



United States Virgin Islands **INVASIVE SPECIES ACTION PLAN**

PREPARED FOR THE DEPARTMENT OF PLANNING AND NATURAL RESOURCES DIVISION OF FISH AND WILDLIFE, NOVEMBER 2016



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PREFACE

Moving Forward

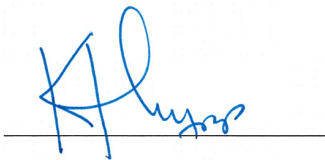
There is a silent invasion in the United States Virgin Islands which is impacting our economy, our environment, the health of our residents, and our quality of life. The silent invasive force is the invasive species of plants and animals which threaten the extinction of our native plants. Invasives destroy natural habitats by competing with native organisms for the limited resources on which they need to thrive. Once established, invasives are especially difficult to eradicate.

To see the impact of invasive species, one need only mention species such as the Lionfish (*Pterois spp.*) which is consuming our native reef fish, or the Powerpost Beetle (*Lyctinae spp.*). These types of non-native species have had a negative impact on the eco-system and on our local economy.

We have a unique opportunity, through the assistance of the U.S. Department of Interior, to act decisively to prevent the adverse impacts of invasive alien species. Through grant funding for training and collaboration with our sister territories, the DOI Office of Insular Affairs is helping to bring the issue of invasive alien species to the forefront of our Territory's decision making. Invasive species represent one of the most significant threats to our ecosystems, our livelihood, and our well-being.

The U.S. Virgin Islands Invasive Species Action Plan is a first step to outline actions that would inspire urgent and effective responses to reduce the threat of invasive/non-native species. It will help us develop future strategies and enable preventive measures for early detection and rapid response at our marine ports and airports, specifically targeting inbound commercial shipments and the importation of exotic animals. It will guide us as we conduct a current assessment of known invasive plants and animals through which we will begin to educate the public.

I would like to thank the members of the U.S. Virgin Islands Invasive Species Action Plan Steering Committee for their efforts with special acknowledgment of Dr. Renata Platenberg, who assisted in the development this plan and who believes in the vision that it represents.



Kenneth E. Mapp
Governor

“In order to carry a positive action, we must develop here a positive vision.” Dalai Lama

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Acronyms used in text

APHIS	U.S.D.A. Animal and Plant Health Inspection Service
BVI	British Virgin Islands
CBP	U.S. Customs and Border Protection
CORE	Caribbean Oceanic Restoration and Education Foundation
DNER	Puerto Rico Department of Natural and Environmental Resources
DPNR	U.S. Virgin Islands Department of Planning and Natural Resources
DFW	DPNR Division of Fish and Wildlife
NOAA	U.S. Dept. of Commerce National Oceanic and Atmospheric Administration
NPS	U.S. D.O.I. National Park Service
TNC	The Nature Conservancy
USDA	United States Department of Agriculture
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USVI	United States Virgin Islands
UVI	University of the Virgin Islands
VI-EPSCoR	Virgin Islands Experimental Program to Stimulate Competitive Research
VIDOA	U.S. Virgin Islands Department of Agriculture
VIMAS	U.V.I. Virgin Islands Marine Advisory Service

This document was produced for the USVI Department of Planning and Natural Resources Division of Fish and Wildlife, St. Thomas.

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INSIDE Cover photo: Red lionfish (*Pterois volitans*) by Paul Cater Deaton, U.S. Virgin Islands, 2013.

US Virgin Islands Invasive Species Action Plan

Vision and Scope

The vision expressed in this document is a framework for the development of a coordinated strategy to manage invasive species in the United States Virgin Islands.

The damage caused by non-native invasive species to biodiversity, infrastructure, and the local economy is costly and affects each one of us. No single entity is able to address all of the actions necessary to effectively prevent, eradicate, and control invasive species. Effective management requires a comprehensive collaborative and committed approach across federal and local government agencies, in the private sector, and throughout our local communities within the U.S. Virgin Islands (U.S.V.I.).

The United States Virgin Islands Invasive Species Action Plan describes the current status of invasive species response in the Territory and identifies planning and implementation needs for establishing a coordinated response initiative for the management of invasive species that threaten the ecological, environmental, cultural, and economic resources of the U.S.V.I.

Context

The Caribbean region is a center of unique biodiversity due to geography and climate (CEPF 2010). The Virgin Island archipelago is situated at the top of the Lesser Antillean island chain to the east of Puerto Rico; the islands of St. Thomas and St. John and their satellite cays, along with the British Virgin Islands (BVI) are part of the Puerto Rican bank, a larger land mass submerged at the end of the Pleistocene. Most of the species of plants and animals of the BVI and the northern USVI are shared with Puerto Rico, although there are a set of endemics that are only found on the eastern PR Bank. St. Croix, located 44 miles south of the Puerto Rico-Virgin Islands shelf, from which it is separated by a 5.2 mile deep trench and is 111 miles from the nearest island to the east, has a different geological origin; because it was never connected to another land mass and due to its relative isolation, many of its species are endemic only to St Croix. Many of these unique ecological resources, both species and habitats, are threatened by a range of human and natural activities, including the presence of non-native invasive species.

Non-native species, also referred to as alien, non-indigenous, foreign, or exotic, are plants, animals, or other organisms (such as microbes) that have been deliberately or unintentionally introduced to an area beyond their native range or from another site of introduction, usually by human actions (Kairo et al. 2003). **Invasive species** are those species (native or non-native) whose establishment causes economic damage, environmental harm to ecosystems, habitats, or species, or harm to human health (Presidential Executive Order 13112 Feb. 1999). Not all invasive species are non-native; native species can become invasive in response to an environmental change, such as habitat destruction or the removal of predator, and likewise, not all non-native species are invasive: these include livestock, agricultural, and ornamental species that confer benefit to human communities. This document focuses primarily on **non-native**

invasive species that have become problematic to habitats and species within the USVI and are having negative environmental, economic, and cultural impacts.

Pathways of Invasion

Almost all goods and raw materials used in the USVI have been imported via ship or air, providing ample opportunity for the movement of non-native organisms. While some problematic species have arrived in the U.S.V.I through colonization events such as natural range expansions (e.g., cattle egrets (*Bulbicus ibis*), although this species has expanded its range in response to widespread anthropogenic habitat change and animal husbandry practices (Arendt 1988)), most non-natives are the result of deliberate or accidental introduction by human mechanisms.

Caribbean islands have a long history of species introductions. Early species of invaders include rats (*Rattus* spp.) transported on European ships, and sailors also introduced goats and other livestock to oceanic islands to ensure the availability of fresh meat on subsequent journeys. More recent unintentional introductions include Pacific Lionfish (*Pterois* spp.) presumably transported in ballast water of cargo ships, the Common Ground Lizard (*Ameiva exsul*) suspected to have been introduced to St. Croix in a tire shipment from Puerto Rico (Treglia et al. 2013), and Cuban Treefrogs (*Osteopilus septentrionalis*) and Puerto Rican Coquis (*Eleutherodactylus coqui*) as hitch-hikers in landscaping or construction material (Platenberg 2007).

The Small Indian Mongoose (*Herpestes auro punctatus*) was deliberately released in an unsuccessful effort to control rats in agricultural fields (Nellis & Everard 1983). Cane Toads (*Rhinella marina*) were also released as a biocontrol for white grub (beetle larvae) agricultural pests. Both guinea grass (*Megathyrsus maximus*) and tan-tan (*Leucaena leucocephala*) were brought in as fodder for livestock. The presence of Red-eared Sliders (*Trachemys scripta elegans*) and *Boa constrictors* is the result of the pet trade: they were either intentionally released when owners were no longer willing or able to care for them, or escaped. The ornamental landscape trade has inadvertently introduced numerous invasive non-native species including: coral vine (*Antigonon leptopus*), rubber vine (*Cryptostegia grandiflora*), and sweet lime (*Triphasia trifolia*).

While there is a good understanding of *how* organisms are arriving in the USVI, there is generally a poor understanding of the transport-enabling factors. These factors are species-specific, and are influenced by the behavior and biological requirements of these species. And while the scientific community is receptive to addressing the issue, the public may be resistant to the knowledge that common practices may have become a threat.

Impacts of Invasives

Invasives are distinguished from other non-native species by their negative impact on native ecosystems. They may be predators of native species, compete with natives for limited resources, or introduce diseases to which the local population has not been exposed. They can also have significant economic

impacts by infesting or invading human food systems, or otherwise affecting agriculture, fisheries, forestry, and tourism.

Environmental impacts

Non-native invasive species have been identified as being a major cause of global biodiversity declines. More than 400 of the over 1300 species currently protected under the US Endangered Species Act are considered to be at risk at least in part due to influences from invasive species (USFWS 2012a). The impact of these species on island systems such as the U.S.V.I. and other U.S. Territories is particularly severe, as these systems contain unique species and community assemblages found nowhere else, occurring in small populations and in small isolated locations with little to no opportunity of dispersal to avoid the impacts.

Threats to native species include direct predation, competition for limited resources, introduction of diseases and parasites, and reduction in the availability of essential habitats. Invasives can also cause destruction or alteration of habitats through disruption of ecosystem function and changes to nutrient cycling, water quality, and hydrology. Environmental impacts can be compounded through cumulative or synergistic effects; for example, the effects of climate change (e.g., drought, increased disturbance through storms or flooding) may make species or habitats more vulnerable to impacts from invasives. Many of these impacts are difficult to quantify.

Historically, the U.S.V.I has experienced losses and declines in biodiversity due to invasives, particularly on St. Croix, with the endemic St. Croix Racer (*Borikenophis sanctaecrucis*) having been driven to extinction and the St. Croix Ground Lizard (*Ameiva polops*) extirpated from the island (Platenberg & Boulon 2006) sometime during the 20th Century. More recently, lack of response to invasive threats has led to severe impacts on endemics, including widespread mortality of the Puerto Rican endemic century plant (*Agave missionum*) on St. Thomas and St. John by the Agave Snout Weevil (*Scyphophorus acupunctatus*), an insect pest introduced via imported ornamental agaves that also has the potential to threaten the federally protected St. Croix Agave (*Agave eggersiana*) if not managed (Chamorro et al. 2016). Another federally protected species, the Virgin Islands Tree Boa (*Chilabothrus granti*) continues to suffer ongoing mortality from predation by feral cats (Platenberg & Boulon 2006, Platenberg & Harvey 2010).

Some species have rapid and measureable impacts, while for others, the impacts are difficult to understand and quantify. Indo-Pacific Lionfish (*Pterois* spp.) are showing rapid and significant deleterious impacts on commercially important reef fish communities; these impacts are exacerbated by the existing stressors of overfishing, habitat damage from land-based sources of pollution and runoff, and climate change effects of increasing sea surface temperature and ocean acidification (Schofield 2009, Côté & Maljković 2010). The lionfish poses a potential threat for severe ecosystem degradation (Albins & Hixon 2013). However, for another rapid marine colonizer, the seagrass *Halophila stipulacea*, the impacts are as yet undetermined (unpublished University of the Virgin Islands Masters in Marine and Environmental Science data). Impacts of other organisms that have been long established, such as the Mediterranean House Gecko (*Hemidactylus mabouia*), Red-footed Tortoise (*Chelonoidis carbonaria*), and Malaysian Trumpet Snail (*Melanoides tuberculata*), have yet to be evaluated. There is virtually no understanding of the impacts of non-native invertebrates, fungi, or microbes within the USVI.

Economic impacts

Invasive species are expensive to island economies. They can damage infrastructure, disrupt agriculture, fisheries, and tourism, and compromise ecosystem services provided by native species (Kairo et al. 2003). The cost of response can overwhelm budgets of small agencies tasked with response. In 2011 alone, the US Department of Interior is estimated to have spent \$100 million on invasive species prevention and response, and other related activities including research, outreach, international cooperation, and habitat restoration (USFWS 2012a). Cost estimates of damage caused by invasives run to more than \$120 billion in the US each year (Pimental et al. 2005). Deer and iguanas in the USVI are causing damage to local crops that significantly affects small-scale farmers. The extent of this impact is unknown, but one farmer claimed he lost an entire crop of lettuce in one afternoon of iguana grazing (Wade, pers. comm., 2016).

The USVI depends on a tourism economy to which invasive species pose a major threat. Tourist visitation to the Caribbean plummeted in 2016 due to fears of Zika, a virus transmitted by the non-native *Aedes* mosquito (World Bank Group 2016). Other potential disruptions to tourism include coral reefs becoming less attractive due to over-predation of colorful reef fish by lionfish. Even iguanas at resorts can have a negative influence when they become too numerous.

The costs of control rise precipitously once species are established. In Florida, over \$6 million has been spent since 2005 in attempts to control and eradicate large invasive constrictor snakes (USFWS 2012b); feral *Boa constrictors* are currently posing a threat to ecosystems on St. Croix (Akin 2015). The US Fish and Wildlife Service (USFWS) spends around \$15,000 annually just to control mongoose during the turtle nesting season at Sandy Point National Wildlife Refuge on St. Croix (N. Angeli, pers. comm., 2016).

The loss of ecosystem services as a result of ecological disruption by invasives is difficult to quantify, especially since there have been few efforts to value ecosystem services in the USVI. The overgrowth of algae on reef systems is likely to be exacerbated by predation of herbivores by lionfish, but economic values of those impacts are unknown.

Social and Cultural impacts

Socio-economic and cultural impacts of invasive species include introduction of diseases or disease vectors (mosquitos and dengue, chikungunya, and zika; cholera in Haiti), disruption of traditional livelihoods, and economic losses from damage to crops or homes. Invasive species can also cause damage to historic structures, by undermining soils or destroying original building materials (Su et al. 2003).

Challenges of Managing Invasives in the USVI

There are numerous challenges to implementing a coordinated response to invasive species in the U.S.V.I.; some of these pertain to cultural practices, others are related to insular geography, but many of the challenges are related to agency capacity and can be addressed through a cohesive initiative. There is a general lack of understanding of the value of biodiversity and the threats that invasives cause, resulting in a low appreciation of risks and causes. Limited access to scientific data and training or management materials such as traps and herbicides, coupled with a shortage of funding and personnel dedicated to

invasives research and response, has hampered efforts to increase institutional commitment to this issue. Additionally, challenges often relate to the turnover of staff and poor communication between agency offices on different islands, which often creates a loss of institutional memory of invasion events and how to manage them. There are few specialized private contractors who are available to provide the needed expertise. A further compounding factor is the lack of federal agencies who have offices in the U.S.V.I., including the U.S. Department of Agriculture APHIS, a key partner in invasive species management (indications are that there are plans to establish an APHIS office on St. Thomas; K. Gruver, APHIS, pers. comm., 2016).

There are also traditional and cultural practices that result in the persistence of non-natives across the island landscape. Livestock, mainly goats and cattle, and in rare cases pigs, are left to forage freely (on invasive guinea grass (*Megathyrsus maximus*). On all four major islands in the U.S.V.I., feral chickens are abundant, but there is a reluctance to harvest them and their eggs. The propensity towards free-range extends to pets, and combined with a general (and religious, for some) resistance to spaying and neutering pets, this has resulted in a growing population of feral dogs and an epidemic of feral cats. While there are efforts to maintain cat feeding stations, and while trap-neuter-release programs do exist, both are largely ineffective at reducing the over-population of feral cats on all of the islands. Free-roaming abandoned and feral cats are non-native predators and cause considerable wildlife destruction and ecosystem disruption, including the deaths of hundreds of birds, small mammals, reptiles, amphibians, and fish. They also pose a threat to public health. Zoonotic concerns include viral (e.g. rabies), bacterial (e.g. *Yersinia pestis*, *Francisella tularensis*, *Campylobacter* spp., *Bartonella* spp.), fungal (e.g. *Microsporium canis*), and parasitic (e.g. *Cryptosporidium* spp., *Toxacara cati*, *Toxoplasma gondii*, *Cheyletiella* spp.) diseases (AVMA ...Feral 2016).

The containment and tracking of invasive species is compounded by the lack of inspection of inbound commercial shipments between the islands and Puerto Rico, other islands in the Caribbean, and from the United States mainland, as well as inter-island in the U.S.V.I. The knowledge that the U.S.V.I. has been a centralized shipping and distribution point for the West Indies since 1671 clearly indicates how easy the introduction of invasives has been in our territory. USDA APHIS, and U.S. Customs and Border Protection (CBP) have the authority to inspect international imports, while the V.I. Department of Agriculture has authority over inter-state shipments. The lack of priority for the issue of invasives, and the lack of a coordinated agency approach, leaves the territory at risk of intentional or unintentional establishment of diseases, pests, and agents that may cause significant harm.

Legislative Framework

Federal recognition of the importance of the prevention, response, and control of invasive species in order to minimize the negative economic, ecological, and human health impacts led to the issuance of Presidential Executive Order 13112 (1999) and which referenced:

- **The Lacey Act** (18 USC 42-43, 16 USC 3371-3378) imposes restrictions on importation and movement across state lines of “injurious” species. When the Lacey Act was passed in 1900, it became the first federal law protecting wildlife. It enforces civil and criminal penalties for the

illegal trade of animals and plants. Today it also regulates the import of any species protected by international or domestic law and prevents the spread of invasive, or non-native, species.

- **National Environmental Policy Act** of 1969 (NEPA) as amended (42 U.S.C. 4321 et seq.) The purpose of NEPA is to ensure that environmental factors are weighted equally when compared to other factors in the decision making process undertaken by federal agencies.
- **Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990**, as amended (16 U.S.C. 4701 et seq.), The purpose of this Act is to prevent introduction of and to control the spread of introduced aquatic nuisance species and the brown tree snake.
- **The Plant Protection Act of 2000 (P.L. 106-224, Title IV)** which superceded the **Federal Plant Pest Act of 1957 (P.L. 85-36)** and the **The Federal Noxious Weed Act of 1974 ("FNWA", Pub.L. 93-629)** Under the new law, the Animal and Plant Health Inspection Service (APHIS) retains broad authority to inspect, seize, quarantine, treat, destroy or dispose of imported plant and animal materials that are potentially harmful to U.S. agriculture, horticulture, forestry, and, to a certain degree, natural resources.
- **Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.)** This Act serves as the enacting legislation to carry out the provisions outlined in The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES 1973), a multilateral treaty to protect endangered plants and animals.

The principal U.S. Virgin Islands legislation is non-specific to invasives but is specific to invasive-related issues, to include legislation established to govern Aquatic Species Protection; Indigenous, Endangered, and Threatened Fish, Wildlife and Plants; the Importation of Snakes; and related to Quarantine Regulations for Animals. That legislation includes:

- **Title 7 V.I. Code Chapter 13 Subchapter II “Virgin Islands Native Aquatic Species Protection Act”**, enacted to establish, maintain, and support, by appropriations to the Department of Planning and Natural Resources (DPNR), efforts to develop strategies to protect Virgin Islands native aquatic species through control of invasive species and other methods, thus benefitting our aquatic ecosystem and our economy.
- **Title 12 V.I. Code Chapter 2 Sections 101-107 Indigenous, Endangered, Threatened . . . Plants and Wildlife**

Sec. 105(c) No person may ship, transport, or export any specimen of an endangered or threatened species, or parts or produce thereof, whether for sale or not, unless such person holds a valid federal permit in the case of a federally listed species, or a valid territorial permit in the case of an **exclusively territorially listed species**.

Sec. 105(d) states that “It shall be unlawful for any person to import or introduce, or cause the importation to the United States Virgin Islands of any species of plant or animal which does not naturally occur in the Territory without express written permission of the Commissioner [*of the V.I. Department of Agriculture*].”

- **Title 14 V.I. Code Chapter 7 Section 192 Importation of Snakes**

192 (a) Whoever imports into the Virgin Islands any snake of any kind, without the prior written permission of the Department of Agriculture, shall be fined not more than \$ 500. (b) Whoever willfully frees within the Virgin Islands any snake of any kind shall be fined not more than \$ 500.

- **Title 19 V.I. Code Part VII Chapters 63 and 65 Sections 2301 and 2501 Veterinary Services & Quarantine**

Section 2301 (a) The Commissioner of Agriculture is authorized, in accordance with law, to establish veterinary inspection services for the supervision and control of the admission into and the exportation from the Virgin Islands of animals and animal products from and to other United States territory, to operate animal terminals and depots established by the Government of the Virgin Islands, and to prescribe, with the approval of the Governor, rules and regulations and fees with respect to the foregoing services, terminals or depots.

Section 2501 The Commissioner of Agriculture may issue quarantine regulations to prevent the importation into the Virgin Islands of diseased or infected animals and animal products, including poultry and poultry products, and may issue all necessary regulations for inspection to effect the object herein specified.

Mechanisms for Management

Prevention

The cost of preventing the arrival of potential invaders is minimal compared to the cost of managing the invaders once they have become established (Pimental et al. 2005). It is critical to be able to identify potential invaders that are likely to have a negative effect in the USVI and intercept them on arrival, and an understanding of pathways of invasion allows for targeted surveillance (e.g., Shamblin et al. 2013). Prevention of entry requires an infrastructure that provides information on acceptable and unacceptable species and products for entry, establishes a territory-wide inspection system, provides training to personnel, and works toward raising awareness and education of local community and visitors (Moultrie 2013). Closing entryways for illegal importation is a key action. Supporting the local native plant landscaping industry has the potential to reduce the inadvertent introduction of many plant and animal pests. Restoring degraded habitat can render areas unsuitable to colonization by potential invaders.

Early detection & rapid response

Early detection and rapid response means that when something unusual is spotted, the observer knows who to contact, and the entity contacted has the tools to respond quickly (NISC 2003). This requires the response community to be aware of current invasive threats and to have active surveillance and monitoring in place for those threats. There must also be infrastructure for rapid communication on detection leading to an immediate deployment of response. This involves mapping of threat species both in and outside of the Territory, public notification, and resources (traps, herbicides, I.D. guides, etc.) available for quick action. The effective model used for lionfish detection and response can be expanded across other potential threats (Kilgo 2014). Enlisting assistance of the public, particularly those who might

be more likely to encounter the invader, such as fishermen, field crews, and outdoor recreationists, can be highly effective. Websites and citizen science projects to inform the community can increase public participation and buy-in.

Control, eradication, and mitigation

Once established, invasive colonizers can show rapid and severe impacts on native species. These impacts must be evaluated to determine action required, whether through elimination, reduction, or mitigation. This involves structured decision making among the response entities and a coordinated use of control methods. Any action requires an initial treatment followed by monitoring and maintenance, and the methods used should be culturally, ethically, and environmentally acceptable (Moultrie 2013). Species-specific plans should be developed for each threat. Appropriate methods for disposal of both target species and any chemicals used should be established in advance. Ecosystem restoration helps to ameliorate stressors caused to native species affected by the threat and can reduce potential of subsequent invasions.

Current Invasive Management Efforts; in the U.S.V.I., Wider Caribbean, and other U.S. Territories

Resource managers in the USVI have been battling invasives for decades. Many of these efforts have demonstrated success in protecting target resources, and the lessons learned can be drawn upon to expand efforts that are coordinated across resources and agencies.

Some examples of existing management of invasives in U.S.V.I. include (this list is not exhaustive and there are other ongoing efforts within the Territory):

- Lionfish response (multiple agencies and private stakeholders: CORE, DPNR, diveshops)
- Removal of goats and rats from cays with nesting shorebird colonies with ongoing monitoring (DPNR)
- Invasive plant management on Buck Island Reef National Monument (NPS)
- Control of mongoose on turtle nesting beaches on St. Croix (USFWS, APHIS, TNC, DPNR, SEA)
- Research on impacts of invasives (e.g., amphibians, *Halophila stipulacea*, lionfish; multiple agencies, UVI)
- Prioritization of forest species of concern (USFS and Geographic Consulting, LLC)
- Restoration of native vegetation at Jacks & Isaacs beaches (TNC)
- Inspection of incoming livestock (V.I. Dept. of Agriculture)

There are many other programs that can be evaluated for guidance. In the Caribbean, there is the eradication of rats from Mona and Desecheo islands in Puerto Rico by Island Conservation and partners (Caribbean Islands National Wildlife Refuge Complex 2011, USFWS & Island Conservation 2013) and the successful inter-disciplinary Antigua Racer Conservation Project (antiguanracer.org) that have resulted in the restoration of island ecosystems. Other regional efforts include invasive species planning by BVI Jost Van Dyke Preservation Society, the Florida Everglades Cooperative Invasive Species Management

Area, and Puerto Rico's Para La Naturaleza in collaboration with the Puerto Rico Department of Natural and Environmental Resources (DNER).

Hawaii provides unique models for cooperative efforts aimed at targeting specific invasives species. The Hawaii Invasive Species Council (HISC) initiated an emergency response effort to combat the Coconut Rhinoceros Beetle (CRB) when it was detected Dec. 23, 2013 at Joint Base Pearl Harbor – Hickam (JBPHH) on coconut trees. A joint effort was mobilized between USDA, University of Hawaii, U.S. Navy, Hawaii's Dept. of Agriculture, and other partners, and an Incident Command System (ICS) was established to respond to this economically damaging pest emergency.

Hawaii's DLNR Division of Aquatic Resources has experienced success in their efforts to control alien invasive algae which was suffocating the reefs in Kaneohe Bay, Oahu, through the removal by suction of the algae and the placement of native sea urchins for cleaning of the coral.

The Brown Treesnake Rapid Response Team (RRT) is led by the United States Geological Survey and is made up of Guam-based biologists and regional stakeholders from the Commonwealth of the Northern Mariana Islands. The team has experiencing success in trapping since they were deployed to Saipan to conduct a coordinated search effort for the damaging Brown Treesnake. Recent sightings on Saipan have led to a regional alert for this invasive animal on Guam, Hawaii, and other Pacific Islands.

The ongoing Invasive species response strategies in the Caribbean, Pacific, Hawaii, and the Bahamas, can serve as models for the development of a strategy for the USVI (see appendix 3). The Department of Interior Office of Insular Affairs is providing funding and support for our strategic development effort through the National Invasive Species Council (NISC); additional funding specific to invasive species management through other federal agencies is anticipated in the 2017 funding cycle.

Actions Towards a Coordinated Response for Non-native Invasive Species in the USVI

The development of a coordinated strategy to address invasive species in the United States Virgin Islands requires coordination and planning among Government departments, federal agencies, and local initiatives aimed specifically at the control and eradication of harmful invasive species infestations throughout the U.S.V.I. and for preventing the introduction of other invasive species that may be potentially harmful.

Institutional framework

Legislation must be developed which outlines a U.S.V.I. institutional framework is needed which will provide territorial leadership regarding invasive species and will define the roles and responsibilities for the development and implementation of a coordinated response to invasives. A mechanism must be

established which will provide for the early detection, rapid containment, and swift eradication of these harmful organism before they become established and due significant harm.

Interagency and stakeholder coordination

Experience learned from other U.S. States and Territories suggests the formation of a local coordinating council for the development of a coordinated response strategy for invasives. Council membership would consist of representatives from various agencies of the Government of the Virgin Islands; Legislature of the Virgin Islands; University of the Virgin Islands; federal agencies; non-governmental organizations; and community stakeholders.

They include:

- **Local entities:** USVI Office of the Governor, USVI Legislature, USVI Department of Planning and Natural Resources, USVI Department of Agriculture, USVI Department of Tourism, University of the Virgin Islands, VI EPSCoR.
- **Federal agencies:** USDA-APHIS, APHIS Wildlife Services, USFWS, National Park Service (NPS), US Customs & Border Protection, Transportation Security Administration (TSA), US Postal Service
- **Non-governmental organizations:** The CORE Foundation, The Nature Conservancy (TNC), St. Croix Environmental Association (SEA).
- **Community stakeholders:** shipping companies, farmers, pet shops, garden centers, landscapers, fishermen, hotels, dive shops, grocery stores, local residents, and others who might be affected by or be able to influence management efforts for invasive species in the USVI.

Capacity

An increase in capacity across all local entities for invasive species response is critical to the success of this effort. While a variety of local and federal agencies have the authority to engage in the detection and response of invasives, they lack the personnel to do so.

Research

Science needs to lead the response to invasives as scientists will look for data and solutions that are not always obvious, and do not confine themselves to conventional paths. More research is needed in species biology and impacts, detection techniques and surveillance, eradication techniques, restoration practices, effects of climate change on invasive species, pathway interdiction methods, and decision support tools (DOI 2016). Understanding species' adaptations to local conditions can predict risks of invasion or establishment. Predictive models of invasion scenarios can prioritize species that are more likely to become problematic.

Funding

There are various mechanisms that can be employed to increase the availability of funds to increase response capacity in the USVI. Local sources of government base funding need to be dedicated in order to demonstrate a commitment; naturally this can be used to leverage and match federal funds from agencies such as the D.O.I. Office of Insular Affairs, National Oceanic and Atmospheric Administration (NOAA), USFWS, U.S. Department of Homeland Security, U.S. Environmental Protection Agency, and others. Mechanisms such as "user fees", where industries that play a role in the importation of non-

native species into the Territory bear more of the cost of invasive species control and management (Jenkins 2002); and “full social cost pricing”, where the cost of environmental externalities are factored into the price of goods and services, may be considered as revenue generators.

Risk assessment

Recognizing which species are currently invasive and which will become invasive in a particular area is a tool that will allow the government to make appropriate decisions in a transparent manner. The goal is to avoid new introduction and spread. Activities such as development on cays should be well-regulated to minimize risk to those vulnerable ecosystems (e.g., Perry & Platenberg 2007). Existing lists of allowable and unallowable species must be developed for the U.S.V.I., along with the appropriate training of personnel for species identification and response. The DPNR Division of Fish and Wildlife has developed recommendations for review of current processes related to the importation of landscaping, agricultural, and construction materials should be evaluated. These recommendations have not been implemented.

Information management and exchange

An Invasive Species information clearing house for the USVI where information on species of concern, response methods, and funding opportunities would be located, needs to be established. Data should also be stored centrally and made available. Access to mapping tools and technical support should also be made available. A repository for specimens (along with training on how to preserve and curate specimens) should be established.

Education and awareness

NGO's such as VI-EPSCoR, VIMAS, St. Croix Environmental Association, Environmental Association of St. Thomas, and CORE offer an existing and effective outreach structure within the USVI environmental community. Several factsheets aimed at increasing community awareness of invasive species within the USVI have already been produced, but are centrally located. A website that collates this information should be a priority as well as identifying gaps in available information. Effectiveness measures of outreach effort should be incorporated into all projects to determine the best ways to access the local community.

Species-specific management strategies

Species have biological traits that make them more or less likely to be transported from their native environment and to become established in a new location. Different species respond differently to novel environments, and species that may not be problematic in one location could have catastrophic effects in another. Detection, control, and eradication methods will also differ across species and across locations where these species have become established. A Lionfish Response Management Plan (Kilgo 2014) was produced that contains research and response data specific to the USVI and provides valuable guidance for local response. The NPS has also produced local management plans for feral cats, hogs, goats, and sheep, as well as mongoose and rats (VINP 2002, 2003, 2004). Such guidance documents should be produced for each priority species and made widely available.

Conclusion

The development and implementation of a coordinated strategy for the response to invasive non-native species needs to be a priority for the U.S.V.I. The island setting and presence of unique biodiversity, which includes endemics and federally protected species, make the need to address a major threat to these valuable resources particularly urgent. This action plan provides a framework for focusing new effort where it will be most effective. This represents a first step towards the commitment to protect our United States Virgin Island biodiversity and thereby protect our economic resources and local culture.

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Appendix 1. The Top Twenty Species of Concern in the US Virgin Islands

Plants

Mother-in-law Tongue	<i>Sanseveria trifasciata</i>
Tan-tan	<i>Leucaena leucocephala</i>
Chinaberry	<i>Melia azedarach</i>
Sweetlime	<i>Triphasia trifolia</i>
Water Hyacinth	<i>Eichhornia crassipes</i>

Terrestrial animals

Feral Cat	<i>Felis catus</i>
Small Indian Mongoose	<i>Herpestes auropunctatus</i>
Black Rat	<i>Rattus rattus</i>
White-tailed Deer	<i>Odocoileus virginianus</i>
Feral Chicken	<i>Gallus gallus domesticus</i>
Boa constrictor	<i>Boa constrictor</i>
Common Ground lizard (on STX)	<i>Ameiva exsul</i>
Puerto Rican Coqui	<i>Eleutherodactylus coqui</i>
Cane Toad	<i>Rhinella marina</i>

Insects

Tiger Mosquito	<i>Aedes aegypti</i>
Fire ant	<i>Solenopsis spp</i>
Unknown agricultural pests	

Fungi

Shelf Mushroom	<i>Ganoderma spp</i>
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Marine Species

Seagrass	<i>Halophila stipulacea</i>
Lionfish	<i>Pterois spp</i>

Appendix 2. Experts Consulted in Action Planning

The listed experts attended or were represented at an Invasive Species Response Scoping Meeting held at DPNR on 21 September 2016 at which constructive feedback was received.

Jen Valiulis	St Croix Environmental Association
Nicole Angeli	Smithsonian Natural History Museum
Clayton Pollock	National Park Service
Shane McKinley	National Park Service
Gary Ray	Virgin Forests VI
Christian Torres	Fundación Luis Muñoz Marín
Towana Guinyard	Veterinary Services USDA- APHIS
Marcia Taylor	UVI VI Marine Advisory Service
John Farchette	St Croix East End Marine Park
Claudia Lombard	US Fish & Wildlife Service
Kitty Edwards	CORE Foundation
Jason Quetel	CORE Foundation
Howard Forbes Jr	UVI VI Marine Advisory Service
Mareike Duffing Romero	UVI
Haley Goodson	UVI
Allie Durdall	UVI
Ruth Gomez	VI DPNR Division of Fish & Wildlife
Daniel Nellis	VI DPNR Division of Fish & Wildlife
Serah James	VI EPSCoR
Joseph deMarco	VI EPSCoR
Toni Thomas	VI Cooperative Extension Service
Bethany Bradford	VI Department of Agriculture
Michael Morgan	UVI

U.S. Virgin Islands Invasive Species Action Plan Steering Committee:

Director Ruth Gomez, Division of Fish and Wildlife, V.I. Department of Planning and Natural Resources
 Mrs. Colette Conroy Monroe, Policy Advisor, Office of the Governor of the U.S. Virgin Islands

Appendix 3. Invasive Species Resources

Invasive Species Partners and Resources

Caribbean Invasive Alien Species Network (ciasnet.org)

CORE Foundation (corevi.org)

Centre for Agriculture and Biosciences International (CABI) Invasive Species as Livelihoods Threat (<http://www.invasive-species.org/>)

Database of Island Invasive Species Eradications (<http://diise.islandconservation.org/>)

Geographic Consulting invasive species fact sheet (<http://geographicconsulting.com/services/invasive-species/>)

Hawaii Invasive Species Council (<http://dlnr.hawaii.gov/hisc/>)

Invasive alien species database for the Caribbean (<http://www.ciasnet.org/wp-content/uploads/2012/11/IAS-in-the-Caribbean-Database-.pdf>)

National Invasive Species Council (<https://www.doi.gov/invasivespecies>)

National Park Service South Florida and Caribbean I& M Network Invasive/Exotic Plants Monitoring Program (https://science.nature.nps.gov/im/units/sfcn/monitor/invasive/inv_plants.cfm)

USDA National Invasive Species Information Center (invasivespeciesinfo.gov)

American Veterinary Medical Association/ Policy on Feral and Free Roaming Cats (<https://www.avma.org/KB/Policies/Pages/Free-roaming-Abandoned-and-Feral-Cats.aspx>)

National and Regional Management Strategies

Guidelines for Invasive Species Management in the Pacific: a Pacific strategy for managing pests, weeds and other invasive species (2009) (http://www.sprep.org/att/publication/000699_RISSFinalLR.pdf)

Hawaii Interagency Biosecurity Plan 2017-2027 (draft, 2016) (<https://hdoa.hawaii.gov/wp-content/uploads/2016/09/Draft-Hawaii-Interagency-Biosecurity-Plan.pdf>)

The Bahamas National Invasive Species Strategy 2013 (<https://breef.org/wp-content/uploads/2015/07/NatInvasiveSpeciesStrategy.pdf>)

Relevant Legislation

Cartagena Protocol on Biosafety (<https://bch.cbd.int/protocol/>)

Invasive Species (Executive Order 13112, Federal Register: Feb 8, 1999 (Volume 64, Number 25))

Protection of Indigenous, Endangered and Threatened Fish, Wildlife and Plants (12 VIC § 105):
importation/introduction of non-native species (DPNR)

Enforcement of conservation offenses (12 VIC § 99a): DPNR enforcement

Veterinary and Related Services (19 VIC § 2301): authorization to establish veterinary inspection services for the supervision & control of the admission to the VI of animals and animal products (VI Dept. Agriculture)

Animal Diseases (19 V.I.C. § 2715): authorization to prevent introduction and spread of infectious diseases in livestock (VI Dept. Agriculture)

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