Critical Situation Analysis (CSA) of Invasive Alien Species (IAS) Status and Management Federation of St. Kitts and Nevis, 2019

Project: *Preventing COSTS of Invasive Alien Species (IAS) in Barbados and the OECS Countries*

GEFSEC ID: 9408
Project component/activity: 1.1 (3) Critical Situational Analyses completed

Kerry M. Dore, Ph.D.

December, 2019

Table of Contents

Acronyms

APHIS	Animal and Plant Health Inspection Service
BHFNP	Brimstone Hill Fortress National Park
CABI	Centre for Agriculture and Biosciences International
CARDI	Caribbean Agricultural Research and Development Institute
CBD	Convention on Biological Diversity
CFCS	Caribbean Food Crop Society
CFRNP	Central Forest Reserve National Park
CISWG	Caribbean Invasive Species Working Group
CRISIS	Caribbean Regional Invasive Species Intervention Strategy
CSA	Critical Situation Analysis
DMR	Department of Marine Resources
DOA	Department of Agriculture
DOE	Department of Environment
EDF SPS	European Development Fund Sanitary and Phytosanitary Measures Project
FAVACA	Florida Association for Volunteer Action in the Caribbean and the Americas
FCP	Feral Cat Program
GEF	Global Environment Facility
GISD	Global Invasive Species Database
GPS	Global Positioning System
IAS	Invasive Alien Species
IUCN	International Union for Conservation of Nature
ISC	Invasive Species Compendium
MEA	Multilateral Environmental Agreement
MOA	Ministry of Agriculture
NASPA	Nevis Air and Sea Port Authority
NBSAP	National Biodiversity Strategy and Action Plan
NCEMA	National Conservation and Environment Management Act
NCEPA	National Conservation and Environmental Protection Act
NEMSAP	National Environmental Management Strategy and Action Plan
NES	National Environmental Summary
NISSAP	National Invasive Species Strategy and Action Plan
OPAAL	OECS Protected Areas and Associated Livelihoods
PHM	Pink Hibiscus Mealybug
PPA	Plant Protection Act
RBVNP	Royal Basseterre Valley National Park
PRA	Pest Risk Analyses
RUSVM	Ross University School of Veterinary Medicine
RUVC	Ross University Veterinary Clinic
SGD	St. George's Declaration
SIDS	Small Island Developing States
SKASPA	St. Kitts Air and Sea Port Authority
SKN	St. Kitts and Nevis
SKSAP	St. Kitts Strategy and Action Plan for Agriculture
TBT	Tropical Bont tick
UNEP	United Nations Environment Programme

UNESCO	United Nations Educational, Scientific, and Cultural Organization
UNDP	United Nations Development Programme
USD	United States Dollar
USDA	United States Department of Agriculture

Executive Summary
This Critical Situation Analysis (CSA) provides a comprehensive review of the occurrence, management history, and current distribution of Invasive Alien Species (IAS) in the Federation of St. Kitts and Nevis. It explains the importance of IAS management in the Caribbean region, evaluates the key stakeholders currently engaged in IAS management in the Federation, and assesses their level of funding, coordination, and collaboration. It describes the environmental profile of the two islands and reviews the material provided by all previous initiatives related to environmental management and biodiversity in the Federation, primarily the National Environmental Management Strategy and Action Plan (NEMSAP), the National Biodiversity Strategy and Action Plan (NBSAP), and the 5th and 6th National Report to the Convention on Biological Diversity (CBD). This CSA reviews the existing IAS databases for the Federation and their level of consistency with regard to specific species and reviews all biodiversity inventories previously conducted in St. Kitts and Nevis, with special attention to protected areas and species that may be negatively impacted by IAS. Finally, this CSA describes the Federation's existing and drafted legislation, policies, and MEAs related to IAS as well as the level of inter-Ministerial coordination and cooperation on IAS issues. African green monkeys are the invasive species cited as the most problematic for the Federation and the focus of the IAS Pilot Project, so special attention is paid to the history of monkeys and their management in the Federation since their arrival in the 1600s. It is likely that invasive plants are also having a serious negative impact, but at the moment they are not considered as important due to a lack of baseline data and studies to determine their impact.

Context, Scope, and Objectives

Invasive alien species (IAS) are exotic species that have been moved outside of their natural range by people (or as a result of their activities) where they establish and proliferate to the detriment of ecosystem health, biodiversity, human and animal health, and water resources (among others) (Witt and Luke 2017). IAS are cited as the second greatest global threat to biodiversity after habitat destruction, and on island nations this threat ranks first (IUCN, see Annex 8 of St. Kitts and Nevis' 6th National Report to the CBD, hereafter referred to as "Annex 8"). Thanks to increased human trade, tourism, transport, travel ("the Four 'T's"), and climate change, IAS have conquered widespread natural barriers (Annex 8). IAS can pose enormous costs to agriculture, forestry, fisheries, human and animal health, and ecosystem services (Krauss 2010). More specifically, IAS can result in the loss of genetic diversity through hybridization, outcompete native species for food and space, introduce disease, and impose significant physical changes to the environment (CABI 2010 in Bullard 2013). While they do not differentiate between alien and indigenous invasive species, the UNEP estimates that invasive species represent a major factor in the potential extinction of 30% of threatened bird species and 15% of threatened plant species. Overall, approximately two-thirds of species extinctions may involve competition with invasive species (Annex 8; Kairo and Ali 2003). Pimentel et al (2001) place the economic and socioeconomic impacts of non-native species invasions at $314 billion USD per year in the United States, United Kingdom, Australia, South Africa, India, and Brazil.

Exotic species can be introduced intentionally or unintentionally. Intentional introductions are often motivated by economic, environmental, or social means (CABI 2012 in Bullard 2013). For example, the mongoose was introduced in St. Kitts and Jamaica to control the rat population (Kairo and Ali 2003), and humans often intentionally smuggle pets or plant material for personal use. Most unintentional introductions happen through "the four 'T's;" for example, many marine species are transported in the ballast water of ships (CABI 2012 in Bullard 2013). The increase in globalization of markets and trading allows more species to move freely into new areas from all parts of the world, thus enhancing the possibility of becoming invasive (Bullard 2013). Relatedly, the increase in tourism allows IAS to arrive through human movement via air, land, and sea, often attaching themselves to clothes or shoes or any object being transported (CABI 2012 in Bullard 2013).

Not all non-indigenous species are problematic; there are many alien species that are not detrimental in their new environments (Bullard 2013). The majority of species used in agriculture, forestry, and fisheries are alien (Annex 8). Thus, an initial step in a national IAS management program must be to distinguish the harmful from the harmless alien species and to identify the impacts of the former on native biodiversity, crop and livestock production, etc. This decision is not always strait forward; conflicts of interest may arise and must also be considered in management plans (Krauss 2010). **Most issues can be resolved with the required data.**

For an alien species to become invasive (i.e. harmful or problematic), it must display certain characteristics. These characteristics include: rapid growth and spread, high reproductive rates, high dispersal ability, the ability to survive on various food types (for vertebrates and invertebrates only), and the ability to adapt to environmental and physiological changes (Kruass 2010, Bullard 2013). IAS are also able to become established due to a lack of natural predators and diseases that would normally aid in controlling the species' population growth (Bullard

2013). Additional characteristics for plants specifically include the ability to compete more effectively for resources than native species, the production of many seeds that can be viable and dormant in the soil for long periods of time and stimulated by fire, and the ability to reproduce vegetatively without the need to produce seeds to disperse. Climate change is expected to intensify threats by causing shifts in the distribution and ranges of species and moving non-native species into the habitat of protected native species, making many native species more vulnerable to non-climate threats (Annex 8). In addition, higher temperatures will reduce developmental rates/times, meaning more generations per year among crop pests, and higher carbon dioxide levels will improve weater-use in some invasive species. In some instances, it may be important to manage only marginally invasive species, alien or not, when they threaten a particularly sensitive site or species of high conservation value (Krauss 2010).

Alarmingly, IAS are considered to be *the* greatest threat to biodiversity in geographically and evolutionarily isolated systems such as St. Kitts and Nevis and the other islands of the Caribbean (Kairo and Ali 2003). Small island developing states (SIDS) generally have high native species diversity and endemism counts and ecological niches that have not been filled due to physical isolation from the mainland. This isolation leaves the islands extremely vulnerable to IAS due to gaps in the ecological niche and the lack of natural competitors and predators competing with established species. Thus, human-introduced IAS can have a dramatic effect on island ecosystems and be a leading cause of species extinctions (Bullard 2013; Krauss 2010).

Countries such as St. Kitts and Nevis, that are party to the Convention on Biological Diversity (CBD), have a legal obligation to address the issue of IAS. The Convention provides that each Contracting Party shall, as far as possible and as appropriate, "prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats, and species" (Art. 8(h)). This was reaffirmed at the Sixth Conference of Parties Meeting at the Hague in 2002 which explicitly calls for action to prevent and mitigate impacts of invasive alien species in Decision VI/23. In addition, Sustainable Development Goal 15 is to "protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss." Under this goal is article 15.8: "by 2020 introduce measures to prevent the introduction and significantly reduce the impact of invasice alien species on land and water ecosystems, and control or eradicate the priority species." Further relevant commitments to the global sustainable development agenda include the Millennium Declaration and the Barbados Programme of Action, otherwise known as the United Nations Programme of Action on the Sustainable Development of Small Island Developing States (Kairo and Ali 2003). St. Kitts and Nevis is also party to the Global Aichi Targets, outlined below in the **Historic Overview** section.

The main objectives of this Critical Situation Analysis are to:

- Review the efforts to prevent, eradicate, and control/mitigate IAS in the Federation. Where discernable, highlight what was effective and what was not, including cost estimates (see **IAS Inventories** section)
- Assess gaps in existing legislative, policy and institutional frameworks including Multilateral Environmental Agreement (MEA) obligations and their fulfillment to prevent IAS introduction to the country as a baseline for the National Invasive

Species Strategy and Action Plan (NISSAP) (see **Multilateral Environmental Agreements** section**)**
- Review key stakeholders currently engaged in IAS management in the Federation and assess their current level of funding, coordination, and collaboration (see **Prevention** and **Sectoral Involvement** sections)
- Review biodiversity inventories in the Federation of St. Kitts and Nevis, paying special attention to the flora and fauna that may be threatened by IAS (see **Biodiversity Inventories** section)
- Highlight the main IAS that are impacting key sectors in the Federation such as agriculture, tourism, biodiversity, and human health (see **IAS Inventories** section)
- Highlight IAS that are not present but have a high probability of affecting the Federation if nothing is done to prevent their entry (see **IAS Inventories** section)

Historic Overview

To date, attention to or concern with IAS in the Federation of St. Kitts and Nevis has been in relation to: 1) their impact on a productive sector like Agriculture or 2) a secondary component of a regional or international initiative regarding conservation or biodiversity, such as the St. George's Declaration (SGD) of Principles for Environmental Sustainability in the OECS (2001) or the Convention on Biological Diversity (CBD).

Past and ongoing IAS projects in St. Kitts and Nevis have been led primarily by the Departments of Agriculture on each island. These include the following initiatives (described in more detail in the **IAS Inventories** section):

- Biological control for the sugarcane stem borer, diamond back moth, army worms, West Indian fruit fly, and cotton cushion scale – 1932-1980
- Caribbean Amblyomma (Tick) Programme – 1995
- Biological Control for Sweetpotato Whitefly – 1996
- Biological Control for Pink Hibiscus Mealybug – 1996
- Primate (Monkey) Control Project – 2010-2013
- National Response to Loss of Coconut Palms Project – 2014

Unlike other islands (e.g. St. Lucia), there is no comprehensive floristic inventory of either St. Kitts or Nevis, which precludes any analysis of invasive plant species (UNDP Protected Areas project document). Early attempts to classify the Federation's biological resources in the name of conservation include the 1990 *Country Environmental Profile: St. Kitts and Nevis*, completed by the Caribbean Conservation Association and Island Resources Foundation, the 1999 *Biodiversity Profile for St. Kitts and Nevis*, completed by the Island Resources Foundation, and the 1999 *A Vegetation Classification of St. Kitts and Nevis: Implications for Conservation*, also completed by the Island Resources Foundation. Regionally, Kairo et al., (2003) was one of the first publications to recognize IAS as a threat to livelihoods and the environment in their paper: *Invasive Species Threats in the Caribbean Region: Report to the Nature Conservancy* (CAB International). This work coincided with the founding of the Caribbean Invasive Species Working Group (CISWG) at the annual meeting of the Caribbean Food Crop Society (CFCS) in Guadeloupe in 2003. CISWG's commitment to the management of environmental IAS, as stated

in its Caribbean Regional Invasive Species Intervention Strategy (CRISIS), has never been implemented (Krauss 2010).

Kairo et al. (2003) list five exotic species for St. Kitts and Nevis, three of which are rated naturalized/invasive (note: Table 1 says only two species are rated as naturalized/invasive, but Appendix 8 lists three). They define exotic as: "known to be present in the Caribbean in cultivation, captivity or in the wild;" naturalised as: "known to be established in the wild in at least one Caribbean country;" and invasive as: "established in the wild and reported to be spreading, and/or regarded as a threat to a native species, ecosystem or causing a socio-economic impact (p. 16)." Specifically in St. Kitts, the silverleaf whitefly (aka sweet potato whitefly, *Bermisia tabaci*), the pink hibiscus mealybug (*Macronellicoccus hirsutus*), the papaya mealybug (*Paracoccus marginatus*), melon thrips (an insect, *Thrips palmi*), the bead tree or red sandalwood tree (*Adenanthera pavonina*), and the candle nut tree (*Aleurites fordii*) are listed as exotic, with the three insect species listed as naturalized and invasive. This is definitely an underestimate of the real situation, as there are probably hundreds of exotic species, many of them naturalized and invasive.

IAS were formally recognized within the Federation as a threat to biodiversity starting in 2004 with both the National Environmental Management Strategy and Action Plan (NEMSAP) and the National Biodiversity Strategy and Action Plan (NBSAP). The 2004 NEMSAP was prepared as a requirement of the Government in discharge of its obligations under the St. George's Declaration (SGD) of Principles for Environmental Sustainability in the OECS, 2001. Under SGD Principle 11, Action 22 ("Adopt and implement the measures contained in the NBSAP"), the specific activities include: finalize NBSAP; arrange for NBSAP to be adopted by Cabinet; identify and implement priority actions, including plan for managing invasive species; and sustained monitoring and controlled use of agrochemicals.

The 2004 NBSAP was an initiative undertaken by the St. Kitts and Nevis (and other OECS countries) on becoming party to the CBD in the early 1990s. These types of initiatives were required by each participating country to satisfy their commitment under the CBD in general and Article 6 in particular (*Each Contracting Party shall, in accordance with its particular conditions and capabilities, 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 measures set out in this Convention relevant to the Contracting Party concerned*). St. Kitts and Nevis' first NBSAP outlined the actions to be taken by the government toward meeting its obligations under the Convention to "ensure sustainable use and conservation of biological resources as well as the fair distribution of benefits related to biodiversity and genetic resources." Invasive species such as the pink hibiscus mealybug (*Macronellicoccus hirsutus*) and tropical bont tick (*Amblyomma variegatum*) are mentioned in the 2004 NBSAP, as well as five invasive agricultural pest species (sugarcane stem borer [*Diatrea saccharalis*], diamond back moth [*Plutells xylostella*], Army worms [*Spodoptera* spp.], West Indian Fruit Fly [*Anestrepha obliqua*], and cotton cushion scale [*Icerya purchasi*]) that were controlled through the use of biological agents between 1932-1980. While cited as "introduced," and not "invasive" per se, data on 12 mammals - the vervet monkey (then classified as *Cercopithecus aethiops*), white tailed deer (*Odocoileus virginianus*), Indian mongoose (*Herpestes edwardsi*), rats (*Rattus rattus; R. norvegicus*), mice (*Mus musculus*), cattle

(*Bos Taurus; B. indicus*), pigs (*Sus scrofa*), rabbits (*Oryctolagus cuniculus*), dogs (*Canus familiaris*), cats (*Felix catus catus*), donkeys (*Equs asinus*), and horses (*Equs caballus*) - are also presented in the 2004 NBSAP. The introduction of invasive alien species is briefly mentioned in Chapter 4 on "Proximate Causes of the Loss of Biodiversity," and a table of invasive pest and disease organisms of importance to animals (e.g. ticks, worms, and viruses) is presented in Appendix 3.

As part of both the "OECS Protected Areas and Associated Livelihoods (OPAAL)" Project, which was initiated in 2010, and the UNDP "Conserving Biodiversity and Reducing Habitat Degradation in Protected Areas and their Areas of Influence" project, which began in 2015 and will end in 2020, the Federation of St. Kitts and Nevis has expanded its Protected Areas, their management, and their biodiversity focus. The authors of the UNDP report list white tailed deer, mongoose, rats, mice, and vervet monkeys in the review of the ecological diversity of St. Kitts & Nevis. They explain that white tailed deer were introduced from Puerto Rico in 1931 to Lodge Estate in St. Kitts, mongoose were introduced in the late 1800s to control rats in the sugar cane plantations, rats and mice were inadvertently introduced in the 1600s or earlier, and monkeys were introduced from West Africa approximately 300 years ago as a pet, "escaped and naturalized" (p 91).

The OPAAL project lists invasive species as a "pressure and threat" for every protected area and state that 18 invasive species have been identified for the Federation on the 2009 Global Invasive Species Database (GISD). The document explains that 10 species are considered "alien," one has an unknown biological status, and seven are considered invasive but are native; however the table does not explain which species fall into what category. As in Kairo et al. (2003), the sweet potato whitefly (*Bermisia tabaci*), and bead tree or red sandalwood tree (*Adenanthera pavonina*) are listed; the pink hibiscus mealybug (*Macronellicoccus hirsutus*), the papaya mealybug (*Paracoccus marginatus*), melon thrips (an insect, *Thrips palmi*), and the candle nut tree (*Aleurites fordii*) are no longer listed as invasive species in the Federation. New invasive species listed at this time (2009) include the following flora: the casuarina or ironwood tree (*Casuarina equisetfolia*); wild mimosa or wild tamarind tree (*Leucaena leucocephala*); paper bark tree (*Melaleuca quinquenervia*); West Indian cedar (*Cedrela odorata*); mimosa, cashier, or needle bush tree (*Acasia farnesiana*); black jack or broom stick herb (*Bidens pilosa*); bitter bush or jack in the bush scrub (*Chromolaena odorata*); cat claw creeper or yellow trumpet vine (*Macfadyena unguis-cati*), guava tree (*Psidium guajava*); and white cedar or whitewood tree (*Tabebuia heterophylla*). Invasive fauna in the Federation in the 2009 Global Invasive Species Database include: the cane toad (*Bufo marinus*); cactus moth or prickly pear moth (*Cactoblastis cactorum*); the carrier pigeon or domestic pigeon (*Columba livia*); the Indian mongoose (*Herpestes javanicus*); Eurasian collared dove (*Streptopelia decaocto*); and the fire ant (*Solenopsis geminata*).

Under the *Convention on Biological Diversity's 2011-2020 Strategic Plan*, St. Kitts and Nevis set twelve National Targets directed by the Global "Aichi Targets." The Federation submitted a 5th National Report for the Convention on Biological Diversity in March 2014 and the second NBSAP in July 2014. In the 5th National Report, invasive species are explicitly stated as a key threat to biodiversity loss; the Federation's Target 7 is: "By 2020, invasive alien species and pathways are identified and prioritized and measures are in place to manage pathways to prevent

their introduction (Aichi Target 9)." Indicators of this target include "a national policy on sustainable management of invasive alien species, rare, endemic, endangered, and threatened species developed and components implemented" (pg 44). In 2014, the 5th National Report showed no significant work/action had been taken in this regard. Appendix A of the 5th National report lists invasive species as a threat to biodiversity and recommends implementing legislation and regulations regarding IAS, increasing public awareness, conducting assessments, and, where practical, removing IAS from the local environment.

The NBSAP was updated in 2014 in recognition of the fact that targets, principles, and priorities would have changed especially with the closure of the sugar industry in St. Kitts and the transformation of the physical and economic landscape of St. Kitts and Nevis. The goal of the plan was to mainstream biodiversity in the overall development process via new national targets, principles and priorities and by targeting stronger institutional integration. In addition, the review sought to identify and examine how various provisions of key legislative, regulatory, and policy instruments could better influence biodiversity management in the Federation. Specifically with regard to IAS, the 2014 NBSAP provides the framework for combining species management principles related to both invasive and alien species and focusing on identifying and controlling pathways for their introduction (5th National Report). IAS are of course cited as a key threat to biodiversity loss, this time with a high threat level, with lion fish and ballast water explicitly highlighted. Target 7/Aichi Target 9 is again mentioned, and again it is stated that: "no significant work/action has been taken in this regard" (pg. 73).

Most recently, in February 2019, the 6th National Report for the Convention on Biological Diversity was released. With regard to IAS, St. Kitts and Nevis' Target 7 and Aichi Target 9 are again mentioned. Section II highlights the measures to be implemented in the Federation and discusses their effectiveness as well as associated obstacles and scientific and technical needs to achieve these targets. One measure is to "Control Invasive Species That Threaten Our Native Biodiversity" (pg. 46). Efforts from the Department of Marine Resources to encourage fishers to catch lionfish (*Pterois* spp.) and restaurants to serve lionfish are highlighted, as well as Nevis' efforts to reduce the number of vervet monkeys and donkeys (it is unclear why St. Kitts' efforts to control monkeys are not mentioned). Key exotic, invasive species outlined as threatening, out-competing, and/or eating native biodiversity are: lionfish, an invasive seagrass (*Halophilia stipulacea*), mongoose, guinea grass (*Megathyrsus maximus*), vervet monkeys, and donkeys. For the first time, special attention is made to the issues with vervet monkeys and donkeys; background information on these species are provided as well as possible ways to reduce or control their population size and mitigate their crop damages.

<u>Background to Pilot Project Study</u>

This UNEP regional project "*Preventing COSTS of Invasive Alien Species (IAS) in Barbados and the OECS Countries*" is focused on the prevention, early detection, control, and management of IAS in the Caribbean. The Global Environment Facility (GEF) is funding the project with the Centre for Agriculture and Biosciences International (CABI) as the Regional Implementing Agency. While seven countries are participating in Component 3 (*Regional Biosecurity*), only Antigua and Barbuda, Barbados, and St. Kitts and Nevis are participating in Components 1 (*IAS Policy, Institutions, and Capacity*) and 2 (*Control and Management of IAS Impacts*). St. Kitts

and Nevis has chosen to focus its efforts for Component 2 on the control and management of African green monkeys (*Chlorocebus sabaeus*).

As the Historic Overview illustrates, the status of African green monkeys in the Federation of St. Kitts and Nevis has significantly changed over time. In earlier reports, monkeys are included as components of the Federation's biodiversity or as exotic species that have "naturalized," and in later reports as an exotic/invasive alien species negatively impacting biodiversity (although no studies have been done to quantify their impact until now). According to local oral histories, the catalyst to this change is Hurricane Hugo in 1989 in Nevis and the closure of the sugar industry in St. Kitts in 2005. Local persons argue that prior to this time, the monkeys were primarily restricted to the central forests of both islands and the southeast peninsula of St. Kitts (Former estate ranger, Winston Lake, personal communication). In Nevis, the belief is that Hugo, Georges, and other hurricanes destroyed the forest fruits so severely that the monkeys were forced out in search of food. In St. Kitts, locals argue that the lack of sugar industry infrastructure (human presence, tractors, and rangers actively shooting monkeys) and hurricanes destroying forest fruits has made it both essential (as the monkeys are searching for food) and easier (due to lack of infrastructure) for the animals to move into the lowlands (Dore 2018). As data were not collected on the density of forest fruits before and after these hurricanes, this information cannot be backed up scientifically. What is clear is that the monkeys were rarely seen outside of the central forest/sugar cane boundary and southeast peninsula in St. Kitts before 2005 and the Central Forest in Nevis before 1989.

As outlined in both the 6th National Report to the CBD and Appendix 16.3 of the UNEP IAS Project Document, green monkeys are having a significant, negative impact on agricultural productivity on both St. Kitts and Nevis (although in the 6th Report, the information is biased towards the efforts that have been made thus far in Nevis, and statements that the monkey issue "is more problematic on Nevis" [pg. 48] are not supported with scientific data). Both islands have thus initiated control measures and organized Federation-wide working groups and meetings related to what is locally called "the monkey problem." Some initial figures are currently available for St. Kitts' and Nevis' recent monkey control efforts. In St. Kitts, 1,879 monkeys were removed from the population between 2010 and 2013 as part of the "Monkey (Primate) Control Project" (210, 698, 467, 252 in each year), which had a budget of approximately 50,000 USD that was provided by the Ministry of Agriculture via a grant from Alba from Venezuela (personal communication, Mr. Melvin James). In Nevis, 4,244 monkeys were removed in 2018 and 2019 (1093 in 2018 and 3151 thus far in 2019) as part of a word-of-mouth campaign calling for help removing monkeys and donkeys from the population (Floyd Liburd, personal communication). The efforts in St. Kitts were the product of a select group of monkey trappers, and in Nevis the efforts were the product a broader group of individuals comprised mainly of individuals with gun permits. In addition to these government led initiatives, three biomedical research facilities in St. Kitts (the Behavioural Science Foundation, The St. Kitts Biomedical Research Foundation, and SKN Primates) routinely pull free-ranging monkeys out of the population for research purposes. The oldest biomedical facility, the Behavioural Science Foundation, has been pulling animals from the St Kitts population since approximately 1972. Since this time, the foundation has taken approximately 12,700 monkeys from St. Kitts and 1,200 from Nevis. The St. Kitts Biomedical Research Facility has removed 1,595 monkeys from the wild since 2015 (888 males and 707 females). The newest biomedical

research facility, SKN Primates, has been in existence since 2012 and has thus far removed approximately 500 monkeys from the wild (personal communication with the heads of all three facilities).

Between 1992 and 1995, the "Monkey Task Force" was created. Mr. Gene Knight from the Policy and Planning Unit has been in charge of the force since it began. He notes: "the Monkey Task Force was one of several taskforces set up by the Department of Agriculture as it experimented with a 'taskforce approach' to the development of agriculture on St. Kitts. Each taskforce was made up of a multi-disciplinary team of experts and was charged with either finding solutions to existing problems or capitalising on known opportunities."

The Monkey Taskforce introduced a monkey trapping programme in the Wingfield and Fahies Settlement farming areas. By 1995, farmers in these areas were experiencing great relief from monkey damage. The relationship between trappers and farmers broke down, however, with a resulting resurgence in the monkey population in those areas. This history highltights the need to have a sustainable plan for the control or management of IAS, as short term plans can make the problem worse by culling the weaker animals.

The newer version of the taskforce was started in 2011. In the three years previous, there were a number of related activities.

- In February, 2009 there was a meeting of experts to discuss the challenge that monkeys were posing to agriculture in the post-sugar period. The meeting included representation from the St. Kitts Behavioural Science Foundation, the St. Kitts Biomedical Research Foundation, the Ross University School of Veterinary Medicine, the Ministry of Agriculture and a trapper. This group would later form the core of the Monkey Taskforce.
- The Department of Agriculture initiated a controlled trapping programme involving a limited number of trappers, operating in designated farming areas. Corral type traps were used and trappers were paid EC$60 for each monkey caught.
- Dr. Santos Hernandez of Cuba was invited to do an estimate of the monkey population on St. Kitts. The planned period of eighteen months was reduced to six months. One month was spent on Nevis. His initial estimate was between forty and fifty thousand animals. He later revised this downwards to between sixteen and twenty thousand.
- Dr. Kerry Dore conducted a one year study on crop raiding patterns by the vervet monkeys within the agricultural sector in St. Kitts. The study covered sixty-five farms across the island.

When the taskforce was convened in 2011, the Hotel and Tourism Association and a farmer were added to the previous list of stakeholders. Dr. Kerry Dore was also invited as a researcher.

The taskforce met one to three times per year and received reports from the various stakeholders on their work in general and how their work could aid efforts to control the monkey population. The Taskforce considered strategies employed for the control of primate and "non-primate" species in different countries. These included spay and neuter programmes, sterilisation

programmes, export to zoos and research facilities, electric fencing and hunting seasons among others.

The welfare of monkeys used in the tourism industry was a source of concern. Vendors allowed tourists to pet the animals and have their picture taken with the monkeys. The questions were whether or not the vendors had the knowledge or the interest to properly care for the monkeys and what happened to the monkeys once they became too large to be used in the industry.

The Taskforce led the staging of an event, jointly funded by the St. Kitts Department of Agriculture and the government of Columbia, termed a "Monkey Summit" in July 2016. This coincided with the visit of a team of primatologists from Colombia, who were invited to contribute to a management solution for the vervet monkey in St. Kitts and Nevis. The Summit proposed a five-pronged strategy to monkey management

- Research to determine effectiveness of different control measures
- Repellent activities using a combination of strategies since monkeys get accustomed to any single deterrent strategy
- Reforestation to provide food for monkeys away from farming areas
- The creation of a bio-reserve for monkeys
- Culling to reduce the population to a manageable size.

The Taskforce is not regularly meeting for the time being as the IAS Steering Committee has taken over the task of finding management strategies to assist with "the monkey problem." The IAS National Steering Committee includes many Taskforce members, including the head of the Taskforce, Mr. Gene Knight.

While the monkeys are clearly having an impact on agriculture and human frustrations, more work is needed to evaluate the monkeys' impact on agriculture from an economic perspective as well as to collect more data on the animals' impact on biodiversity, tourism, and households. St. Kitts and Nevis' goal for the Component 2 pilot project is to collect these data and have a "Management plan developed for the sustained control and management of the monkey (*Chlorocebus sabaeus*) populations." For the agricultural component, anthropologist and primatologist Dr. Kerry Dore will work with economists Dr. Pike Stahlmann-Brown and Dr. Adam Daigneault to develop a statistically significant design to monitor crop losses for three months in St. Kitts and three months in Nevis to establish approximately how many Eastern Caribbean Dollars the Federation is losing annually to monkeys. For the biodiversity component, camera traps will be used to assess the assumptions made by the Environmental Awareness Group that the monkeys may be consuming biologically significant plant and animal species. In addition, fecal samples will be collected in areas deemed important to biodiversity and fecal analysis will be done to establish whether the monkeys are eating plants of conservation concern. For the tourism component, Dr. Kerry Dore will interview key individuals in hotels and government offices across the federation to evaluate the positive and negative impacts of the monkeys on tourism. For the household component, we will work in the same village as the habituated monkeys and collaborate with scientists from Ross University School of Veterinary Medicine to evaluate monkeys' possible negative impacts on household property (housing structures, backyard gardens, etc.) and health. More specifically, we will determine whether

monkeys' increased presence in the villages has led to an increased transmission in parasites, viruses, and bacteria between monkeys and humans.

St. Kitts and Nevis' Environmental Profile

St. Kitts and Nevis are located in the northern part of the Lesser Antilles chain of islands in the Eastern Caribbean. The twin-island Federation has a land area of 269 km^2 (104 mi^2); St. Kitts is 176 km^2 (68 mi^2) and Nevis is 93 km^2 (36 mi^2). The total population of St. Kitts and Nevis is approximately 53,000, of which 11,000 persons reside on Nevis. The physical landscape of St. Kitts is characterized by three volcanic centers: the central northwest range, dominated by the country's highest peak Mt. Liamuiga (1,156 meters elevation), and the middle and southeast ranges, which consist of a number of irregular related peaks reaching heights up to almost 1,000 meters. Most of the flat or moderately sloped land on St. Kitts occurs near the coast, and as a result, most urban and agricultural development has occurred there. The island's coastline largely consists of cliffs, some 15- 30 meters high. The island of Nevis is approximately circular and dominated by the central Nevis Peak (985 meters elevation). Windy Hill (309 meters) and Saddle Hill (381 meters) at the head and tail of the island, respectively, align with Nevis Peak to form a north-northwest/south-south-east trending spine comparable to the more pronounced spine of St. Kitts (UNDP Protected Areas project document).

Both St. Kitts and Nevis have a tropical marine climate, heavily influenced by steady northeast trade winds. There are only small variations in temperature throughout the year, the average at Basseterre being 27.8 degrees C (79.6 F). Nevis temperatures and seasonal variations are similar. At lower elevations, maxima above 32 degrees C (90 F) and minima below 18 degrees C (65 F) are extremely rare. Only at higher elevations, where the rule of thumb is a one degree Celsius ambient temperature drop per 100 meters in altitude above sea level, do temperatures drop below 17 degrees C (60 F). The prevailing winds hold fairly steady from the east, swinging seasonally between northeast and southeast with mean speeds ranging from 5.4 mph in November to 9.1 in July. The months with the higher wind speeds are the dry months from January to March. Cloud cover is more common than would be expected, averaging between 40 and 50 percent, which helps account for the relatively low evapo-transpiration rate of around 40 inches per year. Relative humidity averages 76 percent but ranges from 70 percent in March to 78 percent in September, October, and November. The islands receive an average of nine hours of sunshine per day (Lindsay and Horwith 1999a).

Most of the terrestrial landscape of St. Kitts and Nevis has been significantly transformed by human activity, particularly in lowland areas where intensive land use has removed or transformed the natural vegetation communities. On St. Kitts, agricultural lands account for 28% of land below 1,000 ft. (though some of this area is former sugarcane land that has reverted to scrub, secondary forest, or *Luceana* stands), while infrastructure (residential, commercial, industrial, tourism and institutional) accounts for another 10%, with housing concentrated along the coastlines, and to a lesser extent, in small villages clustered along the island's main roads. The large Southeast Peninsula is primarily covered with scrub vegetation, while the remaining low elevation landscape is made up of rock areas, salt ponds, and beaches. Mid-level elevations are characterized by mixed uses, including grazing, farming of food and tree crops and abandoned sugarcane farms. Above 1,000 feet, the rugged uplands are predominantly covered by forest, though large swathes are secondary forests with many non-native plant species.

Approximately 80% of the land on St. Kitts is owned by the Government. In contrast, on Nevis large-scale sugar and cotton production ended many decades ago, and 70% of the land is under private ownership, primarily in small land holdings (less than 2 ha) that are becoming increasingly fragmented as they are sub-divided and sold. Most agricultural production takes place at lower elevations, while land at mid-level elevations are dominated by housing and other infrastructure development. As on St. Kitts, the areas above 1,000 feet on Nevis Peak are predominantly secondary forest (UNDP Protected Areas project document). The Environmental Vulnerability Index of 359 for the Federation classifies it as "highly vulnerable." (http://chartsbin.com/view/39037)

The National Environmental Summary for St. Kitts and Nevis (UNEP, 2010) has identified five environmental issues of national priority for the Federation from a review of national reports and technocrats interviewed:

1. Negative effects of Climate Change and Natural Disasters;
2. Land Degradation;
3. Degradation of Coastal and Marine Ecosystems;
4. High Energy Cost; and
5. Pollution

Six key issues are listed as drivers of the environmental issues listed above. The first is poverty; in 2010, 35% of Kittitian households and 53% of Nevisian households lived below the poverty line. The second is the economic crisis and the fact that local environmental issues are often addressed within the specific parameters of donor agencies. Other key factors listed include attitudes and the political will of politicians to support the necessary measures to affect change; urbanization and development demands, inadequate institutional capacity; and the existence of outdated legislation and poor enforcement.

Protected Areas and Other Areas of High Conservation Value

The existing protected areas system on St. Kitts and Nevis is relatively small and managed with limited resources. That said, the UNDP (GEF funded) project "Conserving Biodiversity and Reducing Habitat Degradation in Protected Areas and their Areas of Influence," which began in 2015 and has been extended to 2020, has significantly improved the protected areas system in the Federation. In St. Kitts, for the terrestrial landscape, only three national park units (Royal Basseterre Valley, Central Forest Reserve, and Brimstone Hill Fortress) have been legally established. The Central Forest Reserve National Park (CFRNP), which is 5,060 ha and occupies all lands above 1,000 feet in elevation, is managed as an area focused on ecological conservation (i.e. biodiversity conservation; protection of water catchment and other ecosystem services; ecotourism and recreation activities). The Royal Basseterre Valley National Park (RBVNP), which is 200 ha, is managed with the primary goal of protecting the most important aquifer on St. Kitts (which supplies the drinking water for the capital city of Basseterre). The Brimstone Hill Fortress National Park (BHFNP) is a colonial-era fortress managed separately by the Brimstone Hill Fortress National Park Society as a historical and cultural site (this site has been a UNESCO World Heritage Site since 1999 and is the only PA in the country with a user fee system in place). In Nevis, for the terrestrial landscape, a management plan was written for the

Nevis Peak National Park and Camps River Watershed Area in 2009, and while it is still in the "proposed" stage, the Federation is currently working towards making this a legally protected area. In addition to the Nevis Peak National Park and Camps River Watershed Area, another proposed protected terrestrial area is the Booby Island Nature Preserve (UNDP Protected Areas project document; Ms. Claudia Drew, personal communication).

Apart from the BHFNP, management of protected area sites in St. Kitts is the responsibility of the Department of Environment (DOE) within the Ministry of Agriculture (MOA). In Nevis, management of the proposed Nevis Peak National Park and Camps River Watershed Area is the responsibility of the Department of Physical Planning and Environment within the Ministry of Communications et al. The Royal Basseterre Valley National Park, the Central Forest Reserve National Park, and the Nevis Peak National Park and Camps River Watershed Area now have management plans and dedicated staff, as five park rangers have been hired (three in St. Kitts and two in Nevis). These individuals manage and monitor the terrestrial protected areas, do trail upkeep, and are currently trying to map all of the trails. The government is currently in the process of making budgetary allocation to retain these individuals when the project ends. Research or other initiatives at these sites that have taken place prior to and since their designation have been carried out through externally funded initiatives, including the development of the management plans, studies of species, and documentation and designation of the CFRNP as an Important Bird Area (UNDP Protected Areas project document). Recently, Ms. Ephrat Yovel was brought in under the UNDP project as a sustainable financing mechanism consultant, working primarily in the CFRNP (Ms. Claudia Drew, personal communication).

As for the marine environment, the Fisheries, Aquaculture and Marine Resources Act was passed in 2016. An area two miles out from the shoreline of both islands was declared a "Marine Management Area" with three Conservation Zones at Sandy Point (60 ha), Keys (8,931 ha), and The Narrows (2,702 ha). The project has employed two Beach Conservation Officers and four Marine Conservation Officers. Other personnel within the Ministry of Agriculture and Department Marine Resources on St Kitts and the Department Marine Resources on Nevis (formerly the Department of Fisheries) now carry out some monitoring and enforcement of fisheries regulations in many areas, including the new Conservation Zones. However, staff members of these agencies have not received any training in Marine Protected Area management activities and lack the of use of a monitoring vessel purchased by the project (it was received in a damaged state), which impedes their work within the Conservation Zones. The St. Kitts Nevis Defence Force Coast Guard assists in monitoring and research activities (UNDP Protected Areas project document, Ms. Claudia Drew, personal communication).

The recent biodiversity inventories outlined below were done as part of the "Conserving Biodiversity and Reducing Habitat Degradation in Protected Areas and their Areas of Influence" project. The project document states that invasive species are a major threat to all of the protected areas, and each of the inventories addresses invasive species that were observed. In many instances, hypotheses are presented about the impacts of invasives, but no official analysis was undertaken.

Biodiversity Inventories

On St. Kitts, 12 vegetation communities were described in the recent biodiversity survey (which is still in draft form):

- *Seasonal evergreen*: secondary forest, most of which occurs outside of the boundaries of the Central Forest Reserve; 9n moister areas and as elevation increases, it grades into evergreen forest and montane thicket)
- *Evergreen forest*: the forest community that most may typically identify as "rain forest," the most mature and oldest patch on the island is located above Wingfield Manor, and between Phillips village and Phillips Level on the eastern side of the Central Forest Reserve
- *Montane non-forest vegetation*: found on steep upper slopes of the summits of the mountains of the Central Range of St. Kitts, relatively short in stature, to about 3 metres in height, wind-blown, and without a canopy or understory
- *Sierra palm, transitional, and tall cloud forest*: found on the upper slopes of the taller peaks of the Central Forest Reserve, just below elfin woodlands
- *Elfin and sierra palm cloud forest*: occurs close to or on top of the summits of the mountains, where wind is relatively high, cloud cover, mist and humidity high and constant, and water drips from the moss and lichen festooned branches
- *Steep non-forest vegetation*: found on steep windy slopes, especially on thin soils where few trees can withstand the onslaught of constant winds
- *Emergent wetland*: at the bottom of the Mount Liamuiga crater
- *Pasture, hay, or other grassy areas*
- *Water - permanent*
- *Emergent wetland*: associated with the mangroves and permanent water communities. The emergent wetland may be seasonal, with standing water appearing after heavy rains and the annual rainy season from June to November
- *Agriculture*: includes food crops, fruit trees, other horticultural plants, or a mixed cultivation, sometimes including livestock rearing
- *Bare soil*: usually occurs on steep slopes, steep banks, where plants cannot grow, and on landslips and landslides

On Nevis, 14 vegetation communities were described in the recent biodiversity survey (which is still in draft form):

- *Semi-deciduous forest* (includes semi-evergreen forest): this community is found in the mid to lower Camps River Watershed. It is secondary, and in many areas, it intergrades with pastures and open patches, and is often maintained by grazing, fires and land-clearing
- *Seasonal evergreen forest*: this forest intergrades with *semi-deciduous forest* in drier areas, and *evergreen forest* in moister and more sheltered spots. Much of this forest

occurs outside of Camps, especially at Mount Pleasant and adjacent areas, and along parts of the trail to the Source, Butlers.

- *Evergreen forest*: this community is similar in species composition and stature to St. Kitts. It intergrades with Seasonal Evergreen Forest on lower drier slopes of Nevis Peak, and with Montane Non-Forest on higher wetter slopes. It can be found at Butlers, Herberts, Upper Mount Pleasant and The Source.
- *Montane non-forest vegetation:* Found on the summit of Nevis Peak. It is similar in composition and structure to the community on St. Kitts.
- *Sierra Palm, transitional and tall cloud forest:* Similar to the community on St. Kitts, this is a forest community dominated by mountain palms and is typically shrouded in mist and high humidity. On Nevis, the palms may emerge from the forest and dominate above the other trees, especially on the western and southern slopes of the Peak.
- *Steep non-forest vegetation:* Found on the steepest windy slopes of Nevis Peak, this community is often associated and may intergrade with *elfin and sierra palm cloud forest*.
- *Pasture, hay, or other grassy areas*
- *Mangroves*: a riparian outflow area at the end of the Camps Ghaut
- *Water - permanent*
- *Emergent wetland*: associated with the mangroves and permanent water communities. The emergent wetland may be seasonal, with standing water appearing after heavy rains and the annual rainy season from June to November
- *Agriculture*: includes food crops, fruit trees, other horticultural plants, or a mixed cultivation, sometimes including livestock rearing
- *Bare soil*: usually occurs on steep slopes, steep banks, where plants cannot grow, and on landslips and landslides
- *Coastal sand:* this community is typically called "beach" and occurs at the foot of Camps River Watershed.
- *Low density urban:* this community includes individual homesteads, roads, paths, related infrastructure and gardens, as well as low density industrial activity, including the storing and dumping of construction and soil waste, all of which occur within the lower Camps River Watershed area.

On Booby Island, two vegetation communities were described in the recent biodiversity survey (which is still in draft form):

- *Pasture, hay or other grassy areas:* much of Booby Island is dominated by the sedge, *Cyperus planifolius*. Scattered across this pasture habitat are tree species, *Tabebuia heterophylla*, *Quadrella cynophallophora*, and *Cynophalla flexuosa*; the scrambling shrub, *Trichostigma octandra*, forms dense low clumps

- *Coastal sand, rock, cliffs or bare ground*: this community occurs in patches on the southern slopes, and on the cliffs on the northern side of the island. It consists of exposed rocks, and

herbaceous grassy patches dominated by the beach grass, *Sporobolus virginicus*, and the beach morning glory *Ipomoea pes-caprae*. Low growing forms of the tree, *Tabebuia heterophylla* are found where the growth is kept stunted by the shallow soils, and constant winds and salt burn.

Cultivated land area in St. Kitts is estimated to have declined by 59% from 1945 to 2000, while seasonal evergreen, evergreen and cloud forest cover types have increased by a combined 26%. Developed land has increased significantly over the same time period (UNDP Protected Areas project document).

The following is a summary of the biological diversity of the islands of St. Kitts and Nevis (data come from the 2010 OECS Protected Areas Systems Plan, UNDP Protected Areas Doc, the biodiversity survey conducted under the UNDP Protected Areas project, which is still in draft form):

Terrestrial Resources

Flora:

The Flora biodiversity survey for the UNDP project was conducted by Kevel Lindsay and Carolyn Thomas, who visited 92 sites in St. Kitts and 54 in Nevis. Of the 147 sites visited over the course of the field surveys, 49 were within the boundaries of the Central Forest Reserve, St. Kitts, Nevis Peak and Camps River Watershed, and Booby Island Protected Areas. Ninety eight (98) were survey sites outside of these areas. Within the Protected Areas, a total of 538 species of plants were recorded for the Central Forest Reserve National Park, while 192 species were found in the Nevis Peak National Park. Booby Island was populated by just 10 species of plants. Table 1 shows the distribution of species numbers among the four physiognomic categories for the plants recorded at each site.

Site/Location	Island	Physiognomic Category				Families	Native	Introduced	Invasive
		Herbs	Shrubs	Trees	Vines				
Mt Liamuiga Summit	St Kitts	12	6	3	1	13	22	0	1
Montane Mt Liamuiga	St Kitts	10	7	10	3	28	48	1	1
Lower Montane Mt Liamuiga	St Kitts	11	10	17	3	37	53	2	1
Dos D'Ane Trail & Summit	St. Kitts	122	19	42	13	41	193	2	1
Olivees	St Kitts	44	26	34	22	54	113	9	9
Upper Phillips	St Kitts	59	24	32	13	58	112	6	7
Upper Wingfield	St Kitts	63	44	46	25	66	158	14	1
Nevis Peak	Nevis	94	18	49	13	67	172	2	0
Herbert Heights	Nevis	37	27	31	19	51	107	6	6
Morgan Estate	Nevis	13	18	27	9	39	71	8	6

Booby Island	Booby Island	5	1	3	1	10	10	0	0

Table 1. Plant species by physiognomic category for the survey sites in target PAs (St. Kitts, Nevis and Booby Island). Data from Lindsay and Thomas (draft UNDP biodiversity survey report).

Outside of the Protected Areas, a total of 1486 species of plants were recorded in St. Kitts and 881 in Nevis. Table 2 shows the distribution of species numbers among the four physiognomic categories for the plants recorded at each site.

Site/Location	Island	Physiognomic Category				Families	Native	Introduced	Invasives
		Herbs	Shrubs	Trees	Vines				
Bayfords	St Kitts	41	20	31	23	55	93	18	7
Canoe Bay	St Kitts	6`	13	19	4	26	40	4	4
Fahies Land Settlement	St Kitts	31	16	21	3	43	76	10	6
Fountain Ghut	St Kitts	39	19	25	12	48	96	5	4
Green Hill/Cayon River	St Kitts	56	31	32	11	59	123	9	7
Guanna Hill	St Kitts	8	11	18	5	25	39	4	4
Kittitian Hill	St Kitts	52	25	32	10	55	99	19	9
La Valle	St Kitts	14	8	9	5	16	30	6	4
Majors Bay	St Kitts	20	15	22	10	30	56	9	7
Miliken- Lower	St Kitts	29	19	25	10	44	73	8	6
Miliken- Upper	St Kitts	26	10	15	10	27	40	5	5
Monkey Hill	St Kitts	42	33	22	22	47	108	11	11
Pellham/Bloody River	St Kitts	18	7	13	2	29	41	1	2
Phillips- Lower	St Kitts	36	16	18	9	46	81	13	9
Sir Timothy's Hill	St Kitts	11	10	15	9	22	40	5	3
South East Peninsula	St Kitts	22	25	20	14	32	74	8	6
Tabernacle- Upper	St Kitts	14	4	11	10	22	21	4	4
Wingfield- Lower	St Kitts	43	22	39	16	55	120	14	10
Barnes Ghut	Nevis	40	22	40	14	57	102	13	8
Bath Wetland	Nevis	11	2	14	1	20	22	6	5
Cades Bay Wetland	Nevis	7	1	4	1	13	13	5	4
Camp Spring	Nevis	8	13	17	4	25	44	3	6
Cat Ghut	Nevis	16	3	4	4	25	30	10	5
Hamilton Road	Nevis	21	18	28	10	34	70	6	5
Indian Castle	Nevis	14	9	7	2	17	27	6	6
Indian Castle Wetland	Nevis	3	3	4	0	5	7	3	2
Montravers	Nevis	12	20	15	12	32	48	7	5
Mount Pleasant	Nevis	25	16	24	10	40	66	7	6
Nelsons Spring	Nevis	19	6	4	18	18	31	8	4
New River Estates	Nevis	25	12	12	2	27	41	7	5
Pinneys Beach Wetland	Nevis	8	5	6	2	14	17	4	5

Prison Trail	Nevis	19	19	21	5	42	62	6	3
Round Hill	Nevis	7	23	16	5	36	48	4	2

Table 2. Plant species by physiognomic category for the survey sites outside PAs. Data from Lindsay and Thomas (draft UNDP biodiversity survey report).

St. Kitts and Nevis are home to several local and regional endemic plants[1], several of which are found within two of the three target PAs, including the ferns, *Asplenium malcolm-smithii* a hybrid species reported and named by botanist George Proctor for Mount Liamuiga, and regional endemic, *Thelypteris muscicola*, a species reported to be found on the slopes of Nevis Peak. However, little is currently known about the habits, population and distribution of these two plants. In fact, the names, as applied, remain taxonomically "unresolved" according to the International Plant Name Index (IPNI). For regional endemics, there are 83 species, with 34 being Lesser Antillean, 47 being West Indian, and 2 being Caribbean (Lesser Antilles plus Trinidad & Tobago). Table 3 provides a summary of the regional and local endemics (H= herb; S= Shrub; T=Tree; V=Vine, N=Native, C= Common, R= Rare, U= Uncommon), and Table 4 provides a statistical summary of these species. There are no regional or local endemics on Booby Island (draft UNDP biodiversity survey report).

[1] Forty-six (or 45 according to the UNDP Protected Areas project document) plant species known to be endemic to the country or endemic to the Lesser Antilles occur in the country. St. Kitts and Nevis has 145 Pteridophyte species (fern and fern-allies), 22 of which occur on Nevis but not in St. Kitts and 41 of which occur in St. Kitts but not on Nevis. According to Table 3 in the UNEP IAS project document, the Federation has two endemic ferns: *Asplenium malcolm-smithii* (a species of spleenwort, or fern) in St. Kitts and *Thelypteris muscicola* (a species of fern) in Nevis (see also https://www.ipni.org). The UNDP Protected Areas project document states that St. Kitts has one endemic fern and Nevis has two, but it not clear what the second species for Nevis may be. Thirty-seven plant species are assessed by IUCN, with 1 Endangered (Small-leaved Mahogany; *Swietenia mahagoni*), 1 Vulnerable (Spanish Cedar; *Cedrela odorata*) and 1 Near Threatened (Big Pine Key Prickly-pear; *Opuntia triacantha*).

Family	Species	Habit (1)	Origin (2)	Status (3)	Region of Endemism	Comments	STK	NEV
Aspleniaceae	*Asplenium malcolm-smithii* Proctor	H	N	R	St. Kitts	Virtually nothing is known about this species. Thought to be a hybrid	*	?
Cyathaceae	*Alsophila muricata* (Willdenow) Desvaux	T	N	C	L/Antillean		*	*
	Cyathea grandifolia Willdenow	H	N	C	L/Antillean		*	
Dennstaedtiaceae	*Elaphoglossum impressum* (Fée) T. Moore	H	N	U	L/Antillean		*	
	Elaphoglossum plumieri T. Moore	H	N	U	W/Indian		*	
Hymenophyllaceae	*Hymenophyllum hirtellum* Swartz	H	N	U	W/Indian		*	*
	Hymenophyllum cf. *latifrons* Bosch	H	N	R	L/Antillean		*	*
	Palhinhaea torta (Sieber ex Underw. & F.E. Lloyd) Christenh.	H	N	R	L/Antillean		*	
Pteridaceae	*Anetium citrifolium* (Linnaeus) Splitgerber	H	N	R	W/Indian		*	
Selaginelaceae	*Selaginella rotundifolia* Spring	H	N	U	L/Antillean		*	
Thelypteridaceae	*Cyclosorus clypeolutatus* (Desv.) Christenh.	H	N	C	L/Antillean		*	
	Thelypteris antillana Proctor	H	N	R	L/Antillean		*	
	Thelypteris limbata (Sw.) Proctor	H	N	R	L/Antillean		*	
	Thelypteris muscicola Proctor	H	N	R	Nevis	Virtually nothing is known about this species		*
Araceae	*Anthurium cordatum* (L.) Schott	H	N	C	W/Indian		*	*
	Anthurium dominicense Schott	H	N		L/Antillean			*
	Philodendron lingulatum (L.) K. Koch	V	N	C	W/Indian			*
Arecaceae	*Coccothrinax barbadensis* Lood ex Mart	T	N	R	W/Indian & Trinidad	Mostly in cultivated situations, this species likely was once common in dry woodland and lower montane forests, but is now extirpated in the wild	*	*
	Prestoea acuminata (Willd.) H.E. Moore	T	N	R	W/Indian	Red and white forms	*	*
Asparagaceae	*Furcraea tuberosa* (Mill.) Aiton	H	N	R	W/Indian	Not observed in any of the official parks	*	
Bromeliaceae	*Guzmania dussii* Mez	H	N	R	L/Antillean	Not observed during the field surveys, but reported for higher elevations of Nevis		*
	Pitcairnia angustifolia Aiton var. *angustifolia*	H	N	C	W/Indian		*	

	Pitcairnia bifrons (Lindl.) R.W. Read	H	N	R	L/Antillean		*	
Cyclanthaceae	*Asplundia insignis* (Duchass. ex. Griseb.) Harling	H	N	C	L/Antillean		*	
	Asplundia rigida (Aublet) Harling	V	N	C	W/Indian		*	
	Machaerina restioides (Sw.) Vahl	H	N	R	W/Indian		*	*
Orchidaceae	*Epidendrum pallidiflorum* Hook	H	N	R	L/Antillean	Not seen on Nevis Peak, but reported from mid to high elevations		*
	Epidendrum patens Sw.	H	N	R	L/Antillean		*	
	Malaxis umbelliflora Swartz	H	N	R	W/Indian	Not seen during the 2017 surveys, but reported for mid to high elevations, also unofficial reports from St. Kitts, based on photos from hikers	?	*
	Microchilus familiaris Ormerod	H	N	R	W/Indian			*
	Ornithidium coccineum (Jacq.) Salisb.	H	N	R	W/Indian		*	
	Orinthidium inflexum Rchb. f.	H	N	R	W/Indian		*	*
	Ponthieva petiolata Lindl.	H	N	R	W/Indian		*	*
	Stelis dussii Cogn	H	N	R	L/Antillean	Not seen on Nevis Peak, but reported from mid to high elevations		*
Podocarpaceae	*Podocarpus coriaceus* Rich. & A. Rich.	T	N	R	W/Indian		*	*
Acanthaceae	*Odontonema nitidum* (Jacquin) Kuntze	S	N	C	W/Indian		*	*
Anacardiaceae	*Comocladia dodonaea* (L.) Urban	T	N	C	W/Indian	In drier habitats of islands	*	*
Annonaceae	*Guatteria caribaea* Urban	T	N	U	W/Indian		*	
Apocynaceae	*Plumeria alba* Linnaeus	T	N	R	W/Indian	In drier habitats of islands	*	*
Aquifoliaceae	*Ilex macfadyenii* (Walp.) Rehder ssp. *ovata* (Griseb.) Nicolson	T	N	R	L/Antillean		*	
	Ilex sideroxyloides (Sw.) Griseb. ssp. *sideroxyloides*	T	N	R	W/Indian		*	
Araliaceae	*Schefflera attenuata* (Sw.) Frodin	T	N	R	L/Antillean		*	
Bignoniaceae	*Tabebuia heterophylla* (DC.) Kunth	T	N	C	W/Indian	Usually at lower to mid-elevations. Populations at higher elevations have much larger leaves. Needs further study	*	*
Boraginaceae	*Cordia sulcata* Linnaeus	T	N	R	W/Indian		*	
	Varronia nesophila (I.M. Johnston) Borhidi	S	N	R	L/Antillean	Drier habitats to mid-elevations	*	
Burseraceae	*Dacryodes excelsa* Vahl	T	N	C	W/Indian		*	*
Cactaceae	*Melocactus intortus* (Miller) Urban	H	N	R	W/Indian		*	*
	Opuntia triacanthos (Willdenow) Sweet	H	N	R	W/Indian		*	*
Calophyllaceae	*Marila racemosa* Griseb.	T	N	R	L/Antillean	Mid to upper elevations, but not observed during field surveys	*	

Campanulaceae	*Lobelia cirsiifolia* Linnaeus	H	N	R	L/Antillean		*	
	Lobelia stricta Sw.	H	N	R	L/Antillean		*	
Chloranthaceae	*Hedyosmum arborescens* Swartz	T	N	C	W/Indian		*	
Clusiaceae	*Clusia major* Linnaeus	T	N	C	L/Antillean		*	
Connaraceae	*Connarus grandifolius* Planchon	V	N	U	L/Antillean		*	
Cucurbitaceae	*Cayaponia americana* Lamarck	V	N	C	W/Indian	Lower to mid-elevations	*	*
Ebenaceae	*Diospyros revoluta* Poir.	T	N	R	W/Indian	In lower seasonal forest	*	**?**
Elaeocarpaceae	*Sloanea berteroana* Choisy ex DC.	T	N	C	W/Indian		*	
	Sloanea dentata Linnaeus	T	N	C	L/Antillean		*	
	Sloanea truncata Urb.	T	N	C	L/Antillean		*	
Gesneriaceae	*Crantzia cristata* (L.) Scop. ex Fritsch	H	N	R	L/Antillean		*	
Lauraceae	*Aniba bracteata* (Nees) Mez	T	N	C	W/Indian		*	
	Beilschmiedia pendula (Sw.) Hemsley	T	N	C	W/Indian		*	
Marcgraviaceae	*Marcgravia umbellata Linnaeus*	V	N	C	L/Antillean		*	
Melastomataceae	*Blakea pulverulenta* M. Vahl	S	N	R	L/Antilles & Tobago	High on the slopes and summit of Dos D'Ane	*	
	Clidemia umbrosa (Swartz) Cogniaux in DC.	S	N	R	W/Indian		*	
	Miconia globuliflora var. *dominicae* R. Howard & E. Kellogg	S	N	R	L/Antillean			*
	Miconia tetrandra (Sw.) D. Don ex G. Don	S	N	R	L/Antillean			*
	Tetrazygia angustifolia (Swartz) DC.	S	N	C	W/Indian	Lower to mid-elevations	*	
	Tetrazygia discolor (L) DC.	S	N	C	L/Antillean		*	
Pentaphylacaceae	*Freziera undulata* (Sw.) Willd.	T	N	U	L/Antillean		*	*
	Ternstroemia elliptica Swartz	S	N	C	L/Antillean	Mid elevations	*	*
Polygonaceae	*Coccoloba pubescens* Linnaeus	T	N	C	W/Indian	Mid-elevations on Nevis. Occasional at higher elevations		*
Primulaceae	*Ardisia obovata* Hamilton	S	N	R	W/Indian			*
Rhamnaceae	*Ziziphus reticulata* Lamarck	T	N	C	W/Indian	New record for St. Kitts. Found in dry woodlands on SEP	*	
Rosaceae	*Rubus ferrugineus* Wikstrom	H	N	R	L/Antillean	On St. Kitts, known only from Dos D'Ane. Endemic to Guadeloupe and St. Kitts	*	
Rubiaceae	*Schradera exotica* (J. F. Gmelin) Standley	V	N	R	W/Indian		*	
	Ixora ferrea (Jacq.) Bentham	T	N	R	W/Indian			*
Sapotaceae	*Pouteria multiflora* (A. DC.) Eyma	T	N	C	W/Indian		*	*
	Sideroxylon obovatum Linnaeus	T	N	R	W/Indian	Dry woodland habitats, including SEP	*	*

Solanaceae	*Solanum bahamense* Linnaeus	S	N	C	W/Indian	Fairly common weedy species at lower to mid-elevations, especially in disturbed areas	*	*
Urticaceae	*Cecropia schreberiana* Miquel	T	N	C	W/Indian		*	*
	Pilea inequalis (Jessieu ex Poiret) Weddell	H	N	R	W/Indian	There are undoubtedly other *Pilea* spp. at the higher elevations of both St. Kitts and Nevis, but only more careful study will determine this	*	
	Pilea semidentata (Jussieu ex Poiret) Weddell	H	N	C	W/Indian	There are undoubtedly other *Pilea* spp. at the higher elevations of both St. Kitts and Nevis, but only more careful study will determine this	*	

Table 3. Regional and local endemic plants of St. Kitts and Nevis in or near target and proposed PAs.

Growth Habit	Totals	Status	Totals	Region of Endemism	Totals	No. Endemics St. Kitts	No. Endemics Nevis
Herbs	38	Common	30	Nevis endemic	1		
Shrubs	10	Uncommon	7	St. Kitts endemic	1		
Trees	29	Rare	43	LA endemic	32		
Vines	6			WI endemic	47		
				Caribbean endemic	2		
TOTALS	83		83		83	73	39
Number of Families	47						
LA Endemic Species on St. Kitts			??				
WI Endemic Species on St. Kitts			??				
LA Endemic Species on Nevis			18				
WI Endemic Species on Nevis			27				

Table 4. Summary totals for the regional and local endemic plants for Survey Sites on St. Kitts, Nevis & Booby Island.

Aside from all native bromeliads, ferns and orchids, the *species of special concern* are listed in Table 5 (PA= protected area; nPA= non-protected area; pPA= proposed protected area). The reasons for not listing the species of bromeliads, ferns and orchids in the table is that the species records for both islands are incomplete, and the lists are quite long and cumbersome. The list includes 21 species, with 10 being herbs, one shrub, nine trees, and one vine, all in 17 families (draft UNDP biodiversity survey report).

Family	Species	Habt	Concerns/Comments/Threats	STK	NEV
Aspleniaceae	*Asplenium malcolm-smithii* Proctor	H	St. Kitts Endemic. Virtually nothing is known about this species. Thought to be a hybrid. Virtually nothing is known about this species, or even if it still exists	**PA**	**?**
Thelypteridaceae	*Thelypteris muscicola* Proctor	H	Nevis Endemic. Virtually nothing is known about this species, or even if it still exists		**PA**
Asparagaceae	*Agave karatto* Miller	H	This native endemic Agave is now rare and seriously threated by the arrival of the often-deadly Mexican Agave Snout Weevil (*Scyphophorus acupunctatus*). The team found plants on the SEP that were decimated by this introduced invasive weevil, which has driven many Caribbean Agave species to the brink of extinction. The weevil has not been officially documented for The Federation. Conclusions are based on field observations by the survey team	**pPA**	**pPA**
Arecaceae	*Acrocomia aculeata* (Jacquin) Lodd ex Mart	T	Threatened by damage to the heart of the palm by African Green Monkeys, who rip the unopened leaves apart to get at young sugar rich shoots. Forest Rangers indicated seeing animals ripping at these palms. Image xxx shows one of many palms at Lower Wingfield, damaged by monkeys	**PA/ pPA**	**PA/ pPA**
	Coccothrinax barbadensis Lood ex Mart	T	West Indian & Trinidad endemic. This species has disappeared from most islands in the Lesser Antilles. Old reports of "palmettos", including names on St. Kitts maps, may refer to this, and or *Sabal causiarum* palms. The Canada Hills was said to have stands of native "palmettos" in the 1800s.	**PA/ nPA/ pPA**	**PA/ nPA/ pPA**
Acanthaceae	*Avicennia germinans (L.) Linnaeus*	T	Because coastal wetlands are declining and disappearing from both St. Kitts and Nevis, many of the related plants species are in danger of decline. *A. germinans* is now relatively rare on both islands	**pPA**	**pPA**
Cyclanthaceae	*Asplundia insignis* (Duchass. ex. Griseb.) Harling	H	This species is harvested for makings the local drink, Sarsaparilla. Concerns have been expressed that virtually nothing is known about the impacts of this practice on the population, and hence, its sustainability	**PA**	
Heliconiaceae	*Heliconia bihai* (L.) Linnaeus	H	Heliconias, once abundant in lower montane and seasonal forests on St. Kitts and Nevis, seemed have dramatically declined, and the team could	**PA**	**PA**

	Heliconia caribaea Lamarck	H	not find the once dense stands, even at some high elevations. While there are no concrete numbers, local feedback also suggested declines over the last 10 or more years. These declines could be possibly be due to the recent drought, and the added impacts of monkeys and rats, who chew at the succulent bases of these water and sugar rich plants, thereby killing them. Rats have decimated Heliconias on Antigua (Kevel Lindsay pers. observation), so this may also be the same on St. Kitts and Nevis Heliconias, once abundant in lower montane and seasonal forests on St. Kitts and Nevis, seemed have dramatically declined, and the team could not find the once dense stands, even at some high elevations. While there are no concrete numbers, local feedback also suggested declines over the last 10 or more years. These declines could be possibly be due to the recent drought, and the added impacts of monkeys and rats, who chew at the succulent bases of these water and sugar rich plants, thereby killing them. Rats have decimated Heliconias on Antigua (Kevel Lindsay pers. observation), so this may also be the same on St. Kitts and Nevis	**PA**	**PA**
Cactaceae	*Hylocereus trigonus* (Haw.) Saff	V	This West Indian endemic vine cactus is known only from small, but declining colonies on Nevis, at Mt. Pleasant, and these colonies do not show mature, flowering and fruiting stems		**pPA**
	Melocactus intortus (Miller) Urban	H	This West Indian endemic cactus has now become rare on both St. Kitts and Nevis, and only a few hundred may now exist on both. Threats include coastal development, erosion, and donkeys and goats eating the plants to gain access to the water and sugar-rich cores	**pPA**	**pPA**
Goodeniaceae	*Scaevola plumieri* (L.) Vahl	S	This is a native beach shrub, often found growing on and protecting dune habitats. It readily hybridises and is replaced by the introduced invasive species, *S. taccada*	**pPA**	**pPA**
Rhizophoraceae	*Rhizophora mangle* Linnaeus	T	Because coastal wetlands are declining and disappearing from both St. Kitts and Nevis, many of the related plants species are in danger of decline. *R. mangle* is now relatively rare on both islands	**pPA**	**pPA**
Rosaceae	*Rubus ferrugineus* Wikstrom	H	On St. Kitts, known only from Dos D'Ane. Endemic to Guadeloupe and St. Kitts	**PA**	

Combretaceae	*Laguncularia racemosa* (L.) C.F. Gaertner	T	Because coastal wetlands are declining and disappearing from both St. Kitts and Nevis, many of the related plants species are in danger of decline. *L. racemosa* is now relatively rare on both islands	**pPA**	**pPA**
Polygonaceae	*Coccoloba swartzii* Meisn f.	T	On the trail to Dos D'Ane, in 2011, a species of *Coccoloba* was noted, that may be this species. No fertile material was present, so ID remains tenuous	**PA**	
Rhamnaceae	*Ziziphus reticulata* Lamarck	T	This West Indian endemic is a new record for St. Kitts and Nevis, and is widely distributed across the SEP. However, the forests and woodlands of this area are all threated by annual wildfires and development	**pPA**	
Rosaceae	*Rubus coronarius* (Sims) Sweet	H	The status of this native wild rose is unknown, including distribution and populations	**PA**	
	Rubus ferrugineus Wikstrom	H	Lesser Antillean Endemic. On St. Kitts, known only from Dos D'Ane. The single population right at the summit of this peak makes it quite vulnerable, and in fact, nothing is known about the other population on Guadeloupe, which was reported to be rare	**PA**	
Ximeniaceae	*Ximenia americana* Linnaeus	T	A new record for St. Kitts and Nevis, and only a few trees are found across the SEP. However, the forests and woodlands of this area are all threated by annual wildfires and development	**pPA**	
Zygophyllaceae					
	Guaiacum officinale Linnaeus	T	Known invariably by many common names, including Tree of Life, this Neotropical plant has declined or become extinct on many islands. Most mature plants found in gardens, graveyards, church compounds and even around towns and villages, are the offspring of materials imported by Colonial agents from Barbados in the early 19th and 20th Centuries, and more recently, by commercial growers and landscapers, from Florida. Wild native populations are rare but are found on the SEP and warrant protection. Image xxx shows a mature old tree on the Nag's Head Peninsula, St. Kitts.	**pPA**	

Table 5. Species of special concern for St. Kitts and Nevis.

Invertebrates:

The first survey of terrestrial invertebrates was conducted as part of the UNDP Protected Areas Project in 2017. As lead author Michael Ivie explains, the terrestrial invertebrates of St. Kitts and Nevis are largely unstudied. No major effort has ever been directed at this most biodiverse of groups as a whole. Based on work on Montserrat, it is estimated that some 4,000 species of terrestrial invertebrates occur on St. Kitts and Nevis. The history of collecting on these islands is undocumented, and the material reported from the small amount of effort done previously is buried in the vast amount of biological literature dealing with the various groups. No summary or central database has ever been assembled. The 2017 work therefore used Coleoptera, or beetles, as a surrogate for the larger fauna. To date, a total of 57 Families of Coleoptera are represented by more than 200 morpho-species in the 2017 data. This is a very rough, and highly incomplete census; however, many other groups were retained for eventual study, even if it may be beyond the life-times of the workers who collected the material. Table 6 gives a list of higher taxa detected, collected and retained or curated as part of the work.

Group/Phylum/Class	Common Names
NON-INSECTS	
Platyhelmenthes	Flatworms
Aranea #	Orb-weaver Spiders
Opiliones #	Harvestmen, Harvesters or Daddy Longlegs
Scorpiones *	Scorpions
Chilopoda #	Centipedes
Diplopoda #	Millipedes
Crustacea #	Including: Crabs, Lobsters, Crayfish, Shrimp, Krill, Woodlice, Barnacles, among others
Acari	Mites and Tics
Pseudoscorpiones #	Pseudoscorpions
Mollusca #	Molluscs
INSECTS	
Collembola	Springtails
Diplura #	Two-pronged Bristletails
Odonata #	Dragon and Damselflies
Embiidina *	Webspinners
Dermaptera *	Earwigs
Blattodea/Isoptera *	Cockroaches/Termites
Phasmatoidea #	Walking Stick Insects
Orthoptera *	Grasshoppers, Locusts, Crickets, Katydids and Wetas
Hemiptera/Homoptera *	True Bugs/Aphids, Scale Insects, Cicadas and Leafhoppers
Thysanoptera	Thrips
Psocoptera	Booklice, Barklice or Barkflies
Lepidoptera	Butterflies and Moths
Diptera *	True Flies

Neuroptera *	Lacewings, Mantidflies, Antlions and relatives
Hymenoptera *	Sawflies, Wasps, Bees and Ants

Table 6. Non-Beetle taxa detected on St. Kitts and Nevis during surveys in 2017.
Notes: * = fully curated (pinned) specimens retained.
= specimens retained in mixed spirit samples.

Mammals:

The 2017 UNDP biodiversity survey found nine species of bats in the Federation (see Table 6). This recent list includes the Guadeloupe big-eared bat, an endangered species that was not listed in the UNDP project document (which was written before the survey was conducted). All other mammals in the Federation are introduced (see Table 9 in the IAS Inventories section).

Species	Subspecies	Common Name	St. Kitts	Nevis	Habit	Status
Ardops nicholsii	*montserratensis*	Antillean Tree Bat	✓	✓	Fruit bat; roosts mainly in large trees found in seasonal, evergreen, and montane forests.	Common.
Artibeus jamaicensis	*jamaicensis*	Jamaican Fruit Bat	✓	✓	Fruit, nectar, and insects; this sp. roosts in a variety of structures, including buildings, caves, cliffs, overhangs, hollow trees, in trees, amongst dead leaves, under bridges and in roof cavities.	Very common. and widespread. This relatively large bat is the most commonly encountered by residents.
Brachyphylla cavernarum	*cavernarum*	Antillean Fruit-Eating Bat/Cave Bat	✓	✓	Omnivorous - fruit, nectar, and insects. Typically forms large colonies in caves and crevices	Common on Nevis, less so on St. Kitts. Only a small number of roosts are known on both islands.
Chiroderma improvisum	None currently known	Guadeloupe Big-Eared Bat	✓	✓	Fruit bat. Natural history unknown. Assumed to be similar to *A. jamaicensis*	Very rare. Only recently reported from both St. Kitts and Nevis. Listed as ***Endangered*** under the IUCN Red List.
Molossus molossus	*molossus*	Velvety Free-Tailed Bat/ Pallas' Mastiff bat	✓	✓	Insectivorous. Roosts in caves, rock cavities, and it makes extensive use	Common. Forages above the forest canopy but easily sampled and caught over water.

					of manmade structures	
Monophyllus plethodon	*luciae*	Insular Single Leaf Bat	✓	✓	Eats fruits, nectar and insects. Roosts in protected, typically humid caves and cavities. Rarely associated with humans	Rare locally. Prefers forested habitats, but ventures into orchards. It will forage on insects in a variety of habitats.
Natalus stramineus	*stramineus*	Lesser Antillean Funnel-Eared Bat	**?**	✓	Insectivore. Typically roost in humid, sometimes hot, caves. May roost singly or in large colonies.	Rare locally. Known from Mt. Pleasant Estate on Nevis. Not known from St. Kitts.
Noctilio leporinus	*mastivus*	Greater Bulldog Bat/Greater Fishing Bat	✓	✓	Eats fish, shrimp/small crayfish and large insects. Roosts in cavities in overhangs and caves.	Rare locally. Prefers coastal areas, along ghauts and forest paths where water is present, or where large flying insects can be caught.
Tadarida brasiliensis	*antillularum*	Mexican Free-Tailed Bat	✓	✓	An insectivorous species. Roosts in caves, rock cavities, under bridges, in tunnels, ruins and under the metal roofing of homes.	Assumed rare, but this bat is difficult to survey. It has not been recorded on St. Kitts since 1896

Table 6. List and status of the bats of St. Kitts and Nevis.

<u>*Birds*</u>:

According to the UNDP Protected Areas project document, there are no longer any endemic bird species on St. Kitts and Nevis. There are 207 bird species listed for the Federation, of which 104 are land birds, 159 are migratory species, 36 are seabirds and 88 are waterbirds[2]. There are 38 Lesser Antilles Endemic Bird Area restricted- range species (BirdLife International), of which 10 are found on both islands. BirdLife International identifies several threatened and endangered species found in the country: 1 Critically Endangered (Jamaica Petrel), 1 Vulnerable (West Indian Whistlingduck), and 4 Near

[2] OECS protected area system plans says: Of the 116 species of birds found in St. Kitts and Nevis, 113 are indigenous species and 3 are non-native species. Of the 72 native, non resident species, 22 are seabirds, waterfowl or other aquatic species, 26 are shorebirds, 7 are non-passerine landbirds and 17 are passerine landbirds.

Threatened species (Semipalmated Sandpiper - *Calidris pusilla*, Piping Plover - *Charadrius melodus*, Reddish Egret - *Egretta rufescens, and* Caribbean Coot - *Fulica caribaea)*. There are three Important Bird Areas in the country: the Central Forest Reserve, the South-east Peninsula, and Booby Island. The Caribbean Seabird Breeding Atlas of the Lesser Antilles identified 1,580 breeding pairs of Bridle Terns, Brown Noddy, Brown Pelican, Laughing Gull, Least Tern, Roseate Tern and Sooty Tern; these species are concentrated in the salt ponds of the South-east Peninsula, on Booby Island, and in the coastal lagoons and ponds on Nevis.

The more recent biodiversity survey, conducted a few years after the above information was written, lists more than 250 species of native and introduced birds for all three islands (table too large to be included here). More than 50% of the total number of birds recorded for the islands, or about 167 species, are found within these PAs. Of these birds within the PAs, more than half, or 55% are migrants (including vagrants and accidental visitors), which could mean that seasonal species of birds are critical to the ecology and survival of the islands' native forests and ecosystems. Sixty-four species (about 34%) of these species within the PAs are resident and breeding, and 10 are considered introduced, and about two may be extinct or extirpated. None of these species are considered invasive. As far as important species or environments, the survey explains that given the apparent decline of Heliconia spp., epiphytes and other plants of the upland moist forests and communities, we need to understand what species of birds may be critical to the survival of these plants and the habitats.

A review of the species suggests that there are at least 10 introduced avians on St. Kitts and Nevis. Four of these species are typically limited to urban areas, disturbed habitats and farms, but have so far not been labelled as problematic. These species include the Eurasian Collared Dove, the Rock Dove, the House Sparrow and the Nutmeg Mannikin.

One other species, the Shiny Cowbird is a relatively recent breeding resident on both islands. Though birds have been noted since the 1800s, they were always considered as vagrant. Now, it has become established. Cowbirds are parasitic nesters, laying their eggs in the nests of unrelated species, thereby leaving the rearing of their offsprings to others. This habit can be detrimental to other native birds, so there needs to be monitoring of how these other species are faring with this new arrival.

Amphibians and Reptiles:
According to the UNDP Protected Areas project document, there are 2 species of amphibians recorded for the country, both IUCN listed as Least Concern; the Lesser Antillean frog (also known as the miniscule brown tree frog or Johnstone's whistling frog, *Eleutherodactylus johnstonei*) is considered endemic to the Lesser Antilles with a widespread distribution, while the marine toad (listed as both *Bufo marinus* and *Rhinella marina*) is introduced. Recent biodiversity surveys for the UNDP protect confirmed two additional introduced species (both IUCN listed as Least Concern): the Cuban tree frog (*Osteopilus septentrionalis*), brought in by the Four Seasons Resort in Nevis from Florida, and the American bull frog (*Lithobates catesbeianus*). The crapaud or mountain

chicken (*Leptodactylus fallax*), native to St. Kitts and Nevis, became extirpated through habitat modification and overexploitation for food.

As for reptiles, the recent UNDP biodiversity survey recorded six species not recorded in the Federation before, bringing the reptile totals to: 11 lizards (6 native, 5 non-native), 4 snakes (1 native, 3 non-native), 1 tortoise (non-native) and 1 freshwater turtle (non-native). Native lizards include the Saba Pygmy Gecko (*Sphaerodactylus sabanus*), the Leeward Banded Pygmy Gecko (*S. sputator*), Forest Gecko (*Thecadactylus rapicauda*), Spotted Tree Lizard (*Anolis bimaculatus*), Schwartz's anole (*Anolis schwartzi*), Orange-headed Ground Lizard (*Pholidoscelis erythrocephalus*). The five non-native lizards are the African house gecko (*Hemidactylus mabouia*), the Asian house gecko (*Hemidactylus frenatus*), the smooth-scaled worm lizard (*Gymnophthalmus underwoodi*), the Cuban knight Anole (*Anolis equestris*), and the Green Iguana (*Iguana iguana*; not seen but believed to be still present from recent reports). The Leeward Islands Blind Snake (*Antillotyphlops geotomus*) is the Federation's only native snake, and the three introduced species are the Corn Snake (*Pantherophis guttatus*), Eastern Rat Snake (*P. alleghaniensis*), and the Brahminy Blind Snake (*Ramphotyphlops braminus*). The non-native tortoise is the red-footed tortoise (*Chelonoidis carbonaria*; not seen but believed to be still present from recent reports) and the non-native freshwater turtle is the red-eared slider (*Trachemys scripta elegans*).

This UNDP study thus raised the known extant herpetofauna of St. Kitts and Nevis to 20 species, comprising 8 native species and 12 aliens. The number of native species of amphibians and reptiles still in existence on St. Kitts and Nevis is considered rather low, while the number of *non*-natives recorded (13 species), on the other hand, is relatively high for a country of this size. The island of Antigua, for example, is similar in size to St. Kitts and Nevis and has only eight invasive alien amphibians and reptiles documented. There is still a question mark over whether four aliens—the green iguana, Cuban knight anole, corn snake and eastern rat snake—are now breeding on St. Kitts and Nevis or whether the individuals seen had arrived recently as pets or stowaways. Discussions with local Nevis Department of Planning staff suggest that there may be a small population of breeding corn snakes.

Aquatic Life:

During February and May 2017, the aquatics team for the UNDP biodiversity survey completed surveys of freshwater and brackish water animal life in St. Kitts and Nevis. The team visited rivers, artificial ponds/reservoirs, estuaries, brackish coastal systems, and animal troughs. Approximately 60 aquatic species were found, 46 on St. Kitts and 22 on Nevis (see Table 7; there is some overlap with invertebrate and reptile/amphibian surveys). The team found no unique or endangered aquatic species.

Common Name	Class	Order	Family	Binomial	Citation	Status	STK	NEV
Slider Turtle	Reptilia	Testudines	Emydidae	*Trachemys scripta*		Introduced	**X**	
Cane Toad	Amphibia	Anura	Bufonidae	*Rhinella marina*		Introduced	**X**	**X**

Cuban Tree Frog	Amphibia	Anura	Hylidae	*Osteopilus septentrionalis*		Introduced	**X**	**X**
Very Large Tadpole	Amphibia	Anura	Ranidae?	*Lithobates catesbeianus?*		Introduced		**X**
Mosquitofish	Actinopterygii	Cyprinodontiformes	Poeciliidae	*Gambusia* sp.	Horwith & Lindsay, 1999	Introduced	**X**	**X**
Guppy	Actinopterygii	Cyprinodontiformes	Poeciliidae	*Poecilia reticulata*		Introduced	**X**	**X**
Mountain mullet	*Actinopterygii*	Mugiliformes	Mugilidae	*Agonostomus monticola*	Horwith & Lindsay, 1999	Native	***X***	
Unknown, possible mullet	Actinopterygii	Mugiliformes	Mugilidae			Unknown		**X**
Tilapia	Actinopterygii	Perciformes	Cichlidae	*Oreochromis* sp.	Horwith, Lindsay 1999	Introduced	**X**	**X**
River Goby	Actinopterygii	Perciformes	Gobiidae	*Awaous banana*	Fishbase.org	Native	**X**	
Goby 1	Actinopterygii	Perciformes	Gobiidae			Native?	**X**	
Goby 2	Actinopterygii	Perciformes	Gobiidae			Native?		**X**
Freshwater snail 1	Gastropoda	Planorboidea	Physidae			Native?	**X**	
Freshwater snail 2	Gastropoda					Native?	**X**	
Freshwater snail 3	Gastropoda	Planorboidea	Physidae	*Physa* sp.		Native?	**X**	**X**
Freshwater snail 4	Gastropoda					Native?	**X**	
Freshwater snail 5	Gastropoda					Native?	**X**	
Virgin Nerite	Gastropoda		Neritidae	*Neritina virginea*		Native?		**X**
Red-rimmed Melania	Gastropoda		Thiaridae	*Melanoides tuberculata*		Native?	**X**	**X**
Aquatic beetle 1	Insecta	Coleoptera	Hydrophilidae			Native	**X**	
Aquatic beetle 2	Insecta	Coleoptera	Hydrophilidae			Native	**X**	
Aquatic beetle 3	Insecta	Coleoptera	Dytiscidae			Native	**X**	
Aquatic beetle 4	Insecta	Coleoptera	Hydrophilidae			Native	**X**	
Large aquatic beetle larva	Insecta	Coleoptera	Dytiscidae			Native	**X**	
Aquatic beetle larva 1	Insecta	Coleoptera	Hydrophilidae			Native		**X**
Aquatic beetle larva 2	Insecta	Coleoptera	Dytiscidae			Native	**X**	
Mosquito Larva	Insecta	Diptera	Culicidae			Native	**X**	
Midge Larva	Insecta	Diptera				Native	**X**	
Fly Maggot	Insecta	Diptera				Native	**X**	
Mayfly Nymph	Insecta	Zygoptera				Native		**X**
Backswimmer	Insecta	Hemiptera	Notonectidae			Native		**X**

Water Boatman	Insecta	Hemiptera	Corixidae			Native	**X**	
Creeping Water Bug	Insecta	Hemiptera	Naucoridae			Native		**X**
Water Strider 1	Insecta	Hemiptera	Veliidae			Native	**X**	
Water Strider 2	Insecta	Hemiptera	Veliidae			Native	**X**	
Water Strider 3	Insecta	Hemiptera	Veliidae			Native	**X**	
Water Strider 4	Insecta	Hemiptera	Gerridae			Native		**X**
Green Water Strider	Insecta	Hemiptera	Veliidae			Native	**X**	
Rambur's Forktail	Insecta	Odonata	Coenagrionidae			Native	**X**	**X**
Dragonfly nymph 1	Insecta	Odonata	Anisoptera		Meurgey, 2013	Native	**X**	
Dragonfly nymph 2	Insecta	Odonata	Anisoptera		Meurgey, 2014	Native	**X**	
Dragonfly nymph 3	Insecta	Odonata	Anisoptera		Meurgey, 2015	Native		**X**
Dragonfly nymph 4	Insecta	Odonata	Anisoptera		Meurgey, 2016	Native		**X**
Dragonfly nymph 5	Insecta	Odonata	Anisoptera		Meurgey, 2017	Native	**X**	
Dragonfly nymph 6	Insecta	Odonata	Anisoptera		Meurgey, 2018	Native	**X**	
Dragonfly nymph 7	Insecta	Odonata	Anisoptera		Meurgey, 2019	Native	**X**	
Dragonfly nymph 8	Insecta	Odonata	Anisoptera		Meurgey, 2020	Native	**X**	
Dragonfly nymph 9	Insecta	Odonata	Anisoptera		Meurgey, 2021	Native	**X**	
Dragonfly nymph 10	Insecta	Odonata	Anisoptera		Meurgey, 2022	Native	**X**	
Freshwater Shrimp	Malacostraca	Decapoda	Atyidae	*Atya* cf. *innocous*		Native	**X**	**X**
Freshwater Shrimp	Malacostraca	Decapoda	Atyidae	*Atya* cf. *lanipes*		Native	**X**	
Freshwater Shrimp	Malacostraca	Decapoda	Atyidae	*Atya* cf. *scabra*		Native	**X**	
Freshwater Shrimp	Malacostraca	Decapoda	*Atyidae*	*Micratya poeyi*		Native	**?**	**?**
Right Hand Crayfish	Malacostraca	Decapoda	Palaemonidae	*Macrobrachium crenulatum*		Native	**X**	
Left Hand Crayfish	Malacostraca	Decapoda	Palaemonidae	*Macrobrachium faustinum*		Native	**X**	
Bigclaw River Shrimp	Malacostraca	Decapoda	Palaemonidae	*Macrobrachium carcinus*		Native	**X**	
Yellow-nose Shrimp	Malacostraca	Decapoda	Caridea	*Xyphocaris elongata*		Native	**X**	
Transparent Prawn	Malacostraca	Decapoda	Palaemonidae	*Palaemon* sp.		Native	**X**	

Freshwater Shrimp	Malacostraca	Decapoda	*Palaemonidae*	*Palaemon pandaliformis*		Native	**?**	**?**
Tiny shrimp	Malacostraca	Decapoda				Native		**X**
Small crab	Malacostraca	Decapoda				Native	**X**	
Amphipod	Malacostraca	Amphipoda				Native		**X**
Horsehair Worm	Phylum Nematomorpha					Native	**X**	
Unknown invert. parasite						Native	**X**	
TOTALS							**49**	**22**

Table 7. Aquatic species in St. Kitts and Nevis.

Coastal Resources

The island of St. Kitts has a total coastline of 78.1 km, consisting of 34.7 km of cliff rocks, 10.8 km of cobble, 6.3 km of boulders and rocks, 13.1 km of black volcanic sand and 13.2 km of golden sand. Nevis also has sandy beaches, rocky shores and massive sea cliffs. The most prominent sandy beach is a 4 km stretch of coastline north from Charlestown to Cades Bay, called Pinneys Beach.

On the island of St. Kitts, there are a number of saltwater ponds located on the Southeast Peninsula. Nevis has a system of freshwater lagoons located throughout the island, some of which are along the coast and are therefore subject to saltwater intrusion. Two small ponds located northeast of Basseterre are the only freshwater ponds on the island of St. Kitts. These ponds provide habitats for many migratory seabirds and shorebirds in the fall and spring

Generally, the mangroves are not abundant on the island of St. Kitts. The most extensive mangrove systems occur on the Southeast Peninsula. On the island of Nevis, red and black mangroves no longer occur naturally in any of the mangrove systems. Stands of white mangroves are dominant on the island, accompanied by fewer buttonwood species. These mangrove systems can be found at Bath Bogs / Bath Stream, Parris Pond, Pinneys Pond , Jessups Bogs / Bowrin Pond, Fort Ashby Lagoon, Mariners Pub Lagoon / Lawrence's Pond, Cades Bay, Jones Bay, Oualie Beach, Newcastle, Nisbet's, Long Haul Bay and at Indian Castle / White Bay .

Marine Resources

In St. Kitts and Nevis, coral reefs and seagrass beds occur primarily along the Southwest coast between Nag's Head and the southern end of Basseterre Bay, the Northwest coast between Sandy Point and Dieppe Bay, the East coast between Conaree and Friar's Bay, the Southeast coast adjacent to the Narrows, the island of Nevis (reasonable balance of coral reefs surrounding the island), and the Northwestern and southern coasts of Nevis.

The species of coral found in the waters of the islands virtually span the entire spectrum of tropical coral diversity from the finger coral to the Staghorn and Elkhorn corals. Other

species such as sponges and soft corals usually accompany these stony hard corals. Seagrass communities are typically co-dominated by Turtle Grass and Manatee Grass.

Migrant mammals include Humpback Whale, Sperm Whale, Bottled nosed Dolphins, Rough-toothed Dolphins, and Spinner Dolphins. There are 462 species of marine fish tabulated for St. Kitts and Nevis of which 16 species are deemed threatened. There are three species of sea turtles that are known to nest in St. Kitts and Nevis, the Hawksbill Turtle, Green Turtle, and Leatherback Turtle. All are internationally classified as endangered (OECS Protected Areas Doc).

IAS Inventories

Terrestrial IAS

Flora:

Of the nearly 100 species found in or posing a potential threat to the present PAs or proposed PAs, 10 are considered invasive or potentially invasive (i.e. not yet present in the islands). The invasive or potentially invasive species of concern include the following, listed in Table 8.

No.[3]	Species	Type	Common Name	Comments
1	*Alpinia purpurata*	Herb	Ginger Lily	Often cultivated as an ornamental, this species has been introduced into forested areas as an ornamental, and from where it can easily spread. It will easily reproduce from sucker and can outcompete native terrestrial plants. Should be removed when encountered. Image xxx shows plants at Upper Wingfield
2	*Antigonon leptopus*	Vine	Coralita Vine, Coral Vine	Found growing around towns and waste places, this very attractive species is often encouraged for its value to bees, use in burials or as an ornamental. But its deep root habits make it hard to eradicate, and it quickly covers native vegetation and smothers native plants. It

[3] All of the floral species listed in the 2010 OECS doc as from the 2009 GISD are not listed here. These are: the bead tree or red sandalwood tree (*Adenanthera pavonina*), the casuarina or ironwood tree (*Casuarina equisetfolia*); wild mimosa or wild tamarind tree (*Leucaena leucocephala*); paper bark tree (*Melaleuca quinquenervia*); West Indian cedar (*Cedrela odorata*); mimosa, cashier, or needle bush tree (*Acasia farnesiana*); black jack or broom stick herb (*Bidens pilosa*); bitter bush or jack in the bush scrub (*Chromolaena odorata*); cat claw creeper or yellow trumpet vine (*Macfadyena unguis-cati*), guava tree (*Psidium guajava*); and white cedar or whitewood tree (*Tabebuia heterophylla*). Newly added to GISD (but still not here): Cashia tree (*Acacia farnesiana*), hurricane grass (*Bothriochloa pertusa*), and seaside heliotrope (*Heliotropium curassavicum*). Perhaps the reason for this discrepancy is because this project was focused on what species are in Protected Areas?

				covers extensive areas on the lower slopes of Nevis, including areas proposed for inclusion in the country's PA system. There needs to be a systematic plan developed for how to control this invasive
3	*Ardisia elliptica*	Shrub	Shoebutton Ardisia	A native of Asia, this species has been on St. Kitts for many decades, but has now spread high up into areas on both sides of St. Kitts
4	*Asystasia gangetica*	Herb	Chinese Violet	A native of Asia, people often discard this garden plant in waste places, helping to spread it far and wide. It is spreading upslope on both St. Kitts and Nevis, and can outcompete and smother native plants
5	*Azadirachta indica*	Tree	Neem	Often celebrated and planted for its value in local folk medicine and remedies, this tree readily spreads, and can form extensive monocultures, outcompeting native plants and disruption water regimes and flow. Should be removed when encountered in wild areas
6	*Cnidoscolus urens*	Shrub	Bull Nettle, Spurge Nettle	A native of Central America to Venezuela, this introduced spurge is long known by Nevisians, and imparts painful stings, welts and rashes. It covers extensive areas on the lower slopes, especially drier areas, and is a nuisance to farmers, home owners and hikers. In recent years, pigs and donkeys, making their way up into the higher elevations are providing a pathway for this species to invade Nevis Peak's slopes, and this would be a major threat to hikers and would adversely impact native plants, woodlands and fauna. A national invasive species plan should be developed for the control of this species
7	*Epipremium pinnatum*	Vine	Dragon-tail Plant	This introduced garden plant is escaping into areas adjacent to forests and woodlands. Should be removed when encountered
8	*Gliricidia sepium*	Tree	Gliricidia, Quick Stick	Used as a living-fence plant, and in folk remedies, this plant naturally seeds on St. Kitts, and is spreading rapidly up the slopes of the island. It has no natural control agent, and can outcompete native plants and disrupt natural woodlands. Should be removed from wild areas when encountered
9	*Scaevola taccada*	Shrub	Beach Cabbage, Sea Lettuce	Introduced as a hotel landscaping plant, many landscapers quickly applied this species to local garden solutions, spreading it across the islands. Birds readily spread the seeds, and it easily colonises new beaches, since the fruits can float for many days without ill effects. It readily hybridises with the native S. plumieri, outcompeting it and it is now in danger of extirpation. This invasive is found in areas proposed for inclusion in the national PA system
10	*Typha domingensis*	Herb	Typha, Cattail	A recent arrival, which likely arrived by migrant waterfowl. It is native to the Caribbean, but can quickly form extensive colonies in wetlands, smothering the system, changing the hydrology and thereby creating new land. The natural wetlands of both St. Kitts and Nevis may be vulnerable, including Nelson's Spring. There needs to be a plan developed for how to control this species and maintain the wetlands for birds and other native flora and fauna

Table 8. Invasive and potentially invasive species within the target PAs.

To date, no significant efforts have been made to manage invasive flora in the Federation.

Invertebrates:

With regard to invertebrates, the Federation has a rather lengthy history of control. While there is not a lot of data on the earliest initiatives, biological control was used for the sugarcane stem borer, diamond back moth, Army worms, West Indian Fruit Fly, and cotton cushion scale between 1932-1980 (6th National report). Mr. Ken Martin, former Director of Agriculture, explained that assistance with the cotton cushion scale came primarily from Dr. Fred Bennett of the Commonwealth Institute of Biological Control, Trinidad Station. To deal with the cotton cushion scale, a ladybird beetle was brought in through the Trinidad station; the beetle was fed and bred here in the Federation and then sent out to areas where the scale was seen. **Martin called the program "very successful."**

In 1957, St. Kitts and Nevis also used biological control to manage an infestation of invasive cacti species (*Opuntia engelmannii var lindheimeri*) using the cactus moth (*Cactoblastis cactorum*) (2010 OECS protected areas doc; Institute of Food Agricultural Sciences, University of Florida (https://edis.ifas.ufl.edu/pdffiles/IN/IN21300.pdf)). Dr. Arne Witt, of CABI, stated that it is likely that the cacti were native to Nevis and proliferated as a result of overgrazing. The International Institute of Biological Control introduced the moth, which was orginally collected in Argentina and then released in Australia and then in South Africa. From where it was introduced to Nevis. However, the target cactus has not been found on Nevis – so, it is not known if the moth eradicated the cactus or if the original identification was incorrect. Other biocontrol agents, namely *Dactylopius austrinus* and *D. opuntiae* were released against *O. engelmannii*, also in 1957. **The cactus moth project in St. Kitts and Nevis was also considered "very successful."**

In the 1950s, puncture vine (*Tribulus cistoides*) became established via aircraft tires or on travelers' clothing, as it was first found at the edges of the unpaved runway, dubbing it locally "the airport weed." The plant was originally viewed as an attractive ornamental at the airport, but inquires about its potential as a weed were soon raised after it was reported in pasture lands and along the road several miles from the airport. Again with assistance from the Commonwealth Institute of Biological Control, in 1966, the stem weevil *Microlarinus lypriformis* (obtained from Hawaii) was released and became rapidly established, infesting every stem within four months. **Within a year the weed was almost completely replaced by grass and other weeds; apparently the enlargement of the airport destroyed the weed and probably also the weevil population. The weed was first reported in Nevis in 1968; the same procedures were followed, and the weed was gone by 1969.**

The first well-documented invertebrate control program was initiated to deal with the tropical bont tick (TBT; *Amblyomma variegatum*), which was first identified in St. Kitts in 1978. Dr. Burnell Nisbett, Chief Veterinary Officer at that time, explained that the tick was in Antigua starting in about 1830; the disease entered the region via cattle that were brought from Senegal. The tick came to Nevis first and then naturally made its way to St. Kitts. Over seven years, from 1978-1985, the tick had spread to most areas of the island, affecting cattle, sheep, and goats. The ruminant livestock population declined from 6,000, 9,000, and 7,000 cattle, sheep, and goats in 1984 to an estimated 400, 800, and 1,000 respectively in 1990. Dr. Nisbett stated that researchers from the University of London did research in St. Kitts (presumably in the 80s) and could not reproduce dermatophylosis on tick-free cattle, even after placing the bacteria directly on the animals' skin. The conclusion from this work is that the saliva of the tick is immunosuppressive, rendering the animals less able to fight off the bacteria.

A project to control the tick on St. Kitts was implemented in 1983. This effort was based on the use of plunge dips located in communal grazing areas. In October of 1995, the Caribbean Amblyomma Programme was initiated on St. Kitts to eradicate the TBT from the Caribbean. In 1996, there were 416 animal owners with 2,000, 4,300, and 4,000 cattle, sheep, and goats, respectively. Cases of dermatophilosis declined from 657 in 1995 to 153 in 1996. During the period 1997 to 1998, treatment with Flumethrin (or beyticol) continued. The Department of Agriculture initiated activities for treatment compliance, monitoring, and TBT surveillance. The animal population increased to 3,000, 6,000, and 4,500 cattle, sheep, and goats, respectively, with 810 animal owners participating. The number of cases of dermatophilosis declined to 42. In 1998, the TBT was confined to three foci. The remainder of the island was declared provisionally tick free (Phillip 2000). **The USDA estimates that it spent 760M on tick programs in the Caribbean by 1993, but it is unclear how much was spent specifically in the Federation (powerpoint on Caribbean Amblyomma Programme, provided by Dr. Tracey Challenger, Chief Veterinary Officer, September 2019).**

In an August 2019 interview, Dr. Tracey Challenger, Chief Veterinary Officer, explained that the TBT is still present on St. Kitts, as there is not enough bayticol to keep the numbers down. Dr. Nisbett said that the issue is that the system of keeping animals in Nevis was different; there was more land available, with animals roaming wild quite freely than the animals in St. Kitts that were more contained. We had a surveillance program in the 2000s that wasn't done properly, and on top of that, animals continued to come from Nevis to slaughter, bringing the tick back in.

The tick has now expanded to new areas, mainly the southeast peninsula. Dr. Challenger stated that the tick is now present in this area because a livestock farmer from the southeast peninsula took a large bull full of ticks from the abbatoir to the southeast before it was examined, accusing another farmer of stealing it. All of the white tailed deer and livestock on the southeast are now full of ticks. **So while the tick program can be considered successful, it is not fully resolved. The island was considered provisionally free of ticks in 2001, but it appears that it is now lightly infested. More**

work is needed to evaluate the state of amblyomma tick infestation and dermatophylosis infection in livestock in the Federation.

One of the Federation's biggest success stories when it comes to IAS management is the "Biological Control for Pink Hibuscus Mealybug" program which was initiated in 1996. The pink hibiscus mealybug (PHM), *Maconellicoccus hirsutus*, is a dangerous pest of many herbs, trees, and shrubs, including hibiscus, citrus, coffee, sugar cane, annonas, guava, mango, okra, sorrel, peanut, beans, soybean, and others. It is found in most tropical areas around the world. It arrived in Egypt from India in 1912 and in Hawaii in 1984. It appeared in Grenada, Trinidad, and St. Kitts in the 1990s. PHM reportedly caused 1.8M/year crop losses in Grenada in 1996-1997 and deleterious effects on the economy, society, and the environment valued between $3.5 and $10 million (USDA PHM information packet).

The 1996 biological program was initiated by the U.S. Department of Agriculture's (USDA) Animal and Plant Health Inspection Service (APHIS) as a means to prevent the pest form entering the US. On August 2, 1996, *Anagyrus kamali*, an exotic parasite of PHM collected and imported by IIBC from China, was released for the first time in St. Kitts. *A. kamali* causes direct mortality of the PHM by laying an egg inside the body of its host. The releases totaled 3,500 individuals at eleven different locations. Most parasitoids were released on infested hibiscus at residential properties, but some were released on wild cotton, seaside grape, and a wild *Acacia* species. One month following the releases, an average of 17.2% of the PHM were found parasitized by *A. kamali* at seven different selected study sites on St. Kitts; by November, parasitization reached an average of 29.4%. The parasites reproductive potential, twice that of PHM, allows it to increase over time significantly and to overcome the PHM. In addition to *A. kamali, Cryptolaemus montrouzieri*, a coccinellid beetle predator called the "mealybug destroyer," was also used as a biological pesticide to tackle the PHM in St. Kitts. Hotels and residential properties that has extremely heavy PHM population densities were targeted for release by *C. montrouzieri*. By 1997, 145,000 adult beetles, commercially purchased in California, were released on more than 200 properties. Within a period of six to eight weeks, the beetle significantly reduced the mealybug population density (USDA). **Mr. Melvin James estimates that the USDA provided at least 7 million USD for this initiative, but it is unclear how much was spent in the Federation specifically (even after reaching out to the mealybug and invasive species contact persons at APHIS, Dr. Shailaja Rabindran and Dr. Phillip Andreozzi). Today, the PHM is still listed as an invasive invertebrate in St. Kitts and Nevis on some invasive species lists, but they are no longer a significant threat, hence this can be considered one of the country's biggest invasive species management successes.**

In 2010, in collaboration with CARDI, two volunteers from the Florida Association for Volunteer Action in the Caribbean and the Americas (FAVACA), Dr Oscar Liburd and Dr Angeleah Browdy, visited St. Kitts and Nevis to assist in training in Integrated Pest Management, particularly for the diamond back moth in cabbage. In anticipation of the practical training session Dr Liburd provided two reduced risk pesticides, Radiant and Entrust, to be evaluated in a trial along with Phoenix, a new pesticide used by the local

farmers. Plots were set down at three locations, CARDI Field Station Estridge, DOA compound La Guerite and a farmer's field at Molineux. Only the data from the Ministry's plot was analyzed since it was the only one correctly executed. In addition, no data was collected from the farmer's plot. The physical collections showed no population of diamond back moth. There were however weekly increases in the amount of white flies and aphids. This indicates that the pesticides used in the 10-day spraying regime did not control these two pests; it appears that the pesticides used on the moths were killing the natural enemies of the white flies and aphids. **An analysis of the yield data from the plot at the DoA showed that there was no significant difference among the treatments indicating that all three pesticides used performed similarly.**

In 2010, CARDI also provided assistance in assessing the efficacy of the three traps and two lures previously evaluated for the control of the sweet potato weevil (*Cylas formicarius*). **The analyzed results of both trials showed that a trap constructed from a Clorox bottle using the Taiwanese lure/pheromone gave the best results on both occasions.** In conjunction with the focal point person from the DOA, CARDI technicians characterized 43 sweet potato varieties planted at the field station at Estridge to see which were tolerant or resistant to the weevil. In addition to selected physical attributes, pictures were taken of tubers, stems and leaves. These were compiled into one document. **It appears that these data have not been put into action (i.e. there is not preference for planting sweet potatoes with higher tolerances to the weevil). Mr. Laurence Knight from CARDI explained that a workshop was held in Mansion on the sweet potato weevil in 2015 with funding from the 10th EDF SPS (European Development Fund Sanitary and Phytosanitary Measures Project), but that the pest is still an issue as weevil control is still managed on a farmer to farmer basis. The pheromone used to catch the weevil is sold at the agriculture department, and at "Open Day" this year there was a display of weevils and information about how to use the Clorox bottle traps effectively. Plans are in place at CARDI to look at biological control (the use of a bio pesticide/fungus) to control sweet potato weevil.**

Another invasive invertebrate is the fire ant, believed to have been brought in during the construction of the Marriott (personal communication). The fire ant usually invades open areas but can easily colonize human infrastructure and agricultural systems such as sugarcane plantations. Its greatest known threats are its painful sting and the economic losses due to crop damage due to its tending of honeydew producing insects. The species is known to reduce populations of native butterfly eggs and larvae (2010 OECS protected areas doc). **This species is still present in significant numbers thus management efforts are needed.**

According to Director of Agriculture, entomologist Mr. Melvin James, a number of other invertebrate pests have entered the region recently. For example, the avocado lace bug (*Pseudacysta perseae*) has not been officially recorded as it has not been documented by a taxonomist. James explained that the bug is doing damage and spreading, but the country has not yet targeted it for management, as avocado is only a minor crop. Another new invasive invertebrate species is the cycad aulacaspis scale (*Aulacaspis yasumatsui*), which according to Mr. James is wreaking havoc in the hospitality industry, doing a lot of

damage to sago palms at the St. Kitts Marriott and the road to the airport. Apparently iundividuals have not realized what is happening yet, they only see the trees dying. In addition, the croton scale (*Codiaeum variegatum*) came to the Federation no more than two years ago. This scale affects croton plants, but also mangoes too. Mr. James explained that mangoes at the Agriculture Department in St. Kitts are turning black; this is from sooty mold – a sugary substance produced by scale insects. The mold grows on leaves or wherever the sugary exudites land. Mr. James suspects this entered the Federation via Miami, as a lot of the plants that are purchased by the hotels here come from Miami. **Detailed investigations are needed to evaluate the status of these invasive species in the Federation.**

Invasive species inventories list the yellow fever mosquito and southern house mosquito in the Federation. Dr. Patrick Kelly from RUSVM stated that the main invasive mosquito to worry about is *Aedes albopictus*, the Asian tiger mosquito, which has spread throughout Europand the US recently (in water in car tires usually). It is a vector of Zika currently only reported from Barbados, the Dominican Republic, Trinidad, the Caymans, and Cuba. ***Aedes albopictus* has not yet been found in St. Kitts but this is a species we should be actively monitoring for. Dr. Kelly and colleagues were recently awarded a $320,000 USD grant from the National Institutes of Health to assess the role of the green monkey in the epidemiology of chikungunya and dengue fever.**

Mammals:

Aside from bats, all other mammals in the Federation are introduced (see Table 9). Not listed is the Nevis rice rat (*Pennatomys nivalis*), an endemic rodent once widespread across the islands of the Eustatia Bank, including St. Eustatius, Nevis and St. Kitts. When the species went extinct is unknown, but the reason for that it is being discussed here is because of recent reports since the 1980s, that a strange rat inhabits the upland forests of both St. Kitts and Nevis. These reports seemed to have been taken seriously, and several attempts, since the 1990s, have been made to determine if it still exists. The results of these efforts remain inconclusive (UNDP biodiversity survey, 2017)

Order	Family	Scientific name	Common name	Islands			IUCN Red List	Comments
				SK	N	B		
Rodentia	Muridae	*Mus musculus*	House Mouse	**X**	**X**		Least Concern	Mostly commensal, but observed in a rural area on Nevis by Kevel Lindsay
Rodentia	Muridae	*Rattus rattus*	Black Rat; Ship Rat	**X**	**X**		Least Concern	Frequently seen during day time. Faeces abundant in forest.
Rodentia	Muridae	*Rattus norvegicus*	Brown Rat; Norway Rat	**X**	**(X)**		Least Concern	Photographed in Basseterre
Rodentia	Dasyproctidae	*Dasyprocta leporina*	Red-rumped Agouti; Brazilian Agouti	**(X)**	**(X)**		Least Concern	"Believed to be an Amerindian introduction, but extirpated within historical times" (Horwith & Lindsay, 1999).
Primates	Cercopithecidae	*Chlorocebus pygerythrus*	Vervet Monkey; African Green Monkey	**X**	**X**		Least Concern	Ubiquitous. Commonly seen during fieldwork.
Carnivora	Herpestidae	*Herpestes javanicus*	Small Asian Mongoose	**X**	**X**		Least Concern	Introduced in the late 1800s to control rats.
Carnivora	Felidae	*Felis catus*	Domestic Cat	**X**	**X**		N/A	Locally common.
Carnivora	Canidae	*Canis familiaris*	Domestic Dog	**X**	**X**		N/A	Uncertain whether there are truly feral dogs outside of settlements
Artiodactyla	Suidae	*Sus scrofa*	Domestic Pig	**(X)**	**X**		N/A	Scat and rooting activity were noted at Herbert Heights, Nevis
Artiodactyla	Cervidae	*Odocoileus virginianus*	White-tailed Deer	**X**			Least Concern	Appears to be largely restricted to southern St Kitts, including Frigate Bay and the South East Peninsula. A male was reportedly killed by collision with a vehicle along the main road near Major's Bay on December 2017 (Fox Rogers, via Facebook. See: https://www.facebook.com/groups/445396832297065/search/?query=deer&epa=SEARCH_BOX
Artiodactyla	Bovidae	*Capra aegagrus hircus*	Domestic Goat	**X**	**X**		N/A	Free-ranging and possibly some feral groups
Artiodactyla	Bovidae	*Ovis aries*	Domestic Sheep	**X**	**X**		N/A	Free-ranging and possibly some feral groups
Perissodactyla	Equidae	*Equus africanus*	Donkey		**(X)**		N/A	Scat encountered at Herbert Heights, Nevis.

Table 9. Invasive mammals on St Kitts and Nevis.

Rats (*Rattus rattus* and *R. norvegicus*) as well as mice (*Mus muscalus*) were inadvertently introduced around the 1600s or earlier (biodiversity profile). **To date, the only known research dedicated specifically to these species in the Federation is a $15,000 USD grant recently awarded to Dr. Shreekumari Rajeev and Ms. Kanae Shiokawa at RUSVM to assess whether active culling reduces Leptospira reservoirs in rat populations.** Dr. Rajeev explained that she left RUSVM before any culling was performed, and that she is currently working to publish a paper on the prevalence of leptospirosis in the rat population in the Federation.

As previously explained, the green monkey is often cited as one of, if not the most, problematic mammal species in the Federation. This designation as problematic is fairly recent, however, with oral history citing the closure of the sugar industry as the catalyst to increases in monkey movement and likely population size.

In August 2019, Mr. Winston Lake, former sugar industry overseer and monkey ranger, explained that monkey shooting was a routine aspect of the sugar industry. Lake started shooting as a teenager in 1963 at Lynches/Lavington Estate and continued up until 2005. During his 40+ year career, he estimates that he personally shot about 14,000 monkeys – all larger males and occasionally larger females. Over the hundreds of years that sugar dominated St. Kitts' landscape, each estate had a ranger hired to shoot animals entering the fields, and there were a few government rangers in addition to those stationed at each estate. At Lynches/Lavinton, Lake stated that at least 10-12 monkeys were killed each week, but that not all estates had that level of sustained control. At the closure of the sugar industry there were approximately 47 estates; if each had the level of control that Lynches/Lavington did, that would be between 24,400 and 29,328 monkeys killed each year to protect the sugar cane product. Lake stated that toward the end of the industry there was not nearly as much effort put into shooting, but that many other trapping techniques were used. He would say approximately 15,000 monkeys were shot annually around the island.

Most regular shooting and trapping ended when the sugar industry closed in 2005. According to Director of Agriculture Mr. Melvin James, approximately 5 years later, complaints from the smallholding farmers now working on previous cane land led to the initiation to the "Primate (Monkey) Control Project" led by the Department of Agriculture and funded by Alba (Venezuela). Apparently approximately 1M USD was set aside by Alba for monkey control as well as other things; the Department was given approximately 100,000 USD for monkey control. From approximately 2010-2013, 60ecd was given to specific trappers for a live monkey. The trappers were told to bring the monkeys alive, as the ketamine used to sedate them took a few days to get out of their system. At this time they were given to the military personnel for consumption. As previously stated, 1,879 monkeys were killed as part of this program. **The IAS pilot project is aimed at improving our understanding of the monkeys' impact on agriculture, biodiversity, tourism, and households as well as to develop a cost-benefit analysis of potential management strategies. This work should catalyze significant efforts to manage this species in the Federation.**

The mongoose a small, slim-bodied predator native to areas from Iran, through India to Myanmar and the Malay Peninsula. It was introduced to the Federation in the late 1800s to control rats, particularly in sugarcane fields. Unfortunately, native mammals, birds, reptiles, amphibians and invertebrates were found to be easier prey. The mongoose has been responsible for at least three total species extinctions and many other local extinctions. It is also a vector for rabies (OECS 2010 protected areas doc).

Mongoose research in the Federation started in 2013-2014 with the monitoring of species related to rabies. They did not find any antibodies, nor did they prove positive for leptospirosis. They did have cat fleas and a few parasites, but very little. With this project the university also looked at the mongooses' bait consumption (to be used as a rabies vaccination technique if necessary). In 2015-2016 an intramural grant from RUSVM was awarded to Dr. Luis Cruz to assess local human perceptions of the animals. The results indicated a neutral to positive perception, mostly because the mongooses eat snakes. Most recently, Dr. Anne Conan from RUSVM is collaborating with the University of Montreal and the USDA to look at the distribution, population, and repopulation of mongoose; this work will serve as a regional model for rabies control in the areas where they have it (Puerto Rico, Grenada, and the Dominican Republic). The team did population surveys all around the island and designated an area at the aquifer in front of Eastern Caribbean Central Bank for their work. In July 2018, the team did physical and photo capture/recapture at the aquifer and GPS collared 20 animals within a km^2 area to evaluate the animals' movements for six months. Interestingly, a large fire in the area displaced and/or killed a number of animals; the results of this environmental disaster on this mongoose population are still forthcoming. In June 2019, half of the population (N=90) was culled, and in August 2019 another mark/recapture estimate was performed. They are currently analyzing the data on repopulation during this two month time period. **The results of this work can inform mongoose management efforts for the island.**

Feral cats and dogs also roam free in many parts of the island. Some control of cat reproduction exists in St. Kitts: RUSVM has a Feral Cat Program (FCP) that has sterilized 1,799 cats since 2011 (as of October 2019). Four times a semester, approximately 22 cats are trapped in communities where problems have been reported. As there are three semesters per calendar year, approximately 330 cats are spayed each year in this program. Students do all of the community outreach and trapping. Under the guidance of RUSVM faculty veterinary supervisors, the students also do all the surgeries, monitoring, and re-release of the animals. In addition, there is a side component of the program where 30 cats per year become adoptable. **As the program has continued to work in the same communities over time, administrators of the program understand that the program works and is a valuable community service and experience for students, but in terms of cat population control is essentially doing just enough to "keep the pot from boiling over."**

There are other sterilization resources on the island through RUSVM; there is a spay/neuter program for both dogs and cats that is run through the RUVC (Ross University Veterinary Clinic). In this program, local owners can bring their dogs and cats

to Ross and it will be spayed or neutered (for free) by a 7th semester student under the guidance of a surgery faculty member. They also get a free vaccine and dose of dewormer and flea/tick treatment as well as some baseline blood work. In addition there is an international volunteer veterinary organization that has a student chapter at RUSVM. They do 4 sterilization days on Nevis each semester at Nevis Animal Speak. The set up is similar to the FCP where supervising vets volunteer to help teach students surgical techniques and it is all done at no or nominal cost to client. **In sum, while there are efforts to control cat and dog reproduction, these sterilizations are done to a relatively small proportion of the population. Studies are seriously needed to assess the impact feral dogs and cats are having on biodiversity. Cats especially are well known to have major impacts on biodiversity; in the United States alone they kill one to four billion birds annually in addition to millions of reptiles, amphibians, and other organisms.**

"Wild" pigs can often be seen roaming in certain areas of St. Kitts; these animals are former domesticated pigs that were released by their owners. Some local individuals have said that the cost of pig feed got too high and this is why they were let go. The 2001 Country Report on Agricultural Biodiversity explains that at the time of writing the pig industry had experienced a 24% growth since 1988 (from 3,694 to 4,880 individuals) and cited the high cost of feed as the primary constraint to the high demand for pork. The report states that a large percentage of the pig population is represented by *'creole'* types, which are highly inbred but highly adapted to local conditions. Introduced species account for a smaller percentage of pig species. The introduction of special breeds was directly related to efforts to upgrade the existing gene pool by crossing with indigenous species. Benefits from such crosses are better feed efficiency and overall carcass yields. The introduced breeds were mainly Duroc, Landrace and Landrace x Large white crosses. Desirable heterotic qualities such as large litter sizes, good mothering ability and low carcass fat were experienced as a result of these efforts. Today, some farmers will trap and kill pigs on their farm, but they are not being preyed upon in any significant amounts. **Today in St. Kitts, farmers are increasingly complaining about crop damages from pigs, and it is very likely that they are having significant negative impacts on biodiversity in forested areas (where they have been documented already as part of the IAS project). No research has been done to assess wild pig population size, distribution, or impacts to the environment and this is very seriously needed. Examples from other countries, especially Australia, can be used to design studies to assess the impacts of wild pigs on biodiversity in the Federation.**

White tailed deer were brought to the Federation from Puerto Rico (originally from N America) in 1931 to Lodge Estate in St. Kitts. When the herd reached seven animals it was released at Frigate Bay (Biodiversity profile). Today, all of the deer live on the southeast peninsula, and sightings of the animals are beginning to increase. It is possible that the deer population has expanded due to the removal of livestock from the southeast peninsula due to the construction of Christophe Harbour, but no data are available to support this assumption. Keehner et al. (2016) published the only paper on the Federation's deer population. The article focuses on the conservation status of deer and the unique fact that they are invasive, yet protected. Keehner explained in a phone

interview that the original goal was to do a formal population estimate of the deer using pellet identification and general scat analysis, but permission was never granted during his relatively short tenure on the island (just over two years as his wife was a student at RUSVM). From unpublished accounts, it appears the deer have some unique behaviors such as a nocturnal activity cycle and year round breeding, but these also need to be systematically investigated. **Plans are currently being made to initiate a new project at RUSVM with Dr. Keehner and the IAS National Coordinator Dr. Kerry Dore as collaborators. This study will assess deer population size based on trail camera photographic data and scat distribution collected along transects.**

In Nevis, after the monkey, the most significant invasive mammal species is the donkey. Originally brought to the island as a beast of burden for the sugar industry, their population size has grown significantly. They are now a significant crop and farm infrastructure (fencing, irrigation) pest and are reported to cause a significant number of car accidents, especially in the early evening, as they are often found on the side of the road. The Department of Agriculture has made serious efforts to control the donkey in the last two years, culling 2,293 animals in 2018 and 3,636 so far in 2019 (as of July 25, 2019). **Officers from the Department have said that complaints about the donkey have gone down as a result of these efforts.**

Dr. Hilari French and colleagues at Ross University School of Veterinary Medicine has conducted two studies thus far aiming to develop a vaccine that prevents reproduction in donkeys. The first study looked at two vaccines: Porcine Zona Pellucida and a recombinant Zona Pellucida product with Freund's adjuvant, and saw excellent results. Unfortunately, this vaccine also created horrendous injection site abscesses. The second study used the same antigens and a different adjuvant. This study is showing mixed results on efficacy but no injection site reactions. She will likely be running one more study to fine tune everything. The studies are taking about 2 years to run and a year to process all the information. In addition to these experiments, the team has also met Nevis officials several times about implementing a program there, but they first need to get an actual donkey count in order to be able to show its efficacy in a field trial. The team has plans for the donkey population survey but would need at least one individual that could commit to this project and a couple of drones. Once we understood the population and how to track the donkeys we could implement the vaccine as stated in the proposals (requiring 2 darts). The team was approved for a dart gun but has not purchased anything yet. Dr. French explained that they will need about 2 years for the population study and then at least 2 more to determine the efficacy of the product. The budget all comes down to employing a person/persons to do the population study and then it's pretty minimal costs for the actual vaccinations. **The team estimates that they would need $200,000 USD for two years of work, covering post doc payment and housing in Nevis).**

Birds

As outlined in GISD, one invasive bird in the Federation is the carrier pigeon (*Columba livia*). This species is a native to Europe and has been introduced worldwide as a food source. They cause considerable damage to buildings and monuments because of their corrosive droppings. They also pose a health hazard since they are capable of transmitting

a variety of diseases to humans and domestic poultry and wildlife (2010 OECS protected areas doc).

In addition, the Federation is also home to the Eurasian collared dove (*Streptopelia decaocto*). This species is an extremely successful invader that is believed to have been introduced to the West Indies by accidental release of a pet trader in 1974. Negative impacts include competition with endemic birds and potential disease transmission (2010 OECS protected areas doc).

Amphibians and Reptiles:
The cane toad (*Bufo marinus*) was introduced to many countries as biological control agents for various insect pests of sugarcane, such as grubs. They will feed on almost any terrestrial invertebrate and compete with native amphibians for food and breeding habitats.

Locals state that when the Four Seasons Resort in Nevis imported live trees a few years ago, the inadvertently introduced both the Cuban tree frog (*Osteopilus septentrionalis*) and the corn snake (*Pantherophis guttatus*). This information needs to be confirmed at which time the resort can be approached for funding to manage this species.

Bacteria:
The most notorious invasive bacterial parasite in the Federation is lethal yellowing, spread by the planthopper (insect) *Haplaxius crudus*. According to Mr. Melvin James, an expert was brought in from Jamaica to confirm lethal yellowing, but no information could be found about this individual or the source of funding to bring them into the country. The sap sucking bug severely negatively impacted coconut trees in this region after 2010, and as a result, the "National Response to Loss of Coconut Palms Project" program was launched in August of 2014. Many individuals whose livelihoods depended on coconuts were invited to the launch. Ms. Joyelle Clark, who was Director of Constituency Empowerment in 2014, explained that the program was led by the Department of Constituency Empowerment and funded by $100,000 USD from Sugar Industry Diversification Fund. The program planted 3,000 coconut trees (that were donated by the Government of St. Vincent and the Grenadines) at Capisterre Farm. Ms. Clark worked with individuals at the SKN Media Unit to do interviews with individuals impacted by lethal yellowing, and the Inter Agency on Sustainable Development Council in the Ministry of Tourism was the agency in charge of public awareness related to the project. Transitioning under new government led to difficulties in following up and it is not clear whether a new Director of Constituency Empowerment was hired. Several documents and project leads are currently unaccounted for. It is clear that after her departure nothing else was done with the project. It is unknown where the video/interview footage is currently located, and no follow up has been done on the coconut trees planted at Capisterre Farm.

Marine IAS
The most notorious marine invasive species is the Pacific lionfish (*Pterosis volitans*). In fact, there is a lionfish regional strategy (http://www.car-spaw-rac.org/?International-

partners-launch-plan%2c474), and the International Coral Reef Initiative has a Regional Lionfish Committee for the Caribbean (https://www.icriforum.org/groups/our-committees/regional-lionfish-committee). First seen in St. Kitts between 2010-2012, individuals at the Department of Marine Resources, Mr. Marc Williams and Ms. Tricia Greaux, explained that they are now seen fairly infrequently in the shallow coastal waters and that they are mostly found in depths over 200 feet. Some national documents in the Federation highlight a "Lionfish Management Programme," but it appears there was never an official program, rather an encouragement of fishermen to catch them. In addition, there was a "Lionfish Tournament" sponsored by GEF, the St. Christopher National Trust, and Beach Addiction SKN at SpiceMill's Spicefest 2015, where individuals competed to see who could create the tastiest lionfish food. The tournament was the final part of a GEF Coral Reef Conservation Project aimed at supporting and promoting the health of our coral reefs in St. Kitts and Nevis. Mr. Williams said that they also prepare and eat lionfish at Agricultural Open Day to ensure locals that it is safe.

Most recently, an intramural grant was awarded to Dr. Maria Jose Navarrete-Taloni and colleagues at RUSVM to study lionfish ecology/biodiversity and health and do community work. The fish will be aged using their inner ear bone, and their health will be studied by parasitologists, bacteriologists, and pathologists. Dr. Luis Cruz from RUSVM will spearhead community work aimed at promoting the consumption of lionfish.

An invasive sea grass (*Halophila stipulacea*) has also entered the Federation of St. Kitts and Nevis. The belief is that Christophe Harbour brought this species in to the southeast peninsula during its development. Our normal sea grass (primarily *Thalassia testudinum* and *Syringodium filiforme* according to Lindsay and Horwith 1999) grows up, but this one is a runner. It covers the entire ground and kills the natural seagrass. Individuals at the DMR stated that they started seeing the invasive sea grass when they opened up the Christophe Harbour Marina to the ocean. It is currently working its way towards Basseterre from the southeast.

In addition, Jean-Louis Pierre, Master's student at the University of Miami interning at Ross University School of Veterinary Medicine in St. Kitts, recently discovered a non-native brittle sea star (*Ophiothela mirabilis*) in St. Kitts (https://veterinary.rossu.edu/news/new-record-of-the-non-native-ophiothela-mirabilis-in-st-kitts-west-indies). This species is originally from the Indo and Eastern Tropical Pacific. It was first reported as invasive in Brazil in 2000 and was recorded present in French Guiana, Tobago, and St. Vincent in 2012. It reproduces asexually through fission and was seen on a sea fan (*Gorgonia ventalina*) in Cockleshell Bay, St. Kitts, in 2019. The report indicates that the species may have dispersed via boat traffic or planktonic larva.

In terms of marine invasive species to look out for, Mr. Pierre explained that stony coral tissue loss disease is a big problem in Florida due to boat traffic around Miami. The disease is thought to be bacterial vectored, so if a cruise ship picks up water in Florida and drops ballast water in the Federation we could have serious issues for our coral. Dredging would also exacerbate the likelihood of the disease coming to the region; the

sedimentation in the water brings up more organic carbon that could cause bacterial blooms that have diseases in them.

Freshwater IAS

Dr. Arve "Lee" Willingham of RUSVM explained that St. Kitts once contained high levels of the parasite schistosomiasis as a result of the freshwater aquatic snail *Biomphalaria glabrata*. In the 1920s-1950s many individuals had this parasite because it was present in the snails that would get into water containment areas. Monkeys were definite hosts as well; apparently there are documents from the 1920s where the monkeys were necropsied and found to have it. Hydrological changes as well as the introduction of competitor snails (*Melanoides tiburculada*) helped to reduce the issue, and by the 1960s there was a tremendous decrease of schistosomiasis presence. It is not clear whether the competitor snail was brought in intentionally or accidentally, and no surveys have been done since to establish the prevalence of the parasite on the island now. The parasite is considered present in St. Lucia, Antigua, and Suriname; it was nearly gone from St. Lucia but then eradication programs ended and there has been no active surveillance. Thirty years later they are now doing surveys in children. Dr. Willingham and Dr. Reynold Hewitt of the Pan American Health Organization are currently evaluating whether *Biomphalaria* or competitor snails are in Antigua, whether they are infected with schistosomiasis, and whether they are susceptible to schistosomiasis. This work will eventually broaden to include St. Lucia.

In sum, *very little* work is being done to evaluate the state of biodiversity in aquatic ecosystems and the impact invasive species may be having in the region. We are being reactive and not proactive in this area and there lacks a proper response in place to deal with any marine IAS that enter the region.

Invasive Species Inventories

At the time of this writing (3 July 2019), the Global Invasive Species Database lists many of the same invasive species as in 2009 (see Historic Overview); however, the paper bark tree; and the mimosa, cashier, or needle bush tree are no longer listed, and the sweet hibiscus mealybug is listed again. Nine additional new invasive species are listed: the Cashia tree (*Acacia farnesiana*), yellow fever mosquito (*Aedes aegypti*), hurricane grass (*Bothriochloa pertusa*), seaside heliotrope (*Heliotropium curassavicum*), floral ant (*Monomorium floricola*), hairy ant (*Paratrechina longicornis*), a different species of cane toad (*Rhinella marina*), and tiny yellow house ant (*Tapinoma melanocephalum*). The mona monkey (*Cercopithecus mona*) is also listed, but this is inaccurate, as these primates are only found in Grenada (outside of Africa). The database has been notified, and it is likely that green monkeys will be added to this list.

CABI's Invasive Species Compendium (ISC) also lists invasive species for the Federation. Appendix 1 is an abridged version of this list, with all of the species not present in the Federation at this time or listed as "no information available" removed. As the ISC is much more detailed and includes viruses and bacteria, many species are listed in the ISC that are not listed in the GISD. The papaya mealybug (*Paracoccus marginatus*), melon thrips (*Thrips palmi*), the candle nut tree (*Aleurites fordii*), the wild

mimosa or wild tamarind tree (*Leucaena leucocephala*), and the paper bark tree (*Melaleuca quinquenervia*) were taken off the GISD list but appear in the ISC list. Species listed on the GISD and also included in the ISC are colored in red in Appendix 1. The following species are listed on the GISD but not on the ISC: the sweet potato whitefly (*Bermisia tabaci*), the pink hibiscus mealybug (*Macronellicoccus hirsutus*), the mimosa, cashier, or needle bush tree (*Acacia farnesiana*), black jack or broom stick herb (*Bidens pilosa*), cat claw creeper or yellow trumpet vine (*Dolichandra unguis-cati*), the cane toad (*Bufo marinus*), the yellow fever mosquito (*Aedes aegypti*), the seaside heliotrope (*Heliotropium curassavicum*), and the floral ant (*Monomorium floricola*). The West Indian cedar (*Cedrela odorata*) is also listed in the GISD and not on the ISC; interestingly, this species is called Spanish Cedar and listed as endemic and "vulnerable" in the UNDP Protected Areas project document. Green monkeys are not listed in the ISC, nor are the mona monkeys (that were incorrectly listed in the GISD). **Moving forward, baseline data must be assembled to evaluate the impact of IAS (other than monkeys, the focus of our pilot project work) on native biodiversity. Plans are underway to organize national experts' attendance at a workshop to discuss data and perceptions of IAS impacts. This data will be essential in writing the NISSAP.**

Prevention

The monitoring of invasive alien species at ports of entry is led by the Plant Quarantine Unit within the Department of Agriculture. As explained on their website, the Quarantine Unit in St. Kitts and Nevis is a sub-program at the Department of Agriculture that focuses mainly on agricultural health and food safety matters with the fundamental role of preventing the introduction and spread of plant pests in St. Kitts, as they threaten crops, livestock and biodiversity in general. The Quarantine Unit is responsible for the implementation and monitoring of sanitary and phytosanitary measures as it relates to plant health matters. Phytosanitary measures are any legislation, regulation or official procedure having the purpose to prevent the introduction and or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests. Consequently, the Unit seeks to regulate the movement of plants, plant products and regulated articles within and across the borders of St. Kitts with the regulation system allowing for inspection, certification, prohibition of entry, treatment and destruction of plants, plant products and regulated articles.

The Quarantine Unit performs its functions according to the St. Kitts Strategy and Action Plan for Agriculture (SKSAP) 2017-2021 and also performs operational duties under five of the eight Priorities Areas of the SKSAP which are:

- create an environment for agribusiness to be more productive and profitable via capacity building and innovation
- enhance national food and nutrition security with emphasis on food safety
- adopt and develop measures to adopt and mitigate climate change
- develop and strengthen appropriate institutional structures
- mechanisms and human resource capacities and reduce crop and livestock losses

Owing to increased global trade, travel, transport and tourism and regional and international obligations, the quarantine services offered by the Department of Agriculture in St. Kitts play a critically important role in safeguarding plant health, facilitating trade and protecting the environment. Core functions of the Quarantine Unit include:

- issuance of import permits and phytosanitary certificates
- inspection of consignments of plants
- plant products or regulated articles
- pest risk analysis and pest surveillance
- information dissemination related to phytosanitary measures and proposal
- review and enforcement of legislation

The head quarantine officer for the Federation is Ms. Jeanelle Kelly, who is stationed in St. Kitts. In addition to Ms. Kelly, there is one additional quarantine officer in St. Kitts and three additional quarantine assistant officers. Mr. Quincy Bart is the head quarantine officer stationed in Nevis. Mr. Bart has one additional quarantine assistant officer as well as a clerk stationed at the unit.

Much of the work done by the quarantine unit relates to doing pest risk analyses (PRAs) for invasive species that would negatively impact the agricultural sector were they to enter the Federation. As the Quarantine Division is a sector of the Department of Agriculture in St. Kitts and Nevis, the general focus is on pests' potential impact to agriculture, not the environment broadly speaking. PRAs are scientific research processes where individuals from quarantine determine the risk of a potential species becoming a problem in the country. These processes therefore consider factors such as a species' biology and climate compatibility, how the species might enter the country, and the potential economic impact of the particular pest (e.g. what impact it would have on commodities if it came into the country?). If deemed to be a risk, the item would be destroyed. Management plans are developed if the species is already present and deemed to pose a threat. In St. Kitts and Nevis, PRAs have been created for the Mediterranean Fruit Fly (*Ceratitis capitate*), Tomato Leaf Miner (*Tuta absoluta*), Black Sigatoka (a fungal leaf spot disease of banana caused by the organism *Mycosphaerella fijiensis*), and Fusarium Wilt TR4, a destructive disease in bananas caused by the fungus *Fusarium oxysporum***)**.

Another key function of the Quarantine Unit is to update the 1923 Plant Protection Act (PPA). Since 2013-2014, Ms. Kelly and others have been working to make the PPA relevant to a post-sugar St. Kitts and Nevis. Some assistance with this revamping came from funding from the 10th EDF SPS, which was implemented by IICA. The PPA deals with everything related to the function of the National Plant Protection Organization, imports, exports, transit, what things are in free circulation, how to control pests, the penalties associated with failure to follow proper procedures, and our rights to make regulations that make the act effective. Current legislation has information on imports, exports, and fines, but the fees are outdated/too low. The goal is to bring the PPA in line with international standards, as things in St. Kitts have changed so much since the sugar industry closed in 2005.

In terms of prevention, there is a declaration form that incoming persons need to complete. Ideally all plants and animals, and their products should be confiscated and destroyed unless they are accompanied by a Phytosanitary Certificate. Quarantine does training with Customs on an annual basis about processes and procedures, how certain insects look, as well as certain plants or plant products that they need to inspect. If there is a pest is associated with a particular species, then customs may have to sieze and detain the commodity on Quarantine's behalf, then inform Quarantine of a consignment for inspection. Quarantine then makes the final determination if the commodity can be treated, if it needs to be destroyed, or if it needs to be returned to the country of export. In addition, workshops are conducted with individuals that do a lot of importing, such as those that bring in cut flowers. A training was done in February 2019 to remind these individuals of the proper procedures. A training was also held in July 2019 for brokers/traders/shippers about plant import/export procedures, and an information session was held in October 2019 for farmers and importers about Fusarium Wilt TR4. There are future plans to add surveillance activities for palm pests e.g. red palm weevil. One area that requires additional surveillance (and related policy) is monitoring of the refrigerated containers that enter the country to supply grocery stores.

At the moment, Quarantine's most significant preventative effort is the Fruit Fly Surveillance Program. While St. Kitts and Nevis is home to the invasive West Indian fruit fly, this program is aimed at preventing the entry of the Carambola and Mediterranean fruit flies (*Bactrocera carambolae* and *Ceratitis capitata*) onto both islands. The country is at high risk for these species as they are found in Guyana; there is now increased trade between these countries and a growing Guyanese population in the Federation. Pheromone traps are located at the ports of entry in the Federation to monitor for early detection of both of these species. According to Mr. Quincy Bart, as part of surveillance activities being conducted in Nevis, they also do fruit collection - taking suspected foods, enclosing them, and observing them to see if fruit flies emerge. They have a microscope to identify the species and are working with a specialist in Belize. In August 2019, the data collected will be entered into a database that is accessible throughout the Caribbean. Nevis is also monitoring for the mango seed weevil, and the cassava mite, and is actively working to manage bacterial spots recently seen in some mangoes and test varieties that may be more resistant to the papaya ring spot virus. In addition, the Federation is engaged in surveillance of the tomato leaf miner, which, in addition to tomatoes, also impacts sweet bell peppers, season peppers, eggplants and was recently spotted in Haiti.

In terms of a budget, for St. Kitts, in addition to the salaries of the officers, Quarantine spent $11,573 USD in 2016 for the fruit fly surveillance program, $500 USD on awareness via the Agricultural Open Day in 2016, and about $1,900 USD on supplies for inspection in 2017. As the 2016 funding for the fruit fly surveillance program and some of the supplies for inspection lasted a few years, Ms. Kelly estimates that the average annual budget for Quarantine in St. Kitts is $500 USD for surveillance, $200 USD for supplies, and $200 for public awareness. Ultimately, a budget for Quarantine is quite hard to assess as resources are shared with other divisions such as agricultural extension and veterinary services. A specific budget was equally problematic to quantify for Quarantine Nevis, as the funding is shared with agricultural extension. Mr. Randy Elliott, Director of Agriculture, explained that the full time quarantine officers earn a combined 130,000 EC dollars. In addition to these individuals, at times of need, up to three agricultural extension officers may be assigned to work alongside the quarantine officers. Mr. Bart submitted an ideal budget of 14,000 EC dollars for office supplies, inspection, and surveillance, 46,000 EC dollars for a vehicle, and 80,000 EC dollars for two additional full time workers.

Early Detection, Rapid Response, and IAS Control

For a regional perspective, Bullard 2013 explains that early detection, coupled with a rapid assessment and a quick and effective response is viewed as one of the best and cost-efficient ways of dealing with IAS. Some potential IAS are bound to arrive on Caribbean islands due to their geographical make up and many ports of entry.

Early detection and rapid response increase the likelihood that localized invasive populations will be found, contained, and eradicated before they become widely established. It can slow range expansion and avoid the need for costly long-term control

efforts. In order to be effective, early response and rapid response is time sensitive. A successful process ensures that:

1. potential threats are being identified in time to allow risk-mitigation measures to be taken;
2. new invasive species are being detected in time to allow efficient and environmentally sound decisions to be made;
3. responses to invasions are effective and environmentally sound and prevent the spread and permanent establishment of invasive species;
4. adequate and timely information is being provided to decision-makers, the public, and to trading partners concerned about the status of invasive species within an area;
5. lessons learned from past efforts are being used to guide current and future efforts.

This process is only possible through monitoring being carried out by those who are regularly in the field, i.e. farmers, birdwatchers, landscape crews, researchers and the general public. There is a need for a national electronic database that can be assessed by inspectors and other field personnel that identifies existing and potential IAS. Access to a database would increase early detection capacity.

Early detection and eradication is the ideal scenario, and containment is also an option; however, most countries lack proper surveillance which means species are only detected once they are widespread. Once established, IAS should be targeted for management activities, research and innovative responses to minimize their long-term impacts and costs. Risk analysis, cost- benefit analysis and other tools can be used to identify and prioritize the most appropriate and cost-effective mitigation measures to be undertaken, including containment, control and eradication.

Unlike the prior three approaches, management approaches to established IAS tend to be costly and are reactive in nature. Eradication, containment and control of identified priority IAS can involve physical, chemical, biological or integrated strategies. Scientific research on methods and technologies for priority IAS are critical to effectively assign resource use and maximize effectiveness.

Control of invasive species is accomplished using modern resource management methods. Several complementary methods may be implemented in an overall strategy to protect ecosystems and aid in their recovery. Strategies are analyzed and adjusted as needed, and work (including follow-up and monitoring) is conducted for many years. Control efforts reduce invasive species to more acceptable levels, and management prevents their spread or re-emergence. Scientific advances can dramatically improve the outlook for the control of certain species (the above information is adapted from Bullard 2013).

Worldwide, the gold standard in IAS early detection, rapid response, and IAS control are the countries of Australia and New Zealand. On New Zealand’s website

(https://www.mpi.govt.nz/travel-and-recreation/arriving-in-new-zealand/), they explain their strict biosecurity procedures. At all airports and seaports, all goods must be declared or disposed of in marked amnesty bins. All travelers into the country are given Passenger Arrival Cards prior to entry which has a list of what they consider "risk goods." These goods – any food; animals or animal products; plants or plant products; animal medicines, herbal medicines, biological cultures, organisms, soil or water; equipment used with animals, plants, or water (including for gardening, beekeeping, fishing, water sport or diving activities), and items that have been used for outdoor or farming activities (including any footwear, tents, camping, hunting, hiking, golf or sports equipment) – must be declared, and those not disposed of in the amnesty bins are inspected upon arrival. Individuals are made aware up front that their bags may be sniffed by detector dogs, x-rayed, or searched, and informed that the Passenger Arrival Cards are a legal document, so a false declaration is breaking the law and could be fined or put in prison as a result.

On the website individuals can watch the biosecurity in-flight video (which is shown to passengers on board the plane prior to arrival) (https://www.youtube.com/watch?time_continue=10&v=gU_kcbVOwsM&feature=emb_logo). The video makes it clear that at the very least, if items are not declared, individuals will be fined $400. Visitors to the website can view the Passenger Arrival Card as well as detailed lists of all of the foods that must be declared. There is also an interactive tool to help find out what is allowed. An email address is provided so persons with questions can reach out for assistance.

The Federation should use New Zealand's biosecurity measures as a guide to better protect IAS from entering the islands. St. Kitts and Nevis should, at a minimum, provide similar amnesty bins for individuals to dispose of potentially harmful goods prior to entering immigration and customs. Along with customs forms (which are usually provided on the plane or boat prior to arriving), persons could be given an additional document prior to arrival with more information about what items must be declared. Passengers could also be informed that there will be additional checks (such as dogs or inspections) after the amnesty bins, and that there are penalties for those that fail to declare, as this should encourage persons to dispose of their items prior to entering immigration and customs.

Sectoral Involvement

Inter-Ministerial Coordination

In St. Kitts, there are two main Ministries that oversee issues related to IAS: the Ministry of Agriculture, Marine Resources, Cooperatives, Environment, and Human Settlement and the Ministry of Public Infrastructure, Post, Urban Development, and Transport. Within the Ministry of Agriculture, departments relevant to IAS include the Department of Agriculture (which has livestock/veterinary, crops, and quarantine divisions), the Department of Environment, and the Department of Marine Resources. The Department of Agriculture oversees any species that would affect crops or livestock. While quarantine deals with preventing IAS from entering the country, existing agricultural IAS

are managed by agricultural officers and extension officers (agricultural officers are more senior). The Department of Marine Resources is primarily responsible for regulating fishing and other activities in the ocean but would also be responsible for managing marine invasive species, primarily lionfish to date. The Department of Environment is responsible for the implementation of the CBD. One of the main reporting frameworks for the CBD is the NBSAP. The NBSAP articulates the need for the country to manage IAS, which puts the DOE in a position to coordinate with other agencies. For example, if the IAS issue is a marine one, then the issue becomes part of the DOE's mandate to assist in the control of that species. Finally, the Ministry of Public Infrastructure, Post, Urban Development, and Transport is home to the Department of Maritime Affairs. This department is the focal point for the protocol of 1973 to the International Convention for the Prevention of Pollution from Ships as Amended (MARPOL 1973/78). They are therefore responsible for issues related to ballast water.

In Nevis, similar governing bodies (agriculture, environment, and marine) oversee issues related to IAS, but the government is structured slightly differently. Agriculture is part of the Ministry of Agriculture, Lands, Housing, Cooperatives, and Fisheries (Disaster may newly fall under this Ministry but that is unclear at this time.) The Department of Agriculture is comprised of nine divisions, namely: Marketing, Veterinary/Livestock, Abattoir, Extension, Small Farm Equipment Pool, Forestry & Propagation, Quarantine, Clerical and Agro-Processing. Similarly to St. Kitts, agriculture oversees IAS that would affect crops or livestock, quarantine deals with preventing IAS from entering the country, and fisheries is responsible for managing marine invasive species. In Nevis, environmental issues fall within the purview of the Department of Physical Planning and Environment within the Ministry of Communications (which also includes Postal Services, the Water Department, and Public Works). Unlike other ministries, which are distinct across the two islands, with individual Ministers and Directors, the Department of Marine Resources has one director for the Federation (Mr. Mark Williams) with a deputy director (Mr. Lemuel Pemberton) in Nevis.

Any invasive species affecting public health, mainly rats and mosquitos, would also fall under the purview of the Ministries of Health (St. Kitts and Nevis have independent ministries). In St. Kitts this is the Ministry of Health, Social Services, Community Development, Culture & Gender Affairs. Mr. Alex Riley from the Ministry of Health, St. Kitts, explained that no systematic rat control has occurred to date, and that mosquito fogging occurs across the island approximately 4-5 times a year at most.

To a certain extent the St. Christopher National Trust and the Nevis Historical and Conservation Society provide services related to IAS such as helping to support and organize the lionfish food competition.

Issues related to border control would fall under the purview of the Ministry of Finance and the statutory bodies of SKASPA and NASPA.

The issue of concern in this area for St. Kitts and Nevis is that we have far to many Departments involved in IAS managemet. We need a single coordination unit or

body – in other words we need a Biosecurity Unit or body that deals with all IAS issues. This is critical because IAS are a cross-cutting issue affecting multiple sectors. We also need this body to obtain its funding directly from the government and not via a Ministry; the Biosecurity Unit needs to be independent, objective and well resourced.

Committees and Working Groups Dedicated to IAS

As previously explained, the Monkey Task Force is the primary working group related to IAS in the Federation. Mr. Knight explained that "the work of the Taskforce has for the time being been superseded by the introduction of the Invasive Alien Species Project." **The Task Force should be meeting more often to keep abreast of what the IAS project is doing and to critically analyze the pilot project work. In his summary of the task force, Mr. Knight also states that the IAS project has as part of its mandate to develop a strategy for the control of monkeys. In fact, the goal is to collect data to prove that control is in fact necessary and to then provide the government with strategies that may be suitable to sustainably support this endeavor.**

Some documents highlight a Lionfish Committee that was supposedly in place, however no official documentation could be found to support this endeavor. It appears there was simply a word of mouth campaign encouraging fishermen and women to catch these fish as often as possible. As the problem is viewed as primarily resolved, there are no real lionfish initiatives or working groups in the Federation at this time.

Sectoral Gaps and Deficiencies

To date, there is no coordinating mechanism between Ministries (within or between islands) that deal with IAS and this is desperately needed to coordinate efforts moving forward.

Multilateral Environmental Agreements

The Federation of St. Kitts and Nevis has signed on to several multilateral environmental agreements relevant to its sustainability (see Table 10 below, compiled from Annex 2 of the 2010 National Environmental Summary, Federation of St. Kitts and Nevis, with updates from Mr. Eavin Parry). These agreements include the UN Convention on Biological Diversity (CBD), the UN Convention on Biodiversity Cartagena Protocol, and the Convention on International Trade in Endangered Species and Wild Flora and Fauna. These conventions provide the framework for individual member states to develop plans to address the concerns outlined in the documents (Bullard 2013). In most instances, St. Kitts and Nevis has complied with the various agreements and has produced its national action plans (see Historic Overview) to address issues in the UN documents on biodiversity. While issues of IAS are highlighted in the biodiversity documents, this UNEP IAS initiative is the first to explicitly deal with invasive species in the Federation.

Multilateral Environmental Agreements	Status
Wildlife /Conservation	
Convention of International Trade in Endangered Species, 1972 (CITES)	Accession 1997
International Convention for the Regulation of Whaling 1948 ad 1959	Adherence 1992
Specially Protected Areas and Wildlife (SPAW) Protocol to the Cartagena Convention	Under review for ratification
Biodiversity/Bio-safety, Traditional Knowledge	
International Plant Protection Convention, Rome, 1951	Adherence 1990
Convention on Biological Diversity, 1992	Ratified 1993
Cartagena Protocol on Bio-Safety	Accession 2001 Entry into force 2003
Marine Protection and Safety	
Convention on the Protection and Development of the Marine Environment in the Wider Caribbean, 1983 (Cartagena Convention) (RE)	Accession 1999
Protocol Concerning Cooperation in Combating Oil Spills in the Wider Caribbean, 1983 (RE)	Accession 1999
Protocol of 1973 to the International Convention for the Prevention of Pollution from Ships as Amended (MARPOL 1973/78)	Accession 1997
International Convention on Civil Liability for Oil Pollution Damage, 1969 (CLC, 1969)	Accession 1994
Protocol of 1992 to Amend the International Convention on Civil Liability for Oil Pollution Damage, 1969 (CLC PROT, 1992)	Accession 2004
International Convention for the Establishment of an International Fund for the Compensation of Oil Pollution, 1971 (FUND,1971)	Accession 1994
Intervention on the High Seas in Cases of Oil Pollution Casualties, 1969; (INTERVANTIONS, 1969)	Accession 2005
Protocol of 1992 and 2003 to the International Convention for the Establishment of an International Fund for the Compensation of Oil Pollution, 1971	Accession 2005
Convention on the Prevention of Marine Pollution by Dumping Wastes and Other Matter, 1972, (LC PROT 1996)	Accession 2004
Land Based Sources of Marine Pollution (LBS) Protocol to the Cartagena Convention	Under review for ratification
International Convention on Liability and Compensation from Damage in Connection with Carriage of Hazardous and Noxious Substances by Sea (HNS Convention, 1996)	Accession 2004
International Convention on Oil Pollution Preparedness, Response and Cooperation (OPRC Convention), 1990	Accession 2004
International Convention for the Control and Management of Ship Ballast Water and Sediment, 2004 (BMB, 2004)	Accession 2005
Marine Resources	
United Nations Convention on the Law of the Sea, 1982	Ratified 1993
Chemicals/Waste Management	

Basel Convention on the Control of Transboundary Movement of Hazardous Waste and their Disposal	Accession 1994
Sustainable Land Management	
United Nations Convention to Combat Desertification	Accession 1997
Atmospheric/Climate Systems	
Vienna Convention for the Protection of the Ozone Layer, Vienna, 1985	Accession 1993
Montreal Protocol on Substance that Deplete the Ozone, 1989*	Accession 1993
United Nations Framework Convention on Climate Change, 1992	Ratified 1993 Entry into force 1994
Protection of Human Health and the Environment	
Stockholm Convention on Persistent Organic Pollutants (POPs), 2001	Accession 2004
Culture and Natural Heritage	
Convention for the Protection of World Culture and Natural Heritage, 1972	Accepted 1986

Table 10. Multilateral Environmental Agreements in St. Kitts and Nevis

Legislation and Policy

The National Environmental Summary (NES) for St. Kitts & Nevis is an information tool to support the incorporation of environment in United Nations Common Country Assessments (UNCCA) and United Nations Development Assistance Framework (UNDAF). This document provides a critical analysis of gaps in existing policy/programmes responses and in the national legislation in addressing environmental issues and their critical linkages to poverty reduction and development. The NES explains that while SKN is policy rich, it lacks the financial resources to implement many of the policies.

The 2014 NBSAP explains that several pieces of legislation have been enacted by the Government of St. Kitts and Nevis which contribute both directly and indirectly to the goals and objectives of the CBD in SKN. The National Conservation and Environment Management Act (Bill), NCEMA was drafted in 2005 with the view to replace the National Conservation and Environmental Protection Act, 1987 (NCEPA). Once enacted, NCEMA will provide improved provisions for environmental management with a greater focus on biodiversity protection and conservation.

The International Trade in Wild Fauna and Flora Act, 2009 was passed to facilitate SKN's compliance with the obligations under the Convention on International Trade in Wild Flora and Fauna or CITES. This Act also has the objective of conserving and managing the wild flora and fauna of SKN.

The Biosafety Act was enacted in 2012 and addresses the movement, transit, handling and use of all genetically modified organisms that may have adverse effects on the conservation and sustainable use of biological diversity. While the 2014 NBSAP says this act was enacted in 2012, it is apparently still in draft form.

Also, s previously explained, the Plant Protection Act is being updated in response to International Plant Protection Convention 1952 (FAO).

National policies are have not been passed by Parliament but are guides for how a particular plan should be developed. The most relevant policies include the National Environmental Management Strategy and Action Plan (2004). In particular, strategy 40: "take necessary precautionary measures to avoid or minimize, the intentional or accidental introduction or escape, into or from the environment, and the control of alien or living modified organisms that are likely to impact adversely on other organisms, the environment or on human health." In addition there is the St. George's Declaration on Environmental Management (2006), an OECS Environmental Agreement where the country agrees to the "adoption of measures to avoid or minimize the intentional or accidental introduction or escape of invasive alien or modified organisms that have the potential to impact negatively on the environment or human health, and to eradicate or control the pathways of those that have been introduced or escaped." Finally, in response to the CBD, the National Biodiversity Strategy and Action Plan (2014) identifies invasive species management as a national priority. **While many countries have wonderful strategies or plans, they are rarely implemented due to a lack of resourcse, capacity, will, etc. This IAS initiative will ensure that St. Kitts and Nevis implements successful IAS management.**

Public Awareness, Education, and Capacity Building

To date the Federation of St. Kitts and Nevis has not participated in any public awareness or educational campaigns related to IAS. **It is a priority of this project to do so over the next two years. In addition, we aim to build capacity within all sectors overseeing issues related to IAS and across all of the OECS countries participating in this initiative.**

Acknowledgements

I would like to thank all of the individuals that I interviewed or consulted with in writing this Critical Situation Analysis:

Dr. Phillip Andreozzi, USDA
Mr. Quincy Bart, Quarantine Unit, Department of Agriculture, Nevis
Dr. Amy Bierschmitt, RUSVM and Behavioural Science Foundation, St. Kitts
Dr. Sean Callanan, RUSVM
Dr. Ryan Cavanaugh, RUSVM
Dr. Tracey Challenger, Chief Veterinary Officer, St. Kitts
Ms. Joyelle Clark,
Dr. Luis Cruz, RUSVM
Dr. Benjamin Culp, St. Kitts Biomedical Research Foundation
Dr. Michelle Dennis, RUSVM
Mr. William F. Dore, former Permanent Secretary of Agriculture, St. Kitts
Ms. Claudia Drew, National Coordinator, UNDP "Conserving Biodiversity and Reducing Habitat Degradation in Protected Areas and their Areas of Influence" project

Mr. Kistian Flemming, Director, CARDI, St. Kitts
Dr. Mar(k) Freeman, RUSVM
Dr. Hilari French, RUSVM
Mr. Gilbert "Sully" Gordon, SKN Primates
Ms. Tricia Greaux, Department of Marine Resources, St. Kitts and Nevis
Mr. Melvin James, Director of Agriculture, St. Kitts
Dr. Jon Keehner, X
Ms. Jeanelle Kelly, Quarantine Unit, Department of Agriculture, St. Kitts
Dr. Patrick Kelly, RUSVM
Mr. Gene Knight, Senior Project Officer, Policy and Planning Unit, Ministry of Agriculture, St. Kitts
Mr. Laurence Knight, CARDI, St. Kitts
Dr. Darryn Knoebel, RUSVM
Mr. Winston Lake, former sugar industry overseer and monkey ranger, St. Kitts
Mr. Ken Martin, former Director of Agriculture, St. Kitts
Mr. Agustine Merchant, IICA
Dr. Maria Jose Navarette-Taloni, RUSVM
Dr. Burnell Nisbett, former Chief Veterinary Officer, St. Kitts
Ms. Katherine Orchard, St. Christopher National Trust
Dr. Shailaja Rabindran, USDA
Dr. Roberta Palmour, McGill University, Canada, and Behavioural Science Foundation, St. Kitts
Mr. Eavin Parry, Environmental Scientist, Department of Environment, St. Kitts
Mr. Lemuel Pemberton, Department of Marine Resources, Nevis
Mr. Jean-Louis Pierre, Masters Student from University of Miami studying coral health
Mr. Naitram "Bob" Ramnanan, CABI
Mr. Alex Riley, Ministry of Health, St. Kitts
Mr. Marc Williams, Department of Marine Resources, St. Kitts and Nevis
Dr. Arve "Lee" Willingham, RUSVM
Dr. Arne Witt, CABI

References

Bullard, JM. (2013). *Critical Situation Analysis (CSA) of Invasive Alien Species (IAS) Status and Management, the Bahamas, 2013*. Nassau: Department of Marine Resources.

Dore, K.M. 2018. Ethnoprimatology without conservation: the political ecology of farmer-green monkey (*Chlorocebus aethiops sabaeus*) relations in St. Kitts, West Indies. *International Journal of Primatology* 39: 918-944.

Kairo, M. and Ali, K. 2003. *Invasive species threats in the Caribbean Region*. CAB International.

Keehner, J., Cruz-Martinez, L., and Knoebel, D. 2016. Conservation value, history and legal status of non-native white-tailed deer (*Odocoileus virginianus*) on the Caribbean island of St. Kitts. *Tropical Conservation Science* 9: 758-775.

Krauss, U. 2010. *Critical Situation Analysis (CSA) of Invasive Alien Species (IAS) Status and Management, St. Lucia, 2010*. Union: Forestry Department, Ministry of Agriculture, Lands, Forestry and Fisheries.

Lindsay, K. and Horwith, B. 1999. *A Vegetation Classification of St. Kitts and Nevis: Implications for Conservation*. Island Resources Foundation.

Mack, R.N., Simberloff, D., Lonsdale, W.M., Evans, H., Clout, M., Bazzaz, F.A. 2000. Biotic Invasions: Causes, Epidemiology, Global Consequences and Control. *Issues in Ecology* 10: 689-710.

Phillip, K.S. 2000. Tropical bont tick (*Ambylomma variegatum*) eradication in the Caribbean: the St. Kitts experience. *Annals of the New York Academy of Sciences* 916: 320-325.

Pimentel, D., McNair, S., Janecka, J., Wightman, J., Simmonds, C., O'Connell, C., Wong, E., Russel, L, Zern, J., Aquino, T. and Tsomondo, T. 2001. Economic and environmental threats of alien plant, animal, and microbe invasions. *Agriculture, Ecosystems & Environment* 84: 1-20.

Witt, A.B.R. and Luke, Q. 2017. *Guide to the Naturalized and Invasive Plants of Eastern Africa*. CABI, Oxfordshire, UK.

Appendices

Appendix 1: Invasive species compendium list for the Federation of St. Kitts and Nevis.

Domain	Kingdom	Phylum	Species	Distribution	Origin	Invasive	References
Bacteria		Actinobacteria [phylum]	Dermatophilus congolensis	Reported present or known to be present			OIE Handistatus, 2005.
Bacteria		Actinobacteria [phylum]	Leifsonia xyli subsp. xyli (sugarcane ratoon stunting disease)	Present			Bradbury, 1986; CABI/EPPO, 2000; EPPO, 2014.
Bacteria		Firmicutes	Candidatus Phytoplasma palmae (lethal yellowing of coconut)	Restricted distribution			EPPO, 2014; IPPC, 2012.
Bacteria		Proteobacteria	Ehrlichia ruminantium	CAB Abstracts data mining			OIE Handistatus, 2005.
Eukaryota	Chromista	Oomycota	Phytophthora infestans (Phytophthora blight)	Present			CPPC; CMI, 1982.
Eukaryota	Metazoa	Arthropoda	Aceria guerreronis (coconut mite)	Restricted distribution			EPPO, 2014.
Eukaryota	Metazoa	Arthropoda	Aleurocanthus woglumi (citrus blackfly)	Present			EPPO, 2014.
Eukaryota	Metazoa	Arthropoda	Aleurothrixus floccosus (woolly whitefly)	Present			EPPO, 2014.
Eukaryota	Metazoa	Arthropoda	Amblyomma variegatum (tropical bont tick)	Present			CAB ABSTRACTS Data Mining 2001.
Eukaryota	Metazoa	Arthropoda	Anastrepha obliqua (West Indian fruit fly)	Widespread	Introduced	Yes	Kisliuk and Cooley, 1933; CABI/EPPO, 2011; EPPO, 2014.

Domain	Kingdom	Phylum	Species	Distribution	Origin	Invasive	References
Eukaryota	Metazoa	Arthropoda	Anthonomus grandis (Mexican cotton boll weevil)	Present			EPPO, 2014.
Eukaryota	Metazoa	Arthropoda	Aonidiella orientalis (oriental yellow scale)	Present			NHM, 1996.
Eukaryota	Metazoa	Arthropoda	Aonidomytilus albus (tapioca scale)	Present	Native		Schotman, 1989.
Eukaryota	Metazoa	Arthropoda	Aphis craccivora (groundnut aphid)	Present			CIE, 1983.
Eukaryota	Metazoa	Arthropoda	Aphis gossypii (cotton aphid)	Present			UK CAB International, 1968.
Eukaryota	Metazoa	Arthropoda	Artemia (brine shrimp)	Present	Native		Van Stappen, 2002.
Eukaryota	Metazoa	Arthropoda	Aspidiotus destructor (coconut scale)	Present			CIE, 1966.
Eukaryota	Metazoa	Arthropoda	Bemisia tabaci (tobacco whitefly)	Restricted distribution			CABI/EPPO, 1998; EPPO, 2014.
Eukaryota	Metazoa	Arthropoda	Bemisia tabaci (MEAM1) (silverleaf whitefly)	Present			de Barro, 1995; EPPO, 2014.
Eukaryota	Metazoa	Arthropoda	Boophilus microplus	Present			CAB ABSTRACTS Data Mining 2001.
Eukaryota	Metazoa	Arthropoda	Cactoblastis cactorum (cactus moth)	Present	Introduced	Yes	ISSG, 2011; EPPO, 2014.
Eukaryota	Metazoa	Arthropoda	Cryptotermes brevis (powderpost termite)	Present	Introduced	Yes	Coaton, 1948.

Domain	Kingdom	Phylum	Species	Distribution	Origin	Invasive	References
Eukaryota	Metazoa	Arthropoda	Culex quinquefasciatus (southern house mosquito)	Widespread	Introduced		Belkin and Heinemann, 1975.
Eukaryota	Metazoa	Arthropoda	Cylas formicarius (sweet potato weevil)	Restricted distribution			CABI/EPPO, 2004; EPPO, 2014.
Eukaryota	Metazoa	Arthropoda	Dysmicoccus brevipes (pineapple mealybug)	Present			Ben-Dov, 1994.
Eukaryota	Metazoa	Arthropoda	Ferrisia virgata (striped mealybug)	Present			Williams and Granara de Willink, 1992; Ben-Dov, 1994.
Eukaryota	Metazoa	Arthropoda	Helicoverpa zea (American cotton bollworm)	Restricted distribution			EPPO, 2014.
Eukaryota	Metazoa	Arthropoda	Icerya purchasi (cottony cushion scale)	Present	Introduced	Yes	NHM, 1971; EPPO, 2014.
Eukaryota	Metazoa	Arthropoda	Liriomyza sativae (vegetable leaf miner)	Present			EPPO, 2014.
Eukaryota	Metazoa	Arthropoda	Liriomyza trifolii (American serpentine leafminer)	Restricted distribution			EPPO, 2014.
Eukaryota	Metazoa	Arthropoda	Litopenaeus vannamei (whiteleg shrimp)	Present	Introduced		DIAS, 2007.
Eukaryota	Metazoa	Arthropoda	Maconellicoccus hirsutus (pink hibiscus mealybug)	Present	Introduced	Yes	Etienne et al., 1998; Kairo et al., 2000; Anon., 2000a; EPPO, 2014; CABI/EPPO, 2015.
Eukaryota	Metazoa	Arthropoda	Nezara viridula (green stink bug)	Present			CABI/EPPO, 1998.

Domain	Kingdom	Phylum	Species	Distribution	Origin	Invasive	References
Eukaryota	Metazoa	Arthropoda	Nipaecoccus nipae (spiked mealybug)	Present			Ben-Dov, 1994; CABI/EPPO, 2005.
Eukaryota	Metazoa	Arthropoda	Paracoccus marginatus (papaya mealybug)	Present			Pollard, 1999; CABI/EPPO, 2012.
Eukaryota	Metazoa	Arthropoda	Paratrechina longicornis (crazy ant)	Present	Introduced		ISSG, 2011.
Eukaryota	Metazoa	Arthropoda	Pectinophora gossypiella (pink bollworm)	Present			IIE, 1990; EPPO, 2014.
Eukaryota	Metazoa	Arthropoda	Phyllocnistis citrella (citrus leaf miner)	Restricted distribution			CABI/EPPO, 2003; EPPO, 2014.
Eukaryota	Metazoa	Arthropoda	Plutella xylostella (diamondback moth)	Present			CIE, 1967.
Eukaryota	Metazoa	Arthropoda	Pseudaulacaspis pentagona (mulberry scale)	Present			NHM, 1973; EPPO, 2014.
Eukaryota	Metazoa	Arthropoda	Saissetia oleae (olive scale)	Present			NHM, 1973
Eukaryota	Metazoa	Arthropoda	Solenopsis geminata (tropical fire ant)	Present	Native		ISSG, 2009.
Eukaryota	Metazoa	Arthropoda	Solenopsis invicta (red imported fire ant)	Present			Wetterer and Davis, 2010.
Eukaryota	Metazoa	Arthropoda	Spodoptera frugiperda (fall armyworm)	Present			EPPO, 2018.
Eukaryota	Metazoa	Arthropoda	Tapinoma melanocephalum (ghost ant)	Present	Introduced		Wetterer, 2009.

Domain	Kingdom	Phylum	Species	Distribution	Origin	Invasive	References
Eukaryota	Metazoa	Arthropoda	Thrips palmi (melon thrips)	Restricted distribution			Palmer, 1992; CABI and EPPO, 1998; CABI/EPPO, 1998; EPPO, 2014.
Eukaryota	Metazoa	Arthropoda	Toxoptera citricida (black citrus aphid)	Restricted distribution			Yokomi et al., 1994; Anon., 1995; CABI/EPPO, 1998; EPPO, 2014.
Eukaryota	Metazoa	Arthropoda	Unaspis citri (citrus snow scale)	Restricted distribution			CIE, 1962; EPPO, 2014.
Eukaryota	Metazoa	Chordata	Columba livia (pigeons)	Present	Introduced		ISSG, 2011.
Eukaryota	Metazoa	Chordata	Herpestes auropunctatus (small Indian mongoose)	Present	Introduced	Yes	Hoagland et al., 1989.
Eukaryota	Metazoa	Chordata	Molothrus bonariensis (shiny cowbird)	Present, few occurrences			Avibase, 2012.
Eukaryota	Metazoa	Chordata	Pterois volitans (lionfish)	Present	Introduced		Schofield, 2010.
Eukaryota	Metazoa	Chordata	Rachycentron canadum (cobia)	Present	Native		IUCN, 2017.
Eukaryota	Metazoa	Chordata	Rhinella marina (cane toad)	Present	Introduced	No	ISSG, 2011.
Eukaryota	Metazoa	Chordata	Streptopelia decaocto (Eurasian collared-dove)	Present	Introduced		BirdLife International, 2014.
Eukaryota	Metazoa	Mollusca	Marisa cornuarietis (giant ramshorn)	Localised	Introduced		Ferguson et al., 1960; Prentice, 1983; Bass, 2006; Cowie and Hayes, 2012; Horgan et al., 2014.
Eukaryota	Metazoa	Mollusca	Pinctada imbricata radiata (rayed pearl oyster)	Present	Native	No	Leal, 2002.

Domain	Kingdom	Phylum	Species	Distribution	Origin	Invasive	References
Eukaryota	Metazoa	Mollusca	Veronicella cubensis (Cuban slug)	Present	Introduced		USDA-APHIS, 2010.
Eukaryota	Metazoa	Mollusca	Zachrysia provisoria (Cuban brown snail)	Present	Introduced	Yes	Robinson and Fields, 2004.
Eukaryota	Metazoa	Nematoda	Radopholus similis (burrowing nematode)	Restricted distribution			CABI/EPPO, 1999; EPPO, 2014.
Eukaryota	Plantae	Spermatophyta	Abrus precatorius (rosary pea)	Present	Introduced		Acevedo-Rodriguez and Strong, 2012.
Eukaryota	Plantae	Spermatophyta	Abutilon hirtum (Indian mallow)	Present	Introduced		Acevedo-Rodriguez and Strong, 2012.
Eukaryota	Plantae	Spermatophyta	Abutilon indicum (country mallow)	Present	Introduced		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Acacia farnesiana (huisache)	Present	Native		ILDIS, 2002.
Eukaryota	Plantae	Spermatophyta	Acanthospermum hispidum (bristly starbur)	Present	Native		USDA-ARS, 2005.
Eukaryota	Plantae	Spermatophyta	Adenanthera pavonina (red-bead tree)	Widespread	Introduced		Broome et al., 2007; ILDIS, 2002.
Eukaryota	Plantae	Spermatophyta	Ageratum conyzoides (billy goat weed)	Present	Introduced	No	Fournet and Hammerton, 1991.
Eukaryota	Plantae	Spermatophyta	Albizia lebbeck (Indian siris)	Present	Introduced		Lindsay et al., 2009.
Eukaryota	Plantae	Spermatophyta	Albizia procera (white siris)	Present	Introduced		World Agroforestry Centre, 2002.

Domain	Kingdom	Phylum	Species	Distribution	Origin	Invasive	References
Eukaryota	Plantae	Spermatophyta	Aleurites moluccanus (candlenut tree)	Present	Introduced		Krisnawati et al., 2011.
Eukaryota	Plantae	Spermatophyta	Allamanda cathartica (yellow allamanda)	Present	Introduced		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Alpinia purpurata (red ginger)	Present	Introduced		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Alternanthera sessilis (sessile joyweed)	Present	Native		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Alysicarpus vaginalis (alyce clover)	Present	Introduced		Acevedo-Rodriguez and Strong, 2012.
Eukaryota	Plantae	Spermatophyta	Amaranthus dubius (spleen amaranth)	Present	Native		Smithsonian Institution, 2012.
Eukaryota	Plantae	Spermatophyta	Andropogon glomeratus (bushy bluestem)	Present	Native		GBIF, 2015.
Eukaryota	Plantae	Spermatophyta	Annona cherimola (cherimoya)	Present only in captivity/cultivation	Introduced		Acevedo-Rodriguez and Strong, 2012.
Eukaryota	Plantae	Spermatophyta	Annona squamosa (sugar apple)	Present	Introduced		Acevedo-Rodriguez and Strong, 2012; World Agroforestry Centre, 2010.
Eukaryota	Plantae	Spermatophyta	Argemone mexicana (Mexican poppy)	Present	Native		USDA-ARS, 2016.
Eukaryota	Plantae	Spermatophyta	Aristolochia elegans (elegant Dutchman's pipe)	Present	Introduced		Acevedo-Rodriguez and Strong, 2012.
Eukaryota	Plantae	Spermatophyta	Artocarpus altilis (breadfruit)	Widespread	Introduced		Broome et al., 2007.

Domain	Kingdom	Phylum	Species	Distribution	Origin	Invasive	References
Eukaryota	Plantae	Spermatophyta	Arundo donax (giant reed)	Present	Introduced		Acevedo-Rodriguez and Strong, 2012.
Eukaryota	Plantae	Spermatophyta	Avena sterilis (winter wild oat)	Restricted distribution			EPPO, 2014.
Eukaryota	Plantae	Spermatophyta	Azadirachta indica (neem tree)	Present	Introduced		Acevedo-Rodriguez and Strong, 2012.
Eukaryota	Plantae	Spermatophyta	Batis maritima (saltwort)	Present	Native		USDA-ARS, 2015.
Eukaryota	Plantae	Spermatophyta	Bauhinia monandra (Napoleon's plume)	Widespread	Introduced		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Bauhinia tomentosa (yellow bauhinia)	Present	Introduced		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Bixa orellana (annatto)	Present	Introduced		Acevedo-Rodríguez and Strong, 2012.
Eukaryota	Plantae	Spermatophyta	Bocconia frutescens (plume poppy)	Present	Native	No	USDA-ARS, 2013.
Eukaryota	Plantae	Spermatophyta	Boerhavia coccinea (scarlet spiderling)	Present	Native		USDA-ARS, 2016.
Eukaryota	Plantae	Spermatophyta	Bothriochloa pertusa (pitted beard grass)	Present	Introduced		Lindsay and Horwith, 1999.
Eukaryota	Plantae	Spermatophyta	Caesalpinia pulcherrima (peacock flower)	Present	Introduced		Broome et al., 2007; Young, 2008; Acevedo-Rodriguez and Strong, 2012; ILDIS, 2014.
Eukaryota	Plantae	Spermatophyta	Caladium bicolor (heart of Jesus)	Present	Introduced		Cooper et al., 2011.

Domain	Kingdom	Phylum	Species	Distribution	Origin	Invasive	References
Eukaryota	Plantae	Spermatophyta	Callisia repens (creeping inch-plant)	Present	Native		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Calotropis procera (apple of sodom)	Present	Introduced	Yes	World Agroforestry Centre, 2003.
Eukaryota	Plantae	Spermatophyta	Canna indica (canna lilly)	Present	Native	No	USDA-ARS, 2008.
Eukaryota	Plantae	Spermatophyta	Capsicum annuum (bell pepper)	Present			FAO, 2009; Aguilar-Meléndez et al., 2017.
Eukaryota	Plantae	Spermatophyta	Cardiospermum halicacabum (balloon vine)	Widespread			Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Casuarina equisetifolia (casuarina)	Present	Introduced		World Agroforestry Centre, 2002.
Eukaryota	Plantae	Spermatophyta	Catharanthus roseus (Madagascar periwinkle)	Present	Introduced		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Chamaecrista nictitans (sensitive partridge pea)	Present	Native		USDA-ARS, 2013.
Eukaryota	Plantae	Spermatophyta	Chromolaena odorata (Siam weed)	Present	Native		Gautier, 1992b.
Eukaryota	Plantae	Spermatophyta	Cleome rutidosperma (fringed spiderflower)	Present	Introduced		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Cleome viscosa (Asian spiderflower)	Widespread	Introduced		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Clerodendrum speciosissimum (Java glory bower)	Present	Introduced		Broome et al., 2007; Acevedo-Rodriguez and Strong, 2012.

Domain	Kingdom	Phylum	Species	Distribution	Origin	Invasive	References
Eukaryota	Plantae	Spermatophyta	Clidemia hirta (Koster's curse)	Present	Native		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Clitoria ternatea (butterfly-pea)	Present	Introduced		USDA-ARS, 2016.
Eukaryota	Plantae	Spermatophyta	Clusia rosea	Present	Native	No	Riffle, 1998.
Eukaryota	Plantae	Spermatophyta	Cocos nucifera (coconut)	Present	Introduced		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Colocasia esculenta (taro)	Present	Introduced		Robin, 2008.
Eukaryota	Plantae	Spermatophyta	Commelina benghalensis (wandering jew)	Restricted distribution			EPPO, 2014.
Eukaryota	Plantae	Spermatophyta	Cordia obliqua (clammy cherry)	Widespread	Introduced		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Crotalaria retusa (rattleweed)	Present	Introduced		Acevedo-Rodríguez and Strong, 2012.
Eukaryota	Plantae	Spermatophyta	Cyanthillium cinereum (little ironweed)	Present	Introduced		Acevedo-Rodríguez and Strong, 2012.
Eukaryota	Plantae	Spermatophyta	Cynodon dactylon (Bermuda grass)	Present	Introduced		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Dactyloctenium aegyptium (crowfoot grass)	Present	Introduced		Acevedo-Rodríguez and Strong, 2012.
Eukaryota	Plantae	Spermatophyta	Datura stramonium (jimsonweed)	Present			Fournet and Hammerton, 1991.
Eukaryota	Plantae	Spermatophyta	Desmodium incanum (creeping beggerweed)	Present	Native		Acevedo-Rodriguez and Strong, 2012.

Domain	Kingdom	Phylum	Species	Distribution	Origin	Invasive	References
Eukaryota	Plantae	Spermatophyta	Dieffenbachia seguine (dumb cane)	Present	Native	No	Graveson, 2012.
Eukaryota	Plantae	Spermatophyta	Digitaria bicornis (Asian crabgrass)	Present	Introduced		Smithsonian Museum of Natural History, 2016; Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Digitaria ciliaris (southern crabgrass)	Present	Introduced	Yes	Acevedo-Rodríguez and Strong, 2012.
Eukaryota	Plantae	Spermatophyta	Digitaria insularis (sourgrass)	Present	Native		USDA-ARS, 2012.
Eukaryota	Plantae	Spermatophyta	Dioscorea alata (white yam)	Widespread	Introduced		Broome et al., 2007; FAO, 2013.
Eukaryota	Plantae	Spermatophyta	Dioscorea bulbifera (air potato)	Present	Introduced		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Drymaria cordata (tropical chickweed)	Present	Introduced		Acevedo-Rodríguez and Strong, 2012.
Eukaryota	Plantae	Spermatophyta	Duranta erecta (golden dewdrop)	Present	Native		USDA-ARS, 2013.
Eukaryota	Plantae	Spermatophyta	Dysphania ambrosioides (Mexican tea)	Present	Introduced		Acevedo-Rodríguez and Strong, 2012.
Eukaryota	Plantae	Spermatophyta	Echinochloa colona (junglerice)	Present	Introduced		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Eleusine indica (goose grass)	Present	Introduced		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Emilia fosbergii (Florida tassel-flower)	Present	Introduced		Broome et al., 2007.

Domain	Kingdom	Phylum	Species	Distribution	Origin	Invasive	References
Eukaryota	Plantae	Spermatophyta	Emilia sonchifolia (red tasselflower)	Present			Fournet and Hammerton, 1991.
Eukaryota	Plantae	Spermatophyta	Erechtites hieraciifolius (American burnweed)	Present	Native		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Erechtites valerianifolius (tropical burnweed)	Present	Native		USDA-ARS, 2013.
Eukaryota	Plantae	Spermatophyta	Eugenia uniflora (Surinam cherry)	Present	Introduced		Missouri Botanical Garden, 2013.
Eukaryota	Plantae	Spermatophyta	Euphorbia hypericifolia (graceful spurge)	Present	Native		USDA-ARS, 2013.
Eukaryota	Plantae	Spermatophyta	Euphorbia tithymaloides (devil's backbone)	Present	Native		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Ficus benjamina (weeping fig)	Present	Introduced		
Eukaryota	Plantae	Spermatophyta	Ficus elastica (rubber plant)				Broome et al., 2007; Acevedo-Rodriguez and Strong, 2012.
Eukaryota	Plantae	Spermatophyta	Ficus microcarpa (Indian laurel tree)	Present	Native		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Ficus pumila (creeping fig)	Present	Introduced		Broome et al., 2007; Acevedo-Rodriguez and Strong, 2012.
Eukaryota	Plantae	Spermatophyta	Flacourtia indica (governor's plum)	Present	Introduced	No	Kairo et al., 2003.
Eukaryota	Plantae	Spermatophyta	Flemingia strobilifera (wild hops)	Widespread	Introduced		Broome et al., 2007.

Domain	Kingdom	Phylum	Species	Distribution	Origin	Invasive	References
Eukaryota	Plantae	Spermatophyta	Gliricidia sepium (gliricidia)	Present	Introduced		WAC, 2005.
Eukaryota	Plantae	Spermatophyta	Heliconia bihai (macaw flower)	Present	Native		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Hyparrhenia rufa (Jaragua grass)	Widespread	Introduced		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Indigofera tinctoria (true indigo)	Present	Introduced		Acevedo-Rodríguez and Strong, 2012.
Eukaryota	Plantae	Spermatophyta	Jacaranda mimosifolia (jacaranda)	Present	Introduced		Kairo et al., 2003.
Eukaryota	Plantae	Spermatophyta	Jasminum multiflorum (star jasmine)	Present	Introduced		Howard, 1989.
Eukaryota	Plantae	Spermatophyta	Jatropha curcas (jatropha)	Present	Introduced	No	Kairo et al., 2003.
Eukaryota	Plantae	Spermatophyta	Jatropha gossypiifolia (bellyache bush)	Present		No	CSIRO, 1998.
Eukaryota	Plantae	Spermatophyta	Justicia pectoralis (freshcut)	Present			Acevedo-Rodríguez and Strong, 2012.
Eukaryota	Plantae	Spermatophyta	Lagerstroemia indica (Indian crape myrtle)	Present	Introduced		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Lagerstroemia speciosa (Pride of India)	Present	Introduced		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Lantana camara (lantana)	Widespread	Native		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Lawsonia inermis (Egyptian privet)	Present	Introduced		Broome et al., 2007.

Domain	Kingdom	Phylum	Species	Distribution	Origin	Invasive	References
Eukaryota	Plantae	Spermatophyta	Leonotis nepetifolia (Christmas candlestick)	Present	Introduced		Acevedo-Rodríguez and Strong, 2014.
Eukaryota	Plantae	Spermatophyta	Lepidium virginicum (Virginian peppercress)	Present	Native		Acevedo-Rodríguez and Strong, 2012; Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Leucaena diversifolia	Present	Introduced		World Agroforestry Centre, 2002.
Eukaryota	Plantae	Spermatophyta	Leucaena leucocephala (leucaena)	Present	Introduced		Missouri Botanical Garden, 2007; Kairo et al., 2003.
Eukaryota	Plantae	Spermatophyta	Megathyrsus maximus (Guinea grass)	Widespread	Introduced	No	Fournet and Hammerton, 1991.
Eukaryota	Plantae	Spermatophyta	Melaleuca quinquenervia (paperbark tree)	Present	Introduced		Kairo et al., 2003.
Eukaryota	Plantae	Spermatophyta	Melinis repens (natal redtop)	Present			GBIF, 2012.
Eukaryota	Plantae	Spermatophyta	Merremia aegyptia (hairy woodrose)	Present	Native		Powell, 1989.
Eukaryota	Plantae	Spermatophyta	Mimosa pigra (giant sensitive plant)	Widespread			Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Mimosa pudica (sensitive plant)	Present	Native		Alexander, 1901.
Eukaryota	Plantae	Spermatophyta	Mirabilis jalapa (four o'clock flower)	Present	Introduced		New York Botanical Garden, 2016.
Eukaryota	Plantae	Spermatophyta	Momordica charantia (bitter gourd)	Present	Introduced		Broome et al., 2007; Fournet and Hammerton, 1991.

Domain	Kingdom	Phylum	Species	Distribution	Origin	Invasive	References
Eukaryota	Plantae	Spermatophyta	Morinda citrifolia (Indian mulberry)	Present	Introduced		Acevedo-Rodríguez and Strong, 2012.
Eukaryota	Plantae	Spermatophyta	Moringa oleifera (horse radish tree)	Present	Introduced		Acevedo-Rodríguez and Strong, 2012.
Eukaryota	Plantae	Spermatophyta	Nopalea cochenillifera (cochineal cactus)	Present	Introduced		New York Botanical Garden, 2017; Acevedo-Rodríguez and Strong, 2012.
Eukaryota	Plantae	Spermatophyta	Nymphaea ampla (dot-leaf water-lily)	Present			Datamining 2011 - Invasive Species Databases.
Eukaryota	Plantae	Spermatophyta	Odontonema nitidum (shrubby toothedthread)	Present	Native		Howard, 1989.
Eukaryota	Plantae	Spermatophyta	Parkinsonia aculeata (Mexican palo-verde)	Present			
Eukaryota	Plantae	Spermatophyta	Parthenium hysterophorus (parthenium weed)	Present	Native		USDA-ARS, 2012.
Eukaryota	Plantae	Spermatophyta	Paspalidium geminatum (Egyptian paspalidium)	Localised	Native		USDA-ARS, 2013.
Eukaryota	Plantae	Spermatophyta	Paspalum paniculatum (Russell River grass)	Present	Native		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Passiflora foetida (red fruit passion flower)	Present	Native	No	Killip, 1938.
Eukaryota	Plantae	Spermatophyta	Pennisetum polystachion (mission grass)	Present	Introduced		USDA-ARS, 2012.
Eukaryota	Plantae	Spermatophyta	Petiveria alliacea (guinea hen weed)	Present	Native		Broome et al., 2007.

Domain	Kingdom	Phylum	Species	Distribution	Origin	Invasive	References
Eukaryota	Plantae	Spermatophyta	Physalis angulata (cutleaf groundcherry)	Present	Native		USDA-ARS, 2013.
Eukaryota	Plantae	Spermatophyta	Pithecellobium dulce (Manila tamarind)	Present	Introduced		
Eukaryota	Plantae	Spermatophyta	Plectranthus amboinicus (Indian borage)	Present	Introduced		Broome et al., 2007; Acevedo-Rodriguez and Strong, 2012.
Eukaryota	Plantae	Spermatophyta	Pluchea carolinensis (sourbush)	Present	Native	No	USDA-ARS, 2015.
Eukaryota	Plantae	Spermatophyta	Portulaca quadrifida (chickenweed)	Present			Wagner and Lorence, 2015.
Eukaryota	Plantae	Spermatophyta	Psidium cattleianum (strawberry guava)	Present	Introduced		Broome et al., 2007; Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Psidium guajava (guava)	Present	Introduced		Broome et al., 2007; USDA-ARS, 2012.
Eukaryota	Plantae	Spermatophyta	Rivina humilis (bloodberry)	Present	Native		USDA-ARS, 2013.
Eukaryota	Plantae	Spermatophyta	Rottboellia cochinchinensis (itch grass)	Present	Introduced		Missouri Botanical Garden, 2008.
Eukaryota	Plantae	Spermatophyta	Rubus rosifolius (roseleaf raspberry)	Widespread	Introduced		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Samanea saman (rain tree)	Present	Introduced		
Eukaryota	Plantae	Spermatophyta	Senna alata (candle bush)	Present	Native		Broome et al., 2007; Alexander, 1901.

Domain	Kingdom	Phylum	Species	Distribution	Origin	Invasive	References
Eukaryota	Plantae	Spermatophyta	Senna bacillaris (whitebark senna)	Present	Native		Broome et al., 2007; Acevedo-Rodriguez and Strong, 2012.
Eukaryota	Plantae	Spermatophyta	Senna obtusifolia (sicklepod)	Present			Fournet and Hammerton, 1991.
Eukaryota	Plantae	Spermatophyta	Senna occidentalis (coffee senna)	Present	Native		USDA-ARS, 2016; Fournet and Hammerton, 1991.
Eukaryota	Plantae	Spermatophyta	Sesbania sesban (sesban)	Present	Introduced		Acevedo-Rodríguez and Strong, 2014.
Eukaryota	Plantae	Spermatophyta	Sida acuta (sida)	Widespread	Native		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Sida linifolia (flaxleaf fanpetals)	Present	Native		Acevedo-Rodríguez and Strong, 2012.
Eukaryota	Plantae	Spermatophyta	Solanum torvum (turkey berry)	Present			Fournet and Hammerton, 1991.
Eukaryota	Plantae	Spermatophyta	Spathoglottis plicata (Philippine ground orchid)	Present	Introduced		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Sphagneticola trilobata (wedelia)	Present	Introduced		USDA-ARS, 2013.
Eukaryota	Plantae	Spermatophyta	Sporobolus pyramidatus (whorled dropseed)	Present	Native		Acevedo-Rodriguez et al., 2015.
Eukaryota	Plantae	Spermatophyta	Stachytarpheta jamaicensis (Jamaica vervain)	Present			Fournet and Hammerton, 1991.
Eukaryota	Plantae	Spermatophyta	Stenotaphrum secundatum (buffalo grass)	Present	Native		

Domain	Kingdom	Phylum	Species	Distribution	Origin	Invasive	References
Eukaryota	Plantae	Spermatophyta	Sterculia apetala (Panama tree)	Present			
Eukaryota	Plantae	Spermatophyta	Synedrella nodiflora (synedrella)	Present			Fournet and Hammerton, 1991.
Eukaryota	Plantae	Spermatophyta	Syzygium cumini (black plum)	Present	Introduced	No	Kairo et al., 2003.
Eukaryota	Plantae	Spermatophyta	Syzygium jambos (rose apple)	Widespread	Introduced		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Tabebuia heterophylla (pink trumpet tree)	Present	Native	No	USDA-ARS, 2008.
Eukaryota	Plantae	Spermatophyta	Tephrosia candida (white tephrosia)	Present	Introduced		Kairo et al., 2003.
Eukaryota	Plantae	Spermatophyta	Thespesia populnea (portia tree)	Present			USDA-ARS, 2015.
Eukaryota	Plantae	Spermatophyta	Thunbergia fragrans (whitelady)	Present	Introduced		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Tithonia diversifolia (Tithonia)	Present	Introduced		USDA-ARS, 2018.
Eukaryota	Plantae	Spermatophyta	Tribulus cistoides (false puncture vine)	Present			Schotman, 1989.
Eukaryota	Plantae	Spermatophyta	Trimezia steyermarkii (yellow walking iris)	Present	Introduced		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Triphasia trifolia (limeberry)	Widespread	Introduced		Broome et al., 2007.

Domain	Kingdom	Phylum	Species	Distribution	Origin	Invasive	References
Eukaryota	Plantae	Spermatophyta	Turbina corymbosa (Christmas vine)	Present	Native		Powell, 1989.
Eukaryota	Plantae	Spermatophyta	Turnera ulmifolia (West Indian holly)	Present	Native		Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Urena lobata (caesar weed)	Widespread	Native		Fournet and Hammerton, 1991; Broome et al., 2007.
Eukaryota	Plantae	Spermatophyta	Urochloa mutica (para grass)	Present	Introduced		Acevedo-Rodríguez and Strong, 2012.
Eukaryota	Plantae	Spermatophyta	Urochloa reptans (sprawling signalgrass)	Present	Introduced		Acevedo-Rodríguez and Strong, 2012.
Eukaryota	Protista	Protozoa	Babesia	Reported present or known to be present			OIE Handistatus, 2005.
Virus			caprine arthritis encephalitis virus	Reported present or known to be present			OIE Handistatus, 2005.
Virus			Newcastle disease virus	Last reported			OIE Handistatus, 2005.
Virus			Papaya ringspot virus	Present			Chin et al., 2008.
Virus			Sugarcane mosaic virus (mosaic of abaca)	Present			ISSCT, 1989; EPPO, 2014.
Virus			Tomato yellow leaf curl virus (leaf curl)	Restricted distribution			EPPO, 2014.