

TRADE RELATED PATHWAYS TO THE INTRODUCTION OF TERRESTRIAL
INVASIVE SPECIES IN THE INSULAR CARIBBEAN

Report to International Programs, US Forest Service

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Introduction

The New World's first documented environmental crises involved invasive species in the Caribbean (Harvard University 2005). Two ant plagues brought widespread crop destruction. The first was on the island of Hispaniola in 1518-19. The second, in the Lesser Antilles between 1760 and 1770, decimated Barbados' valuable sugar plantations. Professor E. O. Wilson and colleagues have concluded that the former was due a South American fire ant, and the latter an African ant invader. Because neither ant attacks crops, another species must also have been involved; Wilson believes that sap-sucking insects with symbiotic relationships with ants were involved. Today it is not possible to identify the mysterious symbiotic insect, but Wilson may have identified its pathway to introduction; plantains shipped to Caribbean plantations from the Canary Islands.

The Caribbean islands provided an early foothold for Old World colonists in the New World; they were defensible, and they were profitable, especially with forced labor from enslaved indigenous people and African captives. As Europeans colonized the New World, the Caribbean became the center of a global tr

high-risk pathways can be, and often are linked to trade².

The expansion of air travel and seaborne trade overcomes geographic barriers to organisms, enabling them to move great distances in short periods of time. These organisms include agricultural pests and diseases, their vectors, and invasive species injurious to agriculture and human health to ecosystems and environmental services. They may be bacterial, viral, or mycological organisms as well as flora and fauna. They may be present not only in raw and processed commodities, but also in manufactured goods and in packing materials.

Such invasions constitute a "hidden cost" of international trade, and one that is a serious risk to economic, as well as ecological health, of all nations, developed and developing.

This report represents the preliminary steps in a "first cut" analysis of pathways to invasive species in the Caribbean. Its objective is triage, the identification of pathways of high risk for purposes of

Definitions

Caribbean: For purposes of this report the Caribbean is comprised of the insular nations located within the chain of islands surrounding the Caribbean Sea, together with the Bahamas. Overseas territories and dependencies of France, the United States, the United Kingdom and the Netherlands are not addressed, nor is the wider Caribbean region incorporating the continental fringes of the Caribbean basin.

Invasive species: a non-native (alien) species that causes or has the potential to cause harm to the environment, economy, or human health (IUCN, 2000, US Executive Order 13112; Federal Register 1999).

Propagule pressure (also termed "introduction effort") is a composite measure of the number of individual organisms (and/or their

Background

The antecedent of this report is a study by IUCN produced with the support of the US Environmental Protection Agency entitled *Denying Entry: Opportunities to Build Capacity to Prevent the Introduction of Invasive Species and Improve Biosecurity at US Ports* produced in 2007. That study addressed gaps in the US government's knowledge of the role that trade has played in the introduction of invasive species into the US. It concluded not only that there were significant gaps in the documentation of trade necessary to assess risk, but also that capacity was seriously impaired by a range of factors, not least of which was inadequate technical capacity at the ports, stemming in part from poor (or nonexistent) communication with other relevant authorities. This included poor communication within the inspection services, poor communication between the inspection services and other agencies with technical roles, and with other authorities in the chain of custody of people, goods and materiel entering US ports. These constraints hinder early detection and rapid response, and therefore interfere with the implementation of an effective biosecurity strategy. Experts agree that prevention measures are in principle³ more effective than

International Programs Office asked IUCN to review the management of trade-related pathways for invasives introductions in the Caribbean. In the Caribbean, extreme weather events are likely to intensify as a result of global climate change; this is likely to lead to greater levels of disturbance and opportunities for colonization of disturbed sites, bringing greater

Factors influencing the spread of

Mongoose *Herpestes auropunctatus* is among the best known; it was first introduced in Jamaica in 1872 to control other introduced species (rats) living in sugar cane fields (yet another introduced species). The mongoose has been implicated in the extinctions of five endemic species.

Kairo *et al* (2003) identified a total of 552 alien species in the Caribbean region, including 390 species regarded by at least one authority as naturalized and/or invasive. Many of those identified are also recorded as invasive or naturalized on the North American mainland. Terrestrial species vastly outrank freshwater and marine species in the

context of the environmental and socio-economic context of the region. Later

sections will address trends in trade and tourism.

Threats to Caribbean Forests From Invasive Species

Forests of the insular Caribbean cover 5,974,000 hectares, and 26% of the land area⁵. The majority of the regions forests lie in the Greater Antilles nations of Cuba, the Dominican Republic, Jamaica, and the territory of Puerto Rico. The Bahamas and Trinidad and Tobago also have significant forest hold-

Hurricanes and other extreme weather events may also be a factor in the introduction of invasive species. The US Global Climate Change Program Report states that "future disturbance impacts are likely to include...epidemic levels of insects and disease." Climate induced disturbances such as fires and drought are likely to create the conditions likely to create the conditions for the invasion and spread of introduced species. Insects and pathogens in particular, by virtue of their mobility and short reproductive cycles, can respond to climate change much more rapidly than trees. In Puerto Rico, possible increases in the frequency or intensity of hurricanes, floods, droughts, and fires could lead to new and greater stresses and drastic changes in forest structure and composition. A computer model run for the Luquillo reserve of Puerto Rico showed that stronger hurricanes could reduce the numbers and health of the trees, and favor the development of fast-growing, short-lived and weedy species, including invasive species. Source: US Global Climate Change Program (2001). Invasive species pose the largest potential risk to management objectives (Blundell *et al* 2003). Goodland and Healey document repeated mass flowerings of *Cinchona abietifolia* after hurricanes.

In Jamaica's Blue Mountains, disturbance in the form of plantations and trails created pathways and centers for invasive species colonization. *Pittosporum undulatum*, also known as wild coffee and mock orange, has spread from a naturalized population at the he Cinchona Botanic Gardens in 1883, where it

stroyed, or rejected from admittance into a country (Reaser and Waugh, 2007) Another approach is to target pathways (e.g., to fumigate produce, or to require treatment of ballast water). This is deemed a more comprehensive approach than targeting individual species because it can be deployed strategically, and can address organisms not prohibited by regulation (Cock, 2003). Exclusion requires significantly more resources than are generally available to most inspection and quarantine authorities. Efficient use of resources requires a combination of regulatory exclusion methods plus early detection and rapid response measures at key points along

a pathway, such as port facilities. Logically, early detection should involve communication along the pathway, following the chain of custody of both conveyance and cargo. International cooperation, including financial and technical assistance, to interdict invasive species would be in the self-interest of donor countries. "Because every nation is an exporter and importer of goods and services, every national is also a facilitator and victim...Wealthy nations therefore need to help raise the capacity of island nations and territories to minimize the spread and impact of IAS." (Reaser metst33 Td(lowing spre rp7ict invasj0.00elf met- rp7ic[(a co)-3(ribbe.00()7(ibsof) CubiJ0.0Fif]TJy-

in the Caribbean region. The records bear this out, but with a surprising twist. Perhaps because agriculture is so small a part of most Caribbean economies, biosecurity at the borders is relatively lax in comparison with other island tour-

ism destinations. The sheer volume would overwhelm even the best quarantine measures. Few records are available on port interceptions of invasive species, either in the Caribbean or elsewhere.

Horticulture, Tourism and Invasive Species

Examination of the documented invasive species introductions in the region show that there is a correlation with tourism, but rather than the insects and plant diseases that would be expected via passengers, the most frequent pathway for introductions is via horticulture. There may be several factors behind the disproportionate number of invasives from horticulture, including under-sampling of non-plant species due to lack of capacity or emphasis and misattribution of pathways. Nevertheless, horticulture is clearly a significant driver of invasive species introductions, and the major consumer of imported horticultural products throughout the region is the tourism industry. Significant additional work will be required to quantify this through second and third cut pathway analysis.

The magnitude of the problem points to the need for early measures to protect Caribbean nature, through proactive engagement with the tourism industry - architects, landscape architects, contractors, landscapers, and nursery vendors, as well as with national inspection and quarantine services, to develop a plan to reduce the risk of introduction. This may involve improved inspection and quarantine practices, cultivation of native species, and reduction

in inventory of species known to be highly invasive.

In the US, nurseries engaged in international trade in horticultural products must obtain an export certificate from APHIS. They must also possess a valid USDA General Permit, and if exporting live plants, must obtain a phytosanitary permit from the importing country. (USDA FAS, 2003) In granting an expert certificate, the USDA compares the proposed consignment to the importing country's certification and permit requirements. Plants and plant material covered under phytosanitary rules may be subject to sampling, inspecting and testing in advance of shipment

Phytosanitary rules are governed through the International Plant Protection Convention of 1952. The IPPC creates harmonized standards for international trade in plants and plant products and facilitates information exchange between the Parties to the Convention. National plant quarantine officials administer the IPPC at the national level. All the insular Caribbean members are parties to the IPPC.

In most Caribbean islands, live plants comprise the majority of nursery imports. Other common plant products include cuttings and slips, shrubs, trees,

bulbs and tubers. Renovation after extreme weather events can cause spikes in demand. The US is the major exporter of nursery products to the Carib-

(Sherley 2000), recognizing key challenges in managing invasive species:

- Inadequate/inaccessible baseline information and information management tools for use in risk assessment and decision-making
- Inadequate mechanisms for regional coordination
- Inadequate attention to invasive species in existing laws, regulations, and policies
- Inadequate enforcement
- Shortage of technically trained personnel
- Inadequate inspection and quarantine infrastructure
- Insufficient funding

SPREP has been slow to implement its invasive species strategy, which remains in draft form at this time (February, 2008), possibly resulting in lost funding opportunities. Similar conditions apply to the insular Caribbean, as well (Kairo *et al* 2003).

The capacity to inspect and intercept potential invasive species has, with few exceptions, not been particularly strong anywhere, and it certainly has not kept up with the rate of growth in trade. Pimentel *et al* estimated a partial estimate of the annual cost to the economy from invasive species in 1999 to exceed 130 billion dollars for the United States alone. The varroa mite (*Varroa destructor*), a serious pest in honeybee

hives, has recently invaded New Zealand, expecting to have an economic cost of USD\$ 267-602 million. A 1992 report of the Weed Science Society of America estimated that the total cost of invasive weeds was between USD\$ 4.5 and USD\$ 6.3 billion. In the South Africa Cape Floral Kingdom, the establishment of invasive tree species has decreased water supplies for nearby communities, increased fire hazards, and threaten native biodiversity, justifying government expenditures of USD\$40 million per year for a control program (GISP, 2004).

Clearly, the value of global trade must be weighed in the balance between the full costs and benefits. But since the full costs may not be knowable in advance, prophylactic measures are in order to address some of the immediate and indisputable risks. Conspicuous among these are security measures, and significant resources are being invested in many places to ensure the safety of ports from acts of violence, illegal immigration, and contraband substances. Considerably less has been invested in ensuring the safety of ports from biological invasion, with most at-

Focus on Capacity: Jamaica

Focus on Capacity: The Dominican Republic

The Dominican Republic has the highest documented number of invasive species in the insular Caribbean. Invasive species issues are relatively well-known despite lack of effective regulations and poor record keeping.

Like Jamaica, the Dominican Republic is creating a national invasives inventory under the OAS/World Bank's InterAmerican Biodiversity Information Network (IABIN). Dirección Nacional de Vida Silvestre y Biodiversidad is the lead agency

Unlike most of the insular Caribbean the DR is a exporter of agricultural products, with a growing organics industry. Strong biosecurity measures are considered as important to the economy.

The DR also has a strong constituency for biodiversity conservation, including a very active NGO community.

As a party to the CAFTA/DR Free Trade Agreement, the Dominican Republic hopes to benefit from capacity building efforts being initiated by USDA APHIS to address environmental concerns expressed over the accord.

As a pilot country for the Caribbean Regional Diagnostic Program of the CISSIP, the Dominican Republic Secretariat of Agriculture is working with the Universities of Florida and Mayaguez (Puerto Rico) to implement the Distance Diagnostic and Identification System, originally developed by the University of Florida for the Florida Plant Diagnostic Network, part of the National Plant Diagnostic Network system in the USA. The objective is to facilitate collaboration between diagnosticians, taxonomists, and management authorities to expedite the identification of potential invasive and pest species. If the program is successful in enhancing screening and monitoring in the Dominican Republic and Puerto Rico, it will be expanded to other nodes in the region.

Priorities Reflected in National Biodiversity Strategies and Action Plans in the Caribbean

The body of obligations under multilateral environment agreements (MEAs) concerning invasive species, plus the decisions of conferences of parties to these agreements, together amount to 432 separate, broadly applicable action items (Waugh, unpublished review). These can be grouped as creation of laws and policies, assessment of risk and status, management measures, economic instruments, outreach, international cooperation, and finance. The extent to which these recommendations are reflected in national law and policy is, of course, variable. Several tools have been developed to clarify priorities multilateral environmental agreements.

The UN Convention on Biological Diversity (CBD) is significant among MEAs as the primary source of guidance on invasive species. Article 8(h) stipulates that:

“Each Contracting Party shall, as far as possible and as appropriate:
(h) Prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species” (UN, 1992).

CBD also stipulates in Article 6 that “each Contracting Party shall, in accordance with its particular conditions and capabilities:

(a) Develop national strategies, plans or programmes for the conservation and sustainable use of biological diversity or adapt for this purpose existing strategies, plans or programmes which shall reflect, inter alia, the meas-

ures set out in this Convention relevant to the Contracting Party concerned; and

(b) Integrate, as far as possible and as appropriate, the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programmes and policies” (UN 1992).

Eight Caribbean island states have produced draft or final National Biodiversity Strategies and Action Plans (NBSAPS). They are:

- Antigua and Barbuda (Antigua and Barbuda 2001)
- The Bahamas (Bahamas 2003)
- Barbados (Barbados 2002)
- Dominica (Dominica 2001)
- Grenada (Grenada 2000)
- Jamaica (Jamaica 2003)
- St. Lucia (St. Lucia 2000)
- Trinidad and Tobago (Trinidad and Tobago 2000)

Of these, seven have listed prevention and/or control of invasive (exotic, alien) species as a national priority, St. Lucia being the sole exception. Trinidad notes that invasive species is a major issue, but indicates that unlike other Caribbean nations invasives have not yet resulted in the extinction of native species.

The Bahamas NBSAP states “alien plants have been introduced with little control -- and a few by accident -- mainly by gardeners and horticulturists. Several are now recognized as serious

threats to natural ecosystems and to biodiversity. Tree species, such as *Casuarina*, *Melaleuca* and *Schinus*, are aggressive invaders of forests, wetlands and disturbed or open sites, displacing native plant species.

Barbados notes, "There is anecdotal evidence ... that some exotic plant species may be displacing local species in certain key habitats. In some forested areas, the cultivated Macarthur Palm (*Ptychosperma macarthurii*) seems to be displacing the indigenous Macaw Palm (*Aiphanes minima*) as the dominant understorey species. In certain forested gullies, the characteristic shrub layer has been replaced by solid stands of Sweet Lime (*Triphasia trifoliata*) or Mother-in-law's tongue (*Savsevieria hyacinthoides*), both garden escapes."

Dominica indicates in its NBSAP that "storm-resistant" crops have been introduced due to the frequency of extreme weather, which has reduced agrobiodiversity. Jamaica noted a correlation between hurricanes and distribution of non-native species, citing the example of the spread of white-tailed deer (*Odocoileus virginianus*) released from enclosures into the wild during Hurricane Gilbert (1988). Elsewhere are records of *Pittisporum undulatum* dispersal after hurricanes (Goodland and

Healey, 1996 and 1997). Dominica warns "an increase in pests and diseases is likely to result from changes in seasonal climate patterns."

Dominica's NBSAP argued that fire-adapted lemon-grass, or vetiver (*Vetiveria zizanioides*), introduced as a soil conservation measure, quickly became dominant and resulted in "widespread destruction of the dry forest lands on the leeward side of the island." Trinidad and Tobago notes that fire adapted African grass species now dominate the western area of its Northern Range mountains.

Grenada and Jamaica stress the positive aspects of non-native species

CRISIS would be implemented through the Caribbean Invasive Species Surveillance and Information Program (CISSIP). CISSIP is the first tranche of a Greater Caribbean Region surveillance and distance diagnostic surveillance system. Six countries will form the hubs of CISSIP, including in the insular Caribbean, Jamaica, the Dominican Republic, Martinique, and Trinidad and Tobago. A second phase would add Barbados, the Bahamas, and St. Lucia.

The University of Florida has developed the software for the Caribbean Regional Diagnostic Network, one of the key components of CISSIP. It has also provided a Spanish language version the Distance Diagnostic and Identification System to the University of Puerto Rico-

tection, and one of the clear risks from trade is the introduction of alien species, including invasives, pests and pathogens, via trade-related pathways.

Such mechanisms as exist for the exchange of information and the formation of knowledge between inspection and quarantine authorities is limited. Invasive species interventions are typically sectoral in nature, and do not address the full panoply of risks (agriculture, public health, forestry, infrastructure, aquatic systems). Moreover, they tend to be oriented toward the needs of the major economic powers in trade, rather than to the overall health of the system.

An independent learning network

a port, within a country, and between trading partners. This includes the identification of species, the identification of pathways (e.g., a species found in a new type of packing material), and the identification of management measures (e.g., is fumigation an effective treatment).

An Internet based tool such as the Distance Diagnostic and Identification System could provide for access to reference materials such as documentation

The costs of a prototype to demonstrate the proof of concept will require external funding. When the approach is mainstreamed, the greater ef-

Recommendations

1. That **standards** for trade in and handling of horticultural species in the insular Caribbean be adopted, building upon Voluntary Codes of Conduct for the horticulture industry (Center for Plant Conservation, 2001 and as amended in 2002 at <http://www.centerforplantconservation.org/invasives/codesN.html>).
2. That the Caribbean Basin Initiative be modified **to foster and encourage regional cooperation** on invasive species issues in trade-related pathways.
- 3.Center

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Annex 1: selected Voluntary Codes Of Conduct

From the St. Louis Declaration⁷

VOLUNTARY CODE OF CONDUCT FOR GOVERNMENTS

- Require risk assessment for government-led or financed plant introductions to ensure that no new harmful plant species are introduced, intentionally or unintentionally.
- Do not distribute existing holdings of invasive plant species to areas where they can potentially do harm; eliminate these holdings

VOLUNTARY CODE OF CONDUCT FOR NURSERY PROFESSIONALS

- Ensure that invasive potential is assessed prior to introducing and marketing plant species new to North America. Invasive potential should be assessed by the introducer or qualified experts using emerging risk assessment methods that consider plant characteristics and prior observations or experience with the plant elsewhere in the world. Additional insights may be gained through extensive monitoring on the nursery site prior to further distribution.
- Work with regional experts and stakeholders to determine which species in your region are either currently invasive or will become invasive. Identify plants that could be suitable alternatives in your region.
- Develop and promote alternative plant material through plant selection and breeding.
- Where agreement has been reached among nursery associations, government, academia and ecology and conservation organizations, phase-out existing stocks of those specific invasive species in regions where they are considered to be a threat.
- Follow all laws on importation and quarantine of plant materials across political boundaries.
- Encourage customers to use, and garden writers to promote, non-invasive plants.

VOLUNTARY CODE OF CONDUCT FOR LANDSCAPE ARCHITECTS

- Seek out education and information on invasive species issues:
 - Work with local plant ecologists, horticulturists, nurseries, botanic gardens, conservation organizations and others to determine what species in your region either are currently highly

Annex 2: Regional Initiatives

CABI Caribbean and Latin America (Trinidad and Tobago). Established in 1946 as the West Indian Station of the former International Institute of Biological Control, CABI CLA supports activities throughout Latin America and the Caribbean in the prevention and management of invasive species, and in biological controls. CABI CLA is presently involved in the implementation of a pilot project on data management for invasive species in the Caribbean in six countries.

Caribbean Invasive Species Surveillance and Information Program (CISSIP). A proposed project for CARICOM. CISSIP is the first tranche of a Greater Caribbean Region surveillance and distance diagnostic surveillance system. Six countries will form the hubs of CISSIP including in the insular Caribbean, Jamaica, the Do-

