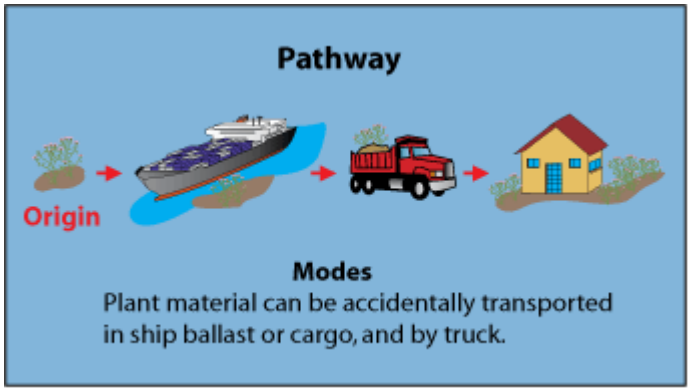
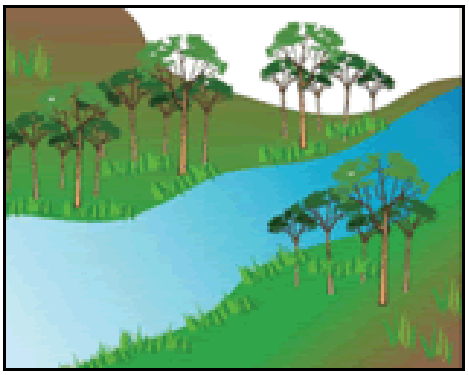
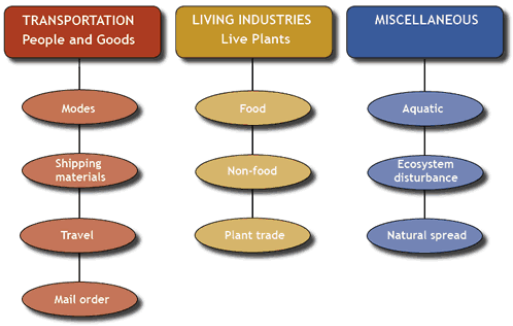
National Invasive Species Strategy for Saint Lucia

PATHWAYS







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Invasive Alien Species (IAS) Pathways: Saint Lucia

by Guy Mathurin

September 2010

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Introduction

This document is produced as part of the development of a National Invasive Species Strategy (NISS) which is being formulated for Saint Lucia under the project "Mitigating the Threat of Invasive Alien Species in the Insular Caribbean". This project is funded by the Global Environment Facility (GEF) and implemented by CABI Bioscience. The aim of this report is to identify possibly pathways by which Invasive Alien Species (IAS) could arrive into Saint Lucia and recommend measures which may be taken to mitigate against them.

INVASIVE SPECIES PATHWAYS

"Pathways", with reference to invasive alien species (IAS) are defined as "routes by which species move from one locale to another, either within a country or between countries" [11]. Natural pathways include wind, sea currents and other forms of dispersal in which a specific species has developed morphological and behavioural characteristics to employ [21]. Man-made pathways are those which are created or enhanced by human activity [21]. Man-made pathways are of two (2) types:

- Intentional – which is the result of a deliberate action to translocate an organism.
- Unintentional – where it is not the intention to translocate an organism [21].

Another definition of "pathway" can be "the *means* (e.g. aircraft, vessel or train), *purpose or activity* (e.g. agriculture, forestry or horticulture), or *commodity* (e.g. timber) by which an alien species may be transported to a new location, either intentionally or unintentionally" [10].

Pathways can also be categorized and broken down into "sub pathways" [4]. Examples of such a categorization and breakdown can be found in the document "*Training and Implementation Guide for Pathway Definition, Risk Analysis and Risk Prioritization*" [4]. Those which are relevant to Saint Lucia are discussed below.

Most of the pathways for the translocation of IAS have been identified and described, but new ones are constantly emerging, as in the case where it was recently discovered and reported that the plastic rings that researchers put on sea birds' legs can transport barnacles from the tropics to Northern Europe [6].

a) Transportation Related Pathways

This category includes all the various pathways related to transportation of people and goods.

Subcategories include:

- **Modes of Transportation**
  Air transportation
  Water/aquatic transportation
  Terrestrial/land

- **Items uses in the shipping process**
  Containers
  Packing or packaging material

- **Mail/Courier companies**
- **Travel/Tourism/Relocation/Recreation**
- **Transportation of heavy vehicles and equipment, including military**

b) Living Industry Pathways

Subcategories include:

- **Plant Pathways**
  Importation of plants for research
  Potting soils and growing media
  Plant trade (nurseries, landscaping, floral)

- **Food Pathways (Transportation of animals for immediate consumption)**:
  Live seafood
  Other live food animals
  Plant and plant parts as food (movement of forage)

- **Non-food Animal Pathways (Transporting animals for reasons other than consumption)**:
  Aquarium trade
  Aquaculture
  Pets
  Non-pet animals
  Release of organisms for religious, cultural or other reasons
  Bait

- **Non-living Animal and Plant Related Pathways:**
  Minimally and partially processed meat products
  Minimally processed plant products

c) Miscellaneous Pathways

Subcategories include:

- **Biological control**
  Release of a species that unexpectedly becomes invasive

- **Other Aquatic Pathways**
  Freshwater rivers, streams and canals
  Marine/estuarine areas and canals

- **Natural spread of Invasive Alien Species**
  Natural migration
  Ocean currents
  Wind patterns
  Unusual weather events
  Climate change

- **Ecosystem Disturbance**

  Long term – highway and utility rights of way, land clearing, logging, construction projects, etc
  Short term – habitat restoration

- **Garbage**

- **Hitchhikers**

- **Hosting of Regional events**

- **Public Health and Environmental Concerns**

REVIEW OF INVASIVE SPECIES PATHWAYS WITH SPECIFIC REFERENCE TO ST. LUCIA

Transportation Related Pathways

Air transportation

Saint Lucia has two (2) airports, the George F. L. Charles Airport (GFL) which is located in northwest Castries and the Hewanorra International Airport (HIA) which is located minutes north of Vieux-Fort. The GFL airport services mainly regional air transport needs and handles passengers, luggage, cargo, animals (live poultry, pets) and animal products, plants and plant products, mail and items transported by courier services. GFL also is a port of entry for smaller chartered international, regional and occasional military flights. The HIA services mainly international air routes and handles passengers, cargo and mail. There are a few inter-island, private and charter flights.

During 2009, the GFL had a total of twenty-two thousand, two hundred and twelve (22,212) flights. There were a total of three hundred and eleven thousand and thirty-five (311,035) passengers, and one million, seventy-eight thousand, nine hundred and four (1,078,904) kilograms of cargo were handled [29, 30].

AIRCRAFT MOVEMENT (George F.L. Charles Airport) – 2009	
Scheduled flights	10,206
Non-scheduled flights	10,186
Other	1,820
TOTAL	22,212

Table 1. Aircraft movement GFL Charles Airport – 2009 [29, 30]

PASSENGER TRAFFIC (George F.L. Charles Airport) – 2009	
Passengers embarked	129,405
Passengers disembarked	119,602
Passengers in-transit	62,028
TOTAL	311,035

Table 2. Passenger traffic GFL Charles Airport – 2009 [29, 30]

CARGO (George F.L. Charles Airport) – 2009 (Kilograms)	
Loaded	393,802
Unloaded	685,102
TOTAL handled	1,078,904

Table 3. Cargo handled GFL Airport – 2009 [29, 30]

During 2009, the HIA had a total of ten thousand and seventy-five (10,075) flights. There were a total of five hundred and fifteen thousand, one hundred and ten (515,110) passengers, and one million, seven hundred and thirteen thousand, two hundred and twenty-five (1,713,225) kilograms of cargo were handled (SLASPA Statistical Digest 2008 – 2009).

AIRCRAFT MOVEMENT (Hewanorra International) – 2009	
Scheduled flights	3,112
Non-scheduled flights	5,998
Other	965
TOTAL	10,075

Table 4. Aircraft movement Hewanorra International Airport – 2009 [29, 30]

PASSENGER TRAFFIC (Hewanorra International) – 2009	
Passengers embarked	229,446
Passengers disembarked	229,819
Passengers in-transit	55,845
TOTAL	515,110

Table 5. Passenger traffic Hewanorra International Airport – 2009 [29, 30]

CARGO (Hewanorra International) – 2009 (Kilograms)	
Loaded	947,851
Unloaded	765,374
TOTAL handled	1,713,225

Table 6. Cargo handled Hewanorra International Airport– 2009 [29, 30]

Air transportation discussion

International air travel has long been recognized as a significant means of moving organisms, including pest species and IAS [40]. Insects, including flies and mosquitoes are regularly found in passenger cabins, cargo and luggage compartments. They, along with other animals, have also been found in wheel bays of aircraft. It is reported that it is relatively easy for human pest and disease pathogens, pests and diseases of agricultural crops and IAS to survive flights of several hours duration [40].

The frontline against IAS at the airports in Saint Lucia includes the Customs and Excise Department Officers, Immigration Officers, Port Authority Workers, Public Health and Ministry of Agriculture (Plant and Animal Health) Officers. They are the personnel who are responsible for identifying the possible entry of any animal, plant or human pests or diseases and other organisms, implementing the provisions of the International Plant Protection Convention (IPPC), the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the Convention on Biological Diversity (CBD), the International Convention for the Prevention of Pollutions from Ships (MARPOL) and any other relevant conventions, bilateral or multilateral agreements. At a National Plant Quarantine Workshop facilitated by the author, it was recently revealed that Customs Officers, Ports Personnel, Ministry of Agriculture and Ministry of Health personnel all needed training in the provisions, requirements and operating procedures of the above-mentioned conventions (National Plant Quarantine Workshop, 26th – 30th July, 2010, Castries, Saint Lucia).

At GFL, a public health nurse is stationed full-time at the port health facility, which was built by the Saint Lucia Air & Sea Ports Authority (SLASPA) to meet requirements for the International Cricket Council (ICC) Cricket World Cup which was hosted in the Caribbean in 2007. At that time there was the fear of a global pandemic of avian influenza (H5N1) and it was believed that the virus could come to the Caribbean via infected fans from countries where the virus existed. Since the building of the facility, which also houses areas for animal and plant health and quarantine, it has never been occupied full-time by plant or animal health/quarantine officers.

An animal/plant health quarantine inspector is based full-time at the HIA. However, he does not work on weekends or allotted time off days. Aircraft are never boarded by the quarantine officer, which should be the first event which takes place after an international flight arrives and the passengers disembark. As it occurs now, after passengers disembark, cleaners board the aircraft to make them ready for return flights. All garbage collected by the cleaners is deposited into the local garbage stream, which ends up in the local landfill. There is no monitoring of the process by public health or animal/plant quarantine.

At the GFL airport, the regional passenger airlines do not stay on the ground for more than 10 – 15 minutes, which makes it difficult (even if an animal/plant health quarantine person was based there) for a quarantine inspection. Also, passengers are almost always on board during the aircraft's time on the tarmac. At either airport, the holds are neither inspected nor treated for any possible human, animal, plant pests or diseases, hitchhikers or possible IAS.

The greatest risk for the introduction of pests and diseases and IAS apart from those carried by human beings and animals, has been found to be in items carried in passenger luggage. Further, the greatest risk in passenger luggage has been found to be in the luggage of persons who are travelling to visit friends and families, or are returning home from vacations [40].

Imported cargo at the airports is not monitored by the public or animal and plant health personnel. Only if animal or plant quarantine products are identified by Customs personnel, then the animal/plant health officers are requested to conduct examinations.

There are no incineration or fumigation facilities at the island's two airports. A newly acquired incinerator has been installed at Roseau, southwest of Castries, near to the old banana research station which was formerly run by the former Windward Islands Banana Association (WINBAN) and is now WINFRESH (just a name, not an acronym). This means that any items confiscated because they present an animal or plant health risk, must be transported inland, through agricultural regions to the incinerator.

Cargo imported by mail or courier services is taken away from the airports and straight to the courier offices without any inspection by the public, animal or plant health personnel. Customs officers are based at those offices and if any plant or animal products show up at the time of their inspections, those personnel are then notified.

A helicopter service based at the GFL airport, transports passengers and luggage between the two airports and conducts island tours. It also provides charter services.

Water/Aquatic Transportation

Saint Lucia has two (2) main seaports: Port Castries and Port Vieux-Fort. In addition, there are two (2) marinas: Rodney Bay and Marigot Bay. There are also sea ports at Soufriere and Cul de Sac. The seaport at Cul de Sac is mainly used for the importation of petroleum products, molasses and aggregate, mainly sand.

Port Castries

Castries Seaport – Container Traffic (TEUs) – 2009		
	TEUs	Tonnage
In	15,055	330,085
Out	15,131	18,248
TOTAL	30,186	348,333

Table 7. Container traffic – Castries seaport, 2009 (TEU = Twenty foot equivalent unit) [29, 30].

In 2009 at Port Castries, approximately four hundred and twenty-seven thousand, three hundred and twenty-six (427,326) short tons (1 short ton = 907.18474kg) of cargo was imported and twenty thousand, two hundred and twenty (20,220) short tons was exported. It consisted mainly of containerized and break-bulk cargo. This figure also includes two hundred and twenty (220) short tons of petroleum products at Port Castries, five thousand, five hundred and eighty-nine (5,589) short tons of molasses at Cul de Sac and (sixteen thousand, five hundred and thirty-eight (16,538) short tons of aggregate at Cul de Sac.

In 2009, there were one thousand and forty seven (1,047) vessel calls to Port Castries. This included cargo vessels, conventional break bulk vessels, container ships, combination ships, product tankers, car and truck carriers, tugs and barges, tugs, cruise ships (regional and international), naval, coast guard and others.

There (in 2009) were three hundred and ninety-seven (397) cruise calls with seven hundred and twelve (712) passengers landed and six hundred and ninety-nine thousand, three hundred and six (699,306) in-transit passengers. There were at least sixteen (16) cruise line companies whose vessels made stops in Port Castries.

Also in 2009, there were one hundred and fifty-three (153) ferry calls with thirty thousand and forty-three (30,043) arriving passengers and twenty-nine thousand, eight hundred and forty-seven (29,847) departing. These ferries were mainly from Martinique, but travelling as far north as Dominica and Guadeloupe.

Port Vieux – Fort

Vieux-Fort Seaport – Container Traffic (TEUs) – 2009		
	TEUs	Tonnage
In	10,782.5	76,089.0
Out	10,973.5	47,404.0
TOTAL	21,756.0	123,493.0

Table 8. Container traffic – Vieux-Fort, 2009 (TEU = Twenty foot equivalent unit) [29, 30].

In 2009, approximately sixty-four thousand, three hundred and seventy (64,370) short tons (1 short ton = 907.18474kg) of cargo was imported and sixty-eight thousand, four hundred and sixty-three (68,463) short tons was exported at Port Vieux-Fort. It consisted mainly of petroleum products, cement, lumber, paper rolls, bananas, general cargo and trans-shipments.

There were six hundred and nine (609) vessel calls to Port Vieux-Fort in 2008. They consisted of cargo vessels, conventional break bulk vessels, container ships, combination ships, product tankers, tugs and barges and tugs. There were no cruise ship calls at Port Vieux-Fort in 2009.

There are no public, plant or animal health personnel stationed at Port Vieux-Fort. If Customs officers intercept any consignment of interest, it is detained and the relevant authorities summoned. Office space had formerly been allocated to plant and animal quarantine, but the area was never refurbished accordingly and was subsequently “re-possessed” by Saint Lucia Marine Terminals Ltd.

Rodney Bay Marina

During 2009, a total of six thousand, one hundred and twenty (6,120) yachts arrived at Rodney Bay Marina. In December 2009, there were an additional two hundred and one (201) yachts which arrived during the Atlantic Rally Crossing (ARC). This is an annual event, with yachts crossing the Atlantic Ocean from the Canary Islands to Saint Lucia every December. The total number of passengers and crew on all yachts for 2009 was thirty-one thousand, nine hundred and ninety-seven (31,997).

Marigot Bay Marina

During the period January to July 2010, there were one thousand, four hundred and thirty-six (1,436) yacht calls to Marigot Bay Marina. The total number of passengers and crew for that period was seven thousand and seventy-three (7,073) (SLASPA Research & Statistics Officer).

There were no figures available from SLASPA for Port Soufriere for 2009.

Water/Aquatic transportation discussion

There is only one animal/plant health inspector from the MALFF stationed at Port Castries. Her office is located at the Ferry Terminal and she is summoned to the other areas of the port by Customs officers when required. She visits the Marigot Bay marina "every other day" and also works at the General Post Office in Castries. There are no other seaports in Saint Lucia where animal or plant health officers/inspectors are based on a full time basis. The Rodney Bay marina is visited by plant and animal health officers from the main Crop Protection and Quarantine Office at Union, Castries, once or twice per week. Whether at Port Castries, Port Vieux Fort or the marinas, these officers only concern themselves with phytosanitary or animal health matters. They are not trained to look out for aquatic alien invasive plants or animals which may enter the sea ports. Hence, there is potential for IAS to arrive into Saint Lucia on ship hulls, navigational buoys, floatation devices, anchors, chains, ropes, and flotsam or jetsam. They may also hitch a ride on containers, pallets, crates, nets, traps, trawls, or other gear associated with the fishing industry and recreational equipment (e.g., boat skis, SCUBA gear, wetsuits, boots, waders, etc.) [12].

Garbage and other waste is normally discharged from cruise ships and other vessels, including yachts. International waste from the cruise ships and other big vessels is handled by the Saint Lucia Solid Waste Management Authority (SLSWMA). The offloading process is sometimes observed by the MALFF officer. The garbage removed from the vessels is transported to the landfills at Deglos, Cul de Sac, or Beausejour, Vieux-Fort. That garbage is required to be "sorted" on board and should not contain any organic material. Garbage from the yachts in the marina is taken off the boats by the crews and then put into a local communal bin at the marina. It is then transported to the landfills. This garbage is not sorted or monitored and presents a very high risk to plant, animal and human health as well as the possibility of the introduction of IAS.

An interview with the Operations Manager of SLASPA revealed that he was not aware of the IAS issue. His department had encountered both live and dead animals in imported consignments of cargo occasionally, but had not thought of them as possibly being invasive in nature. He stated that there were also possibilities of introduction of other animals via the mooring ropes on vessels. He informed the author that although during their day-to-day activities they did not specifically look out for IAS, anytime they saw any dead or live plants or animals, they would halt work and call the "relevant" authorities. He was aware of the issue of ballast water, but was not sure yet what measures were being put in place to manage it. He stated that his department would be willing to work with other collaborating agencies to address the problem of IAS because of their potential threat to Saint Lucia.

The Fisheries Department of the MALFF is aware of the IAS problem. In an interview with the author, the Chief Fisheries Officer stated that her department is very much aware of the IAS issue. They were aware of the problem through their work activities and training. She admitted that not much had been done in the past by her department to address the problem. However, she also stated that her department was now taking part in IAS conferences and workshops addressing the lionfish. It was the intention of her department to include monitoring for IAS in fisheries officers' surveillance activities. Her department was also willing to train plant and animal health officers based at ports of entry, in the recognition and monitoring of IAS and other CITES-related matters.

An interview with the Yachting Specialist at the Ministry of Tourism indicated that they were aware of the IAS problem. He stated that during his tenure as the former general manager of the Rodney Bay Marina, he had done his best to accommodate plant and animal quarantine officers. One of the problems, he stated was the fact that none of the plant/animal health officers were based at the marina on a full-time basis. It was difficult to have passengers and crew comply with measures in the absence of those officers. He admitted that during the "day-to-day" activities of the marina and dry dock, measures had not been sufficiently put in place to mitigate against the threat of IAS through that pathway. The garbage from the yachts was placed in a communal bin and then transported to the local landfill. The scraping from the hulls of yachts was also transported to the landfill or just thrown back into the water. To take care of these issues, he suggested that strict laws be enacted, officers be trained and deployed, the marina workers and public be trained and sensitized. He mentioned that his agency would be willing to work with the IAS project to help train, gather information and sensitize the public on the subject of IAS.

In the Palau National Strategy, reference is made to "blind spots" with respect to the activities of fisher folk, local leisure yachts and the like, who make landings without reporting to immigration, customs or quarantine authorities [24]. This is a normal occurrence at the designated ports of entry and the numerous "unofficial" beaches, bays and coves around Saint Lucia. This is a potential pathway for the introduction of IAS. Reference is also made to "Free Zone Areas", where consignments incoming or outgoing, move without normal port controls and inspections. In Saint Lucia, the Hess Oil Facility and the Beane Field Industrial Park are designated as "Free Zone Areas".

Terrestrial/Land Transportation

Unlike air and water transportation, terrestrial/land transportation in Saint Lucia is confined within the borders of the country. Fortunately, Saint Lucia is protected by the Caribbean Sea and Atlantic Ocean, but this fact does not diminish the impact that terrestrial/land transportation can have with respect to IAS. The main means of terrestrial transportation in Saint Lucia are:

- Car (private, taxi, rentals)
- Minibus (public, private [churches, groups], taxi, rental)
- Container trucks and containers (trucks for hire, private business)
- Pickup vans (private, farmer, rental, transport services)
- Public service vehicles (pickup vans, trucks, jeeps, ambulances, police, fire, ambulance, heavy equipment)
- Utility vehicles and heavy equipment (water, electricity, cable companies)
- Coaster vans (private, taxi, charter)

- Coach (private, taxi, charter)
- Heavy equipment carriers (public ministry, contracting companies, roadworks, construction)
- Motor bikes and scooters (private, rental)
- Bicycles
- ATV's (private and rental)
- Trucks (private, transportation services, rentals)
- Garbage trucks (private, commercial)
- Heavy equipment (construction, road works, rentals)
- Donkey (private and recreational)
- Horse (private and recreational)

The experiences of the plant and animal health services of the MALFF can be applied somewhat to that of IAS. It has been agreed among experts from those fields, that some plant and animal pests and diseases are invasive in nature. After the introductions of the pink hibiscus mealybug (*Maconellicoccus hirsutus*), the Giant African Snail (*Achatina fulica*) and the Amblyomma tick (*Amblyomma* sp.), several public announcements were made urging people from infected/infested areas, not to transport high risk materials to uninfested/uninfected areas. In the case of the Amblyomma tick, actual quarantine areas were demarcated and road signs and posters displayed. It did not take officials long to recognize that, because of the "culture" of the country, it would be virtually impossible to implement such internal quarantines. At several meetings that the author attended, the thought of police assisted road-blocks set up to search for mealybugs, snails, ticks and other pests seemed very "far-fetched". As predicted then, all of these pests/diseases spread island-wide due to human activity and movement of contaminated conveyances and articles. It may be significant to note that the spread of the pink hibiscus mealybug and the Giant African Snail was roughly mapped and found to be closely associated with the road networks in Saint Lucia. That may also be the case of other IAS (especially plants and weeds) present. It is well documented in some countries, that the road networks are a "sub-pathway" for the spread of IAS plants. That is because the verges are usually regularly disturbed and the seeds and other plant parts are carried by human beings, animals and vehicles along those roads [40].

In Saint Lucia, this potential mode of spread for IAS is extremely important and should not be underestimated. All kinds of soil and soil organisms, plants, plant seeds and cuttings, animals (vertebrate and invertebrate) can be potentially spread via the pathway of land/terrestrial transportation and there is little that can be done to stop it, given historical experiences. All of the above-mentioned types of vehicles ply the nation's highways and byways, city, towns, villages, rural communities, farm and forest roads and tracks without a thought being considered for the potential of spreading IAS. It must be stated though, that some members of the public did check their vehicles for hitch-hiking Giant African Snails during the period just after it was reported as present in Saint Lucia (July 2000). This indicated a certain level of awareness and concern.

Construction and roadworks companies from overseas regularly come to work in Saint Lucia. The plant quarantine service is not notified as a matter of routine, to arrange for the inspection of the vehicles and equipment on arrival at the seaports in Saint Lucia. It is therefore possible that IAS could be introduced into Saint Lucia via this pathway.

Items used in the shipping process

Containers:

Sea containers (i.e. 20- and 40-foot intermodal freight or shipping containers) are a significant pathway for the potential entry of IAS and pests, as they are now the most common means of transfer of internationally traded goods and moving personal effects. Insects, snails, other invertebrates and vertebrates may contaminate containers during storage or packing, attracted by odour, light, temperature or humidity conditions. Micro-organisms, seeds and other plant parts and plant debris may be present in contaminating soil, birds' excrement etc. on or inside containers. Some of these organisms may be IAS or pests [33]. The same may apply to air shipping containers although contamination and presence of organisms may be more obvious, since these are handled more closely by airport personnel.

Discussion

Sea containers are not specifically checked for IAS or plant/animal pests and diseases. In many cases, containers arriving into Saint Lucia are taken straight from the ports of entry to the premises where they are unloaded. They are transported all over the island to business places and residential areas before unloading takes place, which means that there is the potential for IAS to be transported with them. A Customs officer has to be present when such containers are opened. If the consignment is agricultural in nature, a quarantine officer also has to be present. There have been instances where exotic insects other animals and storage pests have been found in containers containing non-agricultural commodities and personal effects. Obviously, this presents a challenge for the containment of IAS or plant and animal pests if they were to be found on or in such containers (See Tables 7 and 8). Containers stored at the Castries seaport can be found no more than one metre away from the perimeter fencing, making it potentially easy for IAS to leave the port areas and make their way into the surrounding areas and vegetation.

The International Plant Protection Convention (IPPC) is in the process of creating an International Standard for Phytosanitary Measures (ISPM) which will deal specifically with "sea containers and conveyances in international trade". The Secretariats of the International Maritime Organisation (IMO) and the Convention on Biological Diversity (CDB) are invited to send representatives to sit on the working group which will be responsible for drafting the standard [33].

In the case of air containers, although they never usually leave airport facilities, they may be contaminated especially with insects, because they are usually handled in the well-lit environments of airports.

Packing Material

Packing material which can also be termed "packaging material" is defined as "material used in supporting, protecting or carrying a commodity" (*IPPC ISPM No. 5, 2006*). It can consist of paper, plastic, aluminium foil, bubble wrap, chipboard, foam peanuts, cellophane, corrugated fibreboard and plastic, glass, hessian cloth, jute, straw, plant leaves and stems, polyethylene, peat moss, soil, oasis, saran plastic, wood and many more materials.

Wood packaging material (WPM) is considered as so much of a high risk for plant pests, that a specific standard, ISPM No. 15 – "*Regulation of Wood Packaging Material in International Trade – Revised 2009*", was deemed necessary by the parties to the International Plant Protection Convention (IPPC). It covers wood packaging material such as crates, boxes, packing cases, dunnage (wood packaging material used to secure or support a commodity during transport, but which does not remain associated with the commodity), pallets, cable drums and spools/reels, which can be present in almost any imported consignment, including consignments that would not normally be subject to phytosanitary inspection. It requires the treatment of all WPM by fumigation or heat treatment to rid them of phytosanitary pests, which may include IAS. After the treatment, the WPM is then stamped with the authorised IPPC stamp.

WPM is believed to be the pathway for several exotic plant pest introductions worldwide [40]. There are no regulations specifying the type of wood to be used for WPM and in some cases, bark and portions of vascular tissue may be found on WPM, providing a suitable habitat for some types of beetles [40]. WPM may also consist of one or many different wood species and can be made from fresh cut timber or seasoned lumber. This makes it virtually impossible to know the true origin of WPM [40]. Also WPM is reused and recycled for making more WPM. The presence of WPM does not have to be reported on any manifest and WPM inspected at ports of entry is usually only associated with agricultural commodity consignments although all other consignments often have WPM. Plant pests and diseases (fungi, insects, mites, spiders, weeds, and potential IAS can be found inside and on the outside of WPM. The effectiveness of the required IPPC treatments for WPM are still being studied and it is also possible that such treated wood may become re-infested eventually [40]. The IPPC, with its members, is presently actively looking for new treatments to manage organisms associated with WPM [27].

Discussion

Certain packaging materials are already prohibited from entering Saint Lucia under Plant Protection Regulations (grass, leaves, shag, trash, soil, used bags) due to the possibility of introducing exotic plant pests or diseases [35]. This restriction could also be useful to help prevent the introduction of IAS. Any items containing the above-mentioned materials are usually detained if intercepted by Customs officials and then referred to plant quarantine officers. On a daily basis, WPM (especially pallets and crates) leave the ports of entry for destinations islandwide. There is no regulation of that movement. Pallets can be found all over the island and are usually reused for flooring makeshift bars and stands at public events. They can also be found stacked up outside local bakeries, exposed to the elements. They do present a significant risk for the introduction of IAS and plant pests. Other packing materials are disposed of in the normal garbage stream or recycled for various uses.

Mail/Courier companies

MALFF quarantine officers are usually called to do inspections at mail and courier companies. Plant or animal material or suspect consignments are detained by Customs officials pending examination by the MALFF officers. In most cases, for courier companies, plant and animal material arriving into Saint Lucia is normally covered by import permits. In normal mail this permission is not usually obtained and permit requirements are regularly violated. Consignments include cut flowers, flowers for planting, seeds, herbs (dried and fresh), medicinal herbs, dried floral arrangements, dried herbs and handicraft items. There is a distinct possibility of potential IAS arriving into Saint Lucia via this particular pathway. The greatest risks in mail and courier services are items related to the major crops, landscaping, forests, or IAS which

could become established in those environments [40]. Also (as has been seen in the USA), there is the possibility of mailing human pathogens which are invasive in nature eg. Anthrax.

There are no sorting facilities, x-ray machines or sniffer dogs present at the post offices or courier service companies. Items are chosen for inspection by the contents of the manifest or at the discretion of the postal/courier company workers and/or the Customs officials. There are regular occurrences of wrong declarations on the manifests to try to avoid inspections (personal comm.).

Travel/Tourism/Relocation/Recreation

Invasive alien species can be introduced by travellers to, or spread within a country, in the following ways:

- Purposeful carriage of animals or plants as gifts,
- Intentional carriage of animals and/or plants or micro-organisms for commerce,
- Intentional collection of animals and/or plants or micro-organisms and movement to a another location,
- Accidental carriage of animals or plants or micro-organisms in luggage or on clothing
- Accidental carriage of organisms in soil or other substances present in luggage containers or shoes,
- Accidental carriage of organisms in packing and wrapping materials that are brought with the travelers or sent by post, courier, or as freight [37, 40].

This sub-pathway represents one of the highest risk groups in terms of the spread of IAS and exotic plant and animal pests and diseases. It is reported that over six hundred and fifty million (650,000,000) travellers cross international borders annually [11, 35]. Travellers and tourists may carry plants, seeds, animals for pets, game or agriculture (with their pests/diseases) and human pests/diseases from one country or locale to another. They can also carry on their persons and in their luggage, insect and mite eggs, juveniles and adults, fungal spores, bacteria and other organisms.

Persons actively and purposefully collect plants and plant parts, insects, snails, pieces of wood, soil, sand and other items which may either be IAS or have IAS associated with them [40].

Tourists collect souvenirs from places visited and take them to more places on their vacation and ultimately to their homes. These include plants and plant materials, animals or animal parts, handicraft, soil/sand, and other items which may become IAS if introduced into new areas. Hats made of plant material have been cited as a special concern, because they are worn as people move about and “are at a height where contact with vegetation is easy [40].

Certain microorganisms (eg. the plant pathogen, *Phytopthora ramorum*) are reported to occur more on hiking trails and public lands rather than on minimally disturbed areas [40]. They can be picked up by hikers and spread to other areas. The spores of fungi, nematode cysts and weed seeds can be picked up by hikers and persons who participate in outdoor activities. They may remain viable for long periods of time in dry soil or on clothing and shoes. The same applies to the gear used for recreation (rafting, hiking, mountain climbing, rain forest and jungle excursions and water sports (diving, snorkelling, fishing, etc.) [40]. Weed seeds with adaptations to hook onto animal fur (thus, human clothing) have been found on jackets, cuffs, socks, bags, seams, Velcro and other parts of clothing [40].

Tourists who take cruise vacations in the Caribbean, visit a number of different destinations during a very short time period. It is possible that they can carry viable IAS from one destination to another that is also suitable for the survival of the IAS [40]. This is especially important because cruise passengers often take tours to pristine areas at the destinations and they also visit the local markets.

Even if the tourist and travellers do not vacation or participate in outdoor activities outside of their national boundaries, they, their vehicles and gear could be responsible for the internal spread of IAS.

The food which is served on international flights and cruise ships is usually bought and prepared in one country and served en-route to, or in other countries. The left-overs and scraps which can contain or habour IAS-contaminated materials, is usually disposed of by various means in the destination countries or locales. In Saint Lucia, those organic leftovers and scraps are not landed from cruise ships. They should be held in a storage tank, ground and disposed of on the "high seas". From aircraft those leftovers and scrap join the domestic garbage stream and end up in the possession of the cleaners or in the landfills.

Discussion

Customs officers routinely stop travellers who carry plant and animal materials in their luggage. It's harder to detect micropopagules of plant, animal and human, pests and diseases. However, because of the recent threats by avian and swine influenza, public health officials have been occasionally monitoring travellers for symptoms of illness.

In the case of persons returning home to live from overseas and workers coming to Saint Lucia to work for a while, not all baggage and cargo in their personal effects are inspected. It is safe to assume that potentially invasive plants and animals and their parts and microorganisms may enter the country on a regular basis via this route.

Scanners have been deployed at several ports of entry, but they are not being utilised to inspect passenger baggage, apart from "carry-on" items. In fact, some of them have become obsolete without ever having being used. This is evident at the Ferry Terminal, for example.

This sub-pathway can be considered high risk for the spread of unwanted organisms and a huge amount of reliance on the knowledge and actions of the public is necessary to prevent that spread.

Transportation of Equipment and Military Vehicles

Saint Lucia has been the recipient of donor assistance from countries who sometimes deploy construction personnel, including engineers, workers and military personnel. They undertake projects including the renovation of existing facilities or construction of new ones. In most cases, these groups bring along their own equipment and supplies (tents, food, machinery, tools, medicines, etc.). Plant and animal health personnel are not, as a matter of routine, notified so as to require the inspection of the imported items as in most cases, they are given diplomatic clearances. There is a possibility for the introduction of IAS via this pathway. However, on one occasion, the author observed a military unit cleaning all their heavy equipment and tools prior to their departing Saint Lucia and returning to the USA. Hopefully, that was also done prior to them leaving their last assignment location for Saint Lucia.

LIVING INDUSTRY PATHWAYS

Plant Pathways

Importation of plants for research

In Saint Lucia, cultivars of bananas have been introduced for research purposes and eventual adoption as part of assistance to farmers in the search for improved varieties, enhanced and efficient production. Before 1995, this was done by the Windward Islands Banana Association (WINBAN) whom spearheaded such research. The Caribbean Agricultural Research & Development Institute (CARDI) have also brought in new varieties of agricultural crops such as sweet potatoes (*Ipomea batatas*), yams (*Dioscorea* spp. and hot peppers (*Capsicum annuum*). The introduction of the sweet potato weevil (*Cylas formicarius*) into Saint Lucia, may have been linked to such an introduction.

Since 1995, other plants and plant parts have been imported and introduced into Saint Lucia including sweet potatoes (*Ipomea batatas*), orchids (various species), bananas (*Musa* spp.), dragon fruit (*Hylocereus undatus*), wax apple (*Syzygium samarangense*), Jatropha for biofuel (*Jatropha* spp.) and very little formal, if any research has been done with these plants. In fact, some of these plants or plant parts may have been introduced against the advice of the Crop Protection Unit, MALFF. Concern has been about the possibility of them bringing in new plant pests and diseases and invasiveness.

Potting soils, growing media

Potting soils and media are regularly imported into Saint Lucia under permit from the Crop Protection and Quarantine Unit – MALFF. In most cases they are imported commercially and usually comply with phytosanitary requirements. Samples, however are not taken regularly to verify freedom from possible pests/diseases and IAS.

Plants in potting soils and media are also imported as part of personal effects by persons returning to Saint Lucia, or coming to live in Saint Lucia as residents. In these cases the potting soils and media may enter the country without the required permits and/or treatments. Customs officers are usually the first officials to detect such items in consignments and usually detain them for inspection by MALFF quarantine officials.

Plant Trade (nurseries, landscaping, floral)

Plants for planting are regularly imported into Saint Lucia. They include roses (bare-rooted) (*Rosa* spp.), anthurium lilies (*Anthurium* spp.) and orchids (from tissue culture). In most cases, they meet phytosanitary permit requirements and are required to be sourced from reputable nurseries in Europe and Asia. Plant Quarantine Service – MALFF, informed the author that “invasiveness” is also one characteristic which is evaluated before plants for planting can be given permission to be imported. Inspection by plant quarantine officials at ports of entry is also required before consignments can be cleared.

Enthusiast gardeners request permits to bring exotic plants into Saint Lucia. In many instances permission is denied because the importer cannot provide sufficient detail regarding the plant health history of the plants in their countries of origin. The Plant Quarantine Service – MALFF has had several experiences where containers of plants for planting as part of landscaping projects have been imported into Saint Lucia without the required phytosanitary clearance. Upon opening these containers, apart from soil, live insects, spiders and reptiles have been found. The contents of those containers had to be returned to the country of origin or incinerated.

Nurseries, including the MALFF-run one, also indicate interest and request phytosanitary permits to import exotic plants and plant parts to be sold and introduced into Saint Lucia.

Cut flowers are imported into Saint Lucia on a weekly basis. Among the flowers imported are: roses (*Rosa* spp.), orchids (various species), daisies (*Bellis simplex*), oriental lilies (*Lilium auratum*), Asiatic lilies (*Lilium asiatic*), Alstroemeria (*Alstroemeria psittacina*), chrysanthemums (*Chrysanthemum morifolium*), gladiolus (*Gladioulus* spp.), solidago (*Solidago* spp.), baby breath (*Gypsophila paniculata*), statice (*Limonium leptostachyum*), calla lilies (*Zantesdeschia aethiopica*), pin cushion (*Scabiosa atropurpurea*), fern leaf (various species).

The Plant Quarantine Service – MALFF is sometimes under severe pressure to conduct pest risk analyses (PRAs) to determine whether some of these plants or their parts can be imported into Saint Lucia. In more developed countries, there are entire units of experts with the responsibility to conduct these PRAs. In Saint Lucia, it is usually down to one or two staff and a decision is usually required rapidly. Additional parameters to be analysed now include economic impact, invasiveness and Living Modified Organisms (LMOs). Many times, official plant health information required to be obtained from countries where intended plant imports originate is not easily obtainable.

Due to manpower limitations, the inspection of most of the consignments of imported plants is not thorough and few samples are taken for further analysis in the laboratory (nematodes, pests, diseases, etc.). Because many pests and diseases including IAS are microscopic and they may exist inside the host material, the majority escape detection at ports of entry. Detection is usually based on symptoms expressed and there are many instances where plant quarantine officers could encounter symptomless hosts, or alternate host plants and plant parts. Microscopic mites on plant and animals and their products normally escape detection by inspectors at ports of entry [40]. Even if samples were taken to the laboratory for diagnostic purposes, the manpower and time required to conduct such diagnoses would not be feasible for perishable consignments. No post-entry plant quarantine facilities exist in Saint Lucia.

The IPPC is presently considering a draft ISPM entitled “Integrated Measures Approach for Plants for Planting in International Trade. The draft contends that there are problems with the present phytosanitary regulatory approach for plants, plant pests and diseases in international trade. These problems include: i) the volume of trade is too great for inspection, ii) it addresses risk with known plant pests/diseases, whereas most pests and diseases introduced with plants for planting were previously unknown and iii) the IPPC prohibits phytosanitary measures against “unknown” pests. This draft ISPM recommends a “systems” approach which guarantees that plant for planting in trade are free from all plant pests and diseases, known and unknown. This approach, it claims, would reduce the global spread of plant pests and diseases, some of which are IAS [38, 30].

At least one invasive aquatic plant, the Water Hyacinth (*Eichhornia crassipes*) is listed as present in Saint Lucia [43]. The pathway of arrival can only be speculated upon.

Food Pathways (Transportation of animals for immediate consumption)

Live seafood

The Veterinary and Livestock Services Division – MALFF, informed the author that **no** live seafood is imported into Saint Lucia. It is imported either fresh-chilled, or frozen. All consignments must have been granted an import permit prior to import and are inspected by veterinary officers at ports of entry, or on importer premises in the case of container shipments. These inspections are done alongside officers from the Ministry of Health (Public Health Division). Is it possible that because of the increasing numbers of foreign national residents in Saint Lucia, a market for the importation of live seafood may emerge?

Other live food animals

Other live food animals normally imported are goats, sheep, rabbits, day old chicks and hatchling eggs. Apart from day old chicks, the other importations do not occur on a regular basis.

Between January and December 2008, ninety-three thousand and forty (93,040) broiler and layer chicks were imported from Barbados (Source: Livestock & Veterinary Services Division, MALFF).

Plants and plant parts as forage

Dr Auria King, MALLF Livestock & Veterinary Services Department officer informed the author that no forage was imported into Saint Lucia. Occasionally improved forage seeds are imported for research purposes. These seeds were "certified" and are sown in a "forage bank". She was not aware of any instances where forage grasses had "escaped" from forage banks and had become invasive. Under plant quarantine regulations all grasses, except for certified seed, are prohibited entry into Saint Lucia. The MALFF does have the authority to import such normally prohibited plant material for research purposes [35, 36].

Non-food Animal Pathways (Transporting animals for reasons other than consumption)

Aquarium trade

"The pet/aquaria trade has been identified as a substantial source of potentially invasive species; escaped or released pets and aquaria species can predate upon, compete with, or spread diseases and parasites to native wildlife. Aquaria dumping and water gardening can also be sources of invasive plants [33].

The Livestock & Veterinary Services Department, MALFF reported that several species of fish, including swordfish (*Xiphophorus helleri*), goldfish (*Carassius auratus*), cories (*Corydoras* spp.) and freshwater turtles – the red-eared slider (*Trachemys scripta elegans*), are imported into Saint Lucia as part of the aquarium trade. The management of the only pet store in the island and the Livestock and Veterinary

Services Department confirmed that no aquatic plants are imported. The Fisheries Department, MALFF reviews the applications for importation of aquarium species. Risk analyses are performed based on country of origin and disease status of that species and their relatives in the country of origin. On arrival at ports of entry, any approved species must be inspected by the Veterinary Services and Livestock Division prior to entry.

Aquaculture

Different tilapia species are reported as having been introduced into Saint Lucia as early as the 1950's. There are several verbal accounts of *Tilapi nilotica* and *Tilapia mossambica* being imported into Saint Lucia from Jamaica at that time. They were reportedly imported and introduced into several rivers. Officers from the Fisheries Department, MALFF could not confirm this.

In the 1990's there was also an "Aquaculture Programme" spearheaded by the MALFF, where farmers were encouraged to build ponds on their properties. Tilapia and freshwater prawns were imported and distributed to farmers. Some of those Tilapia and prawns may also have been introduced into rivers on the island. In Saint Lucia if any "aquaculture" species is introduced, it would be extremely difficult to regulate the movement and transfer of those species from pond to pond and possibly, into fresh water canals, streams and rivers. The Fisheries Department mentioned that this is an educational topic usually covered with aquaculture farmers and enthusiasts at exhibitions and during field visits. Six hundred (600) tilapia were imported from the Dominican Republic into Saint Lucia between January and December 2008 (Source: Livestock & Veterinary Services Division, MALFF).

Pets

Pets (dogs, cats, horses, hamsters, budgies) are all regularly imported by residents and the pet store in Saint Lucia. For the importations to take place, applicants must have an import permit from the MALFF and a health certificate from the country of origin. In some instances macaws are also imported and apart from Veterinary and Livestock Services requirements, they have to meet CITES and Forestry Department (Wildlife) specifications. It is widely believed that some pets, especially parrots, cats and dogs and lately, monkeys are imported illegally. For example "pit-bull" dogs are found in all communities and they are officially illegal. Those illegally imported pets present a formidable risk as a pathway for the introduction of IAS, including their related pests, diseases and parasites.

In the Palau National Strategy, it is reported that imported animals, especially ruminants and herbivores could be a pathway for invasive weed seeds. Animals to be imported into Palau, should be fed weed-free feed for a period of time before they are exported from their country of origin [24].

The highest risks for the introduction of IAS along the aquarium and pet pathway according to the Pet Industry Joint Advisory Council and the Global Invasive Species Programme were "likely to be associated with:

- Consumers
- Non – regulated direct sales
- Free or inexpensive pets
- Species which grow large, reproduce easily and in large numbers in captivity, have specialized dietary or other husbandry requirements, have aggressive temperaments and

- Species ecologically suited to the geographic region in which they are maintained as pets" [33].

The management of the local pet store stated that their pets (hamsters and budgies) were unlikely to be invasive in the wild because the conditions for them to feed and breed successfully would not be met. According to them for example, the budgies would need a specific kind of seed for feed not available in the wild and would starve. The hamsters and especially their young, would be attacked by other rodents and ants. The fish and the turtles imported for aquaria would not have conditions in local rivers and streams suitable for their survival and eventually, becoming invasive in Saint Lucia. However, the red-eared slider turtle (*Trachemys scripta elegans*) is reported as being invasive in some countries and in Australia, heavy penalties may be imposed on persons caught with them as pets (from Wikepedia).

COUNTRY	Broiler Chicks	Layer Chicks	Cat	Hatching Eggs (Dozens)	Aquarium Fish	Dogs
Barbados	32,000	5,900				2
USA	158,300	17,450	4	22,360		6
Trinidad					4,592	
Martinique						1
UK						1
TOTAL	**190,300**	**23,350**	**4**	**22,360**	**4,592**	**10**

Table 9 – Live Animal Imports, 2009 (Source Livestock & Veterinary Services Dept. MALFF).

Release of organisms for religious, cultural or other reasons

The Livestock Services & Veterinary Division and the Forestry Department – MALFF, reported that animals were not imported into, or released in Saint Lucia for religious, cultural or other reasons.

In 1992 an elephant was imported into Saint Lucia by Mr. Colin Tennant, also known as Lord Glenconner (UK Independent Newspaper, Obituaries 31st August, 2010). It lived in the Soufriere area at Jalousie Estate and died in 1994.

Roosters are imported into Saint Lucia for "cock-fighting" via both legal avenues and "blind spots" (personal comm).

In the last twenty (20) years, there has been at least one travelling circus to Saint Lucia which included several types of animals including big cats.

Bait

According to officers of the Fisheries Division and the Veterinary & Livestock Services Department – MALFF, no live animals are imported into Saint Lucia to be utilized as bait.

Non-living Animal and Plant Related Pathways

Minimally and partially processed meat products

The Livestock and Veterinary Services Department, MALFF and the Ministry of Health (Public Health) oversee the importation of minimally and partially processed meat products. Sausages, burgers and other meat preparations for the franchises (Burger King, Dominoes Pizza, Subway, etc.) are usually pre-cooked in the United States at special franchise-owned facilities. These have to be pre-cooked at certain temperatures and for certain lengths of time and certified as having been so done before they are imported into Saint Lucia. The standards set by the World Organisation for Animal Health (OIE) and Codex Alimentarius are the ones applied.

Products such as milk and cheese have to be pasteurized before they can be imported into Saint Lucia. No raw milk or cheese is permitted to enter Saint Lucia.

Travellers usually bring cooked meat products into Saint Lucia. Depending on the country of origin, the Veterinary & Livestock Services Department and the Ministry of Health (Public Health) may grant permission for these to enter Saint Lucia.

Minimally processed plant products

Plant products are sometimes “minimally processed” before they are imported into Saint Lucia. This “minimal processing” can range from the defoliation or removal of leaves from stems (in the case of fresh herbs and cut flowers, to drying (in the case of dried herbs, floral arrangements, hats, other outer wear and souvenirs), to varnishing and painting (in the case of furniture and craft items). Many of these items, which are often imported without the required permits, may harbour plant pests and diseases and may also present a risk of introduction of alien invasive species. Such items and consignments are supposed to be detained by Customs officers at ports of entry for inspection by plant quarantine officers. The disposition of these items, if detained, can range from removal of leaves, seeds and other parts capable of propagation, to fumigation for possible wood-boring insects and forestry pests, return to country of origin, or confiscation and incineration.

Other processed plant products which undergo processing such as cooking, canning, pickling and baking are not considered plant health risks and therefore do not require inspection by plant quarantine officers. There is however, concern on plant products which have been dried and may contain pests such and mites, seed borers and other stored product pests not yet reported as being present in Saint Lucia.

Miscellaneous Pathways

Biological control

Saint Lucia has had the experience of importing organisms to effect biological control of a species. After the introduction and establishment of the Pink Hibiscus Mealybug (PHMB) (*Maconellicoccus hirsutus*) into Saint Lucia in 1996, the MALFF imported the ladybird beetle (*Cryptolaemous montrouzeiri*) and the

parasitoid wasp (*Anagyrus kamali*), for the biological control of the PHMB. The effort was very successful and thus far, no reports of invasiveness for any of the imported organisms have been reported. However, no related studies have been done in Saint Lucia.

In the 1980's, entomologists introduced parasitic (parasitoid) wasps into Saint Lucia to control insect pests of agricultural crops. The sugarcane borer (*Diatraea sacchari*) and the Diamond back moth (*Plutella xylostella*) were two of these pests. The releases were done by several entomologists including Dr. Munir M. Alam [41], who worked with CARDI at the time. The fate of these parasitoids is yet to be studied. Attempts have also been made to control the coconut mite *Aceria guerreronis* using a fungus, *Hirsutella thompsonii*. Several strains of *Bacillus thuringiensis* are also available in commercial formulations for the use against lepidopteran pests.

Other Aquatic Pathways

Freshwater rivers, streams and canals

Conversations with senior officers of the Fisheries and Forestry Departments and Veterinary & Livestock Services Department of the MALLF revealed that little or no work is presently being done with respect to monitoring the freshwater rivers, streams and canals for IAS. All of the officers were aware of the impacts which could result from the introductions of IAS, as gained from knowledge in training and information available on the job from various sources (journals, meetings, workshops, etc.). It was generally agreed that inventories of all of these habitats need to be conducted in earnest. However, it was also recognized that any damage which may have resulted from the presence of IAS in those habitats may have never been documented. All of them indicated that they were interested in such research projects, but lacked the capacity (human and financial resources) to address them presently.

There are no measures in place presently to prevent the introduction of IAS into rivers, streams and canals by the local populace.

Marine/estuarine areas and canals

The situation which applied for freshwater rivers, streams and canals also applies to marine/estuarine areas and canals. There have been some unofficial reports of algal blooms reaching our shores and also dead fish sightings which may have been caused by such phenomena. Occasionally, persons complain of sicknesses, rashes and earaches which may have been brought about by organisms drifting in sea currents or released in ballast water. Since these possibilities are not monitored, it would be difficult to confirm. There used to be a "Coastal Zone Management Committee" which included personnel from the Ministries of Tourism, Health, Physical Planning and Agriculture. One of their main functions was to test waters in close proximity to popular beach areas for fecal matter and other organisms potentially harmful to human health. This committee has since become inactive. Presently, there is at least one site (Port Castries) in Saint Lucia where raw sewage is deposited directly into the sea.

Natural spread of Invasive Alien Species

Natural migration

It was stated that humans have "ascended" to the principal agent of dispersal of organisms, including IAS [38]. Since we achieved that "distinction", the "the comparative orderly flow and ebb of natural migration has been disrupted". Human activity has caused long distance dispersals of organisms to become commonplace and thus, it is hard to determine whether the arrival of an IAS, human, animal or plant pest or disease, has been caused by natural forces or human activity [38].

There have been several introductions of plant pests and diseases into Saint Lucia which were invasive in nature and are suspected to have arrived on island by "natural" spread. Some of the more recent examples include:

- Eriophyid Mite of Coconut (*Aceria guerreronis*) – 1980 (across the Atlantic Ocean by wind)
- Pink hibiscus mealybug (*Maconellicoccus hirsutus*) – 1996 (throughout the Caribbean by wind)
- Gliricidia moth (*Azeta repugnalis*) – 2001 (throughout the Caribbean by wind?)
- Red Palm Mite (*Raoiella indica*) – 2004 (throughout the Caribbean by wind?)
- White cedar thrips (*Holopothrips iniquilinus*) – 2007 (throughout the Lesser Antilles by wind?)
- Black Sigatoka (*Mycosphaerella fijiensis*) – December 2009 (throughout the Caribbean by wind?)

Disease spread has been reported as strongly linked to weather events with diseases like Asian Citrus Canker bacterium *Xanthomonas axonopodis* pv. *citri* increasing in distribution in Florida, USA immediately after hurricanes in 2004 – 2005 [40].

There is no doubt that weed seeds, small arthropods, fungal spores, mites and other microorganisms can be spread to and throughout the Caribbean via wind patterns and weather events such as hurricanes [40]. Even if the IAS was not at first introduced into the region via wind, it can be subsequently spread along that pathway.

There are two (2) potential IAS projects on which the Forestry Department is presently working viz., the Ivy Gourd vine (*Coccinia grandis*) and the Central American Iguana (*Iguana* spp.). They both present challenges in terms of resources for public awareness and staffing to assist in the desired eradication attempts. Meanwhile, both of those IAS they are reported to be spreading in their distribution areas (personal comm.). The Ivy Gourd may be spreading due to human activity, seeds and vegetatively, in addition to the aggressive nature of the vine. The Iguana is spreading under its own power, although human activity is responsible for introducing it into Saint Lucia in the first instance.

The movement and spread of other IAS, including plant pests and diseases are not well documented. The Forestry Department has been able with the assistance of this project, to compile a draft list of IAS. Some animals and/or their pests and diseases which are invasive in nature may be easier to document as in the case of the Amblyomma tick (*Amblyomma* spp.). This also applies to invasive human pests and diseases likes Swine or Avian influenza.

Ocean currents

Ocean currents move countless species of plankton and other marine organisms around the globe. With the warming of the oceans due to climate change, it is expected that sea levels will rise. This may flood existing mangrove areas, killing the mangroves and creating the opportunities for invasive sea grasses, weeds and other organisms to move in [42]. Algae is known to be moved by ocean currents and scientists have observed that algae from temperate areas which were strongly seasonal, are now moving into tropical areas and reproducing throughout most of the year [42]. Additionally, because of the melting of ice caps in the arctic regions, new channels have been opened up, allowing organisms to spread from the Pacific Ocean to the Atlantic Ocean in currents [42]. These organisms some of which have invasive properties could cause problems such as species extinction through direct competition and also biodiversity loss. As a small island whose coast provides a livelihood for communities, the fishing and tourism sectors, Saint Lucia could be negatively impacted by invasive alien marine organisms via this sub-pathway.

Coconuts, other plants and plant parts and other organic materials are known to travel around the world via ocean currents.

Wind patterns

The winds in Saint Lucia approach the island primarily from the northeast and east. From December to June they are called the "north-easterly tradewinds". From June to November, the winds may originate off the coast of Africa accompanied by tropical waves which may become hurricanes, or westerly from Central and South America. It is documented that many microorganisms are moved actively or passively via wind currents [40]. At least one or two plant pests are suspected to have arrived into Saint Lucia and the Caribbean region via wind currents for example, the Eriophyid Mite of Coconut (*Aceria guerreronis*) – 1980. The African Desert Locust has arrived in the Caribbean on more than one occasion. Hurricanes have circular wind patterns and may be responsible for the spread of several invasive plant pests and diseases that have the morphological adaptations for that mode of spread. Examples are the red palm mite (*Raoiella indica*) and black sigatoka (*Mycosphaerella fijiensis*) of bananas and plantain. Since it has happened before, possibilities exist that new IAS will be introduced via wind currents.

Unusual weather events

In Saint Lucia, weather patterns are more or less, consistent with defined dry and rainy seasons. The last unusual weather event in my opinion, was the tropical storm "Debbie" on 10th September, 1994. Almost 10 inches of rain fell in less than twelve hours (National Emergency Management Organisation, Wikipedia). Persons were killed, landslides and land slippages occurred. There was widespread flooding and an interruption of the pipe-borne water supply. It is possible that such unusual weather-related events could spread invasive plants and weeds, nematodes and plant and animal pests and diseases via flood waters. Interruption to a clean water supply could also help create a suitable environment for the rapid spread of contagious human diseases. The only other unusual weather pattern in Saint Lucia occurs sometimes during the month of January when the night time temperatures could drop to approximately 65 degrees Fahrenheit.

Climate change

Climate change although with its skeptics, is predicted to have many environmental consequences which will include changes in the present habitat ranges of species of animals, plants and microorganisms. FAO states that "climate change may produce more favourable conditions for invasive species". They predict that due to climate and environmental changes, once dominant native species will be replaced by newly arrived alien invasive species. Global trade patterns may change and also mentioned are the effects of increased greenhouse gases [37].

In Saint Lucia, it is predicted that there will be more prolonged droughts and intense hurricanes, along with the loss of present coastal areas due to rising sea levels. These events may create favourable conditions to plants, animals and microorganisms more suited to the resulting environment along with alien invasives arriving on island due to human activity and natural phenomena.

Ecosystem Disturbance

Long term – highway and utility rights of way, land clearing, logging, construction projects, etc

Recent major roadworks in Saint Lucia included the construction of the east coast road, the construction of the west coast road and the widening of the Castries – Gros Islet Highway from the Choc Junction to John Compton Highway. The equipment brought in from overseas for these road projects was never inspected by plant health officials to determine if they were contaminated with soil and weeds, etc. If they were contaminated it is likely that potential IAS could have been introduced. Local weeds and plants of an invasive nature could have been facilitated by the road works and the movement of equipment along the routes being constructed.

The island's electricity supply company erected some pylons island-wide to carry high tension/voltage wires to various locations island. The vegetation under those lines was removed and it is possible that plants invasive in nature have replaced the original vegetation.

Land clearing, including logging have long been sore points for the MALFF. Some farmers use the "slash and burn" method where all vegetation, including trees is felled and when they dry up, fire is set to them. This usually leaves exposed land where food crops are supposed to be planted. This technique was especially prevalent in the early days and peak of the banana industry. Weeds species which favoured the new habitat quickly invaded the exposed areas, sometimes resulting in an additional cost to banana production. In other cases the cleared land was never planted and invasive weeds quickly replaced the original vegetation. This method of land clearing was also blamed for landslips and landslides during or after periods of heavy rainfall.

Construction projects, which have to be approved by the Development Control Authority (DCA) of the Ministry of Physical Planning, have in some instances not been completed. In some cases, the land may be cleared prior to the beginning of the construction and landscaping phases of development. If for economic or other reasons, the development has to be halted as is the case in several recent projects, the land area is subject to opportunistic invasive species of plants.

Short term – habitat restoration

As persons become more aware of the impact of IAS in Saint Lucia, especially through this project, it is hoped that efforts will be initiated to select IAS to be eradicated from vulnerable habitats. Efforts to remove certain IAS (rodents, for example) on some of the islets off the east coast have been successful. The rodents posed a threat to endemic reptiles and nesting endemic and migratory birds. Repeats of such success on the main island for invasive plants and animals will be more challenging on several levels (education, manpower and funding) and will require the efforts of whole communities.

Garbage

Until fairly recently, all garbage in Saint Lucia was disposed on in open air "rubbish dumps" where people and animals had fairly easy access to them. This practice may have resulted in the spread of IAS to other areas of the country. Biomedical waste and plant and animal health waste and confiscations were also disposed of at the same locations, after which they were set on fire. It was not unusual, especially in the case of disposed plant material, to return to the scene of the fire to find persons actually trying to put out the fires and remove the plant material. It is very likely that they were sometimes successful in their attempts, resulting in the possible movement of pests and diseases and IAS.

With the formation of the Saint Lucia Solid Waste Management Authority (SLSWMA) in October 1996 and the introduction of garbage disposal by way of the "sanitary landfill", much better control of garbage after it had been disposed of by residents and business establishments was effected. The garbage is usually buried in the landfill and the area is secured. It has also resulted in much less burning and pilferage of previously dumped refuse.

Garbage disposed of at the landfills is transported from business and residential locations island-wide. There is limited sorting of garbage, except for bulk (old fridges, washing machines, freezers, etc.) items which are usually collected once per month. The vehicles used to collect and transport the garbage range from used specialised garbage trucks with compacters, to open vans and trucks. In the case of the used garbage trucks which are imported, they usually leak liquids from the garbage from where it is picked up, all the way to the landfill. During a national quarantine course (July 26th – 30th, 2010) , participants observed one of those garbage trucks, recently imported, on the docks contaminated with soil from the country of origin. In the case of open vans and trucks, there is a requirement for these vehicles to be covered with tarpaulin when transporting materials. This requirement is not always met.

As previously mentioned, garbage, presumably sorted is taken from cruise ships. It is definitely not clear that other ships meet these requirements and it is known that for yachts, schooners and aircraft, that the garbage enters the domestic stream without any inspection or control.

There is no doubt that this is a sub-pathway of concern for the introduction and spread of IAS, and the internal spread of invasive species.

Hitchhikers

Hitchhikers in the sense of IAS can be considered to be IAS "which are moved to a different location not in association with a host commodity, but either in a commodity which is not a host, or on/in the conveyance (plane, maritime vessel, etc) or shipping container used for transport" [40].

Hitchhikers may arrive into a location in or on a non-host commodity, conveyance or container by chance or because of attractive environmental conditions (light, odour, temperature, humidity). IAS which may have formerly been associated with a commodity may be left behind in a container after off-loading and then become a hitchhiking IAS [40].

It is reported that both live and dead hitchhikers, especially insects are regularly found in aircraft passenger cabins and baggage compartments. They have also been found in the holds of cargo aircraft [40]. In some cases these hitchhikers are attracted to the aircraft because airports are usually well lit areas.

Hitchhikers are also found contaminating cruise and cargo ships' decks, quarters, holds and stores [40].

Shipping containers (air and sea) are found with hitchhikers (mollusks, weeds, and arthropods, including insect egg masses). Some of the live insects found contaminating containers were identified as potential forestry pests. Others were stored product pests. Soil, which may habour fungi, nematodes, seeds and bacterial pathogens has also been found contaminating shipping containers [40]. The likelihood of containers being contaminated usually depends on the country or ports of origin and those visited en-route (including transshipment storage), time of shipping, storage and handling of containers [40]. It appears that containers can be contaminated with hitchhikers regardless of the content of the containers (commercial goods or personal effects).

Studies have demonstrated that for many IAS and plant and animal pests, their chances of survival during transportation from one country or area to another, whether it be inside or outside of aircraft, maritime vessels and/or their shipping containers, is mostly favourable [40].

Hosting of regional events

The MALFF has had the experience of dealing with the importation of plant and animals, their products and associated equipment to facilitate international and regional festival and trade – related events. In many instances the lack of collaboration between Ministries of government facilitating such events and the MALFF, has caused the delays in the ability of those plants and animals and their products to enter Saint Lucia. On the other hand, that same lack of collaboration has facilitated the entry of those items without the requisite permits and inspections at ports of entry. Usually, some of the items imported for those events may eventually be sold or given to locals as gifts, returned to the country of origin or disposed of in the regular garbage stream. There has also been in the past, the arrival of at least one touring circus with live animals including monkeys, lions, tigers, etc..

Regional and some international sporting events are hosted by Saint Lucia and results in the importation (in most cases on a temporary basis) of clothing (boots, shoes), equipment and gear. Some of these events are outdoor (eg. Road, bike and horse races, golf, cricket, football, etc) and could cause the

introduction of IAS by contaminated clothing, gear and equipment. In most instances all of the associated luggage, gear and equipment is facilitated entry into Saint Lucia without the requisite permits and inspections at ports of entry.

This sub-pathway presents considerable risk for the entry of plant, animal and human pests and diseases and IAS.

Public Health and Environmental Concerns

Saint Lucian people are becoming progressively aware of the negative impacts of pesticides use to human and environmental health. This awareness partially resulted in the cessation of aerial banana spraying for fungal disease control during the two decades. Fogging for mosquitoes with Malathion insecticide to prevent Dengue fever, takes place under the supervision of the Ministry of Health. In situations where efforts to mitigate against the impact of IAS include pesticides applications and use, there may be public opposition to that particular method of management. This could affect IAS control programmes negatively [37].

RECOMMENDATIONS TO MIGITATE AGAINST IAS PATHWAYS

"Unfortunately, scientific knowledge and institutional mechanisms are currently insufficient to effectively predict, prevent or mitigate the impacts of invasive species – whether plant, animal, fish, insect or micro-organism – on native biodiversity and other human systems, such as agriculture and livestock" [10].

"It is even less realistic to expect that developing countries with severe resource limitations can effectively address invasive alien species once they have been introduced or become established. For all of these reasons, adopting vigorous prevention measures to keep invasive alien species from being introduced in the first place plainly is the best way to decouple introductions from the increase in volume of trade" [10].

It is recommended that existing capacity is used for early detection. This includes the Crop Protection Unit, Veterinary and Livestock Services Unit, farmers, divers, hikers, photographers, port workers, Extension officers, Customs officers, bird watchers, etc. Education and awareness programmes targeted at these groups will be important. Obviously that education or awareness programme will have to demonstrate the value of native biodiversity and instil some sense of pride in protecting it.

All the above-mentioned groups and other stakeholders should meet to conduct an "inter agency needs assessment" and create a comprehensive biosecurity plan with cross budget, to integrate all commodity and product inspection services. The co-housing of relevant staff may enhance effectiveness [3].

As usual, adequate resources and political will be required.

Air Transportation Recommendations

- Work with Civil Aviation to educate them on the risks associated with civil aviation pathways.
- On arrival, plant/animal health inspectors should board aircraft from international destinations to inspect the passenger and baggage areas for organisms of concern and IAS before cleaners are deployed. All items confiscated during these inspections should be incinerated.

- **All** passenger luggage and carry-on items should be scanned for plant/animals and their products on arrival, using appropriate technology
- Cargo aircraft should be inspected on arrival at the airports and before cargo is removed from the aircraft.
- Air cargo containers should not be stored too close to perimeter fences and under security lighting.
- Courier mail aircraft should be inspected on arrival at the airports and before mail is removed from the aircraft.
- Customs declaration forms should require passenger information on possible transportation of animals, plants, their products and possible visits to farms, forests, gardens and other places of high risk for IAS
- Plant and Animal Health Inspectors with the assistance of the Forestry Department, should monitor the perimeters of ports of entry on a monthly basis to look for potential IAS.
- Ministry of Health personnel should be re-instated at ports of entry to observe incoming passengers for signs of ill health.
- Cross - training is required for plant and animal health inspectors, ports health personnel, Customs officers, port authority workers on matters pertaining to IAS, the IPPC, MARPOL, CDB, Ballast Water, CITES, etc.
- Educate air travellers prior to departure and arrival on the economic and environmental consequences of the introduction of IAS

Water/Aquatic Transportation Recommendations

- The manifests of container cargo should be made available to plant and animal health inspectors, whom could make copies available to the Forest and Fisheries Divisions for their review to determine if there are any potential risks and so advise the inspectors.
- Containers should be examined externally during offloading for hitchhiking organisms.
- Encourage cargo loading when pest entry is least likely (not at nights).
- Inspect and clean containers and conveyances, including empty containers.
- Traps for insects and mollusks should be placed on maritime vessels.
- All containers should be stored at least 3 – 4 metres away from perimeter fences at the ports of entry.
- Containers with non-agricultural consignments, especially personal effects, should be examined by a plant or animal health inspector at the time of opening the container on the premises where it is to be offloaded.
- Samples of ballast water should be taken from maritime vessels for analysis (determination of organisms present).
- Cargo, lumber and cruise ships should be boarded on arrival into ports by animal/plant health inspectors as part of the boarding party before any cargo is offloaded.
- Monitor inter-island cargo traffic via sea (commodities, quantities, countries of origin, destination and incidence of wood packing material).
- All yachts should be boarded by animal and plant health inspectors before final clearance is granted by Customs and Immigration authorities.
- All garbage from yachts should be collected in special receptacles for incineration. It should not join the local garbage stream.

- All incoming passenger luggage and cargo from ferry traffic should be scanned using appropriate technology.
- Fisheries officers should monitor marinas and coastal areas monthly for marine IAS. Marinas should submit monthly information reports on activities to the Fisheries Department.
- Hull cleaning should be conducted using best practices to minimize hull fouling. Saint Lucia should support more effective non-toxic anti fouling systems to replace those banned by IMO's International Convention on the Control of Harmful Anti-Fouling Systems. This should be monitored by the Fisheries Department as part of the suggested monthly reports from the marinas, including dry docks.
- Place information signage on IAS in marinas and include questions on IAS in customs/immigration declarations.
- Full time presence and visibility at the marinas by plant/animal health officers is required.
- There should be increased monitoring of "blind spots" for IAS. This would require monthly daytime surveys by Forestry and Fisheries Department officers.

Packaging Material Recommendations

- The provisions of the IPPC's ISPM No. 15 on wood packing material should be implemented.
- All organic packing materials should be prohibited unless prior approval is granted in import permit conditions. Inspection on arrival should be mandatory.
- All packaging materials should be subject to inspection at the discretion of the plant/animal inspectors based on information contained in the manifests accompanying consignments in trade.
- Adequate inspection of wood packing material on all agricultural and non-agricultural cargo.

Mail and courier company recommendations

- Put up posters at all mail facilities to inform workers and the public about IAS, CITES, human, plant and animal health.
- Training of mail and courier facility personnel along with all other co-operators.
- Upgrade data collection at mail and courier facilities.
- Employ sniffer dogs for detecting organic materials.
- Utilise scanning facilities to examine mail and parcels.

Traveller/Tourist Recommendations

- All tourism sites, including ecotourism sites, nature trails, beaches and hotel properties should be monitored for IAS. Monthly reports on activities should be submitted to the Forestry and/or Fisheries Divisions.
- Educational and public awareness programmes should be ongoing on maritime vessels and aircraft.
- Tour guides, dive operators, taxi drivers, eco tourism site managers and other hospitality workers should be trained on IAS and the risks involved with the movement and introduction of IAS.
- Post signs at ecotourism sites.
- Clean shoes and clothing after leaving natural and agricultural areas.
- Raise funds and awareness by selling souvenirs at eco-tourism sites. A user fee system could be implemented for IAS prevention and management.
- Conduct biodiversity impact studies at eco-tourism sites.

Recommendations for heavy equipment and military vehicles

- The plant quarantine office should be notified when it is the intention for heavy equipment and military vehicles to be imported.
- All such equipment should be thoroughly cleaned in the country of origin, examined and certified. It should then be inspected on arrival into Saint Lucia before it is allowed to be offloaded from maritime vessels or aircraft.
- Develop a code of conduct to minimise the risk of introduction of IAS during engineering and infrastructure development.

Recommendations for plants for research

- Before plants or their parts are imported for research purposes, application should be made to the Crop Protection & Quarantine Unit, MALFF seeking permission to import such plant material to conduct trials. Information provided should include information on the purpose of the trials, expected results, design and layout in the field, location, treatments, duration, precautions to be taken in the event of weather events or project termination, and the final disposition of the harvested/final produce or products.
- All trials should be monitored by regulatory officials from MALFF and other designated agencies.
- Results of such trials should be made available to regulatory officials from MALFF, even if they have to be kept confidential.
- Given the number of unofficial trials purported to take place in Saint Lucia and the increasing requests for different species and varieties of plants to be imported, serious consideration should be given to the establishment of a post-entry quarantine facility.
- The Jatropha biofuel project has been terminated. At least forty thousand (40,000) seeds were imported from India for that project. MALFF should immediately follow up on this project to locate the nursery and follow up on plants distributed under this project.

Recommendations for potting media

- All potting media should be accompanied by plant import permit and phytosanitary certification.
- Consignments should be sampled regularly for bacteria, nematodes, mites, fungal spores and related microorganisms to verify freedom from the above-mentioned.

Recommendations for plant trade

- Efforts should be made to educate nurseries and garden enthusiasts to work with and improve local varieties of plants instead of the desire to import plants and varieties from foreign sources.
- The CPU-MALFF along with importers and other stakeholders should seek to implement the provisions of relevant ISPMs.
- Improve personnel numbers at ports of entry and inspection protocols.
- Post-entry phytosanitary monitoring of plants imported for planting.
- Cooperate with nurseries, gardeners, landscapers to develop awareness and a code of conduct or best practices.

Recommendations for live seafood

- Continue to enforce ban on live seafood.
- Monitor the ports and "blind spots" for attempts at illegal importations.

Recommendations for plants for forage

- The same phytosanitary requirements as for plants for research purposes should be met.
- Strict control and supervision by the Crop Protection Unit, Livestock & Veterinary Services Division and the Forestry Department.

Recommendations for the aquarium trade

- The whole aquarium trade and industry should be assessed with a view to establishing the potential risk from IAS.
- Public awareness and education on IAS is required for collectors, agents, retailers and customers.
- A recovery mechanism for unwanted pets should be put in place. The pet shops should offer this service in conjunction with the Fisheries and Livestock & Veterinary Services Department, MALFF.
- Code of conduct should be developed.

Recommendations for aquaculture

- Assessment of entire industry should be implemented with regards to IAS.
- Regular audits of fish and prawn farms.
- A code of conduct for responsible fisheries which also addresses the risk of escapes from fish farms should be developed.
- Public and stakeholder education and awareness programmes.

Recommendation for pets

- Same recommendations as for the aquarium trade.
- "Blind spots" and rumours should be monitored for information on illegal pets in Saint Lucia.

Recommendations for minimally processed meats

- Continue status quo with increased vigilance.

Recommendations for minimally processed plants

- Increased phytosanitary inspections of such plants and their products are required.

Recommendations for biological control

- Implement the provisions of all the relevant ISPMs of the IPPC prior to importing organisms for biological control purposes.
- Conduct studies on the status organisms already introduced into Saint Lucia for biological control purposes.

Recommendations for fresh water rivers, streams, canals

- A baseline inventory of the species inhabiting fresh water rivers, streams and canals in Saint Lucia should be conducted.
- The Fisheries or Forestry Department, or both, should take "ownership" of these areas, implement regulatory controls to prevent the introduction of IAS and conduct regular monitoring exercises, especially in high risk areas.

Recommendations for marine/estuarine areas, canals

- A baseline inventory of the species inhabiting those habitats should be undertaken.
- High risk areas such as seaports and marinas should be monitored. Fishers and divers and sea coastal tour operators can assist with other areas along the coastline. Provision of monthly reports from officially established business interests should be submitted to the Fisheries Department.

Recommendations for natural spread by of IAS by ocean currents, wind, water, self propelled and unusual weather events

- Monitor and surveys should be conducted after events such as hurricanes, strong winds, rains, floods, Sahara dust. This is part of early detection capability.
- Keep updated and informed about potential IAS already threatening and expected to impact Saint Lucia.

Recommendations for climate change

- Nationally, implement measures which mitigate against climate change and environmentally unsound practices which damage our small environment.
- In future planning activities, be prepared to work with a changing landscape, especially near the coastline.
- Continued and improved establishment of germplasm banks locally and with international assistance.

Recommendations for ecosystem disturbance

- Liaise with the Ministries of Planning and the Environment and other stakeholder entities to encourage comprehensive impact assessments and minimal ecosystem disturbance.
- As mentioned earlier, establish a code of conduct to minimise the risk of introduction of IAS during engineering and infrastructure development.

Recommendations for garbage

- Garbage truck companies should observe good transportation practices. These include proper covering of loads and prevention of liquid leakages and spills along routes.
- Monitor routes and landfill areas for IAS.
- Public education and awareness.
- All foreign organic garbage to be prohibited or incinerated immediately after arrival into Saint Lucia.

Hitchikers

- Increased vigilance at ports of entry by all border authorities.
- Increased vigilance by travellers, farmers, gardeners, road workers, hikers, divers, photographers and enthusiasts.
- Public education.

Recommendations for hosting of regional events

- Insist on compliance with laws and regulations governing the movement of restricted articles.
- Monitor, to ensure compliance is adhered to.
- Impose penalties for violations.

Recommendations for public health and environmental concerns

- Implement integrated pest management practices for public health pests and diseases, using pesticides as a last resort.
- Public awareness and education

PATHWAY RISK ASSESSMENT

The general pathway risk assessment process includes the following stages:

1) "Pathway magnitude (number of species, inoculation strength and frequency, diversity of species carried via pathway)
2) Survivability or viability of organisms during transport and in transit
3) Likelihood of pathway to transmit IAS which are difficult to detect or manage during transport and/or transit in the pathway
4) Environmental comparability of origin and destination habitats
5) Ease of spread (via artificial or natural means) of the IAS once present
6) Environmental comparability to that of the country of origin
7) Difficulty of control if the IAS becomes established" [21]

It is recommended that agencies responsible for granting permits for the importation of plant, plant parts or their products, animals, animal parts and their products, and also other organisms, conduct an IAS pathway risk assessment in addition to their primary risk assessments to assist in the determination of their entry status.

ANNEX 1.

LIST OF ACRONYMS

1) ARC – Atlantic Rally Crossing
2) ATV's – All terrain vehicles
3) CARDI – Caribbean Agricultural Research & Development Institute
4) CBD – Convention on Biological Diversity
5) CITES - Convention on International Trade in Endangered Species of Wild Fauna and Flora
6) DCA – Development Control Authority
7) GEF – Global Environment Facility
8) GFL – George F. L. Charles Airport
9) HIA – Hewanorra International Airport
10) IAS – Invasive Alien Species
11) ICC – International Cricket Council
12) IPPC – International Plant Protection Convention
13) ISPM – International Standard for Phytosanitary Measures
14) LMOs – Living Modified Organisms
15) MALFF – Ministry of Agriculture, Lands, Forestry & Fisheries
16) MARPOL – the International Convention for the Prevention of Pollutions from Ships
17) NISS – National Invasive Species Strategy
18) OIE – World Organization for Animal Health
19) SLASPA – Saint Lucia Air & Sea Ports Authority
20) SLSWMA – Saint Lucia Solid Waste Management Authority
21) USA – United States of America
22) WINBAN – Windward Islands Banana Association

ANNEX 2.

INTERVIEWEE QUESTIONNAIRE

1) Are you aware of Invasive Alien Species (IAS)?

2) Are you aware of IAS “pathways”?

3) Are you aware of IAS pathways in your business/operation?

4) Are you doing anything to mitigate against IAS in YOUR pathway/operation?

5) Would you cooperate with agencies who seek to mitigate against IAS in your operation/pathway?

6) Do you care to make any comments, remarks or suggestions as to how potential threats from IAS can be handled in Saint Lucia.

ANNEX 3.

Results of Interviews with Persons on IAS

I interviewed a total of twenty-seven (27) persons in the process of preparing this report. All of them worked in areas where they could come into contact (knowingly or unknowingly) with IAS during the course of their day to day activities. Six (6) questions were asked and I requested the answers immediately, without giving them a chance to research the topic.

The results of the interviews were as follows:

Question 1 – Are you aware of Invasive Alien Species (IAS)?

- 88.8% (24) responded that they were
- 11.2% (3) responded that they were not

Most of the respondents knew about IAS through their work or general knowledge. It was suprising to learn that until the term was explained, one of the persons from the port authority and the one from the pet shop had never heard the term. They did however, know of IAS like the Giant African Snail.

Question 2 – Are you aware of IAS pathways?

- 88.8% (24) responded that they were
- 11.2% (3) responded that they were not

Some of the responses included: winds, tourism, trade, sea currents, winds, smuggling, travel, escapes from trade.

Question 3 – Are you aware of IAS pathways in your business/operation?

- 85.2% (23) responded that they were
- 14.8% (4) responded that they were not

Question 4 – Are you doing anything to mitigate against IAS in YOUR pathway/operation?

- 88.8% (24) responded that they were doing something to mitigate against IAS
- 11.2% (3) responded that they were not doing anything to mitigate against IAS

Some of the actions being taken included choosing clean plant material for planting; phytosanitary activities; deep burial of waste at the landfills; working in existing IAS programmes; ensuring importation of clean equipment from overseas; farmer training; port human health programme; animal health programme at ports of entry.

Question 5 – Would you cooperate with agencies who seek to mitigate against IAS in your operation/pathway?

- 100% (27) responded that they would

Question 6 – Do you care to make any comments, remarks and suggestions as to how potential threats from IAS can be handled in Saint Lucia.

Comments included the following:

- Workshops and conferences on IAS
- Ports of entry: ship waste protocols
- Importation of clean used vehicles and heavy equipment
- Cooperation among all "the players"
- Provision of funding to facilitate port health programmes
- All relevant agencies should sit together to plan and strategize
- Early identification and quick responses to IAS were necessary
- "Sustained" public awareness campaigns showing negative effects of IAS
- Updating legislation and regulations
- Best practices
- Training of more front line officers
- Baseline surveys to determine what IAS exist in Saint Lucia
- Sign and ratify relevant treaties
- Incinerators at all ports of entry
- Timely surveys of borders for IAS
- Post entry quarantine facilities
- Persons should stop smuggling animals and plants into the country
- Penalties for persons violating border protection laws

ANNEX 4.

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