

A Brief Assessment of the Impacts of Hurricanes Irma and Maria on the Trees, Landscape and Wildlife of St. John, USVI



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Also, a special thanks to Gail Karlsson for her initiative in proposing, organizing and managing the project, and for her contributions to the report.

And thanks to the many colleagues and supporters who have in countless ways helped to advance this effort, and to further the protection and conservation of the flora and fauna of St. John and the Virgin Islands.



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Summary

This assessment of the impacts of the 2017 hurricanes Irma and Maria on the plants, forests and ecosystems of St. John was funded through a grant from the Unitarian Universalist Fellowship of St. John (UUF).

The UUF Green Sanctuary Committee published a book in 2016 on *Learning About Trees and Plants*, which included information about the ecological and cultural roles of St. John's trees and plants, and encouraged people to appreciate and preserve them. Sadly, many of the trees on St. John were badly battered by the 2017 storms. Since the storms, limited attention has been paid to the conditions and recovery prospects for St. John's trees, plants and wildlife, given all the other critical hurricane response needs.

The two experts who worked on the UUF *Learning About Trees and Plants* book, Eleanor Gibney and Kevel Lindsay, were approached by Gail Karlsson from the UUF Green Sanctuary Committee about post-hurricane follow-up activities. They agreed to work on a preliminary evaluation of tree and ecosystem impacts in critical areas of St. John, and to put together suggestions to support recovery and resilience.

Special attention was requested regarding recommendations on limiting destructive coastal and upland erosion, planting native species that can help support wildlife after storms, and discouraging the spread of invasive species that take advantage of post-storm conditions.

Although the UUF could not provide sufficient resources to fund an in-depth scientific survey of the condition of the trees and plants across the island, this report was expected to provide a preliminary evaluation and set of recommendations (for residents, organizations and government entities) that could serve as a catalyst for additional funding and collaborative work in this area.

The findings of this assessment report are based on 11 days of field surveys on St. John, from February 21 to March 3, 2019, carried out by Kevel Lindsay and Eleanor Gibney, with participation by Gail Karlsson. The team visited 28 sites, including mangroves, beaches and coastal habitats, as well as the highest slopes and several inland sites.

Main Findings

Coastal Areas

Shorelines have been dramatically changed due to erosion and loss of (non-native) Coconut Palms (*Cocos nucifera*), as well as native trees such as Sea Grapes (*Coccoloba uvifera*), and Buttonwood (*Conocarpus erectus*). Replanting is needed to help stabilize the beaches. Coconut Palms have compact dense root systems that do not extend far from the tree. The combination of waves and wind easily removed many of them completely, allowing waves to further erode

the beach behind them. Other factors that appear to have added to sandy shore erosion include construction of buildings immediately behind the front line, and the paving of roadways adjoining beaches.

Mangrove wetlands were also very negatively affected. They are gradually showing regrowth but in many areas the mangroves are struggling due to over-grazing by introduced White-tailed Deer, and this situation requires urgent attention.

Debris and contaminants that wash down through the guts negatively affect the beaches, wetlands, and marine environment.

Trees and Forests

Much of the wind damage to the trees was on the western facing and northern slopes of the island, except at Coral Bay, which faces the east. The trees were stripped of foliage and branches, the twisting effect of violent gusts separated bark from the wood of trunks and roots, and countless numbers were blown down. Many trees died due to the storm damage, and others succumbed to insect, fungal, bacterial and viral attacks, and other post-hurricane stresses.

Over time, much of the forest is likely to be restored, as these ecosystems evolved over centuries with hurricanes and severe weather events, and some species rely on occasional dramatic breaks in the forest canopy for their continued survival. However, if climate change contributes to more frequent and stronger hurricanes affecting the Caribbean islands in the decades to come, the forests may not have time to recover between events, resulting in permanent changes to island forests and other ecosystems.

Plants and Vegetation

Many types of vegetation partially or wholly succumbed to diseases and pests as a result of hurricane-related stresses. In addition, the increase in chemicals applied for weed and pest control on St. John properties represents a major threat to the local vegetation, and to human and wildlife welfare.

The survey team did not find any native plant species that are in unsustainable declines, though some rare plants need special protection.

Some former pastures that appeared to be returning to forest have reverted to grass and weeds as a result of the hurricanes. The forest areas offered little opportunity for new invasive plants to establish, but there was a quick surge in the growth of vines.

In particularly disturbed areas, increased sunlight levels combined with drenching rains caused seeds that were in dormancy in the soil seed bank to germinate, some apparently having remained viable for decades, if not longer. Seed dormancy in tropical species has been little

studied, but has obviously been a factor in the reemergence of some invasive plants in areas where they had been removed long ago.

Due to storm surges, two coastal species, one introduced in the 1800s (Haiti-haiti or Beach Maho, *Thespesia populnea*) and the other in the 1990s (Beach Naupaka or Sea Lettuce, *Scaevola taccada*), have been observed in greatly increased numbers on sandy shores, and also inland.

In moister areas, such as Bordeaux Mountain, exotic vines in the Philodendron family are greatly increasing their spread, as are Heliconias, in part due to careless dumping of plant debris.

Wildlife

Although some birds and insects suffered significant losses in population as a result of the storms, most of those species are now recovering. That process can be supported by retention and expansion of trees and plants that provide food and habitat for birds, butterflies, and insects, and are in turn pollinated by them. More information is needed to help the community support struggling bird species, like hummingbirds and pigeons, as well as bats.

Invasive animals: Many trees and plants are having a hard time recovering as a result of the impacts of the introduced invasive deer. There was strong evidence of over-browsing by the deer in all mangroves and salt ponds, and along most trails in forests.

It appears that deer are selectively removing seedlings of many common species, such as Turpentine (*Bursera simaruba*,) severely affecting forest regeneration. Urgent action is needed to reduce the deer population, which does not appear to have been diminished by the storms. Free-roaming goats, sheep, and donkeys, plus invasive iguanas, also consume valuable vegetation.

Main Recommendations

Organize community education and outreach to increase awareness about the value of healthy forests, mangroves and native plants, as well as ways to improve residents' property, lives and wellbeing through a healthy environment, and support hurricane preparedness and response. Attention should be given to the negative impacts on ecosystems from debris and toxins in the guts, and chemicals applied for pest and weed control.

Share this assessment report with community groups, environmental, conservation and scientific organizations, the Virgin Islands National Park, Virgin Islands governmental agencies, and key local natural resources managers and scientists. This will be an important way to amplify the impact of the report and catalyze action on issues of critical concern.

Establish a native plant garden to help secure populations of rare and endangered native plants, and provide seedlings for forest restoration and conservation, as well as to promote education and outreach efforts, support wildlife, and supply plants for native gardens and urban landscapes. Residents should be encouraged to support birds, bats, bees and butterflies by planting species that flower and fruit quickly after storms. Recommended species include:

- Angelin or Pigturd (*Andira inermis*)
- Bay Cedar (*Suriana maritima*)
- Black Mampoo (*Guapira fragrans*)
- Black Torch (*Erithallis fruticosa*)
- Black Wattle (*Piper amalago*)
- Century Plant (*Agave missionum*)
- Fiddlewood (*Citharexylum fruticosum*)
- Gre-gre (*Bucida buceras*)
- Guavaberry (*Myrciaria floribunda*)
- Milkweed or Kitty Mcwanny (*Asclepias currassivica*)
- Nothing Nut or False Nutmeg (*Cassine xylocarpa*)
- Orange Manjack (*Cordia rickseckeri*)
- Pink Sage (*Lantana involucrata*)
- Sea Grape (*Coccoloba uvifera*)
- Turpentine (*Bursera simaruba*)
- Tyre Palm (*Coccothrinax alta*)
- Pigeon Berry (*Bourreria succulenta*)
- Water Mampoo (*Pisonia subcordata*)
- West Indian Boxwood (*Sideroxylon obovata*)
- Wild Fig (*Ficus citrifolia*)
- White Cedar (*Tabebuia heterophylla*)

Replant the most severely hit coastal areas using native plants. Some Coconut (*Cocos nucifera*) trees could be included, but not placed directly onto beaches, because that can increase erosion of beaches, compact sand and limit sea turtle nesting. The most durable, fast-growing and long-lived for this situation are Sea Grape (*Coccoloba uvifera*) and Buttonwood (*Conocarpus erecta*). The large and extremely durable Gre-gre Tree (*Bucida buceras*) is an excellent choice for the back-beach area behind the first line.

Other native species for coastal areas include: Bay Cedar (*Suriana maritima*), Black Torch (*Erithallis fruticosa*), Nothing Nut or False Nutmeg (*Cassine xylocarpa*), Orange Manjack (*Cordia rickseckeri*), Pigeon Berry (*Bourreria succulenta*), Turpentine tree (*Bursera simaruba*), Water Mampoo (*Pisonia subcordata*), West Indian Boxwood (*Sideroxylon obovata*), and White Cedar (*Tabebuia heterophylla*).

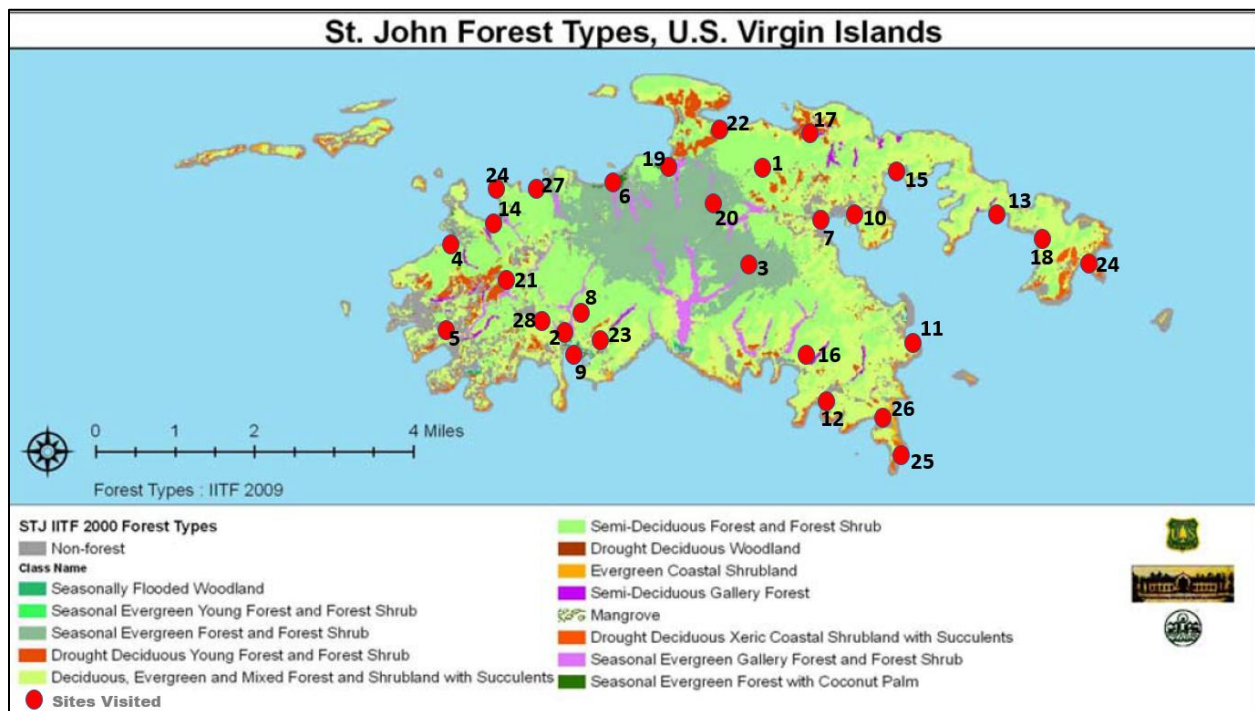
Some hard-hit mangrove areas, particularly Hurricane Hole, should be replanted and also protected from deer to help them recover. The fringing Red Mangroves of Hurricane Hole are

most important because their prop-roots supported diverse and rare marine life, in a habitat not replicated in the territory or perhaps anywhere else in the Caribbean.

Develop a plan to manage the deer population as soon as possible, to reduce the grazing and loss of valuable vegetation.

Conduct additional, more comprehensive post-hurricane environmental assessments::

- a. Long-term monitoring plots within forests and woodlands
- b. Evaluation of wetlands conditions
- c. Assessment of erosion and landslide risks in guts, debris removal, and survey of gut-based wildlife
- d. Erosion control assessment for Bordeaux Mountain



Map 1. Sites and locations for field survey assessment on St. John, Feb - March 2019

Background

The United States Virgin Islands (USVI), an insular territory of the United States of America, is located about 40 miles east of Puerto Rico. There are three main islands, St. Croix (the largest), St. Thomas and St. John, and a number of minor cays (outer islands). The total land area of the territory is 133 square miles. The total land territory of St. John is about 20 square miles, with a population of about 4,000 in 2010, before the hurricanes.

About 60% of St. John is included in the Virgin Islands National Park (VINP), a federally listed protected area administered by the US Department of the Interior. An additional 5,500 acres of adjacent marine area are included in the VINP.

Pedro Acevedo-Rodríguez listed 747 species of trees and plants in his book *Flora of St. John, U.S. Virgin Islands* (1996), and we have identified about 12 more, most native and a few naturalized.

According to categories used in the VI Department of Agriculture's Forestry Division's 2010 assessment in collaboration with the US Department of Agriculture's Forest Service and the International Institute of Tropical Forestry (see Chakroff, 2010), the island has at least 13 main forest types and one non-forest type (urban). We included another category 'beach', covering coastal sandy areas, for the purposes of the assessment. *Map 1* shows the vegetation communities, along with the sites visited and assessed during the field visits from February 21 to March 3, 2019.

St. John also has numerous invertebrate species, nine amphibians (one extirpated), 10 reptiles (including lizards and snakes), seven known bats, the introduced Small Indian Mongoose (*Herpestes javanicus*), and the introduced and highly invasive White-tailed Deer (*Odocoileus virginianus*), as well as wild and free-roaming goats, donkeys, pigs and cattle, and about 159 native and naturalized bird species (according to www.ebirds.com).

As St. John and the rest of the US Virgin Islands recover and rebuild from Hurricanes Irma and Maria, attention is now turning to the storms' impacts on the natural environment, including the forests, plants, landscapes, and fauna. Residents, as they begin to focus more broadly on issues other than family, personal lives and business, are asking questions like: Will the trees recover? What has happened to the wasps and butterflies? Where are the birds? What can we do to help restore the mangroves?

The purpose of this assessment was to briefly evaluate the post-hurricane condition of the forests, plants and ecosystems on St. John, to help inform residents of what has happened, and to help guide recovery and restoration efforts.

Methodology and Approach

The Team

The survey and reporting team for this effort included Kevel Lindsay, ecologist and naturalist, Eleanor Gibney, local botanist and historian, and Gail Karlsson, environmental lawyer and author, and chair of the UUF Green Sanctuary Committee.

Planning and Mobilization

In January 2019, after conversations with Kevel Lindsay and Eleanor Gibney about the need for post-hurricane information and recommendations about St. John's ecosystems, Gail Karlsson drafted a Green Sanctuary Committee funding proposal for follow-up on the UUF Tree Project. The proposal was presented to and approved by the UUF Executive Committee on January 13, 2019 and endorsed at the UUF Annual Meeting in February 2019.

Prior to the field work, which took place from February 21 to March 3, Kevel Lindsay, Eleanor Gibney and Gail Karlsson held several discussions via phone and through emails to plan for the effort, considering key questions and issues that, in their judgment, were critical to understanding the post-hurricane impacts. These targets were further refined during a sit-down session among the three members, on February 21 at Cruz Bay.

Initially, the team began by outlining general plant and environmental issues and concerns that have arisen post-hurricanes. Many of these issues and key points were broad and ambitious, but the team felt that despite the financial resource and time constraints, there should be an attempt to assess as much as possible, and come up with recommendations and suggestions for critical action targets that could be submitted to the UUF members, the Virgin Islands National Park, key local stakeholders, and the Virgin Islands government.

Issues and Concerns

1. What coastal areas and habitats need assessment and attention? Prioritize those areas in need of ground checks, then provide a status of the site and habitat.
2. Come up with a list of priority wild plants and animals, then determine which ones should be checked and provide the status for each.
3. For inland sites, determine which habitats need assessment and attention. Prioritize the areas that need ground checks, then provide a status of the site and habitat.
4. Determine how best to physically and effectively assess these sites and species.

5. Evaluate conditions in the major settlements: Cruz Bay and Coral Bay.
6. Update status for all mangrove sites and salt pond sites, where possible.
7. Visit and provide an update for Bordeaux Mountain, especially given that it is the highest point on the island and experienced considerable wind forces.
8. Suggest any plant species that can be used for reforestation, and how and where.
9. Get in touch with regional and national plant conservation and wildlife agencies and seek their help, including the Division of Fish and Wildlife, USVI, Virgin Islands Conservation Society, US Fish and Wildlife Service, the International Institute of Tropical Forestry, Puerto Rico and the US Department of Agriculture.
10. Consider other questions to ask, and suggestions for moving forward. Consult with other local experts and possible stakeholders.
11. Think about other problems and challenges.

In attempting to refine the above list, Eleanor Gibney provided target sites, species and issues during the February 21 meeting. The list of target sites is provided in *Table 1*.

Table 1. List of target sites for post-hurricane assessment.

No.	Site/Location	Assessed?
1	Battery Gut	Yes
2	Bordeaux	Yes
3	Cinnamon Bay	Yes
4	Coccoloba Point	No
5	Coral Bay Mangroves	Yes
6	Denis Bay	No
7	East End	Yes (consists of several sites)
8	Europa/White Cliffs	No
9	Fish Bay Mangrove	Yes
10	Frances Bay Pond	No
11	Hawksnest/Gibney/Oppenheimer	Yes
12	Hurricane Hole	Yes
13	Lameshure	Yes
14	Leinster Trail, Mangroves and Area	Yes
15	Maho and Maho Mangroves	Yes
16	Mamee Peak	Yes
17	Mary Creek and Mangroves	Yes
18	Nanny Point	No

19	Ram Head	Yes
20	Reef Bay and Mangroves	No
21	Reef Bay Trail	No
22	Salt Pond	Yes
23	Trunk Bay and Pond	Yes
24	Upper Rendezvous Bay	Yes

In addition to the 25 sites initially listed, the team also visited 13 additional sites during the field surveys. These sites included:

- 1) Ajax Peak
- 2) Caneel Bay
- 3) Cruz Bay
- 4) Haulover – East End
- 5) Fish Bay Gut
- 6) Fortsberg salt pond
- 7) Grootpan Bay salt pond
- 8) Hansen Bay
- 9) Long Bay – East End
- 10) Margaret Hill
- 11) Mollendal Gut
- 12) Privateer – East End
- 13) Sabbat Point

The priority types and species of plants included:

Plants for butterflies
Mangrove species and forests
Epiphytes (especially bromeliads and orchids)
The two federally listed endangered plants: namely *Calypttranthes thomasiana* and
Zanthoxylum thomasianum
Lignum Vitae (*Guaiacum officinale*)
Tree Fern (*Cyathea arborea*)
Solanum conocarpum, Virgin Islands endemic
Eugenia sp.
Urban trees

The native wildlife species of concern included: bats, amphibians, insects (especially *Polistes* wasps), butterflies, and birds - including the Screech Owl (*Megascops nudipes newtoni*), Yellow Warbler (*Setophaga petechia*) and Antillean-crested Hummingbird (*Orthorhyncus cristatus*), as well as the brown-throated Parakeet/St. Thomas Conure (*Eupsittula pertinax*).

The team was also concerned about the status and potential post-hurricane impacts of the introduced invasive animals, including the Mongoose (*Herpestes javanicus*), the White-tailed

Deer (*Odocoileus virginianus*), donkeys, the Puerto Rican coqui frog (*Eleutherodactylus coqui*), the cane toad (*Rhinella marina*), the green iguana (*Iguana iguana*) and goats. Additionally, the team was also on the lookout for the spread of plant pests, or the recent introduction of plant pests as a result of the storms.

Field Assessments and Surveys

To assess and survey the sites, the team began by focusing on areas with easy access and in relatively proximity to the home bases of each member.

Field work and assessment began on February 21, when Kevel Lindsay visited Hawksnest with Eleanor Gibney. This and adjoining coastal bays were heavily inundated by storm surge, overland flooding, rain and strong winds.

During field visits, the team searched for priority plant species, habitat types, including mangroves and other wetlands, targeted wildlife species and environmental issues. Points of interest were marked by GPS using a handheld global satellite navigation unit. Photos were taken, and information collected, for further analysis.

The information, photos, GPS coordinates and discussions were later analyzed offsite, in preparation for this report.

Results and Discussion

Of the initially listed 25 priority sites, 20 were visited and surveyed. Eight sites were later added and visited, bringing the total to 28 locations. East End, a relatively large and diverse landscape, is divided into three sites. *Table 2* provides summary results for these sites, including habitat type and post-hurricane impacts observed, and *Map 1* shows the locations and the vegetation communities of the island.

Table 2. List of target sites visited by survey team, for post-hurricane assessment.

Map Code No.	Site/Location	Habitat Type	Post-hurricane Impacts and Issues
1	Ajax Peak	Semi-Deciduous Forest and Forest Shrub & Non-forest Urban	The uppermost ridge and parts of the south slopes of this range are now in residential development. The natural forest is fragmented and experienced some damage, as did several homes and structures. The north slopes of the peak were severely damaged by winds, and numerous dead trees can be seen here. The native Tyre Palm survived well and recovered relatively quickly.
2	Battery Gut	Seasonal Evergreen Gallery Forest and Forest Shrub & Deciduous Evergreen and Mixed Forest and Shrubland with Succulents	Some parts of the mid and upper-slopes are now in residential development. The area is steep, and with friable soils/slopes. Erosion is a critical problem, especially for Fish Bay, as the once-closed canopy forest over the gut is now fully open as a result of storm damage. Debris from buildings and human activities in the upper watershed needs to be removed. Invasive deer are also over-browsing the undergrowth and are heavily impacting seedling growth and forest recovery.
3	Bordeaux	Seasonal Evergreen Forest and Forest Shrub	Ongoing erosion issues in the developed sections are now further exacerbated by the damage to the forests caused by the storm winds. Flooding, landslides and landslips are now more problematic in some areas. Several structures were damaged, and debris from many structures remains unrecovered, posing a threat to the lower watersheds. Dumping of

			<p>storm debris into guts is also an issue. Many, if not most, of the large trees are recovering (based on visual observations). Numerous ornamental species are escaping from gardens.</p>
4	Caneel Bay	Deciduous Evergreen and Mixed Forest and Shrubland with Succulents, Beach and & Non-forest Urban	<p>As with much of the natural forest and woodlands on the northwest-facing slopes of the island, wind damage from the storms is extensive and quite evident. However, although the hotel site was hard-hit structurally, many of the large trees survived. The beaches and low-lying areas were heavily inundated by storm surges and flooding in 2017, and suffered additional heavy flooding damage in November 2018. Coastal erosion is most concerning at Turtle Bay Point, site of an extensive Pre-Columbian settlement. Removal of all natural vegetation from the western edge of the point in the early 2000s evidently contributed to loss of land. Several highly invasive plants have proliferated due to the lack of clearing and cleaning of the grounds.</p>
5	Cruz Bay	Urban	<p>Many residential and commercial structures, as well as roads and infrastructure, were hard hit in the main town of St. John. Many of the large and old trees survived, but some historic trees, including ancient Genips (<i>Meliococcus bijugatus</i>) and large Tamarinds (<i>Tamarindus indicus</i>) were destroyed by the high winds. Coastal plants, such as the vine cactus, and the night-blooming Queen-of-the-night (<i>Selenicereus grandiflorus</i>), once prolific and prominent on the rocks along the coast of the Battery, have been reduced to a few bits of</p>

			stems (which are likely to grow back over time). Former pasture lands on Lind Point lost early successional woody vegetation and reverted to partial grassland, a situation repeated in many 20 th century pasture areas.
6	Cinnamon Bay	Seasonal Evergreen Forest and Forest Shrub, Seasonal Evergreen Gallery Forest and Forest Shrub, Seasonal Evergreen Forest with Coconut Palm & Mangrove	The camping infrastructure and facilities have been severely damaged by the storm winds and storm surges. The western beach, flatlands and coastal areas have been heavily eroded by the surges and floods, and the upper slopes were heavily wind-battered. Deer are severely impacting the recovery of the forests, and are quite common in the area (even seen during the field visit).
7	Coral Bay Mangroves	Mangrove, Seasonally Flooded Woodland & Urban	The mangroves were severely impacted by winds and storm surges. This has been compounded by past human activities in the area. Most large Red Mangrove (<i>Rhizophora mangle</i>) trees were killed by the storm, but thousands of seedlings are now germinating. Deer damage is less apparent here than in other mangrove areas.
8	Fish Bay Gut	Seasonally Flooded Woodland, Seasonal Evergreen Gallery Forest and Forest Shrub & Deciduous, Evergreen and Mixed Forest and Shrubland with Succulents	Conditions here are similar to the nearby Battery Gut. Parts of the mid-slope areas are now in residential development. The area is steep, and with friable soils/slopes. As the forest is now much more open due to storm damage, erosion is a critical problem, negatively affecting the nearby bay. Debris from buildings and human activities in the upper watershed needs to be removed. Invasive deer are also over-browsing the undergrowth and are heavily impacting seedling growth and forest recovery.

9	Fish Bay Mangrove	Seasonally Flooded Woodland & Mangrove	The mature mangrove trees were severely damaged by the storms, storm surges, flooding and siltation, and many died. Regrowth and regeneration are evident, though the deer are severely browsing the regrowth and seedlings, retarding the recovery. Debris from the upper watershed, and siltation, are major concerns.
10	Fortsberg Salt Pond	Mangrove	This salt pond and fringing mangrove system emerged with limited damage, though over-browsing by deer is a major concern.
11	Friis Bay	Drought-Deciduous Xeric Coastal Shrubland with Succulents, Evergreen Coastal Shrubland, Deciduous, Evergreen and Mixed Forest and Shrubland with Succulents & Mangroves	The low-lying coastal peninsula was moderately damaged by the storm, including the mangrove lagoon. While regrowth is evident in the bay, by the presence of Red Mangrove (<i>Rhizophora mangle</i>) seedlings, the small salt pond and fringing mangroves were cleared out after the storms. Who did this and why were not determined. Free-roaming goats remain a major issue in this area, including as traffic hazards.
12	Grootpan Bay Salt Pond	Mangrove, Deciduous Evergreen and Mixed Forest and Shrubland with Succulents & Drought Deciduous Woodland	Mature mangrove trees experienced some dieback, but overall the salt pond and fringing mangrove system had limited damage. Over-browsing by deer is a major concern now. The forests and woodlands in the watershed were moderately impacted. Siltation of the pond from upland slopes is of concern.
13	Haulover Bay	Semi-Deciduous Gallery Forest, Mangrove, Deciduous, Evergreen and Mixed Forest and Shrubland with Succulents, Semi-Deciduous Forest and Forest Scrub & Beach	Mangrove trees were decimated by the storm wind and storm surges, but some regrowth as well as regeneration is obvious. The ponds in the area remain viable, having water even during the early weeks of the annual dry

			season. However, the beaches and coastal areas did sustain moderate damage from storm surges and flooding. Debris and garbage continue to be problematic in this area, especially on north-facing areas.
14	Hawksnest/Gibney/Oppenheimer	Semi-Deciduous Forest and Forest Shrub, Semi-Deciduous Gallery Forest, Seasonal Evergreen Forest with Coconut Palm, Semi-Deciduous Forest and Forest Scrub & Beach	The forests and woodlands in the mid and upper watersheds were severely impacted, and there are many damaged and dead trees, though recovery is obvious by the regrowth. Coastal areas, including the beaches, were severely eroded by 2017 storm surges and flooding, and heavy rains in November 2018. Erosion is obviously linked to structures too close to the beach, and loss of front-line vegetation over time. Severe erosion at the former Oppenheimer house was increased by removal of surviving trees after the storm.
15	Hurricane Hole	Mangrove, Semi-Deciduous Forest and Forest Scrub & Drought Deciduous Woodland	Most of the mature mangrove trees were killed or badly damaged by storm winds and storm surges, as well as the blunt force of boats that had moored and anchored in the area to ride out the hurricanes. Regrowth and regeneration of the dominant Red Mangroves is evident, but deer are severely over-browsing. The forests and woodlands on the mid and upper slopes of the watershed were moderately to severely impacted by storm winds, though recovery is evident by the regrowth on the trunks and crowns of trees.
16	Lameshur	Semi-Deciduous Forest and Forest Shrub, Deciduous, Evergreen and Mixed Forest and Shrubland with Succulents, Semi-Deciduous Gallery Forest, Seasonal Flooded Woodland, Semi-Deciduous Forest and Forest Scrub, Mangrove, Drought Deciduous Woodland, Drought Deciduous Xeric Coastal Shrubland with Succulents & Beach	The mangroves at Lameshur were severely impacted by the storms and surges, and deer are having a major impact on their recovery. The beaches and coastal areas were eroded by flooding and storm surges. The Virgin Islands Environmental Research Station

			(VIERS) was severely damaged during the storm and remains closed. The forests and woodlands were moderately impacted.
17	Leinster Trail, Mangroves and Area	Seasonal Flooded Woodland, Semi-Deciduous Forest and Forest Scrub, Deciduous, Evergreen and Mixed Forest and Shrubland with Succulents, Drought Deciduous Young Forest and Forest Shrub, Mangrove, Drought Deciduous Woodland, Drought Deciduous Xeric Coastal Shrubland with Succulents & Beach	The mangroves, and coastal and upland forests and woodlands were severely impacted by the storms. Storm surges and flooding caused some erosion, but recovery of the mangroves and upland vegetation are evident by vigorous regrowth of such species as the native Tyre Palm, though many trees seem to remain dead. (This is somewhat illusory because many are in fact re-growing, though lower on the trunks). However, in some areas on the mid- to -upper slopes of the watershed, many of the trees were completely blown over.
18	Long Bay/Hansen Bay – East End	Semi-Deciduous Forest and Forest Scrub, Deciduous, Evergreen and Mixed Forest and Shrubland with Succulents, Drought Deciduous Xeric Coastal Shrubland with Succulents, Beach & Urban	Some of the residential buildings in the area were impacted and sustained damage, though it was relatively moderate. A few of the old and large Tamarind trees, were blown over or damaged, though most survived.
19	Maho and Maho Mangroves	Seasonal Evergreen Forest and Forest Shrub, Semi-Deciduous Forest and Forest Shrub, Semi-Deciduous Gallery Forest, Seasonal Evergreen Forest with Coconut Palm, Semi-Deciduous Forest and Forest Scrub, Seasonally Flooded Woodland, Mangrove & Beach	The damage here is similar to Hawksnest, Trunk and Cinnamon Bays. The coastal area underwent severe storm surge impacts, and any future development should take this into consideration. The large White Mangrove (<i>Laguncularia racemosa</i>) woodland shows little recovery and extensive browsing by deer.
20	Mamey Peak	Seasonal Evergreen Forest and Forest Shrub, Deciduous, Evergreen and Mixed Forest and Shrubland with Succulents & Seasonal Evergreen Gallery Forest and Forest Shrub	The summit and north slopes of this peak were severely impacted by storm winds. This can readily be seen from lower slopes on the north at locations such as Annaberg. Homeowners on the southern side of the road have apparently over-cleared on the VI

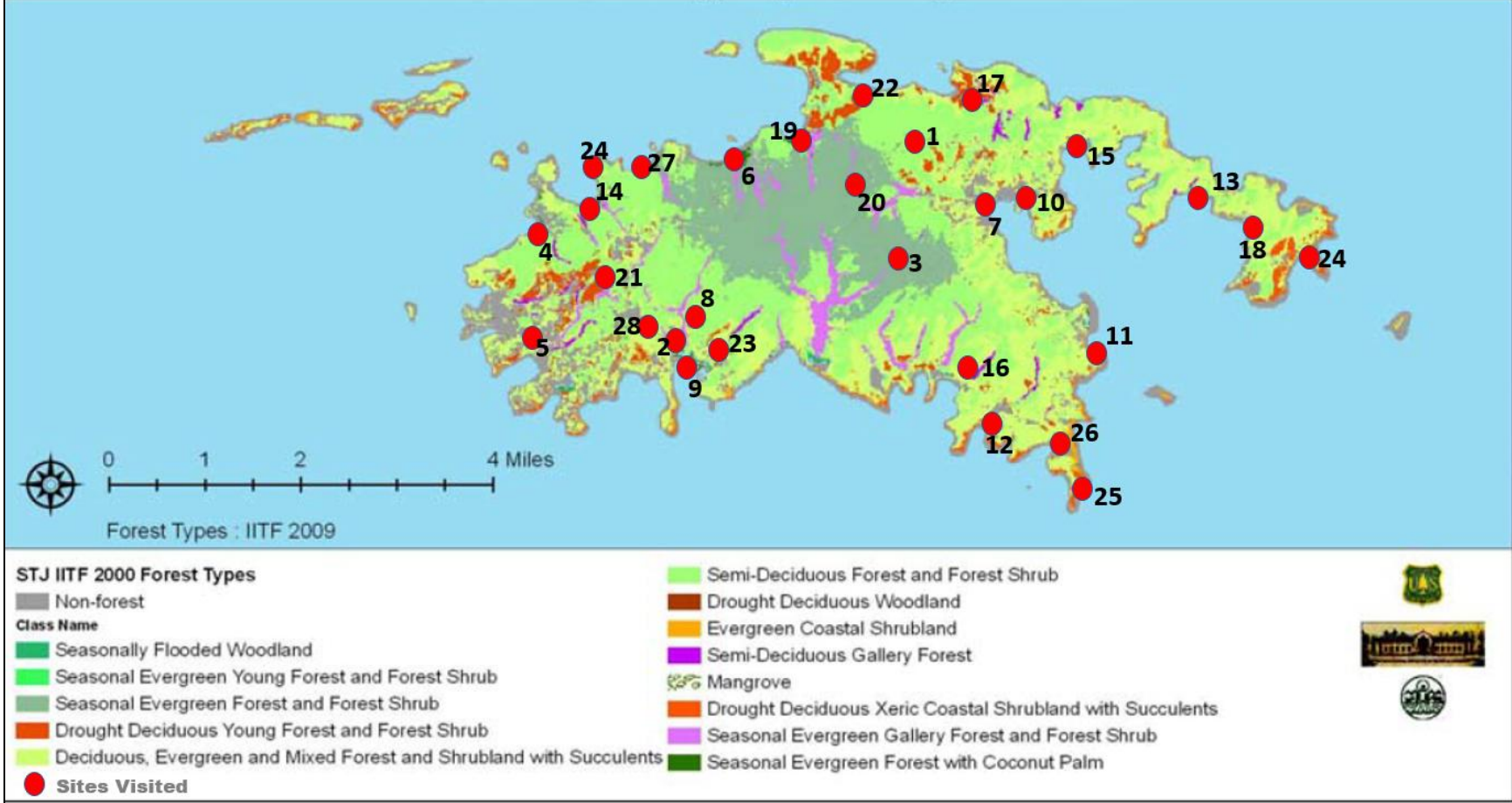
			National Park land to the north, with a large area completely bare of woody vegetation.
21	Margaret Hill	Drought Deciduous Young Forest and Forest Shrub, Deciduous, Evergreen and Mixed Forest and Shrubland with Succulents, Semi-Deciduous Forest and Forest Shrub & Drought Deciduous Woodland	West and northwest exposed slopes of this ridge and hill were severely damaged by storm winds. The forest in many parts, is now open as large trees were blown over, and/or branches were broken and blown off.
22	Mary Creek and Mangroves (Annaberg) Image 1	Seasonal Flooded Woodland, Semi-Deciduous Forest and Forest Scrub, Deciduous, Evergreen and Mixed Forest and Shrubland with Succulents, Drought Deciduous Young Forest and Forest Shrub, Mangrove, Drought Deciduous Woodland, Drought Deciduous Xeric Coastal Shrubland with Succulents	Damage to the mangroves and slopes of the watershed in this area are similar to the nearby <i>Leinster Trail and Mangroves</i> area. Deer are severely retarding the recovery of the mangroves and forests by over-browsing regrowth and seedlings, and by their hoof impacts on the bed of the salt pond.
23	Mollendal Gut	Semi-Deciduous Gallery Forest, Seasonally Flooded Woodland, Seasonal Evergreen Gallery Forest and Forest Shrub & Deciduous, Evergreen and Mixed Forest and Shrubland with Succulents	Conditions, impacts and issues here are similar to Battery and Fish Bay Guts. Some parts of the mid slopes are now in residential development. The area is steep, with friable soils/slopes, and erosion is a problem, as the forest is now much more open. Debris from buildings and human activities in the upper watershed needs to be collected and removed. Invasive deer are also over-browsing the undergrowth and are heavily impacting seedling growth and forest recovery.
24	Privateer – East End	Drought-Deciduous Xeric Coastal Shrubland with Succulents & Deciduous, Evergreen and Mixed Forest and Shrubland with Succulents	The forests, woodlands and open landscapes of this area were moderately impacted by the storms. Goat browsing, already a major concern, has escalated in the more open post-storm landscape. Soil erosion is severe.

25	Ram Head	Drought-Deciduous Xeric Coastal Shrubland with Succulents, Evergreen Coastal Shrubland & Deciduous, Evergreen and Mixed Forest and Shrubland with Succulents	The forests, woodlands and open landscapes of this area were lightly to moderately impacted by the storms. However, deer over-browsing continues to be a major problem in this area. Wild Lignum Vitae (<i>Guaiacum officinale</i>) trees, though damaged, are showing strong signs of recovery.
26	Salt Pond	Drought-Deciduous Xeric Coastal Shrubland with Succulents, Evergreen Coastal Shrubland, Deciduous, Evergreen and Mixed Forest and Shrubland with Succulents & Mangroves	The forests, woodlands and open landscapes of this area were lightly to moderately impacted by the storms. However, the nearby Concordia resort was severely damaged by the storm winds; debris has not been removed and the facility remains closed. The few remaining stands of the rare native columnar cactus <i>Stenocereus fimbriatus</i> , were severely damaged by winds, and all have been broken, with stems on the ground, many unable to re-sprout. Deer are over-browsing and continue to be a major problem in this area.
27	Trunk Bay and Pond	Seasonal Evergreen Forest and Forest Shrub, Seasonal Evergreen Gallery Forest and Forest Shrub, Seasonal Evergreen Forest with Coconut Palm	The impacts of the hurricanes and issues are similar to those of nearby Hawksnest, Maho, and Cinnamon Bays. Erosion of the shore was most dramatic adjoining the paved road and walkways at the eastern end of the beach.
28	Upper Rendezvous Bay	Deciduous, Evergreen and Mixed Forest and Shrubland with Succulents, Drought Deciduous Xeric Coastal Shrubland with Succulents & Evergreen Coastal Shrubland	The forests, woodlands and rare species— <i>Tillandsia</i> spp., <i>Calyptrocalyx thomasiana</i> , and <i>Zanthoxylum thomasianum</i> – were only lightly to moderately impacted by the hurricanes and are faring well.

Table notes

- I. The habitat and land-use types used for this assessment are based on those used in 2010 by the VI Department of Agriculture Forestry Division, US Department of Agriculture, and International Institute of Tropical Forestry (Chakroff, 2010).
- II. The vegetation map, classification and descriptions from 2010 were obviously done long before the 2017 storms, and many changes undoubtedly have occurred as a result of these major events, including the loss of most of the mature coconut trees and groves found especially along coastal areas on the north coast. The vegetation type: *Seasonal Evergreen Forest with Coconut Palm* is a pre-hurricane (2017) designation.
- III. No formal measurements of the extent of the damage, of the trees, of plant and animal distributions and populations, were undertaken, since the time, resources and human capacity were very limited for this effort.

St. John Forest Types, U.S. Virgin Islands



Map 1. Sites and locations for field survey assessment on St. John, February to March 2019.

Post-Hurricane Environmental Issues

Change in the natural landscape on St. John is generally very slow. Undisturbed forests have very heavy competition, and mature trees on hillsides increase in trunk diameter less than one inch every 20 years. But cataclysmic events compress a lot of change into a very short time.

The following are key observations from the team's February 21 to March 3, 2019 field surveys and observations.

Coastal erosion

Coming on the day of the September full moon, the time of the year's highest tides, Irma's storm surge on St. John's north shore was higher than any in centuries. Massive old trees were swept from both sandy and rocky shores, gigantic boulders were shifted, cliffs collapsed, and tons of soil eroded, especially from west-facing shores.

A huge late-winter storm in March of 2018 returned quantities of sand and restored beach profiles, but in many cases the old trees that lined the shore are now totally gone.

Factors that appear to have added to sandy shore erosion include: Coconut Palms on the front line of vegetation, construction of buildings immediately behind the front line, and the paving of roadways adjoining beaches.

Coconut Palms have compact dense root systems that do not extend far from the tree. The combination of waves and wind easily removed many of them completely, allowing waves to further erode the beach behind them. All of St. John's most photographed palms in recent years, ones that leaned out over beaches, were leaning because of substantial erosion from Hurricane Earl in 2010.

In every case, the most significant beach erosion on St. John from Irma and Maria occurred where there were concrete structures at or near the tree line, with west or northwest exposure. This includes several of Caneel Bay's beaches, the pavilions at Hawksnest Beach, the house at Oppenheimer Beach, the roadway and sidewalk at the east side of Trunk Bay, the Boulon family's pavilion on Windswept beach, the old warehouse and cottages at Cinnamon Bay, and the former Birch house and pavilion at Maho Bay.

Several of these sites had noticeable erosion and tree loss prior to 2017. Apparently even a relatively small area devoid of healthy tree roots can make an area vulnerable to these hurricane surges.

Tree and Forest Damage

Much of the extreme wind damage to the vegetation occurred on slopes exposed to winds from the west and northwest. The trees were stripped of foliage and branches, and countless numbers were blown down. Many trees have since succumbed to insect, fungal, bacterial and viral attacks, and to other post-hurricane stresses. As a result of the defoliation, branch damage, collapse of stems, and damage to bark and roots, many of the trees have since died, especially in areas such as Annaberg and nearby watersheds. *Image 1* shows how the Red Mangroves in Annaberg looked in February 2019, with the standing and collapsed dried stems still evident.



Image 1. The hills above the Mary Creek Red Mangroves at Annaberg, February 2019. The white sheen to the forests is the result of dead trees and branches. The foreground shows dead mangroves in the salt pond.

Impacts on Plants

Many types of vegetation partially or wholly succumbed to diseases and pests as a result of hurricane-related stresses.

One of the most striking effects of Irma's path was how totally many areas of early secondary vegetation reverted to grass and weeds. Pastures of the 20th century, most abandoned between 1950 and 1970, had been starting to seem almost-forested, but that illusion was wiped out in those few hours. Lind Point, Pastory, Mary Point, and the Carolina Valley are once again mainly covered by Guinea Grass and Tan-tan (*Megathyrsus maximus* and *Leucaena leucocephala*), the two livestock fodder plants that now dominate much of the tropical world and were introduced here in the 19th century.

Also worth noting was the explosive growth of vines immediately after the storms, most obviously Melon-leaf (*Cayaponia americana*). This slender vine, normally inconspicuous or totally absent in the forest, is an example of presumed long-term seed dormancy. Within 3 weeks of the passage of Irma, explosive growth of Melon-leaf began in all the hard-hit forests, and soon grew to cover almost every tree, dead or alive, that remained standing. After producing abundant seeds, the vines died back, virtually disappearing within a few months.

Invasive plants: Hurricane Irma's winds and storm surge certainly created the most profound disturbance to the island in the past 100 years, and in that time many potentially problematic plants have arrived. Vastly increased sunlight levels, combined with drenching rains, have caused many seeds that were in dormancy in the soil seed bank to germinate, some apparently having remained viable for decades, if not longer. Seed dormancy in tropical species has been little studied, but has obviously been a factor in the reemergence of some invasive plants in areas where they had been removed long ago.

Two coastal species, one introduced in the 1800s (Haiti-haiti or Beach Maho, *Thespesia populnea*) and the other in the 1990s (Beach Naupaka or Sea Lettuce, *Scaevola taccada*), have been observed in greatly increased numbers on sandy shores, and up to about 100 feet inland where seeds were carried by the surge. In moister areas, such as Bordeaux Mountain, exotic vines in the Philodendron family are greatly increasing their spread, as are Heliconias. Many of these are escaping due to decades of dumping of garden and yard debris in vacant areas, mostly in the VI National Park.

Tree and Plant Recovery Processes

The survey team did not find any native plant species that are in unsustainable declines as a result of the storms and storm surges. Many of the trees and other plants are now recovering, and are showing signs of regrowth and regeneration, despite the presence of numerous broken, dead or damaged stems and trunks. *Image 2* shows regrowth of upper branches of the

native tree, *Pouteria multiflora*, and other trees, at Bordeaux observed in February 2019. Dead and fallen trees will also slowly rot, thereby providing much needed nutrients to the soil.



Image 2. Signs of recovery and regrowth on *Pouteria multiflora*, and other trees, at Bordeaux. The trees are alive despite the presence of numerous dead and damaged branches.

The island's ecosystems evolved with hurricanes and severe weather events, and some species are dependent on storms to ensure their survival, taking advantage of opportunities when the forest becomes open and exposed to the elements. Opened canopies give sun-loving species on the forest floor a chance to regenerate. However, it is not clear how different species and habitats will be affected as severe storms become more frequent due to climate change.

The team did find that many plants are having a hard time recovering as a result of the impacts of the introduced invasive deer, and free-roaming goats and sheep (especially on the East End). Red Mangrove (*Rhizophora mangle*) is a prime example. Mature trees cannot regenerate from leaf buds, so once the small branches are destroyed, the tree dies. In an undisturbed system, there would always be abundant mangrove seedlings that remain short and suppressed, ready to quickly replace downed trees when sunlight increased following a hurricane. The explosion of the formerly small deer population on St. John in the past 20 years has led to an absence of mangrove seedlings, especially in the vitally important fringing mangroves of Hurricane Hole.

The team found strong evidence of over-browsing by deer in all mangroves and salt ponds, along most trails and in most forests visited. The deer range from the coast to the highest point on the island and are known to swim to the offshore islands to forage, though no assessment has been done on these cays to determine hurricane impacts. *Image 3* shows over-browsing of Black Mangrove trees (*Avicennia germinans*) and seedlings in the Fish Bay wetlands.



Image 3. Black Mangrove (*Avicennia germinans*) regrowth over-browsed by deer in Fish Bay wetland

Changes to the Landscape

Hurricanes Irma and Maria were major catastrophic and life events that have had psychological, emotional, cultural and social, as well as spatial and ecological impacts on life, property and landscapes of St. John and the Virgin Islands. Those who witnessed it and have survived, are able to recall not only the experience, but can vividly retell what life was like before, and after the events, and continue to live with those experiences even today. The strong winds, driving rains, floods, storm surges and post-hurricane impacts destroyed familiar structures, and the natural environment, once so seemingly permanent, dramatically changed overnight, shifting to

a new, and often, jarring and alien vista. *Image 4* shows Gibney Beach in February 2019, with few of the iconic Coconut Palms now remaining.



Image 4. Two lone Coconut Palms (*Cocos nucifera*) on an overcast afternoon of February 21, 2019, are among the only sentinels left standing, out of the once extensive groves all along the north coast of St. John.

Today, many of the hillsides bear physical scars of the September 2017 hurricanes, with some trees still in recovery mode, and quite a few now dead or dying. Landslides, beach erosion and the loss of the extensive coconut groves are starkly apparent and may seem like open wounds. Hotels and tourist facilities, such as Caneel Bay and Concordia, were badly damaged and remain closed. They were once active and vibrant commercial, cultural, social, recreational and economic hubs for residents and outsiders.

Recovery, regeneration, restoration and clean-up will allow for some healing, though the outward migration of many friends and family, and changes to familiar landscapes and natural iconography will remain as obvious gaps in the lives of many St. John residents for some time.

Communities and Trees

The two major urban centers of St. John, Cruz Bay on the western coast, and Coral Bay on the east, were both severely impacted by the storms, with many boats in the bays damaged or lost, and homes and businesses destroyed by strong winds, driving rains and storm surges. Other communities were also similarly impacted. However, large and old trees in many of these areas were surprisingly resilient and most survived, though many lost branches or were broken in some way. Some old trees in places like Hansen Bay, East End, were uprooted and blown over, but are re-growing (*Image 5*).



Image 5. Fallen old Tamarind Tree at Hansen Bay, East End.

Many of the large trees on west and northern facing slopes, including in yards and compounds, were lost or badly damaged. It is difficult to quantify the extent and number of trees lost in the yards of residents and businesses across the island, since it would require a house-to-house visit and assessment, but future efforts should include a survey, to determine the plant needs of these homes, and to encourage the replanting of native trees and plants.

Of the St. John trees included in the book, *Remarkable Big Trees of the US Virgin Islands* (Nicholls, 2006), only one appears to have been totally killed—the VI’s largest Bully Mastic tree (*Sideroxylon foetidissimum*), which grew at the edge of the swampy end of the Trunk Bay gut, near the west end of the beach. Two other Virgin Island champion trees, a Tropical Almond (*Terminalia catappa*) and a Tamarind (*Tamarindus indica*), were shattered and lost most of their structure, but are showing regrowth from their bases.

Virgin Islands Department of Agriculture List of Forestry Priorities

In 2010, the VI Department of Agriculture Forestry Division, under the project *US Virgin Islands Forest Resources Assessment and Strategies*, outlined eight priority issues that it considered critical to forest conservation, and sustaining the forests and wildlife of the Virgin Islands, including St. John. These priorities were written seven years before the 2017 hurricanes, but highlight the urgency of addressing issues that had been discussed and reported for many years. *Excerpt 1* outlines eight priorities and issues.

Excerpt 1. Summary of eight priorities and the issues that emerged from the analysis of data and input from stakeholders throughout the USVI during VI Department of Agriculture’s project: *U. S. Virgin Islands Forest Resources Assessment and Strategies*.

The following paragraphs summarize the issues that emerged from the analysis of data and input from stakeholders throughout the USVI. Through this process, the areas of highest priority for protection and delivery of forestry programs were identified as: the northwestern corner and eastern end of St. Croix, west end and north shore of St. Thomas, and the east end and south shore of St. John.

Issue 1: Contiguous Forest Loss

Many areas of contiguous forest that contribute to habitat conservation and water quality are under pressure from development. Forested lands are under increasing pressure due to the demand for housing, as a result of continued population growth, and the concurrent demand for economic development, resulting in the planning for and construction of resorts and golf courses. In addition, forested lands are being cleared for agricultural use. Existing zoning laws and environmental regulations are weak and have not been enforced. If existing forested lands are not protected, soon little forested land will be left. This forest conservation priority issue identifies those areas of contiguous forest that are in need of immediate protection and management on the islands of St. Croix, St. John, and St. Thomas.

Issue 2: Loss of Transitional Forests to Development

Transitional forests represent land areas under constant change from one land use type to another. Many of these areas were once forested, then cleared for agricultural uses such as cattle grazing or crop production. As the use of these lands for agriculture diminishes, they will most likely transition to early successional forest or be converted to some type of development, such as housing. At present, more than 1,000 acres of transitional forest in the U.S. Virgin Islands could be lost due to proposed large development schemes. Promoting the establishment of more diverse forests in transitional forest areas would keep some of these areas under forest cover.

Issue 3: Urban Forest Sustainability

Lack of data for urban and community forests has hindered the ability of land managers to measure the value of these abundant resources that provide many natural and cultural benefits to the people of the Virgin Islands. Values attributed to urban forests, especially on a tropical island, include but are not limited to: real estate values; recreation; health benefits; psychological well-being; and cultural and economic attributes. The management of urban and community forests affects the daily lives of Virgin Islanders by providing the aforementioned benefits.

Fragmentation of forests on urban edges is especially prevalent near roads and as a result of poor management practices.

Lack of a comprehensive urban forest management plan and lack of trained professionals has contributed to a fragmented urban landscape.

Issue 4: Hazard Mitigation

Both urban and rural trees in the USVI are subject to the extremes of nature, especially tropical storms and hurricanes. Urban trees are especially susceptible to these storms and tend to be isolated from the forest, and are often located near buildings and along roads. During and after a storm event, many urban trees become hazards as branches break and fall on vehicles or across wires or roads. Rural areas are susceptible to trees falling across roads or clogging drainage. There is a need to monitor the health of trees to prevent them from becoming hazards during and after these storms.

Issue 5: Water Management

Good quality drinking water is one of the biggest concerns in the USVI. Most of the potable drinking water in the territory is rainwater collected from rooftops and stored in underground cisterns or water piped from the desalination plants. About 10% of the water used in the USVI comes from wells. Ground water recharge affects potable well water resources and surface waters used for agricultural purposes. Water drainage issues cause flooding during rain events that last for prolonged periods of time, and sedimentation in the marine water effects fisheries and tourism alike. Forests have a direct impact on water management issues.

Issue 6: Degradation of Coastal Forest Ecosystems

Coastal forests including wetlands and mangrove forests are the connective region between the terrestrial and marine environments. Providing habitat for fish nurseries and a wide variety of area fauna and flora, these areas are under threat from a variety of sources, such as climate change and development. Coastal forest resources provide a variety of ecological services such as sediment and nutrient control into the marine environment. A lack of data on coastal forest resources has made it difficult to track how these systems have been affected. According to the last land cover analysis there were approximately 622 acres of mangroves or flooded woodlands, and 600 acres of coastal shrubland in the US VI. It is imperative that remaining coastal forest ecosystems be protected.

Issue 7: Invasive Species

Invasive species are identified as the second leading cause of biodiversity loss in the USVI (TNC, 2003). However, little data exist on the effects, threats, or future effects of invasive species on forests in the Virgin Islands. Limited invasive plant species studies have been conducted through the VI Department of Planning and Natural Resources Division of Fish and Wildlife (DFW) in partnership with the University of the Virgin Islands for the purpose of drafting regulatory legislation. Invasive plant species such as sweet lime (*Triphasia trifolia*) and snake plant (*Sanseveria trifasciata*) can be found in the understory in many of the forests of the USVI. As there is no timber industry in the islands, invasive insect pests are not been identified as being as important as invasive plants, and do not appear to cause much damage to the overall health of the forests. Exotic animals such as deer, donkeys, horses, iguanas, and feral pigs do exist and may alter the forest structure through overgrazing or altered seed dispersal mechanisms. The degree to which these introduced species affect the local forest is unknown.

Issue 8: Wildfire

Global climate change will likely result in changes in wind and rainfall patterns in the Caribbean. An increase in the length or severity of droughts could contribute to an increase in wildfires in the USVI. The forests of the USVI are not fire-dependent but rather fire-sensitive; they are not ecologically adapted to periodic fires. Wildfires are a relatively minor factor in the forests of the USVI and more often occur in scrubland and grassland on the eastern end of St. Croix where there is limited rainfall year-round. Very few wildfires occur on St. Thomas or St. John. The wildfires that do occur on St. Croix tend to be human-caused and located near roads.

As the VI Department of Agriculture points out:

“Both urban and rural trees in the USVI are subject to the extremes of nature, especially tropical storms and hurricanes. Urban trees are especially susceptible to these storms and tend to be isolated from the forest, and are often located near buildings and along roads. During and after a storm event, many urban trees become hazards as branches break and fall on vehicles or across wires or roads. Rural areas are susceptible to trees falling across roads or clogging drainage. There is a need to monitor the health of trees to prevent them from becoming hazards during and after these storms.”

Those words were prophetic and continue to resonate today. Planning for the eventual landfall of a powerful hurricane is essential. And in addition, post-hurricane reckoning is critical to recovery and healing, as well as future preparedness of St. John.

Rare and Endangered Plants

St. John has about 760 native and naturalized plants. *Table 3* provides a summary of the physiognomic origin and status breakdown of St. John’s plants.

Table 3. Physiognomic origin and status breakdown of St. John’s plants.

Growth Habitat	St. John
Herb	274
Tree	210
Shrub	143
Vine	100
Total	727
Native species	594
Introduced	141
Origin in Question	1
Extinct	0
<i>Families</i>	<i>106</i>
Total	727

Of the total plants, 13 are endemic to St. John and/or St. Thomas and St. Croix, the islands of the Puerto Rico Bank, and the West Indies.

In 2015, the Island Resources Foundation identified 14 priority species of concern for St. John and the USVI (Lindsay et al., 2015). *Table 4* provides a list of these species.

Table 4. Priority Species of Concern for St. John

Family	Species	Post-Hurricane Status/Comments
<i>Cactaceae</i>	<i>Mammillaria nivosa</i> Link ex N.E. Pfeiffer	At least 3 populations on the north shore washed away by storm surge.
	<i>Stenocereus fimbriatus</i> (Lam.) Lourteig	Image 6. Plants at Salt Pond Bay are severely damaged, and the species is in need of urgent attention and conservation.
<i>Euphorbiaceae</i>	<i>Croton fishlockii</i> Britton	Population not assessed during this effort, but population remains stable.
<i>Fabaceae</i>	<i>Erythrina eggersii</i> Krukoff & Moldenke	Trees at Battery and Fish Bay guts and Hawksnest Point are in good condition and remain stable.
	<i>Galactia eggersii</i> Urb.	Some plants observed during the Feb-March 2019 survey. Population seems stable.
<i>Malvaceae</i>	<i>Bastardiopsis eggersii</i> (Baker f.) Fuertes & Fryxell	Population not assessed during the Feb-March 2019 survey, largest population is in a remote part of the island, with a few on nearby cays.
<i>Myrtaceae</i>	<i>Calyptrocalyx thomasiana</i> Berg	Population on St. John is limited in range, but seems stable, on the protected eastern side of Bordeaux.
	<i>Eugenia earhartii</i> Acev.-Rodr.	Populations reportedly survived the hurricanes and are stable.
	<i>Mosiera xerophytica</i> (Britton) Salywon	Reported to be extirpated on St. John by residential development. Has not been seen since 1996.
<i>Rubiaceae</i>	<i>Machaonia woodburyana</i> Acev.-Rodr.	Population at Upper Rendezvous Bay seem stable, East End population severely affected.
<i>Rutaceae</i>	<i>Zanthoxylum thomasianum</i> (Krug & Urb.) Krug & Urb. ex P. Wilson	Population at Upper Rendezvous Bay seems stable.
<i>Solanaceae</i>	<i>Solanum conocarpum</i> Dunal	Populations are reportedly doing well after the storms, but threatened by overgrowth of weedy vines.
<i>Zygophyllaceae</i>	<i>Guaiacum officinale</i> L.	Populations across the island seem to be recovering after the storms, with at least one large wild tree lost totally in a landslide.



Image 6. *Stenocereus* cactus after the hurricanes, left 2019, and before, right 2015.

During the planning and mobilization stage for this post-hurricane assessment, Eleanor Gibney singled out three endemics for attention, the first two of which are federally listed endangered species:

- i. *Calypttranthes thomasiiana*
- ii. *Zanthoxylum thomasiianum*
- iii. *Solanum conocarpum*

In addition to these three endemics, Eleanor also included the following:

- Epiphytes, including native bromeliads and orchids
- Eugenia* sp. (an as-yet-to-be-identified *Eugenia* at Bordeaux)
- Large Trees
- Lignum Vitae (*Guaiacum officinale*)
- Mangroves
- Tree Fern (*Cyathea arborea*)

Regarding epiphytes, the strong winds and driving rain decimated the plants in the canopy, and many succumbed during tree falls and broken branches. However, populations growing on rocks and amongst low shrubby growths fared relatively well.

Eleanor and Kevel visited the rare *Tillandsia* species of bromeliads, including *Tillandsia fasciculata* var. *fasciculata*, and the hybrid, *Tillandsia x lineatispica*, at Upper Rendezvous Bay, and found the plants had little damage. *Image 7* shows some of the *Tillandsia* spp. growing in this area.



Image 7. Native rare bromeliad, *Tillandsia fasciculata* var. *fasciculata* at Upper Rendezvous Bay.

Other native bromeliads seem to be stable, except *Catopsis floribunda*, which was not observed during the field survey. This is primarily an arboreal epiphyte on Bordeaux Mountain and would have been severely impacted by strong winds.

Among the bromeliads were numerous Christmas Orchid plants, *Epidendrum ciliare*, and although they survived in the hillside setting, numerous populations on the north shore sea cliffs were severely damaged or extirpated. This orchid has also been heavily damaged by deer browsing wherever it is accessible.

The Puerto Rico Bank endemic Butterfly Orchid, *Psychilis macconnelliae*, also fared well. The island has 15 recorded species, but only three were observed during the field survey.

The only other orchid species observed was *Tolumnia prionochila*. Other species, such as native Vanilla orchids, and terrestrial orchids were not observed.

The *Eugenia* sp., a plant first noted by Eleanor on Bordeaux many years previously, but which has not been properly identified, has fared well. Populations seem stable.

Wild and urban Lignum Vitae (*Guaiacum officinale*) generally survived well during and after the hurricanes. Exceptions were the relatively young (50-year-old) tree at the Lutheran church in Cruz bay, and a large wild tree that was brought down in the landslide near the Coral Bay overlook.

However, mangrove wetlands and trees did not do well during and after the hurricanes. Despite this, it must be noted that these natural systems evolved with storms and storm surges, and are resilient enough to recover over time, provided the impact of grazing deer is mitigated.

The strong storm winds and surging seas flattened trees, uprooted many, broke branches and battered them, and led to post-hurricane stresses, which made them vulnerable to diseases and insects. All mangrove sites were severely impacted, but nevertheless, some have strong signs of regrowth, including seedling recruitment, sprouting of fresh growth from the stems and roots of many damaged trees, and the seedlings of other wetland-associated plant species such as Pond Apple (*Annona glabra*) at Mary Creek (Annaberg), grasses, sedges and herbaceous growth.

Some important areas, such as Hurricane Hole, would benefit greatly from restoration planting of Red Mangroves.

The death of many of the trees has opened the wetlands to full sun, which encourages regrowth, and the proliferation of aquatic floating single-cell plants and animals, which provide an abundance of food for birds such as migrant warblers, herons, egrets, ducks and shorebirds. In fact, birds such as the migrant Northern Waterthrush (*Parkesia noveboracensis*) were in high abundance across these wetlands, and a number were heard throughout the days of the survey, including at the Fish Bay, Leinster and Mary Point mangroves.



Image 8. Team member, Kevel Lindsay, checks on the Tree Fern (*Cyathea arborea*) at Bordeaux, St. John on February 28, 2019.

Caribbean Tree Ferns (*Cyathea arborea*) are most often associated with moist mountain forests of the Caribbean, and better known in places such as the Luquillo Forest in nearby Puerto Rico. However, though rare, the species also occurs on St. Thomas, Tortola, and perhaps was once on St. Croix. It is also found in one location on St. John's Bordeaux Mountain. This patch of habitat is only a few square meters in extent, making the species vulnerable to major events such as storms, diseases, droughts, landslides and vandalism. In fact, the plants at Bordeaux are found at the base of a large landslide scar. However, the tree fern has been known on St. John for many years. The survey team was concerned about the possible loss of the species to the hurricanes, but a visit revealed that they continue to survive, though at least one had succumbed to the storms.

For the future of this species, efforts are needed to establish viable populations elsewhere on Bordeaux, to ensure that it survives similar future events. *Image 8* shows trees on the site during the February 2019 field survey.

Wildlife After the Storms

The team used this post-hurricane survey opportunity to observe and report on the status of St. John's wildlife, where possible. Given the limited time, funding and personnel, the team could not undertake a comprehensive and extensive assessment of wildlife. The summary below is based on some direct field observations, feedback from local residents and experts, reports online and from past reports. Kevel and the team did identify bats, amphibians, insects (especially *Polistes* wasps), the Yellow Warbler (*Setophaga petechia*), snakes, Brown-throated Parakeet/St. Thomas Conure (*Eupsittula pertinax*) and butterflies. They also reviewed the negative impacts of some invasive species, including the Mongoose (*Herpestes javanicus*), the White-tailed Deer (*Odocoileus virginianus*), donkeys, the Puerto Rican Coqui frog (*Eleutherodactylus coqui*), the Cane Toad (*Rhinella marina*), the Green Iguana (*Iguana iguana*) and goats. Additionally, the team was also paying particular attention to the potential spread of plant pests, or the recent introduction of plant pests as a result of the storms.

Native Wildlife

Bats: There are seven known species of bats occurring on St. John. Though time did not permit a comprehensive survey of bats, Kevel Lindsay did carry out one night of bat mist-netting at Fish Bay Gut. Only two bats were caught, and those were of the common insect species, *Molossus molossus*. He also saw a Fishing Bat (*Noctilio leporinus*) flying over the pools as well. Additionally, Kevel Lindsay and Gail Karlsson visited the bat cave at Europa Point, Lameshur, and heard Cave Bats (*Brachyphylla cavernarum*) calling in numbers there. The Fishing Bat was also recently reported to still reside in the cave.

Discussions with Renata Platenberg, a wildlife biologist on St. Thomas who is carrying out regular bat surveys and monitoring, showed that capture of the other four species has been quite low, and numbers are well below pre-hurricane surveys. Of concern are the storms' impacts on the VI endemic subspecies of the forest or Red Fruit Bat (*Stenoderma rufum rufum*), and the small insect bat, *Tadarida brasiliensis*, the latter of which has not been captured either on St. Thomas or St. John in many years. The forest bat roosts in trees during the day, and would have been quite vulnerable to the strong winds. Dr. Platenberg is planning to undertake a comprehensive survey of the bats of both islands, and this will help to shed some light on the status of the bats on St. John in the coming year.

Amphibians: While no formal survey of native amphibians took place during the February to March 2019 field assessment, most of the native species were heard calling on numerous occasions. Amphibians seemed to have fared well during and after the storms.

Insects (especially *Polistes* wasps, and butterflies): There is no comprehensive list and guide to the invertebrates, including insects, of St. John and the Virgin Islands, so identifications and assessment of the status of many of the species remains very difficult, especially after these two major storms, when strong winds could have brought in new species or caused the decline

of many. The team did not undertake a formal survey of the insects, but noted observations where possible, especially of the butterflies, native wasps and the dragonflies.

The disruption of vegetation throughout the island led to an abundance of weeds and herbaceous plants in bloom this winter, and populations of some butterflies and day-flying moths were well above the long-term average.

The team will provide a summary of the butterflies observed, along with a list and summary of recommended wild and garden plants to encourage butterflies. This will be made widely available, along with photos of the identified species.

Though residents, including Eleanor Gibney, had expressed concern that native *Polistes* paper wasps had dramatically declined as a result of the hurricanes, the team did find that populations are rebounding, especially on the southern areas of St. John.

VI Screech Owl (*Megascops nudipes newtoni*): The Screech Owl has always been rare in the Virgin Islands, was only infrequently seen by residents, and hard to locate even by experts. Finding individual birds was often done at night when they called to announce themselves and protect their territories. There were reports of birds calling in the Coral Bay valley prior to the storm, and on one occasion in March 2019 the owl was observed on Bordeaux Mountain.

Yellow Warbler (*Setophaga petechia*) and Antillean Crested Hummingbird (*Orthorhyncus cristatus*): Residents had expressed concern that the Yellow Warbler had drastically declined in numbers as a result of the storm and was in danger of local extinction. Observations during the February to March 2019 field assessment showed that the species is widely distributed and seemed to be doing well across much of St. John, especially on the eastern and southern areas of the island. Several sightings of the Antillean Crested Hummingbirds were also reported.

Local snakes: There are four native snakes recorded for St. John, populations of which had suffered as a result of the introduced mongoose. Observations of these snakes were scarce prior to the storms, and there have been no reports of any snakes since. This is quite concerning, especially since there are anecdotal reports that populations of the Mongoose seem to be on the increase once again, after many decades of sharp declines. Further work on documenting the island's snakes is recommended as part of any formal post-hurricane wildlife surveys.



Image 9. A male and female pair of the Brown-throated Parakeet/St. Thomas Conure (*Eupsittula pertinax*), Mongoose Junction Cruz Bay, St. John.

The Brown-throated Parakeet/St. Thomas Conure (*Eupsittula pertinax*): The Brown-throated Parakeet, or St. Thomas Conure, is a species of parrot known from the Virgin Islands and Puerto Rico since at least the 1700s, and may have arrived in this part of the Caribbean much earlier, during a major hurricane. (Some publications suggest that it may be introduced, though this is purely speculative.) The species is also native to Aruba, Bonaire, Curacao and parts of Central and South America. The populations in Puerto Rico and the Virgin Islands have gone through boom and bust years, frequently expanding across the islands during some years, then shrinking back to St. Thomas in other years.

This species has once again colonized St. John right after the storm and has shown signs of breeding. The birds are being seen from Cruz Bay to Hawksnest, though Cruz Bay seems to be their center of activity. The team observed at least six pairs on February 27, 2019, near Mongoose Junction, and took several photographs. It is quite possible that this species is native to the Virgin Islands and it should be encouraged and protected. It urgently needs research attention to determine its population, breeding success, range, status and needs, and to finally determine its origins. *Image 9* shows a pair of these birds at Mongoose Junction.

Invasive Wildlife Species

Mongoose (*Herpestes javanicus*): Local reports indicate that the mongoose seems to be on the increase once again, after many decades of sharp decline. This species has enormous impacts on native invertebrates, amphibians and reptiles and on birds. It is especially common in dry areas of the East End and is increasing on the southern side of the island, including Fish Bay. What impact the storms had on them is not known.

The White-tailed Deer (*Odocoileus virginianus*): These deer are abundant across St. John, and on St. Thomas, and they can swim back and forth. The hurricanes do not seem to have adversely affected the population, and many were seen, including mothers with grown fawns, at all elevations of the island. Signs of deer were seen throughout, including browsing, footprints and dung. The deer are over-browsing native plants, including hard-hit mangroves and coastal forests, retarding the recovery and regrowth of trees and seedlings. Deer will slow or stop the recovery of the forest and woodlands over time. Urgent efforts are needed to restrict the deer from certain areas, including wetlands, and reduce pressures on native species and habitats. *Image 10* shows a doe feeding at Cinnamon Bay.



Image 10. White-tailed Deer (*Odocoileus virginianus*) female at Cinnamon Bay, St. John.

Donkeys: Like the deer, free-roaming and feral donkeys are over-browsing native plants and forests, though they are restricted to roadsides and heavily disturbed open areas. They also pose an enormous traffic hazard to motorists and pedestrians. There needs to be outreach to tourists and transplant residents to discourage the feeding of donkeys from cars.

The Puerto Rican Coqui Frog (*Eleutherodactylus coqui*): This frog is native Puerto Rico and has been deliberately and inadvertently introduced to many parts of the world. It was heard at several locations on the island, but it is not known what impacts the hurricanes had on its status and distribution. (Invasive Cuban Tree Frogs (*Osteopilus septentrionalis*) have been observed in significant numbers.)

The Cane Toad (*Rhinella marina*): This introduced invasive toad was recently reported on St. John, where it was absent from quite some time. It has been present across the region and on nearby St. Thomas, for many decades. A number of them were seen and photographed at Mongoose Junction in 2018, but none were heard or seen during the February to March 2019 field survey. It is believed that the impending dry weather of the annual dry season, January to April, has caused them to aestivate (become dormant). Any attempt to rid the island of this species would be welcome.

The Green Iguana (*Iguana iguana*): The Green Iguana is introduced and is widespread across St. John. Residents have complained, for years, that the iguanas destroy their gardens and are a nuisance. It is not known what effects the storms have had on the population, but they remain common and several were seen, including many as roadkill, during the February to March 2019 field survey.

Goats and Sheep: VI National Park efforts at controlling goat populations within the park have benefitted the entire island, but an extremely damaging group has multiplied on the far East End, centered on the Privateer Bay subdivision. The arid conditions and steep slopes are allowing this herd to totally denude the landscape and landslides are increasing. Sheep remain only in a domestic flock centered in Coral Bay that seldom ventures from the roadsides and fields, but cause aggravation to gardeners and homeowners in the area.

Plants for Reforestation and for Wildlife

To help improve the conditions for wildlife, coastal habitats need to be restored, including the mangroves and beaches. In addition to plants for reforestation, there are a number of plants that could be used to attract native animals such as bats, birds and insects. The below discussions and suggestions are for the medium and long-term, and to encourage wider community and government involvement and efforts in the recovery of the natural environment of St. John.

If any person doubts the importance of abundant and diverse vegetation to our human habitat, the aftermath of a Category 5 hurricane might instantly convert them into plant appreciators. The unsettling sight of a tropical landscape totally denuded of foliage, the incredible heat of September sun, without any shade, the massive erosion where there were few roots to hold the land, the birds literally starving and falling from the trees at your feet—these images of

desolation will stay with all of us. But then, the first green leaves emerged, and life flowed back into the land—still the effects will be with us through the remainder of our lives.

What are some of the lessons we learned, and what can we do to help repair damage and mitigate the effects of future storms?

Hurricane Irma's path meant that the strongest winds were from the west-northwest, as opposed to the east-southeast direction of Hugo and Marilyn, the only other major storms of the past 80+ years. This meant that the areas hit hardest by Irma had all been the most protected places in those previous storms, and also protected from the ordinary winds that prevail from the east through the year. There is little that could have prevented catastrophic damage to vegetation and wildlife, but some observations suggest helpful measures.



Image 11. West end of Gibney Beach, after the hurricanes, late November 2017 (left), and before the hurricanes, late November 2016 (right).

Coastal erosion: As mentioned above, sandy shores that were exposed to the western waves and surge experienced massive flooding and erosion. *Image 11* shows the state of the western end of Gibney Beach after the hurricanes in November 2017 and before the storms in November 2016. The photos, by Eleanor Gibney, show the loss of the coastal coconut grove along that beach.

When beach exposure was coupled with Coconut Palms and/or structures near the shore, the effects were magnified. As has been demonstrated throughout the world, the construction of retaining walls or other solid barriers on coasts often leads to accelerated erosion.

All areas with significant loss of land could be replanted with a variety of native trees, with at least three tiers of planting, rather than one narrow line. While many native vines and ground covers are reestablishing on shores already, these will do little to protect against future storms; trees with wide spreading roots are needed. The most durable, fast-growing and long-lived for this situation are Sea Grape (*Coccoloba uvifera*) and Buttonwood (*Conocarpus erecta*). The large

and extremely durable Gre-gre Tree (*Bucida buceras*) is an excellent choice for the back-beach area behind the first line.

There are numerous other native species that can be added to this group to enhance diversity and wildlife support.

- Angelin or Pig-turd (*Andira inermis*)
- Bay Cedar (*Suriana maritima*)
- Black Mampoo (*Guapira fragrans*)
- Black Torch (*Erithallis fruticosa*)
- Black Wattle (*Piper amalago*)
- Century Plant (*Agave missionum*)
- Fiddlewood (*Citharexylum fruticosum*)
- Gre-gre (*Bucida buceras*)
- Guavaberry (*Myrciaria floribunda*)
- Milkweed or Kitty Mcwanny (*Asclepias currassivica*)
- Nothing Nut or False Nutmeg (*Cassine xylocarpa*)
- Orange Manjack (*Cordia rickseckeri*)
- Pink Sage (*Lantana involucrata*)
- Sea Grape (*Coccoloba uvifera*)
- Turpentine (*Bursera simaruba*)
- Tyre Palm (*Coccothrinax alta*)
- Pigeon Berry (*Bouyeria succulenta*)
- Water Mampoo (*Pisonia subcordata*)
- West Indian Boxwood (*Sideroxylon obovata*)
- Wild Fig (*Ficus citrifolia*)
- White Cedar (*Tabebuia heterophylla*)

Land erosion: The foremost factor contributing to slope erosion on St. John is poorly planned construction, mainly of secondary roads and driveways, that redirect storm-water from its natural path, while also often depositing fill to create unstable slopes. Planning that may be adequate for rainfall intensities of the past may no longer be enough, as 3 inches per hour rains are now occurring, even outside of tropical storm systems, on a regular basis.

We are frequently asked to recommend plants that can stabilize steep slopes with construction disturbance, but there is really very little that can help, given the velocity and quantity of storm-water now moving in major rainfalls. All residents can assist the Virgin Islands government in enforcing construction regulations by reporting issues and being watchdogs of road and driveway construction practices.

Mangrove restoration: Even in less powerful storms, it has been obvious that mangroves are adapted to be heavily affected by hurricanes and then regenerate quickly. The water deficits

that inhibit growth of other trees on St. John are not a factor, and trees can mature in a few years. At the time of Hurricane Marilyn in 1995, White-tailed Deer were not a major threat to mangrove populations and wetlands on the island. The increase in deer since 2000 has placed many mangrove areas at a strong disadvantage for recovery.

The fringing Red Mangroves of Hurricane Hole are probably the most important to focus on, since their prop-roots supported diverse and rare marine life, in a habitat not replicated in the territory or perhaps anywhere else in the Caribbean. Detailed observations in Princess Bay in 2016 pointed to heavy browsing by deer, to the point that only a tiny number of mangrove seedlings survived past their first year. This remains the case, with only a very few scattered young mangroves to replace the dense line killed by Irma.

The VI National Park and the Friends of the VINP should be very strongly encouraged to replant mangroves in Hurricane Hole, with temporary deer protection, and to focus intensely on managing deer populations as soon as possible.

Planting for Birds and Bats: Birds and bats that eat insects and fish as their main diet revived relatively quickly after the storms, but nectar and fruit eaters are still nowhere near pre-hurricane levels. Hummingbirds were almost totally absent for 15 months, Scaly-naped Pigeons (*Patagioenas squamosa*) are scarce, and fruit bats (on St. John, there are three fruit-eating bats, namely, *Artibeus jamaicensis*, *Brachyphylla cavernarum*, and *Stenoderma rufum*), our most important seed distributors, are still nearly nonexistent.

A hurricane of Irma's strength will not leave much behind, no matter what, but there are some trees and shrubs, both native and introduced, that come back into flower and fruit faster than others, and these are well worth increasing in gardens and urban landscapes, either by planting or retaining existing ones as desirable when land is cleared.

Our surviving native Tyre Palms burst into bloom within a week after Irma, and had ripe fruit by late November, something also observed after Hugo and Marilyn. Puerto Rican Royal Palms (*Roystonea borinquena*), although uncommon on St. John, behave in a similar fashion. The aptly named Pigeon Berry (*Bourreria succulenta*), a common native tree, recovered fairly quickly, the first native tree to regain foliage, and in less catastrophic storms, mature trees often retained most of their berries, even when most of the foliage was removed by strong winds.

Among hummingbird plants, the Mexican Firecracker plant (*Russellia equisetiformis*), fairly popular in gardens, was low enough to escape heavy damage and continued to bloom, although there was not enough available to sustain many birds. Ixora, Bougainvillea and Common Red Hibiscus, all long cultivated here, were also visited by birds that survived the storms. The Papaya trees that sprang up in huge numbers from seeds long dormant in the soil are also very helpful, as their flowers, especially the male blooms, are popular with the nectar feeders, and the fruit are now being consumed in quantity by several bird species.

Recommendations and Next Steps

Organize community education and outreach to: increase awareness about the value of healthy forests, mangroves and native plants, as well as ways to improve residents' property, lives and wellbeing through a healthy environment; encourage native fauna such as butterflies, birds, and bees through plantings; and support pre-hurricane and post-hurricane preparedness and response. Attention should also be given to the negative impacts on ecosystems from debris and toxins in the guts, and chemicals applied for pest and weed control.

Share this assessment report with community groups, environmental, conservation and scientific organizations, the Virgin Islands National Park, Virgin Islands governmental agencies, the Governor's Office, and key local natural resource managers and scientists. This will be an important way to amplify the impact of the report and catalyze action on issues of critical concern.

Establish a native plant garden to help secure populations of rare and endangered native plants, and provide seedlings for forest restoration and conservation, as well as to support education and outreach efforts and wildlife conservation, and provide plants for native gardens and urban landscapes, including commercial properties.

Table 5 provides a list of native rare, endangered and range-restricted plants (Virgin Islands and West Indian endemics), that are of concern and should be the focus of native plant conservation efforts. Given the impacts of the storms, this list may need to be adjusted and updated. Special protection efforts are needed for Tree Ferns (*Cyathea arborea*) and columnar cactus (*Stenocereus fimbriatus*).

Plant species recommended to enhance and encourage native wildlife include:

- Angelin or Pig-turd (*Andira inermis*)
- Bay Cedar (*Suriana maritima*)
- Black Mampoo (*Guapira fragrans*)
- Black Torch (*Erithallis fruticosa*)
- Black Wattle (*Piper amalago*)
- Century Plant (*Agave missionum*)
- Fiddlewood (*Citharexylum fruticosum*)
- Gre-gre (*Bucida buceras*)
- Guavaberry (*Myrciaria floribunda*)
- Milkweed or Kitty Mcwanny (*Asclepias currassivica*)
- Nothing Nut or False Nutmeg (*Cassine xylocarpa*)
- Orange Manjack (*Cordia rickseckeri*)
- Pink Sage (*Lantana involucrata*)
- Sea Grape (*Coccoloba uvifera*)
- Turpentine (*Bursera simaruba*)

- Tyre Palm (*Coccothrinax alta*)
- Pigeon Berry (*Boufferea succulenta*)
- Water Mampoo (*Pisonia subcordata*)
- West Indian Boxwood (*Sideroxylon obovata*)
- Wild Fig (*Ficus citrifolia*)
- White Cedar (*Tabebuia heterophylla*)

Replant the most severely hit coastal areas using native plants. Some Coconut Palms could be included, but not placed directly onto beaches, because that can increase erosion of beaches, compact sand and limit sea turtle nesting. The most durable, fast-growing and long-lived for this situation are Sea Grape (*Coccoloba uvifera*) and Buttonwood (*Conocarpus erecta*). The large and extremely durable Gre-gre Tree (*Bucida buceras*) is an excellent choice for the back-beach area behind the first line.

Some critical mangrove areas, such as Hurricane Hole, should also be replanted and also protected from deer to help them recover.

Develop a plan to manage the deer population as soon as possible, to reduce the grazing and loss of valuable vegetation and promote regeneration and growth.

Conduct additional, more comprehensive post-hurricane environmental assessments, including:

- a. Long-term monitoring plots within forests and woodlands
- b. Evaluation of wetlands conditions
- c. Assessment of guts, including a survey of the riparian fauna such as crustaceans, insects and fish, removal of hazardous debris, and identification of weak faults and areas where future landslides and collapses may occur.
- d. Erosion control assessment for Bordeaux Mountain with the aim of arresting further decline in slope and soils. This effort could be done in concert with soil and water conservation work being done by the Coral Bay Community Council.

Table 5. Native rare, endangered and range-restricted plants of concern for St. John and VI

Family	Species	Habit
Asparagaceae	<i>Agave missionum</i>	H
Aquifoliaceae	<i>Ilex nidita</i> var. <i>nitida</i>	T
Aquifoliaceae	<i>Ilex urbaniana</i>	T
Araceae	<i>Diffenbachia seguine</i>	H
Araceae	<i>Philodendron giganteum</i>	V

Bignoniaceae	<i>Amphitecna latifolia</i>	T
Bignoniaceae	<i>Crescentia linearifolia</i>	T
Boraginaceae	<i>Cordia rickseckeri</i>	T
Boraginaceae	<i>Rocheportia acathophora</i>	T
Boraginaceae	<i>Tournefortia filiflora</i>	T/S
Bromeliaceae	<i>Tillandsia fasciculata</i>	H
Boraginaceae	<i>Tournefortia gnaphalodes</i>	S
Cactaceae	<i>Mammillaria nivosa</i>	S
Cactaceae	<i>Stenocereus frimbriatus</i>	T
Combretaceae	<i>Buchnavia tetraphylla</i>	T
Convolvulaceae	<i>Ipomoea eggersiana</i>	V
Cyatheaceae	<i>Cyathea arborea</i>	T
Ericaceae	<i>Lyonia rubiginosa</i>	T
Euphorbiaceae	<i>Argythamnia stahlII</i>	S
Euphorbiaceae	<i>Euphorbia tithymaloides</i> subsp. <i>angustifolius</i>	S
Euphorbiaceae	<i>Euphorbia tithymaloides</i> subsp. <i>parasitica</i>	S
Euphorbiaceae	<i>Euphorbia tithymaloides</i> subsp. <i>tithymaloides</i>	S
Euphorbiaceae	<i>Sapium glandulosum</i>	T
Fabaceae	<i>Canvalia nitida</i>	V
Fabaceae	<i>Pictetia aculeata</i>	S
Fabaceae	<i>Senegalia vogeliana</i>	S/V
Fabaceae	<i>Senna polyphylla</i> var. <i>polyphylla</i>	T
Krameriaceae	<i>Krameria ixine</i>	S
Lamiaceae	<i>Vitex divaricata</i>	T
Malpighiaceae	<i>Byrsomina lucida</i>	T
Malvaceae	<i>Cienfuegosia hetrophylla</i>	S
Malvaceae	<i>Malpighia infestissima</i>	T
Malvaceae	<i>Malpighia woodburyana</i>	S
Malvaceae	<i>Malpighia coccigera</i> (tree-like form at Salt Pond bay)	T
Malvaceae	<i>Malpighia coccigera</i> subsp. <i>coccigera</i> (regular form)	S
Myrtaceae	<i>Calyptanthes thomasiana</i>	T
Myrtaceae	<i>Eugenia sessiliflora</i>	T
Myrtaceae	<i>Eugenia</i> sp.	T
Myrtaceae	<i>Myrcianthes fragrans</i>	T
Myrtaceae	<i>Psidium amplexicaule</i>	T
Nyctaginaceae	<i>Neea buxifolia</i>	T
Ochnaceae	<i>Ouratea litorallis</i>	T

Oleaceae	<i>Forestiera eggersiana</i>	T
Orchidaceae	<i>Epidendrum anceps</i>	H
Orchidaceae	<i>Epidendrum ciiae</i>	H
Orchidaceae	<i>Psychillis macconnellii</i>	H
Orchidaceae	<i>Tetramicra canaliculata</i>	H
Orchidaceae	<i>Tolumnia prionochilla</i>	H
Orchidaceae	<i>Tolumnia variegata</i>	H
Orchidaceae	<i>Vanilla barbellata</i>	H
Pentaphragaceae	<i>Ternstroemia peduncularis</i>	S
Poaceae	<i>Arthostylidium farctum</i>	S
Poaceae	<i>Uniola virgata</i>	H
Putranjivaceae	<i>Drypetes alba</i>	T
Rhamnaceae	<i>Reynosia guama</i>	T
Rosaceae	<i>Prunus pleuradenia</i>	T
Rubiaceae	<i>Rondeletia pilosa</i>	T
Rubiaceae	<i>Scolosanthus versicolor</i>	S
Rubiaceae	<i>Stenostomum lucidum</i>	S
Rutaceae	<i>Amyris diatripa</i>	T
Rutaceae	<i>Pilocarpus racemosus</i>	T
Rutaceae	<i>Zanthoxylum flavum</i>	T
Rutaceae	<i>Zanthoxylum thomasianum</i>	T
Salicaceae	<i>Xylosma buxifolia</i>	T
Sapindaceae	<i>Allophylus racemosus</i>	T
Sapotaceae	<i>Chrysophyllum bicolor</i>	T
Sapotaceae	<i>Chrysophyllum pauciflorum</i>	T
Sapotaceae	<i>Manilkara bidentata</i> subsp. <i>surinamensis</i>	T
Sapotaceae	<i>Pouteria multiflora</i>	T
Sapotaceae	<i>Sideroxylum foedissimum</i>	T
Schoepfiaceae	<i>Schoepfia schreberi</i>	T
Schoepfiaceae	<i>Schoepfia obovata</i>	T
Simaroubaceae	<i>Picrasma excelsa</i>	T
Solanaceae	<i>Solanum conocarpum</i>	S
Tuneraeae	<i>Turnera diffusa</i>	S
Verbenaceae	<i>Nashia inaguensis</i>	S
Zygophyllaceae	<i>Guaiacum officinale</i>	T

Notes: H=herb, S=shrub, T=trees, V=vine.

The Team

Kevel Lindsay: A national of Antigua, Kevel Lindsay is a trained forester and biologist, with a degree in Environmental Biology from Columbia University. Mr. Lindsay is an expert on Caribbean plant ecology and faunal species, particularly birds and bats. He is a principal contributor to several key regional biodiversity planning documents, including a vegetation classification system for Antigua and Barbuda, St. Kitts and Nevis, and the U.S. Virgin Islands. He is co-author of *The Wild Plants of Antigua and Barbuda* (2009, 405 pp.) and the author of *The Ferns of Antigua*.

Eleanor Gibney: A life-long resident of St. John, Eleanor Gibney is a horticulturist with particular interest in native Virgin Islands flora. She has been propagating and growing native plants, especially rarer and threatened species, for over three decades. Additionally, she is a student of Virgin Islands history, focusing on historic land use and its effects on present-day forests and species distribution. She is the author of *A Field Guide to the Native Trees and Plants of East End, St. John*, and co-editor of *St. John: Life in Five Quarters, Selected Readings from the Archives of the St. John Historical Society*.

Gail Karlsson: An environmental lawyer and consultant to the United Nations who has worked and written extensively on sustainable development, renewable energy and climate change policies. She is also a columnist for the St. John Tradewinds on 'Connecting with Nature', author of *The Wild Life in an Island House*, lead author for the UUF book *Learning About Trees and Plants*, nature photographer, and chair of the Green Sanctuary Committee of the Unitarian Universalist Fellowship of St. John.

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