to a quarantine area at an agricultural research station. By interbreeding the queens through artificial insemination with European drones, Kerr produced first generation hybrids. At this stage 29 Africanised honeybee colonies were maintained in hive boxes equipped with queen excluders (a device put over the hive entrance with holes too small to allow the queen to escape but large enough for the workers to pass through, so that the normal activity of the hive is maintained while the danger of swarming is eliminated).

In October of 1957, however, according to the story that Warwick Kerr has told countless times, a local beekeeper wandered by, noticed the queen excluders and removed them. Such excluders are normally only used in the time before queens begin laying eggs and it is possible that the fellow was just trying to be helpful. In any case, as the story goes, the removal of the excluders accidentally released 26 Africanised honeybee queens with small swarms into the lush forest nearby. By the time Kerr learned of the accident, there was no way of knowing where the bees had gone. He continued his work with the remaining Africanised honeybees and hybrid queens thinking that perhaps the escaped bees would either perish in the wild or mate with European honeybees and eventually lose their African characteristics.

Within a few years, however, the researchers at Rio Claro began getting reports from surrounding rural areas of feral bees furiously attacking farm animals and even humans. Many poor Brazilian farmers suffered livestock losses, and, eventually, there were human fatalities as well. By the early 1960s, it was clear that a rapid expansion had occurred among feral bee colonies and that the Africanised honey bees were moving quickly into other parts of the country. The rest is history.

Edited from The University of Arizona Africanised Honey Bee Education Project, Information Sheet 15: Africanised Honey Bees: Historical Perspective at http://ag.arizona.edu/pubs/insects/ahb/inf15.html

The above examples illustrate the extensive impact of just a few of the species that are known to be invasive in Guyana. In addition, many other plants, vertebrates and insects that could negatively affect the environment in Guyana, include:

- Barbados pride (*Caesalpinia pulcherrima*);

- Niaouli or broad-leaved paper bark (*Melaleuca quinquenervia*);
- Bengal clock vine (*Thunbergia grandiflora*);
- Bronze anole (*Anolis aeneus*);
- Tropical house gecko (*Hemidactylus mabouia*);
- Grass carp (*Ctenopharyngodon idella*);
- Bicoloured trailing ant (*Monomorium floricola*); and
- Tramp ant (*Tapinoma melanocephalum*).

Several economically important alien species with no specified biostatus in terms of invasiveness, are:

- Spanish cedar (*Cedrela odorata*);
- West Indian pennisetum (*Cenchrus polystachios*);
- Boston fern (*Nephrolepis cordifolia*);
- Common guava (*Psidium guajava*),
- Rainbow trout (*Oncorhynchus mykiss*); and
- Common pleco (*Pterygoplichthys multiradiatus*).

Yet, the problem extends beyond the invasive species that have already invaded Guyana, to the many species that may invade the country in the future with increasing international trade and tourism. It is widely recognised that once invasive species become established, they are extremely difficult to eradicate. Prevention needs to be seen as the first and best line of defence, and also the most cost-effective.

As alarming as this is may be, the reality is that due to limited documentation and research of invasive species to date, there is an inadequate knowledge base of the true extent of invasive species and their impacts in Guyana. Priority should be given to improving the quality and availability of information to support decision making. Additional information on the species that actually represent a threat will be required when completing the prioritisation process. Leadership (from Government) and coordination is also needed to support more consistent, effective management targeting priority pests.

Box 1: IAS ALERT LIST

Figure 14: The red lionfish (*Pterois volitans*). Photo PPG Aquarium

An imminent threat coming from the Caribbean Sea is the red lionfish (*Pterois volitans).* It is invasive in Caribbean waters and requires implementation of active control mechanisms to prevent its spread.

Lionfish (figure 14) represent a serious threat to both native marine life and human health and safety. This species has spread to new marine environments through the aquarium trade (Albins and Hixon, 2008), and its expansion in nature has been rapid and exponential.

This alert should be used as a warning. Guyana's fishermen and people along the coast could be advised to report any sightings of the red lionfish to the EPA.

ECOLOGY

Lionfish are ravenous predators which consume juvenile fish and crustaceans in large quantities. They reach sexual maturity at 1-2 years of age, and reproduce year-round. The success of the lionfish is partly attributable to its resistance to predation, largely because of its elaborate portfolio of venomous spines. They are generally resistant to parasites and tend to grow quickly, effectively out competing native species for food and habitat (Morris et al., 2009).

OCCURRENCE IN THE CARIBBEAN SEA

Increasing reports of this species' success in invading Atlantic and Caribbean waters has demonstrated the need for an early warning and rapid response system to prevent it spreading to new areas (Schofield et al., 2011) including Guyana, where lionfish are not considered to be present at this time (March 2011), invasion is likely imminent.

Because of this threat, this species has been included in the IAS inventory as a species on the Alert List.

Natural limitations on lionfish densities within its native range are poorly understood, but they have been recorded in the stomachs of large-bodied Caribbean groupers (*Epinephelus striatus* and *Myceteroperca tigris)*. This does not necessarily imply that groupers act as a biocontrol, but pest biocontrol by predatory fishes has been reported in other ecosystems (Mumby et al., 2011).

If their populations are allowed to continue growing unchecked, lionfish have the potential to severely reduce reef biodiversity, with the possible extinction of several species. Although it is still too early to be definitive, anecdotal evidence from the Bahamas corroborates this premise (Dell, 2009).

5.0 MAIN PATHWAYS AND VECTORS OF INTRODUCTION

The movement of organisms and the colonisation of new sites is a process that has occurred naturally throughout time. However, the growth of human populations, and their movements and activities linked to economic, social and cultural development have increased the frequency, number and diversity of non-native organisms that are transported and can become established in new areas. These relocations have produced a number of negative ecological, economic, and social impacts.

The identification, analysis, and management of pathways of introduction is critical to preventing the uncontrolled entry and dispersion of species outside their natural historic ranges.

Pathways are those processes through which a species is transferred from its native region to a new area that it would not have been able to reach through natural dispersion. The CBD defines introduction as movement of an alien species that can be either within a country or between countries or areas beyond national jurisdiction (Miller et al., 2006).

Vectors are mechanisms - the physical means, activities or products - through which a non-native species can be intentionally or accidentally transported to new surroundings (Lockwood et al., 2007; Koike et al., 2006). *Natural pathways* include winds, currents or other natural means, for which some species have developed morphological or behavioural adaptations. *Artificial pathways* are those that open up or increase as a direct consequence of human activities.

Introduction pathways can be divided in two types: *intentional pathways*, which are a result of deliberate transportation, trade, handling and intentional release of organisms or propagules; and *unintentional pathways*, which transport species indirectly. Examples include activities associated with the construction of infrastructure and means of communication, ballast water, organisms attached to the hulls of ships, soil for gardening or plant nurseries, food import or tourism, fishing gear and mariculture equipment, shipments of edible and ornamental species, frozen foodstuffs and bait for aquaculture, and items used for aquariums, fishery and sport fishing purposes (Kriesch, 2007).

Monitoring pathways and vectors of introduction is one of the main tools that should be considered in the fight against invasive species.

Knowledge of the means of initial introduction is crucial for developing preventative methods such as screening systems, interception programmes, early warning strategies, and import regulations (Wittenberg and Cock, 2001; Hulme, 2009).

To assist with the management of these introductions, Hulme et al., (2008) identified three broad mechanisms by which alien species may, as a direct or indirect result of human activity, arrive and enter into a new region; the importation of a commodity, the arrival of a transport vector, and/or natural spread from neighbouring region(s) where the species is alien. The three mechanisms result in six principal pathways, reflecting a gradient of human involvement: release, escape, contaminant, stowaway, corridor, and unaided (Figure 15).

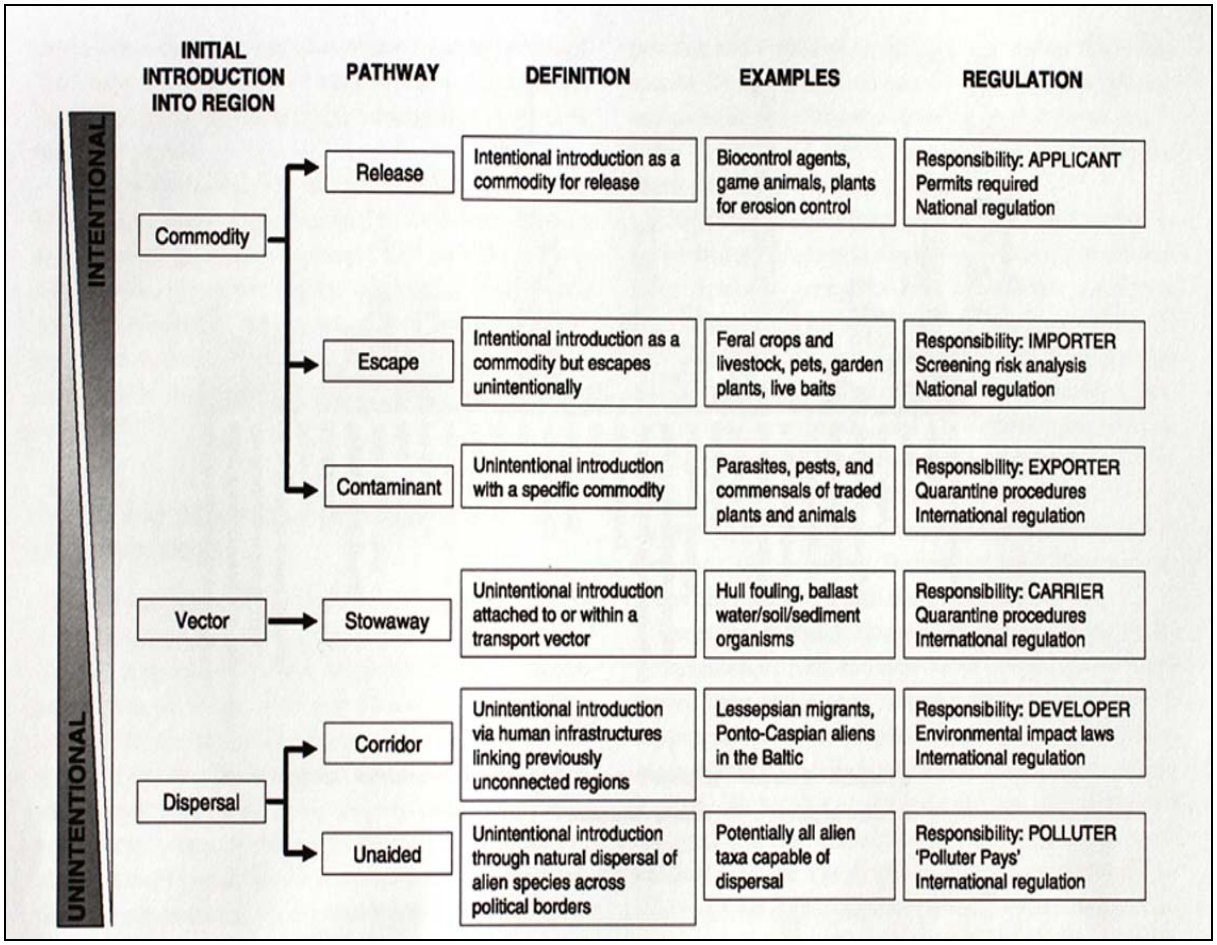

Figure 15: A simplified framework categorising the pathways of initial introduction of alien species into a new region.

Alien species may, as a direct or indirect result of human activity, arrive and enter into a new region through three broad mechanisms: the importation of a commodity, the arrival of a transport vector and/or natural spread from a neighbouring region where the species is itself alien. Five pathways are associated with human activity either as commodities (release and escape), contaminants of commodities, stowaways on modes of transport and opportunists exploiting corridors resulting from transport infrastructures. The sixth category highlights alien species that may arrive unaided in a region as a result of natural spread (rather than human transport) following a primary human-mediated introduction in a neighbouring region. For each pathway a brief description is presented with examples. The different regulatory approaches for each pathway are also illustrated. While a case is often made regarding differences between intentional and unintentional introductions, the scheme highlights a gradient of human intention that reflects the difficulty in distinguishing between ignorant and premeditated action (Hulme et al., 2008).

5.1 Pathways for IAS entry in Guyana

The mechanisms and pathways identified by Hulme et al., (2008) (figure 15) as critical for the management of IAS introductions, are important inputs for border control activities in Guyana, which will be crucial for improving prevention measures.

Guyana is an attractive country to do business in because of the richness of its biodiversity and indigenous resources. Biosecurity is considered one of the most critical issues in the shaping of Guyana's future well-being.

Guyana has an established framework, the National Biosafety Framework (NBF), for the management of plant and animal quarantine pests through phytosanitary and zoosanitary norms (EPA, 2007).

Inside the NBF, the Biosecurity Protocol covers all activities aimed at managing the introduction of new species and managing their impacts once introduced, in order to assure the eradication or effective management of risks posed by pests and diseases to the economy, environment and human health (EPA, 2007).

Based on this framework, there is no post-entry quarantine facility and the veterinary diagnostic facilities are not presently in use (EPA, 2007).

This consultancy revisited the institutional arrangements identified as components of IAS management structures in Guyana and provided an extensive, though not exhaustive, analysis of pathways for alien species introductions and suggested methods for intervention. This section also recommends the adoption of procedures for the prevention and control of IAS that have been successful elsewhere, as well as their evaluation and incorporation into best practices at the national level.

Information on pathways of IAS introduction to Guyana is not readily available and, for this consultancy, it was often necessary to assume that the original pathways of entry to Guyana were the same as those for the rest of South America. No report has ever been commissioned to identify the main pathways of introduction for IAS entry into Guyana. As Guyana does not have quarantine facilities in-country, the adoption of risk assessment for evaluating species introductions becomes even more important, and the existing mandate for risk-assessment and border control needs to be broadened to include environmental pests, i.e., invasive alien species. This is strongly recommended.

5.1.1 Ballast Water

Guyana is a country of large rivers and active domestic navigation (figure 16). As such, it may be susceptible to the transport of IAS in ballast water, which has received global attention as a major source of introductions of aquatic invasive species.

Ballast water systems are an integral part of ship design, and contribute to stability and balance as well as the structural integrity of the hull.

Ballast water is pumped into specially designed tanks distributed throughout the hull as ships are off loaded, and pumped out again on arrival in a port (figure 17) where cargo is to be loaded (Tamelander et al., 2010). Water carried as ballast inevitably contains a large number of organisms of different species at different life stages (e.g. eggs and larvae; cysts, spores or resting stages; and adults). Thus, it constitutes a significant potential vector for the spread of IAS.

Figure 16: Georgetown harbour.

Species introduced by ballast water can cause the following problems:

a) Health problems, such as Cholera or different parasitic diseases, which affect humans, animals and plants, including organisms used in aquaculture (Anderson, 1989);
b) Predation of native species, and the negative effects on the habitat; and
c) Pollution, such as blockage of pipelines, and increased clarification in water bodies associated with the propagation of exotic molluscs.

The most effective way to reduce the impact of ballast water is the exchange of ballast water in the high seas (ocean floor depths greater than 500 m), because the ocean environment is inhospitable for fresh water, estuarine and most coastal marine organisms. Although this ballast water treatment method is not 100% efficient, ballast water exchange in the high seas, combined with a system of control and revision, drastically lowers the risk of introduction of unwanted species (Hallegraeff, 1993).

Recognizing that addressing IAS requires coordinated responses between nations and especially between nations closely connected geographically and/or through trade and travel, regional IAS strategies and plans have also been developed. Under the GloBallast Partnerships Programme, Regional Strategies and Action Plans for Ballast Water Management (BWM) are being developed in all affiliated regions.

Guyana is one of the nations that agreed to this programme through the establishment of Regional Task Forces, under the Regional Activities Centre/ Regional Marine Pollution Emergency, Information and Training Centre (RAC/REMPEITC) activities, to ensure regional harmonisation in order to effectively manage the risk of species introductions through ballast

water effectively (Salles Vianna Da Silva et al., 2004).

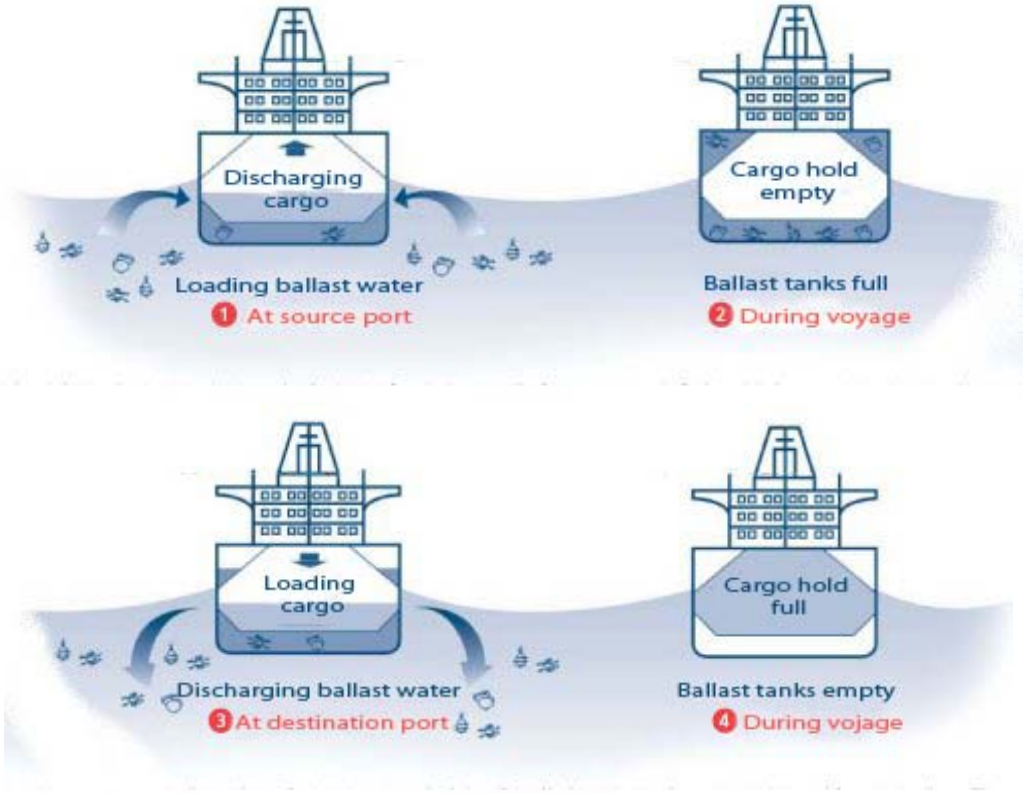

Figure 17: Cross section of a ship showing ballast tanks and ballast water cycle.
Source: GloBallast, International Maritime Organization (IMO 2000-2011).

Recommendations

Some of the recommendations to reduce the risk of translocation of species due to ballast water are:

- Inspect ships that arrive from ports where water conditions are similar to the port of arrival to ensure that ballast water was exchanged at high seas. A pathways assessment should be carried out to identify the main ports with which Guyana has commercial affairs that have similar environmental conditions to the ports of arrival. This will enable the country to optimize inspections and resources, increasing efficiency (a detailed pathways assessment model is available on Appendix VIII);
- Each port should have a specific area assigned for this manoeuvre: very shallow waters and polluted (dredged) zones, as well as red tide areas should be avoided;
- Avoid, whenever possible, the discharge of ballast water; and
- Multiple mechanical, physical, chemical (Salles Vianna Da Silva et al., 2004) and biological treatments have been proposed to kill, diminish or sterilize organisms contained in ballast waters and sediments, as well as special antifouling paints with biocides to diminish the amount of organisms adhered to hulls (Ferreira et al., 2004).

5.1.2 Marine Biofouling

Biofouling can occur in or on vessels e.g. vessel hulls; underwater fittings such as propellers, rudders and bow thrusters as well as damp or wet niche areas such as anchor lockers, sea-chests and bilges etc. Biofouling provides a means by which both sessile and mobile organisms can be translocate to new areas. It is estimated that biofouling is responsible for the introduction of over two thirds of all non-native algal species globally and about three quarters of all non-native marine invertebrates in different parts of the world (Salles Vianna Da Silva et al., 2004).

Biofouling is important as both a primary and secondary vector of IAS introduction. While international shipping has been responsible for the introduction of numerous species from one corner of the globe to another, domestic or regional shipping is equally important in spreading those species which have been introduced within a country or region. The golden mussel (*Limnoperna fortunei)* for example, which was introduced to Brazil in 1991 – probably through ballast water, is considered to have spread approximately 240 km/year up-river as a result of biofouling on local boats (Darrigran and Escurra de Drago, 2000; Oliviera et al., 2006).

Other examples include the green alga (*Caulerpa taxifolia),* originally introduced to the Mediterranean *via* the Monaco aquarium and then spread by small craft and fishing vessels (Ribera Siguan, 2003), and the wireweed (*Sargassum muticum)*, where secondary spread occurred *via* oyster movements and small craft (Wallentinus, 1999).

Fouling organisms on ship hulls have caused economic losses since the first ships sailed the oceans. The greatest invasive species risks are associated with ships and machinery kept in ports for some time and then transferred to a new destination. Several cases have come to light where docks were moved to another port and upon arrival several hundred species were found living on the hull. It is very important to maintain clear and detailed records of all biofouling mitigation, maintenance and repair activities carried out on a vessel. A well maintained antifouling paint and a cleaned surface is the best defence against marine biofouling (Commonwealth of Australia, 2008).

It is also important to encourage the development of national strategies and plans for responding to actual or potential threats from alien invasive species introduced by hull fouling within the context of national strategies and plans for the conservation of biodiversity, particularly in places like Guyana, where port activities are intense.

Recommendations

Hull fouling guidelines for Guyana may include these recommendations*:*

- Routine vessel monitoring to document the risk of species invasions by hull fouling;
- Identification of vessels which are likely to carry high risk species in their hull fouling(risk assessment);
- Identify ports which receive a large number of vessels suspected of contamination;
- Evaluate hull treatment methods for vessels;
- Increase awareness amongst dockyard and scrap yard operators that organisms removed from ship hulls should be collected and discharged safely on land; and
- Strongly encourage marina operators to apply these proposed guidelines.

5.1.3 Aquaria Releases

Trade in aquarium and ornamental species must be considered as another important source of species with potential to invade aquatic habitats in Guyana. These species are spread throughout the world in what is generally an unregulated industry. Escapes can occur inadvertently or by deliberate thoughtless releases when a domestic aquarium or its contents are no longer wanted. Small fragments of some aquarium plants can readily survive to grow into new plants vegetatively and translocation of these escaped plants can occur via ballast water, hull fouling and uncleaned fishing, mariculture and scuba diving equipment (Brunel, 2009).

An important example is the red lionfish (*Pterois volitans*), which escaped in 1992 from aquariums in Florida destroyed by hurricane Andrew, and spread throughout the Caribbean and the coast of Venezuela (Morris et al., 2009). Over the last five years, the lionfish (*Pterois volitans*), which is one of the world's most ornate fishes, has invaded much of the Caribbean, spanning an area exceeding 5,000 km^2 (Schofield, 2009).

The aquarium pet trade is a worldwide business, increased, particularly with the growth of internet mail ordering services where many types of marine organisms have become widely available. Domestic, public and research aquaria can exert for producing tough, thermally tolerant strains with enhanced growth and regenerative potential. Other examples of aquaria escapes are represented by the red-eared slider (*Trachemys scripta elegans)* as well as the water hyacinth (*Eichhornia crassipes*) (Hilliard, 2005) (case study 1).

Figure 18: Group of juvenile (*Trachemys scripta elegans*) in a pet shop. Photo: Henrik Bringsøe.

By the end of the Second World War the demand for pet turtles increased dramatically and massive numbers of young red-eared sliders were bred on turtle farms in the USA for the pet trade all around the world (figure 18). Introductions of red-eared sliders due to releases and/or escapes from the pet trade have been reported also in Guyana (Ernst, 1990; Ramsay et al., 2007).

Recommendations

- The aquarium industry must promote the responsible management of domestic aquaria, including free acceptance of any unwanted specimens returned to vendors;
- Governments must create, review or improve regulations on the aquaria trade and highlight the risks and illegality of aquaria releases; and
- Vendors must be responsible for providing information to clients on responsible ownership and on returning unwanted animals.

A discussion is currently being held by the Convention on Biological Diversity on minimizing risks from the pet trade. The results should be considered by the government of Guyana as they become available.

5.1.4 Marine transportation and trade

After a brief survey attempt in March 2011, it became clear that inspections carried out by trained staff for any goods or freights arriving at the Georgetown harbour are not consistent. The goods are opened without any measures in place to prevent the escape of pests into the environment (figure 19).

Figure 19: Georgetown harbour with containers in the background.

Merchandise is then moved from the port into a warehouse (figure 20) with no protection for the escape of flying insects or pathogens. Staff do not carry appropriate equipment to enable them to identify species and the goods are immediately offered for sale and rubbish is taken to a dump to be disposed of.

Figure 20: Stabroek Market the main market of Georgetown, near the Demerara River.

International trade requires the establishment of regulatory quarantine measures to prevent the introduction of species travelling as stowaways. The crazy ant (*Paratrechina longicornis),* the giant African snail *(Achatina fulica)* (case study 3), the dengue, and yellow fever mosquito (*Aedes aegypti)* have spread to new habitats in this manner.

Due to staff and financial limitations, quarantine laws are often not adequately enforced. Invasive alien species that threaten biodiversity need to be included in inspection routines in addition to the current major focus on agricultural pests. This might require adjustments to the legal framework.

Recommendations

- Define a specific enclosed area in the port for inspections, to prevent the escape of flying insects and other animals (for cargo suspected of contamination, the goods and their package material and containers can be treated with pesticides through fumigation, and immersion. Other methods include heat or cold treatment and irradiation);
- Establish regulatory quarantine measures to prevent the introduction of stowaway species in cargo;
- Train officials to conduct safe inspections to prevent species escaping;
- Create a support system for the identification of IAS in cargo, e.g. arrange for entomologists to be available to look at digital images taken at the harbour and sent by email, to reduce propagule pressure;
- Ensure that trading countries follow the International Plant Protection Convention (IPPC) Standard for Wood Packaging material, so that wood crates are treated before shipping.

Carry out inspections to verify that sources are reliable;
- Establish and enforce quarantine for suspect materials, to avoid new introductions;
- Treat suspected cargo with pesticides through fumigation and immersion as appropriate. Hot or cold treatments can also be used as available; and
- Clean goods or packages before they leave the port as disinfection measures. Despite the cost, preventing the spread of species is cheaper than controlling them at a later stage.

Resources

There are several international regulations focusing on invasive organisms and global trade, including the World Trade Organization Sanitary and Phytosanitary Agreement (WTO SPS Agreement), the International Plant Protection Convention (IPPC), and the World Organization for Animal Health (OIE).

The WTO SPS Agreement defines the basic rights and obligations of WTO member countries with regard to the use of sanitary and phytosanitary measures, which are necessary to protect human, animal or plant life or health, including procedures to test, diagnose, isolate, control or eradicate diseases and pests (Shine et al., 2010).

The IPPC develops international standards for phytosanitary measures, e.g. "Code of Conduct for the Import and Release of Exotic Biological Control Agents"; while the OIE is establishing animal health standards and guidelines for international trade in animals and animal products (Shine et al., 2010).

CASE STUDY 3 - Eradication of the giant African snail from Florida, USA

The giant African snail, *Achatina fulica*, about three inches long, has been introduced widely in Asia, to islands in the Pacific and Indian Oceans, and recently to the West Indies. It is seen as a serious agricultural pest, and predatory snails such as *Euglandina rosea* that were introduced to attack it have only added to the problem by extinguishing many native snail species. It was, however, successfully eradicated from Florida - although neither easily nor cheaply.

In 1966, a boy returning from Hawaii smuggled three of the snails into Miami, and his grandmother released them in her garden. Reproduction ensued, and in 1969 the Florida Division of Plant Industry (DPI) was alerted, leading to an immediate survey. The state Commissioner of Agriculture notified the news media about the giant snail, mailed over 150,000 copies of an attractive brochure, and called for public assistance in reporting and eliminating it. An area covering about forty-two city blocks was quarantined, but within days, a second infestation was discovered - in Hollywood, 25 miles north of Miami and well outside the initial quarantine zone.

The ensuing eradication campaign relied primarily on hand-picking, plus a granulated chemical bait. There were frequent surveys, and by 1971 in a six months period only forty-six snails were found - compared to 17,000 in the previous sixteen months. In Hollywood, seventeen months after its initial infestation, only one adult snail was found. But less than a month after the effort seemed to have succeeded, a third infestation, probably three years old, was discovered three

miles south of the original Miami site, with over 1,000 live snails on one block. The block was quarantined, and a large buffer zone was surveyed and treated. Nine months later, a fourth infestation, again about three years old, was found two miles north of the original one, followed by a fifth, about half a mile north of the initial infestation.

Although profoundly disappointed, the DPI persisted. By 1973, seven years after the three snails were brought into the city, more than 18,000 had been found, and many eggs. In the first half of that year, by contrast, only three snails were collected, in two sites. By April of 1975, no live specimens had been found for almost two years, and the campaign - which had cost over US $1,000,000 - was judged successful. Frequent surveys were continued for many months, along with the application of bait and chemical drenching. As a result, the giant African snail has not been found again, anywhere in the state.

Edited from Simberloff, D. (1996) Impacts of Introduced Species in the United States. Consequences 2(2), 13-23.

5.1.5 Tourism

The dramatic increase in the volume and mobility of tourism means that tourism is swiftly increasing in importance as a vector for the introduction of IAS into new areas. The trend for new outdoor activities and sports is leading to more rapid movement of tourists and their equipment into the remotest corners of the globe, which includes the tropical forests of Guyana.

Education before travellers depart offers perhaps the best way to prevent introductions, by encouraging them to clean their equipment and leave prohibited items behind. Public awareness of the problems involved with bioinvasions and public education about how to behave are considered an essential element of prevention programmes. The difficulty is that these actions cannot be carried out by the receiving country, which needs to rely on other measures.

Recommendations

- Ensure the application of laws regulating the exportation and importation of live species and propagules as souvenirs;
- Implement videos to be shown on international flights requesting people not bring in biological material, explaining the reasons of protecting native biodiversity, and other measures such as cleaning shoes of mud, turning in fruits or any other food on board;
- Increase border control procedures to check for the entry of biological material using trained dogs or luggage inspections. Carry out pathways assessment to define which flights should be controlled according to origin and chances of species establishment;
- Regulate and advise tour operators to follow rules including prevention measures to avoid the spread of propagules into remote areas, or along roads;
- Keep records of species or propagules intercepted at entry points;
- Border inspections should target species or propagules that can harm agriculture, health or the environment. Training of border control agents might be necessary;
- Engage partners such as NGOs working on environmental issues to increase awareness; and
- Deliver leaflets on restrictions and the reasons for them along with airline boarding passes

to increase awareness.

Tourism is considered a high risk pathway for IAS brought in baggage. For the long term, there needs to be an emphasis on programmes to reach children through the environmental component of the school curriculum as developed by the Ministry of Education. Addressing the tourism pathway includes a focus on the economic costs of IAS to the whole country and the need for preventive action as the most effective and economic control option. Such activities could include:

For commercial goods

- Technical leaflets with reference to legislation on the types of commodities that are permitted, restricted and prohibited and the methodology of application to import;
- Talks to groups of importers/exporters to explain procedures, and risks of IAS impacts and cost;
- Leaflets that could be attached to import permits and phytosanitary/sanitary permits; and
- Leaflets for parcels that are opened at Post Office.

For Tourism

- Posters and displays at arrival halls of airports and seaports, as well as other border crossings;
- Short segments on televisions at arrival halls;
- Amnesty bins and posters, sited at points of entry; and
- Include an explanatory section in declaration forms for passengers, in Creole and English.

For travel and transport

- Announcements on arriving vessels and planes;
- Explanatory text to accompany the arrivals IAS declaration;
- Advertise information in airline and local magazines;
- Articles on the wildlife/biodiversity theme with biosecurity messages in local magazines and newspapers, possibly sponsored by resorts and other tourism areas;
- Biosecurity leaflets indicating what is prohibited from import issued with air tickets in Guyana –sponsored by travel companies;
- Leaflets and posters for internal travel, boats and helicopters; and
- Training to airline operators and airport authorities.

5.1.6 Other key pathways of concern for Guyana

Within Guyana, other key pathways, like aquaculture, are foreseen to increase IAS introduction in the country. In early 2006, the Government called for a Fast Track Sector Development Plan to address commercial aquaculture to diversify Guyana's natural resources and reduce dependence on traditional crops such as rice and sugar (NAAG, 2008). Guyana is considered to offer several advantages to encourage investment in semi-intensive aquaculture development, including proximity to North America and Caribbean markets (location in northern South America facilitates premium access to shipping lanes and air travel), inexpensive labour, the fertility and development of land and an abundance of fresh and brackish water (NAAG, 2008).

However escapes from aquaculture are not uncommon and escapees often invade the new habitats (Wittenberg and Cock, 2001) (case study 4). Since containment in aquaculture cannot be guaranteed, species should not be introduced until a risk of entry has been undertaken to assess the safety of the action proposed (Wittenberg and Cock, 2001):

CASE STUDY 4 - Release of Exotic Fish by Aquarium Hobbyists – the USA Experience

Most fishes available for sale in pet shops are exotic and are imported into the USA predominantly from Central and South America, Africa, and South-east Asia. Each year, over 2000 species, representing nearly 150 million exotic freshwater and marine fishes, are imported into the USA for use in the aquarium trade. Unfortunately, some exotic fishes are released into the wild each year. Hobbyists may not be able to take their fish with them when they move, or they simply may lose interest in maintaining an aquarium. Fish may also be released if they outgrow the aquarium or if they appear to be in poor health.

Currently, at least 185 different species of exotic fishes have been caught in open waters of the USA, and 75 of these are known to have established breeding populations. Over half of these introductions are due to the release or escape of aquarium fishes. Because many of these fishes are native to tropical regions of the world, their thermal requirements usually prevent them from surviving in temperate areas. In the USA, therefore, most introduced fishes have become established in Florida, Texas, and the South-west USA. Examples include a number of cichlids, such as the Jack Dempsey, jewelfish, convict cichlid, Midas cichlid, and spotted tilapia; and livebearers, such as swordtails, platies and mollies, and armoured catfishes. The goldfish, a native of China, is one of the few examples of a temperate aquarium species that is established throughout the USA.

Instead of subjecting the fish to potentially harmful environmental conditions or risking potential eco logical problems by releasing it, there are alternative means for disposing of unwanted pet fish:

- Return to a local pet shop for resale or trade;
- Give it another hobbyist, an aquarium in a professional office, a museum or to a public aquarium or zoological park; and
- Donate it to a public institution, such as school, nursing home, hospital, or a prison.

If these options are not available, rather than release fish into the wild, they should be "put to step", i.e. by replacing the fish in a container of water and putting it into a freezer. Because cold temperature is a natural anaesthetic to tropical fishes, this is considered a very humane method of euthanasia

.

Edited from the U. S. Department of the Interior Geological Survey Non-indigenous Aquatic Species website "Problems with the Release of Exotic Fish " at: http://nas.er.usgs.gov/fishes/dont_rel.htm through http://nas.er.usgs.gov/

5.2 Vectors of spread after introduction from neighbouring countries

Quite apart from initial intentional releases or accidental introductions, many species then spread within a country or across national boundaries. Some species undergo an explosive expansion of their range after "biological barriers" are removed or new pathways are opened by human activity, even if the initial introduction happened a long time previously. When an invasive species spreads into neighbouring countries it raises questions of responsibility and liability.

In Guyana, the most significant examples of IAS spreading from a neighbouring country are the Foot and mouth disease (FMD), a viral illness that rarely affects humans but causes fever, malaise and painful lesions in cattle, sheep, pigs and other livestock (case study 5) and the Carambola fruit fly (*Bactrocera carambolae,)* a serious pest of Carambola plants that affected Guyana until the year 2000 when this pest was successfully eradicated (case study 6).

Dispersal of *B. carambolae* can occur through the fly moving to other areas, or through humans carrying produce to other areas/countries, as happened with the introduction into Suriname from its original area of distribution in Southeast Asia. This pest is native to Indonesia, Malaysia and Thailand and was first collected in South America in 1975 in Paramaribo, Suriname. It is now present in Suriname, French Guiana, and Brazil (State of Amapa) (Malavasi et al., 1998).

B. carambolae was also detected in Guyana, and an eradication campaign was initiated in 1996, gaining the attention of the ministry and international partners. No effort was spared to eliminate this potential threat to the upswing of agricultural development, and this work set the foundation for a prosperous sector (GINA, 2009b). The *B. carambolae* eradication campaign appears to have been ultimately successful and Guyana has been declared free of *B. carambolae* since October 2000 (Sauers-Muller, 1990 -2001 annual reports).

Recommendations

Given the proximity of Brazil, French Guiana and Suriname to Guyana, a re-infestation is always possible. This situation demands:

- Immediate response of appropriate control measures to address any infestations;
- A robust strategy to ultimately eradicate the pest from South America; and
- On-going training of farmers and extension agents, induction of new skilled practitioners and the procurement of necessary equipment as part of capacity building.

International regulations ratified by neighbouring countries can reduce the risks of bioinvasions by implementation of agreed measures. Regional initiatives will frequently be needed to exclude invasive alien species, and to manage them once they are established.

CASE STUDY 5 - Foot and Mouth Disease: protective measures in Guyana.

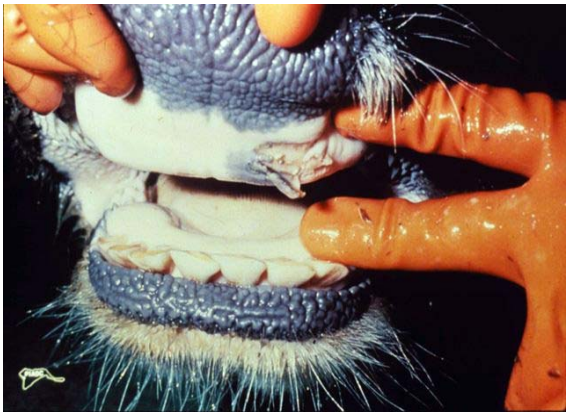

Figure 21: Foot and Mouth disease.

Foot and mouth disease (FMD) is a viral illness that rarely affects humans but causes fever, malaise and painful lesions in cattle, sheep, pigs and other livestock (figure 21). In young animals, the disease can be fatal, while older animals suffer weight loss, slowed growth and reduced lactation. Outbreaks result in major losses in livestock and milk production (PAHO, 2003).

In 1973 the South American Commission for the Fight Against Foot and Mouth Disease (COSALFA), was set up to coordinate international action. Through this and other multilateral forums, Pan American Foot and Mouth Disease Centre (PANAFTOSA) helped the countries organize their measures against FMD (PAHO, 2003).

Guyana has been free of Foot-and-Mouth Disease since 1978 and as a result does not carry out a national vaccination programme. Protective measures are in force at the border with Brazil where the disease is prevalent, to prevent the spread of the disease to the country.

The Minister of Agriculture, Robert Persaud, at a Foot and Mouth Disease Workshop (December 2009) at the Savannah Inn, Lethem, stressed that it is paramount that Guyana maintains its disease free status if the country's cattle industry is to be developed for export purposes (GINA, 2009a). "Guyana is one of two countries in South America that is free of FMD without vaccination, a status which we are proud of and are committed to maintain at all cost," said Agriculture Minister Robert Persaud (GINA,2009a).

Foot and mouth disease, is spread by cloven-hoof animals including cattle, water buffalo, sheep, goats and pigs. "COSALFA acts as a regional coordinating mechanism to promote lines of action, and evaluate the activities carried out for FMD control, development of epidemiological models and eradication in the continent," (GINA,2009a).

6.0 EVALUATION OF GUYANA'S POLICY AND INSTITUTIONAL BASELINE

Section 6 outlines the international and regional policy context within which Guyana needs to develop its National IAS Strategy and Action Plan (6.1-6.2). It then analyses the policy baseline in Guyana with regard to relevant institutions (6.3) and identifies existing strategies, laws and regulations (6.4). The chapter concludes with an evaluation of the baseline's main gaps and constraints and suggests priorities to be addressed through the future National IAS Strategy and Action Plan (6.5).

6.1 International context for action

IAS policies are shaped by international commitments related to environmental protection, plant and animal health and some transport pathways. These consist of multilateral agreements, standards and guidelines developed separately by different sectors over recent decades. This fragmented policy landscape, and the relationship of key instruments to the international trade regime, has been extensively studied for the Global Invasive Species Programme, the CBD and other bodies (see e.g. Shine, 2007; Burgiel et al., 2006).

Environmental protection

For Guyana, the overarching instrument governing environmental protection against IAS impacts is the **Convention on Biological Diversity** (CBD). As a Party to the CBD, Guyana is required to take necessary measures to "prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species" (Article 8(h)) and to tackle IAS as a cross-cutting issue in line with CBD decisions. Relevant provisions and recommendations apply to terrestrial, inland water and coastal and marine ecosystems.

In 2002, CBD Parties adopted *Guiding Principles for the prevention, introduction and mitigation of impacts of alien species that threaten ecosystems, habitats and species* (Box 1). The fifteen Principles are non-binding but provide a framework for governments developing effective strategies for IAS prevention and management. They cover both intentional and unintentional pathways of introduction and apply to all groups of organisms, including GMOs and LMOs where these are IAS. Decision-making should be based on the precautionary and ecosystem approaches and provide for transboundary cooperation where appropriate.

The Guiding Principles are based on the 'three stage hierarchy' which states that prevention is generally more cost-effective and environmentally desirable than measures taken following the introduction and establishment of an IAS: priority should be given to preventing the introduction of IAS between and within States (e.g. through border control and quarantine measures). If an IAS has been introduced, early detection and rapid eradication should take place to prevent its establishment. In the event that eradication is not feasible or resources are not available for eradication, containment and long-term control measures should be implemented.

In 2010, CBD Parties adopted the new Strategic Plan 2011-2020, supported by the Aichi Targets for implementation (10th meeting of the CBD Conference of the Parties: Nagoya, Japan, October 2010). Target 9 provides that "By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment."

Box 2: CBD Guiding Principles for the prevention, introduction and mitigation of impacts of alien species that threaten ecosystems, habitats or species

General principles
Guiding principle 1. Application of precautionary approach;
Guiding principle 2. Application of three-stage hierarchical approach, i.e. prevention, eradication and control;
Guiding principle 3. Application of ecosystem approach as described in COP Decision V/6;
Guiding principle 4. The role of States in recognising the risk that activities within their jurisdiction or control may pose to other States as a potential source of IAS and taking appropriate actions to minimise that risk.
Guiding principle 5. Undertaking research and monitoring activities
Guiding principle 6. Increasing education and public awareness
Prevention
Guiding principle 7. Implementing border control and quarantine measures
Guiding principle 8. Exchanging of information on IAS
Guiding principle 9. Increasing cooperation, including capacity-building
Introduction of species
Guiding principle 10. Guidelines regarding intentional introduction
Guiding principle 11. Guidelines regarding unintentional introductions
Mitigation of impacts
Guiding principle 12. Taking appropriate steps to mitigate impacts of IAS
Guiding principle 13. Eradication when feasible
Guiding principle 14. Containment when eradication of not appropriate
Guiding principle 15. Implementing effective control measures

Annex to CBD Decision VI/23, available at **http://www.cbd.int/decision/cop/?id=7197**

Since 2008, Guyana has been a Party to the **Cartagena Protocol on Biosafety**. This is an international treaty governing the movements of living modified organisms (LMOs) from one country to another, and was adopted in 2000 as a supplementary agreement to the CBD. It seeks to protect biodiversity from the potential risks posed by LMOs and establishes an advanced informed agreement procedure for ensuring that countries are provided with the information necessary to make informed decisions before agreeing to the import of such organisms into their territory.

Guyana is a longstanding party to the **Convention on International Trade in Endangered Species of Wild Fauna and Flora** (CITES) which entered into force in 1977. Its primary purpose is to regulate species trade for the purposes of conservation but at a secondary level, Parties have recognized that alien species can pose significant threats to biodiversity, and that species of fauna and flora in commercial trade are likely to be introduced to new habitats as a result of international trade. Resolution 13.10 (as amended) on *Trade in alien invasive species* recommends that Parties:

- Consider IAS problems when developing national legislation and regulations that deal with trade in live animals or plants;
- Consult with the proposed country of import's Management Authority, (i.e. in the destination country) when considering exports of potentially invasive species, to determine whether there are domestic measures regulating such imports ; and
- Explore appropriate cooperation and collaboration between CITES and the CBD on the issue of introductions of alien species that are potentially invasive.

Guyana is not a Party to the Ramsar Convention on Wetlands or the Convention on Migratory

Species which also address certain environmental impacts of IAS.

Animal and plant health and the international trade regime

Many terms and concepts are used in the field of IAS prevention and management, depending on sector, organisation and instrument. However, the term 'invasive alien species', as defined under the CBD Guiding Principles, is internationally recognised as being broad enough to encompass alien pests and diseases of plants and animals as well as covering wider environmental impacts.

The Inter-agency Liaison Group on Invasive Alien Species[2], established by the CBD Secretariat to facilitate cooperation among relevant organizations on IAS prevention and management, comprises representatives of the International Plant Protection Convention (IPPC) and the World Organisation for Animal Health (OIE), the Food and Agriculture Organization (FAO), the World Trade Organization (WTO) as well as other bodies. Guyana is a member country of OIE and a party to the IPPC.

OIE and IPPC provide the global biosecurity framework for national veterinary / phytosanitary bodies to take measures (import and export controls, certification systems, regulatory quarantine, notification, response to incursions etc.) to prevent or minimise the spread of animal diseases and plant pests through trade. The OIE establishes animal health codes and guidelines for international trade in animals and animal products, including for aquatic animals, while the IPPC develops international standards for phytosanitary measures (ISPMs), some of which are directly relevant to IAS risks (e.g. ISPM 3: *Code of Conduct for the Import and Release of Exotic Biological Control Agents*).

OIE and IPPC are recognized as standard-setting bodies by the World Trade Organization Agreement on the Application of Sanitary and Phytosanitary Measures. This Agreement defines the basic rights and obligations of WTO member countries with regard to the use of sanitary and phytosanitary measures (measures necessary to protect human, animal or plant life or health, including procedures to test, diagnose, isolate, control or eradicate diseases and pests). National measures based on OIE/IPPC standards are presumed not to require separate risk assessment.

OIE and IPPC have traditionally focused on preventing and managing threats to farmed livestock and agricultural crops. Under the IPPC, the need to address risks to wild species and the uncultivated environment has been recognized over the last decade and a joint programme of work with the CBD, involving consultation in the development of new standards, is now in place.

IPPC has a network of Regional Plant Protection Organizations which may develop regionally-applicable standards or guidance. Guyana is a member of the Caribbean Plant Protection Organization (CPPO), which does not currently have an active work programme.

Transport vectors

In the transport sector, the only binding instrument for an introduction vector is the International Maritime Organization (IMO) International Convention for the Control and Management of Ships'

[2] For a report of its Second Meeting (Geneva, 14) 15 February 2011), see http://www.cbd.int/invasive/doc/iaslg-02-03-en.pdf

Ballast Water and Sediments 2004. This will enter into force 12 months after ratification by 30 States, representing 35% of world merchant shipping tonnage. Guyana is not a party to this Convention.

At the regional level, ballast water risks are also addressed through Regional Strategies and Action Plans for Ballast Water Management (BWM), developed for affiliated regions within the GloBallast Partnerships Programme. Guyana participates in the Regional Task Force for the Caribbean, set up by the Regional Activities Centre/ Regional Marine Pollution Emergency, Information and Training Centre (RAC/REMPEITC) to promote regional harmonisation to manage the risk of species introductions through ballast water effectively (Tamelander et al., 2010). The first meeting to draft a Regional Strategic Action Plan was held in December 2009.

Inter-agency cooperation

At the global and regional levels, gaps in the regulatory framework have been identified in relation to many IAS pathways. There are, for example, no binding instruments to cover known pathways like hull fouling, civil air transport and aquaculture/mariculture. Other pathways characterised by specific gaps and inconsistencies include military activities; emergency relief, aid and response; international development assistance; scientific research; tourism; pets, aquarium and garden pond species, live bait and live food; biocontrol agents; ex-situ animal breeding programmes; incentive schemes linked to reforestation (e.g. carbon credits); and inter-basin water transfer and canals.

In 2011, the CBD established an Inter-Agency Liaison Group on IAS to address gaps and inconsistencies in the international regulatory frameworks, promote capacity development activities, assist inter-sectoral cooperation and cooperation at the national level through each organization's national and regional focal points, cooperate in the development and use of relevant information and information systems and generally improve coordination and reduce duplication.

As of May 2011, the following international organizations have been invited by the Executive Secretary to participate in the Liaison Group: IPPC, OIE, the Committee on Fisheries (a subsidiary body of the FAO Council), the World Trade Organization – Sanitary and Phytosanitary Agreement Committee (WTO SPS), the International Civil Aviation Organization, the International Maritime Organisation, CITES and the WTO's Standards and Trade Development Facility and the International Union for the Conservation of Nature (CBD, 2011)

6.2 Regional context for action

Within the Caribbean and Latin America, Guyana is a member of, or official signatory to, several regional cooperation frameworks, some of which are relevant to IAS.

The **Cartagena Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region** (WCR) is a regional umbrella agreement for protection and development of the marine environment, supplemented by issue-specific protocols. The most relevant to IAS is the **Protocol on Specially Protected Areas and Wildlife** (SPAW Protocol), adopted in 1990, which provides a more detailed regional framework for CBD implementation, based on the ecosystem approach.

The SPAW Protocol aims to protect, preserve and sustainably manage 1) areas and ecosystems that require protection to safeguard their special value, 2) threatened or endangered species of flora and fauna and their habitats, and 3) species, with the objective of preventing them from becoming endangered or threatened. As part of mandatory protection measures, Article 5.2.f requires Parties to regulate or prohibit the introduction of non-indigenous species. The United Nations Environment Programme's Caribbean Environment Programme supports capacity building and training activities in the marine sector as well as the development of national strategies for SPAW Parties. A regional Network and Forum of Marine Protected Areas has been established to support Caribbean marine protected areas managers.

Guyana is a member of the **Caribbean Community** (CARICOM) which provides support to policy and legislative harmonisation, including in the area of plant and animal health. CARICOM is the executing agency for the programme on **Mainstreaming Adaptation for Climate Change** (MACC), which aims to build capacity to identify risks and reduce vulnerability to climate change as part of sustainable development in CARICOM states.

Guyana is also a member country of the **Caribbean Invasive Species Working Group** (CISWG) formed in 2003. This assists countries to develop strategies which safeguard the Caribbean against IAS and has launched the Caribbean Invasive Species Surveillance and Information Programme. Its focus to date has been on invasive species that present a threat to agricultural and trade in agricultural commodities and products. However, the on-going CABI/GEF project *Mitigating the Threats of Invasive Alien Species in the Insular Caribbean*, will support the broadening of Caribbean IAS activities to include IAS which threaten biodiversity, including aquatic IAS.

The **Caribbean Taxonomic Network** (CARINET) and **Caribbean Pest Information Network** CARIPESTNET provide some diagnostic services, staff involvement (arthropods, micro-organisms, nematodes, molluscs, weeds) and the foundations for developing a searchable database.

The **Amazonian Cooperation Treaty Organisation** (ACTO) 1978 promotes sustainable development of the Amazon Basin and has eight member states. Pursuant to the Amazon Cooperation Strategic Agenda, the Coordinating Office of Environment provides a regional coordination framework for conservation, protection and sustainable use of renewable natural resources. Many of these activities are relevant to building resilient ecosystems but there does not appear to be IAS-specific activities under way at present.

The **Latin American Network for Technical Co-operation in National Parks, Protected Areas and Wildlife** (LAN-NPPAW) provides a framework for conservation and development of wild land areas and wildlife in the region and collectively identifies species for priority conservation action (which could include species subject to IAS threats).

The **Guiana Shield Initiative** is based in Suriname and focuses on forest ecosystem conservation, biodiversity protection and general conservation support. It covers 2.5 million km^2 extends from Colombia to the Brazilian state of Amapa and covers all of Guyana. The most distinctive component is the series of payment mechanisms to counter threats from large-scale agriculture, plantations, mining, and other forms of land conversion and provide alternative means to its inhabitants, notably to help owners and users conserve tropical rain forests of the area.

6.3 National context: institutional framework in Guyana

Because IAS affects several sectors, a range of government departments and other bodies carry out relevant functions. An outline of Guyana's most relevant institutions and stakeholders is presented below.

Government departments and agencies

The Environmental Protection Agency (EPA) is a statutory body established by the Environmental Protection Act, 1996 to take measures necessary for effective protection and management of the natural environment, coordination of conservation programmes, sustainable use of natural resources, assessment of the impact of development activities on the environment and integration of appropriate environmental provisions into development planning.
Its comprehensive mandate (Article 3) includes the following specific functions:

- Effective management of the natural environment to ensure conservation, protection, and sustainable use of its natural resources;
- Promoting public participation in the process of integrating environmental concerns in planning for sustainable development;
- Coordinating environmental management activities;
- Enforcement of regulations, pollution prevention and control, coordinating integrated coastal zone management and prior assessment of environmental impacts of development activities;
- Coordinating and maintaining a programme for conservation and sustainable use of biodiversity; and
- Coordinating and maintaining a national park and protected areas system and a wildlife protection management programme.

The Act confers broad regulatory powers on the EPA to carry out and enforce these functions, through collaboration with public and private sector organisations, NGOs, communities and individuals. The EPA's substantive work is conducted by three technical Divisions: Environmental Management; Natural Resources Management (which is responsible for biodiversity monitoring); and Education, Information and Training (which prepares National Environmental Awareness Strategies).

The **Wildlife Management Authority** (WMA) is a separate entity with primary responsibility for CITES implementation and regulating the trade of wild fauna and flora, pursuant to the Species Protection Regulations 1999.

The **Ministry of Agriculture** (MOA) is responsible for administering the agriculture sector, including crops and lands, hydrometeorology and climate change and the operation of phytosanitary measures at ports of entry. The units most relevant to IAS prevention and management are:

- The *Quarantine, and Animal and Plant Health Units* which operate border and coastal surveillance and control programmes for pests and diseases of agricultural livestock and crops essential to its statutory agricultural biosecurity function, in cooperation with the Customs and Trade Administration (EPA, 2003).

- The *Pink Mealy Bug Unit*, the only existing local entity that specifically addresses IAS issues (EPA, 2006);
- Fisheries Department: this handles fisheries policy, planning and regulation and aquaculture enforcement and regulation.
- The **Guyana Forestry Commission** (GFC) is a subsidiary body of the Ministry of Agriculture. Nearly 85% of Guyana's territory is covered with natural forest, of which about 80% is classified as State Forests under GFC jurisdiction. GFC is responsible for advising the subject Minister on issues relating to forest policy, forestry laws and regulations and for the administration and management of all State Forest land. Its work is guided by a Draft National Forest developed to address the forest policy.

The **Guyana Lands and Surveys Commission** (GL&SC) has overall responsibility for land use planning. It is the principal steward of State Lands and administrates land leases for agricultural purposes, carries out land surveys, produces maps and stores and distributes geographical information through Guyana Integrated Natural Resources Information System (GINRIS).

The **Guyana Geology and Mines Commission** (GGMC) was established in 1979 to support economic diversification through activities in the mineral sector and regulate all mining activities on behalf of the government. Its technical division includes an Environmental Research and Development Department responsible for coordination, promotion and overseeing the implementation of efficient mineral processing and environmentally sound mining techniques across the whole industry. Specific functions potentially relevant to IAS prevention (at the strategic level) and management (site-specific control measures) include:

- Proposing environmental strategies to facilitate the execution of national mineral development policies; and
- Development and review of environmental monitoring programmes, management plans, emergency response and contingency plans and mine site rehabilitation programmes.

The **Ministry of Health** has responsibility for public health and certain aspects of biosecurity in relation to bio-warfare and other forms of bioterrorism, which directly impact the human health of both locals and tourists.

Two statutory cross-sectoral coordination structures have been established to support development and implementation of environment and development policies in Guyana.

The Natural Resource and Environment Advisory Committee (NREAC) comprises heads of natural resource agencies (including forestry, mining, energy and land use) and the EPA. It examines environmental and natural resource policies prior to submission to the Cabinet for approval and has the overall role of coordinating the work of the United Nations Conventions.

The National Biodiversity Committee (NBC) is a sector-level body established in February 2008 for policy development and sector level collaboration on natural resource management and has an advisory role on emerging issues relating to biodiversity planning and management. It comprises representatives from key sector agencies, including EPA, the Wildlife Management Authority (WMA), the Guyana Forestry Commission (GFC), (the Ministry of Health, the Ministry of Local Government, the Ministry of Amerindian Affairs (MOAA), the Guyana Lands and Surveys Commission (GL&SC), the Guyana Revenue Authority (GRA), the Guyana Tourism Authority

(GTA), the National Agriculture Research and Extension Institute (NAREI), the University of Guyana (UG), the Iwokrama International Centre for Rainforest Conservation and Development (IIC) and Conservation International (CI).

In 2008, the EPA established a multi-disciplinary IAS Task Force comprising representatives from stakeholder agencies directly involved with aspects of introduction and management of IAS. Its purpose was to provide overall guidance to the EPA on matters related to IAS in Guyana. Its main objectives included: the preparation of an IAS inventory, to produce a situation analysis of IAS in Guyana, to identify the key issues in Guyana as they relate to IAS, to develop an IAS monitoring strategy, including funding options, and to participate in long-term monitoring of IAS in Guyana. The IAS Task Force synthesised public information on IAS which included an appearance on a local television programme and prepared public awareness materials. However, it gradually became dormant and only made limited progress to achieve the above-mentioned objectives.

Within the **University of Guyana**, the Centre for the Study of Biological Diversity maintains the national collections of biological specimens and information databases. It also carries out systematic biodiversity research and uses this information to help identify management areas in Guyana. The School of Earth and Environmental Sciences carries out research and training in environmental management, land use planning, and environmental education.

Non-government and private sector entities

The **Iwokrama International Centre for Rainforest Conservation and Development (IIC)** was established in 1996 under a joint mandate from the Government of Guyana and the Commonwealth Secretariat to manage the Iwokrama forest (371,000 hectares). It seeks to promote the conservation and the sustainable and equitable use of tropical rainforests in a manner that will lead to lasting ecological, economic and social benefits to the people of Guyana and to the world in general by undertaking research, training and the development and dissemination of technologies. Iwokrama plays a leading role in scientific research and innovative forest business governance models in Guyana: it has addressed IAS risks in its environmental impact assessment of its own business activities.

Key sector stakeholder bodies include the **Guyana Gold and Diamond Miners Association** and the **National Aquaculture Association of Guyana (NAAG)**, established in 2006 as a forum for public-private stakeholders to steer development of the aquaculture industry and provide extension and training services to members.

6.4 National context: policy and legislative framework in Guyana

Provisions relevant to IAS are typically found in instruments dealing with customs and immigration, plant/animal health, environment, nature conservation, wildlife trade, public health, fisheries, forestry, trade and/or transport. Depending on their focus, relevant measures may cover:

- Biosecurity, import and quarantine rules applied pre-border or at point of entry to prevent the arrival of potentially invasive species on national territory;
- Early detection and rapid response to eliminate newly-arrived pests before they can spread far beyond the point of arrival: these may include surveillance, reporting,

information exchange, contingency planning and technical protocols;
- Rules to prevent the internal spread of potentially invasive species, applicable to transport, holding, movement, release and/or use in the wild;
- Control and management requirements for existing invasive species; and
- Cross-cutting measures (e.g. planning, information systems, education and public awareness, capacity-building and incentive measures).

The following summary outlines key components of Guyana's existing and proposed policy and legal framework, covering key sectors. The section concludes with a synthesis table which evaluates coverage and gaps under each of the five categories mentioned above (Table 2).

Environmental protection

The **National Development Strategy 2000** sets out the principle that "Guyana's development must not threaten the integrity of the environment". Development should be based on the "prevention of environmental degradation, rather than on the application of remedial measures of doubtful efficacy, after the damage has already been done". The Strategy lists Guyana's specific vulnerabilities to environmental pressures (and thus to IAS): these include fragile forest ecosystems, oceanic flood risks to the narrow coastal belt, the economy's dependence on coastal plantation type agriculture and poverty.

The **Environmental Protection Act 1996** is a comprehensive framework law for regulation, monitoring and enforcement of environmental standards and the safeguarding of national ecosystems, resources, human and environmental health. It establishes the EPA's mandate and functions, a legal basis for environmental impact assessments (EIA), and a range of enforcement procedures and sanctions. The Act establishes Guyana's Environment Trust Fund and Environment Tribunal. Its limited range of definitions does not cover biodiversity or IAS.

The **Environmental Protection Regulations (2000)** were issued under the 1996 Act to ensure that measures for environmental protection are integrated into development activities. It established detailed EIA and authorisation requirements for any new development activity that may have significant environmental impacts. In 2002, the EPA issued a list of processes and activities requiring authorisation, covering the mining, forestry, agriculture, infrastructure, energy, and tourism and fisheries sectors. There is no reference to IAS or to species introductions (except for genetically modified organisms). However, several of the project categories may foreseeably provide new pathways for introduction and/or the spread of potential IAS. These include the construction of roads, harbours, and airfields; installations designed to hold or store liquid on a long-term basis; the importation of any waste matter whether hazardous or not; the release, use or keeping of any genetically modified organisms; the harvesting and utilisation of forest resources; and the extraction and conversion of mineral resources.

Biodiversity, ecosystems and protected areas

The **National Strategy for the Conservation and Sustainable Use of Guyana's Biological Diversity (1997)** committed Guyana to establish systems at the policy, administrative, technical and institutional levels for the management, conservation and sustainable use of biodiversity.

Two Action Plans have been developed to support integration of biodiversity considerations at all levels and across sectors, consistent with the National Development Strategy. The **National**

Biodiversity Action Plan I (1999) identified a lack of awareness of biodiversity as a unified concept as well as biodiversity issues and provided for planning and management efforts to be participatory, adaptive and based on the precautionary principle.

The current plan **- National Biodiversity Action Plan II (2007-2011)** – noted that policy and legislation regarding GMOs and alien species are now critical and contained a specific commitment to prevent the introduction of IAS that threaten ecosystems and to mitigate their negative impacts on forest biodiversity in accordance with international law. Whilst Guyanese authorities consider that invasion of agriculture pests are adequately addressed by the agricultural sector (EPA, 2003), they recognise the need to broaden coverage to include environmental pests.

Guyana's Fourth National Report to the CBD identified IAS introductions as a threat to biodiversity and of particular relevance for the expansion of the agricultural sector to improve food security at the National and at the CARICOM level. The IAS Task Force has developed awareness materials outlining basic concepts and lists some species found in Guyana: *Adenanthera pavonina* (red bead tree/ red sandalwood tree), *Psidium guajava* (guava), *Leucaena leucocephala* (jumble bean), *Columba livia* (rock pigeon), *Herpestes javanicus* (small Asian mongoose) and *Oreochromis mossambicus* (Mozambique tilapia) (EPA, 2010b).

A major challenge in Guyana has been the lack of dedicated legislation for biodiversity or protected areas. The new **Protected Areas Act 2011,** passed on 20 June 2011 and enacted on 1 November 2011, will provide a legal framework for the establishment and management of a national system of protected areas and for maintenance of ecosystem services, including climate regulation. Depending on how the Act is implemented, its objectives and provisions could provide a legal basis for site-specific provisions for IAS prevention or management, including prohibiting introduction of non-native species into protected areas. Management plans for protected areas could combine native species conservation measures with IAS prevention and control measures and where necessary, measures for site rehabilitation to restore ecosystem services impacted by IAS. Management entities responsible for different categories of protected areas could, as part of their powers and duties, be tasked with IAS monitoring, management and public awareness.

Prior to the Act's adoption, Guyana had already established three legally protected areas: the Kaieteur National Park, the Iwokrama Rainforest Preserve and the community-owned Konashen Conservation Area (which amount to just under 5% of Guyana's terrestrial landmass). Other areas under some form of management include the Moraballi Forest Reserve, the Mabura Hill Reserve, and the Upper Essequibo Conservation Concession. Opportunities to integrate IAS prevention and control into the management regimes for these areas could be maximised.

Spatial planning and conservation measures are also laid down by the **Amerindian Act 2006**. This establishes an environmental governance framework for Amerindian communities (approximately 97, with land covering 15% of Guyana's land area) and provides for Village Councils to make village rules. These may cover mining and timber leases, proposals for new protected areas and working with national agencies (e.g. GFC, GGMC and EPA) to enforce environmental laws. Building local governance capacity on biodiversity and forests will be critical to countering threats from economic activity spilling over from Brazil and related land use conflicts (Grimes et al., 2008).

Wildlife trade, including CITES implementation, is currently governed by the **Species Protection Regulations 1999,** issued under the Environment Protection Act 1996; which does not contain provisions to address trade or the holding of species that may present an ecological threat to Guyana's endemic and native biodiversity. The Government has begun the process of drafting Wildlife Management Conservation Regulations which, may be designed to provide a mechanism to address this gap.

Biodiversity databases, monitoring and information systems are under-developed in Guyana. The **Research: National Capacity Self-Assessment (2007)** found that there were no national mechanisms in place to maintain and organise data, derived from identification and monitoring activities, although various agencies and bodies had established their own mechanisms. It specifically called for steps to strengthen research and monitoring of invasive alien species and also recommended:

- As a priority action, to develop a comprehensive list of baseline data required and implement and/or streamline studies to obtain information for full identification of flora and fauna;
- To develop the infrastructure to use remote sensing as a tool for monitoring; and
- To review *Guidelines for conducting assessments on the environmental impacts of tourism* to ensure that such studies provide comprehensive coverage of biodiversity.

Plant and animal health and agriculture

The **National Development Strategy 2000** focuses on the economic, institutional and legislative development of the agriculture sector. However, its objectives on crops, livestock, animal health, genetic improvement, plant protection and quarantine are all relevant to tackling IAS risks that may impact on Guyana's biodiversity. The Strategy identifies critical needs relating to the preservation of genetic diversity for breeding purposes, characterization of the genetic diversity and the protection of local species and habitats from potentially damaging invasive and disease species.

Guyana is developing new legislation to progressively align the country's plant and animal health framework with the requirements of the IPPC, the OIE and the WTO-SPS Agreement (see 6.1 above).

The new **Plant Protection and Seeds Act 2011** replaces the Plant Protection Act (1942) and provide modernised powers and duties for the prevention, eradication and control of diseases and pests affecting plants. The old law established powers to regulate imports and exports, but its implementation was hampered because Guyana did not have post-entry quarantine facilities or diagnostic facilities and did not enable Plant Quarantine Inspectors/Officers to effectively execute the regulations (EPA, 2007). It was also outdated, having an exclusively agricultural focus and was adopted prior to the creation of the WTO-SPS Agreement. The new Act has been drafted to meet International Plant Protection Convention (IPPC) requirements, conform to the CARICOM's model and support implementation of Guyana's National Biosafety Framework's measures to address risks associated with GMOs and biosecurity (see below). It will require Customs officers to support plant quarantine officers in the execution of their respective duties. Measures applicable to seeds will regulate the production, sale, import and export of seed for sowing and enable

authorities to provide for the certification of seeds either coming or leaving Guyana.

At an operational level for plant health, international cooperation also exists for the biological monitoring and control of pests, especially for sugar (EPA, 2006). Biocontrol is being conducted by the National Agriculture Research and Extension Institute (NAREI), Guyana Sugar Corporation (GuySuCo) and University of Guyana within integrated pest management (IPM) programmes for paddy bug (rice) and pink mealy bug.

New legislation (**Animal Health Bill 2011)** was passed in May 2011 to pave the way for the resuscitation of agriculture development[3], consistent with the regional framework of CARICOM's recent joint approach to establish the Caribbean Agriculture Health and Food Safety Agency. It seeks to protect animals against diseases by controlling the movement of animals into, out of and within Guyana so as to prevent the introduction and spread of animal diseases within Guyana and other countries, and to ensure the safe and humane movement of animals to and from Guyana and to regulate the importation of animals and production of animal products and livestock feeds. The current law - the Animals (Movement and Disease Prevention) Act No.14 (2003) - provides for the establishment, monitoring and enforcement of veterinary regulations pertaining to the health, welfare and movement of animals including disease epidemics and quarantine procedures, and governs Guyana's Veterinary Authority. It defines 'animal' as "any non–human mammal, bird, fish, reptile, amphibian, crustacean or insect" (section 2) and is thus broad enough to cover aquatic animal health and trade, in line with the OIE.

The **Pesticides and Toxic Chemicals Control Act No. 13 (2000)** covers import requirements, monitoring and enforcement related to pesticides and toxic chemicals used in the production and storage of produce for agriculture, apiculture, aquaculture, forestry, horticulture, animal husbandry, product preservation and so on. This can be relevant for the use of chemical substances for IAS control, including in the context of integrated pest management (IPM).

The import provisions of the above instruments need to be read in conjunction with the **Customs Act 1952 (Amendment No. 1, 2005**), administered by the Guyana Revenue Authority. This governs commodity tariffs as well as monitoring and enforcement of customs regulations, including restrictive measures for Living Modified Organisms (LMOs).

Forestry

Guyana's **National Forest Policy 1997** aims to achieve improved sustainable forest yields, while ensuring the conservation of ecosystems, biodiversity and the environment; ensure watershed protection and rehabilitation, prevent and arrest soil erosion and the degradation of forests, grazing lands, soil and water.

Preventing and managing IAS incursions is directly relevant to achievement of this policy goal. However, the **National Forest Plan 1998** did not explicitly reference IAS in its five programme areas (land use; forest management; research and information; forestry training and education; forest administration and governance) although it stressed the need to strengthen collaboration between the GFC and the National Biodiversity Committee.

[3] Source: Ministry of Agriculture Bulletin, 20 August 2011, http://www.agriculture.gov.gy

The National Biodiversity Action Plan NBAPII (2007-2011) noted that forestry can have impacts on freshwater ecosystems, the potential for introduction of harmful alien species, and the need for work on genetics of important wild tree species. The **Forests Act 2009 (**revising 1953 Act**)** formally integrates biodiversity considerations and provides that in collaboration with the EPA, land can be identified for conservation for a maximum of 25 years. Guyana's most recent National Report to the CBD noted that EIAs were required by new forest companies and by existing companies pursuing Forest Stewardship Council (FSC) certification (EPA, 2010b).

Fisheries and aquaculture

The **Fisheries Act (2002)** covers monitoring and enforcement of all ocean and inland fisheries regulations and establishes a Fisheries Advisory Committee. The definition of fish is broad enough to cover all aquatic organisms (any aquatic animal, whether piscine or not, including shellfish, turtle, mollusc, crustacean, coral, sponge, echinoderm, holothurian, its young and its eggs: section 2).

The draft **Fisheries Management and Development Plan (2006)** covers management and regulation for both marine and inland water ecosystems, including education and awareness, research and surveys and collaboration with sector agencies.

In 2009, the Ministry of Agriculture issued an **Inland Fisheries Policy Guidelines (MOA, 2009)** that aims to support the implementation of the non-binding FAO Code of Conduct for Responsible Fisheries which contains specific IAS risk reduction measures (FAO, 1995). The Guidelines recognise that modern management practices seek to influence the composition of the fish fauna to correspond to society's requirements, including by introducing new species and stocking with those seen as valuable, and that these may conflict with the conservation-oriented requirements of the FAO Code. They stress that fisheries management should promote the maintenance of the quality, diversity and availability of fishery resources in sufficient quantities for present and future generations in the context of food security, poverty alleviation and sustainable development (6.2) and encourage bilateral and multilateral research co-operation due to the transboundary nature of many aquatic ecosystems.

Guyana does not have specific legislation in force to manage the aquaculture sector although there is a draft Aquaculture Bill in preparation which would, once approved, become part of the Fisheries Act. The Bill would govern licensing of farms, specification of rearing areas, specification of inputs to be used in the rearing process, waste disposal, movement of aquatic species and other measures necessary for the development of aquaculture in Guyana[4], including measures to address the ecological risks of introductions for the aquaculture sector.

Coastal planning

The National Development Strategy 2000 highlights that Guyana's coastal zone is particularly fragile both to human and environmental pressures: this may increase vulnerability to biological invasions. The **National Coastal Zone Management Plan (2000)** initiated an ongoing Integrated Coastal Zone Management process, covering policy development, planning, coordination and information management amongst others. However, NBAPII identifies the complexity and

[4] http://www.competitiveness.org.gy/initiative/ncs-action-plan/sub-sectors/acquaculture.

inefficiency of fragmented legislation and governance for Guyana's coastal zone and highlights the urgent need for harmonisation of legislation to specifically address coastal biodiversity.

Climate change and energy

The Low Carbon Development Strategy (LCDS) sets out Guyana's strategy to forge a new low carbon economy. It identifies eight priorities for national investment linked to LCDS implementation in 2010-2011[5], outlines priorities for 2012-2015, and sets out the framework for further consultation and strategy development on Guyana's long-term low carbon development. This policy area can be relevant to IAS because, as highlighted within the CBD, renewable energy policies may promote cultivation and afforestation of potentially invasive fast-growing species or genotypes for biofuel/biogas production within the context of climate change mitigation.

National Biosafety Framework 2007 (NBF) and Biosafety Bill

Guyana's Biotechnology, Biosafety and Biosecurity Policy is set out in the NBF (EPA, 2007). In line with the CBD Cartagena Protocol it aims to:(1) to guide the judicious use of modern biotechnology for sustainable development without jeopardising human or environmental health, including Guyana's biodiversity and genetic resources; and (2) ensure effective control of transboundary movement of GMOs or products thereby resulting from modern biotechnology through exchange of information and a scientifically based, transparent system of advance informed agreement.

The NBF defines 'biosecurity' very broadly to cover the introduction of plant pests, animal pests and diseases, zoonoses, the introduction and release of GMOs and their products, and the introduction and management of IAS and genotypes. Its scope explicitly covers human diseases and the entire spectrum of bioterrorism, related bio-arsenal and global pandemics are included within the scope of the NBF. This breadth reflects the integrated coverage underpinning advanced IAS policy frameworks in e.g. New Zealand.

The goals, pathway coverage and regulatory tools envisaged under the NBF provide a potentially robust platform for integrated IAS prevention and management in Guyana:

- **Goals**: (1) prevention and exclusion of pests and unwanted organisms capable of causing unacceptable harm to the economy, environment and people's health; (2) surveillance and response, covering early detection, identification and assessment of pests and unwanted organisms capable of causing unacceptable harm and where appropriate, deployment of a rapid and effective incursion response; and (3) effective management (including eradication, containment and control) of established pests and unwanted organisms capable of causing harm to the economy, environment and people's health;
- **Pathway coverage:** the NBF would include imported goods; ships and aircraft; ship ballast water; vessel hull fouling; shipping containers; used vehicles and machinery; passengers' effects; mail and courier pack; smuggling; and wind and ocean currents; and

[5] These investment priorities include Amaila Falls Equity, Amerindian Development Fund, Amerindian Land Titling, Fibre Optic Cable, SME and Vulnerable Groups' Alternative Livelihoods, International Centre for Bio-Diversity Research, Low Carbon Curriculum Development and IT Training, MRV and Other Support for LCDS and, in the longer term, Adaptation.

- **Regulatory tools**: (1) Pre-border activities consistent with Guyana's international commitments, including testing, inspection and treatment or quarantine; and (2) Border (marine and terrestrial) and post-border activities, including a combination of embargos, inspection and treatment/certification at point of origin/point of entry and post-entry quarantine facilities especially for plant propagative or animal reproductive materials.

The NBF proposes a comprehensive governance framework, with a National Biosafety Authority to address invasive species in context of GMOs in Industry and Environment, supported by a Biosecurity Scientific Advisory Sub-Committee.

The Guyanese government has drafted legislation to implement the NBF, but this has not yet been approved or implemented (see further 6.5). As drafted, the **Biosafety Bill** would govern monitoring and enforcement of biosafety standards, risk assessment of GMOs and related products where relevant; safeguarding of national ecosystems, resources, animal, plant, human, and environmental health; and ensuring the safe use of biotechnology and related products. The Bill proposes a tripartite system of implementation, led by the Environmental Protection Agency in partnership with the Agriculture and Health Ministries and supported by the National Biosafety Authority. Compliance would be overseen by National Biosafety Inspectorate Unit

The Bill lays down a regulatory procedure for Deliberate Release into the Environment: this applies to GMOs but the science-based criteria and advisory oversight proposed are equally pertinent for other alien organisms. Authorisations for deliberate release would require detailed information on the GMO's characteristics, compliance with all environmental management guidelines under the EPA, an expert opinion from the Biosafety Scientific Advisory Committee; compliance with Occupational Safety and Health Act; an EIA; risk assessment statement and biodiversity impact statement identifying the possibilities, if any, for gene introgression and horizontal gene transfer between the GMO and local biodiversity with particular emphasis on the national endemic species and keystone species.

Schedule 2 to the Bill (Risk Assessment Framework) requires information on the potential environmental impact of GMO release. These include the likelihood of the GMO becoming more persistent or invasive than recipient organisms, any selective advantage or disadvantage conferred to other sexually compatible species, which may result from genetic transfer from the GMO; the potential environmental impact of the interaction between the GMO and target organisms; and any possible environmental impact resulting from potential interactions with non-target organisms[6].

[6] see: Box 7, Sample risk assessment template to guide applications for LM or GM plants: National Biosafety Framework for Guyana (EPA, 2007).

Table 2: Synthesis of Guyana's existing policies with regards to IAS

Main policy instruments	Coverage and comment
Biosecurity measures pre-border and at point of entry	
Plant Protection and Seeds Act 2011 (replacing Plant Protection Act (1942) Animal Health Bill 2011 (modifying Animals (Movement and Disease Prevention) Act No.14 (2003) Customs legislation	Modernisation of system under way to align it with IPPC, OIE and WTO/SPS requirements. Traditionally, agricultural crops/livestock are the main focus of prevention efforts: some consideration of environmental impacts. Limited scope of additional animal disease/quarantine rules. No clear legal basis to screen imports of potential ecological threat species if not of agricultural relevance. Low capacity for post-entry quarantine. No mechanisms to control introduction pathways or vectors of alien species in marine and coastal environments (EPA, 2006)
National Biosafety Framework Draft Biosafety Bill	Potential to provide integrated framework, scientific criteria and cross-sectoral advisory structures for risk assessment and decision-making on new introductions (GMOs, other alien species) with full integration of potential environment and biodiversity impacts, based on precautionary principle.
Internal biosecurity	
Plant/animal health legislation EIA regulations under Environmental Protection Act 1996 National Biosafety Framework Draft Biosafety Bill Forestry Bill Aquaculture Bill	Powers to impose trade/movement restrictions for pest/disease incursions. Absence of clear general rules establishing a presumption against release into the natural environment (but scope to clarify legal situation following enactment of Protected Areas Act 2011). Possibility of sector-based scrutiny and EIA 1) under generic EIA regulations 2) under dedicated forestry policies, aligned by FSC best practices; and 3) aquaculture instruments, aligned with FAO technical guidelines. IAS spread risks not addressed in context of transport/infrastructure policies.
Early detection and rapid response	
Plant/animal health legislation National Biosafety Framework Draft Biosafety Bill	Comments as above: surveillance focus and investments is on economic sectors (phytosanitary/veterinary context). No monitoring for new risks around entry points and disturbed areas. No contingency planning for incursions outside plant/animal disease e.g. for marine pollution incidents, extreme weather risks No reporting schemes to mobilise public/specific groups of stakeholders. Relatively low regional resource mobilisation.
Control and management of invasive species	
Plant/animal health legislation Environmental Protection Act 1996 Forest Bill 2008 Pesticides and Toxic Chemicals Control Act No. 13 (2000)	Powers to mandate control for plant pests and animal diseases: series of IAS-relevant action plans adopted for key problem species. Possibility to require site restoration under mining and forestry policies: could include preference for use of native species as part of rehabilitation (at economic operator's expense). Ad hoc involvement of NGOs: scope to integrate monitoring of invasive species within protected species conservation monitoring New draft protected area legislation could incorporate strict prohibition on intentional introductions to wild.
Horizontal measures (strategy, EIA/planning, information systems, incentives etc.)	
EPA and coordination National Biosafety Framework Draft Biosafety Bill	IAS Task Force and other coordination mechanisms available EIA regulations provide framework to integrate IAS criteria into planning. Emerging biosafety framework and modernisation of plant/animal health legislation provide opportunities for cost recovery IAS inventory/monitoring weakest for marine environment.

6.5 Challenges and priorities for the IAS Strategy and Action Plan

Sections 6.3 - 6.4 described Guyana's current institutional and policy baseline and relevant ongoing developments, notably for biosafety. This section summarises key gaps and constraints and identifies practical steps to be addressed through the National IAS Strategy and Action Plan.

It should be emphasised that many institutional and legislative constraints identified through this review are common to other countries and reflect the fragmented way in which IAS policy has developed at international level. The NBSAPII recognises the general need to assess policies, legal and administrative frameworks for biodiversity management and the structures required by institutions for Guyana's future harmonized policy and legal framework, which is now well under development.

Guyana's future actions on IAS prevention and management should be guided by the CBD's Aichi Target 9, approved in October 2010. This provides that "By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment."

Regional coordination and maximising available capacity

Regional exposure to biosecurity risks is increasing with the expansion of trade, tourism and transport pathways (e.g. port expansion, air traffic, construction, aquaculture and hydrocarbon development, future growth of tourism). General constraints include lack of awareness, baseline data, quarantine infrastructure, equipment and manpower.

Topics for regional collaboration – through Caribbean and/or Amazonian regional institutions (see 6.2) – could include steps to strengthen pre-border biosecurity, working with Guyana's main trading partners. Cooperative research could focus on techniques to reduce key pathway risks and leverage economies of scale through shared protocols for regional application.

A regionally-coordinated risk assessment platform could improve access to available protocols, for application at species, pathway and/or biogeographical levels. This should support consideration of biodiversity and ecosystem impacts and, where possible, socio-economic impacts linked to cost-benefit analysis.

Regional electronic networking is important to provide species-based information and early warning alerts, linking regional invasive species specialists, taxonomic databases and other resources. Regional codes of conduct and information campaigns for different target audiences could also prove cost-effective.

Institutional and administrative framework and coordination

Guyana's current framework relies primarily on animal/plant health legislation to prevent and manage IAS risks with a focus on agricultural pests. Invasive species with environmental impacts have low legal 'visibility'.

Guyana needs a policy continuum for prevention, early warning and rapid response and management across key sectors, to improve efficiency and make best use of scarce resources. This will require coverage across all taxonomic groups as well as a common understanding of key terms and concepts that may be used differently in different sectors. The Strategy will need to

define roles and responsibilities to set up cost-effective systems to ensure environmental biosecurity, harmonised with relevant international and regional frameworks and standards.

There is no single body with lead responsibility on IAS issues. Guyana has well-established environmental and biodiversity coordination mechanisms with statutory backing. However, the IAS Task Force established in 2008 was an informal (non-statutory) body which was not able to carry out the technical functions entrusted to it, although it made progress in agriculture-environment cooperation and public awareness-building and communication.

The IAS Task Force needs to be revived as a cross-sectoral body with increased legitimacy to support IAS mainstreaming in relevant policy areas and ensure that due consideration is given to the protection of Guyana's environment and ecosystem functions and services. This is critical in the short term, particularly as the biosafety coordination mechanism envisaged under the NBF (for intentional introductions) has not been implemented. In the longer term, the optimum coordination mechanism may need to be reviewed.

Section 6.3 identified some of the key bodies that should be involved in IAS policy coordination. These include but are not limited to EPA, MOA, Fisheries Department, GFC, GGMC, Ministry of Health, Regional Democratic Council, Ministry of Public Works, Guyana Sugar Corporation (GuySuCo), National Parks Commission, National Agricultural Research and Extension Institute (NAREI), Guyana Livestock Development Authority, Guyana Rice Development Board (GRDB), Guyana Water Inc., Customs, Maritime Administration Department, University of Guyana, and community and leading NGOs.

Given the vast areas of national territory for which it has responsibility, the Guyana Forestry Commission could be a focal point for IAS management, in collaboration with EPA, to leverage compliance by local and international stakeholders with Forest Stewardship Council standards. The Iwokrama International Centre could function as a strong and well-resourced partner with particular skills and capacity in monitoring frameworks for the Interior, including in the area where new road infrastructure to Lethem is under consideration.

Prevention: pre-border, at point of entry and within Guyana

Guyana currently lacks a comprehensive prevention framework at its external borders: available manpower and resources are focused on risks to primary production sectors and/or human health. Some high-risk introduction pathways, including infrastructure and mineral development within the interior, construction and air traffic, do not appear to be covered by risk management measures.

Major steps have been taken to modernise Guyana's plant and animal health frameworks, with new legislation coming on stream in 2011, and to develop ambitious integrated biosafety/biosecurity policy and legislation. Taken together, these new instruments may theoretically be broad enough to encompass all potential IAS and introduction pathways, covering not only socio-economic impacts but also risks to the unmanaged environment and native biodiversity. However, to become fully operational they would require significant investments in staff training, technical capacity (e.g. for environmental risk assessment) and information systems.

From an IAS perspective, priorities to address through the Strategy and Action Plan include:

- Standards and procedures applicable on arrival at Customs, passenger, cargo and storage facilities at Guyana's ports and airports, including best practices on ballast water management and hull fouling;
- Stronger quarantine regulation and enforcement to cover a broader range of pathways and vectors, including for environmental pests: this should be consistent with an assessed level of risk and relevant international standards; and
- Clear designation and coordination of biosecurity responsibilities (to overcome current fragmentation), possibly supported by a consolidated operating manual.

Guyana's legal framework needs to establish clear and unambiguous powers to regulate imports of species liable to threaten native biodiversity or ecosystems, as well as socio-economic interests. A simplified system of risk categorisation could be developed to facilitate administration and improve transparency and predictability for users. The most common approach for a risk-based system is to use implementing regulations to set out – and regularly update – lists of prohibited, restricted or permitted species/goods (Shine et al., 2010). The criteria and data used to develop such lists can be determined at national level and complemented by regional databases and expertise and also selected global IAS databases. Under a three-way approach:

- species evaluated as low risk could be included in a regulatory 'white list' i.e. not subject to import or release restriction provided that they comply with plant or animal health legislation. Availability of a white list can be useful for awareness-building and to encourage species substitution away from known invasive species;
- species known to be high risk – i.e. already problematic in Guyana or in neighbouring countries with similar climatic or ecological conditions, or identified on databases as potentially highly invasive – could be included on a 'black list' (prohibition);
- other non-native species should be subject to import risk assessment prior to introduction (this should cover all non-native species new to Guyana unless categorised as low risk, and should include exotic biological control agents). Importers/applicants should meet the costs or otherwise bear the burden of proof that an import will not pose a risk. This is a demanding standard but in practice assessments will be made on the basis of already available information, including from neighbouring states and organisations, based on the precautionary principle.

Legislation is relatively weak with regard to internal biosecurity. Intentional introductions to the wild are not regulated under environmental protection legislation, though the Protected Areas Act 2011 could help to address this. This gap needs to be addressed. It is important to ensure consistency in sectoral policies that can lead to intentional introductions (e.g. forestry, energy, aquaculture) or provide pathways for unintentional introductions, such as transport (e.g. the paving of the main Georgetown-Lethem road) and mining. IAS criteria should be incorporated into EIA regulations and/or practitioner guidance.

Appropriate precautions should be taken for species that are native in parts of Guyana and alien (and potentially invasive) in other parts of Guyana.

'Green list' policies could be developed to promote the cultivation, supply and use of native plant species in catchment management, erosion control, forestry (where applicable), landscaping, tourism, infrastructure and rural development projects. Associated codes of practice could be referenced in EIA procedures.

Early detection and rapid response

There is currently no systematic monitoring for new incursions around points of entry or contingency plans to respond to detected incursions. As a priority, improved horizon scanning, data supply and technical capacity are needed to support early detection while rapid eradication is still technically and financially feasible.

As noted above, regional cooperation within the Caribbean and/or Amazon Basin could improve the efficiency and cost-effectiveness of national efforts. This could include exchange of information on the spread of invasive and potentially invasive species and disseminate status and distribution updates from islands and main trading partners. Regional contingency plans to address common threats could be prepared up-front and adapted to local conditions as necessary. Practical guidance and information alerts (e.g. posters, identification sheets, local media) could be developed to strengthen surveillance at points of entry (ports, airports, warehouses etc.) and around sensitive natural areas, supported by local contact details to encourage reporting of target species.

Monitoring, control and management

Guyana appears to have no programmes or criteria to monitor the status and spread of IAS and no regulatory lists of species subject to mandatory controls, except for plant pest/animal disease incursions (e.g. the MOA and NAREI are cooperating on control of IAS such as aquatic plant the Common Duckweed (*Lemna minor)* and the Carambola Fruit Fly, *Bactrocera sp.*(EPA, 2010b).

A nationally coherent approach for managing established IAS and ecological restoration within the broader policy framework is needed, taking account of climate change as a future driver of the spread of IAS. The NBF calls for effective strategies to be put in place for eradicating, containing and controlling pests and diseases already established. For this to be effective responsibilities for control of existing invasive species need to be identified, backed by measures to prevent the spread of specified highly-invasive species to areas that are currently uninfested or where eradication is still feasible. It may be necessary to introduce regulations to prohibit the growing or cultivation of any plant, or the keeping of any animal, if this is liable to damage the welfare or continued existence of any plant or animal endemic or indigenous to Guyana.

The adoption of modern protected area/biodiversity legislation could provide a legal basis for structured IAS monitoring and management within a broader framework. Opportunities to integrate the monitoring of IAS and their impacts into existing conservation and species recovery programmes (whether governmental or NGO) should be maximised. 'Passive' monitoring schemes, through which services and stakeholders on the ground are encouraged to participate with the help of simple technical information and reporting sheets, could provide an additional low-cost alert network.

Government agencies can lead and fund the development of environmentally sound methods to control harmful invasive plant species, seek control of such species on public lands and promote

their control on adjacent private lands. This may require the adoption or amendment of legislation and/or incentive measures to ensure that landowners undertake actions necessary to the long-term success of a control programme. Rehabilitation following IAS control should be undertaken where feasible, using appropriate native species.

Stakeholder consultation should be undertaken where necessary to address conflicts of interest over introduced invasive species of value to people and/or possible ethical objections to species control.

Horizontal measures

Particularly in a country like Guyana, enforcement presents difficulties for IAS-related offences as the capacity for detection, proof of violation and subsequent prosecution is extremely limited. These factors make it even more important to promote voluntary best practices and awareness-building in target communities and sectors.

A coherent incentive framework should be aligned with general principles of environmental policy (precaution, prevention, rectifying pollution at source and 'polluter pays'). Measures could include campaigns to increase issue visibility at political, industry and consumer levels; codes of conduct to support technical innovation and species substitution; market-based instruments, including development or extension of certification schemes to address key pathways; improved cost recovery and liability mechanisms.

Within the region, there are several examples of voluntary codes that could be scaled up for use in Guyana. For example, in 2003, the Bahamas adopted a National Invasive Species Strategy that establishes a Code of Conduct for Government to promote best practices across all policies and activities conducted on public land and/or by all categories of public servants. Nine voluntary codes of conduct are annexed to the Strategy covering key target groups: botanical gardens; landscape architects; the gardening public; nursery professionals; zoos and aquaria; farms (agricultural and aquacultural); pet stores, breeders and dealers; pet owners; and veterinarians (Appendix IX).

7.0 NATIONAL STRATEGY ON INVASIVE ALIEN SPECIES

Guyana has many advantages when it comes to tackling invasive species threats. It is a country with many pristine forest ecosystems and it has amazing and unique biological heritage and breathtaking landscapes. Pathways and points of entry, though expanding, are relatively limited compared to more urbanised countries. Guyana has remained relatively pest-free and its exceptional natural resources can give economic and community stakeholders an incentive to support robust protection policies.

7.1 Development and content of the Strategy

This Project was funded by the Global Environment Facility (GEF); and is entitled, "Assessment of Capacity Building Needs, Preparation of Second and Third National Reports (CBD) and the Clearing House Mechanism in Guyana". It is being implemented by the United Nations Development Programme (UNDP) and executed by the Environmental Protection Agency (EPA). This component aimed to increase regional capacity to reduce the impact of invasive species in Guyana and to pave the way for a national strategy, national early warning system and awareness raising and training activities for the private sector and affected communities.

This Strategy and its Action Plan are based on the discussions and conclusions of a national workshop held in Georgetown on 23th of March 2011 (Appendix V-VI).
Participants spanned a range of sectors, including nature conservation, scientific research, environmental management, agriculture, plant and animal health, transport, public works, public relations and policies (Appendix VII). Through interactive working groups, participants assessed progress, identified gaps and priorities for future efforts, and drew up agreed lists of concrete actions to adapt to the Territory characteristics and needs.

Following the national meeting, the Strategy was drafted which sets out broad objectives for tackling regional invasive species threats, supported by Key Actions for each operational section. Each action is prioritised, assigned a lead agency and potential partners, and costed in terms of time.

The Action Plan will permit practical progress on Strategy delivery to be measured. It is suggested that the Action Plan be updated every 4 years to take into account progress achieved and future emerging issues.

7.2 Who is the Strategy for?

The Strategy is aimed at guiding future invasive species work in Guyana, and it is primarily designed to be a working document for the country. This Strategy, seeks to engage all those who can contribute to invasive species prevention and management in Guyana and help to build a more sustainable and dynamic future for its communities. Potential audiences and users include:

- Everyone who lives in Guyana;
- Everyone who visits Guyana, whether for work or leisure;
- Stakeholders whose activities provide opportunities for the introduction of potentially invasive organisms (exporting countries and territories; shipping and aviation operators; military services; traders and retailers; growers, breeders and resource managers);

- Governments institutions and decision-makers across all relevant departments;
- Institutions concerned with the conservation of biodiversity in Guyana; and
- NGOs and research institutes.

7.3 Overview of the National IAS Strategy

The National IAS Strategy aims to clearly specify its objectives and the roles and responsibilities of the many stakeholders who will cooperate to fulfil them.

Vision

A nation, in which the negative impacts of invasive alien species on the economy, environment and society are avoided, eliminated or minimised.

Objective

To guide the nation so that all Guyanese are responsible for avoiding, minimising or removing the negative impacts of invasive alien species.

Target audience

The diverse range of stakeholders' whose activities are affected by IAS impacts in Guyana. These include government organisations, non-governmental and civil society organisations, the private sector, and affected communities.

Scope

The National Invasive Alien Species Strategy for Guyana provides a framework for the protection of the aquatic and terrestrial ecosystems of Guyana, and their native biological diversity (including people), from the risks posed by invasive alien species.

This Strategy is applicable to all intentional introductions, both authorised and unauthorised (illegal), and all unintentional introductions. It includes those alien species that are imported and introduced from other countries.

It represents a first step towards a comprehensive and cooperative approach to the management of IAS impacts in Guyana.

This strategy recognises the roles and responsibilities of all levels of government in regulating and managing invasive alien species and the importance of the involvement of non-governmental and civil society organisations, the private sector and the general public. It also recognises the need for international cooperation to supplement actions at national and local levels.

7.4 Operational elements of the National IAS Strategy

It is suggested that the National Strategy should comprise ten interlinked elements.

Four "**Management Elements**" cover "on the ground actions" that directly address the Strategy's vision of a nation in which the negative impacts of IAS on the economy, environment, and society are minimised;

1. Prevention;
2. Early Detection and Rapid Response;
3. Eradication; and
4. Control and Monitoring.

Four "**Cross-Cutting Elements**" cover enabling actions that must be undertaken if the management elements are to successfully address the Strategy's vision.

5. Legal, Policy and Institutional Frameworks;
6. Capacity Building and Education;
7. Information Management and Research; and
8. Public Awareness and Engagement.

7.5 Approach to IAS Management under the National IAS Strategy

There are four basic management strategies to deal with problematic invasive species: prevention; early detection; eradication; and control (Wittenberg and Cock, 2001). To this may be added ecological restoration where feasible.

IAS management in the holistic sense combines various methods and/or techniques for these objectives. Each technique and or method used achieves a different level of impact reduction, requires various degrees of skill, technology, resources (both human and capital) and commitment, and is specific to each target species and prevailing environmental circumstances

7.5.1 Prevention

As noted above, prevention of introductions is the most ideal and cost-effective option as "prevention is better than cure". There are three major methods by which to prevent species invasions: interception based on regulations enforced with inspections and fees; treatment of material suspected to be contaminated with invasive species; and prohibition of certain commodities in accordance with international regulations.

7.5.2 Early detection

Early detection of potential invaders is usually critical in determining whether eradication is feasible. Early detection involves surveys of the species of concern or a particular site where the species is thought to be found. Since the prospect of early eradication or at least containment of the invasive species is much cheaper than later control or eradication once the species has spread widely, investment in early detection is very worthwhile.

7.5.3 Eradication and control

When prevention has failed, the next preferred management option is eradication. However, a very careful assessment of the costs and likelihood of success must be made and sufficient resources mobilised before eradication is attempted. Eradication often requires very significant resources and the employment of many different methods at once, but is preferred over control as costs are not ongoing after eradication is completed. Eradication has been applied most successfully to vertebrate pests (such as rats, pigs and goats), rather than plants or invertebrates

which tend to be very hard to eradicate, except in relatively small areas. The final step in the sequence of management options is the control of invasive species when eradication is not feasible.

The purpose of control is to reduce the density and abundance of invasive organisms to below an acceptable threshold. This operation must be continued indefinitely unless populations of the pest are reduced to a level where eradication becomes feasible, because by its nature, in the long run, this management option could be very costly. Invasive species control uses many of the same techniques as eradication such as mechanical (e.g. pulling weeds), chemical (e.g. using toxic baits against vertebrates or poisons against plants), habitat management (e.g. sanitation, habitat removal, barriers, grazing, flooding, and prescribed burning) and prescribed hunting of invasive vertebrates. Biological control can be another very cost-effective measure but careful assessment of the environmental impacts of bio-control agents is necessary before introduction. As with eradication, the integration of several control methods often provides the most effective management strategy.

8.0 COMPONENTS OF IAS MANAGEMENT AND PRIORITY ACTIONS OF THE NATIONAL STRATEGY

In order for the IAS Strategy to fulfil the mandate of effective prevention, early detection and rapid response to regional IAS threats, key objectives must be achieved in a timely manner. The framework below outlines the activities and tasks that need to be taken by regional stakeholders to achieve these objectives.

Prioritisation of Recommendations

Priority setting is critical for the development and implementation of the National IAS Strategy. Two priority levels have been established for recommended actions, following consultation with stakeholders:

1. **High Priority** actions are essential for the successful implementation of the IAS Strategy and should also be initiated as soon as possible, but in many cases their implementation is contingent upon prior actions being undertaken.

2. **Low Priority** actions are in some cases contingent upon the undertaking of high priority actions. In other cases, it is deemed that they would be of value but are not essential to the successful implementation of the IAS Strategy

8.1 Prevention

Goal: To develop appropriate programs and procedures to minimize the impacts of established invasive species and minimise the number of unintended and intended IAS introductions to the Guyana.

Prevention is the first line of defence against further introduction and establishment of IAS and is the most efficient and cost-effective strategy to minimise their long-term negative impacts. Prevention needs to be practiced at the national level and among isolated ecosystems within Guyana. Prevention is especially important for terrestrial[7] introductions. Alien species can be extremely hard to detect in inland water ecosystems and they can disperse rapidly, making eradication or control exceedingly difficult.

Prevention has two principal aspects – prevention of those species that arrive unintentionally as "hitchhikers" on a commodity, conveyance, or person and prevention of those species that are intentionally introduced for a specific purpose and are likely to have harmful consequences. Intentional introductions can be authorised (legal) and unauthorised (illegal). Some illegal introductions to Guyana are likely to be brought in through unofficial entry points at the border with the neighbouring countries or by the waters in private vessels.

[7]Terrestrial include inland water ecosystems

Guyana also has a role to play in IAS prevention efforts of those countries with which it interacts by ensuring that it does not export IAS to other countries.

8.1.1 Risk assessment

Implement a screening process for species imported in order to avoid the introduction of more IAS in the country. A risk-based approach is recommended, as this would allow informed decision-making in relation to species introductions. This approach requires consideration of the likelihood of establishment and spread, and the severity of the resultant impacts. Such an approach should apply both to introductions to Guyana.

Recommended actions

High priority:

- Incorporate risk assessment as a tool for screening new introductions and strengthening Guyana's EIA regulations.

Low priority:

- Carry out risk assessment for non-native species already in the country to identify priority threats. Generate species list with risk categories (high, low).

8.1.2 Vectors and pathways assessment

Assess how new species reach the country, especially when involuntary introductions occur. The objective is to interfere in the transit of species and avoid new introductions or the spread of species within the country.

Recommended actions

High priority:

- Carry out vectors and pathways assessment for commercial routes (e.g. considering ballast water, and the ornamental plant and pet trades) in order to optimize inspection in cargo, vessels or flights arriving from areas of high risk to Guyana.

Low priority:

- Implement contingency plans for priority pathways, in order for procedures to be in place when species arriving through the assessed pathways are detected, and introductions can be stopped at the border.
- Carry out vectors and pathways assessment for species already introduced, but with limited distribution, to define containment or eradication efforts within Guyana, and protect important areas for conservation and tourism.

8.1.3 Prevention measures (quarantine, inspection, border control)

Prevention can only be effective if border control and quarantine are prioritised, gaps, weaknesses and constraints are addressed, relevant capacity is built and sufficient resources are secured. International cooperation is essential. This includes pre-border activities aimed at

intercepting IAS at their source and the sharing of information between relevant organisations regionally and internationally.

These measures are intended to help reduce the amount of species introductions or the amount of propagules that can enter the country through commerce, tourism, and general transport, as well as illegal introductions.

Recommended actions

High priority:

- Implement and intensify border control to avoid the entry of non-native species or related vectors. Pathways assessments are helpful in selecting priorities for inspection.
- Implement prevention measures/ media to reduce the involuntary entry of non-native species, such as spraying airplanes and using Phytosanitary rugs in points of entry.

Low priority:

- Collaborate with other countries to avoid new entries.

8.2 Early detection and rapid response (EDRR)

Goal: To minimise the number of IAS that tend to have harmful consequences once they are introduced to Guyana.

If prevention measures fail to avoid introduction, the country should have an early detection and rapid response system in place to start eradication or control efforts and mitigate impacts on biodiversity and the economy.

No system of prevention can ever be one hundred percent effective. It is therefore essential to implement an early detection and rapid response system (EDRR) to identify those species that have escaped prevention and are now present in low densities in regions of the country (or within defined ecosystem units - islets, conservation areas, etc.). Because an invasive species is more likely to become a permanent resident in an ecosystem once it becomes established, EDRR efforts if successful are likely to be far less costly than long-term invasive species management programs. The cost of managing several species at low densities, even if most of them do not establish, is often far outweighed by the cost of managing a single established species.

Key elements of an EDRR system include: A surveillance system for identifying alien species new to the country and new to ecosystem units within the country (rapid and accurate species identification is essential); access to reliable scientific and management information; access to appropriate technical expertise; robust standard procedures for rapid risk assessment; an effective stakeholder consultation and coordination process; rapid access to stable funding for emergency response efforts and public understanding and support.

The initial response phase to a new incursion consists of the following actions:

1. Identify the suspected organism;
2. Conduct an initial assessment of its extent and likely impacts;
3. Determine the initial response level;
4. Determine the initial means of introduction and ensure that this loophole is closed;
5. Consult key stakeholders (those potentially affected and those with advice and information);
6. Conduct a more thorough survey of the extent of the incursion;
7. Check legal issues related to any response;
8. Decide if eradication is feasible;
9. If yes, undertake an eradication campaign and decide upon who should do it and with what resources; and
10. If no, undertake containment, sustained control (and decide upon who should do it and with what resources) or do nothing.

Guyana has experience in the implementation of EDRR. The Carambola fruit fly (*Bactrocera carambolae*) Eradication Campaign appears to have been successful and the pest has not been found in Guyana since the year 2000 (Sauers-Muller, 1990 -2001 annual reports) (case study 6).

The Carambola fruit fly is still present in Suriname, French Guiana and Brazil (State of Amapa) (Malavasi et al., 1998). Given the proximity of these countries to Guyana, a re-infestation of this plant disease is always possible. This situation demands immediate response by way of appropriate control measures to address any re-infestation, and a robust strategy to ultimately eradicate the pest from South America.

Recommended actions

High priority:

- Identify priority species and pathways for immediate monitoring, containment and control. Adopt existing protocol and test pathway risk assessment protocol (e.g. there is a protocol available at http://i3n.iabin.net).
- Monitor areas of potential entry of invasive species for early detection. Create contingency plans and train personnel on the issue.
- Monitor commercial points for ornamental plants, pets, and aquaculture. Create contingency plans and train personnel on the issue.

Low priority:

- Develop a model for action plans upon early detection of non-native species. Identify procedures aimed at current specific priority invasive species.
- Build a network of trained experts for early detection. Develop website for reference and reporting system. Post risk assessment results for species in the country.
- Include records of non-native species in scientific collections and biodiversity surveys.
- Make detailed recommendations for improvements with an aim to filling the gaps to allow effective implementation of the national IAS strategy.

8.3 Eradication, control and monitoring

Goal: An agreed framework for eradication priorities to be put in place, eradications are undertaken as necessary and results are disseminated.

Existing invasive species problems need to be addressed by eradication and control programs (case study 6). Priority species and priority areas must be defined in order to optimise efforts.

Eradication is often associated with EDRR, i.e. the eradication of a species from a small area close to the point of introduction. However, with improved techniques, it is now becoming possible to eradicate certain species from areas where previously long-term control was the only management option.

The mainland areas are not particularly suitable for species eradications because of the high possibility of reinvasions but this can be mitigated by adequate biosecurity measures. Some species, notably plants and aquatic organisms are extremely difficult to eradicate unless their populations are very small and confined.

Eradication is not an end in itself and must be justified by ecosystem level goals so in some cases eradication might not be appropriate even if it were to be feasible. The eradication method or methods should be selected on the basis of their effectiveness against the target species, selectivity and cost.

All individuals of a target species must be put at risk by the spatial scale over which operations are conducted, the density of resource allocation and by the technique(s) chosen.

The chosen methods should be as humane as possible and impacts on non-target species and the target ecosystem should be minimised. The risk of reinvasion should be as close to zero as possible. Effort, costs and results should be monitored and funding and personnel should be committed for the duration of the eradication campaign.

Recommended actions

High priority:

- Implement eradication and control systems for IAS in protected areas, on the coastline and other priority areas for the conservation of biodiversity and ecosystem services.
- Define priorities and action plans for IAS and priority areas.
- Promote the use of biological control agents as appropriate.

Low priority:

- Make information on IAS best practices and control available to the public.

CASE STUDY 6 - Carambola fruit fly, a story of eradication success in Guyana

Figure 22: Carambola fruit fly (*Bactrocera carambolae*) Photo: Natasha Wright

The Carambola fruit fly, *Bactrocera carambolae*, (figure 22) is a serious pest of Carambola plants. This pest is native to Indonesia, Malaysia and Thailand and was first collected in South America in 1975 in Paramaribo, Suriname.

In the mid-1990s, the presence of the Carambola fruit fly represented a major threat to the production and marketing of fruits and vegetables throughout tropical and subtropical Central and South America and the Caribbean.

Entomologists identified 236 different species of host fruit; and surveys found that the initial spread of the pest was linked with increased fruit cultivation and the transportation and marketing of infected material (Malavasi et al., 1998).

The presence of the Carambola fruit fly in Suriname and French Guiana in the 1990s represented a major threat to production and marketing of fruits and vegetables throughout tropical and sub-tropical Central and South America and the Caribbean (Mathur, 2003).

In view of the steady increase in volume of unofficial trade in fruit across national borders in the region, the situation demanded an immediate response.

The Carambola fruit fly Eradication Campaign was consequently initiated in Guyana in 1996 and gained the attention of the Ministry of Agriculture and international partners, who spared no effort to eliminate this potential threat to the upswing of agricultural development, thus setting the foundation for a prosperous sector (GINA, 2009b). Simple technologies (the fax machine) were used to discover the range of the pest (it can migrate distances of more than 50 km). Guyana has been declared free of the Carambola fruit fly since October 2000 (Sauers-Muller, 1990 -2001 annual reports)

The Minister of Agriculture, Robert Persaud, in his address to participants at a meeting held in 2009 in Georgetown, spoke of his interest in expanding and modernising the agriculture sector in Guyana, considering the significant investment made in the development of the agriculture sector, and how heavily dependent national development is on that sector. He ensured that all measures to reduce risks and hindrances to development would be taken. Monitoring and surveillance efforts will help the Ministry and its agencies to detect the prevalence or potential invasion of future threats and help them to devise and implement measures to deal appropriately with it (GINA, 2009b). On-going training of farmers and extension agents, induction of new skilled practitioners and the procurement of necessary equipment are all part of capacity building within the wide framework of diversification and modernisation (GINA, 2009b).

8.4 Legal framework and public policies

Goal: A coordinated policy and management framework that minimises the risk of IAS to the economy, environment and society of Guyana.

Countries beginning to deal with invasive alien species tend not to have a legal framework established to facilitate the work. It is very important that the legal aspects are addressed to enable prevention efforts as well as control work, which can be controversial for some groups in civil society.

In the Guyanese context, IAS can also be addressed as a biosecurity issue through the emerging National Biosafety Framework. Economic policies, though not necessarily directly addressing IAS issues, can help to promote behaviour that can increase or decrease IAS impact.

Institutional mandates regarding IAS issues in Guyana are few, fragmented and spread across departments in different ministries. Private land owners also have obligations.

Guyana has no formal body responsible for IAS issues. In 2009, the EPA established an IAS Task Force, comprising representatives from the key stakeholder agencies that are directly involved with the introduction and management of IAS, responsible for providing advice on IAS issues to individual government departments but it has no formal authority and no full time staff. Over the years, the task force became dormant and as such very limited work was done to achieve the objectives.

A formalised IAS Task Force body for IAS issues would have more authority, capacity and resources to act.

Because biological invasions often indicate market failure, an important part of any strategy to manage IAS is to make markets work to minimise IAS impacts wherever possible and to provide alternative solutions if markets do not exist or cannot be created. Therefore, countries must incorporate economic principles into their national strategies for addressing IAS, building on the following main principles: user pays, full social cost pricing and the precautionary principle.

Ensuring that IAS issues are addressed in institutional mandates and incorporating IAS considerations into economic instruments are examples of the mainstreaming process. This process is to be guided by the National Invasive Alien Species Strategy for Guyana which provides the framework for action to be taken to minimise the negative impacts of IAS in Guyana.

8.4.1 Public policies

Recommended actions

High priority:

- Develop public policies to enable the control of invasive alien species identified as high risk for biodiversity in Guyana, including capacity building and subsidies for farmers to clear private properties.
- Promote the production and the use of indigenous species as alternatives to non-native

species (and provide appropriate guidance).

- Promote capacity building for taxonomists on non-native species to improve local references.

Low priority:

- Create Biodiversity Fund (including IAS) and Ecosystem Health Fund.

8.4.2 Legal regulations

Recommended actions

High priority:

- Establish conditions for the use of IAS of economic value to prevent and mitigate impacts.
- Ensure that legal regulations request and allow control and eradication work to be carried out.
- Prohibit the use of invasive aliens species for restoration and rehabilitation purposes.

Low priority:

- Include border screening for IAS in the mandate of border control agents.
- Regulate production by plant nurseries avoiding use of IAS or restricting distribution for specific purposes.

8.5 Capacity building

Goal: To enhance the knowledge and understanding of the Guyana community to increase levels of compliance and support for preventing the introduction of IAS that have not yet reached Guyana, and managing those already here.

Increasing technical capacity and public awareness is a key action for work on invasive alien species to be successful and sustainable. Different target publics need to be reached. It is critical therefore, that existing capacity is used optimally. It is also imperative that capacity building initiatives at the national level are closely linked to regional and international efforts. International collaboration can result in resource sharing and pooling of expertise.

8.5.1 Official list of invasive alien species

An official list of IAS (Table 1) is key in promoting public awareness and the initial step in establishing specific legal regulations. The list can include restrictions or ban certain species from being used in the country

Recommended actions

High priority:

- Establish official IAS list and categories for restricted use or prohibition. (Establish IAS of economic value).
- Establish regulations and guidelines as it relates to internal IAS of commercial interest and value.

Low priority:

- Review official list periodically, e.g. every 2-3 years.

8.5.2 For early detection and rapid response

Recommended actions

High priority:

- Design and implement a regional invasive species training plan to build capacity at the regional and national levels.
- Provide capacity building on early detection to border control agents.

Low priority:

- Provide capacity building and training on early detection to protected area managers and staff.
- Provide capacity building to scientists and researchers in museums, herbaria, universities, and NGOs.
- Establish and maintain a system of technical advice and support based on a register of relevant regional and international experts.

8.5.3 For prevention measures

Recommended actions

High priority:

- Identify critical control points for prevention and early detection.
- Provide capacity building on inspection methods to border control agents.

Low priority:

- Design and implement a regional invasive species training plan to build capacity at the regional and national levels; and
- Ensure international collaboration and linkages in selected areas.

8.5.4 For eradication and control activies

Recommended actions

High priority:

- Provide capacity building on IAS and control methods to technical staff and scientists.

Low priority:

- Organize training programmes for selected personnel.

8.5.5 For teachers and professors

Recommended actions

High priority:

- Provide capacity building on IAS and on native biodiversity to teachers and professors.

Low priority:

- Provide teachers and professors with printed materials for lessons.

8.6 Information and education system

Goal: (i) To have a clear understanding of the economic, environmental and social impacts of IAS that have become established in Guyana; (ii) to have ready access to critical information that will support IAS management programmes; and (iii) to provide a strong scientific basis for decision making and resource allocation.

A publicly available information system can be used to disseminate information and serve as a reference for regulations and control work.

IAS-related information has expanded hugely in recent years. Numerous studies conducted in South-America and other parts of the world provide those working on IAS issues with an unprecedented opportunity to access valuable information from within the region and elsewhere. The challenge is not a lack of information but the provision of accessible, accurate, referenced, up-to-date, comprehensive and comprehensible information on invasive species that will be useful to policy makers, managers, scientists, teachers, students and others.

A national IAS online information system, linked to relevant and reliable national (e.g. EPA, GFC, Ministry of Agriculture, Ministry of Health, Guyana Tourism Authority) and international websites (e.g. GISP, GISD, IABIN, and I3N) could provide a one-stop shop for IAS information related to and of relevance to Guyana.

The general public has a key role to play in reducing the threat of invasive alien species by not releasing pets into natural areas or not cultivating invasive plants. All levels of education should be reached in time, so the concept of invasive species is well-known.

Recommended actions

High priority:

- Implement the I3N invasive species database for national reference, following the model used in more than 12 countries in Latin America. (Contact sziller@institutohorus.org.br).
- Build a network of data providers and collaborators to feed the national database.
- Make the national database available on the web for the general public.

Low priority:

- Maintain the database and website with updates from the networks.

8.7 Public awareness

Goal: The general public, decision makers, scientists and other stakeholders in Guyana have a high level of awareness of IAS risks and the benefits of IAS prevention and management for the economy, environment and society; stakeholders who are actively engaged in the development of best practices to minimise the negative impacts of IAS.

Views of invasive species issues are moulded by human values, decisions and behaviours. In Guyana there is currently a very high level of awareness of the significance of certain invasive species to certain sectors e.g. foot and mouth disease, malaria and dengue.

However, awareness of IAS as a generic and cross-sectoral issue is low. Most people in Guyana would probably not be familiar with the term "invasive alien species". IAS prevention and management will require a change in behaviours, values and beliefs and in the way that decisions are made regarding our actions to address IAS. Such changes will be of benefit to all aspects of IAS management.

Public awareness work is essential if these changes are to be made. This work needs be closely coordinated with IAS capacity building and education initiatives. It also needs to be linked to existing awareness raising programmes that relate to the biodiversity conservation, the wider environment, agriculture and health. This is one way in which IAS issues can be mainstreamed. Awareness-raising work will be principally targeted, at Guyana's residents but all those who engage in activities related to Guyana's trade, travel and transport need to be targeted as well.

Public awareness programmes undertaken in Guyana can benefit from similar public awareness programmes undertaken in other countries which can be adapted to the local context. Information on Guyana experiences can also be very useful for those working on IAS issues regionally and internationally.

Recommended actions

High priority:

- Carry out national awareness campaigns on IAS.
- Develop programmes and materials to increase awareness for key regional, national, sectoral and community target groups, including curriculum development for formal education.

8.8 Research

Goal: to provide a strong scientific basis for decision making and resource allocation and help with solutions for the implementation of the national strategy.

Research on issues that are specific to the Guyana situation is vital and findings from this research have been and will continue to be of value to the international community. A large amount of information can be derived from monitoring programmes which assess the impact of management actions on target organisms and ecosystems, or from the development of these management actions themselves. It is critical that all data is collated, analysed and written up in a way that makes it accessible to a number of different audiences. This dissemination process will improve understanding of IAS issues and provide valuable information that can be used to improve future IAS management efforts.

Recommended actions

High priority:

- Define control methods for IAS in the country;
- Perform risk assessment of existing non-native species; and
- Develop prevention measures for production activities and for border control.

Low priority:

- Carry out risk assessment for non-native species present in Guyana to verify which have the potential to become invasive in the future.

9.0 ACTION PLAN

1 - PREVENTION					
Goal: To develop appropriate programs and procedures to minimize the impacts of established invasive species and minimise the number of unintended and intended IAS introductions to Guyana.					
Recommended actions		**Lead Agency/Group**	**Potential partners**	**Priority**	**Timeframe**
Risk assessment					
1.1.1	Carry out risk assessment for non-native species already in the country to identify priority threats. Generate species list with risk categories (high, low).	EPA, Ministry of Agriculture, and National Agricultural Research and Extension Institute	Ministry of Agriculture, Universities, scientific community. Ministry of Health, border control agencies.	Low	Year 3 - 4
1.1.2	Incorporate risk assessment as a tool for screening new introductions and strengthening Guyana's EIA regulations	EPA	Ministry of Agriculture, University of Guyana	High	Year 1 - 2
Vectors and pathways assessment					
1.2.1	Carry out vectors and pathways assessment for commercial routes (e.g. considering ballast water, the ornamental plant and pet trade)in order to optimize inspection in cargo, vessels or flights arriving from areas of high risk to Guyana.	EPA, Maritime Administration, Ministry of Agriculture.	International commercial organizations, Coast Guard, Airport Authority, Tourism Authority, scientific community, NGOs.	High	Year 1 - 2
1.2.2	Carry out vectors and pathways assessment for species already introduced, but with limited distribution, to define containment or eradication efforts within Guyana, and protect important areas for conservation and tourism.	EPA, Ministry of Agriculture.	Maritime administration, Coast Guard, Airport Authorities, Scientific community, NGOs.	Low	Year 3 - 4
1.2.3	Implement contingency plans for priority species pathways, in order for procedures to be in place when species arriving through the assessed pathways are detected, and introductions can be stopped at the border.	EPA, Ministry of Agriculture, academic institutes.	Airport Authorities, Coast Guard, scientific community, NGOs, Private companies.	Low	Year 3 - 4
Prevention measures (quarantine, inspection, border control)					
1.3.1	Implement and intensify border control to avoid the entry of non-native species or related vectors. Pathways assessments are helpful in selecting priorities for inspection.	Ministry of Agriculture, Maritime Administration, EPA.	Wildlife Customs Department, International commercial organizations, Airport Authority, Police, Ministry of Health.	High	Year 1 - 2
1.3.2	Implement prevention measures/ media to reduce the involuntary entry of non-native species, such as spraying airplanes and using Phytosanitary rugs at points of entry.	EPA	Ministry of Agriculture, Ministry of Health, Coast Guard, Civil Aviation Authority (Ministry of Public Works).	High	Year 1 - 2
1.3.3	Collaborate with other countries to avoid new entries.	Airport Authority	Ministry of Agriculture, Ministry of Health, Coast Guard, Civil Aviation Authority (Ministry of Public Works).	Low	Year 3 - 4

2 - EARLY DETECTION AND RAPID RESPONSE					
Goal: To minimise the number of IAS that tend to have harmful consequences once they are introduced to Guyana					
Recommended action		**Lead Agency/Group**	**Potential partners**	**Priority**	**Timeframe**
2.1	Develop a model for action plans upon early detection of non-native species. Identify procedures aimed at current specific priority invasive species.	IAS Focal point	EPA, Ministry of Agriculture, Indigenous communities, Ministry of Amerindian Affairs, NGOs, Universities, Museums, Scientific community, Police.	Low	Year 3 - 4
2.2	Identify priority species and pathways for immediate monitoring, containment and control. Adopt existing protocol and test pathway risk assessment protocol (e.g. there is a protocol available at http://i3n.iabin.net through Tools)	EPA, IAS Focal point	Airport Authority, Customs, Ministry of Home Affairs, Ministry of Maritime Affairs, Ministry of Transports.	High	Year 1 - 2
2.3	Build a network of trained experts for early detection. Develop website for reference and reporting system. Post risk assessment results for species in the country.	EPA, IAS Focal point	Ministry of Agriculture, Taxonomists, Museums, Universities, NGOs, Civil Society volunteers trained for early detection.	Low	Year 3 - 4
2.4	Monitor areas of potential entry of invasive species for early detection. Create contingency plans and train personnel on the issue.	EPA, Ministry of Agriculture.	Airport Authority, Universities, Museums, NGOs.	High	Year 1 - 2
2.5	Monitor commercial points for ornamental plants, pets, and aquaculture. Create contingency plans and train personnel on the issue.	EPA, Police	Ministry of Agriculture, Plant Nursery.	High	Year 1 - 2
2.6	Include records of non-native species in scientific collections and biodiversity surveys.	EPA	Museums and Universities, Iwokrama, Researchers and related experts.	Low	Year 3 - 4
2.7	Make detailed recommendations for improvements with an aim to filling the gaps to allow effective implementation of the national IAS strategy.	EPA	Ministry of Agriculture, Ministry of Amerindian Affairs, NGOs, Universities, Scientific community.	Low	Year 3 - 4

3 - ERADICATION, CONTROL AND MONITORING					
Goal: An agreed framework for eradication priorities to be put in place, eradications are undertaken as necessary and results are disseminated.					
Recommended actions		**Lead Agency/Group**	**Potential partners**	**Priority**	**Timeframe**
3.1	Implement prevention, eradication and control systems for IAS in protected areas, on the coastline and other priority areas for the conservation of biodiversity and ecosystem services.	National Parks Commission, Ministry of Amerindian Affairs	EPA, Iwokrama, Conservation International, Museums, Universities, NGOs, Civil society volunteers trained for control work.	High	Year 1 - 2
3.2	Make information on IAS best practices and control available to the public.	EPA, Ministry of Tourism, Industry and Commerce	Scientific community and civil society.	Low	Year 3 - 4
3.3	Define priorities and action plans for IAS and priority areas.	Private Sector Commission	Museums, Universities, NGOs, Scientific community.	High	Year 1 - 2
3.4	Promote the use of biological control agents as appropriate.	Ministry of Agriculture, EPA	Museums, Universities, NGOs, Scientific community.	High	Year 1 - 2
4 - LEGAL FRAMEWORK AND PUBLIC POLICIES					
Goal: A coordinated policy and management framework that minimises the risk of IAS to the economy, environment and society of Guyana.					
Recommended actions		**Lead Agency/Group**	**Potential partners**	**Priority**	**Timeframe**
Public policies					
4.1.1	Create Biodiversity Fund (including IAS). Ecosystem Health Fund	Environmental Protection Agency	Ministry of Finance	Low	Year 3 – 4
4.1.2	Develop public policies to enable the control of invasive alien species identified as high risk for biodiversity in Guyana, including capacity building and subsidies for farmers to clear private properties.	Ministry of Amerindian Affairs. Ministry of Agriculture	Lands and Surveys Commission.	High	Year 1 – 2
4.1.3	Promote the production and the use of indigenous species as alternatives to non-native species (and provide appropriate guidance)	Guyana Geology and Mines Commission, Guyana Forestry Commission, National Agriculture Research and Extension Institute (NAREI), Guyana Rice Development Board (GRDB), Guyana Livestock Development Authority (GLDA), Fisheries.	University of Guyana, NGOs in Agriculture as Inter-American Institute for Cooperation in Agriculture (IICA) and Caribbean Agricultural Research and Development Institute (CARDI), Nurseries, Ornamental plant producers, Guyana Sugar Corporation (GuySuCo), Communities Based Organizations, Fisheries, Institute of Private Enterprise Development, Chemical Industries such as Amazon Chemical, Associated Industries Limited (AINLIM), Caribbean Chemicals.	High	Year 1 – 2

4.1.4	Promote capacity building for taxonomists on non-native species to improve local references	Environmental Protection Agency and University of Guyana	Ministry of Health, Ministry of Agriculture, Guyana Rice Development Board (GRDB), Guyana Sugar Corporation (GuySuCo), National Agriculture Research and Extension Institute (NAREI), Iwokrama, relevant NGO's (e.g. WWF).	High	Year 3 – 4
Legal regulations					
4.2.1	Establish conditions for the use of IAS of economic value to prevent and mitigate impacts.	EPA	Guyana Geology and Mines Commission. Guyana Gold and Diamond miners Association.	High	Year 1 – 2
4.2.2	Ensure that legal regulations request and allow control and eradication work to be carried out.	EPA	Guyana Lands and Surveys Commission, Ministry of Amerindian Affairs, Guyana Geology and Mines Commission.	High	Year 1 - 2
4.2.3	Regulate production by plant nurseries avoiding use of IAS or restricting distribution for specific purposes.	Ministry of Agriculture (with EPA oversight)	Ministry of Agriculture, National Agriculture Research and Extension Institute (NAREI).	Low	Year 3 - 4
4.2.4	Prohibit the use of invasive alien species for restoration and rehabilitation purposes.	EPA	Guyana Geology and Mines Commission, Guyana Gold and Diamond miners Association.	High	Year 1 - 2
4.2.5	Include border screening for IAS in the mandate of border control agents	EPA,	Ministry of Agriculture, Ministry of Health, Coast Guard, Civil Aviation Authority (Ministry of Public Works).	Low	Year 3 - 4
5 - CAPACITY BUILDING					
Goal: To enhance the knowledge and understanding of the Guyana community to increase levels of compliance and support for preventing the introduction of IAS that have not yet reached Guyana, and managing those already here.					
Recommended actions		**Lead Agency/Group**	**Potential partners**	**Priority**	**Timeframe**
Official list of invasive alien species					
5.1.1	Establish official IAS list and categories for restricted use or prohibition	EPA	University of Guyana (Centre for the Study of Biological Diversity (CSBD)), Ministry of Health, Ministry of Agriculture NGOs, scientists.	High	Year 1 – 2
5.1.2	Establish regulations and guidelines as it relates to IAS of commercial interest and value	EPA, Ministry of Agriculture and Health.	University of Guyana (Centre for the Study of Biological Diversity (CSBD)), Ministry of Health, Ministry of Agriculture NGOs, scientists.	High	Year 1 - 2

5.1.3	Review official list periodically, e.g. every 2-3 years	EPA	University of Guyana (Centre for the Study of Biological Diversity (CSBD)), Ministry of Health, Ministry of Agriculture NGOs, scientists.	Low	Year 3 - 4
For early detection and rapid response					
5.2.1	Design and implement a regional invasive species training plan to build capacity at the regional and national levels.	EPA, IAS Focal point	Ministry of Education, Ministry of Health, Universities, Schools, Relevant agencies.	High	Year 1 - 2
5.2.2	Provide capacity building and training on early detection to protected area managers and staff.	EPA	Guyana Forestry Commission, NGOs.	Low	Year 3 - 4
5.2.3	Provide capacity building on early detection to border control agents.	Ministry of Agriculture	Customs, Ministry of Home Affairs, Ministry of Transports.	High	Year 1 - 2
5.2.4	Provide capacity building to scientists and researchers in museums, herbaria, universities, and NGOs.	Ministry of Agriculture, Ministry of Health.	Ministry of Education, NGOs, Ministry of Public Services, National Agriculture and Research Extension Institute (NAREI), University of Guyana.	Low	Year 3 - 4
5.2.5	Establish and maintain a system of technical advice and support based on a register of relevant regional and international experts.	EPA	IAS Focal point.	Low	Year 3 - 4
For prevention measures					
5.3.1	Identify critical control points for prevention and early detection.	EPA, Ministry of Agriculture	Ministry of Agriculture, Ministry of Health, Ministry of Education.	High	Year 1 - 2
4.3.2	Provide capacity building on inspection methods to border control agents.	EPA, Ministry of Agriculture	Ministry of Home Affairs (Customs and Immigration).	High	Year 1 - 2
5.3.3	Design and implement a regional invasive species training plan to build capacity at the regional and national levels.	EPA, IAS Focal point	Ministry of Agriculture, Ministry of Health, Ministry of Education.	Low	Year 3 - 4
5.3.4	Ensure international collaboration and linkages in selected areas.	EPA, IAS Focal point	Ministry of Agriculture, Ministry of Health, Ministry of Transports, Ministry of Education.	Low	Year 3 - 4
For eradication and control activities					
5.4.1	Organize training programmes for selected persons.	EPA, IAS Focal point	Ministry of Agriculture, Ministry of Health, Ministry of Transports, Ministry of Education.	Low	Year 3 - 4
5.4.2	Provide capacity building on IAS and control methods to technical staff and scientists.	EPA, Ministry of Agriculture	NGOs, Universities, Schools, Relevant agencies.	High	Year 1 - 2
For teachers and professors					
5.5.1	Provide capacity building on IAS and on native biodiversity to teachers and professors.	Ministry of Education	EPA, Ministry of Agriculture, NGOs, University of Guyana.	High	Year 1 - 2
5.5.2	Provide teachers and professors with printed materials for lessons	Ministry of Education	EPA, Ministry of Agriculture, NGOs, University of Guyana.	Low	Year 3 - 4

6 - INFORMATION AND EDUCATION SYSTEM					
Goal: (i) To have a clear understanding of the economic, environmental and social impacts of IAS that have become established in Guyana; (ii) to have ready access to critical information that will support IAS management programmes; and (iii) to provide a strong scientific basis for decision-making and resource allocation.					
Recommended actions		**Lead Agency/Group**	**Potential partners**	**Priority**	**Timeframe**
6.1.1	Implement the I3N invasive species database for national reference, following the model used in more than 12 countries in Latin America. (Contact sziller@institutohorus.org.br).	I3N IABIN (Inter-American Biodiversity Information Network) Focal point, EPA, Ministry of Agriculture.	I3N, NGOs, Universities, I3N member countries.	High	Year 1 - 2
6.1.2	Build a network of data providers and collaborators to feed the national database.	I3N IABIN (Inter-American Biodiversity Information Network) Focal point, EPA, Ministry of Agriculture.	NGOs, Museums, Universities, Scientific community, others interested in the topic.	High	Year 1 - 2
6.1.3	Make the national database available on the web for the general public.	I3N IABIN (Inter-American Biodiversity Information Network) Focal point, EPA, Ministry of Agriculture.	I3N, EPA.	High	Year 1 - 2
6.1.4	Maintain the database and website with updates from the network.	I3N IABIN (Inter-American Biodiversity Information Network) Focal point, EPA, Ministry of Agriculture.	I3N, EPA.I3N member countries	Low	Year 3 - 4

7 - PUBLIC AWARENESS					
Goal: The general public, decision-makers, scientists and other stakeholders in Guyana have a high level of awareness of IAS risks and the benefits of IAS prevention and management for the economy, environment and society; stakeholders who are actively engaged in the development of best practices to minimise the negative impacts of IAS.					
Recommended actions		**Lead Agency/Group**	**Potential partners**	**Priority**	**Timeframe**
7.1	Carry out national awareness campaigns on IAS.	EPA, Ministry of Agriculture.	Ministry of Education, NGOs, GINA, Media.	High	Year 1 - 2
7.2	Develop programmes and materials to increase awareness for key regional, national, sectoral and community target groups, including curriculum development for formal education.	EPA, Ministry of Agriculture.	Ministry of Education, NGOs, GINA, Media.	High	Year 1 - 2
8 - RESEARCH					
Goal: To provide a strong scientific basis for decision-making and resource allocation and help with solutions for the implementation of the national strategy.					
Recommended actions		**Potential partners**	**Priority**	**Timeframe**	
8.1	Define control methods for IAS in the country.	Ministry of Agriculture	National Agriculture Research and Extension Institute (NAREI), Guyana Sugar Corporation (GuySuCo) Guyana Rice Development Board (GRDB), Universities.	High	Year 1 – 2
8.2	Perform risk assessment of existing non-native species.	Ministry of Agriculture	National Agriculture Research and Extension Institute (NAREI), Guyana Sugar Corporation (GuySuCo), Guyana Rice Development Board (GRDB), Universities.	High	Year 1 – 2
8.3	Develop prevention measures for production activities and for border control.	Ministry of Agriculture	National Agriculture Research and Extension Institute (NAREI), Guyana Sugar Corporation (GuySuCo), Guyana Rice Development Board (GRDB), Universities.	High	Year 1 – 2

10.0 CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Invasive alien species have been established throughout Guyana, damaging both natural and cultivated ecosystems and causing severe health impacts. As a consequence IAS are now recognised as among the most serious threats to the nation's economy, environment and society.

At the National IAS Workshop held in Georgetown (March 23, 2011), participating experts and key stakeholders, who were clearly interested in addressing problems posed by IAS in Guyana.

The Workshop helped to clarify needs, build consensus and stimulate a concerted national approach. Seven priority areas were identified: local and regional capacity; education; legal aspects; policies and institutions; information management; research; and technical aspects.

The objectives of the workshop were achieved, given time restrictions of a one day event. Participants selected national priorities in the areas of concern from the draft Action Plan prepared by the consultancy, added comments and suggestions, and excluded propositions that were not considered to be of relevance to Guyana. Some important considerations coming from stakeholders for local actions (see chapter 8 for a detailed breakdown) were included and further developed during the National Consultation held in March 2011.

These are presented in Appendix VI and should serve as guidelines for the team leading the implementation of the National IAS Strategy for Guyana. It is highly recommended that a core team of stakeholders who participated in the IAS Workshop have a second meeting to review the selected actions and to add deadlines and levels of priority, as well as attribute each action to an institution and identify a person to be responsible. This core team can become a national council that oversees and manages the implementation of the strategy, registers progress, and reviews the plan each year to establish priorities for the short term.

Conclusions and suggestions of general relevance included:

- IAS in Guyana is mainly a coastal problem. At present many IAS are located in the capital city, Georgetown. This is an advantage for Guyana compared to some other countries with reference to the management of IAS;
- There is no "zero risk" and there will always be some form of risk from the importation of genetic resources into a country. However, Guyana should take responsibility for any species it intends to import, and should have the appropriate control mechanisms in place;
- The linkage with the I3N and GISD databases is a precious resource for the entire region to gain considerable information about IAS present in Guyana. However, for the full benefits to be obtained, the information must be accurate and as comprehensive as possible. Ensuring consistency and data quality will be important;
- A clause on the need to prevent and control or eradicate IAS should be included in the Protected Areas legislation;
- The IAS inventory presented at the workshop is an open list of IAS species that should be expanded to incorporate IAS yet to be identified in Guyana and also extended to bacteria and viruses. It may also be expanded to include information which addresses the degree of

risk posed by IAS and measures taken to reduce these risks;

- Research has already been conducted on the invasiveness of *Acacia mangium.* This species, used in the reclamation of mined out sites, competes with other plants for resources and inhibits native plants from growing due to allelopathy. *A. mangium* should be replaced by native plants in restoration work, eliminating risks of biological invasion.

Recommendations

Recommendations proposed by the stakeholders focused on prioritizing actions under the revised Action Plan linked to the Strategy (see chapter 8 for a detailed breakdown). These actions are structured in accordance with the three-stage hierarchy endorsed under the CBD and embedded in the CBD Guiding Principles (Box 2).

The following actions were identified as **high priority:**

a) Prevention, early detection and rapid response

- Incorporate risk assessment as a tool for screening new introductions and strengthening Guyana's EIA regulations;
- Carry out vectors and pathways assessment for commercial routes in order to optimize inspection in cargo, vessels or flights arriving from areas of high risk to Guyana;
- Implement and intensify border control and implement simple prevention measures at entry points;
- Implement prevention measures/media to reduce the involuntary entry of non-native species at points of entry;
- Identify priority species and pathways for monitoring, containment and control; and
- Develop contingency plans for early detection and rapid response at commercial entry points.

b) Eradication, control and monitoring

- Implement a prevention, eradication and control system in protected areas;
- Define priorities and action plans for priority IAS and areas; and
- Promote the use of biocontrol agents as appropriate.

c) Legal framework and public policies

- Develop public policies to enable the control of invasive alien species identified as high risk for biodiversity in Guyana, including capacity building and subsidies for farmers to clear private properties;
- Promote the production and the use of indigenous species as alternatives to non-native species;
- Promote capacity building for taxonomists on non-native species;
- Establish conditions for the use of IAS of economic value to prevent and mitigate impacts. Ensure that legal regulations request and allow control and eradication work to be carried out; and
- Prohibit the use of invasive alien species for restoration and rehabilitation purposes.

d) Capacity building

- Establish an official IAS list and categories for restricted use or prohibition;

- Establish regulations and guidelines as it relates to IAS of commercial interest and value;
- Design and implement a regional invasive species training plan to build capacity at the regional and national levels;
- Provide capacity building on early detection for border control agents, including inspection methods;
- Identify critical control points for prevention and early detection;
- Provide capacity building on inspection methods for border control agents;
- Provide capacity building on IAS and control methods for technical staff and scientists; and
- Provide capacity building on IAS and on native biodiversity for teachers and professors.

When developing an official list with categories that refer to restricted use or prohibition, special care must be taken with species that have economic value. Economic interest should not be a single criterion for not banning a species. Most species are introduced for commercial interests, but many of them fail to establish a market or generate marginal benefits. When introduced species become invasive and are difficult to control, the negative impacts often outweigh the benefits. In this case, it is best to recommend alternative species, possibly allowing a period of 1-2 years for their replacement with non-invasive species.

e) Information system

- Implement the I3N invasive species database for national reference, following the model used in more than 12 countries in Latin America. (Contact sziller@institutohorus.org.br);
- Build a network of data providers and collaborators to populate the national database; and
- Make a national database available on the web for the general public.

f) Education and public awareness

- Carry out national awareness campaigns on IAS; and
- Develop programmes and materials to increase awareness of target groups.

g) Research

- Define control methods for IAS in Guyana;
- Perform risk assessment of introduced non-native species; and
- Develop prevention measures and border control.

Implementation

Given the number of high priority actions, a well-structured approach to implementation needs to be organised and planned for. This should include steps to raise political awareness of IAS issues and leverage secure funding for prevention and management efforts.

An operational plan should be generated attributing responsibilities and timeframes for different organisations. The most robust approach to ensure effective oversight of implementation would be to establish a National Committee for Invasive Alien Species, with EPA as the Lead, and include representatives of Agriculture, Health, Trade, Water and Education, as many of these actions are cross-sectoral and need to be carried out with a consensus. Alternatively, EPA could make more proactive use of the less formal IAS Task Force to strengthen inter-agency

coordination and engage stakeholders on a regular basis.

Guyana also needs to recognise its responsibilities to neighbouring countries and the mutual benefits to be gained from active participation in sub-regional and regional IAS coordination and networking. This applies to information collection and information exchange, to practical prevention efforts and to shared management programmes.

In the context of limited information being available for many species, there is plenty of scope for surveys, research and improvements on current knowledge. The information assembled here on invasive species in Guyana is the first concerted effort to identify the main invasive species and also the current status of invasive species issues at both the national and regional level. This effort is only a beginning and needs to be expanded and continued in a structured manner.

This Strategy is intended to generate an effective, integrated, comprehensive, and science-based approach for addressing the IAS problem in Guyana, now and in the future. It is anticipated that its implementation will lead to reduced environmental degradation, a decrease in losses of native species and improved socio-economic opportunities for communities.

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APPENDICES

APPENDIX I – TERMS OF REFERENCE

The Environmental Protection Agency/
UNITED NATIONS DEVELOPMENT PROGRAMME
Assessment of Capacity Building Needs for National Biodiversity Priorities

Project No. 00060126

Terms of Reference

Subcontract Title: Report on Invasive and Alien Species (IAS) in Guyana

Duration: 3 months

I. Project Background

Funded by the Global Environment Facility (GEF), the project entitled, "Assessment of Capacity Building Needs, Preparation of Second and Third National Reports (CBD) and the Clearing House Mechanism in Guyana", is being implemented by the United Nations Development Programme (UNDP) and executed by the Environmental Protection Agency.

Guyana became signatory to the Convention on Biological Diversity (CBD) in 1994. One of the cross-cutting issues identified under this Convention is Invasive and Alien Species (IAS), which was introduced after the fourth meeting of the Conferences of Parties (COP) to the CBD.

Globally, IAS have been identified as a significant threat to native biodiversity, costing economies billions of dollars annually. Significant efforts are being made to control, reduce and eradicate these species from non-native habitats. However, very little work on IAS has been done in Guyana.

In the past, a number of alien and invasive species have been introduced to Guyana, both intentionally and unintentionally. The prevalence and impacts of these IAS in Guyana are not well studied or understood. Identifying and managing potential pathways for further IAS introduction is also critical to addressing the threats posed to local biodiversity. This Consultancy will therefore examine the issues related to invasive and alien species in Guyana, and include the compilation of information, the preparation of reports, and the development of strategies and plans to address the threat of IAS to the country.

II. Objectives

The objectives are to:

1. Determine the extent of the presence and prevalence of IAS in Guyana;

2. Examine the pathways and causes of IAS introduction, and their impacts on local biological diversity; and
3. Identify appropriate mechanisms to prevent further introduction of IAS, and the management or eventual eradication of IAS currently found in Guyana.

III. Primary Outputs

Under this project the Consultant will produce:

1. An Assessment report, with focus on examining the prevalence of IAS and determining the pathways and causes of the introduction of alien species, its impacts on biological diversity, and the appropriate mechanisms of control.
2. An inventory of IAS in Guyana, including species profiles and geographic distribution at the national level, where possible.
3. A Thematic report on IAS according to the guidelines of the UNCBD.
4. A Strategy and Action Plan for the incorporation of IAS knowledge into biodiversity management practices.

IV. Methodological Considerations

The assessment should be guided by, and adhere to, the principles of participatory research. The Consultant should allow for stakeholders to actively contribute to the preparation and verification of the primary outputs.

V. Specific Deliverables

1. A proposed sub-project work-plan, including a detailed description of the proposed methodology to achieve the objectives, outputs and deliverables outlined in this Terms of Reference.
2. Monthly progress reports, including workshop reports, any data collection tools (e.g. questionnaire) developed and a record of the number of consultations as well as the list of stakeholders involved.
3. An Assessment Report, which includes an examination of the prevalence of IAS, the pathways and the causes of their introduction, and their impacts on native biodiversity. The Report must also provide an overview of the existing and potential impacts of IAS on ecosystem services and key sectors, such as Agriculture, Forestry, Health and Trade.
4. A Thematic report, as per the UNCBD guidelines for detailed thematic reports on alien species.
5. A Strategy and Action Plan, which includes the targets for monitoring of IAS. This will entail priorities for legal and regulatory frameworks, institutional roles and coordination, human resources development needs and training, and financial mechanisms. The Plan must also provide guidance on how to control, contain and/or eradicate existing IAS. Systems and tools for the management of future introductions, and the prevention of unintentional introductions, of IAS should be included.
6. An inventory of IAS found in Guyana, which should include:

    - Origin and means of introduction;
    - Geographical distribution for Guyana;
    - Related threats and impacts; and
    - Socio-economical or cultural value.

7. Copy of any questionnaires used in initial assessment and monitoring programmes.

To ensure the successful execution of this contract, the Consultant should hold at least one (1) National Stakeholder Workshop to solicit suggestions and comments from stakeholders and other concerned parties during the contract implementation. All outputs of the consultant are subject to the final acceptance of the Environmental Protection Agency.

VI. Qualifications

- The Consultant should possess at least a MSc. in Environmental Studies, Biology, Forestry, Agriculture or related field, and at least 4 years relevant experience;
- The Consultant should have excellent skills in facilitation, communicating and coordinating, as well as advanced oral and written proficiency; and
- The Consultant should have an in-depth understanding of national and international biodiversity policies.

VII- Guiding Documents

a. Environmental Regulations, enacted under the EP Act, 1996;
b. Agenda 21;
c. CBD National Reports, Guyana;
d. National Environmental Action Plan;
e. National Biodiversity Action Plan I & II;
f. NCSA Report;
g. CBD documents; and
h. Report of the Biosafety project.

APPENDIX II – LIST OF STAKEHOLDERS

Conservation International – Guyana (CI-G)
Centre for Disease Control (CDC)
Guyana Marine Turtle Conservation Society (GMTCS)
Guyana Sugar Corporation (GuySuCo)
Guyana Rice Development Board (GRDB)
Guyana Tourism Authority (GTA)
Guyana Revenue Authority: Customs, Trade and Administration (GRA – CTA)
Guyana School of Agriculture (GSA)
Guyana Police Force (GPF)
Guyana Defence Force (GDF)
Guyana Lands and Surveys Commission (GLSC)
Guyana Geology and Mines Commission (GGMC)
Guyana Forestry Commission (GFC)
Guyana Shield Initiative Project (GSIP)
Institute of Applied Science and Technology (IAST)
Iwokrama International Centre (IIC)
Ministry of Agriculture (MOA)
Ministry of Amerindian Affairs (MOAA)
Ministry of Foreign Affairs (MOFA)
Ministry of Foreign Trade and International Cooperation (MOFTIC)
Ministry of Health (MOH)
Ministry of Legal Affairs (MOLA)
Ministry of Public Works& Communication - Maritime Administration (MPW&C – MA)
Ministry of Tourism, Industry and Commerce (MOTIC)
National Parks Commission (NPC)
National Agricultural Research and Extension Institute (NAREI)
Office of the President (OP)
Office of Climate Change (OCC)
United Nations Development Programme (UNDP)
University of Guyana, Centre for the Study of Biological Diversity (UG-CSBD)
University of Guyana, Faculty of Agriculture and Forestry
University of Guyana, Faculty of Natural Sciences
University of Guyana, School of Earth and Environmental Sciences (SEES)
Wildlife Management Authority (WMA)
World Wildlife Fund (WWF)

APPENDIX III – DETAILED METHODOLOGY AND QUESTIONNAIRE

Methodology

The sub-project deliverables will be developed based on:

- a review of published literature;
- information provided by a wide range of departments and agencies in their reports, websites and direct interviews;
- responses to questionnaires sent out to territorial and municipal government departments, non-government organizations (NGOs) and corporations across Guyana;
- consultation and collaboration with stakeholders during and after the dedicated participatory IAS workshop (Georgetown, 23 March 2011); and
- follow-up contacts and regular consultation during the preparation of sub-project primary outputs.

Timeline

Phase 1: data compilation and stakeholder engagement

The questionnaire and data gathering will be carried out from project inception to *March 22, 2011*. Consistent with sub-project objectives, the following tasks are proposed:

- The collation of data on individual invasive alien species (IAS), across all taxa, known from Guyana;
- The compilation and review of current government policies and regulations relevant to IAS and where relevant, strategies and programmes of key NGOs and the private sector in Guyana;
- The identification and assessment of current (and potential future) threats and impacts of IAS in Guyana and the wider region, including key pathways for movement, elements of vulnerability to invasion, opportunities for mitigation and prevention and opportunities for regional collaboration etc.;
- Based on these inputs, the preliminary identification of gaps in current knowledge, regulations and understanding of threats and impacts; and
- Discussion and refinement of these inputs at the Workshop, together with priority setting for future initiatives in Guyana and in the wider region.

Phase 2: data analysis and preparation of draft primary outputs

Based on data compiled and stakeholder input from interviews and the Workshop, the following tasks are proposed to develop the four primary outputs:

- **IAS Inventory**: development of a summarised list of documented invasive species of Guyana, grouped by taxa, broad natural organism type, area of occurrence, with notes on the significance of their impacts, where possible;
- **IAS Assessment report**: Overview of the impacts of invasive species on native biodiversity and socioeconomic in Guyana, incorporating an analysis of current (and potential future) threats and impacts of invasive species in the region, including key pathways for movement, elements of vulnerability to invasion, opportunities for mitigation and prevention, etc.;
- **IAS Thematic report**: Taking account of specific issues relevant to the country context, structured in accordance with the CBD guidelines; and

- **IAS Strategy and Action Plan**: Building on gap analysis in current knowledge, regulation and understanding of threats and impacts, this will develop recommendations for future initiatives, including opportunities for the development and implementation of IAS threat-reduction strategies in Guyana, and set out suggested priorities and key actions. It will also include contact information for key individuals and organisations engaged in work on invasive species in Guyana and identify possible mechanisms for coordination and allocation of tasks.

Phase 3: consultation on draft primary outputs, revision and finalisation
Consistent with the required methodological considerations, stakeholders will be actively engaged through the circulation and comment on draft primary outputs. Continuity will be ensured by involving all stakeholders interviewed and/or consulted through the workshop or by electronic means.

Submission of the four primary outputs required under the sub-project

1.2 Information collation and synthesis

1.2.1 List of contacts
To begin the collation of information, an initial list was prepared of relevant experts, resource persons and practitioners within and outside the region. As well as drawing on in-house knowledge, databases were searched for relevant contacts. This list was used for the future work and was modified as the project progressed. In Guyana, a range of key players such regional and extra-regional institutions, instruments and programmes, already exist.
They could assist in the development and implementation of a regional initiative to address the invasive species problem. The key players are provided in the Appendix to the work plan.

1.2.2 Questionnaire and e-mails
A questionnaire was developed to generate interest and provide direction for further investigations (Box 3). The questionnaire, presented to the stakeholders during the Workshop session, sought to obtain specific information with respect to invasive species on a regional basis, as well as to test the level of awareness that existed within the region on the problem of invasive species and their management. It was used as a tool to facilitate the further addition of resource persons and institutions to the database. In addition to direct communication with those experts with knowledge of invasive species within the Guyana region, the questionnaire could be also circulate via the following electronic mailing lists of stakeholders or any other interested sector of activity.

Box 3: PROJECT QUESTIONNAIRE

INVASIVE SPECIES THREATS IN GUYANA

Many species of animals, plants and even micro-organisms have been introduced in Guyana either accidentally or deliberately, for a variety of reasons. Some introduced species have spread rapidly and represent serious environmental and economic threats. In a few cases, environmental changes may have allowed indigenous species to spread rapidly in a similar way. This problem, which is one of the main causes of biodiversity loss around the world, was ignored for a long time. Although the basic principles that lead to the introduction of species to new environments are known, the magnitude of the damage that these can cause to ecosystems, environmental services and human, animal and plant health have not yet been fully studied. Therefore the environmental and social impacts caused by invasive species have not been evaluated in all their dimensions, or the associated economic losses.

BUILDING A KNOWLEDGE BASE ON INVASIVE SPECIES IN GUYANA

The EPA is leading a new initiative, with UNDP support, to assess invasive species issues across Guyana and develop a national Strategy and Action Plan. We hope that you will take this opportunity to assist in this exercise, which is intended to identify gaps in knowledge and collate available information on invasive species, their impacts, and their management.

Please take a few moments to respond to any of the questions below, and do not hesitate to contact us if you have any thoughts on these important issues.

1. Do you have knowledge of invasive species problems in a particular Guyana context(s)?
If so, please give details (sector, region, type of ecosystem etc.).

2. Are you aware of any attempts to collate information on invasive species problems in a particular Guyana contest(s)? If so, please give details.

3. Are you aware of any public or private initiatives for the prevention and management of invasive species in a particular Guyana contest (s)? If so, please give details.

4. What do you see as the key challenges and opportunities for addressing the invasive species problem, either locally or regionally, in Guyana?

5. Can you suggest names of other people or institutions who you think we should contact?
Please note that our intention is to build a database of contacts, and may wish to follow up on these matters with you. If you are happy to be included in this process, please provide your contact details.

APPENDIX IV – STAKEHOLDERS INTERVIEWED

Organisation	Personnel Interviewed	Date Interviewed
Guyana Tourism Authority (GTA)	Mr. Indranauth Haralsingh, Director	March 01, 2011
Guyana Forestry Commission (GFC)	Ms. Sumedha Mahadeo, Botanist	March 02, 2011
National Parks Commission (NPC)	Ms. Yolanda Vasconcellos, General Manager	March 04, 2011
IWOKRAMA International Centre (IIC) for Rainforest Conservation and Development	Dr. Raquel Thomas, Director of Resource Management and Training	March 04, 2011
Guyana Sugar Corporation Inc. (GuySuCo)	Mr. Gavindra Ramnarain, Agricultural Research Director Mr. Ravindra Persaud, Research Agronomist – Weeds Ms. Claudette Richards-Haynes, Research Agronomist – Pests	March 04, 2011
National Agriculture Research and Extension Institute (NAREI)	Dr. Oudho Homenauth, Director Mr. Brian Sears	March 8, 2011
Guyana Geology and Mines Commission (GGMC)	Ms. Karen Livan, Environmental Manager	March 9, 2011
Customs and Trade Administration	Mr. Robert James, Deputy Commissioner Mr. David Josiah, Director Enforcement	March 9, 2011

Organisation	Personnel Interviewed	Date Interviewed
Wildlife Management Authority (WMA)	Ms. Alona Sankar, Head Dr. Lennox Applewhaite, Veterinary Officer	March 10, 2011
University of Guyana, Faculty of Natural Sciences	Mr. John Ceaser, Senior Lecturer	March 10, 2011
Guyana Rice Development Board (GRDB)	Mr. Jagnarine Singh, General Manager Ms. Allison Peters, Quality Control Manager	March 10, 2011
Ministry of Health	Dr. Ashok Sookdeo, Director of Environmental Health Dr. Shamdeo Persaud, Chief Medical Officer	March 11, 2011 March 15, 2011
Guyana Shield Initiative (GSI) Project	Dr. Patrick Chesney, Chief Technical Advisor	March 11, 2011
Conservation International-Guyana (CI-G)	Mr. Curtis Bernard, Technical Manager Mr. Eustace Alexander, Ecosystem Services Coordinator	March 14, 2011
Transport and Harbour Department - Maritime Administration	Mr. Taig Kallicharran Director of Ports	March 17, 2011
Ministry of Agriculture (MOA)	Mr. George Jarvis, Permanent Secretary Mr. Cecil Seepersaud, Head – Agricultural Project Cycle Unit	March 22, 2011
Resource Persons		
Mr. Joseph Singh	Major General (ret'd)	March 09, 2011
Mr. Ben Ter Welle	Team Leader, GFA Consultancy	March 09, 2011

APPENDIX V – WORKSHOP AGENDA

Direction and Priorities for Invasive and Alien Species Management in Guyana

Wednesday, March 23, 2011
Woodbine Room, Cara Lodge, Quamina St.

WORKSHOP AGENDA

8:30h	Registration	
9:00h	Welcome and Introduction	EPA
9:15h	Background and introduction to IAS: A global issue with local impacts	Mr. Giorgio Muscetta (Team Leader)
9:30h	IAS in South America	Dr. Silvia Ziller
10:00h	Discussion	
10:35 h	**BREAK**	
10:50h	Towards a National IAS Policy in Guyana	Dr. Clare Shine
11:15h	Discussion	
12:00h	**LUNCH**	
13: 00h	IAS Inventory of Guyana I3N Database	Mr. Giorgio Muscetta Dr. Silvia Ziller
13:30h	Possible Components of a National Strategy and Action Plan on IAS - Working Group Discussions	
15:00h	**BREAK**	
16:30h	Close	

APPENDIX VI - REPORT ON THE FIRST NATIONAL WORKSHOP ON IAS

Direction and Priorities for Invasive Alien Species Management in Guyana
Cara Lodge, Woodbine Room, Quamina Street, March 23, 2011.

Opening of Workshop

Dr. Indarjit Ramdass, Executive Director, Environmental Protection Agency (EPA) provided opening statements in which he welcomed the participants and introduced the Consultancy team. He stated that the Consultancy was being conducted within the framework of the Biodiversity Enabling Activity Project, and will assist the Government of Guyana in fulfilling its obligations under the Convention of Biological Diversity (CBD). The outputs of the Consultancy were also mentioned, which includes the preparation of an Assessment Report, an inventory, which defines the profile and distribution of relevant Invasive Alien Species at a national level, Thematic Report, which would be prepared in accordance with the guidelines of the Convention and a Strategy and Action Plan. The Executive Director then wished the participants a productive and successful workshop and declared the workshop officially open.

Objectives

The objectives of the workshop were as follows:

- To identify IAS and their impacts in Guyana and assess strengths and weaknesses of existing legal and institutional frameworks to address related threats;
- To access information needs to inform management activities and identify available regional resources and international partners;
- To identify strategic goals, objectives and anticipated outcomes, and suggest priority actions for the short, medium and long term; and
- To build awareness of IAS threats and solutions with all relevant stakeholders.

The workshop focused on the exchange of national experiences and featured the following presentations:

Direction and Priorities for Invasive Alien Species Management in Guyana - Mr. Giorgio Muscetta

Mr. Muscetta provided an overview of Invasive Alien Species in which he quoted a definition from McNeely *et al.* (2001): IAS are "non-native organisms that cause, or have the potential to cause, harm to the environment, economies, or human health". Further, the Consultant stated that some alien species are dangerous whereas others are not. It was mentioned that IAS can be found in all taxonomic groups and possess the ability to spread rapidly. He also stated that IAS can adversely affect the environment and highlighted examples of negative ecological, social and economic impacts. Mr. Muscetta also described the pathways of species introduction and indicated that species are transported accidentally through Ballast Water. He spokes of methods

of IAS control and elaborated on the Prevention and Quarantine systems.

Managing Invasive Species - Dr. Silvia Ziller, Brazil

Dr. Ziller's presentation described several invasive species and highlighted their impacts on the environment: *Acacia mangium* (wattle) - competes with other plants for resources and inhibits native plants from growing. Its growth can be controlled using herbicide. It is also recommended that native plants be used instead of this species; *Elaeis guineensis* (African oil palm) - this species is native to Congo and it is used for the extraction of oil and promoted for use as a bio-fuel. It is also dispersed by animals. Methods of control include uprooting young plants, and the injection of herbicide into stems and felling; *Achatina fulica* (giant African snail) - The African snail was introduced for breeding as a food source and is currently invasive in twenty three (23) states in Brazil. It is also a vector for two types of meningitis; *Apis mellifera* (Africanised bee) - The Africanised bee was introduced to Brazil to improve honey production. A hybrid between the European bee and the Africanised bee was produced and twenty six (26) queen bees escaped and colonized the continent; *Callithrix jacchus* (white ear-tufted marmoset) - These animals are native to Northeast of Brazil; however they were introduced to the South through trafficking and would compete with birds for resources. *Limnoperma fortune* (golden mussel) – The golden mussel was introduced by ballast water in Argentina. It was stated that they can block the passage of water and corrode pipes.

The Consultant reiterated that there are species that can threaten the economy, culture, health and biodiversity of a country. It was also mentioned that problems that are caused by such biological invasions can be approached using a combined Control. The Combine Control includes: Mechanical Control, Chemical Control, Biological Control, and Restoration efforts. She also elaborated on the importance of capacity building and public awareness on matters relating to IAS.

Towards a National IAS Policy in Guyana- Clare Shine

Clare Shine provided presented on existing international frameworks and stated that Invasive species is a cross-cutting issue. Reference was also made to Article 8(h) "prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species". Clare Shine mentioned that Guiding Principles were adopted to harmonize national and regional actions. The Actions to be taken should include: principles of precaution, prevention, polluter pays and responsibility beyond borders: which includes risk assessment to inform decision-making. Specific goals that that are in line with the Convention were also mentioned. She also discussed pre-border, border and post border prevention measures. The presentation also focused on existing policies, legislation and sectoral instruments as well as challenges and gaps in relation to management of IAS. She stated that public awareness which incorporates information exchange and consultation is critical to curb the risk posed by IAS.

IAS Inventory in Guyana - Mr. Giorgio Muscetta

Mr. Muscetta presented the inventory of IAS to the participants which included the origin of IAS and means of introduction, geographic distribution of IAS in Guyana, threats and impacts and their socio-economic and cultural value. The list includes thirty (30) IAS that currently exists in Guyana. However, he emphasized that this list is subject to modification and can be updated as new information arise.

It was mentioned that the *Eichhornia crassipes* (water hyacinth) was nominated by the Global

Invasive Species Database (ISSG) as being among the top 100 of the world's worst IAS and is not native to the Guiana Shield.
The presence of water hyacinth in Lake Victoria, Africa, adversely affects fishing activities within the area. However, since this species has been recently introduced in Guyana and is apparently not yet widespread, it can be managed.
Echinochloa pyramidalis (antelope grass) was introduced legally as a food source for cattle, however, it was reported that Guyana spend in excess of $GYD 700 Million dollars for the management of the antelope grass. Mr. Muscetta also highlighted the techniques used to control the growth of this grass.
Pterois volitans (lionfish) is an invasive species found in Atlantic and Caribbean waters and requires implementation of a contingent plan as active control to prevent its spread. Mr. Muscetta also indicated that this species can become invasive in Guyana.

I3N Tool for IAS - Dr. Silva Ziller, I3N Lead, Brazil
Dr. Ziller presented on the Inter-American Biodiversity Information Network (IABIN), I3N Database-Tools for IAS, and stated that nineteen (19) countries are currently members of this Network. She also mentioned that there are five (5) Thematic networks: invasive species, ecosystems species and specimens, pollinators and protected areas, of which IAS is the oldest. She also demonstrated the functions and use of the database to the participants (an example may be viewed at http://jamaica.inbiar.org.ar/. The I3N Database is operated and managed at the national level, but uses regional data standards to facilitate information exchange. The database is available from I3N at no cost, and I3N might be able to provide training and support for its implementation in Guyana.

Main issues arising from the presentations
- Previous research was conducted on the invasiveness of *Acacia* species and this information is available upon request;
- Guyana has an advantage compared to some other countries with reference to the management of IAS. The Consultant noted that there are presently many invasive plants located in Georgetown, however these plants are said to be dormant in nature and will pose no major threats to the environment;
- A clause on IAS should be included as a text within the draft Protected Areas legislation;
- There is no "zero risk" and there will always be some form of risk, resulting from the importation of genetic resources into a country, however countries should be responsible about the species they intend to import and should have the appropriate control mechanisms in place;
- *Psidium guajava*, (common guava) can become invasive, however this depends on the ecosystem in which it exists;
- Manatees (*Trichechus manatus*) can be used as a biocontrol agents in their natural distribution range to manage the spread of *Eichhornia crassipes* (water hyacinth);
- *Jatropha* species can become invasive although promoted for biofuels;
- A recommendation was made to expand the list to incorporate bacteria and viruses. The inventory can also include information which addresses the degree of risk and measures taken to reduce this risk; and
- It was mentioned that *Eichhornia crassipes* (water hyacinth), although an invasive species, can be used absorb toxins from the water.

Participants were divided in three working groups which focused on the following topics: (i) co-

ordination and outreach, (ii) prevention, early detection and rapid response, and (iii) legal framework and public policies. Stakeholders were asked to review the outline of the draft Action Plan and indicate comments and suggestions.

Conclusion

The objectives of this workshop were achieved and participants received a greater awareness of the impacts of Invasive Alien Species and the methods of control. Ms. Saheed expressed gratitude to the United Nations Development Programme (UNDP), the Consultancy team, and the participants for making the workshop productive and successful. She stated that the participants' contributions have highlighted and addressed matters regarding implementation and the way forward for this project. She also indicated that the comments and suggestions that were raised by the participants will be incorporated into the final reports.

APPENDIX VII – WORKSHOP PARTICIPANTS

No.	Institution	Names	Designation
1	EPA	Dr. Indarjit Ramdass	Executive Director
2	EPA	Dominique Saheed	Senior Environmental Officer
3	EPA	Oumardatt Ramcharran	Senior Environmental Officer
4	EPA	Joanne Ford	Special Projects Officer
5	EPA	Diana Fernandes	Environmental Officer
6	EPA	Stacy Lord	Environmental Officer
7	G.L.D.A.	Prahesh Mahadeo	Livestock Officer
8	Guyana Forestry Commission	Sumedha Mahadeo	Botanist
9	Guyana Geology and Mines	Kim Goldchild	Environmental Officer
10	Guyana Land & Service Commission	Andrea Mahammed	Senior Land Use Planner
11	Guyana Rice Development Board	Donata McGowan	Research Assistant (Agronomy)
12	Guyana Rice Development Board	Narita Singh	Research Assistant (entomology)
13	Guyana Rice Development Board	Allison Peters	Quality Control Manager
14	Guyana Tourism Authority	Indranauth Haralsingh	Director of Tourism
15	Guyana Tourism Authority	Annarie Shiwram	Product Dev't Officer
16	GuySuCo	Claudette Richard-Haynes	Research agronomist (pests)
17	GuySuCo	Ravindra Persuad	Research agronomist (weeds)
18	MARAD	Geoffrey Babb	Pilot/PSCO
19	Ministry of Agriculture	Ms. Michelle Lutchman	Lecturer
20	Ministry of Agriculture (PHS)	Shamein Moseley	Agriculture Officer
21	Ministry Of Foreign Trade & International Corporation	Aneesha Allie	Foreign Trade Officer
22	Ministry of Health	Dr. Ashok Sookdeo	Director Environmental Health Unit
23	Office of Climate Change Office of the President	Michael E. Brotherson	Senior Foreign Service Office
24	Office of the President	Mr. Le Roy Cort	Cabinet Monitoring Officer
25	United Nations Development Programme	Dr. Patrick Chesney	Chief Technical advisor
26	University of Guyana	Inde McDonald	Lecturer
27	University of Guyana	Mr. John Caesar	Plant Biologist
28	Wildlife Management Authority	Dr. Lennox Applewhaite	Vet Officer
29	Wildlife Management Authority	Adjua Bernard	Scientific Officer
30	WWF Guyana	Janice Bollers	Forest Officer

APPENDIX VIII – VECTORS AND PATHWAYS ANALYSIS TOOL

This tool includes a list of vectors, and species or groups of species potentially associated with each one. Vectors and pathways considered in the I3N database of invasive species are used, and also others from risk analysis systems in USA (NISC, 2005) as well as global revisions (Ruiz and Carlton, 2003). Species are grouped according to the way they are introduced (e.g. "ornamental fish" or "live bait") or to their typical dispersal vectors (e.g. "ants" or "terrestrial snails"). In spite of including groups of IAS of interest for human, animal and plant health and economy, emphasis is given to organisms having potential impact on biological diversity and natural ecosystems, since the former are already considered more widely in current monitoring systems. The list includes vectors and pathways of introduction, as well as others that are more associated with species dispersal within national territories.

This model is available at: http://i3n.iabin.net/tools/web_tools.html

1. NATURAL MEANS

1.1. Rivers and canals
- 1.1.1. Free (plankton, larvae and adults of amphibians and fish, freshwater snails, plants, seeds, algae)
- 1.1.2. Associated with floating vegetation (amphibians, reptiles, mammals, terrestrial and freshwater snails, insects and other invertebrates, plants, seeds)
- 1.1.3. Migratory animals (viruses, bacteria, parasites, seeds, fungal spores)

1.2. Floods and overflowing ponds and lakes (plankton, larvae and adults of amphibians and fish, freshwater snails, plants, seeds, algae)

1.3. Hurricanes and storms (plants, seeds, birds)

2. ARTIFICIAL MEANS

A- ASSOCIATED WITH TRANSPORT

2.1. Terrestrial transport (trucks, trains, rural and road machinery, buses, 4x4 pick-ups, private cars and vans)
- 2.1.1. Mud stuck to wheels and chassis (seeds, fungus, ants)
- 2.1.2. Transported by vehicles (invertebrates in general, land snails, amphibians, reptiles, small mammals)
- 2.1.3. Boats, canoes and other vessels transported by road or rail (invertebrates in general, land snails, amphibians, reptiles, small mammals; bivalves and crustaceans stuck to hulls, motors, propellers, ropes, chains, anchors or trailers)

2.2. Marine and river transport (including barges, passenger boats and private vessels)
- 2.2.1. Ballast water and sediments (plankton, larvae, bentonic organisms, algae, fish, crustaceans, pathogens)

2.2.2. Hulls, anchors and anchor chains (bivalves, crustaceans)
2.2.3. Deck, masts and boat superstructure (invertebrate larvae and adults, amphibians, reptiles and small mammals)
2.2.4. Nets and other fishing apparel (bivalves, crustaceans)
2.2.5. Buoys (bivalves, crustaceans)

2.3. Air transport
2.3.1. Landing gear (reptiles: tree snakes or others that climb, other reptiles e.g. geckos, land snails, plant pathogens, seeds)
2.3.2. Cabin
2.3.2.1. Flying insects
2.3.2.2. Cabin baggage (reptiles, amphibians, mammals, invertebrates and other small pets, seeds)
2.3.3. Cargo
2.3.3.1. Dispatched luggage (small mammals such as rats and mice, amphibians and reptiles, insects, arachnids, land snails, seeds, fungus, plant pathogens)
2.3.3.2. Packaging

B- ASSOCIATED WITH PEOPLE (CREW, PASSENGERS) (viruses, bacteria, parasites, seeds and plant pathogens on shoes)

C- ASSOCIATED WITH CARGO

2.4. Construction timber, cellulose pulp or firewood (Invertebrate larvae, land snails, amphibians and reptiles, seeds, fungus, plant pathogens)
2.5. Fruit and vegetables (eggs and adults of land snails, insects, arachnids, amphibians)
2.6. Soil, stone, sand or rubble (plants, seeds, ants and other invertebrates, amphibians, reptiles, small mammals)
2.7. Packaging (small mammals such as rats and mice, amphibians and reptiles, insects, arachnids, land snails, seeds, fungus, plant pathogens)

D- TRADE OF LIVING ORGANISMS

2.8. Livestock (cattle, goats, pigs, donkeys and horses becoming feral; associated bacteria, viruses and parasites)
2.9. Agriculture (crops, forage species and weeds that colonise natural areas)
2.10. Commercial plantations, windbreaks, roadside trees (conifers, acacias, eucalypts and other tree species that invade natural areas)
2.11. Aquaculture (escaped fish, molluscs or crustaceans; dissemination of viruses, bacteria and parasites)
2.12. Pets breeding (escaped land snails, amphibians, reptiles, birds or mammals; dissemination of viruses, bacteria and parasites)
2.13. Pet trade (sale of invertebrates, amphibians, reptiles, birds and mammals)
2.14. Trade of ornamental plants (plants, seeds, plant pathogens)
2.15. Culture of fish for aquariums (fish, marine and freshwater invertebrates, algae, viruses, bacteria and parasites)
2.16. Live food products (bivalves, crustaceans, fish, viruses, bacteria and parasites)

2.17. Live bait (small fish, worms and other invertebrates, viruses, bacteria and parasites)
2.18. Lombriculture (worms, viruses, bacteria and parasites)
2.19. Game (game birds and mammals, viruses, bacteria and parasites)

E- MAIL (by air, sea, river or overland)

2.20. Packets and envelopes (seeds, bulbs, rhizomes, fungi and other plant pathogens)

F- OTHERS

2.21. Fishing tackle (crustaceans, bivalves, algae, dissemination of viruses, bacteria and parasites)
2.22. Camping equipment (tents and sleeping bags) (seed, fungi, ants and other invertebrates, small mammals such as rats and mice)
2.23. Herding, live animal transport e.g. bees (seed, fungi, bacteria, viruses and parasites)
2.24. Trade by Internet (seed, bulbs, rhizomes, plants, terrestrial and aquatic snails, crustaceans, insects, birds and mammals)
2.25. Scientific research (microorganisms, laboratory animals including invertebrates, fish, amphibians, reptiles, birds and mammals, pathogens)
2.26. Biological control (invertebrates, fungi, pathogens, snails, ants, reptiles, birds, mammals, viruses, bacteria and parasites)
2.27. Fish seeding (salmonids and other fish species)
2.28. Landfill sites (fungi, snails, ants and other invertebrates, plants, seeds)
2.29. Erosion control (plants)

APPENDIX IX – THE BAHAMAS IAS CODE OF CONDUCT TO PROMOTE BEST PRACTICES

(BEST, 2003)

V. Code of Conduct for Government

- Require risk assessment for Government-led or financed plant and animal introductions to ensure that no new harmful species are introduced, intentionally or unintentionally;
- Do not distribute existing holdings of invasive plant and animal species to areas where they can potentially do harm;
- Coordinate and facilitate collaboration in databases, early warning systems, monitoring and other means of preventing invasive plant species problems;
- Lead and fund the development of environmentally sound methods to control harmful invasive plant species, seek control of such species on Crown and other public lands and promote their control on adjacent private lands;
- Develop and promote the use of non-invasive plant species within all Government agencies and to the public;
- Facilitate, lead, coordinate and evaluate public outreach and education on harmful invasive species;
- Encourage public servants and managers to participate in ongoing training programmes on invasive species;
- Foster international and regional cooperation to minimize the risk of import and export of potentially invasive species;
- Develop partnerships and incentive programmes to lessen the impact of invasive species and provide non-invasive restoration materials;
- Provide a forum for regular evaluation of the effectiveness of these voluntary codes of conduct towards preventing the invasive species problem; and
- Enforce existing invasive species legislation at all levels, and enact new legislation where deficiencies occur in existing legislation.

VI. Voluntary Code of Conduct for Botanical Gardens

- Conduct an internal review examining all activities that provide an opportunity to prevent the spread of invasive species and to inform visitors on this issue

- Avoid introducing invasive plants by establishing an invasive plant assessment procedure; This procedure should involve responsible and regular monitoring of the garden site;

- Remove invasive species from plant collections. If for any reason the decision is made to retain an invasive species, ensure its control and provide strong interpretation to the public explaining the risk of the species and its function in the garden;

- Seek to control harmful invasive species in natural areas managed by the garden and assist others in controlling them on their property, whenever possible;

- Promote non-invasive alternative plants or help develop non-invasive alternatives through plant selection or breeding;

- If your institution participates in seed or plant distribution, do not distribute known invasive plants except for bona fide research purposes and consider the consequences of distribution outside your biogeographic region. Consider attaching a statement of caution to species that appear to be potentially invasive but have not been fully evaluated;

- Increase public awareness about invasive plants. Provide information on why they are a problem, their origin, mechanisms of harm and need for prevention and control. Work with local nurseries and seed industries to assist the public in environmentally safe gardening and sales;

- Participate in developing, implementing or supporting regional, national or local early warning systems for immediate reporting and control;

- Participate in the creation of regional lists of concern;

- Become informed about the invasiveness of species within your institution in other biogeographic regions. Compile and share this information in a manner accessible to all;

- Become partners with other organizations in the management of harmful invasive species; and

- Follow all laws on importation, exportation, quarantine and distribution of plant materials across political boundaries. Be sensitive to conventions and treaties that deal with this issue and encourage affiliated organizations (plant societies, garden clubs, etc.) to do the same.

VII. Voluntary Code of Conduct for Landscape Architects

- Work with local plant ecologists, horticulturists, nurseries, botanic gardens, conservation organizations and others to determine what species in your region either are currently highly invasive or show aggressive potential;

- Increase interaction with other professionals and non-professionals to identify alternative

plant material and other solutions to problems caused by harmful invasive plants;

- Take advantage of continuing education opportunities to learn more about the invasive species issue;

- Identify and specify non-invasive species that are aesthetically and horticulturally suitable alternatives to invasive species in your region;

- Eliminate specification of species that are invasive in your region;

- Be aware of potential environmental impacts beyond the designed and managed area of the landscape plan (for example, plants may spread to adjacent natural areas or cropland);

- Encourage nurseries and other suppliers to provide landscape contractors and the public with non-invasive plants; and

- Collaborate with other local experts and agencies in the development and revision of local landscape ordinances. Promote inclusion of invasive species issues in these ordinances.

VIII. Voluntary Code of Conduct for the Gardening Public

- Ask for only non-invasive species when you purchase plants. Plant only environmentally safe species in your gardens. Work towards and promote new landscape design that is friendly to local ecosystems;

- Seek the best information on which species are invasive in your area. Sources could include botanical gardens, nurseries, horticulturists, conservationists and Government agencies;

- Remove invasive species from your property and replace them with non-invasive species suited to your site and needs;

- Do not trade plants with other gardeners if you know they are species with invasive characteristics;

- Request that botanical gardens and nurseries promote, display and sell only non-invasive species;

- Help educate your community and other gardeners in your area through personal contact and in such settings as garden clubs and other civic groups;

- Ask garden writers and other media to emphasize the problem of invasive species and provide information. Request that garden writers promote only non-invasive species;

- Invite speakers knowledgeable on the invasive species issue to speak to garden clubs, schools and other community groups;

- Seek the best information on control of invasive plant species and organize neighbourhood work groups to remove invasive plant species under the guidance of knowledgeable professionals;

- Volunteer at botanical gardens and natural areas to assist ongoing efforts to diminish the threat of invasive plants;

- Participate in early warning systems by reporting invasive species you observe in your area to the relevant authority, i.e. the BEST Commission, Department of Agriculture or the Botanical Gardens;

- Assist garden clubs to create policies regarding the use of invasive species not only in horticulture, but in activities such as flower shows; and

- Urge florists and other to eliminate the use of invasive plant material.

IX. Voluntary Code of Conduct for Nursery Professionals

- Ensure that the invasive potential of plants is assessed prior to introducing and marketing a plant species new to The Bahamas. Invasive potential should be assessed by the introducer or qualified experts using risk assessment methods that consider plant characteristics and prior observations or experience with the plant elsewhere in the world;

- Additional insights may be gained through extensive monitoring on the nursery site prior to distribution;

- Work with local experts and stakeholders to determine which species are either currently invasive or will become invasive. Identify plants that could be suitable alternatives in your area;

- Develop and promote alternative plant material through plant selection and breeding;

- Where agreement has been reached among nursery associations, Government, academia and ecology and conservation organizations, phase out existing stocks of invasive species in areas where they are considered to be a threat;

- Follow all laws on importation and quarantine of plant materials across political boundaries; and

- Encourage customers to use non-invasive plants.

X. Voluntary Code of Conduct for Zoos and Aquaria

- Conduct an internal review examining all activities that provide an opportunity to prevent

the spread of invasive species and to inform visitors on the issue;

- Avoid introducing invasive animals by establishing an invasive animal assessment procedure. This procedure should involve responsible and regular monitoring of the facility;

- Take due care to prevent the release or escape of animals that are known to cause damage as invasives or may be potential invasives;

- Remove invasive species from exhibits or displays. If the decision is made to retain an invasive species, ensure its control and containment and provide strong interpretation to the public explaining the risk associated with the species and its function in the facility;

- If your institution participates in breed stock exchange, do not distribute known invasive animals except for bona fide research purposes and consider the consequence of distribution outside your biogeographic region. Consider attaching a statement of caution to species that appear to be potentially invasive but have not been fully evaluated.

- Increase public awareness about invasive animals. Provide information on why they are a problem, their origin, mechanisms of harm and need for prevention and control;

- Participate in developing, implementing or supporting regional, national or local early warning systems for immediate reporting and control;

- Participate in the creation of regional lists of concern;

- Become informed about the invasiveness of species within your facility in other biogeographic regions. Compile and share this information in a manner accessible to all;

- Become partners with other organizations in the management of harmful invasive species; and

- Follow all laws on importation, exportation, quarantine and distribution of animals across political boundaries. Be sensitive to conventions and treaties that deal with this issue and encourage affiliated organizations to do the same.

XI. Voluntary Code of Conduct for Farms (Agricultural and Aquacultural)

- Ask for only non-invasive species when you purchase livestock or fish stock. If for any reason, the decision is taken to farm invasive species, ensure that they are controlled and contained through appropriate mechanisms, e.g. fencing to prevent escape or breeding with native species;

- Take due care to prevent the release or escape of domestic animals that are known to cause damage as feral animals, e.g. pigs and goats;

- Take due care to prevent the release or escape of livestock or fish stock that are known to cause damage due to their invasive characteristics or potential;

- Seek information on which species are invasive in your area. Sources could include breeders, veterinarians, conservationists and Government agencies;

- Do not trade stock with other farmers if you know that they are species with invasive characteristics;

- Request that breeders and dealers promote and sell non-invasive species;

- Help educate your community and other farmers in your area through personal contact and in such settings as farmers' association meetings;

- Ask writers and other media to emphasize the problem of invasive species and be willing to provide information;

- Invite speakers knowledgeable on the invasive species issue to speak to farmers' association meetings, schools and other community groups;

- Seek the best information on control of invasive animal species;

- Participate in early warning systems by reporting invasive species you observe in your area to the relevant authority, i.e. the BEST Commission, Department of Agriculture or Department of Fisheries; and

- Assist farmers' associations to create policies regarding the use of invasive species in agriculture and aquaculture.

XII. Voluntary Code of Conduct for Pet Stores, Breeders and Dealers

- Ensure that the invasive potential of animals is assessed prior to introducing and marketing an animal species new to The Bahamas. Invasive potential should be assessed by the introducer or qualified experts using risk assessment methods that consider animal characteristics and prior observations or experience with the animal elsewhere in the world;

- Additional insights may be gained through extensive monitoring at your facility prior to distribution;

- Work with local experts and stakeholders to determine which species are either currently invasive or will become invasive. Identify animals that could be suitable alternatives in your area;

- Where agreement has been reached among associations, Government, academia and ecology and conservation organizations, phase out existing stocks of invasive species in

areas where they are considered to be a threat;

- Follow all laws on importation and quarantine of animals across political boundaries; and
- Encourage customers to purchase non-invasive pets or livestock.

XIII. Voluntary Code of Conduct for Pet Owners

- Ask for non-invasive species when you purchase pets. If the decision is taken to own an invasive species, ensure that it is contained and controlled through confinement to your property and reproductive control (e.g. spaying and neutering);
- Seek information on which species are invasive in your country. Sources could include zoos, aquaria, pet stores, ecologists, conservationists and Government agencies;
- Do not trade pets with other pet owners if you know they are species with invasive characteristics;
- Request that pet stores and breeders promote, display and sell non-invasive species;
- Help educate your community and other pet owners in your area through personal contact and in such settings as pet shows, training sessions, visits to the vet and other gatherings involving activities with pets;
- Ask writers and other media to emphasize the problem of invasive species and provide information;
- Invite speakers knowledgeable on the invasive species issue to speak to associations, clubs, schools and other community groups;
- Seek the best information on control of invasive animal species and work with other like-minded individuals to remove these species from your area in an ethical and humane manner under the guidance of knowledgeable professionals;
- Volunteer at zoos, aquaria, national parks and other natural areas to assist ongoing efforts to diminish the threat of invasive animals; and
- Participate in early warning systems by reporting invasive species you observe in your area to the relevant authority, i.e. the BEST Commission, Department of Agriculture or the Animal Control Unit.

XIV. Voluntary Code of Conduct for Veterinarians

- Work with local ecologists, breeders, pet stores, conservation organizations and others to determine what species in your region either are currently highly invasive or show

aggressive potential;

- Increase interaction with other professionals and non-professionals to identify non-invasive animals and other solutions to problems caused by harmful invasive animals;

- Take advantage of continuing education opportunities to learn more about the invasive species issue;

- Identify and specify non-invasive species that are aesthetically and ecologically suitable alternatives to invasive species in your region;

- Eliminate specification of species that are invasive in your region; and

- Encourage breeders and pet stores to provide farmers, private firms and the public with non-invasive animals.

APPENDIX X - SWOT ANALYSIS

STRENGTHS	WEAKNESSES
• IAS inventory list is available and in constant updating; • Guyana has signed international agreements on the matter of IAS; • IAS international experts willing to collaborate; • Some IAS research projects have been carried out in the Country; • Systemic, institutional and individual capacities within and among Caribbean countries has been developed for effective management of IAS; • Recruiting specialised staff would ensure the best use of synergies and technical ability in implementing the IAS Strategy; and • The Guyana IAS Strategy would ensure the best use of existing tools, synergy with other International institutions (European and New Zealand) and structures.	• Lack of knowledge on the ecology and impacts of IAS; • Lack of coordination and follow up among institutions; • No monitoring or early detection systems; • Gaps and inconsistencies in the legal framework; • Lack or deficiency of measures for the control of entry and expansion of IAS; • Lack of educational plans that include the issue of IAS; • Laws, regulations or norms are not applied in an adequate manner; • Awareness about the importance of invasive species issues among relevant policy-makers and other stakeholders is less than adequate; and • Lack of qualified personnel.
OPPORTUNITIES	**THREATS**
• Interest from the media; • Available information technologies for communication; • Interest and cooperation between the stakeholders regarding the IAS issue; • Integration and coordination between the region countries (CARIBBEAN); • The Guyana IAS Strategy could be a model to provide valuable technical support and advice to other countries (French Guyana, Suriname); and • The I3N database represents a good opportunity to improve the knowledge about the IAS in South America.	• Insufficient information to the different sectors on the problem caused by IAS; • Increase in the introduction and dispersion of IAS; • Increase of severe ecological damage due to IAS in the ecosystems; • Greater potential for ecological and economic damage due to the dissemination of IAS; • Increase in commercial movements and transit of people; • The lack of a legal basis would limit the ability to address complex issues such as those involving trade regulations; • Distribution of roles and competencies; • Lack of founding of environmental agencies and personnel exercising regulations; and • Increase in biological invasions in neighbouring countries.