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Buck Island Reef National Monument, U.S. Virgin Islands Vegetation Mapping Project, 2009

Natural Resource Technical Report NPS/SFCN/NRTR—2010/293



ON THE COVER

2007 U.S. Army Corps of Engineers 30cm resolution orthoimage of Buck Island within Buck Island Reef National Monument**.**

Buck Island Reef National Monument, U.S. Virgin Islands, Vegetation Mapping Project, 2009

Natural Resource Technical Report NPS/SFCN/NRTR—2010/293

Jonathan G. Moser[1,2]
Resource Management Intern

Kevin R. T. Whelan, Ph.D.[2]
Community Ecologist

Robert B. Shamblin[2]
Botanist

Andrea J. Atkinson, Ph.D.[2]
Quantitative Ecologist

Judd M. Patterson[2]
GIS Specialist

[1]Florida International University
Southeast Environmental Research Center
University Park Campus
Miami, FL 33199

[2]National Park Service
South Florida / Caribbean Network
18001 Old Cutler Rd., Suite 419
Village of Palmetto Bay, FL 33157

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Contents

Figures v

Tables vii

Appendices ix

Acknowledgments xi

Summary xiii

Introduction 1

Buck Island Reef National Monument Vegetation Mapping Project 1

Introduction to Buck Island Reef National Monument 1

Methods 5

Project Overview 5

Phase 1: Gathering Background Information 5

Phase 2: Imagery Acquisition 6

Phase 3: Draft Polygons Creation 7

Phase 4: Selection of Plots, Creation of Field Data Sheets, and Guides 7

Phase 5: Collection of Field Data 8

Phase 6: Database Design and Creation 9

Phase 7: Vegetation Classification 9

Phase 8: Refinement and Finalization of Polygons 10

Results and Discussion 13

Plots 13

Mapping Classes 13

Polygons 13

Accuracy Assessment 13

Summary of final project specifications, products and files 14

Literature Cited 24

Figures

Figure 1. South Florida / Caribbean Network parks. 2

Figure 2. Buck Island Reef National Monument (BUIS) in relation to St. Croix. 2

Figure 3. Bait stations for rat eradication project (40x40m grid) from “The Eradication of Introduced Rats at Buck Island Reef National Monument, St. Croix, U.S. Virgin Islands” (Witmer *et al.* 2002)..... 15

Figure 4. Vegetation mapping cells (160x160m grid) from “Vascular plant inventory and mapping of Buck Island Buck Island Reef National Monument St. Croix, U.S. Virgin Islands” (Ray 2003). 16

Figure 5. Map of vegetation polygons and field plots for Buck Island Reef National Monument. 17

Figure 6. Map of classified vegetation polygons for Buck Island Reef National Monument. 18

Tables

Table 1. Descriptions of Fields for Vegetation Field Plots Database. 19

Table 2. Additional Description of Community Type - Virgin Islands Sub-formations (Level_3) 20

Table 3. Additional Description of Hurricane Omar Damage. 20

Table 4. Descriptions of Fields for Polygons 20

Table 5. Vegetation Classification. 21

Table 6. Vegetation mapping class statistics. 22

Table 7. Buck Island Reef National Monument vegetation mapping projects products or file descriptions and filenames. Naming conventions and required files follow guidelines from the NPS Vegetation Mapping Inventory Program. 23

Appendices

Appendix A: Vegetation Classification (includes Vegetation Key and Class Descriptions)

Appendix B: Photo-interpretation Key (includes Map Class Descriptions and Photos)

Appendix C: List of Species Observed during Vegetation Mapping

Appendix D: Vegetation Species Photo Guide for Buck Island Reef National Monument

Appendix E: Field Data Sheets

Appendix F: Reference Literature

F.1 A guide to Caribbean vegetation types: preliminary classification system and descriptions

F.2 Environmental assessment for Buck Island Reef National Monument St. Croix, U. S. Virgin Islands: Control and Management of Non-Native Invasive Plant

F.3 Vegetation of Buck Island Reef National Monument

F.4 U.S. Virgin Islands vegetation community classification: basic community descriptions – habitat mapping in support of land use and biodiversity planning in the Virgin Islands

F.5 Vascular plant inventory and mapping of Buck Island Buck Island Reef National Monument St. Croix, U.S. Virgin Islands

F.6 The eradication of introduced rats at Buck Island Reef National Monument, St. Croix, U.S. Virgin Islands – Final Report

F.7 Flora of Buck Island Reef National Monument (U.S. Virgin Islands)

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Summary

The National Park Service Vegetation Mapping Inventory Program (NPS-VMP) funded the NPS South Florida / Caribbean Network (SFCN) to map Buck Island of Buck Island Reef National Monument in 2007. The project was completed in 2009. SFCN established a cooperative agreement with Florida International University for the Resource Management Intern Program with one of the deliverables being development of a vegetation map of Buck Island Reef National Monument.

The Buck Island vegetation map was made in UTM, NAD 83, zone 20N coordinates with a minimum mapping unit of 400m^2. Photo-interpretation was based on aerial imagery of a single U.S. Army Corps of Engineers natural color GeoTIFF orthophoto acquired as part of a larger collection in 2006-2007. SFCN field assessment indicate that the horizontal accuracy (RMSE) of the aerial image to be approximately 2.2m.

The final vegetation map has a total of 26 mapping classes and 51 polygons. A vegetation key and classification were generated as part of the project which included four proposed new Alliances, and 11 new Associations. The vegetation classification system was created based on vegetation physiognomic class, Caribbean Formations from Areces-Mallea *et al.* (1999), U.S. Virgin Islands Sub-formations from Gibney *et al.* (2000), and Alliances/Associations defined by the SFCN based on data from vegetation plots and field notes.

Also included are: a photo-interpretation key, a list of vegetation species observed in the field during this project, a vegetation species photo guide for Buck Island Reef National Monument, field data sheets, and reference literature. Ninety-two percent of the polygons either had vegetation data collection or were directly visited and confirmed; consequently SFCN concluded the map meets the NPS-VMP requirement of 80% accuracy with 90% confidence. The final product meets the FGDC metadata standard.

Introduction

Buck Island Reef National Monument Vegetation Mapping Project

The National Park Service (NPS) South Florida/Caribbean Inventory and Monitoring Network (SFCN) (http://science.nature.nps.gov/im/units/sfcn/) consists of seven NPS units, encompassing 2.5 million acres (Figures 1 and 2) and includes Buck Island Reef National Monument. The NPS Vegetation Mapping Inventory Program (http://science.nature.nps.gov/im/inventory/veg/) funded the SFCN to create a vegetation map of Buck Island, the entire terrestrial portion of Buck Island Reef National Monument in 2007. The SFCN used the Resource Management Intern Program cooperative agreement at Florida International University to fund the Buck Island Reef National Monument Vegetation Mapping Project. The deliverable associated with this project was for development of a vegetation map of Buck Island. The project was completed in 2009. Vegetation mapping is one of the twelve NPS basic inventories produced as part of the NPS Natural Resource Challenge.

This report documents the steps involved in creating the Buck Island Reef National Monument vegetation map. These steps are: 1) Previous vegetation literature and reports on Buck Island were researched, species data was collected, and documents associated with community classification were gathered. 2) The most current and highest resolution aerial imagery was acquired and the geographic accuracy of the image was assessed through the use of ground control points. 3) Draft vegetation polygons were digitized in ESRI ArcMap based on photo-interpretation of the aerial imagery. 4) Vegetation plots were selected based on draft polygons and field observations and a list of vegetation species observed in the field during this project and a vegetation species photo guide for Buck Island Reef National Monument were created for field use. 5) Pre-selected vegetation plots were visited, additional plots were added while in the field, and significant vegetation data was recorded at each vegetation plot. 6) A database was designed and created based on data collected at each vegetation plot, including all data from field observations. 7) A vegetation classification system was created based on vegetation physiognomic class, Caribbean Formations from Areces-Mallea *et al.* (1999), U.S. Virgin Islands Sub-formations from Gibney *et al.* (2000), and Alliances/Associations defined by the SFCN based on data from vegetation plots and field notes; 8) The final vegetation map consisting of data accumulated throughout this project was created in ESRI ArcMap and the spatial topology of the vegetation polygons was verified using ESRI ArcMap.

Introduction to Buck Island Reef National Monument

Buck Island Reef National Monument was established by Presidential Proclamation in 1961. On January 17, 2001, under the U.S. Coral Reef Initiative, the monument was expanded by Presidential Proclamation from 880 to 19,015 acres, adding extensive marine resources to the monument.

The barrier reef surrounding two-thirds of the island is between 8,000-10,000 years old and contains extraordinary coral formations, deep grottoes, abundant reef fishes, sea fans and gorgonians with the eastern most point of the reef containing the famous “Underwater Trail”. The 176-acre island has an overland nature trail and white coral sand beaches. Buck Island is 1 mile long and approximately ½ mile at its widest (Woodbury and Little 1976) and is 340 feet (104 meters) above sea level (Gibney 1996) at its tallest, with most of its surface sloping from

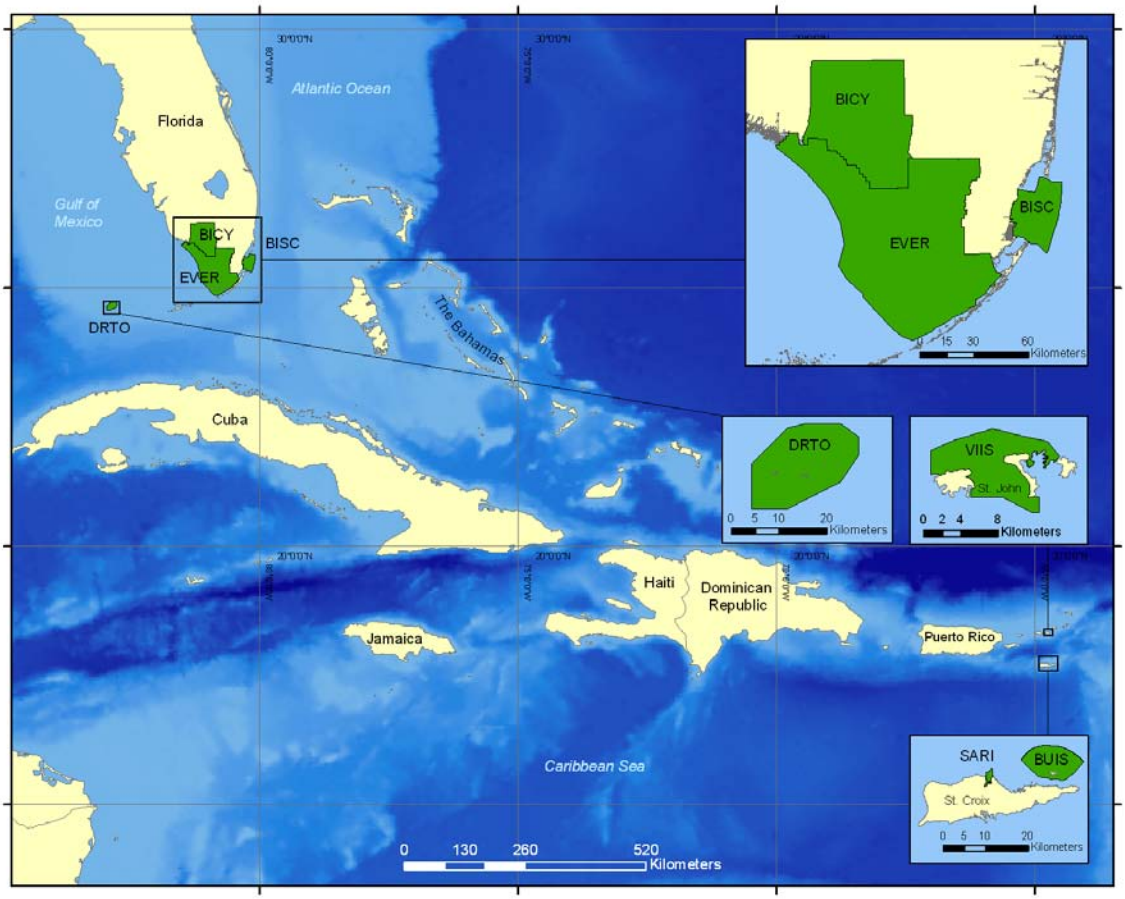


Figure 1. South Florida / Caribbean Network parks.

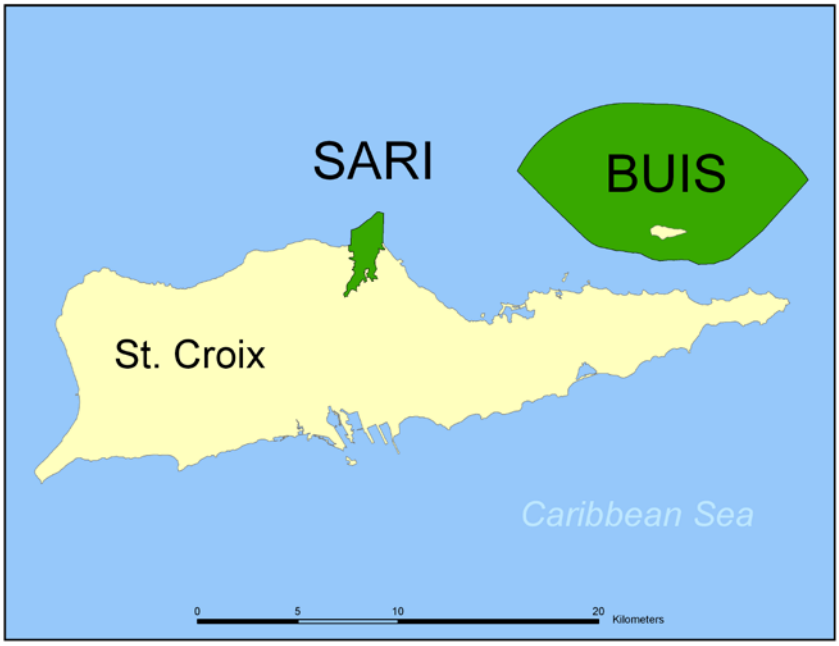


Figure 2. Buck Island Reef National Monument (BUIS) in relation to St. Croix.

20-70% (Davis 1998 as cited in Ray 2003). Many of the slopes and ridges of Buck Island are made up of Victory-Southgate soil complex (VsE and VsF) (Davis 1998 as cited in Ray 2003). Buck Island is rarely subject to earthquakes, although there is an active fault zone which lies approximately 100 miles north in the Puerto Rico trench (Hall 2005). The monument supports a large variety of native flora and fauna, including several threatened and endangered species such as the stinging bush *Malpighia infestissima*, the wooly nipple cactus (*Mammilaria nivosa*), leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), loggerhead (*Caretta caretta*), and green (*Chelonia mydas*) sea turtles, elkhorn (*Acropora palmata*) and staghorn (*Acropora cervicornis*) coral, and brown pelicans (*Pelecanus occidentalis*). Buck Island Reef National Monument has been subjected to several major hurricanes (the devastating Hurricane Hugo in 1989, Marilyn and Luis in 1995, George in 1998, Lenny in 1999, and Omar in 2008). Additionally, the natural resources of Buck Island have been negatively impacted by exotic fauna like the tree rat (*Rattus rattus*) and mongoose (*Herpestes javanicus*). Buck Island began exotic predator control in the 1980s removing all mongooses by 1986. In 1999 the park began an island-wide rat eradication program which successfully controlled the tree rat population. The only non-native predator that remains is the European house mouse, *Mus musculus*, which is being monitored bi-annually. In 2003, in collaboration with the NPS Florida / Caribbean Exotic Plant Management Program, BUIS has undertaken an island-wide, non-native plant control program targeting 10 invasive species: Guinea grass (*Urochloa maxima*), tan-tan (*Leucaena leucocephala*), Ginger Thomas (*Tecoma stans*), pinguin (*Bromelia pinguin*), boerhavia (*Boerhavia erecta*), aloe (*Aloe vera*), genip (*Melicoccus bijugatus*), seaside maho (*Thespesia populnea*), noni (*Morinda citrifolia*), and tamarind (*Tamarindus indica*) (Clark and Hillis-Starr 2004). This exotic plant removal treatment affected specific parts of the island more than others (Clark and Hillis-Starr 2004). The control of these exotic species will affect the entire terrestrial ecosystem and is essential to preserve the island's present biodiversity.

An accurate vegetation map will catalog current vegetation conditions and assist resource management decisions in the future. There is an anticipated change in vegetation as a result of the removal of rats, which fed heavily on fruits, seedlings, and plants on Buck Island (Witmer *et al.* 2002, Clark and Hillis-Starr 2004). Additionally, the island was impacted by a number of exotic plants species, which outcompeted native species for space and affected the micro-climate (Ray 2003, Clark and Hillis-Starr 2004). With the removal of these pressures, presumably a more native vegetation community should continue to develop on Buck Island. Future management decisions may attempt to reestablish native species which have been extirpated from Buck Island.

Methods

Project Overview

SFCN conducted the Buck Island Reef National Monument vegetation mapping project by establishing a cooperative agreement with Florida International University which established the Resource Management Intern Program. The Resource Management Intern created most of the map polygons under the supervision of the SFCN community ecologist. SFCN staff conducted the field data collection, analysis and vegetation classification development. SFCN consulted with park resource management staff and received considerable assistance with logistical support, important references, and review of the resulting map.

Creation of the map involved the following seven phases which are detailed below:

Phase 1: Gathering Background Information
Phase 2: Imagery Acquisition
Phase 3: Draft Polygons Creation
Phase 4: Selection of Plots, Creation of Field Data Sheets, and Guides
Phase 5: Collection of Field Data
Phase 6: Database Design and Creation
Phase 7: Vegetation Classification
Phase 8: Refinement and Finalization of Polygons

The project was initially funded in 2007; work began in earnest in May of 2008, and was completed in May of 2009.

Phase 1: Gathering Background Information

This vegetation map project began by acquiring materials immediately associated with Buck Island vegetation. Previous vegetation literature and reports on Buck Island were researched, species data was collected, and documents associated with community classification were gathered.

The following sources, "Flora of Buck Island Reef National Monument" (Woodbury and Little 1976), "Vegetation of Buck Island Reef National Monument" (Gibney 1996), "Vascular plant inventory and mapping of Buck Island, Buck Island Reef National Monument St. Croix, U.S. Virgin Islands" (Ray 2003), and an interview with Dan Clark concerning the vegetation on BUIS (Clark 2008), describe general information about Buck Island with a focus on vegetation over a 30 year span. Woodbury and Little (1976) is one of the first publications about the vegetation of Buck Island (Appendix J). Gibney (1996) is an unpublished report to the NPS about vegetation on Buck Island 20 years later (Appendix I). Dan Clark is a former Supervisory Exotic Plant Management Specialist with the Florida / Caribbean Exotic Plant Management Team who is familiar with vegetation on Buck Island. Mr. Clark worked frequently on Buck Island performing exotic plant removal.

"The Eradication of Introduced Rats at Buck Island Reef National Monument, St. Croix, U.S. Virgin Islands" (Witmer *et al.* 2002) is the technical report for an island-wide tree rat (*Rattus rattus*) eradication by the U.S. Department of the Interior National Park Service (NPS) and U.S. Department of Agriculture Wildlife Services (WS) that began in September 1999 and was

completed in February 2000 (Appendix H). This technical report describes methodology used during this eradication project in which a 40x40 meter grid was overlaid on Buck Island, with each intersection point representing an individual rat bait station (Figure 3, page 15) and a piece of rebar established at each station. Vegetation data was collected from each bait station location during the installation of the bait stations. A database was created using MS Access©, which included information relating to bait consumption, habitat conditions, and surrounding vegetation for each bait station. This database was never published and identifying the correct scientific name for each plant species reported has proven challenging since the authors only recorded common names.

A "Vascular plant inventory and mapping of Buck Island, Buck Island Reef National Monument St. Croix, U.S. Virgin Islands" (Ray 2003) and the "Flora of St. John, U.S. Virgin Islands" (Acevedo-Rodriguez 1996) were used to create a list of potential vegetation species for use while surveying vegetation plots on Buck Island. Ray (2003) is an unpublished report of a vascular plant inventory of Buck Island contracted by the SFCN. Ray used the 40x40 meter grid from the rat eradication, expanding it to a 160x160 meter grid that was overlaid on Buck Island, with each cell representing an area of interest (Figure 4, page 16). Ray then recorded all observed species in each cell using the Braun-Blanquet cover-abundance scale to analyze vegetation. Acevedo-Rodriguez (1996) is a published text that was relied on to identify (key out) unfamiliar vegetation species collected while in the field.

"A guide to Caribbean vegetation types: preliminary classification system and descriptions" (Areces-Mallea *et al.* 1999) and "U.S. Virgin Islands vegetation community classification: basic community descriptions – habitat mapping in support of land use and biodiversity planning in the Virgin Islands" (Gibney *et al.* 2000) were used to establish and create the vegetation classification used for this vegetation mapping project. "A guide to Caribbean vegetation types: preliminary classification system and descriptions" by Areces-Mallea *et al.* (1999) is a published preliminary classification system with descriptions of Caribbean vegetation communities at the "Formation" level using the conventions found in the National Vegetation Classification System (Appendix G). "U.S. Virgin Islands vegetation community classification: basic community descriptions – habitat mapping in support of land use and biodiversity planning in the Virgin Islands" by Gibney *et al.* (2000) is an unpublished document discussing basic community descriptions occurring in the U.S. Virgin Islands (Appendix F). No species were included in any of the community descriptions of this document.

Phase 2: Imagery Acquisition

U.S. Army Corps of Engineers 2006-2007 orthophotos were determined to be the most current and detailed imagery available. The imagery used in this project was a small extract from a collection of natural color GeoTIFF orthophotos that cover the islands of Puerto Rico, Culebra, Vieques, St. Thomas, St. John, and St. Croix. An orthophoto is remotely sensed image data in which displacement of features in the image caused by terrain relief and sensor orientation have been mathematically removed. Orthophotography combines the image characteristics of a photograph with the geometric qualities of a map. The source imagery was obtained from November 2006 through March 2007 and used to produce orthophotos with a one foot ground sample distance (GSD). Imagery was acquired at 0.9 foot GSD resolution. Flight height maintained during mission was 8,650 feet above ground level (AGL). The imagery was captured

at 12-bit radiometric resolution and converted to 8-bit radiometric resolution during post processing. The imagery was captured with 30% side lap between all adjacent flight lines. The imagery was obtained and processed by all digital means beginning with data acquisition using an ADS40 digital sensor. The orthophotos are available in GeoTIFF form. The original projected coordinate system was State Plane Puerto Rico / US Virgin Islands (Zone 5200), NAD 83, GRS 80, Units Meters. These orthophotos were originally collected for the U.S. Army Corps of Engineers. A single orthophoto captured the entirety of Buck Island and is included in the project files as *buisortho.zip.*

SFCN verified the horizontal accuracy of the imagery by analyzing 8 control point locations in the imagery. Locations were considered to be suitable control points if they were visible in the orthoimage and had a well-defined corner (e.g. dock or corner of building). In areas of the park without structures, distinct rocks or shrubs were used. A field crew visited each control point in October 2008 and January 2009 with a Garmin 60CSx handheld Global Positioning System (GPS) unit. After locating a control point location, the field crew collected a single GPS point by averaging 120 positions.

To determine the horizontal accuracy of the imagery, the shapefile of corrected control points was overlaid on the orthoimage in ESRI ArcMap. The ruler tool was used to measure the distance in meters between each corrected control point and the expected position of the control point on the image. The root mean square error (RMSE) was calculated by squaring the offsets, averaging these squared offsets, and finally taking the square root.

The results of the SFCN check of the horizontal accuracy indicated that positions of well defined points were within 2.2m of their true location.

Phase 3: Draft Polygons Creation

Polygons were digitized in ESRI ArcMap for the entirety of Buck Island based on an initial photo-interpretation of the digital orthoimage within a range of 1:200 through 1:7000 scales. The variation in scale proved helpful in defining larger polygons at larger scales and vice versa. Vegetation polygons in general were digitized with a minimum mapping unit of $400m^2$. However nine polygons were digitized smaller than the minimum mapping unit. All nine of these polygons had a high degree of certainty in their mapping class and location (e.g., buildings).

Phase 4: Selection of Plots, Creation of Field Data Sheets, and Guides

Locations of field vegetation plots were selected with the primary goal of visiting as many polygons as possible, while ensuring each plot was representative of the visited polygon. Anticipating feasibility of reaching plots given the steep terrain of Buck Island was challenging. The degree of difficulty of reaching a given plot was difficult to predetermine as will be discussed further in the next section. Prior to field analysis, potential plots were preselected in ESRI ArcMap using the following guidelines: (1) Each plot was a minimum distance of five meters inside the targeted polygon; (2) Each plot was in a part of the targeted polygon with a distinct visual pattern compared with other surrounding polygons (i.e., ecotones were avoided). (3) Each plot was (to the best of our knowledge) accessible with a reasonable efficiency of effort. (4) Each plot was inside a polygon of a significant size and visual (pattern) significance.

A field data sheet was created prior to field work (Appendix E) to collect the following data to assist vegetation mapping: Location of the Plot (Park, GPS Mark #, Training Point #, and Polygon #), Dominant Species Present in Overstory and Understory, Average Canopy Height, Canopy Cover Percent Cover, Community Type, Area Description/Sub Strata, and Successional Stage. Additional data was recorded when applicable to the vegetation plot (# of Pictures Taken/Description, Disturbance, Representative of Polygon, and Remarks/Point Changed). In October 2008, Hurricane Omar passed over the northeast end of St. Croix, U.S. Virgin Islands including Buck Island. In general minor to moderate vegetation damage (Table 3) was observed and thus the level of disturbance was also recorded during the October field work.

A list was made of vegetation species observed in the field during this project (Appendix C), with a vegetation species photo guide for Buck Island Reef National Monument additionally made (Appendix D). The vegetation species photo guide for Buck Island Reef National Monument includes photos or sketches, scientific and common name, family, and a six letter species code. This code was created using the first three letters of the genus name and first three letters of the specific epithet name, and did not necessarily match Integrated Taxonomic Information System (ITIS) species codes. However, vegetation species names were subsequently checked and updated to the current species names in ITIS.

Phase 5: Collection of Field Data

All vegetation plots were reached via hiking, often traversing steep slopes amongst thorny/poisonous vegetation. Data was collected from vegetation plots that were both preselected (potential) and non-preselected. Preselected plots were selected using ESRI ArcMap prior to field work (see Phase 4). A Garmin GPSMap 60CSx Handheld GPS Navigator was used to navigate to preselected plots. Upon arriving at the plot, a new GPS coordinate was taken and allowed to average for at least 120 seconds. Standing at the center of the plot, the primary observer visually evaluated a circular area with an average radius of 10 meters from the center of the plot, representing approximately an area of $300m^2$. Some polygons were too narrow and the area evaluated was adjusted accordingly. The primary observer dictated the items in the field data sheet which was filled out by an assistant observer and photos were taken that visually represented to the plot. Additional photos were taken while traveling between plots. Plant species that were unable to be identified in the field were bagged and later keyed out by SFCN botanist R. B. Shamblin using the *Flora of St. John, U.S. Virgin Islands*. Additional, non-preselected plots were sometimes recorded in areas of interest as determined in the field when reaching the selected point was not feasible or an area of vegetation visited had no other field points but was clearly different. These plots were treated in the same manner as preselected plots aside from not being preselected prior to field work.

Some non-preselected plots were observed from a distance and thus were not able to have a GPS coordinate taken. In the field these “offset” plots were observed, for example, from the visitor observation platform or from the beach looking up and were an attempt to gather data about viewable but difficult to reach or dangerous points. The field data sheet was completed by observation from a distance ranging 10-380 meters using binoculars. Approximate “offset” plot locations were determined in ESRI ArcMap through a combination of field notes, GPS locating distances, and discussion with the primary observer. “Offset” plots initially observed from long distances were later confirmed with nearby field plots.

As demonstrated in not going to a preselected plot, going to a non-preselected plot, and creating an offset plot, there was a degree of flexibility in choosing which plots to visit. The primary cause for not going to a preselected plot or going to a non-preselected plot was inaccessibility and time-effort effectiveness. Though most vegetated polygons were able to be sampled with at least one plot, some polygons were inaccessible and due to time constraints were unable to be sampled. Through the use of offset plots, the number of polygons without vegetation data was minimized.

Phase 6: Database Design and Creation

After returning from the field, all GPS units used for vegetation mapping were downloaded into an ESRI ArcMap shapefile for each visit. A database was created including the fields given in Table 1 (page 19) with additional descriptions provided in Tables 2 and 3 (page 20). Data recorded on field data sheets and notes were entered in the database. A ThumbsPlus 7© database was used to catalog all photos taken during each day of the field visit, allowing data from field data sheets to be digitally associated with each individual photo.

Phase 7: Vegetation Classification

The National Vegetation Classification System (NVCS) hierarchy is currently under revision and is especially underdeveloped in the areas of the U.S. Virgin Islands and sub-tropical Florida. SFCN was able to locate two previous vegetation classification documents: Areces-Mallea *et al.* (1999) and Gibney *et al.* (2000). The Areces-Mallea *et al.* (1999) document provides a NVCS classification, including Caribbean Formations, Alliances, and Associations, however the Alliances and Associations described are not found on Buck Island. Gibney *et al.* (2000) provides Areces-Mallea *et al.* (1999) Caribbean Formations and then additional sub-divisions (called Virgin Islands Sub-formations for the purpose of this document) that provide extra specificity between the Formation level and the Alliance level. Neither classification describes vegetation to the Alliance or Association level for Virgin Islands vegetation communities.

The vegetation classification created for this project incorporates material from Areces-Mallea *et al.* (1999) and Gibney *et al.* (2000) but adds proposed Alliances or, where possible, Associations described by SFCN botanist R. B. Shamblin. Vegetation communities were categorized in the following hierarchy:

Vegetation Physiognomic Class (NVCS)
Caribbean Formation (Areces-Mallea *et al.* 1999)
Virgin Islands Sub-formation (Gibney *et al.* 2000)
Alliance or Association (R. B. Shamblin)

Five vegetation physiognomic classes (Forest, Woodland, Shrubland, Sparse Vegetation, and Hierarchy Placement Undetermined) were used as a broad division of classification. Ten Caribbean Formations defined by Areces-Mallea *et al.* (1999) were used to maintain linkage between the National Vegetation Classification System and the unique Virgin Islands communities. Thirteen Virgin Islands vegetation communities defined by Gibney *et al.* (2000) were incorporated as Virgin Islands Sub-formations. An additional three Virgin Islands Sub-formations (Semi-evergreen Woodland, Coastal Evergreen Shrubland, and Beach Dune) were created by R. B. Shamblin to define communities that were absent in Gibney *et al.* (2000). Four

Alliances and 11 Associations were defined by R. B. Shamblin with the former having descriptions of characteristic species in the overstory and the later also including characteristic species in the understory based upon vegetation plot data collected at Buck Island Reef National Monument. Field plot data collection included canopy height, dominant species for canopy overstory and understory (when possible and applicable), and additional species present (Phase 5).

The vegetation classification hierarchy is given in Table 5 (page 21). Appendix A provides the vegetation classification key and descriptions of all Virgin Islands Sub-formations, Alliances, and Associations, including:

Alliance/Association Name:	Name using scientific names.
Name, translated:	Name using common names.
Vegetation	Describes dominant overstory species and where possible understory species at Buck Island Reef National Monument. Other characteristic species, canopy height and canopy cover are also included.
Environment	Describes location/environment at Buck Island Reef National Monument. Please note: some additional environmental descriptions of U.S. Virgin Islands Dry Forests, Shrublands, etc. is provided in Gibney *et al.* (2000).
Plots:	SFCN field plot identification labels for plots on which description is based.

The Virgin Islands Sub-formations, Alliances, and Associations described in this report are considered provisional as they have not been officially accepted into the National Vegetation Classification System at this time. This report makes no attempt to extrapolate ranges beyond Buck Island Reef National Monument or make assumptions about other species that might be present at other places. SFCN assumes that the detailed formatting and descriptions necessary to complete descriptions for the National Vegetation Classification System will be provided separately by the NPS Vegetation Mapping Inventory Program once the NVCS revisions are complete.

All mapping classes are described within the vegetation classification. A separate photo-interpretation key and photos of map classes used (whether Virgin Islands Sub-formation, Alliance, or Association) are included in Appendix B.

Phase 8: Refinement and Finalization of Polygons

Polygons were re-digitized for the entirety of Buck Island based on a combination of photo-interpretation, vegetation plots, and field notes. Some polygons where mapped in the field independent from photo-interpretation of the imagery. The attributes table for the polygon shapefile includes the following fields: Level_1, Level_2, Level_3, Level_4, and Level_4_L (Table 4, page 20).

Level_1 = Vegetation physiognomic class.

Level_2 = Caribbean Formation (Areces-Mallea *et al.* 1999).

Level_3 = Virgin Islands Sub-formation (Gibney *et al.* 2000; with additions by SFCN).
Level_4 = Alliance/Association using species codes (SFCN); if no Alliance/Association classification made, then Level_3 classification used.
Level_4_L = Alliance/Association using species scientific names (SFCN); if no Alliance/Association classification made, then Level_3 classification used.

Vegetation classifications were assigned to each polygon based on vegetation plots, field notes, photos, and vegetation data from the rat eradication (Witmer *et al.* 2002). The Witmer *et al.* (2002) vegetation data was used as a secondary source during the few cases when there was no familiarity with a polygon, i.e., when no vegetation plots were taken in a polygon or no walk through of that polygon occurred at any time during vegetation mapping. Vegetation data from Witmer *et al.* (2002) was used in identifying well-known dominant species to aid in classifying to the Virgin Islands Sub-formation level of the unknown polygon. An Alliance or Association classification was never made using the Witmer *et al.* (2002) vegetation data.

The spatial topology of the final polygon shapefile was checked using ESRI ArcMap to find any slivers or overlaps which often occur during the drawing of polygons. This finalized polygon shapefile was colored coded based on the Level_4_L field, all values in effect representing vegetation map classes.

Results and Discussion

Plots

A total of 67 vegetation plots were visited over two trips (Figure 5, page 17). The first trip in October 2008 resulted in 46 vegetation plots, and the second trip in January 2009 afforded 21 vegetation plots. Thirty-nine of the plots were directly visited while 28 were recorded from "off-set" locations. Appendix C lists the 54 vegetation species observed in the field during this project.

Mapping Classes

There were a total of 26 mapping classes used in classifying all polygons that were digitized (Table 6, page 22). Of the 26 mapping classes, there were 11 Virgin Islands Sub-formations, four Alliances, and 11 Associations that are described in the Vegetation Classification (Appendix A). Twenty of the 26 mapping classes had one or more vegetation plots representing them (Table 6, page 22). Four of the six mapping classes lacking vegetation plots were directly visited and confirmed although a formal vegetation plot data collection did not occur (Beach, Developed Area, Salt Pond, and Coastal Southgate Rock Cliff Alliance). One of the six mapping classes lacking vegetation plots was walked through on the way to other vegetation plots (*Pisonia subcordata* Woodland Association). One of the six mapping classes lacking vegetation plots was not directly visited and was only identified to the Virgin Islands Sub-formation (Gibney *et al.* 2000) level (Semi-deciduous Forest).

Polygons

A total of 51 polygons were digitized (Figures 5 and 6, pages 17 and 18) based on interpretation of the imagery used (see Photo-interpretation Key Appendix B). Thirty of the 51 polygons had one or more vegetation plots occurring in them (Figure 5, page 17). Sixteen of the 21 polygons lacking vegetation plots were directly visited and confirmed although a formal vegetation plot data collection did not occur (six polygons of Beach, four polygons of Developed Area, one polygon of Salt Pond, and five polygons of Coastal Southgate Rock Cliff Alliance). One of the 21 polygons lacking vegetation plots was walked through on the way to other vegetation plots (*Pisonia subcordata* Woodland Association). Four of the 21 polygons lacking vegetation plots were not visited (one polygon of *Pisonia subcordata* Woodland Association, two polygons of Semi-deciduous Forest, and one polygon of Gallery Semi-deciduous Forest). Nine of the total 51 polygons were smaller than the minimum mapping unit of 400m^2 (one polygon of *Laguncularia racemosa* Shrubland Association, one polygon of Coastal Southgate Rock Cliff Alliance, three polygons of Beach, and four polygons of Developed Area). A vegetation classified map was designed identifying all of the map classes representing polygons (Figure 6, page 18). Some polygons graded gently into one another and where to place the polygon boundary in the ecotone was difficult to determine and was made with the mapper's best judgment.

Accuracy Assessment

SFCN did not conduct a separate accuracy assessment of the classification accuracy as 30 of the 51 polygons had vegetation plot data collection. In addition, Beach (6 polygons), Developed Area (4 polygons), Salt Pond (1 polygon) and Coastal Southgate Rock Cliff Alliance (5 polygons) were directly visited and confirmed although a formal vegetation plot data collection did not occur. Thus 92% of the polygons either had vegetation data collection or were directly

visited and confirmed. We note that of the remaining five vegetated polygons without vegetation plots, one was also walked through on the way to other vegetation plots. These five polygons were observed visually from neighboring polygons and Witmer *et al.* 2002 rat eradication vegetation data was used to further confirm classification. Where there was any uncertainty in classification due to lack of field data, polygons were only identified to the Virgin Islands Sub-formation (Gibney *et al.* 2000), including four non-visited polygons. Thus SFCN felt the combination of these factors is sufficient enough to meet the National Vegetation Inventory Program standard of 80% classification accuracy with 90% confidence.

As mentioned above the SFCN check of the horizontal accuracy indicated that positions of well defined points on the imagery were within 2.2m of their true location. A separate positional accuracy of the vegetation map was not possible, due to the scarcity of well-defined map-able objects. However, the accuracy of the imagery suggests that the map should be well within the 12.2 meters required by the NPS Vegetation Mapping Inventory Program.

Summary of final project specifications, products and files

The Buck Island vegetation map was made in UTM, NAD 83, zone 20N coordinates with a minimum mapping unit of 400m^2. Aerial imagery used was a single U.S. Army Corps of Engineers natural color GeoTIFF orthophoto acquired as part of a larger collection in 2006-2007. SFCN tests showed the horizontal accuracy (RMSE) of the aerial image to be 2.2m. The final vegetation map has a total of 26 mapping classes and 51 polygons. A vegetation key and classification are included in Appendix A and a photo-interpretation key and map photos are included in Appendix B. Four proposed new Alliances, and 11 new Associations are described in the vegetation classification. A list of vegetation species observed in the field during this project is provided in Appendix C and a vegetation species photo guide for Buck Island Reef National Monument is provided in Appendix D. Data and photos were collected for 67 field plots as well as additional photos along trails or between plots. Ninety-two percent of the polygons either had vegetation data collection or were directly visited and confirmed; consequently SFCN feels the map meets the NPS VMP requirement of 80% accuracy with 90% confidence. The final product meets the FGDC metadata standard.

Table 7 (page 23) summarizes the products and filenames included in the Buck Island Reef National Monument vegetation mapping project products and files.

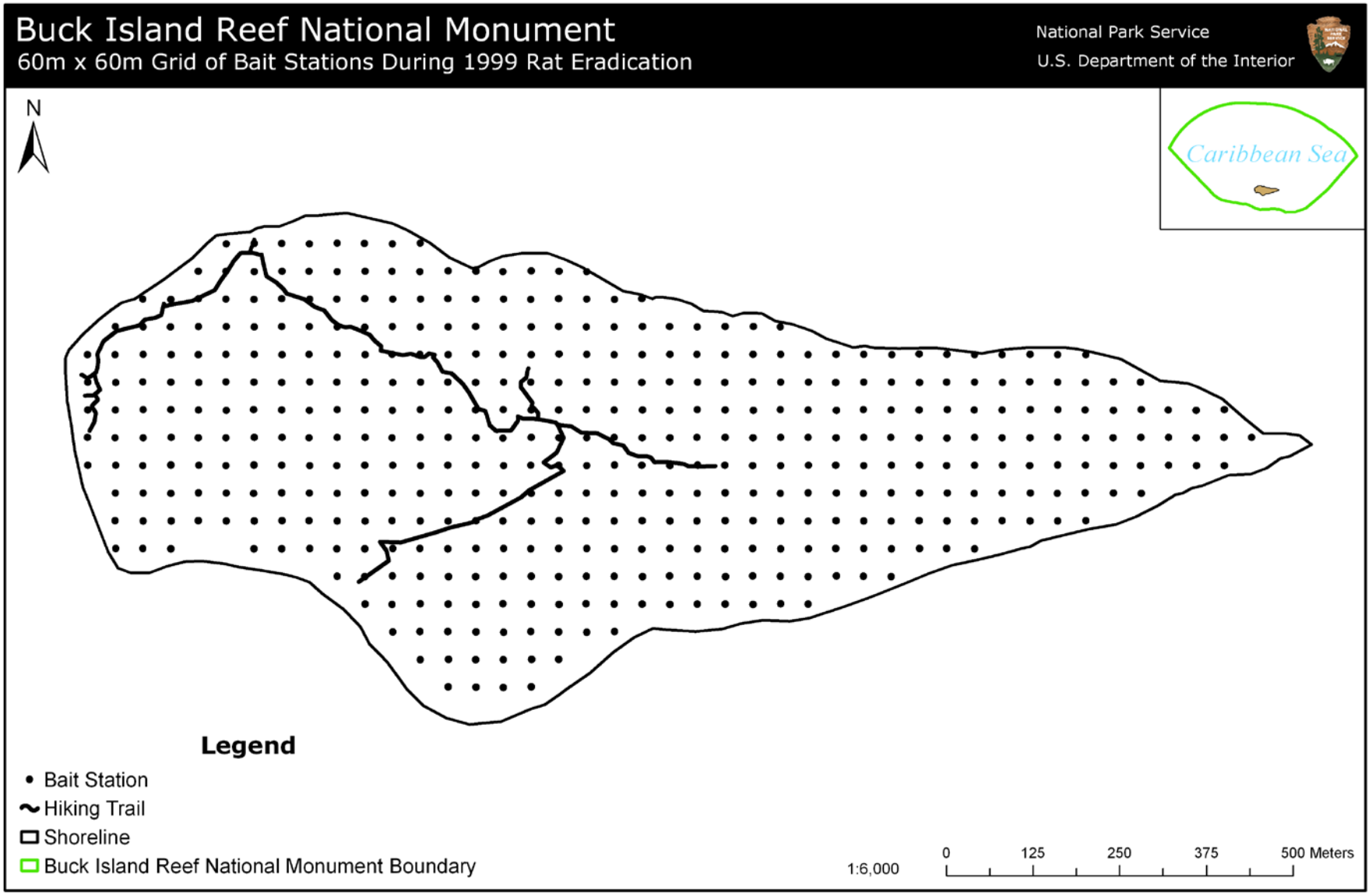


Figure 3. Bait stations for rat eradication project (40x40m grid) from “The Eradication of Introduced Rats at Buck Island Reef National Monument, St. Croix, U.S. Virgin Islands” (Witmer *et al.* 2002).

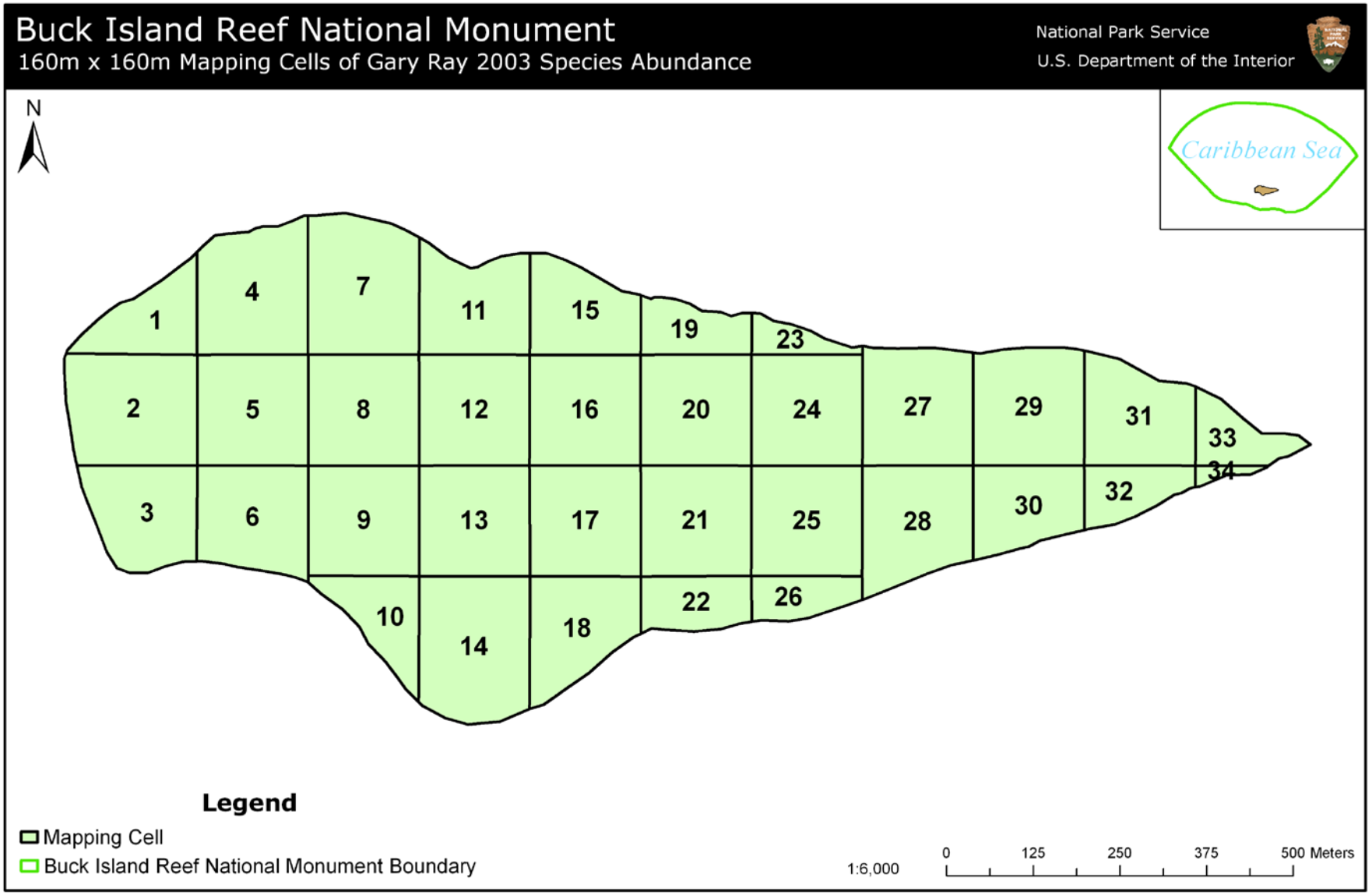


Figure 4. Vegetation mapping cells (160x160m grid) from “Vascular plant inventory and mapping of Buck Island Buck Island Reef National Monument St. Croix, U.S. Virgin Islands” (Ray 2003).

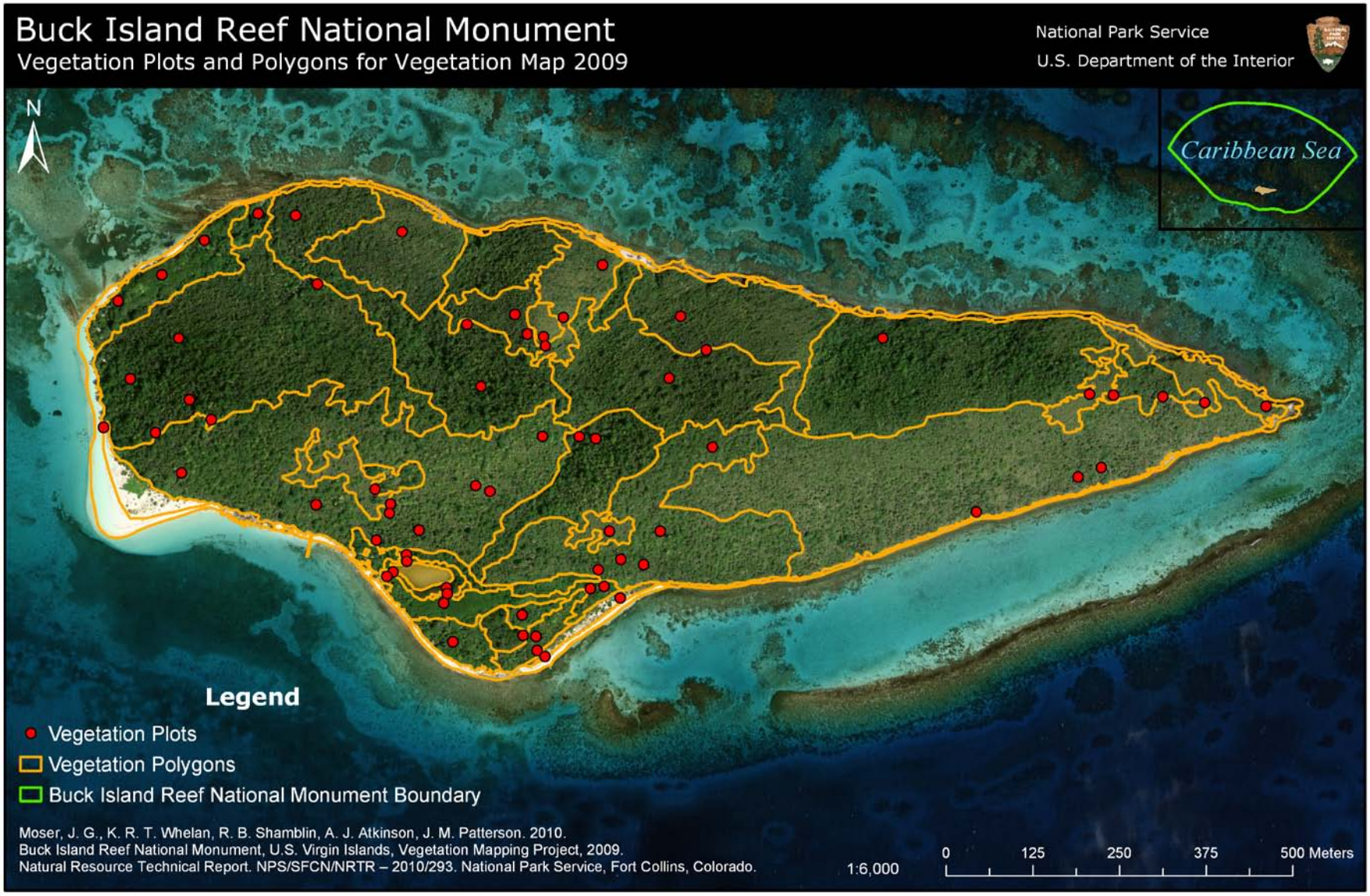


Figure 5. Map of vegetation polygons and field plots for Buck Island Reef National Monument.

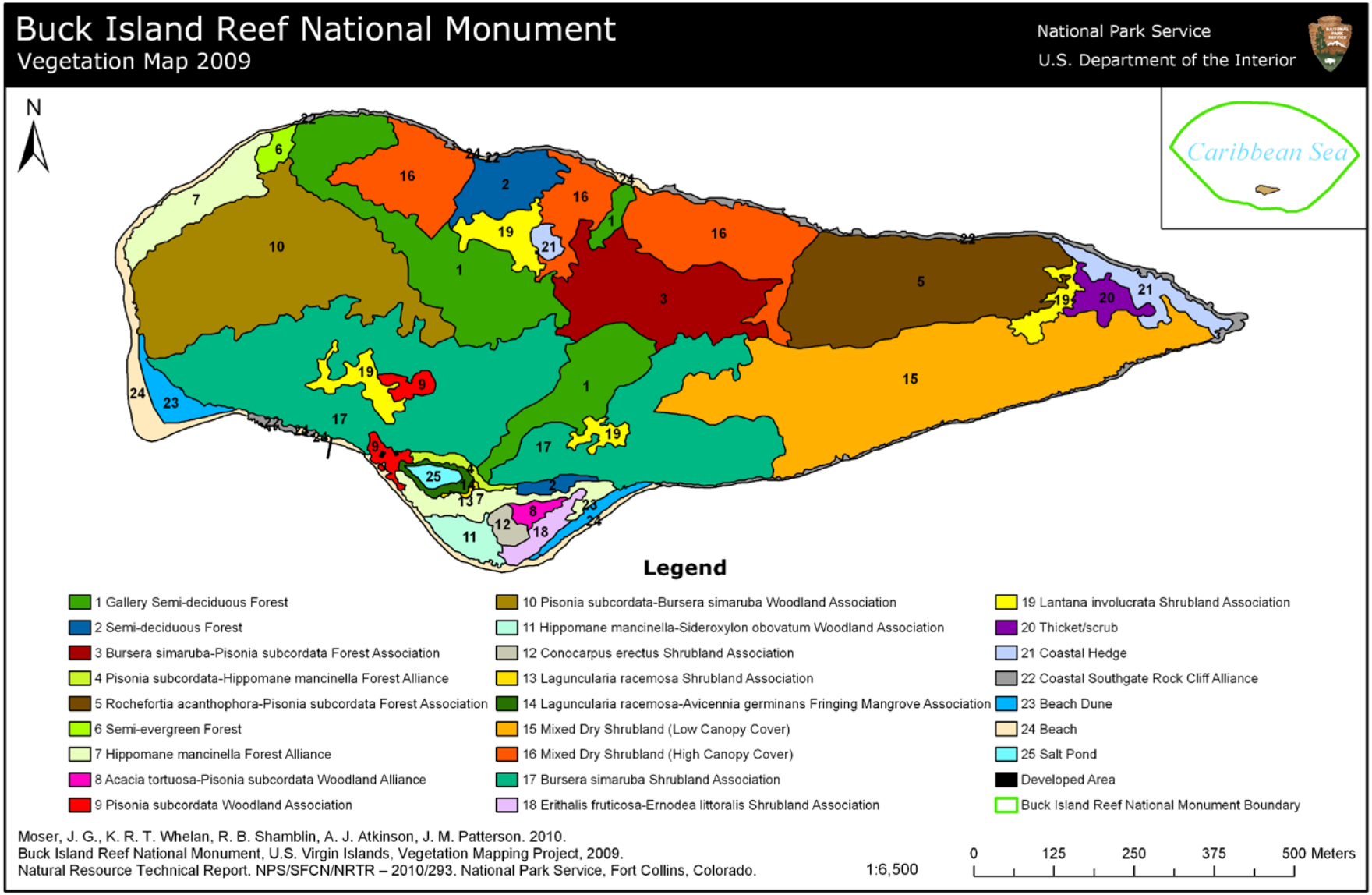


Figure 6. Map of classified vegetation polygons for Buck Island Reef National Monument.

Table 1. Descriptions of Fields for Vegetation Field Plots Database.

Field Name	Description
IDENT	GPS mark number (ID)
Site_ID	Unique site ID
LAT	Latitude
LONG	Longitude
COMMENT	Date collected
ALTITUDE	Altitude in meters
MODEL	GPS unit model
GPS_Unit	GPS unit number
Field_Date	Date in Field; date data was collected in the field (year, month, day)
Xcoord	UTM easting
Ycoord	UTM northing
Site	NPS park acronym
Site_Description	Site Description; description of general area around GPS mark
Remarks	Main observer, general remarks, and interesting observations
Height	Average Height of Canopy; this is the average visual estimate of canopy height (in meters) at the site
Cover	Canopy Cover; percent (%); visual estimate; with overlap
Level_3	Community Type - Virgin Islands Sub-formations: See additional description Forest >5m 60% Woodland >5m 25-50% Shrubland <5m >25% shrub & <25% tree
Spp_1	Dominant species code in upper canopy of field plot or point. Note; six letter species codes were created using the first three letters of the genus and first three letters of the species name, and do not necessarily match ITIS species codes.
Spp_2	Dominant species code in upper canopy; if filled out is co-dominant
Spp_Additional	Additional species code found at site
Observer	Primary field observer
Num_Photos	Number of vegetation photos indicated on the data sheet
Num_Thumbsplus	Number of vegetation photos actually relating to the Thumbsplus database
Hurr_Cover_B4	Canopy Cover Before Hurricane Omar; visual estimate of site canopy cover (%) as it may have been before Hurricane Omar
Hurr_Damage	Hurricane Omar Damage: See additional description; see Table 3
Height_Und	Average Height of Understory; this is the average visual estimate of understory height (in meters) at the site
Cover_Und	Understory Cover; percent (%); visual estimate; with overlap
Spp_1_Und	Dominant species code in understory of field plot or point
Spp_2_Und	Dominant species code in understory; if filled out is co-dominant
Strata	Area Description/Sub Strata; description of vegetation structure
Stage	Successional Stage; Early, Secondary, Late (climax)
Disturbance	Disturbance; recent; notes any detection of disturbance at site
Slope	Flat, moderate, or steep
Tree_Height	Canopy height of tree layer in meters
Tree_Cover	Canopy cover of tree layer in meters
Shrub_Height	Canopy height of shrub layer in meters
Shrub_Cover	Canopy cover of shrub layer in meters
Herb_Height	Canopy height of herb layer in meters
Herb_Cover	Canopy cover of herb layer in meters

Table 2. Additional Description of Community Type - Virgin Islands Sub-formations (Level_3).

Vegetation Physiognomic Class	Virgin Islands Sub-formation
Forest	Gallery Semi-deciduous Forest
	Semi-deciduous Forest
	Semi-evergreen Forest
Woodland	Semi-deciduous Woodland
	Semi-evergreen Woodland
Shrubland	Coastal Evergreen Shrubland
	Mangrove Shrubland
	Fringing Mangrove
	Mixed Dry Shrubland
	Thicket/scrub
	Coastal Hedge
Sparse Vegetation	Rock Pavement
	Beach Dune
	Beach
	Salt Pond
Hierarchy Placement Undetermined	Developed Area

Table 3. Additional Description of Hurricane Omar Damage.

Damage	Description
None	no obvious damage
Minor	leaf loss and small branches broken off
Moderate	about 50% of plants have major branch breaks
Severe	majority of plants have tip ups and major branch breaks*
Total Loss	extensive damage with most plants showing major branch breaks, tip ups, or trunk snaps**

*This category was only recorded once **This category was not observed

Table 4. Descriptions of Fields for Polygons.

Field Name	Description
Level_1	Vegetation Physiognomic Class - most basic vegetation community description
Level_2	Caribbean Formation - further description built on Level_1 found in *A guide to Caribbean vegetation types: preliminary classification system and descriptions* by Areces-Mallea *et al.* (1999)
Level_3	Virgin Islands Sub-formation - further description built on Level_2 found in *U.S. Virgin Islands vegetation community classification: basic community descriptions – habitat mapping in support of land use and biodiversity planning in the Virgin Islands* by Gibney *et al.* (2000) with additions by SFCN
Level_4	Alliance/Association - further description built on Level_3, species Alliance/Association which include dominant species if applicable (using species codes) by SFCN
Level_4_L	Alliance/Association - further description built on Level_3, species Alliance/Association which include dominant species spelled out if applicable (using species scientific name) by SFCN
Acres	Area of polygon in acres
Perim_mile	Perimeter of polygon in miles
Shape_Area	Area of polygon in square meters
Shape_Length	Perimeter of polygon in meters
Num	Polygon number label

Table 5. Vegetation Classification.

Vegetation Physiognomic Class
Caribbean Formation
Virgin Islands Sub-formation
Alliance/Association

I. FOREST
I.C.1.N.a. Lowland tropical/subtropical semi-deciduous forest
1. Gallery Semi-deciduous Forest
2. Semi-deciduous Forest
Bursera simaruba-Pisonia subcordata Forest Association
Pisonia subcordata-Hippomane mancinella Forest Alliance
Rochefortia acanthophora-Pisonia subcordata Forest Association
3. Semi-evergreen Forest
Hippomane mancinella Forest Alliance

II. WOODLAND
II.C.1.N.a. Tropical or subtropical semi-deciduous woodland
1. Semi-deciduous Woodland
Acacia tortuosa-Pisonia subcordata Woodland Alliance
Pisonia subcordata Woodland Association
Pisonia subcordata-Bursera simaruba Woodland Association
2. Semi-evergreen Woodland
Hippomane mancinella-Sideroxylon obovatum Woodland Association

III. SHRUBLAND
III.A.1.N.b. Tropical/subtropical broad-leaved evergreen shrubland
1. Coastal Evergreen Shrubland
Conocarpus erectus Shrubland Association
III.A.1.N.e. Seasonally flooded/saturated tropical/subtropical broad-leaved evergreen shrubland
1. Mangrove Shrubland
Laguncularia racemosa Shrubland Association
III.A.1.N.g. Semi-permanently flooded tropical or subtropical broad-leaved evergreen shrubland
1. Fringing Mangrove
Laguncularia racemosa-Avicennia germinans Fringing Mangrove Association
III.B.1.N.a. Lowland drought deciduous shrubland
1. Mixed Dry Shrubland
Bursera simaruba Shrubland Association
Erithalis fruticosa-Ernodea littoralis Shrubland Association
Lantana involucrata Shrubland Association
2. Thicket/scrub
3. Coastal Hedge

VII. SPARSE VEGETATION
VII.A.1.N.a. Cliffs with sparse vascular vegetation
1. Rock Pavement
Coastal Southgate Rock Cliff Alliance
VII.C.1.N.a. Dunes with sparse herbaceous vegetation
1. Beach Dune
VII.C.2.N.b. Intermittently flooded sand beaches and shores
1. Beach
VII.C.4.N.b. Intermittently flooded mud flat
1. Salt Pond

XX. HIERARCHY PLACEMENT UNDETERMINED
XX. Hierarchy Placement Undetermined
1. Developed Area

Table 6. Vegetation mapping class statistics.

Vegetation Class	Number of Polygons	Total Area (acres)	Number of Plots Sampled	Average Area (acres)	Minimum Area (acres)	Maximum Area (acres)
Gallery Semi-deciduous Forest Virgin Islands Sub-formation	3	17.6	5	5.9	0.7	11.7
Semi-deciduous Forest Virgin Islands Sub-formation	2	3.7	0	1.8	0.5	3.1
Bursera simaruba-Pisonia subcordata Forest Association	1	9.6	2	9.6	9.6	9.6
Pisonia subcordata-Hippomane mancinella Forest Alliance	1	0.6	1	0.6	0.6	0.6
Rochefortia acanthophora-Pisonia subcordata Forest Association	1	15	1	15	15	15
Semi-evergreen Forest Virgin Islands Sub-formation	1	0.7	1	0.7	0.7	0.7
Hippomane mancinella Forest Alliance	2	5.8	7	2.9	2.3	3.5
Acacia tortuosa-Pisonia subcordata Woodland Alliance	1	0.5	1	0.5	0.5	0.5
Pisonia subcordata Woodland Association	2	1.2	0	0.6	0.6	0.6
Pisonia subcordata-Bursera simaruba Woodland Association	1	19.5	6	19.5	19.5	19.5
Hippomane mancinella-Sideroxylon obovatum Woodland Association	1	1.4	1	1.4	1.4	1.4
Conocarpus erectus Shrubland Association	1	0.6	1	0.6	0.6	0.6
Laguncularia racemosa Shrubland Association	1	0.1	1	0.1	0.1	0.1
Laguncularia racemosa-Avicennia germinans Fringing Mangrove Association	1	0.6	3	0.6	0.6	0.6
Mixed Dry Shrubland (Low Canopy Cover) Virgin Islands Sub-formation	1	25.0	4	25.0	25.0	25.0
Mixed Dry Shrubland (High Canopy Cover) Virgin Islands Sub-formation	3	15.9	5	5.3	3.0	7.7
Bursera simaruba Shrubland Association	2	34.3	13	17.1	12.5	21.8
Erithalis fruticosa-Ernodea littoralis Shrubland Association	1	1.1	2	1.1	1.1	1.1
Lantana involucrata Shrubland Association	4	5.3	6	1.3	0.7	2.0
Thicket/scrub Virgin Islands Sub-formation	1	1.4	1	1.4	1.4	1.4
Coastal Hedge Virgin Islands Sub-formation	2	2.8	3	1.4	0.5	2.4
Coastal Southgate Rock Cliff Alliance	5	3.6	0	0.7	0.03	2.6
Beach Dune Virgin Islands Sub-formation	2	2.2	3	1.1	0.8	1.4
Beach Virgin Islands Sub-formation	6	4.2	0	0.7	0.04	2.6
Salt Pond Virgin Islands Sub-formation	1	0.5	0	0.5	0.5	0.5
Developed Area Virgin Islands Sub-formation	4	0.04	0	0.01	0.005	0.02
Total	51	173.4	67			

Table 7. Buck Island Reef National Monument vegetation mapping projects products or file descriptions and filenames. Naming conventions and required files follow guidelines from the NPS Vegetation Mapping Inventory Program.

Category	Product or File Description	Filename
Aerial Photography	Orthophoto graphic Self extracting file containing spatial orthophoto data	buisortho.pdf buisortho.zip
Project Report	Project report (contains full report about the vegetation map 2009 including funding source, background information, methods and results, final product specifications, brief description of products and files, vegetation classification and key, photo-interpretation key, map class descriptions, photos of map classes, species list from plots, and example field data sheets)	buisrpt.pdf
Field Data	Graphic showing location of field sites MS Excel format of Plot data MS Excel format of Species List Data for Plots Field plot photos (photos named using Site_ID field in plots.xls, i.e., *Site_ID*_a, *Site_ID*_b,…)	buisplots.pdf plots.xls sp_cov.xls field_photos.zip
Geospatial Vegetation Information	Zip folder containing geodatabase (buis.mdb) of spatial data (includes data for vegetation polygons, field plot points and data, park boundaries, and shoreline) ESRI ArcMap Project file – displays geodatabase (MDB) files Graphic of vegetation communities (low resolution) Graphic of vegetation communities (high resolution) Although use of the geodatabase and ArcMap Project File is recommended, individual shapefiles are also included as zip files: Vegetation polygons Vegetation plots Park boundary Shoreline	buis.zip buis_veg_project.mxd buis.pdf buis_large.pdf buis_vegetation_polygons.zip buis_vegetation_plots.zip buis_boundary.zip buis_shoreline.zip
Accuracy Assessment Information	*(Not applicable)*	
Project Metadata	Aerial photo metadata Field plots metadata Spatial vegetation metadata Park boundary metadata Shoreline metadata	metabuisortho.txt metabuisfield.txt metabuisspatial.txt metabuisbdy.txt metabuisshl.txt

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Appendix A: Vegetation Classification (includes Vegetation Key and Class Descriptions)

Contents

I. FOREST A-3
I.C.1.N.a. Lowland tropical/subtropical semi-deciduous forest (Caribbean Formation) A-3
1. Gallery Semi-deciduous Forest (Virgin Islands Sub-formation) A-3
2. Semi-deciduous Forest (Virgin Islands Sub-formation) A-3
Bursera simaruba-Pisonia subcordata Forest Association A-3
Pisonia subcordata-Hippomane mancinella Forest Alliance A-3
Rochefortia acanthophora-Pisonia subcordata Forest Association A-4
3. Semi-evergreen Forest (Virgin Islands Sub-formation) A-4
Hippomane mancinella Forest Alliance A-4

II. WOODLAND A-5
II.C.1.N.a. Tropical or subtropical semi-deciduous woodland (Caribbean Formation) A-5
1. Semi-deciduous Woodland (Virgin Islands Sub-formation) A-5
Acacia tortuosa-Pisonia subcordata Woodland Alliance A-5
Pisonia subcordata Woodland Association A-5
Pisonia subcordata-Bursera simaruba Woodland Association A-5
2. Semi-evergreen Woodland (Virgin Islands Sub-formation) A-6
Hippomane mancinella-Sideroxylon obovatum Woodland Association A-6

III. SHRUBLAND A-7
III.A.1.N.b. Tropical/subtropical broad-leaved evergreen shrubland (Caribbean Formation) A-7
1. Coastal Evergreen Shrubland (Virgin Islands Sub-formation) A-7
Conocarpus erectus Shrubland Association A-7
III.A.1.N.e. Seasonally flooded/saturated tropical/subtropical broad-leaved evergreen shrubland (Caribbean Formation) A-7
1. Mangrove Shrubland (Virgin Islands Sub-formation) A-7
Laguncularia racemosa Shrubland Association A-7
III.A.1.N.g. Semi-permanently flooded tropical or subtropical broad-leaved evergreen shrubland (Caribbean Formation) A-8
1. Fringing Mangrove (Virgin Islands Sub-formation) A-8
Laguncularia racemosa-Avicennia germinans Fringing Mangrove Association A-8
III.B.1.N.a. Lowland drought deciduous shrubland (Caribbean Formation) A-8
1. Mixed Dry Shrubland (Virgin Islands Sub-formation) A-8
Bursera simaruba Shrubland Association A-8
Erithalis fruticosa-Ernodea littoralis Shrubland Association A-9
Lantana involucrata Shrubland Association A-9
2. Thicket/scrub (Virgin Islands Sub-formation) A-9
3. Coastal Hedge (Virgin Islands Sub-formation) A-10

VII. SPARSE VEGETATION A-11
VII.A.1.N.a. Cliffs with sparse vascular vegetation (Caribbean Formation) A-11
1. Rock Pavement (Virgin Islands Sub-formation) A-11
Coastal Southgate Rock Cliff Association A-11
VII.C.1.N.a. Dunes with sparse herbaceous vegetation (Caribbean Formation) A-11
2. Beach Dune (Virgin Islands Sub-formation) A-11
VII.C.2.N.b. Intermittently flooded sand beaches and shores (Caribbean Formation) A-11
1. Beach (Virgin Islands Sub-formation) A-11
VII.C.4.N.b. Intermittently flooded mud flat (Caribbean Formation) A-11
1. Salt Pond (Virgin Islands Sub-formation) A-11

XX. HIERARCHY PLACEMENT UNDETERMINED A-12
XX. Hierarchy Placement Undetermined A-12
1. Developed Area (Virgin Islands Sub-formation) A-12

Disclaimer

Vegetation species listed were observed while surveying vegetation plots on Buck Island. The listed species represent only a subset of the common species found on Buck Island, and do not represent a complete inventory for a polygon or community.

I. FOREST

Forest types are characterized by a closed tree canopy and canopy cover that is greater than 60%. Trees are greater than 5m in height.

I.C.1.N.a. Lowland tropical/subtropical semi-deciduous forest (Caribbean Formation)

1. Gallery Semi-deciduous Forest (Virgin Islands Sub-formation) – "This vegetation type is limited to the smaller riparian corridors such as ravines, guts and intermittent streams found within dry forest watersheds. Additional moisture is available to the vegetation as a result of runoff. The taller dry forest species find their maximum height in these locations. Shrub and herb community development are variable" (Gibney *et al.* 2000).

2. Semi-deciduous Forest (Virgin Islands Sub-formation) – "Throughout the Virgin Islands, this is the dominant forest cover. On St. John, well over 50% of the island is vegetated with this cover type. A large percentage of the remaining undeveloped land on St. Thomas and a majority of the small quantity of remaining forest on northwestern hill slopes on St. Croix are classified as this forest type. This forest group contains a number of fairly distinct forest types, which vary in physiognomy, composition and in degree of human modification. In most cases these forests may be found on north facing hillsides of all main islands, upper southern facing elevations below 250m, in basins without large watersheds, along smaller guts and ravines and mixed with dry deciduous forests on lower south facing slopes" (Gibney *et al.* 2000).

***Bursera simaruba-Pisonia subcordata* Forest Association**

Name, translated: Gumbo Limbo-Water Mampoo Forest Association

Vegetation (Buck Island Reef National Monument):

Dry forest dominated by the emergent tree species *Bursera simaruba* (Gumbo Limbo) and *Pisonia subcordata* (Water Mampoo). Other characteristic overstory species include *Rochefortia acanthophora*, *Pilosocereus royenii*, *Bourreria succulenta*, and *Plumeria alba*. Characteristic understory species include *Acacia tortuosa*, *Comocladia dodonaea*, and *Lantana involucrata*. Canopy height generally 5-8m with canopy cover of 60-80%.

Environment (Buck Island Reef National Monument):

Found on Buck Island near the crest of hills.

Plots: 026_3_2009-01-13, 036-poly12_NA_2008-10-23

***Pisonia subcordata-Hippomane mancinella* Forest Alliance**

Name, translated: Water Mampoo-Manchineel Forest Alliance

Vegetation (Buck Island Reef National Monument):

Coastal forest community dominated by *Pisonia subcordata* (Water Mampoo) and *Hippomane mancinella* (Manchineel). Other characteristic species include *Comocladia dodonaea*.

Environment (Buck Island Reef National Monument):

This community is found near the coast in low elevation areas consisting of a

sandy substrate, in close proximity to the *Laguncularia racemosa-Avicennia germinans* Fringing Mangrove Association of south-central Buck Island.

Plots: 098-offset_NA_2008-10-23

***Rochefortia acanthophora-Pisonia subcordata* Forest Association**

Name, translated: Rochefortia-Water Mampoo Forest Association

Vegetation (Buck Island Reef National Monument):

Dry forest dominated by *Rochefortia acanthophora* (Rochefortia) and *Pisonia subcordata* (Water Mampoo). Other characteristic overstory species include *Pilosocereus royenii*, *Bursera simaruba*, and *Capparis indica*. Characteristic understory species include *Cordia angustifolia* and *Plumbago scandens*. There can be two canopy strata in this community with the overstory at 8m tall with an understory at 2m in height. Canopy cover is generally 70%.

Environment (Buck Island Reef National Monument):

This community encompasses a large forested area on northeast hillsides of Buck Island.

Plots: 028_3_2009-01-13

3. Semi-evergreen Forest (Virgin Islands Sub-formation) – "This forest cover type is very similar in distribution to the semi deciduous type and in many locations grades into it. It is generally found above 250m in elevation, on northwest facing slopes below moist forest levels. Species composition changes to include a shift toward a greater majority of evergreen species. This type is found on all three main islands, but to a greater degree on St. Thomas west end" (Gibney *et al.* 2000).

***Hippomane mancinella* Forest Alliance**

Name, translated: Manchineel Forest Alliance

Vegetation (Buck Island Reef National Monument):

Coastal forest dominated by *Hippomane mancinella* (Manchineel). Other characteristic species include *Coccoloba uvifera*, *Acacia tortuosa*, *Capparis indica*, and *Comocladia dodonaea*. This community can occur in near monotypic stands and has a closed canopy. Canopy height usually 5-8m.

Environment (Buck Island Reef National Monument):

Found at the west and south central coasts of Buck Island.

Plots: 029_3_2009-01-14, 060_1_2008-10-22, 081_1_2008-10-23, 061-offset_NA_2008-10-22, 080-offset_NA_2008-10-23, 097-offset_NA_2008-10-23

II. WOODLAND

Woodland types have low density stands of trees characterized by an open tree canopy and canopy cover is ~10-60%. Tree heights are greater than 5m.

II.C.1.N.a. Tropical or subtropical semi-deciduous woodland (Caribbean Formation)

1. Semi-deciduous Woodland (Virgin Islands Sub-formation) – "Found primarily on abandoned agricultural land on St. Croix and also in central and eastern St. Thomas. The species composition is comprised mainly of common native and naturalized exotics. The size range varies considerably with past land use history and may range from 5-25m. Canopy cover is open, from 25-60% commonly. These areas are typically influenced by hurricane winds which reduce canopy cover temporarily" (Gibney *et al.* 2000).

***Acacia tortuosa-Pisonia subcordata* Woodland Alliance**

Name, translated: Acacia-Water Mampoo Woodland Alliance

Vegetation (Buck Island Reef National Monument):

Low diversity woodland dominated by large individuals of *Acacia tortuosa* (Acacia) with co-dominant tree species *Pisonia subcordata* (Water Mampoo). May have sub-dominant tree species such as *Hippomane mancinella* and *Sideroxylon obovatum*. Canopy height usually 5m with as much as 50-55% canopy cover.

Environment (Buck Island Reef National Monument):

Found primarily on sandy substrates, in low elevation areas at the bottom of south facing hills of Buck Island.

Plots: 057_1_2008-10-22

Pisonia subcordata* Woodland Associ*ation

Name, translated: Water Mampoo Woodland Association

Vegetation (Buck Island Reef National Monument):

Woodland where the canopy is dominated by *Pisonia subcordata* (Water Mampoo). Other characteristic overstory species include *Bursera simaruba* and *Hippomane mancinella*. Understory species include *Malpighia infestissima*, *Comocladia dodonaea*, *Lantana involucrata*, and *Tillandsia utriculata*.

Environment (Buck Island Reef National Monument):

Found on south facing slopes and low elevation sandy coastal areas of central Buck Island.

Plots: None

***Pisonia subcordata-Bursera simaruba* Woodland Association**

Name, translated: Water Mampoo-Gumbo Limbo Woodland Association

Vegetation (Buck Island Reef National Monument):

Woodland where the canopy is dominated by *Pisonia subcordata* (Water Mampoo) and *Bursera simaruba* (Gumbo Limbo). Other overstory species include *Pilosocereus royenii*, and *Rochefortia acanthophora*, with an understory consisting of *Lantana involucrata, Tillandsia utriculata, Comocladia dodonaea,* and *Acacia tortuosa*. Overstory canopy height ranges from 5-8m with understory canopy height of 1-3m.

Environment (Buck Island Reef National Monument):

This community encompasses a large area on upper southwest hillsides of Buck Island.

Plots: 039_3_2009-01-14, 082-offset_NA_2008-10-23, 083-offset_NA_2008-10-23, 086-offset-1_NA_2008-10-23, 086-offset-2_NA_2008-10-23, 096-offset-1_NA_2008-10-23

2. Semi-evergreen Woodland (Virgin Islands Sub-formation) – Coastal woodland usually with two canopy strata in which the overstory may consist of *Hippomane mancinella* (Manchineel) and *Sideroxylon obovatum* (Mastic) and the understory consisting predominately of *Erithalis fruticosa*, *Acacia tortuosa*, and *Capparis indica*. Overstory strata generally 7m in height with an understory height of 3m.

***Hippomane mancinella-Sideroxylon obovatum* Woodland Association**

Name, translated: Manchineel-Mastic Woodland Association

Vegetation (Buck Island Reef National Monument):

Coastal woodland usually with two canopy strata with the overstory dominated by *Hippomane mancinella* (Manchineel) and *Sideroxylon obovatum* (Mastic) and the understory dominated by *Erithalis fruticosa*, *Acacia tortuosa*, and *Capparis indica*. Overstory strata generally 7m in height with an understory height of 3m.

Environment (Buck Island Reef National Monument):

This community is found in low elevations on coastal sandy substrates of Buck Island.

Plots: 032_3_2009-01-14

III. SHRUBLAND

Shrubland types are usually characterized by a high density of small trees or shrubs with heights ranging from 0.5-5m.

III.A.1.N.b. Tropical/subtropical broad-leaved evergreen shrubland (Caribbean Formation)

1. Coastal Evergreen Shrubland (Virgin Islands Sub-formation) – Shrubland dominated by evergreen tree and shrub species located near the coast. This community may exhibit more than one stratum with the overstory consisting of salt adapted species such as *Coccoloba uvifera*, *Conocarpus erectus*, *Sideroxylon obovatum*, and *Pithecellobium unguis-cati*. Understory species include *Acacia tortuosa* and *Oplonia spinosa*. This community is found near the coast on sandy substrates of south-central Buck Island.

***Conocarpus erectus* Shrubland Association**

Name, translated: Buttonwood Shrubland Association

Vegetation (Buck Island Reef National Monument):

Shrubland dominated by *Conocarpus erectus* (Buttonwood). Other characteristic species include emergent trees *Coccoloba uvifera* and *Sideroxylon obovatum*, with understory consisting of *Oplonia spinosa*. Canopy height is 3-4m with canopy cover 45-100%.

Environment (Buck Island Reef National Monument):

This community is found in coastal areas south-central Buck Island.

Plots: 033_3_2009-01-14

III.A.1.N.e. Seasonally flooded/saturated tropical/subtropical broad-leaved evergreen shrubland (Caribbean Formation)

1. Mangrove Shrubland (Virgin Islands Sub-formation) – "Non-tidal shrublands or scrub mangrove thickets. Occurs in more stressed sites than mangrove forests and has shorter individuals (less than 5m and usually only 1.5-2m tall) and often sparser as well" (Gibney *et al.* 2000).

***Laguncularia racemosa* Shrubland Association**

Name, translated: White Mangrove Shrubland Association

Vegetation (Buck Island Reef National Monument):

Shrubland community dominated by *Laguncularia racemosa* (White Mangrove). Other characteristic overstory species include *Coccoloba uvifera*. May have an understory of *Chloris barbata*.

Environment (Buck Island Reef National Monument):

On Buck Island, this community appears as a recovering habitat where the tree species are less than two meters in height and immediately grades into the adjacent *Hippomane mancinella* Forest Alliance.

Plots: 030_3_2009-01-14

III.A.1.N.g. Semi-permanently flooded tropical or subtropical broad-leaved evergreen shrubland (Caribbean Formation)

1. Fringing Mangrove (Virgin Islands Sub-formation) – "Shoreline and salt pond vegetation which is semi-permanently and tidally flooded. These areas are quite common to all islands" (Gibney *et al.* 2000).

***Laguncularia racemosa-Avicennia germinans* Fringing Mangrove Association**
Name, translated: Fringing White Mangrove-Black Mangrove Association
Vegetation (Buck Island Reef National Monument):

> Fringing mangrove community dominated by *Laguncularia racemosa* (White Mangrove) and *Avicennia germinans* (Black Mangrove).

Environment (Buck Island Reef National Monument):

> Found fringing the salt pond at Buck Island, this community is a species poor community, usually with only these two mangrove species present.

Plots: 031_3_2009-01-14, 097_1_2008-10-23, 098_1_2008-10-23

III.B.1.N.a. Lowland drought deciduous shrubland (Caribbean Formation)

1. Mixed Dry Shrubland (Virgin Islands Sub-formation) – "This vegetation cover is common to the drier parts of all three islands; east and south shores and low elevation locations. It may in some places extend as far up as 275m on south facing slopes. An extremely diverse community, Cacti and Agave are common though scattered, while vegetation height can range from 1-10m. The taller forms may consist of a canopy layer of larger individuals under slightly more moist conditions. The shorter forms are common to very exposed locations such as the east sides of headlands on the south shores" (Gibney *et al.* 2000). Mixed Dry Shrubland Low Canopy Cover categorized by having generally taller species of 2-5 meters and a canopy cover usually less than 60%. May include stands of small trees or shrub size specimens of *Bursera simaruba.* Mixed Dry Shrubland High Canopy Cover categorized by having generally shorter species of 1-3 meters and a canopy cover usually greater than 60%. This community is usually dominated by *Lantana involucrata, Tillandsia utriculata,* and cacti.

***Bursera simaruba* Shrubland Association**
Name, translated: Gumbo Limbo Shrubland Association
Vegetation (Buck Island Reef National Monument):

> A diverse shrubland community usually co-dominated by *Bursera simaruba* (Gumbo Limbo), *Pilosocereus royenii* (Organ Pipe), and *Pisonia subcordata*. Other common overstory species may include *Acacia tortuosa* (Acacia), *Rochefortia acanthophora,* and *Plumeria alba*. Common understory species include *Lantana involucrata, Capparis indica, Comocladia dodonaea, Tillandsia utriculata, Tournefortia microphylla*, and *Flueggea acidoton*. Overstory canopy height generally 3-5m with an understory canopy height of 2m.

Environment (Buck Island Reef National Monument):

This community has a wide distribution on Buck Island, and can be found on south facing hills. This community grades into the *Bursera simaruba-Pisonia subcordata* Woodland Association uphill and to the west.

Plots: 027_1_2008-10-21, 028_1_2008-10-21, 030_1_2008-10-21, 025_3_2009-01-13, 062_1_2008-10-22, 065_1_2008-10-22, 066-offset-1_NA_2008-10-22, 066-offset-2_NA_2008-10-22, 074-offset-3_NA_2008-10-23, 071-offset_NA_2008-10-23, 072-offset_NA_2008-10-23, 073-offset_NA_2008-10-23, 096-offset-2_NA_2008-10-23

***Erithalis fruticosa-Ernodea littoralis* Shrubland Association**

Name, translated: Black Torch-Beach Creeper Shrubland Association

Vegetation (Buck Island Reef National Monument):

Coastal shrubland dominated by *Erithalis fruticosa* (Black Torch) and *Ernodea littoralis* (Beach Creeper). Other species typically found in this community include *Coccoloba uvifera, Scaevola plumieri*, *Hippomane mancinella*, and *Malpighia infestissima*. The canopy height is 2-3m with a canopy cover of 60-80%.

Environment (Buck Island Reef National Monument):

This community occurs behind the beach dune system of south central Buck Island.

Plots: 055_1_2008-10-22, 056_1_2008-10-22

***Lantana involucrata* Shrubland Association**

Name, translated: Buttonsage Shrubland Association

Vegetation (Buck Island Reef National Monument):

A diverse shrubland dominated by low growing (1-3m tall) *Lantana involucrata* (Buttonsage). Other characteristic overstory species include *Bursera simaruba* (Gumbo Limbo), *Pilosocereus royenii, Rochefortia acanthophora*, *Bourreria succulenta, Pisonia subcordata, Sideroxylon obovatum* and *Acacia tortuosa*. Understory species are generally 1-3m in height and consist of *Melocactus intortus, Tillandsia utriculata, Psychilis macconnelliae*, *Corchorus hirsutus, Opuntia repens, Croton rigidus* and *Tournefortia microphylla*.

Environment (Buck Island Reef National Monument):

This community has a wide distribution on Buck Island, and can be found on north and south facing hills. This community grades into the *Bursera simaruba-Pisonia subcordata* Forest Association uphill and to the south.

Plots: 029_1_2008-10-21, 019_2_2009-01-14, 034_3_2009-01-14, 036-poly01_NA_2008-10-23, 036-poly03_NA_2008-10-23, 101-poly14_NA_2009-01-14

2. Thicket/scrub (Virgin Islands Sub-formation) – "This deciduous formation is quite common on all three islands and cays. It is characterized by thorny scrub communities which generally form a very dense, closed cover community. The height of the vegetation averages approximately 3-4 meters with occasional emergent trees. These communities may have uniform height as mono-specific stands or structural variety as a mixture of two species. This community type may also exist in many locations as a transitional seral

stage to taller woodland or dry forest types. Land use history has great influence in the distribution of this cover" (Gibney *et al.* 2000).

3. Coastal Hedge (Virgin Islands Sub-formation) – "Shaped by wind shear and salt spray, these dense patch communities can be very low growing (less than 1m) or as tall as 3m. They are generally found on east, southeast or northeast coastal areas with exposure to prevailing winds. The limited species are generally wind and salt adapted. The formation may occur on the berms of beaches, seaward of salt ponds and flats or above rocky coasts or pavement. Hedge effect from wind is the prevailing structural architect for the environment as almost all of the species found here are capable of greater height in less hostile environments. The severe environment causes plants to produce small, succulent leaves which can be highly cutinized" (Gibney *et al.* 2000). The Coastal hedge community may be dominated by *Lantana involucrata* (Buttonsage). Other species typically found in this community include *Pilosocereus royenii*, *Rochefortia acanthophora*, *Acacia tortuosa*, *Tillandsia utriculata*, and *Melocactus intortus*. The canopy height for this community is usually no more than a meter in height due to exposure to prevailing winds and salt spray.

VII. SPARSE VEGETATION

VII.A.1.N.a. Cliffs with sparse vascular vegetation (Caribbean Formation)

1. Rock Pavement (Virgin Islands Sub-formation) – "Coastal cliffs, rocky outcrops, boulder fields and landslide areas with less than 10% vegetative cover" (Gibney *et al.* 2000).

Coastal Southgate Rock Cliff Alliance
Name, translated: Coastal Southgate Rock Cliff Alliance
Vegetation (Buck Island Reef National Monument):

Coastal areas dominated by Southgate rock formations with cliffs ranging from one to several meters in height. These coastal cliffs are exposed to extremes of wind, salt spray and low moisture and are usually sparsely vegetated. Vegetative component usually includes *Melocactus intortus*, *Lantana involucrata*, *Pilosocereus royenii*, *Tillandsia utriculata*, *Comocladia dodonaea*, and *Chloris barbata*. Vegetation canopy generally from 1-3m in height.

Environment (Buck Island Reef National Monument):

Found along northern, eastern and southern shorelines of Buck Island.

Plots: None

VII.C.1.N.a. Dunes with sparse herbaceous vegetation (Caribbean Formation)

2. Beach Dune (Virgin Islands Sub-formation) – Sandy area usually behind the beach with a higher vegetative cover (10-100%) than the beach category. The vegetative component is adapted to harsh conditions and includes *Scaevola plumieri*, *Ipomoea pes-caprae*, *Suriana maritima*, *Sporobolus virginicus*, *Sesuvium portulacastrum*, *Dalbergia ecastaphyllum*, and *Spartina patens*. Found behind the beaches at the western end and south-central Buck Island. This is a species poor community due to exposure of winds, salt spray, and low moisture. This habitat may be sporadically inundated with salt water from high tides and storm surges. These species are generally no more than 1m in height and canopy cover fluctuates based on recent environmental conditions.

VII.C.2.N.b. Intermittently flooded sand beaches and shores (Caribbean Formation)

1. Beach (Virgin Islands Sub-formation) – "Shoreline beaches of sand, cobble or gravel that exhibit less than 10% vegetative cover" (Gibney *et al.* 2000).

VII.C.4.N.b. Intermittently flooded mud flat (Caribbean Formation)

1. Salt Pond (Virgin Islands Sub-formation) – "Permanently flooded coastal ponds" (Gibney *et al.* 2000). On Buck Island there is one salt pond with a fringing mangrove community consisting of *Laguncularia racemosa* (White Mangrove) and *Avicennia germinans* (Black Mangrove). This salt pond is located at near the coast in south-central Buck Island.

XX. HIERARCHY PLACEMENT UNDETERMINED

Non-vegetative or anthropogenic cover.

XX. Hierarchy Placement Undetermined

1. Developed Area (Virgin Islands Sub-formation) – "Areas permanently altered for the purpose of residential, commercial and industrial uses" (Gibney *et al.* 2000).

Appendix B: Photo-interpretation Key (includes Map Class Descriptions and Photos)

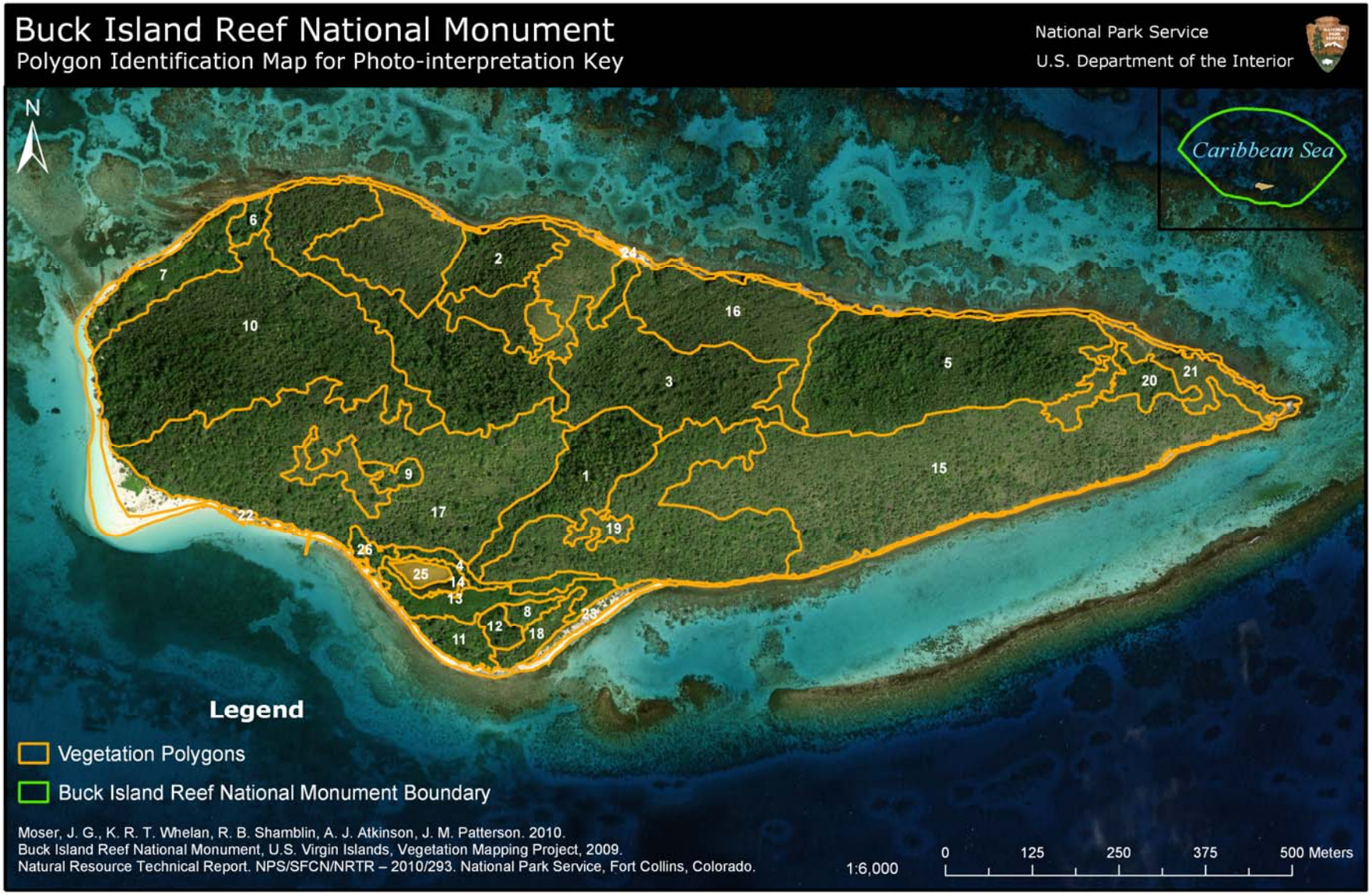
Contents

Polygon Identification Map for Photo-interpretation Key……...B-2

Gallery Semi-deciduous Forest Virgin Islands Sub-formation..... B-3
Semi-deciduous Forest Virgin Islands Sub-formation..... B-4
Bursera simaruba-Pisonia subcordata Forest Association..... B-5
Pisonia subcordata-Hippomane mancinella Forest Alliance..... B-6
Rochefortia acanthophora-Pisonia subcordata Forest Association..... B-7
Semi-evergreen Forest Virgin Islands Sub-formation..... B-8
Hippomane mancinella Forest Alliance..... B-9
Semi-deciduous Woodland Virgin Islands Sub-formation..... B-10
Acacia tortuosa-Pisonia subcordata Woodland Alliance..... B-10
Pisonia subcordata Woodland Association..... B-11
Pisonia subcordata-Bursera simaruba Woodland Association..... B-12
Hippomane mancinella-Sideroxylon obovatum Woodland Association..... B-13
Coastal Evergreen Shrubland Virgin Islands Sub-formation..... B-14
Conocarpus erectus Shrubland Association..... B-14
Mangrove Shrubland Virgin Islands Sub-formation..... B-15
Laguncularia racemosa Shrubland Association..... B-15
Fringing Mangrove Virgin Islands Sub-formation..... B-16
Laguncularia racemosa-Avicennia germinans Fringing Mangrove Association..... B-16
Mixed Dry Shrubland Virgin Islands Sub-formation..... B-17
Mixed Dry Shrubland (Low Canopy Cover) Virgin Islands Sub-formation..... B-17
Mixed Dry Shrubland (High Canopy Cover) Virgin Islands Sub-formation..... B-18
Bursera simaruba Shrubland Association..... B-19
Erithalis fruticosa-Ernodea littoralis Shrubland Association..... B-20
Lantana involucrata Shrubland Association..... B-21
Thicket/scrub Virgin Islands Sub-formation..... B-22
Coastal Hedge Virgin Islands Sub-formation..... B-23
Rock Pavement Virgin Islands Sub-formation..... B-24
Coastal Southgate Rock Cliff Alliance..... B-24
Beach Dune Virgin Islands Sub-formation..... B-25
Beach Virgin Islands Sub-formation..... B-26
Salt Pond Virgin Islands Sub-formation..... B-27
Developed Area Virgin Islands Sub-formation..... B-28

Disclaimer

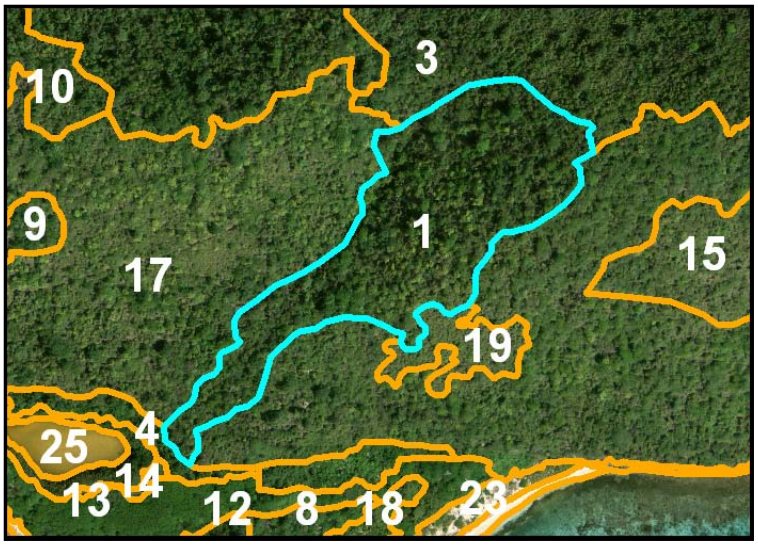
Vegetation species listed were observed while surveying vegetation plots on Buck Island. The listed species represent only a subset of the common species found on Buck Island, and do not represent a complete inventory for a polygon or community.


Buck Island Reef National Monument
Polygon Identification Map for Photo-interpretation Key
National Park Service
U.S. Department of the Interior
N
Caribbean Sea
6
7
2
24
10
16
5
3
20
21
9
1
15
17
22
19
26
25
4
14
13
8
12
18
11
Legend
Vegetation Polygons
Buck Island Reef National Monument Boundary
Moser, J. G., K. R. T. Whelan, R. B. Shamblin, A. J. Atkinson, J. M. Patterson. 2010.
Buck Island Reef National Monument, U.S. Virgin Islands, Vegetation Mapping Project, 2009.
Natural Resource Technical Report. NPS/SFCN/NRTR – 2010/293. National Park Service, Fort Collins, Colorado.
1:6,000
0
125
250
375
500 Meters

Gallery Semi-deciduous Forest Virgin Islands Sub-formation

Gallery Semi-deciduous Forest Virgin Islands Sub-formation

Photo Signature Example



Common species:

Bursera simaruba
Pisonia subcordata
Flueggia acidoton
Rochefortia acanthophora
Plumeria alba
Pilosocereus royenii
Acacia tortuosa
Piscidia carthagenensis
Tillandsia utriculata

Project Specifics:

Frequency = 3 polygons
Total Area = 17.6 acres
Average Area = 5.9 acres
Minimum Area = 0.7 acres
Maximum Area = 11.7 acres

Description:

"This vegetation type is limited to the smaller riparian corridors such as ravines, guts and intermittent streams found within dry forest watersheds. Additional moisture is available to the vegetation as a result of runoff. The taller dry forest species find their maximum height in these locations. Shrub and herb community development are variable" (Gibney *et al.* 2000).

Ground Photos

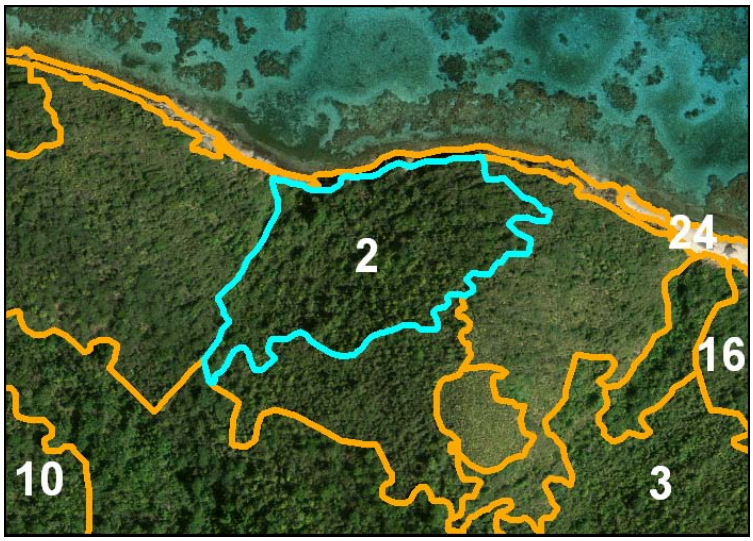




Semi-deciduous Forest Virgin Islands Sub-formation

Semi-deciduous Forest Virgin Islands Sub-formation

Photo Signature Example



Common species:
Bursera simaruba
Pisonia subcordata
Rochefortia acanthophora
Pilosocereus royenii
Bourreria succulenta

Project Specifics:
Frequency = 2 polygons
Total Area = 3.7 acres
Average Area = 1.8 acres
Minimum Area = 0.5 acres
Maximum Area = 3.1 acres

Description:
"Throughout the Virgin Islands, this is the dominant forest cover. On St. John, well over 50% of the island is vegetated with this cover type. A large percentage of the remaining undeveloped land on St. Thomas and a majority of the small quantity of remaining forest on northwestern hill slopes on St. Croix are classified as this forest type. This forest group contains a number of fairly distinct forest types, which vary in physiognomy, composition and in degree of human modification. In most cases these forests may be found on north facing hillsides of all main islands, upper southern facing elevations below 250m, in basins without large watersheds, along smaller guts and ravines and mixed with dry deciduous forests on lower south facing slopes" (Gibney *et al.* 2000).

Ground Photos

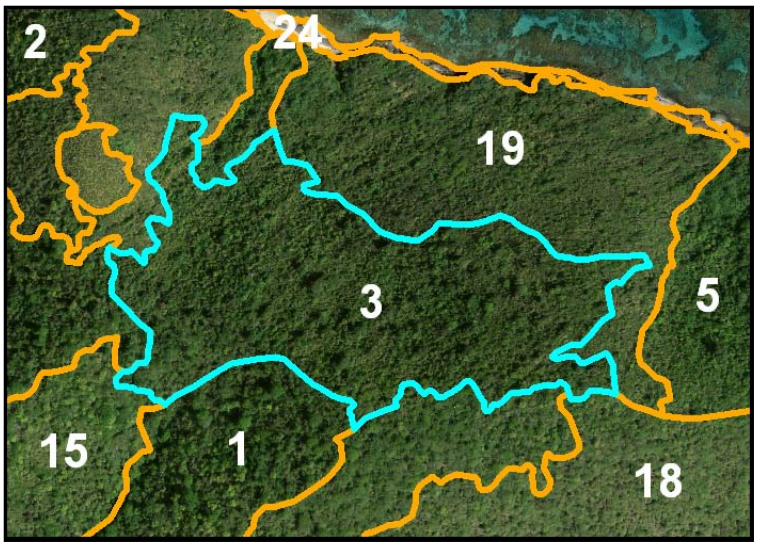


Semi-deciduous Forest Virgin Islands Sub-formation

Bursera simaruba-Pisonia subcordata Forest Association
Gumbo Limbo-Water Mampoo Forest Association

Photo Signature Example

Common species:
Bursera simaruba
Pisonia subcordata
Rochefortia acanthophora
Pilosocereus royenii
Bourreria succulenta
Plumeria alba
Acacia tortuosa
Comocladia dodonaea
Lantana involucrata



Project Specifics:
Frequency = 1 polygon
Total Area = 9.6 acres
Average Area = 9.6 acres
Minimum Area = 9.6 acres
Maximum Area = 9.6 acres

Description:
Dry forest dominated by the emergent tree species *Bursera simaruba* (Gumbo Limbo) and *Pisonia subcordata* (Water Mampoo). Other characteristic overstory species include *Rochefortia acanthophora, Pilosocereus royenii, Bourreria succulenta*, and *Plumeria alba*. Characteristic understory species include *Acacia tortuosa, Comocladia dodonaea*, and *Lantana involucrata*. Canopy height generally 5-8m with canopy cover of 60-80%. Found on Buck Island near the crest of hills.

Ground Photos

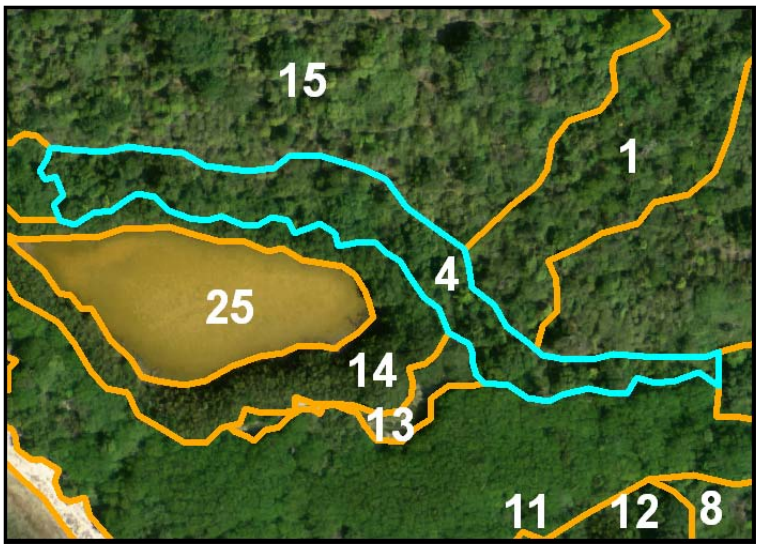


Semi-deciduous Forest Virgin Islands Sub-formation

Pisonia subcordata-Hippomane mancinella Forest Alliance
Water Mampoo-Manchineel Forest Alliance

Photo Signature Example

Common species:
Pisonia subcordata
Hippomane mancinella
Comocladia dodonaea



Project Specifics:
Frequency = 1 polygon
Total Area = 0.6 acres
Average Area = 0.6 acres
Minimum Area = 0.6 acres
Maximum Area = 0.6 acres

Description:
Coastal forest community dominated by *Pisonia subcordata* (Water Mampoo) and *Hippomane mancinella* (Manchineel). Other characteristic species include *Comocladia dodonaea*. This community is found near the coast in low elevation areas consisting of a sandy substrate, in close proximity to the *Laguncularia racemosa-Avicennia germinans* Fringing Mangrove Association of south-central Buck Island.

Ground Photos

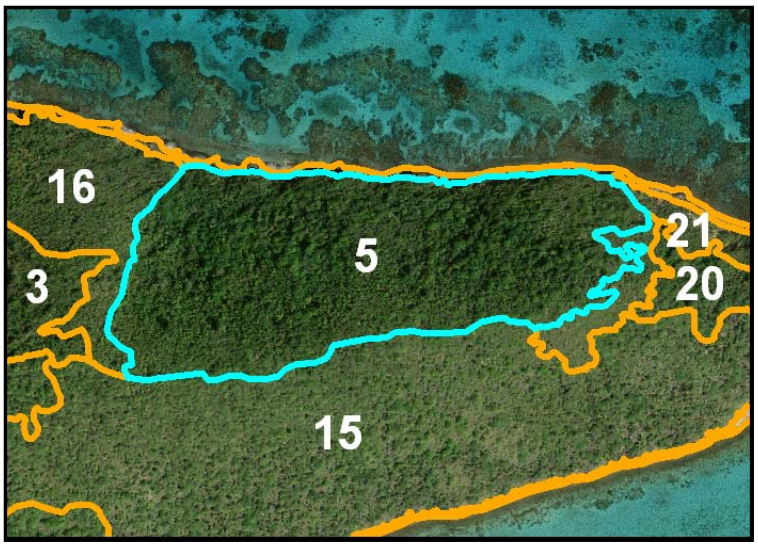




Semi-deciduous Forest Virgin Islands Sub-formation

Rochefortia acanthophora-Pisonia subcordata Forest Association
Rochefortia-Water Mampoo Forest Association

Photo Signature Example



Common species:
Rochefortia acanthophora
Pisonia subcordata
Pilosocereus royenii
Bursera simaruba
Capparis indica
Cordia angustifolia
Plumbago scandens
Flueggea acidoton

Project Specifics:
Frequency = 1 polygon
Total Area = 15.0 acres
Average Area = 15.0 acres
Minimum Area = 15.0 acres
Maximum Area = 15.0 acres

Description:
This community encompasses a large forested area on northeast hillsides of Buck Island. Dry forest dominated by *Rochefortia acanthophora* (Rochefortia) and *Pisonia subcordata* (Water Mampoo). Other characteristic overstory species include *Pilosocereus royenii*, *Bursera simaruba*, and *Capparis indica*. Characteristic understory species include *Cordia angustifolia*, and *Plumbago scandens*. There can be two canopy strata in this community with the overstory at 8m tall with an understory at 2m in height. Canopy cover is generally 70%.

Ground Photos

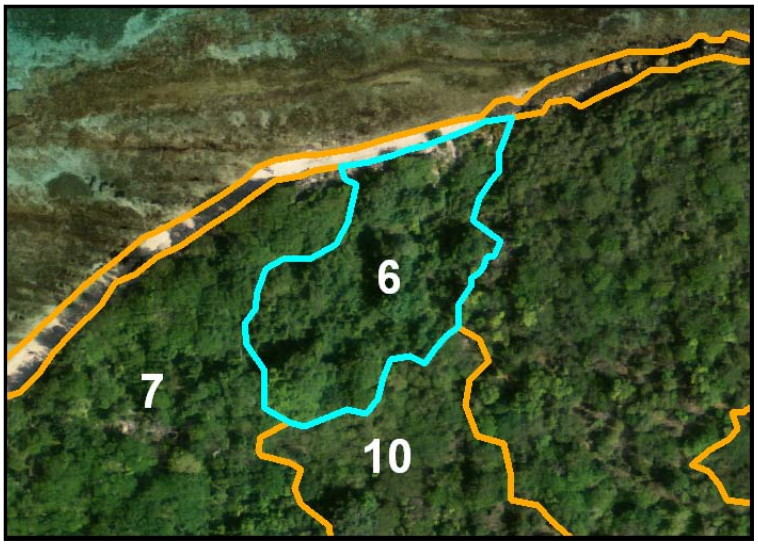




Semi-evergreen Forest Virgin Islands Sub-formation

Semi-evergreen Forest Virgin Islands Sub-formation

Photo Signature Example



Common species:

Coccoloba uvifera
Hippomane mancinella
Pisonia subcordata
Piscidia carthagenensis
Acacia tortuosa
Conocarpus erectus
Duranta erecta
Cissus trifoliata

Project Specifics:

Frequency = 1 polygon
Total Area = 0.7 acres
Average Area = 0.7 acres
Minimum Area = 0.7 acres
Maximum Area = 0.7 acres

Description:

"This forest cover type is very similar in distribution to the semi deciduous type and in many locations grades into it. It is generally found above 250m in elevation, on northwest facing slopes below moist forest levels. Species composition changes to include a shift toward a greater majority of evergreen species. This type is found on all three main islands, but to a greater degree on St. Thomas west end" (Gibney *et al.* 2000).

Ground Photos

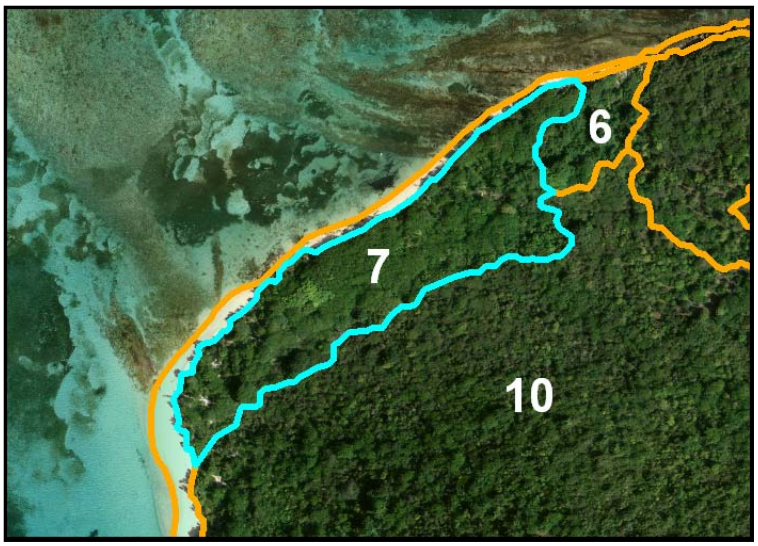




Semi-evergreen Forest Virgin Islands Sub-formation

Hippomane mancinella Forest Alliance
Manchineel Forest Alliance

Photo Signature Example



Common species:
Hippomane mancinella
Coccoloba uvifera
Acacia tortuosa
Capparis indica
Comocladia dodonaea

Project Specifics:
Frequency = 2 polygons
Total Area = 5.8 acres
Average Area = 2.9 acres
Minimum Area = 2.3 acres
Maximum Area = 3.5 acres

Description:
Found at the west and south central coasts of Buck Island. Coastal forest dominated by *Hippomane mancinella* (Manchineel). Other characteristic species include *Coccoloba uvifera*, *Acacia tortuosa*, *Capparis indica*, and *Comocladia dodonaea*. This community can occur in near monotypic stands and has a closed canopy. Canopy height usually 5-8m.

Ground Photos

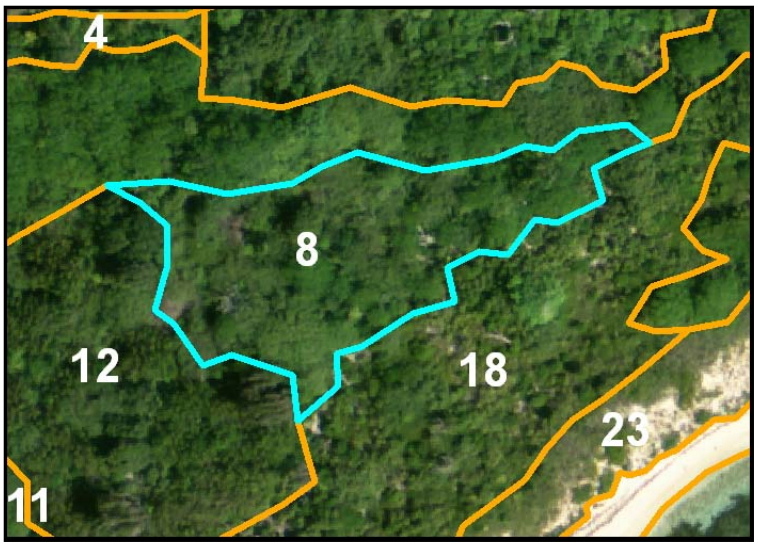




Semi-deciduous Woodland Virgin Islands Sub-formation

Acacia tortuosa-Pisonia subcordata Woodland Alliance
Acacia-Water Mampoo Woodland Alliance

Photo Signature Example



Common species:
Acacia tortuosa
Pisonia subcordata
Hippomane mancinella
Sideroxylon obovatum

Project Specifics:
Frequency = 1 polygon
Total Area = 0.5 acres
Average Area = 0.5 acres
Minimum Area = 0.5 acres
Maximum Area = 0.5 acres

Description:
Found primarily on sandy substrates, in low elevation areas at the bottom of south facing hills of Buck Island. Low diversity woodland dominated by large individuals of *Acacia tortuosa* (Acacia) with co-dominant tree species *Pisonia subcordata* (Water Mampoo). May have sub-dominant tree species such as *Hippomane mancinella* and *Sideroxylon obovatum*. Canopy height usually 5m with as much as 50-55% canopy cover.

Ground Photos

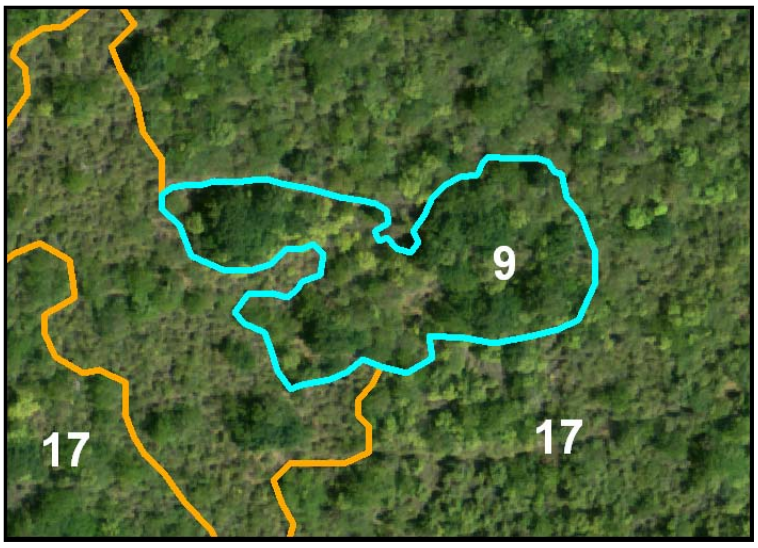




Semi-deciduous Woodland Virgin Islands Sub-formation

Pisonia subcordata Woodland Association
Water Mampoo Woodland Association

Photo Signature Example



Common species:
Pisonia subcordata
Bursera simaruba
Hippomane mancinella
Malpighia infestissima
Comocladia dodonaea
Lantana involucrata
Tillandsia utriculata

Project Specifics:
Frequency = 2 polygons
Total Area = 1.2 acres
Average Area = 0.6 acres
Minimum Area = 0.6 acres
Maximum Area = 0.6 acres

Description:
Found on south facing slopes and low elevation sandy coastal areas of central Buck Island. Woodland where the canopy is dominated by *Pisonia subcordata* (Water Mampoo). Other characteristic overstory species include *Bursera simaruba* and *Hippomane mancinella*. Understory species include *Malpighia infestissima*, *Comocladia dodonaea*, *Lantana involucrata*, and *Tillandsia utriculata*.

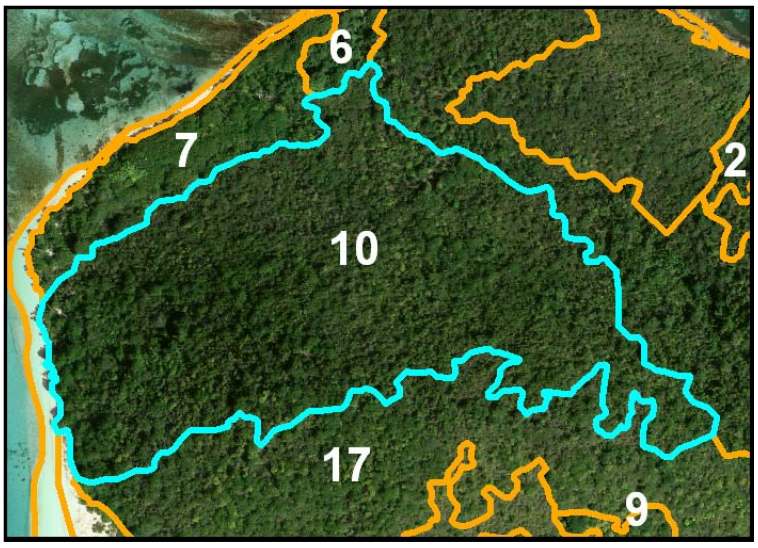
Ground Photos



Semi-deciduous Woodland Virgin Islands Sub-formation

Pisonia subcordata-Bursera simaruba Woodland Association
Water Mampoo-Gumbo Limbo Woodland Association

Photo Signature Example



Common species:
Pisonia subcordata
Bursera simaruba
Pilosocereus royenii
Rochefortia acanthophora
Lantana involucrata
Tillandsia utriculata
Comocladia dodonaea
Acacia tortuosa

Project Specifics:
Frequency = 1 polygon
Total Area = 19.5 acres
Average Area = 19.5 acres
Minimum Area = 19.5 acres
Maximum Area = 19.5 acres

Description:
This community encompasses a large area on upper southwest hillsides of Buck Island. Woodland where the canopy is dominated by *Pisonia subcordata* (Water Mampoo) and *Bursera simaruba* (Gumbo Limbo). Other overstory species include *Pilosocereus royenii*, and *Rochefortia acanthophora*, with an understory consisting of *Lantana involucrata*, *Tillandsia utriculata*, *Comocladia dodonaea*, and *Acacia tortuosa*. Overstory canopy height ranges from 5-8m with understory canopy height of 1-3m.

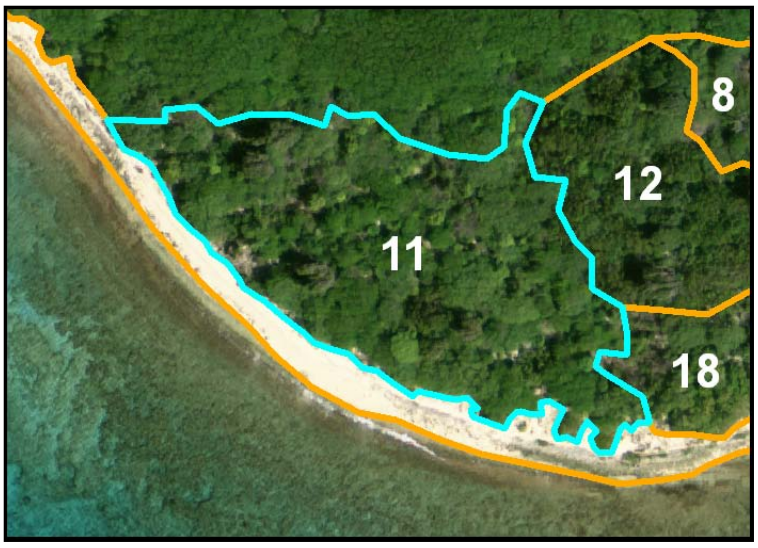
Ground Photos



Semi-evergreen Woodland Virgin Islands Sub-formation

Hippomane mancinella-Sideroxylon obovatum Woodland Association
Manchineel- *Sideroxylon obovatum* Woodland Association

Photo Signature Example



Common species:
Hippomane mancinella
Sideroxylon obovatum
Erithalis fruticosa
Acacia tortuosa
Capparis indica

Project Specifics:
Frequency = 1 polygon
Total Area = 1.4 acres
Average Area = 1.4 acres
Minimum Area = 1.4 acres
Maximum Area = 1.4 acres

Description:
This community is found in low elevations on coastal sandy substrates of Buck Island. Coastal woodland usually with two canopy strata with the overstory dominated by *Hippomane mancinella* (Manchineel) and *Sideroxylon obovatum* (Mastic) and the understory dominated by *Erithalis fruticosa*, *Acacia tortuosa*, and *Capparis indica*. Overstory strata generally 7m in height with an understory height of 3m.

Ground Photos

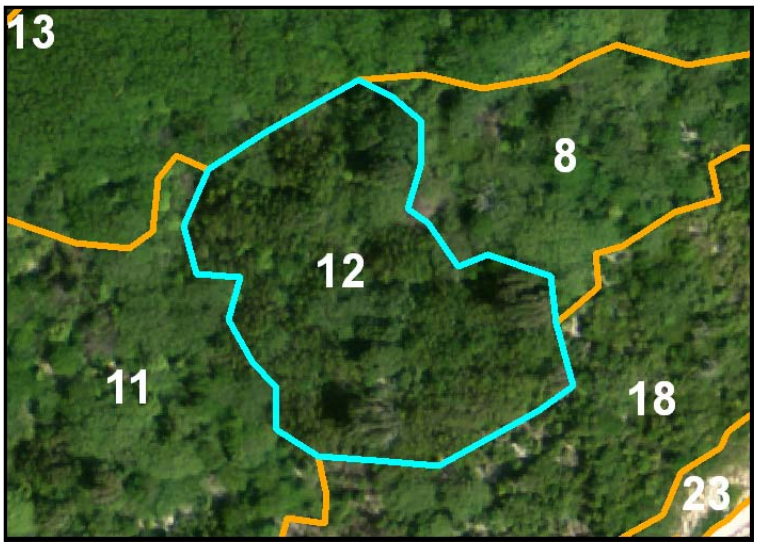




Coastal Evergreen Shrubland Virgin Islands Sub-formation

Conocarpus erectus Shrubland Association
Buttonwood Shrubland Association

Photo Signature Example



Common species:
Conocarpus erectus
Coccoloba uvifera
Sideroxylon obovatum
Oplonia spinosa

Project Specifics:
Frequency = 1 polygon
Total Area = 0.6 acres
Average Area = 0.6 acres
Minimum Area = 0.6 acres
Maximum Area = 0.6 acres

Description:
This community is found in coastal areas south-central Buck Island. Shrubland dominated by *Conocarpus erectus* (Buttonwood). Other characteristic species include emergent trees *Coccoloba uvifera* and *Sideroxylon obovatum*, with understory consisting of *Oplonia spinosa*. Canopy height is 3-4m with canopy cover 45-100%.

Ground Photos

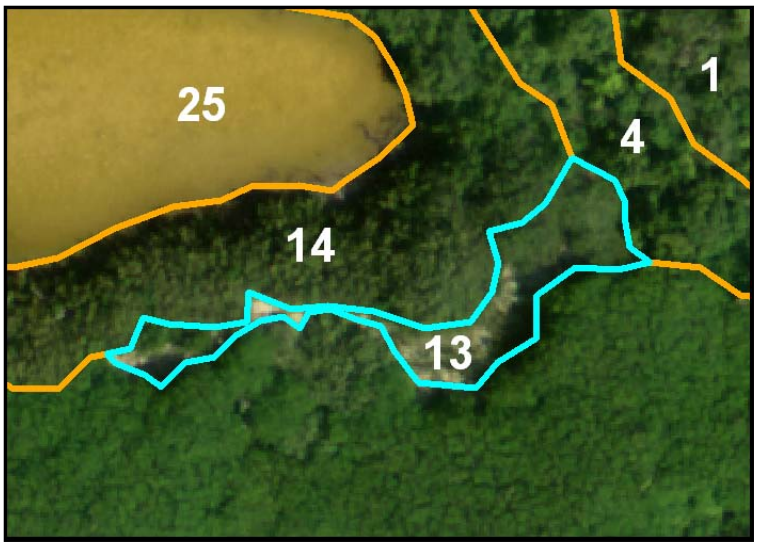




Mangrove Shrubland Virgin Islands Sub-formation

Laguncularia racemosa Shrubland Association
White Mangrove Shrubland Association

Photo Signature Example



Common species:
Laguncularia racemosa
Coccoloba uvifera
Chloris barbata

Project Specifics:
Frequency = 1 polygon
Total Area = 0.1 acres
Average Area = 0.1 acres
Minimum Area = 0.1 acres
Maximum Area = 0.1 acres

Description:
On Buck Island, this community appears as a recovering habitat where the tree species are less than two meters in height and immediately grades into the adjacent *Hippomane mancinella* Forest Alliance. Shrubland community dominated by *Laguncularia racemosa* (White Mangrove). Other characteristic overstory species include *Coccoloba uvifera*. May have an understory of *Chloris barbata*.

Ground Photos

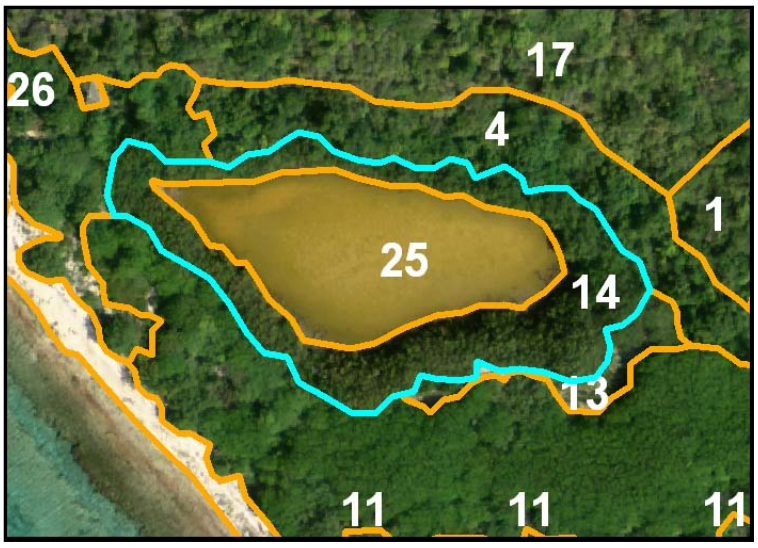




Fringing Mangrove Virgin Islands Sub-formation

Laguncularia racemosa-Avicennia germinans Fringing Mangrove Association
White Mangrove-Black Mangrove Association

Photo Signature Example



Common species:
Laguncularia racemosa
Avicennia germinans

Project Specifics:
Frequency = 1 polygon
Total Area = 0.6 acres
Average Area = 0.6 acres
Minimum Area = 0.6 acres
Maximum Area = 0.6 acres

Description:
Found fringing the salt pond at Buck Island, this community is a species poor community, usually with only these two mangrove species present. Fringing mangrove community dominated by *Laguncularia racemosa* (White Mangrove) and *Avicennia germinans* (Black Mangrove).

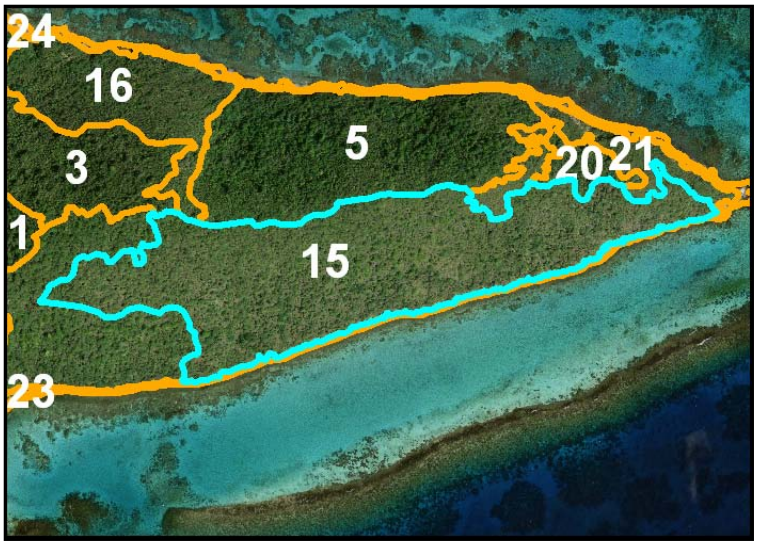
Ground Photos



Mixed Dry Shrubland Virgin Islands Sub-formation

Mixed Dry Shrubland (Low Canopy Cover) Virgin Islands Sub-formation

Photo Signature Example



Common species:
Bursera simaruba
Pilosocereus royenii
Plumeria alba
Rochefortia acanthophora
Acacia tortuosa
Comocladia dodonaea
Lantana involucrata
Opuntia repens
Tillandsia utriculata
Melocactus intortus

Project Specifics:
Frequency = 1 polygon
Total Area = 25.0 acres
Average Area = 25.0 acres
Minimum Area = 25.0 acres
Maximum Area = 25.0 acres

Description:
"This vegetation cover is common to the drier parts of all three islands; east and south shores and low elevation locations. It may in some places extend as far up as 275m on south facing slopes. An extremely diverse community, Cacti and Agave are common though scattered, while vegetation height can range from 1-10m. The taller forms may consist of a canopy layer of larger individuals under slightly more moist conditions. The shorter forms are common to very exposed locations such as the east sides of headlands on the south shores" (Gibney *et al.* 2000). Mixed Dry Shrubland Low Canopy Cover categorized by having generally taller species of 2-5 meters and a canopy cover usually less than 60%. May include stands of small trees or shrub size specimens of *Bursera simaruba.*

Ground Photos

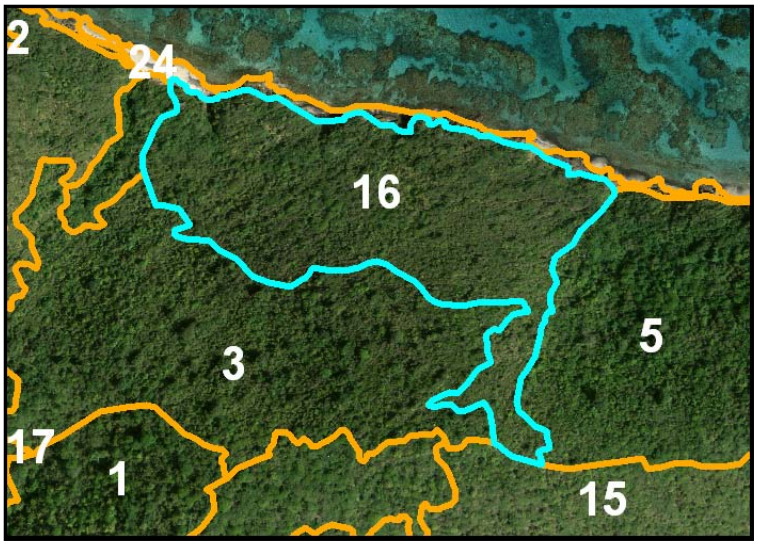




Mixed Dry Shrubland Virgin Islands Sub-formation

Mixed Dry Shrubland (High Canopy Cover) Virgin Islands Sub-formation

Photo Signature Example



Common species:
Bursera simaruba
Pilosocereus royenii
Plumeria alba
Rochefortia acanthophora
Acacia tortuosa
Comocladia dodonaea
Lantana involucrata
Opuntia repens
Tillandsia utriculata
Melocactus intortus

Project Specifics:
Frequency = 3 polygons
Total Area = 15.9 acres
Average Area = 5.3 acres
Minimum Area = 3.0 acres
Maximum Area = 7.7 acres

Description:
"This vegetation cover is common to the drier parts of all three islands; east and south shores and low elevation locations. It may in some places extend as far up as 275m on south facing slopes. An extremely diverse community, Cacti and Agave are common though scattered, while vegetation height can range from 1-10m. The taller forms may consist of a canopy layer of larger individuals under slightly more moist conditions. The shorter forms are common to very exposed locations such as the east sides of headlands on the south shores" (Gibney *et al.* 2000). Mixed Dry Shrubland High Canopy Cover categorized by having generally shorter species of 1-3 meters and a canopy cover usually greater than 60%. This community is usually dominated by *Lantana involucrata, Tillandsia utriculata,* and cacti.

Ground Photos

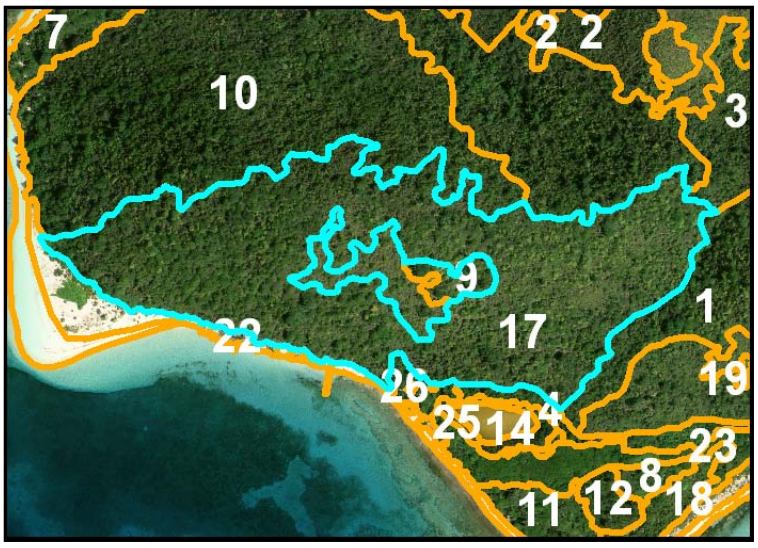




Mixed Dry Shrubland Virgin Islands Sub-formation

Bursera simaruba Shrubland Association
Gumbo Limbo Shrubland Association

Photo Signature Example



Common species:
Bursera simaruba
Pilosocereus royenii
Pisonia subcordata
Acacia tortuosa
Rochefortia acanthophora
Plumeria alba
Lantana involucrata
Capparis indica
Comocladia dodonaea
Tillandsia utriculata
Tournefortia microphylla
Flueggea acidoton

Project Specifics:
Frequency = 2 polygons
Total Area = 34.3 acres
Average Area = 17.1 acres
Minimum Area = 12.5 acres
Maximum Area = 21.8 acres

Description:
A diverse shrubland community usually co-dominated by *Bursera simaruba* (Gumbo Limbo), *Pilosocereus royenii* (Organ Pipe), and *Pisonia subcordata*. Other common overstory species may include *Acacia tortuosa* (Acacia), *Rochefortia acanthophora*, and *Plumeria alba*. Common understory species include *Lantana involucrata*, *Capparis indica*, *Comocladia dodonaea*, *Tillandsia utriculata*, *Tournefortia microphylla*, and *Flueggea acidoton*. Overstory canopy height generally 3-5m with an understory canopy height of 2m. This community has a wide distribution on Buck Island, and can be found on south facing hills. This community grades into the *Bursera simaruba-Pisonia subcordata* Woodland Association uphill and to the west.

Ground Photos

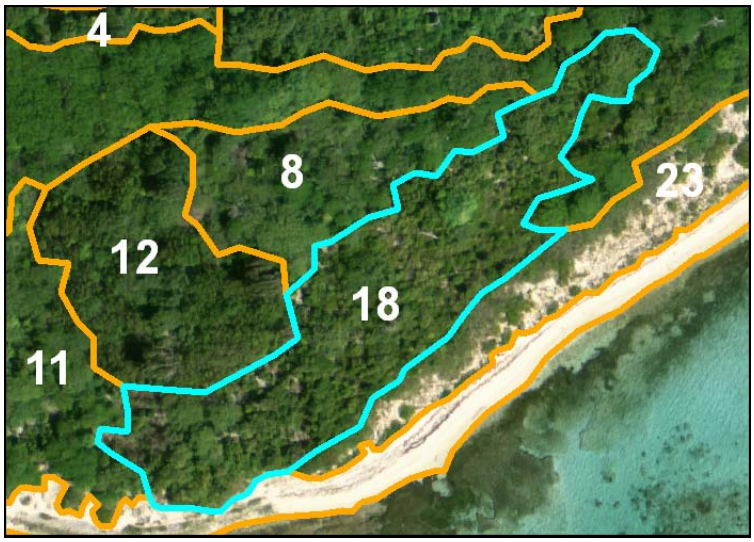




Mixed Dry Shrubland Virgin Islands Sub-formation

Erithalis fruticosa-Ernodea littoralis Shrubland Association
Black Torch-Beach Creeper Shrubland Association

Photo Signature Example



Common species:
Erithalis fruticosa
Ernodea littoralis
Coccoloba uvifera
Scaevola plumieri
Hippomane mancinella
Malpighia infestissima

Project Specifics:
Frequency = 1 polygon
Total Area = 1.1 acres
Average Area = 1.1 acres
Minimum Area = 1.1 acres
Maximum Area = 1.1 acres

Description:
This community occurs behind the beach dune system of south central Buck Island. Coastal shrubland dominated by *Erithalis fruticosa* (Black Torch) and *Ernodea littoralis* (Beach Creeper). Other species typically found in this community include *Coccoloba uvifera*, *Scaevola plumieri*, *Hippomane mancinella*, and *Malpighia infestissima*. The canopy height is 2-3m with a canopy cover of 60-80%.

Ground Photos

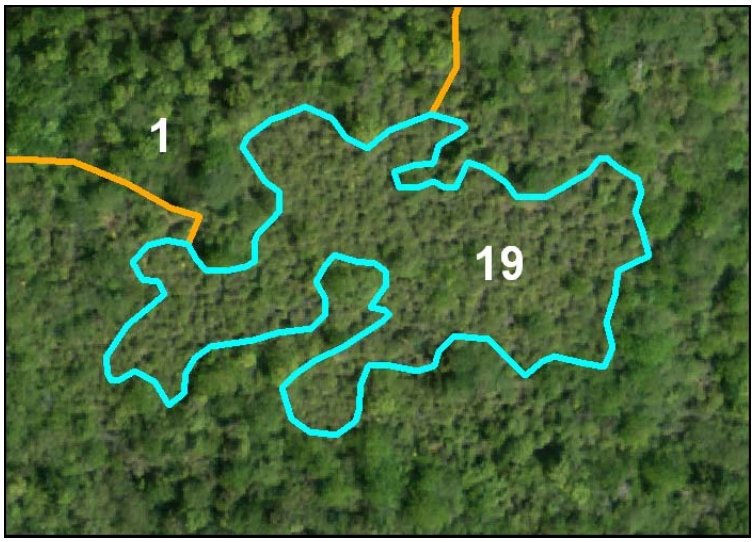




Mixed Dry Shrubland Virgin Islands Sub-formation

Lantana involucrata Shrubland Association
Buttonsage Shrubland Association

Photo Signature Example



Common species:
Lantana involucrata
Pilosocereus royenii
Bourreria succulenta
Pisonia subcordata
Sideroxylon obovatum
Acacia tortuosa
Melocactus intortus
Tillandsia utriculata
Psychilis macconnelliae
Corchorus hirsutus
Opuntia repens
Croton rigidus
Tournefortia microphylla

Project Specifics:
Frequency = 4 polygons
Total Area = 5.3 acres
Average Area = 1.3 acres
Minimum Area = 0.7 acres
Maximum Area = 2.0 acres

Description:
This community has a wide distribution on Buck Island, and can be found on north and south facing hills. This community grades into the *Bursera simaruba-Pisonia subcordata* Forest Association uphill and to the south. A diverse shrubland dominated by low growing (1-3m tall) *Lantana involucrata* (Buttonsage). Other characteristic overstory species include *Bursera simaruba* (Gumbo Limbo), *Pilosocereus royenii*, *Rochefortia acanthophora*, *Bourreria succulenta, Pisonia subcordata, Sideroxylon obovatum* and *Acacia tortuosa*. Understory species are generally 1-3m in height and consist of *Melocactus intortus, Tillandsia utriculata, Psychilis macconnelliae, Corchorus hirsutus, Opuntia repens, Croton rigidus* and *Tournefortia microphylla*.

Ground Photos

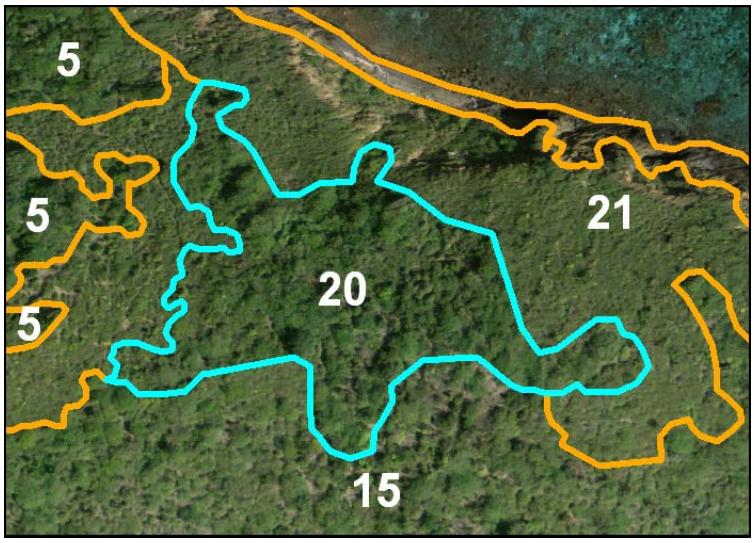




Thicket/scrub Virgin Islands Sub-formation

Thicket/scrub Virgin Islands Sub-formation

Photo Signature Example



Common species:

Acacia tortuosa
Pilosocereus royenii
Lantana involucrata
Rochefortia acanthophora
Bursera simaruba
Corchorus hirsutus
Melocactus intortus

Project Specifics:

Frequency = 1 polygon
Total Area = 1.4 acres
Average Area = 1.4 acres
Minimum Area = 1.4 acres
Maximum Area = 1.4 acres

Description:

"This deciduous formation is quite common on all three islands and cays. It is characterized by thorny scrub communities which generally form a very dense, closed cover community. The height of the vegetation averages approximately 3-4 meters with occasional emergent trees. These communities may have uniform height as mono-specific stands or structural variety as a mixture of two species. This community type may also exist in many locations as a transitional seral stage to taller woodland or dry forest types. Land use history has great influence in the distribution of this cover" (Gibney *et al.* 2000).

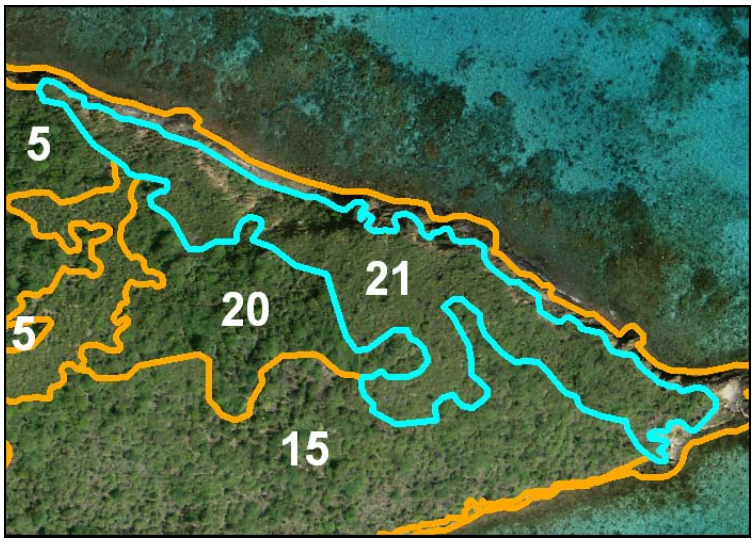
Ground Photos



Coastal Hedge Virgin Islands Sub-formation

Coastal Hedge Virgin Islands Sub-formation

Photo Signature Example



Common species:

Lantana involucrata
Pilosocereus royenii
Rochefortia acanthophora
Acacia tortuosa
Tillandsia utriculata
Melocactus intortus

Project Specifics:

Frequency = 2 polygons
Total Area = 2.8 acres
Average Area = 1.4 acres
Minimum Area = 0.5 acres
Maximum Area = 2.4 acres

Description:

"This formation is shaped by wind shear and salt spray, these dense patch communities can be very low growing (less than 1m) or as tall as 3m. They are generally found on east, southeast or northeast coastal areas with exposure to prevailing winds. The limited species are generally wind and salt adapted. The formation may occur on the berms of beaches, seaward of salt ponds and flats or above rocky coasts or pavement. Hedge effect from wind is the prevailing structural architect for the environment as almost all of the species found here are capable of greater height in less hostile environments. The severe environment causes plants to produce small, succulent leaves which can be highly cutinized" (Gibney *et al.* 2000). The Coastal hedge community may be dominated by *Lantana involucrata* (Buttonsage). Other species typically found in this community include *Pilosocereus royenii*, *Rochefortia acanthophora*, *Acacia tortuosa*, *Tillandsia utriculata*, and *Melocactus intortus*. The canopy height for this community is usually no more than a meter in height due to exposure to prevailing winds and salt spray.

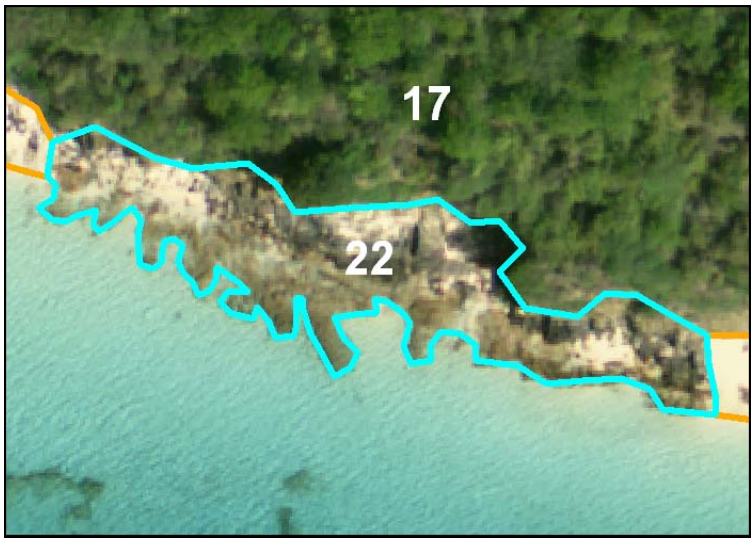
Ground Photos



Rock Pavement Virgin Islands Sub-formation

Coastal Southgate Rock Cliff Alliance

Photo Signature Example



Common species:
Melocactus intortus
Lantana involucrata
Pilosocereus royenii
Tillandsia utriculata
Comocladia dodonaea
Chloris barbata

Project Specifics:
Frequency = 5 polygons
Total Area = 3.6 acres
Average Area = 0.7 acres
Minimum Area = 0.03 acres
Maximum Area = 2.6 acres

Description:
Found along northern, eastern and southern shorelines of Buck Island. Coastal areas dominated by Southgate rock formations with cliffs ranging from one to several meters in height. These coastal cliffs are exposed to extremes of wind, salt spray and low moisture and are usually sparsely vegetated. Vegetative component usually includes *Melocactus intortus, Lantana involucrata, Pilosocereus royenii, Tillandsia utriculata, Comocladia dodonaea*, and *Chloris barbata*. Vegetation canopy generally from 1-3m in height.

Ground Photos



Beach Dune Virgin Islands Sub-formation

Beach Dune Virgin Islands Sub-formation

Photo Signature Example



Common species:

Scaevola plumieri
Ipomoea pes-caprae
Suriana maritima
Sporobolus virginicus
Sesuvium portulacastrum
Dalbergia ecastaphyllum
Spartina patens

Project Specifics:

Frequency = 2 polygons
Total Area = 2.2 acres
Average Area = 1.1 acres
Minimum Area = 0.8 acres
Maximum Area = 1.4 acres

Description:

Sandy area usually behind the beach with a higher vegetative cover (10-100%) than the beach category. The vegetative component is adapted to harsh conditions and includes *Scaevola plumieri*, *Ipomoea pes-caprae*, *Suriana maritima*, *Sporobolus virginicus*, *Sesuvium portulacastrum*, *Dalbergia ecastaphyllum*, and *Spartina patens*. Found behind the beaches at the western end and south-central Buck Island. This is a species poor community due to exposure of winds, salt spray, and low moisture. This habitat may be sporadically inundated with salt water from high tides and storm surges. These species are generally no more than 1m in height and canopy cover fluctuates based on recent environmental conditions.

Ground Photos

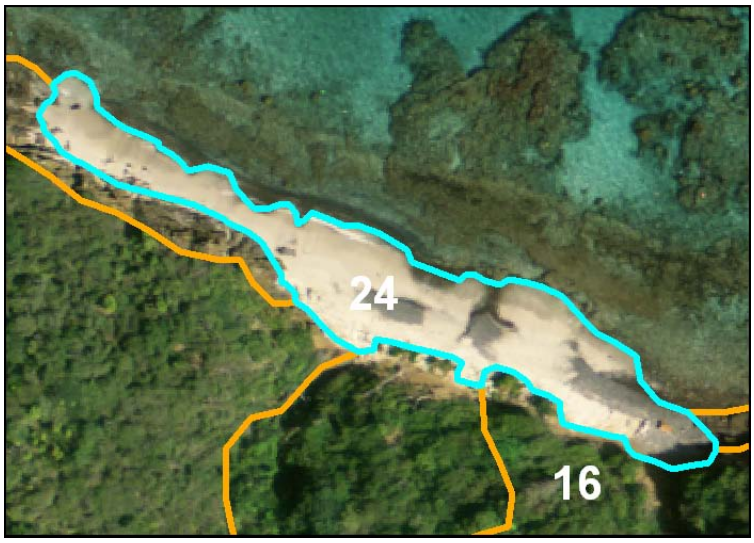




Beach Virgin Islands Sub-formation

Beach Virgin Islands Sub-formation

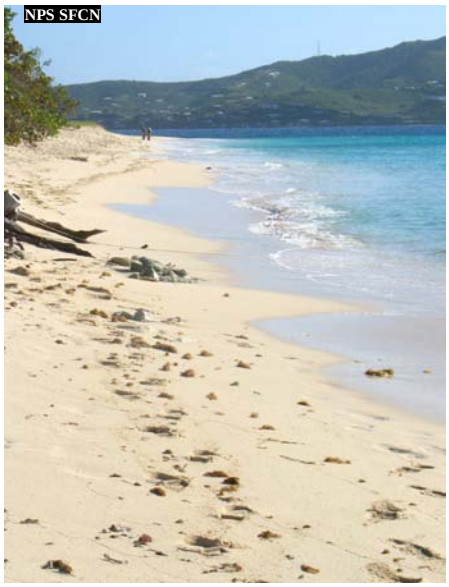
Photo Signature Example



Project Specifics:
Frequency = 6 polygons
Total Area = 4.2 acres
Average Area = 0.7 acres
Minimum Area = 0.04 acres
Maximum Area = 2.6 acres

Description:
"Shoreline beaches of sand, cobble or gravel that exhibit less than 10% vegetative cover" (Gibney *et al.* 2000).

Ground Photos

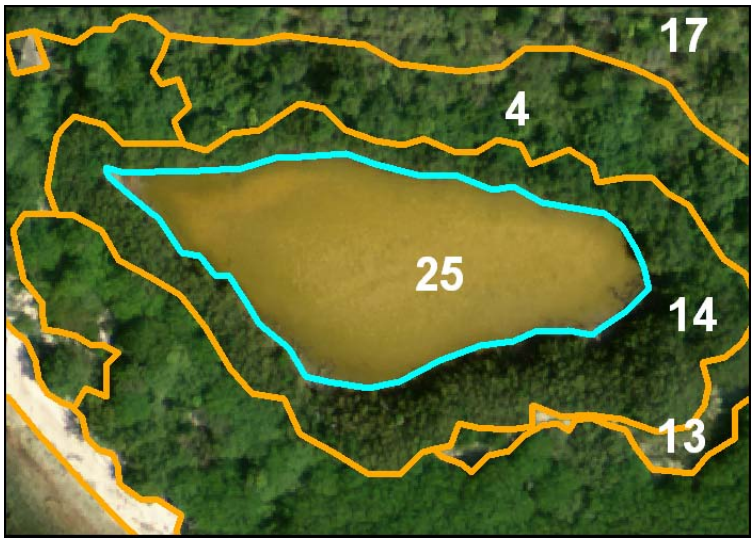




Salt Pond Virgin Islands Sub-formation

Salt Pond Virgin Islands Sub-formation

Photo Signature Example



Common species:
Laguncularia racemosa
Avicennia germinans

Project Specifics:
Frequency = 1 polygon
Total Area = 0.5 acres
Average Area = 0.5 acres
Minimum Area = 0.5 acres
Maximum Area = 0.5 acres

Description:
"Permanently flooded coastal ponds" (Gibney *et al.* 2000). On Buck Island there is one salt pond with a fringing mangrove community consisting of *Laguncularia racemosa* (White Mangrove) and *Avicennia germinans* (Black Mangrove). This salt pond is located at near the coast in south-central Buck Island.

Ground Photos





Developed Area Virgin Islands Sub-formation

Developed Area Virgin Islands Sub-formation

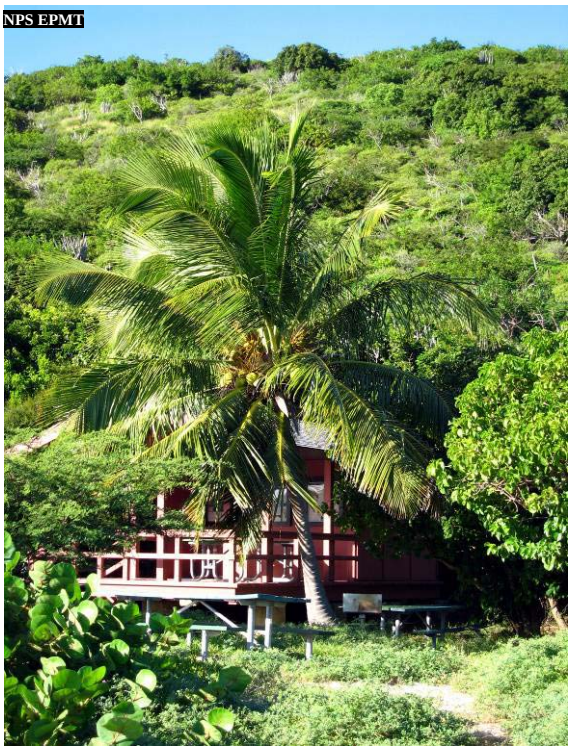
Photo Signature Example



Project Specifics:
Frequency = 4 polygons
Total Area = 0.04 acres
Average Area = 0.01 acres
Minimum Area = 0.005 acres
Maximum Area = 0.02 acres

Description:
"Areas permanently altered for the purpose of residential, commercial and industrial uses" (Gibney *et al.* 2000).

Ground Photos





Appendix C: List of Species Observed during Vegetation Mapping*

Family	Scientific Name	Common Name	Code
Acanthaceae	*Oplonia spinosa* (Jacq.) Raf.	pricklybush	oplspi
Aizoaceae	*Sesuvium portulacastrum* (L.) L.	sea purslane	sespor
Anacardiaceae	*Comocladia dodonaea* (L.) Urban	Christmas bush	comdod
Apocynaceae	*Plumeria alba* L.	frangipani	plualb
Bignoniaceae	*Tecoma stans* (L.) Juss. ex Kunth. (EXOTIC)	ginger thomas	tecsta
Boraginaceae	*Bourreria succulenta* Jacq.	pigeon berry	bousuc
	Cordia angustifolia (West ex Willd.) Roemer & J.A. Schultes	basora	corang
	Cordia rickseckeri Millsp.	black manjack	corric
	Heliotropium ternatum Vahl	bushy heliotrope	helter
	Rochefortia acanthophora (DC.) Griseb.	greenheart ebony	rocaca
	Tournefortia volubilis L.	twining soldierbush	touvol
Bromeliaceae	*Tillandsia utriculata* L.	wild pine	tilutr
Burseraceae	*Bursera simaruba* (L.) Sarg.	gumbo limbo	bursim
Cactaceae	*Melocactus intortus* (P. Mill.) Urban	turk's cap	melint
	Opuntia repens Bello	suckers	opurep
	Pilosocereus royenii (L.) Byles & Rowley	organ pipe	pilroy
Capparaceae	*Capparis indica* (L.) Druce	linguam	capind
Combretaceae	*Conocarpus erectus* L.	button wood	conere
	Laguncularia racemosa (L.) Gaertn. f.	white mangrove	lagrac
Convolvulaceae	*Ipomoea pes-caprae* (L.) R. Br.	beach morning glory	ipopes
Euphorbiaceae	*Chamaesyce mesembrianthemifolia* (Jacq.) Dugand	coastal beach sandmat	chames
	Croton rigidus (Mull.-Arg.) Britt.	marang	crorig
	Flueggea acidoton (L.) G.L. Webster	simpleleaf bushweed	fluaci
	Hippomane mancinella L.	manchineel	hipman
Fabaceae	*Acacia tortuosa* (L.) Willd.	casha	acator
	Caesalpinia ciliata (Bergius ex Wikstr.) Urban	yellow nicker	caecil
	Chamaecrista glandulosa var. *swartzii* (Wikstr.) Irwin & Barneby	Swartz's Jamaica broom	chagla
	Dalbergia ecastaphyllum (L.) Taubert	coin vine	daleca
	Piscidia carthagenensis Jacq.	fish poison tree	piscar
	Pithecellobium unguis-cati (L.) Benth.	blackbead	pitung
Goodeniaceae	*Scaevola plumieri* (L.) Vahl	gullweed	scaplu
Malpighiaceae	*Malpighia infestissima L.C. Rich. ex Niedenzu*	stinging bush	malinf
Moraceae	*Ficus citrifolia* P. Mill.	white fig	ficcit
Myrtaceae	*Eugenia axillaris* (Sw.) Willd.	white stopper eugenia	eugaxi
Nyctaginaceae	*Pisonia subcordata* Sw.	water mampoo	pissub
Orchidaceae	*Psychilis macconnelliae* Sauleda	island peacock orchid	psymac
Plumbaginaceae	*Plumbago scandens* L.	blister leaf	plusca
Poaceae	*Chloris barbata* Sw.	fingergrass	chlbar
	Paspalum laxum Lam.	coconut paspalum	paslax
	Sporobolus virginicus (L.) Kunth	seashore dropseed	spovir
	Urochloa maxima (Jacq.) R. Webster (EXOTIC)	guinea grass	uromax
Polygonaceae	*Coccoloba uvifera* (L.) L.	seagrape	cocuvi
Rhamnaceae	*Krugiodendron ferreum* (Vahl) Urban	ironwood	krufer
Rubiaceae	*Erithalis fruticosa* L.	black torch	erifru
	Ernodea littoralis Sw.	cough bush	ernlit
Sapotaceae	*Sideroxylon obovatum* Lam.	mastic	sidobo
Sterculiaceae	*Melochia tomentosa* L.	broom weed	meltom
Surianaceae	*Suriana maritima* L.	bay cedar	surmar
Theophrastaceae	*Jacquinia armillaris* Jacq.	barbasco	jacarm
Tiliaceae	*Corchorus hirsutus* L.	jack switch	corhir
Verbenaceae	*Avicennia germinans* (L.) L.	black mangrove	aviger
	Duranta erecta L.	golden dewdrops	durere
	Lantana involucrata L.	sage	laninv
Vitaceae	*Cissus trifoliata* (L.) L.	sorrel vine	cistri

Disclaimer

***** This is a list of vegetation species observed in the field during this project, and represents only a subset of the common species found on Buck Island. For a complete list of vegetation species occurring on Buck Island Reef National Monument, see Ray's (2003) Vascular plant inventory and mapping of Buck Island Buck Island Reef National Monument St. Croix, U.S. Virgin Islands.

Appendix D: Vegetation Species Photo Guide for Buck Island Reef National Monument

included in

Buck Island Reef National Monument, U.S. Virgin Islands
Vegetation Mapping Project, 2009



Contents

Introduction D-3

Scientific Name to Common Names List D-4

Common Name to Scientific Name List D-6

Index of Species Alphabetically D-8

Index of Species based on Form & Family Name D-10

Species based on Form & Family Name D-13

- Trees D-13
- Shrubs D-26
- Herbs D-41
- Vines D-47

Introduction

This is a photo guide intended for field use in indentifying plants species in Buck Island Reef National Monument (BUIS) by NPS personnel. It includes a scientific to common name list, as well as a common name to scientific name list to better aid those with and without a botany background. Vegetation species are divided by form (tree, shrub, herb, or vine) then by family, and then by scientific name. Each vegetation species has at least one photograph or sketch as well as a table of information shown below.

Common	common name(s) listed by Acevedo-Rodriguez (1996), Ray (2003), or ITIS*
Form	form defined by Acevedo-Rodriguez (1996), Ray (2003), or R. B. Shamblin
Family	scientific family name as given in ITIS
Scientific	scientific name as given in ITIS
Code	6 letter code used by SFCN, based on the first 3 letters of genus and species
Habitat	habitat defined by Ray (2003) or R. B. Shamblin
FSJ#	Acevedo-Rodriguez (1996) page number, F (indicates sketch)

All species included in this guide can be found in Ray's (2003) *Vascular plant inventory and mapping of Buck Island Buck Island Reef National Monument St. Croix, U.S. Virgin Islands.*

This is a collection of vegetation species observed in the field during this project and selected from Ray's (2003) inventory, and represents only a subset of the common species found on Buck Island. For a complete list of vegetation species occurring on Buck Island Reef National Monument, see a *Vascular plant inventory and mapping of Buck Island Buck Island Reef National Monument St. Croix, U.S. Virgin Islands* (Ray 2003).

For additional assistance in species identification, see *Flora of St. John, U.S. Virgin Islands* (Acevedo-Rodriguez 1996).

The majority of photos in this guide were taken by the NPS South Florida and Caribbean Network (SFCN) staff, by Dan Clark, NPS Florida/Caribbean Exotic Plant Management Team (EPMT), or by NPS Buck Island Reef NM Division of Resource Management, St. Croix (NPS BUIS). Other photos are cited as to their ownership.

*****Integrated Taxonomic Information System

Scientific Name to Common Names List

Superscript indicates sources of common names

Scientific Name	Family	Common Name(s)
Acacia tortuosa	Fabaceae	casha[12], huisachillo[3], poponax[3], twisted acacia[23]
Avicennia germinans	Verbenaceae	black mangrove[123]
Bothriochloa pertusa	Poaceae	hurricane grass[12], pitted beardgrass[3]
Bourreria succulenta	Boraginaceae	bodywood[3], chink[1], chinkwood[1], juniper[1], pigeon berry[12], pigeon wood[13], spoon tree[1]
Bursera simaruba	Burseraceae	cachibou[1], gommier[1], gumbo limbo[13], naked indian[1], red belly tree[1], takantin[1], tourist tree[1], turpentine tree[2], West Indian birch[3]
Caesalpinia ciliata	Fabaceae	mato[3], yellow nicker[12]
Capparis cynophallophora	Capparaceae	black willie[1], black witty[1], Jamaican caper[123], linguam tree[1]
Capparis indica	Capparaceae	linguam[123], white caper[2]
Chamaecrista glandulosa var. swartzii	Fabaceae	Swartz's Jamaican broom[3]
Chamaesyce mesembrianthemifolia	Euphorbiaceae	coastal beach sandmat[3]
Cissus trifoliata	Vitaceae	sorrel vine[123]
Coccoloba uvifera	Polygonaceae	seagrape[123]
Comocladia dodonaea	Anacardiaceae	Christmas bush[12], Christmas tree[1], five finger[1], poison ash[13], pra pra[1]
Conocarpus erectus	Combretaceae	button mangrove[123], button wood[12]
Corchorus hirsutus	Tiliaceae	jack switch[123]
Cordia angustifolia	Boraginaceae	basora[3]
Cordia rickseckeri	Boraginaceae	black manjack[1], dog almond[1], orange manjack[2], San Bartolome[3]
Croton rigidus	Euphorbiaceae	marang[1], yellow balsam[3], yellow marang[12]
Dalbergia ecastaphyllum	Fabaceae	coinvine[3]
Duranta erecta	Verbenaceae	golden dewdrops[3]
Erithalis fruticosa	Rubiaceae	black torch[23]
Ernodea littoralis	Rubiaceae	coughbush[3]
Eugenia axillaris	Myrtaceae	white stopper[3], white stopper eugenia[2]
Eugenia cordata	Myrtaceae	lathberry[3]
Eugenia procera	Myrtaceae	rockmyrtle[3]
Eugenia rhombea	Myrtaceae	crumberry[1], red stopper[3], spiceberry eugenia[2]
Ficus citrifolia	Moraceae	shortleaf fig[23], white fig[1], wild banyantree[3]
Flueggea acidoton	Euphorbiaceae	simpleleaf bushweed[3]
Guajacum officinale	Zygophyllaceae	lignum vitae[123], liki wiki[1], pockenholt[1]
Gymnanthes lucida	Euphorbiaceae	crab wood[1], goat wood[1], oysterwood[23]
Heliotropium angiospermum	Boraginaceae	eyebright[12], scorpion's tail[3]
Heliotropium ternatum	Boraginaceae	bushy heliotrope[3]
Hippomane mancinella	Euphorbiaceae	death apple[1], manchineel[123], mangineedle[1], poison apple[1]
Ipomoea pes-caprae	Convolvulaceae	bayhops[3], bay vine[1], beach morning glory[1], Eggers' morning glory[2], goat foot morning glory[1]
Jacquinia armillaris	Theophrastaceae	barbasco[2], braceletwood[3]
Krugiodendron ferreum	Rhamnaceae	ebony[1], guatafer[1], ironwood[12], leadwood[3]
Laguncularia racemosa	Asteraceae	white mangrove[123]
Lantana involucrata	Combretaceae	buttonsage[3], sage[12]
Malpighia infestissima	Malpighiaceae	cowhage cherry[3], mad dog[1], stinging bush[12], touch me not[1]
Mammillaria nivosa	Cactaceae	wooly nipple cactus[23]

Scientific Name	Family	Common Name(s)
Melocactus intortus	Cactaceae	barrel cactus[12], pope's head[1], turk's cap[123]
Melochia tomentosa	Sterculiaceae	broom weed[12], broom wood[1], teabush[3]
Oplonia spinosa	Acanthaceae	pricklybush[3]
Opuntia repens	Cactaceae	jumping cactus[2], roving pricklypear[3], suckers[12]
Paspalum laxum	Poaceae	coconut paspalum[3]
Pilosocereus royenii	Cactaceae	dacta dul dul[1], didledoo[1], pipe organ[1], pipe organ cactus[2], Royen's tree cactus[3]
Piscidia carthagenensis	Fabaceae	dogwood[1], fish poison tree[12], stink tree[1], stinkwood[3]
Pisonia subcordata	Nyctaginaceae	loblolly[12], mampoo[1], water mampoo[123]
Pithecellobium unguis-cati	Fabaceae	blackbead[1], bread-and-cheese[12], catclaw blackbead[3], crabprickle[1], goatbush[1]
Plumbago scandens	Plumbaginaceae	blister leaf[1], doctorbush[3], guinea leaf[1], plumbago[3]
Plumeria alba	Apocynaceae	frangipani[1], klang hout[1], milk tree[12], milky bush[1], nosegay tree[3], paucipan[1], snake root[1], wild frangipani[12], wormy tree[1]
Psychilis macconnelliae	Orchidaceae	island peacock orchid[3]
Rochefortia acanthophora	Boraginaceae	greenheart ebony[3]
Scaevola plumieri	Goodeniaceae	gullfeed[3]
Schaefferia frutescens	Celastraceae	boxwood[1], Florida boxwood[23]
Sesuvium portulacastrum	Aizoaceae	bay flower[1], sea purslane[12], sea pusley[1], shoreline sea purslane[3]
Sideroxylon obovatum	Sapotaceae	arana gato[2], breakbill[3], mastic[2]
Spartina patens	Poaceae	marshhay cordgrass[3], salt meadow cordgrass[3]
Sporobolus virginicus	Poaceae	seashore dropseed[23]
Suriana maritima	Surianaceae	bay cedar[123]
Tecoma stans	Bignoniaceae	catapult tree[1], ginger thomas[1], trumpet bush[3], trumpet flower[3], yellow cedar[1], yellow elder[3], yellow trumpet bush[3], yellow trumpet flower[3]
Tillandsia utriculata	Bromeliaceae	spreading airplant[3], Tillandsia base inflada[3], wild pine[1]
Tournefortia volubilis	Boraginaceae	twining soldierbush[3]
Urochloa maxima	Poaceae	guinea grass[123]

[1] Acevedo-Rodriguez (1996)
[2] Ray (2003)
[3] ITIS

Common Name to Scientific Name List

Superscript indicates sources of common names

Common Name	Scientific Name
arana gato[2]	*Sideroxylon obovatum*
barbasco[2]	*Jacquinia armillaris*
barrel cactus[12]	*Melocactus intortus*
basora[3]	*Cordia angustifolia*
bay cedar[123]	*Suriana maritima*
bay flower[1]	*Sesuvium portulacastrum*
bay vine[1]	*Ipomoea pes-caprae*
bayhops[3]	*Ipomoea pes-caprae*
beach morning glory[1]	*Ipomoea pes-caprae*
black mangrove[123]	*Avicennia germinans*
black manjack[1]	*Cordia rickseckeri*
black torch[23]	*Erithalis fruticosa*
black willie[1]	*Capparis cynophallophora*
black witty[1]	*Capparis cynophallophora*
blackbead[1]	*Pithecellobium unguis-cati*
blister leaf[1]	*Plumbago scandens*
bodywood[3]	*Bourreria succulenta*
boxwood[1]	*Schaefferia frutescens*
braceletwood[3]	*Jacquinia armillaris*
bread-and-cheese[12]	*Pithecellobium unguis-cati*
breakbill[3]	*Sideroxylon obovatum*
broom weed[12]	*Melochia tomentosa*
broom wood[1]	*Melochia tomentosa*
bushy heliotrope[3]	*Heliotropium ternatum*
button mangrove[123]	*Conocarpus erectus*
button wood[12]	*Conocarpus erectus*
buttonsage[3]	*Lantana involucrata*
cachibou[1]	*Bursera simaruba*
casha[12]	*Acacia tortuosa*
catapult tree[1]	*Tecoma stans*
catclaw blackbead[3]	*Pithecellobium unguis-cati*
chink[1]	*Bourreria succulenta*
chinkwood[1]	*Bourreria succulenta*
Christmas bush[12]	*Comocladia dodonaea*
Christmas tree[1]	*Comocladia dodonaea*
coastal beach sandmat[3]	*Chamaesyce mesembrianthemifolia*
coconut paspalum[3]	*Paspalum laxum*
coinvine[3]	*Dalbergia ecastaphyllum*
coughbush[3]	*Ernodea littoralis*
cowhage cherry[3]	*Malpighia infestissima*
crab wood[1]	*Gymnanthes lucida*
crabprickle[1]	*Pithecellobium unguis-cati*
crumberry[1]	*Eugenia rhombea*
dacta dul dul[1]	*Pilosocereus royenii*
death apple[1]	*Hippomane mancinella*
didledoo[1]	*Pilosocereus royenii*
doctorbush[3]	*Plumbago scandens*
dog almond[1]	*Cordia rickseckeri*
dogwood[1]	*Piscidia carthagenensis*
ebony[1]	*Krugiodendron ferreum*
Eggers' morning glory[2]	*Ipomoea pes-caprae*
eyebright[12]	*Heliotropium angiospermum*
fish poison tree[12]	*Piscidia carthagenensis*
five finger[1]	*Comocladia dodonaea*
Florida boxwood[23]	*Schaefferia frutescens*
frangipani[1]	*Plumeria alba*
ginger thomas[1]	*Tecoma stans*
goat foot morning glory[1]	*Ipomoea pes-caprae*
goat wood[1]	*Gymnanthes lucida*
goatbush[1]	*Pithecellobium unguis-cati*
golden dewdrops[3]	*Duranta erecta*
gommier[1]	*Bursera simaruba*
greenheart ebony[3]	*Rochefortia acanthophora*
guatafer[1]	*Krugiodendron ferreum*
guinea grass[123]	*Urochloa maxima*
guinea leaf[1]	*Plumbago scandens*
gullfeed[3]	*Scaevola plumieri*
gumbo limbo[13]	*Bursera simaruba*
huisachillo[3]	*Acacia tortuosa*
hurricane grass[12]	*Bothriochloa pertusa*
ironwood[12]	*Krugiodendron ferreum*
island peacock orchid[3]	*Psychilis macconnelliae*
jack switch[123]	*Corchorus hirsutus*
Jamaican caper[123]	*Capparis cynophallophora*
jumping cactus[2]	*Opuntia repens*
juniper[1]	*Bourreria succulenta*
klang hout[1]	*Plumeria alba*
lathberry[3]	*Eugenia cordata*
leadwood[3]	*Krugiodendron ferreum*
lignum vitae[123]	*Guajacum officinale*
liki wiki[1]	*Guajacum officinale*
linguam tree[1]	*Capparis cynophallophora*
linguam[123]	*Capparis indica*
loblolly[12]	*Pisonia subcordata*

Common Name	Scientific Name
mad dog[1]	*Malpighia infestissima*
mampoo[1]	*Pisonia subcordata*
manchineel[123]	*Hippomane mancinella*
mangineedle[1]	*Hippomane mancinella*
marang[1]	*Croton rigidus*
marshhay cordgrass[3]	*Spartina patens*
mastic[2]	*Sideroxylon obovatum*
mato[3]	*Caesalpinia ciliata*
milk tree[12]	*Plumeria alba*
milky bush[1]	*Plumeria alba*
naked indian[1]	*Bursera simaruba*
nosegay tree[3]	*Plumeria alba*
orange manjack[2]	*Cordia rickseckeri*
oysterwood[23]	*Gymnanthes lucida*
paucipan[1]	*Plumeria alba*
pigeon berry[12]	*Bourreria succulenta*
pigeon wood[13]	*Bourreria succulenta*
pipe organ cactus[2]	*Pilosocereus royenii*
pipe organ[1]	*Pilosocereus royenii*
pitted beardgrass[3]	*Bothriochloa pertusa*
plumbago[3]	*Plumbago scandens*
pockenholt[1]	*Guajacum officinale*
poison apple[1]	*Hippomane mancinella*
poison ash[13]	*Comocladia dodonaea*
pope's head[1]	*Melocactus intortus*
poponax[3]	*Acacia tortuosa*
pra pra[1]	*Comocladia dodonaea*
pricklybush[3]	*Oplonia spinosa*
red belly tree[1]	*Bursera simaruba*
red stopper[3]	*Eugenia rhombea*
rockmyrtle[3]	*Eugenia procera*
roving pricklypear[3]	*Opuntia repens*
Royen's tree cactus[3]	*Pilosocereus royenii*
sage[12]	*Lantana involucrata*
salt meadow cordgrass[3]	*Spartina patens*
San Bartolome[3]	*Cordia rickseckeri*
scorpion's tail[3]	*Heliotropium angiospermum*
sea purslane[12]	*Sesuvium portulacastrum*
sea pusley[1]	*Sesuvium portulacastrum*
seagrape[123]	*Coccoloba uvifera*
seashore dropseed[23]	*Sporobolus virginicus*
shoreline sea purslane[3]	*Sesuvium portulacastrum*
shortleaf fig[23]	*Ficus citrifolia*
simpleleaf bushweed[3]	*Flueggea acidoton*
snake root[1]	*Plumeria alba*
sorrel vine[123]	*Cissus trifoliata*
spiceberry eugenia[2]	*Eugenia rhombea*
spoon tree[1]	*Bourreria succulenta*
spreading airplant[3]	*Tillandsia utriculata*
stinging bush[12]	*Malpighia infestissima*
stink tree[1]	*Piscidia carthagenensis*
stinkwood[3]	*Piscidia carthagenensis*
suckers[12]	*Opuntia repens*
Swartz's Jamaican broom[3]	*Chamaecrista glandulosa var. swartzii*
takantin[1]	*Bursera simaruba*
teabush[3]	*Melochia tomentosa*
Tillandsia base inflada[3]	*Tillandsia utriculata*
touch me not[1]	*Malpighia infestissima*
tourist tree[1]	*Bursera simaruba*
trumpet bush[3]	*Tecoma stans*
trumpet flower[3]	*Tecoma stans*
turk's cap[123]	*Melocactus intortus*
turpentine tree[2]	*Bursera simaruba*
twining soldierbush[3]	*Tournefortia volubilis*
twisted acacia[23]	*Acacia tortuosa*
water mampoo[123]	*Pisonia subcordata*
West Indian birch[3]	*Bursera simaruba*
white caper[2]	*Capparis indica*
white fig[1]	*Ficus citrifolia*
white mangrove[123]	*Laguncularia racemosa*
white stopper eugenia[2]	*Eugenia axillaris*
white stopper[3]	*Eugenia axillaris*
wild banyantree[3]	*Ficus citrifolia*
wild frangipani[12]	*Plumeria alba*
wild pine[1]	*Tillandsia utriculata*
wooly nipple cactus[23]	*Mammillaria nivosa*
wormy tree[1]	*Plumeria alba*
yellow balsam[3]	*Croton rigidus*
yellow cedar[1]	*Tecoma stans*
yellow elder[3]	*Tecoma stans*
yellow marang[12]	*Croton rigidus*
yellow nicker[12]	*Caesalpinia ciliata*
yellow trumpet bush[3]	*Tecoma stans*
yellow trumpet flower[3]	*Tecoma stans*

[1] Acevedo-Rodriguez (1996)
[2] Ray (2003)
[3] ITIS

Index of Species Alphabetically

Acacia tortuosa D-32
Avicennia germinans D-24
Bothriochloa pertusa D-44
Bourreria succulenta D-14
Bursera simaruba D-15
Caesalpinia ciliata D-33
Capparis cynophallophora D-16
Capparis indica D-16
Chamaecrista glandulosa var. swartzii D-33
Chamaesyce mesembrianthemifolia D-31
Cissus trifoliata D-49
Coccoloba uvifera D-23
Comocladia dodonaea D-27
Conocarpus erectus D-18
Corchorus hirsutus D-39
Cordia angustifolia D-28
Cordia rickseckeri D-15
Croton rigidus D-31
Dalbergia ecastaphyllum D-34
Duranta erecta D-40
Erithalis fruticosa D-37
Ernodea littoralis D-37
Eugenia axillaris D-21
Eugenia cordata D-35
Eugenia procera D-36
Eugenia rhombea D-22
Ficus citrifolia D-21
Flueggea acidoton D-32
Guajacum officinale D-25
Gymnanthes lucida D-19
Heliotropium angiospermum D-42
Heliotropium ternatum D-29
Hippomane mancinella D-19
Ipomoea pes-caprae D-48
Jacquinia armillaris D-39
Krugiodendron ferreum D-23
Laguncularia racemosa D-18
Lantana involucrata D-40
Malpighia infestissima D-20
Mammillaria nivosa D-43
Melocactus intortus D-30
Melochia tomentosa D-38
Oplonia spinosa D-27
Opuntia repens D-30

Paspalum laxum D-45
Pilosocereus royenii D-16
Piscidia carthagenensis D-20
Pisonia subcordata D-22
Pithecellobium unguis-cati D-34
Plumbago scandens D-36
Plumeria alba D-14
Psychilis macconnelliae D-44
Rochefortia acanthophora D-29
Scaevola plumieri D-35
Schaefferia frutescens D-17
Sesuvium portulacastrum D-42
Sideroxylon obovatum D-24
Spartina patens D-45
Sporobolus virginicus D-46
Suriana maritima D-38
Tecoma stans D-28
Tillandsia utriculata D-43
Tournefortia volubilis D-48
Urochloa maxima D-46

Index of Species based on Form & Family Name

Trees D-13
Apocynaceae D-14
Plumeria alba D-14
Boraginaceae D-14
Bourreria succulenta D-14
Cordia rickseckeri D-15
Burseraceae D-15
Bursera simaruba D-15
Cactaceae D-16
Pilosocereus royenii D-16
Capparaceae D-16
Capparis cynophallophora D-16
Capparis indica D-17
Celastraceae D-17
Schaefferia frutescens D-17
Combretaceae D-18
Conocarpus erectus D-18
Laguncularia racemosa D-18
Euphorbiaceae D-19
Gymnanthes lucida D-19
Hippomane mancinella D-19
Fabaceae D-20
Piscidia carthagenensis D-20
Malpighiaceae D-20
Malpighia infestissima D-20
Moraceae D-21
Ficus citrifolia D-21
Myrtaceae D-21
Eugenia axillaris D-21
Eugenia rhombea D-22
Nyctaginaceae D-22
Pisonia subcordata D-22
Polygonaceae D-23
Coccoloba uvifera D-23
Rhamnaceae D-23
Krugiodendron ferreum D-23
Sapotaceae D-24
Sideroxylon obovatum D-24
Verbenaceae D-24
Avicennia germinans D-24
Zygophyllaceae D-25
Guajacum officinale D-25

Shrubs D-26
Acanthaceae D-27
Oplonia spinosa D-27
Anacardiaceae D-27
Comocladia dodonaea D-27
Bignoniaceae D-28
Tecoma stans D-28
Boraginaceae D-28
Cordia angustifolia D-28
Heliotropium ternatum D-29
Rochefortia acanthophora D-29
Cactaceae D-30
Melocactus intortus D-30
Opuntia repens D-30
Euphorbiaceae D-31
Chamaesyce mesembrianthemifolia D-31
Croton rigidus D-31
Flueggea acidoton D-32
Fabaceae D-32
Acacia tortuosa D-32
Caesalpinia ciliata D-33
Chamaecrista glandulosa var. swartzii D-33
Dalbergia ecastaphyllum D-34
Pithecellobium unguis-cati D-34
Goodeniaceae D-35
Scaevola plumieri D-35
Myrtaceae D-35
Eugenia cordata D-35
Eugenia procera D-36
Plumbaginaceae D-36
Plumbago scandens D-36
Rubiaceae D-37
Erithalis fruticosa D-37
Ernodea littoralis D-37
Sterculiaceae D-38
Melochia tomentosa D-38
Surianaceae D-38
Suriana maritima D-38
Theophrastaceae D-39
Jacquinia armillaris D-39
Tiliaceae D-39
Corchorus hirsutus D-39
Verbenaceae D-40
Duranta erecta D-40
Lantana involucrata D-40

Herbs D-41
Aizoaceae D-42
Sesuvium portulacastrum D-42
Boraginaceae D-42
Heliotropium angiospermum D-42
Bromeliaceae D-43
Tillandsia utriculata D-43
Cactaceae D-43
Mammillaria nivosa D-43
Orchidaceae D-44
Psychilis macconnelliae D-44
Poaceae D-44
Bothriochloa pertusa D-44
Paspalum laxum D-45
Spartina patens D-45
Sporobolus virginicus D-46
Urochloa maxima D-46

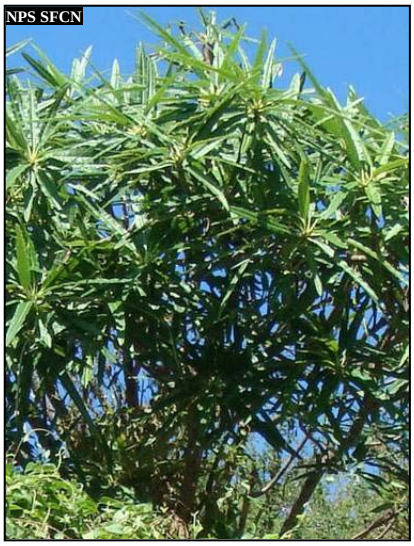
Vines D-47
Boraginaceae D-48
Tournefortia volubilis D-48
Convolvulaceae D-48
Ipomoea pes-caprae D-48
Vitaceae D-49
Cissus trifoliata D-49

Trees

Plumeria alba



Common frangipani
Form Tree
Family Apocynaceae
Scientific *Plumeria alba*
Code plualb
Habitat shrub thickets
FSJ# 74



Bourreria succulenta

Common pigeon berry
Form Tree
Family Boraginaceae
Scientific *Bourreria succulenta*
Code bousuc
Habitat beach & upland forests
FSJ# 135-F





Cordia rickseckeri

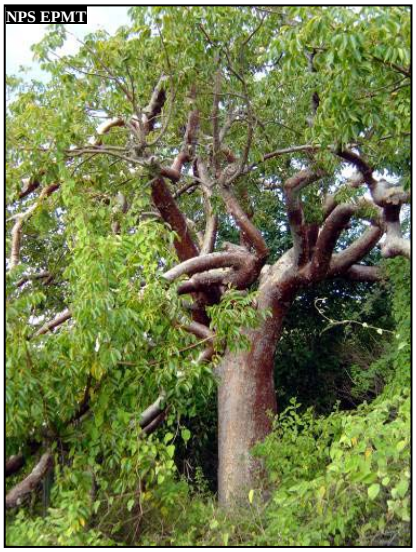


Common	black manjack
Form	Tree
Family	Boraginaceae
Scientific	*Cordia rickseckeri*
Code	corric
Habitat	beach and upland forests
FSJ#	139-F



Bursera simaruba

Common	gumbo limbo
Form	Tree
Family	Burseraceae
Scientific	*Bursera simaruba*
Code	bursim
Habitat	upland forest
FSJ#	146-F

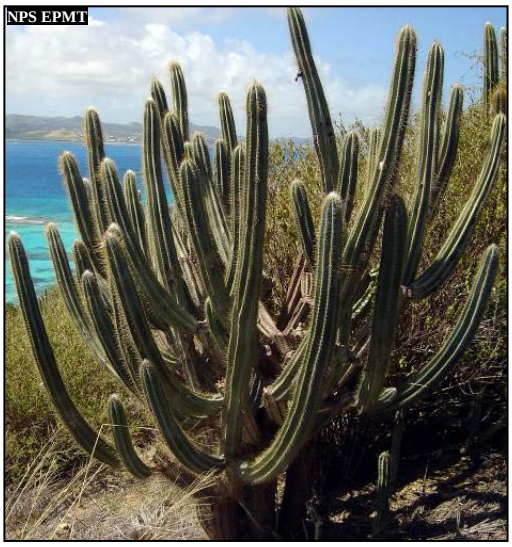




Pilosocereus royenii



Common organ pipe
Form Tree
Family Cactaceae
Scientific *Pilosocereus royenii*
Code pilroy
Habitat scrub thickets, rocky areas
FSJ# 154-F



Capparis cynophallophora

Common Jamaican caper
Form Tree
Family Capparaceae
Scientific *Capparis cynophallophora*
Code capcyn
Habitat slopes, coast forest
FSJ# 158-F





Capparis indica



Common linguam
Form Tree
Family Capparaceae
Scientific *Capparis indica*
Code capind
Habitat upland and slopes
FSJ# 160



Schaefferia frutescens

Common boxwood
Form Tree
Family Celastraceae
Scientific *Schaefferia frutescens*
Code schfru
Habitat upland and beach forests
FSJ# 169-F





Conocarpus erectus

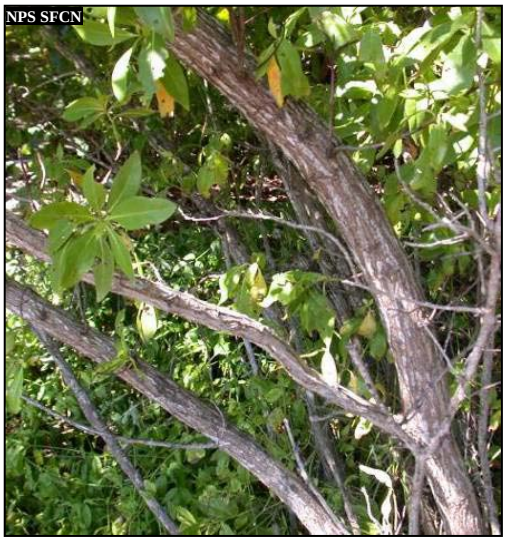


Common button wood
Form Tree
Family Combretaceae
Scientific *Conocarpus erectus*
Code conere
Habitat salt pond edge
FSJ# 176-F



Laguncularia racemosa

Common white mangrove
Form Tree
Family Combretaceae
Scientific *Laguncularia racemosa*
Code lagrac
Habitat salt pond edge
FSJ# 176-F





Gymnanthes lucida

Common crab wood
Form Tree
Family Euphorbiaceae
Scientific *Gymnanthes lucida*
Code gymluc
Habitat upland forest
FSJ# 213-F



Hippomane mancinella



Common manchineel
Form Tree
Family Euphorbiaceae
Scientific *Hippomane mancinella*
Code hipman
Habitat beach forest
FSJ# 213-F



Piscidia carthagenensis

Common fish poison tree
Form Tree
Family Fabaceae
Scientific *Piscidia carthagenensis*
Code piscar
Habitat upland and guts
FSJ# 254-F





Malpighia infestissima



Common stinging bush
Form Tree
Family Malpighiaceae
Scientific *Malpighia infestissima*
Code malinf
Habitat beach forest
FSJ# 294

Ficus citrifolia



Common	white fig
Form	Tree
Family	Moraceae
Scientific	*Ficus citrifolia*
Code	ficcit
Habitat	forest
FSJ#	320-F

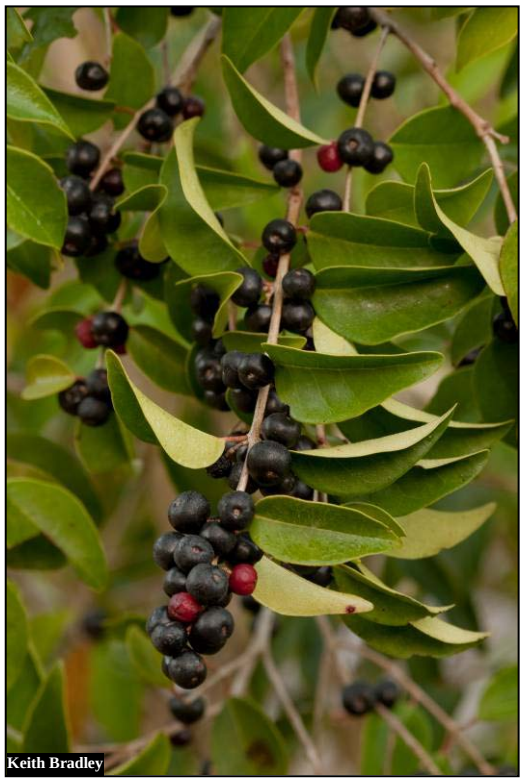


Eugenia axillaris

Common	white stopper eugenia
Form	Tree
Family	Myrtaceae
Scientific	*Eugenia axillaris*
Code	eugaxi
Habitat	beach & upland forests
FSJ#	328







Eugenia rhombea



Common crumberry
Form Tree
Family Myrtaceae
Scientific *Eugenia rhombea*
Code eugrho
Habitat beach & upland forests
FSJ# 329

Pisonia subcordata

Common water mampoo
Form Tree
Family Nyctaginaceae
Scientific *Pisonia subcordata*
Code pissub
Habitat upland forest and guts
FSJ# 339





Coccoloba uvifera



Common seagrape
Form Tree
Family Polygonaceae
Scientific *Coccoloba uvifera*
Code cocuvi
Habitat beach forest
FSJ# 362



Krugiodendron ferreum

Common ironwood
Form Tree
Family Rhamnaceae
Scientific *Krugiodendron ferreum*
Code krufer
Habitat upland forest
FSJ# 368-F







Sideroxylon obovatum



Common	mastic
Form	Tree
Family	Sapotaceae
Scientific	*Sideroxylon obovatum*
Code	sidobo
Habitat	beach & upland forests
FSJ#	404-F



Avicennia germinans

Common	black mangrove
Form	Tree
Family	Verbenaceae
Scientific	*Avicennia germinans*
Code	aviger
Habitat	salt pond edge
FSJ#	440-F





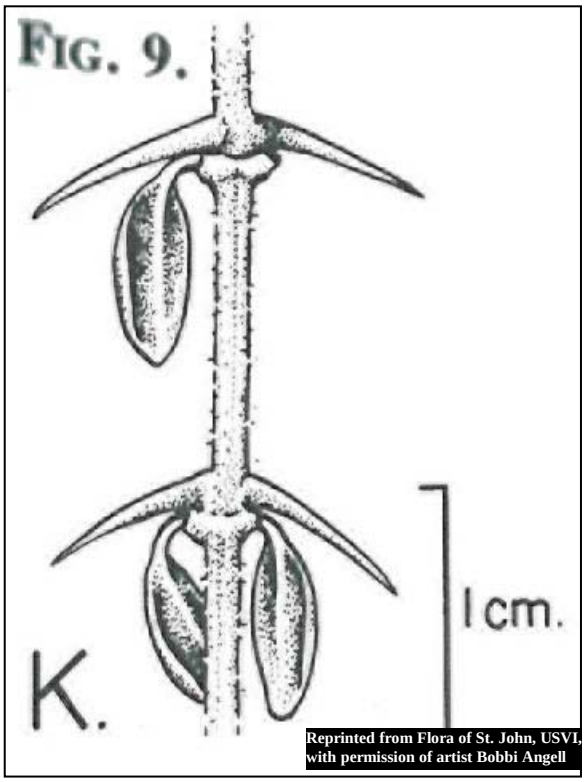
Guajacum officinale



Common	lignum vitae
Form	Tree
Family	Zygophyllaceae
Scientific	*Guajacum officinale*
Code	guaoff
Habitat	replanted
FSJ#	451-F

Shrubs

Oplonia spinosa



Common	prickly bush
Form	Shrub
Family	Acanthaceae
Scientific	*Oplonia spinosa*
Code	oplspi
Habitat	hillsides and ravines
FSJ#	48-F

Comocladia dodonaea

Common	Christmas bush
Form	Shrub
Family	Anacardiaceae
Scientific	*Comocladia dodonaea*
Code	comdod
Habitat	upland forest
FSJ#	62-F





Tecoma stans

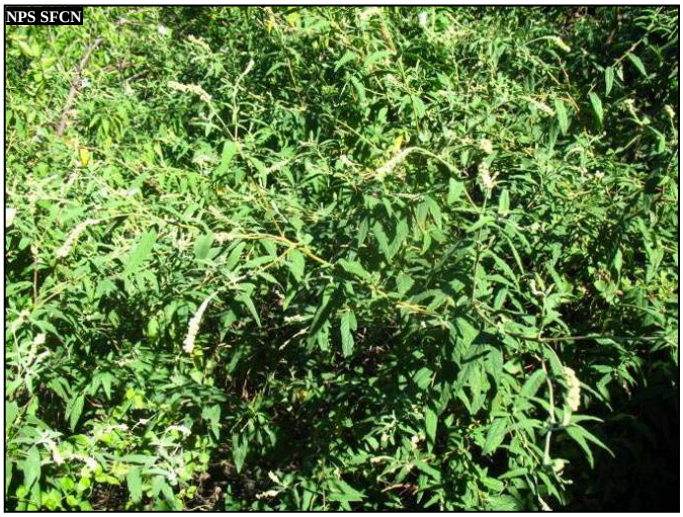


Common ginger thomas
Form Shrub
Family Bignoniaceae
Scientific *Tecoma stans*
Code tecsta
Habitat open slopes - **EXOTIC**
FSJ# 131-F



Cordia angustifolia

Common basora
Form Shrub
Family Boraginaceae
Scientific *Cordia angustifolia*
Code corang
Habitat shrub thickets
FSJ# Species not listed in FSJ





Heliotropium ternatum



Common busy heliotrope
Form Shrub
Family Boraginaceae
Scientific *Heliotropium ternatum*
Code helter
Habitat open slopes
FSJ# 140



Rochefortia acanthophora

Common greenheart ebony
Form Shrub
Family Boraginaceae
Scientific *Rochefortia acanthophora*
Code rocaca
Habitat upland forest
FSJ# 141-F

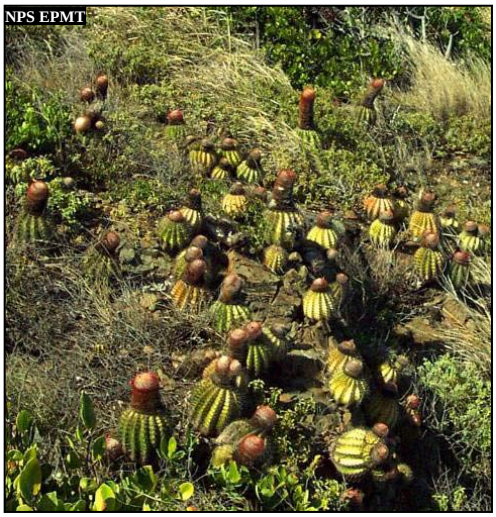




Melocactus intortus



Common	turk's cap
Form	Shrub
Family	Cactaceae
Scientific	*Melocactus intortus*
Code	melint
Habitat	dry, rocky shorelines
FSJ#	149-F



Opuntia repens

Common	suckers
Form	Shrub
Family	Cactaceae
Scientific	*Opuntia repens*
Code	opurep
Habitat	semi arid sites
FSJ#	151-F



Chamaesyce mesembrianthemifolia



Common coastal beach sandmat
Form Shrub
Family Euphorbiaceae
Scientific *Chamaesyce mesembrianthemifolia*
Code chames
Habitat sandy coasts
FSJ# 206-F



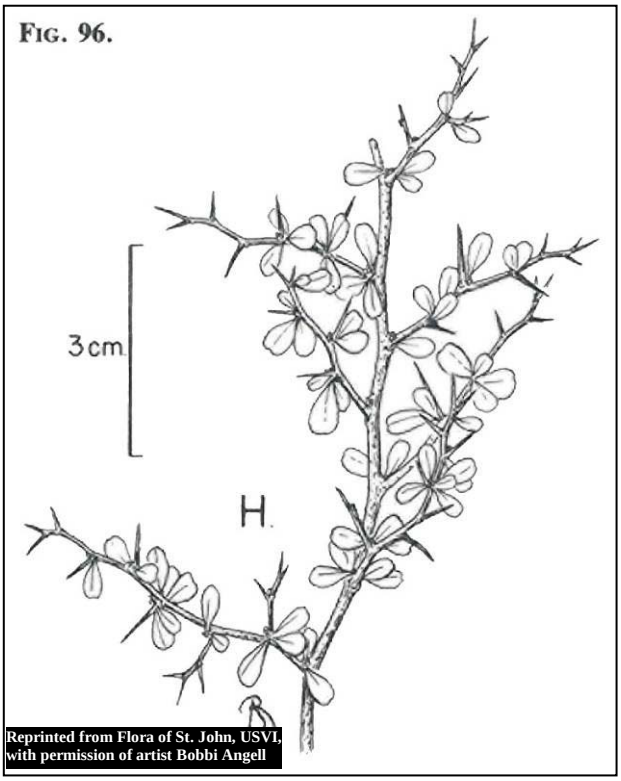
Croton rigidus

Common marang
Form Shrub
Family Euphorbiaceae
Scientific *Croton rigidus*
Code crorig
Habitat open areas
FSJ# 209





Flueggea acidoton



Common simpleleaf bushweed
Form Shrub
Family Euphorbiaceae
Scientific *Flueggea acidoton*
Code fluaci
Habitat thickets
FSJ# 213-F



Acacia tortuosa

Common casha
Form Shrub
Family Fabaceae
Scientific *Acacia tortuosa*
Code acator
Habitat upland, disturbed
FSJ# 262





Caesalpinia ciliata



Common yellow nicker
Form Shrub
Family Fabaceae
Scientific *Caesalpinia ciliata*
Code caecil
Habitat beach strand
FSJ# 226-F



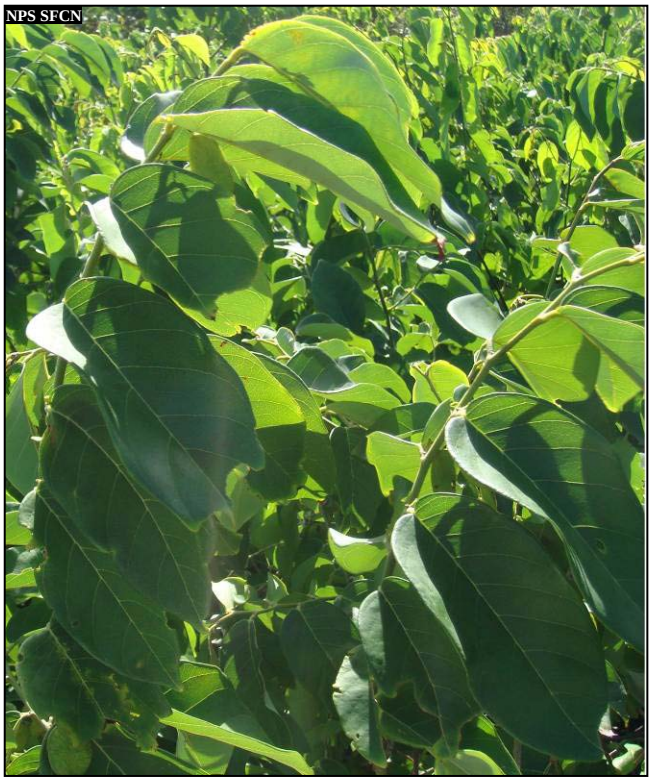
Chamaecrista glandulosa var. swartzii

Common Swartz's Jamaica broom
Form Shrub
Family Fabaceae
Scientific *Chamaecrista glandulosa var. swartzii*
Code chagla
Habitat open forest
FSJ# 226-F





Dalbergia ecastaphyllum



Common coinvine
Form Shrub
Family Fabaceae
Scientific *Dalbergia ecastaphyllum*
Code daleca
Habitat beach (southwest)
FSJ# 245-F



Pithecellobium unguis-cati

Common blackbead
Form Shrub
Family Fabaceae
Scientific *Pithecellobium unguis-cati*
Code pitung
Habitat upland forest
FSJ# 269-F



Scaevola plumieri



Common gullfeed
Form Shrub
Family Goodeniaceae
Scientific *Scaevola plumieri*
Code scaplu
Habitat beach
FSJ# 276-F



Eugenia cordata

Common lathberry
Form Shrub
Family Myrtaceae
Scientific *Eugenia cordata*
Code eugcor
Habitat gallery forest
FSJ# 328





Eugenia procera



Common rockmyrtle
Form Shrub
Family Myrtaceae
Scientific *Eugenia procera*
Code eugpro
Habitat gallery forest
FSJ# 329



Plumbago scandens

Common blister leaf
Form Shrub
Family Plumbaginaceae
Scientific *Plumbago scandens*
Code plusca
Habitat roadside weed
FSJ# 358-F





Erithalis fruticosa



Common	black torch
Form	Shrub
Family	Rubiaceae
Scientific	*Erithalis fruticosa*
Code	erifru
Habitat	beach forest
FSJ#	374-F



Ernodea littoralis

Common	cough bush
Form	Shrub
Family	Rubiaceae
Scientific	*Ernodea littoralis*
Code	ernlit
Habitat	beach strand
FSJ#	389







Melochia tomentosa



Common broom weed
Form Shrub
Family Sterculiaceae
Scientific *Melochia tomentosa*
Code meltom
Habitat thickets
FSJ# 422-F

Suriana maritima

Common bay cedar
Form Shrub
Family Surianaceae
Scientific *Suriana maritima*
Code surmar
Habitat beach strand
FSJ# 423-F







Jacquinia armillaris



Common barbasco
Form Shrub
Family Theophrastaceae
Scientific *Jacquinia armillaris*
Code jacarm
Habitat beach forest
FSJ# 427



Corchorus hirsutus

Common jack switch
Form Shrub
Family Tiliaceae
Scientific *Corchorus hirsutus*
Code corhir
Habitat coastal
FSJ# 431-F



Duranta erecta

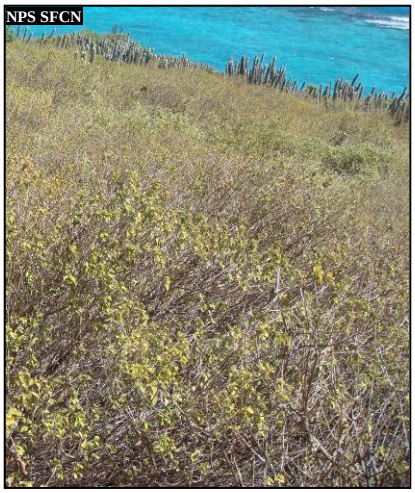


Common golden dewdrops
Form Shrub
Family Verbenaceae
Scientific *Duranta erecta*
Code durere
Habhabitat upland forest
FSJ# 444-F



Lantana involucrata

Common sage
Form Shrub
Family Verbenaceae
Scientific *Lantana involucrata*
Code laninv
Habitat shrub thickets
FSJ# 444-F





Herbs

Sesuvium portulacastrum



Common sea purslane
Form Herb
Family Aizoaceae
Scientific *Sesuvium portulacastrum*
Code sespor
Habitat coastal
FSJ# 53-F



Heliotropium angiospermum

Common eyebright
Form Herb
Family Boraginaceae
Scientific *Heliotropium angiospermum*
Code helang
Habitat slopes & beach forest
FSJ# 140



Tillandsia utriculata





Common wild pine
Form Herb
Family Bromeliaceae
Scientific *Tillandsia utriculata*
Code tilutr
Habitat upper slopes/ridges
FSJ# 472-F



Mammillaria nivosa

Common wooly nipple cactus
Form Herb
Family Cactaceae
Scientific *Mammillaria nivosa*
Code mamniv
Habitat rocky shorelines
FSJ# 149-F



Psychilis macconnelliae



Common island peacock orchid
Form Herb
Family Orchidaceae
Scientific *Psychilis macconnelliae*
Code psymac
Habitat open woodland
FSJ# 506-F



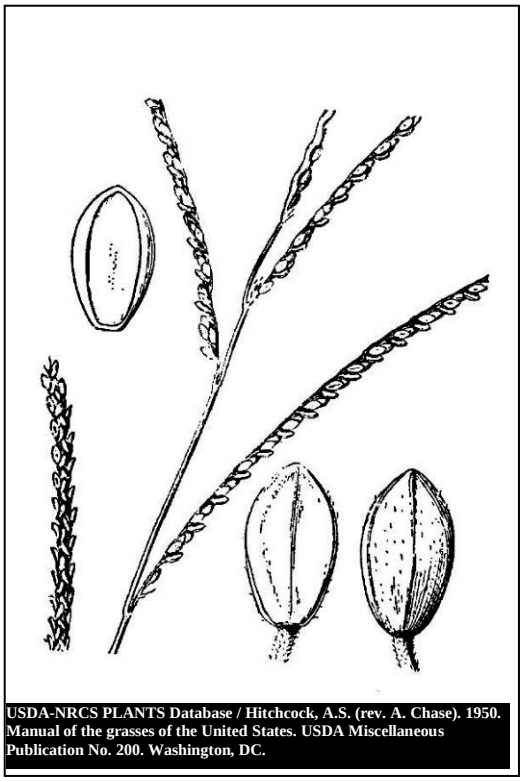
Bothriochloa pertusa

Common hurricane grass
Form Herb
Family Poaceae
Scientific *Bothriochloa pertusa*
Code botper
Habitat open areas - **EXOTIC**
FSJ# 516-F





Paspalum laxum



USDA-NRCS PLANTS Database / Hitchcock, A.S. (rev. A. Chase). 1950. Manual of the grasses of the United States. USDA Miscellaneous Publication No. 200. Washington, DC.

Common	coconut paspalum
Form	Herb
Family	Poaceae
Scientific	*Paspalum laxum*
Code	paslax
Habitat	coastal
FSJ#	531

Spartina patens

Common	salt meadow cordgrass
Form	Herb
Family	Poaceae
Scientific	*Spartina patens*
Code	spapat
Habitat	beach strand
FSJ#	536-F



Sporobolus virginicus



Common	seashore dropseed
Form	Herb
Family	Poaceae
Scientific	*Sporobolus virginicus*
Code	spovir
Habitat	beach strand; salt ponds
FSJ#	538



Urochloa maxima

Common	guinea grass
Form	Herb
Family	Poaceae
Scientific	*Urochloa maxima*
Code	uromax
Habitat	open - **EXOTIC**
FSJ#	539





Vines

Tournefortia volubilis



Common	twinning soldierbush
Form	Vine
Family	Boraginaceae
Scientific	*Tournefortia volubilis*
Code	touvol
Habitat	slopes
FSJ#	142-F



Ipomoea pes-caprae

Common	beach morning glory
Form	Vine
Family	Convolvulaceae
Scientific	*Ipomoea pes-caprae*
Code	ipopes
Habitat	beach strand
FSJ#	185





Cissus trifoliata



Common	sorrel vine
Form	Vine
Family	Vitaceae
Scientific	*Cissus trifoliata*
Code	cistri
Habitat	beach forest
FSJ#	448-F

Appendix E: Field Data Sheets

October 2008 Field Data Sheet

Date: _____ **Observers:** _____

Mark #: _____ **Unit:** ___ **# of Photos:** ___

Community Type: _____

Dominant Vegetation Type in Cell

Canopy Height: _____m

Canopy Cover: _____%

Species (D = dominant species)

1)	6)
2)	7)
3)	8)
4)	9)
5)	10)

Remarks

Hurricane Omar (October 2008)

Hurricane Damage: _____

Canopy Before Hurricane: _____

January 2009 Field Data Sheet

BUIS TRAINING POINTS FOR VEGETATION MAPPING

Park: **Date:**

GPS Mark #: **# of Pictures taken/Description:**

Polygon #:

Training Point #:

Observers:
Primary -
Assistant -

Avg. Canopy Height:

Canopy Cover %:

Dominant Species present:

Community Type:

Forest: height > 5m & > 60% canopy cover- Gallery Semi-deciduous Forest - Dry Semi-deciduous Forest

Woodland: height > 5m & 25-50% canopy cover - Gallery Semi-deciduous Woodland - Semi-deciduous Woodland

Shrubland: height < 5m & > 25% shrub canopy cover & < 25% tree canopy cover

Mixed Dry Shrubland- diverse, with Cacti and Agave

Thicket Scrub- thorny, dense, closed cover, 3-4m tall with occasional emergent tree

Gallery Shrubland - found in small guts and ravines

Wetlands: Mangrove (forest, woodland, shrubland), Salt Pond, Salt flat

Herbaceous: (coastal grassland)

Beach

Coastal Hedge

(Gibney *et al.* 2000)

1

BUIS TRAINING POINTS FOR VEGETATION MAPPING

Area Description/Sub Strata:

Disturbance?

Successional stage?

Representative of Polygon?

Remarks/Point changed? :

2

Appendix F: Reference Literature

F.1 A guide to Caribbean vegetation types: preliminary classification system and descriptions

F.2 Environmental assessment for Buck Island Reef National Monument St. Croix, U. S. Virgin Islands: control and management of non-native invasive plants

F.3 Vegetation of Buck Island Reef National Monument

F.4 U.S. Virgin Islands vegetation community classification: basic community descriptions – habitat mapping in support of land use and biodiversity planning in the Virgin Islands

F.5 Vascular plant inventory and mapping of Buck Island Buck Island Reef National Monument St. Croix, U.S. Virgin Islands

F.6 The eradication of introduced rats at Buck Island Reef National Monument, St. Croix, U.S. Virgin Islands – Final Report

F.7 Flora of Buck Island Reef National Monument (U.S. Virgin Islands)

F.1 A guide to Caribbean vegetation types: preliminary classification system and descriptions

Areces-Mallea, A. E., A. S. Weakley, X. Li, R. G. Sayre, J. D. Parrish, C. V. Tipton, T. Boucher. 1999. A guide to Caribbean vegetation types: preliminary classification system and descriptions. The Nature Conservancy, International Institute of Tropical Forestry – USDA Forest Service, Eros Data Center – U.S. Geological Service, USAID, Washington.

A Guide to Caribbean Vegetation Types:

Preliminary Classification System and Descriptions

Written by
Alberto E. Areces-Mallea, Alan S. Weakley, Xiaojun Li, Roger G. Sayre, Jeffrey D. Parrish, Camille V. Tipton and Timothy Boucher

Edited by
Nicole Panagopoulos









A Guide to Caribbean Vegetation Types: Preliminary Classification System and Descriptions

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The mission of The Nature Conservancy is to preserve the plants, animals and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive.

Table of Contents

Acknowledgments **1**

Executive Summary **3**

Chapter One **9**
Vegetation Classification and Vegetation Mapping of the Caribbean Islands—A Review
- Background 9
- General Classification Systems Applicable to Caribbean Tropical Vegetation 10
- Major Vegetation Classification Systems and Vegetation Maps for the Greater Caribbean 11
- Major Vegetation Classification Systems and Vegetation Maps for Islands or Groups of Islands 14
  - Aruba, Bonaire, and Curaçao 14
  - Bahamas (Including Turks and Caicos) 14
  - Bermuda 14
  - Cayman Islands 14
  - Cuba 15
  - Hispaniola 16
  - Jamaica 17
  - The Lesser Antilles 18
  - Puerto Rico and the Virgin Islands 19
  - Trinidad and Tobago 21

Chapter Two **23**
The International Classification of Ecological Communities (ICEC)
- Overview 23
- Classification Units versus Mapping Units 24

Chapter Three **25**
Standardized Terminology for Classifying Vegetation

Chapter Four **41**
Vegetation of the Caribbean Islands: Formations

Conclusion **55**

Appendices

Appendix One 59
Vegetation of the Caribbean Islands: Descriptions of Alliances and Associations

Appendix Two 137
Caribbean Vegetation Classification References

Appendix Three 163
Members of the Caribbean Vegetation Ecology Working Group

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Alberto Areces-Mallea	The New York Botanical Garden
Dayle Barry	U.S. Virgin Islands Conservation Data Center
Luis Beltrán Burgos	Puerto Rico Natural Heritage Program
Tim Boucher	The Nature Conservancy
Gary Breckon	University of Puerto Rico Biology Department
Daniel Dávila Casanova	Puerto Rico Natural Heritage Program
Olasee Davis	University of the Virgin Islands
William Edwards	International Institute of Tropical Forestry
Julio C. Figueroa Colón	International Institute of Tropical Forestry
Ethan Freid	Miami University of Ohio
Elanor Gibney	Virgin Islands specialist
Stevie Henry	U.S. Virgin Islands Conservation Data Center
Richard Howard	Harvard University Herbaria

Duane Kolterman	University of Puerto Rico Biology Department
Xiaojun Li	The Nature Conservancy
Eric Lindsay	**Department of Planning and Natural Resources—U.S. Virgin Islands**
Kevel Lindsay	Island Resources Foundation
Carol Mayes	The Nature Conservancy—U.S. Virgin Islands
Rudy O'Reilly	USDA Natural Resources—Conservation Science
Jeffrey Parrish	The Nature Conservancy
George Proctor	U.S. National Herbarium, Smithsonian Institute
Vicente Quevedo Bonilla	Puerto Rico Natural Heritage Program
Olga Ramos	International Institute of Tropical Forestry
Gary Ray	Virgin Islands specialist
Enrique del Risco	Instituto de Investigaciones Forestales—Cuba
Carlos Rodriguez	International Institute of Tropical Forestry
Roger Sayre	The Nature Conservancy
Susan Solander	U.S. Fish & Wildlife Service
Larry Tieszen	EROS Data Center, USGS
Alan Weakley	The Nature Conservancy

Contact information for this group can be found in Appendix Three**.**

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Executive Summary

Background

Stretching almost 6,800 km. and composed of a chain of over 1,000 islands, the West Indies have been and continue today to be a center of evolution and ecological diversity. Their geologic histories are varied: some islands are young and still actively volcanic, others older uplifts of fossilized coral reefs, others are but vestiges of once massive volcanic mountain chains which formed large land masses that have been at varying times interconnected and isolated. This complex history has led to the presence of many unique vegetation types which provide habitat for an astonishing diversity of flora and fauna, some of which is endemic to the region, and an alarming proportion of which is also highly threatened. Ultimately, our ability to protect this vast array of species and communities is dependent at the coarse level on our ability to target and conserve representative examples of these vegetation types. Conserving biological diversity at the level of natural communities is an important complementary approach to single-species conservation efforts because natural communities contain important assemblages of species and the habitats that support these species.

Improved conservation of the distinct natural vegetation types that occur on Caribbean islands is greatly facilitated if these vegetation types are accurately understood, described, and mapped in a manner that is accepted and respected by the diversity of countries, cultures, and peoples that make up the Caribbean today. The Caribbean Vegetation Classification and Atlas Project has been a key step towards characterizing the natural vegetation and landcover of the region, island-by-island, based on a newly derived standardized vegetation and classification system.

This Project has involved the following key steps:

⇒ review of existing vegetation classification efforts

⇒ convening of a Caribbean Vegetation Ecology Working Group

⇒ development of a Standard Classification System for the Caribbean

⇒ production of a Vegetation and Landcover Atlas following the newly derived standard classification system

After an exhaustive review of existing vegetation classification systems, the Working Group and project team developed a standardized vegetation classification system and set of maps which characterize the vegetation types of the Caribbean in a scientifically consistent manner.

Review of Previous Classification Efforts

Many distinguished botanists have visited the West Indies over the past centuries, but most botanical expeditions and research efforts have targeted individual islands. In fact, no comprehensive flora or detailed vegetation map exists for the whole region. As a result of this situation, very few regional vegetation studies have been conducted which cover the entire Caribbean archipelago and which are sufficiently detailed to be of practical value in the assessment of vegetation community status and distribution.

Various systems of classification have, however, been proposed for the vegetation of a few groups of Caribbean islands, or for individual islands themselves. Extensive library research was conducted throughout the project to produce a comprehensive list of published papers (over 700 references, presented in Appendix Two) dealing with vegetation classification and vegetation mapping in the Caribbean islands. Nine different classification systems were found that had relevance to the Caribbean and had been developed at larger scales (e.g., worldwide, or for the tropics of the Western Hemisphere), yet none of these had sufficient detail to prove useful for landscapes with the high variability and degree of endemism that exists in the Caribbean. Over 20 different classification systems were reviewed that dealt with the vegetation of individual islands (e.g., Cuba, Jamaica, or Hispaniola) or smaller groups of islands (e.g. Trinidad and Tobago, the Bahamas, and the U.S. Virgin Islands/Puerto Rico). Yet none of these could be extrapolated across the entire Caribbean to provide a classification structure for assessments of conservation status or distribution of vegetation types. An extensive review of Caribbean vegetation classification efforts can be found in Chapter One.

Adopting a Standardized Classification System

To develop a standardized classification system that enables regional scale comparisons of vegetation condition and distribution, a Caribbean Vegetation Ecology Working Group was convened. This group provided advice and data on vegetation types and distributions from the different island nations to adopt and approve a standard vegetation classification system. The Working Group, composed of 30 vegetation experts, identified the International Classification of Ecological Communities (ICEC) system (see Chapter Two) as an appropriate standard from which to work. This system has been selected by the United States Federal Geographic Data Committee (FGDC 1997) as the standard for describing vegetation communities in the United States. This vegetation classification system is international in design and concept, and is being developed for vegetation communities throughout the Americas.

Originally developed by ecologists from The Nature Conservancy in partnership with scientists from the network of Natural Heritage Programs, Conservation Data Centers, government agencies, and academia, this classification system is based on earlier work by the United Nations Educational Scientific Cultural Organization (UNESCO 1973) and Driscoll et al (1984). Scientifically sound, consistent, and flexible, the system can be used to classify all types of vegetated communities, from natural to anthropogenic. One of its principal strengths is the standardized classification approach, enabling scientists from different areas to assess and compare the distribution and condition of vegetation types using a common "currency." The classification system also permits these assessments and comparisons to be made at multiple levels of detail, depending on the amount and quality of data on vegetation patterns that are available.

The hierarchical structural units are:
Class
Subclass
Group
Subgroup
Formation
Alliance
Association

The ICEC describes vegetation types in several hierarchical levels. The upper levels in the hierarchy are defined by vegetation structure, and the finer levels are defined by vegetation composition. The ICEC is further described in Chapter Two.

Classification Results

A total of 104 vegetation formations were recognized for the Caribbean region—24 of which are new to the ICEC system. These 104 units are estimated to cover about 95% of the theoretical total number of vegetation formations potentially existing in the Caribbean islands. Descriptions of the Caribbean vegetation formations were developed, arranged with respect to their subordinate position within each major category of the ICEC system. Each standard term corresponding to a formation was accompanied by a short, abbreviated name both in English and Spanish, to be used as a mapping label. The most important formations—according to this new Caribbean system—were crosslisted with their equivalent vegetation units used in previous local or regional classification systems in the Caribbean, and a table with 438 components was developed. This effort, presented in Chapter Four, reconciled 21 of the most important vegetation systems used throughout the Caribbean islands.

A detailed, preliminary system of classification of the vegetation communities of the Caribbean Islands at the more precise alliances and associations level was also developed. Given the complexity of an archipelago that is considered one of the richest in the world in terms of plants species and communities, this was an extraordinary task. The new Caribbean vegetation system, based upon FGDC's classification standards recognized, named, and described 187 alliances. In addition, 199 associations were recognized and named. More than 90% of the associations were also briefly described, based on

the knowledge of the Vegetation Ecology Experts Working Group (See Appendix Three). This classification effort is estimated to have included about 50% of the theoretical total number of vegetation alliances and about 30% of all associations present in the Caribbean islands, many of which are still to be defined, named, and described. We estimate that there are about 350 vegetation alliances and 750 to 800 vegetation associations for the West Indian Islands.

The Caribbean Vegetation Atlas

To develop the Atlas, vegetation types at the formation level were mapped and organized into an atlas of Caribbean vegetation. This selection of existing vegetation maps of the West Indies covering most islands was digitally reproduced, and the polygons labeled with the original vegetation unit information. Depending upon island size and complexity of vegetation, working scales for these maps were determined individually, ranging from relatively small (1:500,000) to relatively large (1:24,000). These maps were carefully studied, then their mapping units were "crosswalked" (relabeled) to reconcile them with the standardized classification. Only the names were changed; the actual mapped areas for each of the vegetation types were not altered. The resulting atlas, available at http://edcintl.cr.usgs.gov/igdn/tnc/metadata.html, although limited by the quality of the original data, provides the first ever consistently labeled and classified map of the vegetation units of the Caribbean.

…the classification and Atlas can be used for regional vegetation assessments, cross-regional comparisons of vegetation distribution, and other environmental applications

Potential Uses of the Classification System and the Atlas

These final products will support Caribbean conservation practitioners in biodiversity conservation-related reporting, analysis, planning, monitoring, and decision making on both the site and regional scales. Although limited by currently available data, the classification and Atlas can be used for regional vegetation assessments, cross-regional comparisons of vegetation distribution, and other environmental applications (e.g., disaster preparedness, ecological restoration, and sustainable development projects) at regional scales. The products should also prove useful for similar applications at finer scales, both national and local (e.g., protected area network design, site conservation planning). The utility of the Atlas as a regional framework for economic, social, and natural resource development projects is potentially great.

Next Steps

The Atlas represents a comprehensive attempt to map Caribbean vegetation in a systematic fashion. It is a compilation of existing maps where vegetation has been relabeled into a singular, regional, standardized classification system. It is widely acknowledged, however, that some existing national

vegetation maps for Caribbean islands may be out-of-date, erroneous, or lacking information.

To improve the accuracy of the Atlas, the authors are currently acquiring recent satellite imagery to update the island-by-island vegetation maps. This second phase of Caribbean vegetation mapping will also include a regional conservation assessment based on a Gap Analysis to identify unprotected or underprotected vegetation types. Field verification of mapped vegetation types will also be conducted during this second phase, and refinement of the vegetation classification system itself as necessary.

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Chapter One
Vegetation Classification and Vegetation Mapping of the Caribbean Islands—A Review

Background

The West Indies constitute a complex chain of more than 1,000 islands stretching nearly 4,800 kilometers south from the Bahamas, extending east through Cuba, Jamaica, Hispaniola, Puerto Rico, and the Virgin Islands; curving due south to Grenada and Trinidad; and ending with a westward tail comprised of Aruba, Bonaire, and Curaçao. They are divided primarily into three main geographical units:

a) the Bahama Bank assemblage, located southeast of the Florida peninsula
b) the partially elevated platform of the Greater Antilles, which supports a mature volcanic range peaking in Hispaniola and sloping west to Cuba and Jamaica and east to Puerto Rico
c) the Lesser Antilles

This last group consists of an outer chain of islands composed of low coral and limestone arranged in a north-south direction from Anegada to Barbados, and an inner chain of steep volcanic islands which reach their peak in Dominica. The Lesser Antilles are further subdivided into the Leeward Islands, extending from the Virgin Islands to Guadeloupe, and the Windward Islands, stretching south from Dominica to Grenada.

Many distinguished botanists have visited the West Indies since the seventeenth century. The history of botanical interest in the Caribbean islands has been a long one, but it has been devoted primarily to the studies of individual islands from the times of Christopher Columbus to the nationalistic studies of island groups of more recent years (Howard 1973). In fact, no comprehensive flora or detailed vegetation map exists for the whole region. A project on the Flora of the Greater Antilles with an introductory chapter on vegetation has been initiated by the New York Botanical Gardens, but much remains to be done to make this document available. As a result of this situation, very few regional vegetation studies have been produced to cover the entire Caribbean archipelago, none of them is sufficiently detailed to be of current practical value. However,

various systems of classification have been proposed for the vegetation of some groups of Caribbean islands or for individual islands.

General Classification Systems Applicable to Caribbean Tropical Vegetation

Attempts to characterize and differentiate tropical vegetation ecosystems have generally involved grouping observations into classes, the members of which share common characteristics. This grouping may be followed by attempts to relate classes to underlying environmental conditions. However, generally acceptable classifications of tropical vegetation have proved somewhat elusive. As De Laubenfels (1975) pointed out, when external factors such as climate and soil are used as criteria, the resulting categories have lack validity. In fact, where vegetation characteristics reflect external factors, it makes more sense to use the vegetation characteristics as classifiers (Wadsworth 1997). Because of the great variety of physiognomic and environmental characteristics used to classify vegetation for various purposes, however, no classification has yet proven to be the most useful in all circumstances.

At the turn of the century, A. F. W. Schimper developed a system of classification in which plant communities were named reflecting general moisture and temperature regimes and local soil conditions as climatic or edaphic "formations." He defined "woodland" as vegetation dominated by woody plants, and included "forest" (if closed), "bushwood" (if shrubs were more abundant than trees), and "shrubwood" (if entirely of shrubs). In the tropics, Schimper (1903) recognized five woodland categories of climatic vegetation units, and six categories of edaphic units (see Appendix Two). Although Schimper somewhat underestimated edaphic influences on vegetation types in the wet tropics, where they are less evident than in the seasonal tropics, there is no doubt that he provided much groundwork for followers interested in the study and characterization of tropical vegetation.

Another scientist built upon Schimper's system to craft his own approach to classifying Caribbean vegetation. Chipp's classification system combines vegetative physiognomy with edaphic and climatic bases (Tansley and Chipp 1926) (see Appendix Two). However, Chipp's system did not cover all existing vegetation types (e.g. deciduous forests) and was vague as to the boundaries of some types. Yet another scientist, Champion, developed a system based on the use of physiognomy in classifying tropical forests (Champion 1936).

Tropical America's climate and soils are conducive to the natural development of forests. Barbour (1942) recognized four primary forest types for tropical America and the Caribbean, based primarily on the climatic character of

their associations. The four types are dry forest, rain forest, deciduous forest and cloud forest. In his work, Barbour expressed his preference for the European concept of the forest —as established by Cajander in 1926— over the concept adopted by American foresters (see Forest Terminology, in *J. of Forestry*, 15(1), 1917). The European forest concept intimately relates the forest to its ecological factors, whereas the American forest concept recognizes and separates the forest types in a descriptive fashion, according to their composition. Because Barbour's four basic categories applied well to Caribbean forest formations, Stehlé (1945, 1946) used them in his own system of classification of the Lesser Antilles' forest types with the corresponding descriptive terms of Xerophytic, Mesophytic, Hygrophytic, and Altitudinal.

Holdridge (1967) proposed a classification of the world's plant formations (now more correctly termed "life zones") based solely on climate. He considered temperature and rainfall to prevail over other environmental factors in determining vegetation. Although the Holdridge system of bioclimatic units has been used in the West Indies [e.g. in the Dominican Republic (Tasaico 1967) and Puerto Rico (Tosi 1959, Kumme and Briscoe 1963, Ewel and Whitmore 1973)], it has never been applied extensively in the region to make it a useful tool for comparing different islands. Actually, the Holdridge model has not been shown to be very practical in the Caribbean where different types of soil, exposure, relief, and many other geological and geographical factors strongly influence its plant communities. Notwithstanding, it could be very useful as a baseline model for the main categories of an integrated system of mapping units for the Caribbean.

In 1978, a committee from UNESCO attempted to standardize the classification of vegetation worldwide. The UNESCO system includes many categories for tropical and subtropical forest formations. The UNESCO system establishes physiognomically and environmentally-separated vegetation types in a multiple-tiered classification hierarchy.

Major Vegetation Classification Systems and Vegetation Maps for the Greater Caribbean

The Caribbean Islands were the first area in the New World to receive attention from botanists. On his second trip to Hispaniola in 1493, Christopher Columbus carried along a naturalist to assess the potential value of the plants in the newly discovered land (Moscoso 1943). It was not until 200 years later that scientific knowledge of plants began to accumulate with Plumier's *Description des Plantes de l'Amerique* (1693) and Sloane's *Catalogus plantarum quae in insula Jamaica sponte proveniunt* (1696). Although these islands are geographically close to one another, they each have a separate, distinct botanical history, related to their

Spanish, French, and English colonial statuses. This history of botanical isolation has persisted to the present time, maintaining an almost 300 year old tradition.

The classification of the vegetation in the Caribbean islands has often been performed in order to map the islands. Because of the area's multinational composition, this task has been accomplished on an individual island basis (or groups of islands) and at rather different scales. Also, different systems of classification have been used, and the results generally reflect the biases of what the mapper regards as important vegetation types, without taking very much into consideration the regional biogeographical context.

Most important among the regional systems is the system Beard developed (1944, 1955). This author proposed a three-category vegetation classification system based on floristics, physiognomy, and habitat. The floristic grouping recognized the climax association, the physiognomic grouping recognized the formation, and the habitat grouping recognized the formation-series. The twenty-eight categories presented on the following page by Beard apply to all of tropical America, but not all are represented in the Antillean archipelago.

Beard's Classification Hierarchy

I. OPTIMUM FORMATION

1. Rain forest

II. SEASONAL FORMATIONS

2. Evergreen seasonal forest
3. Semi-evergreen seasonal forest
4. Deciduous seasonal forest
5. Thorn woodland
6. Cactus scrub
7. Desert

III. DRY EVERGREEN FORMATIONS

8. Dry rain forest
9. Dry evergreen forest
10. Dry evergreen woodland and littoral woodland
11. Dry evergreen thicket and littoral thicket
12. Evergreen bushland and littoral hedge
13. Rock pavement vegetation

IV. MONTANE FORMATIONS

14. Lower montane rain forest
15. Montane rain forest or cloud forest
16. Montane thicket
17. High mountain forest
18. Elfin woodland or mossy forest
19. Paramo
20. Tundra

V. SEASONAL SWAMP FORMATIONS

21. Seasonal swamp forest
22. Seasonal swamp woodland
23. Seasonal swamp thicket
24. Savanna

VI. SWAMP FORMATIONS

25. Swamp forest and mangrove forest
26. Swamp woodland
27. Swamp thicket
28. Herbaceous swamp

Richard Howard was the most recent scientist to develop a system to classify the vegetation of the entire region. Howard (1973) used a simplified system of classification of seventeen categories for his study on the composition, distribution and relationships of the vegetation of the Antilles (see Appendix Two).

Major Vegetation Classification Systems and Vegetation Maps for the Islands or Groups of Islands

Aruba, Bonaire, and Curaçao

For the Leeward Islands, Stoffers described 18 different vegetation types, in three groups, applying the terminology of Beard (1949):

1. Primary climatic climax communties
2. Primary edaphic climax communities
3. Secondary and sub-climax communities

Stoffers published three relatively detailed vegetation maps for Aruba, Bonaire, and Curaçao in his classic paper *Studies on the flora of Curaçao and other Caribbean islands, vol. 1* (1956). Since all the recognized vegetation types are not represented in the three islands, Stoffers used varying units for each of his maps (see Appendix Two).

Bahamas (Including Turks and Caicos)

In 1905, Coker wrote the first important paper on the vegetation of the Bahama Islands, including six formations and nine associations (see Appendix Five). A number of additional studies concerning the vegetation of these islands were conducted by: McCartney *et al*. (1986), Godfrey and Herchenreder (1986), Kass and Stephens (1990) and Kass *et al.* (1994), Smith and Vankat (1992) and Smith *et al.* (1992), and Frazer and Eshbaugh (1993, 1997). Detailed maps and classification systems describing the vegetation of many islands within the Bahamas archipeligo are currently being developed.

Bermuda

Two major papers describing the floristics and vegetation of Bermuda were written by Britton (1918) and Herwitz (1992), respectively.

Cayman Islands

The Directorate of Overseas Surveys published a map (at a scale of 1:25,000) with units representing dominant species in the Caymans. Units uitilzed for Mangrove and Related Swamps are distinguished further by height classifications.

Cuba

Cuba is the largest island in the Greater Antilles. In 1943, Seifriz conducted the first vegetation research trip (*sensu strict*.) in Cuba using a geobotanic approach. From this trip he distinguished ten plant formations—thus providing a survey of the most important vegetation types of the island. León published the first vegetation map of Cuba in 1946 which appeared on the inside face of the cover of the first volume of the *Flora of Cuba* on a scale of 1:5,000,000. On the map, he distinguished eight vegetation types: Pinares (Pine forest/savanna), Manglares (Mangroves), Sabanas arenosas (Savannas on sandy soil), Vegetación de Mogotes (Limestone/serpentine vegetation), Vegetación Xerófila (Xerophilic vegetation), Sabanas arcillosas fértiles (Savannas on dry soil), Montes (Forests), Sabanas serpentinosas (Savannas on serpentine soil).

In 1954, E. Smith published *The Forests of Cuba*, a survey on valuable tree species found in Cuban forests. The report established a practical classification of forests from a forestry viewpoint and contained valuable data with qualitative lists and sample plot analyses. However, it is incomplete from a phytosociological angle.

Following the revolution in country in the 1960s, researchers from Czechoslovakia, East Germany, and Hungary began studying the vegetation of Cuba. V. Samek investigated the pine-woodlands and forests and the water vegetation of sandy lagoons (Samek and Moncada 1970) of western Cuba using the phytosociological methods of the Zürich-Montpellier School (Samek 1967, 1973a, 1973b). He also mapped the vegetation of the Isle of Pines in his work (Samek 1967, 1969). Hadac and Hadacová (1969, 1971) also contributed to the study of plant communities in the sandy regions of western Cuba. Borhidi, Muñiz, and del Risco published the first systematic review of Cuban plant communities in 1979. Subsequent intensive explorations of the plant communities have been made by Borhidi, Capote, and Balátová-Tulácková and collaborators (see Appendix Two).

Voronov and collaborators published the second map of Cuban vegetation on a scale of 1:1,500,000 in the *Atlas Nacional* (1970). However, this map does not distinguish among the different forest types, and the units cannot be identified with the generally accepted types shown by tropical vegetation maps. Areces-Mallea (1978) published a vegetation map of Cuba on a scale of 1:1,750,000. Due to the scale of this map, some closely related vegetation units are lumped together in major units. Thirty six vegetation units were mapped (see Appendix Five). A potential vegetation map at the scale of 1:375,000 was published by Borhidi (1974) containing 21 vegetation units. This map was the basis for a more detailed map distinguishing 34 vegetation units published in 1980, and revised in 1984. Capote and Berazaín (1984) developed a

classification system of all the vegetation formations of Cuba summarizing and describing the recognized units (see Appendix Five). An amended version of this system was used in the most recent Cuban vegetation map by Capote *et al.* (1989).

Hispaniola

Hispaniola, the second largest island of the Greater Antilles, has a complicated botanical history because of its bicultural colonial history. This is also complicated by Hispaniola's complex geological history and its diverse topography, with Pico Duarte reaching more than 3,100 m., the highest mountain in the Caribbean. In 1982, Liogier estimated the number of flowering plants on the island approaches 5,000 species.

Hispaniola, the second largest island of the Greater Antilles, has a complicated botanical history because of its bicultural colonial history.

Durland (1922) discussed Hispaniola's forest types, distinguishing six different categories of forests and savannas. His classification system is simple and not therefore not very useful in describing Hispaniola's highly diverse vegetation. Ciferri published the first detailed description of the Dominican Republic's vegetation in 1936. His treatment follows the concept of climax vegetation, organizing it in stages of succession. Currently, most of the vegetation types identified by Ciferri can still be located in Hispaniola. Ciferri's system of classification, in particular the vegetation units, are patterned after the European concepts of succession and hierarchy popular during the early part of this century. Most of the observations of the island published between 1920-1930 belong to Ciferri and Ekman.

Chardon (1939) classified the forests of the Dominican Republic into six main categories. Due to the fact that Chardon was only concerned with forest exploitation, he did not consider any noncommercial timber vegetation type.

More recently, the Holdridge system (1947) has been applied to the vegetation of the island. Tasaico (1967) prepared a map of the life zones on a scale of 1:250,000 with descriptions based on the aforementioned Holdridge system. The sources of data for the map are aerial photographs and topographic maps, on a scale of 1:50,000 from the Series E034 and E733 of 1962, completed by the Instituto Cartográfico Universitario of the Universidad Autónoma de Santo Domingo and the U.S. Army Map Service. This map is considered potential vegetation, based on the Holdridge system.

In addition to these life zones, Tasaico's work included another seven transition zones which are inadequately described and are often unrecognizable in the field. Several existing vegetation studies and maps dealt only with small areas, such as the Peninsula de Barahona (Dirección Nacional de Parques 1986),

the western Sierra de Baoruco (Fisher- Meerow & Judd 1989), several mountain ecosystems (Liogier 1981), the sand dunes of Baní (SEA/Departamento de Vida Silvestre 1988), Catalina Island (Zanoni *et al.* 1989), Loma Diego de Ocampo (Zanoni 1990), Loma Quita Espuela (Hager 1990), and Los Haitises (Zanoni *et al.* 1990).

In 1990, the Secretaria de Estado de Agricultura (SEA) developed a classification system for the Dominican Republic that is the most detailed of all the systems ever proposed for Hispaniola (Hager and Zanoni 1993). The vegetation of Parque Nacional del Este was described and mapped using this system in a Rapid Ecological Assessment (REA) of the area in 1994-95 (The Nature Conservancy 1997). A national vegetation map using this classification was recently published (Moscosoa 1999) and is likely to receive considerable attention and use in the Dominican Republic. Moreover, ongoing classification work and vegetation studies by M. Mejía and R. Garcia at the National Botanical Gardens promise to keep vegetation classification work at the forefront of Dominican conservation efforts.

Jamaica

Jamaica, only one-seventh the size of Hispaniola, has a flowering plant flora of more than 3,200 species. The first diagram of the topographic distribution of the different vegetation types was recorded in 1857 by Ørsted, a Danish naturalist. Almost 100 years later, a comprehensive categorization of Jamaican plant communities was written by Asprey and Robbins (see Appendix Two) following Beard's system for Caribbean vegetation (1944, 1955). Jamaica's first island-wide Rapid Ecological Assessment (REA) conducted by The Nature Conservancy in 1992 resulted in a new vegetation classification system (see Appendix Five, Grossman et. Al.) which resembles the categories of Beard (1944 and 1955) and Asprey & Robbins (1953).

A number of vegetation studies have greatly influenced the classification of communities within the Blue and John Crow Mountains National Park of Jamaica. These studies include montane vegetation descriptions developed by Shreve in 1914 and much more recent accounts focusing on the Blue and John Crow Mountains. Shreve was first to report a high altitude grassland in the Blue Mountains near High Peak, and he also distinguished between various forests by topography, ridges, windward and leeward slopes, and gullies.

Grubb and Tanner (1976) documented eight forest types for the Blue and Port Royal mountain ranges and two for the John Crow range. The establishment of permanent plots (1977) generated ecological baseline data for future studies (Healey 1990 and Tanner 1980a, 1980b, 1986). Bellingham collected

extensively along the ridges and the lesser explored northern slopes (1993) while Iremonger augmented the descriptions of the forests above 1,850 meters.

For the most part, the Blue Mountain lower montane forests have not been well described, although a survey was conducted by Asprey and Robbins in 1953. Their account was based on observations from the Cuna Cuna Pass area and the John Crow Mountain lower slopes. In contrast, the lower slopes of the John Crow Mountains was better described by Kelly and collaborators (1986, 1988). Permanent plots were established in these studies, resulting in good baseline data. The upper montane forests, however, have only been briefly described by Asprey and Robbins (1953) and Grubb and Tanner (1976). In 1994, The Nature Conservancy conducted a Rapid Ecological Assessment in the Blue and John Crow Mountains National Park, a survey which gathered more data about the vegetation of the Mountains.

The Lesser Antilles

The first major papers treating the vegetation of the Lesser Antilles was published in 1945 and 1946 by Stehlé, an agricultural and agronomic engineer based in Martinique.

In his system, Stehlé recognized fifteen forest facies, all dependent on altitudinal distribution, rainfall, and soil (see Appendix Five). Additionally, he published a simplified vegetation map of the Lesser Antilles on a scale 1:1,195,000 (1945), very general in coverage and only reflecting his aforementioned five major forest types.

In 1942, J. S. Beard, then of the Colonial Forest Service in Trinidad and Tobago, carried out an assessment of the forest resources of the Windward and Leeward island groups. Working with the guidance and financing of the British Treasury in London under the Colonial Development and Welfare Plan, Beard began a decade of work by questioning the existing classification systems.

Early in his investigations, he realized that the systems of classification then in use for these islands lacked any real ecological basis. He therefore proposed a new system of vegetation classification which led to the classic monograph, *The Natural Vegetation of the Windward and Leeward Islands* (1949). Beard defined his formations (climax natural vegetation types) according to physiognomy, structure, and life-form, arranging them in a series along environmental gradients (see Appendix Five). These formations were further subdivided into associations (communities) based on floristic compositions. In addition, he described the Lowland Rain Forest to be the “optimum” expression of vegetational development, with variations in formations representing deviations from the optimum. Deviations could consist of differences due to drought (seasonal formations) and poor soil conditions (edaphic formations), to

name a few examples. Additionally, Beard provided black-and-white maps recording the vegetation of the following islands: Antigua, Barbuda, Dominica, Grenada, Montserrat, Nevis, St. Kitts, St. Lucia, and St. Vincent.

The flora and vegetation of Dominica was described by Hodge, who listed five formations of plant community classifications (see Appendix Two).

Harris (1965) published an interesting ecological study of Antigua, Barbuda, and Anguilla describing nine vegetation types (see Appendix Two).

Portecop (1978) published an important, color, vegetation map (scale 1:75,000) for Martinique. Kimber (1988) describes the flora and all the vegetation units of this island in detail in his monograph of the island.

Other vegetation maps and papers published in the last decade covering the flora of different islands include:

- St. Lucia: Organization of American States, 1987
- St. Kitts: Meagher, 1996
- Anguilla, St. Martin, St. Barthélemy, Saba, St Eustasius, Barbuda, St. Kitts, Nevis, Antigua, Montserrat, Guadeloupe, Dominica, Martinique, St. Lucia, Barbados, St. Vincent, St. Vincent Grenadines, Grenada Grenadines, and Grenada: The Eastern Caribbean Natural Area Management Program, 1980
- St. Vincent, St. Vincent Grenadines, St. Kitts, Nevis, St. Lucia, Dominica, Antigua, Barbuda, and Grenada: The Caribbean Conservation Association, 1991

A recent vegetation classification study was developed for the islands of Antigua, Barbuda, and Redonda (Lindsay and Horwith, 1997), adhering to the National Vegetation Classification System proposed by the U.S. Federal Geographic Data Committee (1996). Fifty-four alliances/associations were identified in this study.

Puerto Rico and the Virgin Islands

Puerto Rico, the smallest island in the Greater Antilles, has a long botanical history, and in addition to Cuba, has a number of vegetation studies and vegetation maps. Most important and useful are the classical studies of Gleason and Cook (1927) and Dansereau (1966). Little and Wadsworth (1964) and especially Ewel and Withmore (1973) published important maps, the latter based on the Holdridge system of life zones. More recently, Ramos and Lugo (1994) produced a vegetation map of the island interpreting a 1977-1978 set of aerial photographs. Other attempts at mapping of vegetation in Puerto Rico (e.g. Murphy 1916, and Picó 1954, 1969) provide more limited information and are not taken into consideration in this summary report.

Dansereau (1966) recognized and mapped six major vegetation zones, generalized and extrapolated from physiographic and climatic features. Within each zone he distinguished, but did not map, 34 different ecosystems, and within the ecosystems identified a number of vegetational units defined by their composition and structure (see Appendix Five). Ewel and Whitmore (1973) published a 1:250,000 color map of the Vegetation of Puerto Rico and its neighboring islands: Mona, Desecheo, Vieques and Culebra. The map also included the three U.S. Virgin Islands, St. Croix, St. Thomas, and St. John. The basis of classification used for this map was the life zone system devised by Holdridge (1947, 1967).

Ewel and Whitmore were not the first to introduce Holdridge's system in Puerto Rico. The system was applied first to the island by Tosi (1959), although the author applied the concept only to western Puerto Rico, and the work was done prior to the elimination of high temperatures in the calculation of biotemperature. Similarly, Kumme and Briscoe (1963) mapped the island using climatic data, but they modified the climatic limits of the life zone boundaries, rendering their work of limited value.

Ramos and Lugo's 1994 map meticulously interpreted a set of aerial photographs from 1977 and 1978, resulting in a map that reflects the actual vegetation coverage at that time. Twelve general categories of vegetation were recognized. However, this map does not accurately reflect the island's individual vegetation types.

In 1980, the Eastern Caribbean Natural Area Management Program published simple vegetation maps for Anegada, Virgin Gorda, and Tortola, (BritishVirgin Islands). In a similar manner, Foreman described the characteristics of the 10 distinctive ecosystem types, which are mostly based on vegetation (see Appendix Two).

Trinidad and Tobago

In 1939, Marshall published the one of the first maps with practical value of the major forest types of Trinidad and Tobago. He recognized 14 major forest types in his study.

A turning point in the vegetation knowledge of Trinidad occurred in 1946 when Beard published a highly detailed vegetation map of the island. Beard, then working for the Colonial Forest Service in Trinidad and Tobago, proposed 30 units in his classification system. This work built upon a previous black and

white map Beard developed of the islands recognizing 10 vegetation units) (see Appendix Two).

Concurrent with the publication of his major vegetation map and classification system for Trinidad, Beard published two smaller maps (1946b) dealing with specific forest types. He later published a map which focused on the savannas of Trinidad (1953). Additional maps detailing the vegetation of Trinidad were published by Beebe (1952) and Ross (1961). Brown and collaborators introduced a vegetation map of Tobago with six vegetation units in 1965.

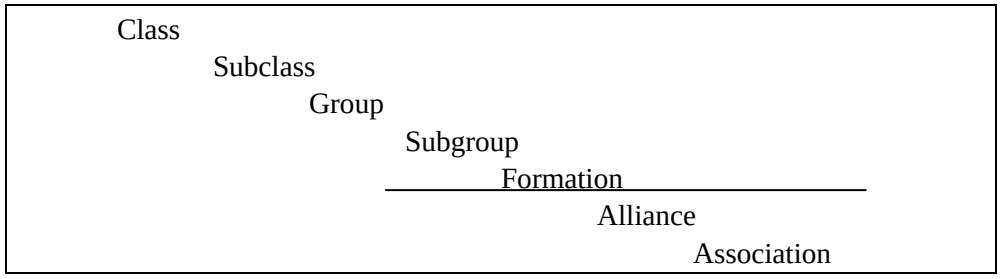
The following chapters will describe in detail the classification system adopted for this project, the units which form its hierarchy, and an explanation of terms utilized in describing these vegetation units.

Chapter Two
The International Classification of Ecological Communities (ICEC)

Overview

As has been seen in the previous chapter, a number of classification systems have been employed to describe Caribbean vegetation. A standardized classification system that described Caribbean vegetation in a unified, consistent manner would enable cross-island, regional scale comparisons of vegetation distribution. One such classification system, the International Classification of Ecological Communities (ICEC), groups vegetation communities in a standardized, globally compatible manner. The ICEC was selected by the Federal Geographic Data Committee (FGDC) as the national standard for describing vegetation in the United States, where it is also known as the U.S. National Vegetation Classification (USNVC) system.

The ICEC is a modified version of the UNESCO worldwide framework for classifiying vegetation at coarse scales. In the UNESCO system, vegetation is classified by its physiognomic characteristics (vegetation structure). The ICEC adds newer, finer levels of classification which incorporate floristic characteristics (vegetation composition). The hierarchical levels that describe the ICEC are as follows:



The first five levels in the classification hierarchy separate vegetation types according to physiognomic differences. The two "lowest" tiers in the classification hierarchy, Alliance and Association, represent the finest classification of vegetation, incorporating floristic information as well. For more information on the ICEC, please consult Grossman et al. (1998) and Maybury (ed.), 1999.

The ICEC system was selected and refined for classifying and mapping the vegetation of the Caribbean. Vegetation types on Caribbean islands which had previously been classified using another system were reconciled to the ICEC by studying individual units in detail and "crosswalking" them to the appropriate level and unit in the ICEC.

Classification Units versus Mapping Units

It is important to note here that the classification units used to describe vegetation types are not always the same mapping units that are used to portray the distribution of vegetation on the ground. Mapping vegetation is normally accomplished by delineating areas or features discernible in imagery (aerial photographs or satellite images) onto a map base. These discernible features in imagery are usually the result of differences in spectral reflectance from objects on the ground. Since different vegetation types usually produce different spectral reflectances, it is generally possible to map different vegetation types from imagery. These map units, however, nearly always need to be reconciled with vegetation classification units, which distinguish vegetation types based on physiognomic (structure) and floristic (composition) differences, not spectral properties. Mapped vegetation types must always be interpreted in this regard, as there is rarely a one-to-one correspondence between vegetation types displayed on a map and vegetation types described in a vegetation classification system.

The remainder of this document presents the classification units which we developed for the Caribbean using the ICEC framework. The next chapter presents a glossary of terms to simplify understanding of the vegetation descriptions.

Chapter Three
Standardized Terminology for Classifying Vegetation

The following terms and definitions are used in the International Classification of Ecological Communities (ICEC). We include this glossary here, prior to presentation of the classification system, to simplify understanding of the vegetation descriptions.

Agricultural Field - Bare Soil, Crop Residue - Cropland, either tilled or untilled, which has little or no live crop vegetation present. Such areas may or may not have crop residue from previous crops on the surface. This category also includes cropland in a fallow state -- that is, cropland which has been left idle during the whole or greater portion of the growing season.

Alliance - A physiognomically uniform group of Associations sharing one or more diagnostic (dominant, differential, indicator, or character) species which, as a rule, are found in the uppermost stratum of the vegetation.

Alluvial - Characterized by the deposition of sediment by a stream or other running water at any point along its course.

Alpine - The zone on mountain tops between permanent snow and the cold limits of trees.

Annual - Plant species that complete their life-cycle within a single growing season.

Annual Close-Grown Forbs and Grasses - Annual (non-perennial) forbs and grasses which are drill-seeded or broadcast. Examples include wheat, barley, and oats.

Annual Row-Crop Forbs and Grasses - Annual (non-perennial) forbs and grasses planted in rows on a regular and generally consistent row and plant spacing. Examples include corn, soybeans, tomatoes, potatoes, sorghum, and cotton.

Annual Vegetation - Associations that persist for less than one year or are dominated by annual species.

Assemblages - Vegetative communities composed of several to many different species of plants that assemble themselves based on specific site conditions and the presence of seed.

Association - The finest level of the classification standard. The Association is a physiognomically uniform group of vegetation stands that share one or more diagnostic (dominant, differential, indicator, or character) overstory and

understory species. These elements occur as repeatable patterns of assemblages across the landscape, and are generally found under similar habitat conditions. (The Association refers to existing vegetation, not a potential vegetation type).

Biennial - Plant species that complete their life-cycles within two growing seasons.

Boreal - Northern biogeographical region typically referring to subpolar and cold temperate areas.

Brackish - Tidal water with a salinity of 0.5-30 parts per thousand.

Broad-leaved - A plant with leaves that have well-defined leaf blades and are relatively wide in outline (shape) as opposed to needle-like or linear; leaf area is typically greater than 500 square millimeters or 1 square inch.

Bryophyte - Nonvascular, terrestrial green plant, including mosses, hornworts, and liverworts.

Bunch Grass - Multi-stemmed (caespitose) life form of grasses characterized by clumps of erect shoots that slowly spread horizontally by tillers, generally creating distinct individual plants spaced across the ground; often applied to sedges and other graminoids with similar life forms.

Caespitose (cespitose) - Describes a low branching pattern from near the base that forms a multi-stemmed or a bunched appearance.

Canopy Cover - The proportion of ground, usually expressed as a percentage, that is occupied by the perpendicular projection down on to it of the aerial parts of the vegetation or the species under consideration. The additive cover of multiple strata or species may exceed 100%.

Canopy Stratum - Canopy layer.

Classification - The grouping of similar types (in this case – vegetation) according to criteria (in this case – physiognomic and floristic) which are considered significant for this purpose. The rules for classification must be clarified prior to identification of the types within the classification standard. The classification methods should be clear, precise, where possible quantitative, and based upon objective criteria, so that the outcome would be the same whoever performs the definition (or description). Classification necessarily involves definition of class boundaries (UNEP/FAO 1995).

Cliff - Any high, very steep to perpendicular, or overhanging face of a rock outcrop.

Closed Tree Canopy - A class of vegetation that is dominated by trees with interlocking crowns (generally forming 60-100% crown cover).

…The Association is a physiognomically uniform group of vegetation stands that share one or more diagnostic (dominant, differential, indicator, or character) overstory and understory species…

Crosswalk - Organizational and definitional property of a classification standard which provides that all its categories either share a common definition with an FGDC vegetation standard category at some level of the hierarchy, or represent a subset of one and only one category at a given level of the FGDC Vegetation Classification Standard. When a standard crosswalks with the FGDC Vegetation Classification, it means that all categories of the standard have one and only one place with the FGDC Standard where they logically exist. It does not mean that all categories of the standard must crosswalk to the same level of the FGDC Standard.

Cloud Forest - Tropical and subtropical montane forest characterized by a high incidence of low-level cloud cover, usually at the canopy level, promoting development of an abundance of vascular epiphytes.

Cold Deciduous - A class of vegetation where the leaves drop in the unfavorable season of winter frost and freeze. The foliage is dropped every year. Applied to vegetation adapted to cold season influences (temperate).

Conical-crowned - Describes a needle-leaved evergreen tree with a pyramidal or cone-shaped canopy or life form; for example, Douglas fir and silver fir (*Pseudotsuga menziesii* and *Abies amabilis*).

Cover - The area of ground covered by the vertical projection of the aerial parts of plants of one or more species.

Cover Type - A designation based upon the plant species forming a plurality of composition within a given area (e.g., Oak-Hickory).

Creeping - The pattern of stems growing at or just beneath the surface of the ground and usually producing roots at nodes.

Crustose Lichen - Lichen life form that grows in intimate contact with its substrate, lacks a lower cortex and rhizoids (root-like structures), and is impossible to separate from the substrate without destroying the thallus; lichen with an unlobed, flattened thallus, growing adnate to the substrate.

Cushion Plant - A low, woody, plant life form so densely branched that it forms a compact canopy that is pad- or bolster-like in appearance; usually with microphyllous foliage; characteristic of alpine and tundra plants.

Cylindrical-crowned - A needle-leaved evergreen tree with a narrow, essentially cylinder-shaped canopy or life form; for example, subalpine fir and black spruce (*Abies lasiocarpa* and *Picea mariana*).

Deciduous - A woody plant that seasonally loses all of its leaves and becomes temporarily bare-stemmed.

Deciduous Cover - Vegetation classes where 75% or more of the diagnostic vegetation is made up of tree or shrub species that shed foliage simultaneously in response to an unfavorable season. There is usually one "leaf-off" season every year.

Deciduous Vegetation - Associations in which deciduous woody plants generally contribute 75% or more to total dominant plant cover.

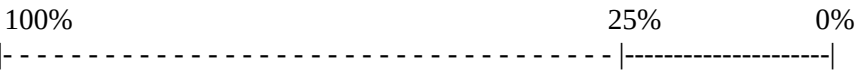
Diagnostic Species - a.k.a. **indicator species or phytometers**. Used to evaluate [i.e., diagnose] an area, or site, for some characteristic. For example, the presence and relative density of a Vaccinium stamineum var. stamineum (gooseberry) understory existing beneath a canopy of chestnut oak, black oak, and Virginia pine indicates that the site is xeric (or dry). The oaks and pines can inhabit a wide range of sites, wet to dry. But the gooseberry understory is the indicator of a drier habitat (which is probably due to a combination of factors including: soil type, slope, aspect, elevation, and site history).

Division - This is the first level in the classification standard separating Earth cover into either vegetated or non-vegetated categories (See also Order)

Dominance - The extent to which a given species or life form predominates in a community because of its size, abundance or cover, and affects the fitness of associated species. Dominance is interpreted in two different ways for vegetation classification purposes:



Where one or more vegetation strata (life form) covers greater than 25% (represented by the ---- line), the life form greater than 25% which constitutes the uppermost canopy is referred to as the dominant life form.



Where no vegetation life form covers greater than 25% (represented by the - - - line), the life form with the highest percent canopy cover is referred to as the dominant life form. In the case of a 'tie', the upper canopy will be referred to as the dominant life form.

Dominant - An organism, group of organisms, or taxon that by its size, abundance, or coverage exerts considerable influence upon an association's biotic (such as structure and function) and abiotic (such as shade and relative humidity) conditions.

Dominant Vegetation Stratum - see **Canopy Stratum** (above).

Drought Deciduous - Vegetation where the leaves drop in response to an annual unfavorable season characterized by drought. The foliage is dropped every year. Applied to vegetation adapted to climates with seasonal drought and little cold-season influence (tropical-subtropical).

Dwarf Shrubland - A class of vegetation dominated by a life form of shrubs and/or trees under 0.5 m tall. These types generally have greater than 25% cover of dwarf shrubs and less than 25% cover of trees and shrubs. Herbs and non-vascular plants may be present at any cover value. In rare cases (e.g., alpine and polar regions), dwarf shrub cover may exceed the cover of trees, shrubs, herbs and, non-vascular plants and be less than 25% of the total cover.

Dwarf Shrubs - Multi-stemmed woody plants with a life form at a height of less than 0.5 m due either to genetic or environmental constraints.

Earth Cover - The observed physical cover as seen on the ground or through remote sensing. Examples of earth cover classes might be vegetated, unvegetated, water and artificial cover (human construction). A given piece of land can only fit in one earth cover class that makes earth cover mutually exclusive at the same scale of mapping.

Ephemeral Forb Vegetation - Annual associations or synusiae that, during favorable periods, dominate areas that are usually sparsely vegetated or unvegetated for most of the year.

Epiphyte - Vascular plant that grows by germinating and rooting on other plants or other perched structures; sometimes called "air plants."

Episodic Forb Vegetation - Herbaceous-dominated associations that occupy areas periodically denuded of vegetation.

Ericoid - Plants of the Heath Family or Family Eriaceae; for example, heaths, rhododendrons, and blueberries (Erica, Rhododendron, and Vaccinium).

Established - Species that invade, occupy, and reproduce on a non-native site.

Evergreen - A plant that has green leaves all year round; or a plant that in xeric habitats has green stems or trunks and never produces leaves.

Evergreen Cover - Vegetation classes where 75% or more of the diagnostic vegetation consists of trees or shrubs having leaves all year. Canopy is never without green foliage. Examples are pine, spruce, juniper, laurel, Cefrela, Ceiba, Guaiacum, Live Oak, Magnolia, Mescal Bean, Texas Ebony, Palms, etc.

Evergreen Vegetation - Associations in which evergreen woody plants generally contribute 75% or more to total dominant plant cover; vegetation canopy is never without photosynthetic tissue.

Extremely Xeromorphic - Associations that are adapted primarily to growing in drought-persistent environments and are only secondarily adapted to other environmental stresses; plants typically have several well-developed xeromorphic characteristics.

Facultatively Deciduous - Evergreen species that shed leaves only under extreme conditions; this strategy is often associated with plants found in semiarid

saline/alkaline environments; for example, Atriplex-Kochia saltbush in Australia and North America.

Foliose Lichen - Lichen life form that is leafy in appearance and loosely attached to its substrate; lichen with a lobed, flattened thallus growing loosely attached to the substrate, the lobes flattened or inflated with distinctly differentiated upper and lower surfaces; umbilicate lichens are included.

Forb - A broad-leaved herbaceous plant.

Formation - A level in the classification based on ecological groupings of vegetation units with broadly defined environmental and additional physiognomic factors in common. This level is subject to revision as the vegetation Alliances and Associations are organized under the upper levels of the hierarchy. Different variables are applied to this hierarchical level in the sparsely vegetated class.

Fresh Water - Water with a salinity of less than 0.5 parts per thousand.

Fruit/Nut Shrubs and Vines (vineyards) - Areas dominated by fruit or nut shrubs and vines planted on a regular and generally consistent row and plant spacing. Vegetation is planted for the purpose of producing a fruit or nut crop. Examples include blueberries, cranberries, blackberries, and grapes.

Fruticose Lichen - Lichen life form that is bunched, shrubby or "hairy" in appearance and loosely attached to its substrate; lichen with the thallus branched, the branches solid, or hollow and round, or flattened without distinctly differentiated upper and lower surfaces; squamulose lichens are included.

Giant - Mature forests in which the height of a typical canopy exceeds 50 meters or 165 feet.

Graminoid - Grasses and grass-like plants, including sedges and rushes.

Grassland - Vegetation dominated by perennial graminoid plants.

Growth Form - The shape or appearance of a plant; it primarily reflects the influence of growing conditions.

Hemi-sclerophyllous - A plant with stiff, firm, leathery leaves that partially retain their rigidity during wilting; for example, rhododendron and salal (*Rhododendron* and *Gaultheria*).

Herb - A vascular plant without significant woody tissue above or at the ground; an annual, biennial, or perennial plant lacking significant thickening by secondary woody growth, with perennating buds borne at or below the ground surface (hemicryophytes, geophytes, helophytes, and therophytes of Raunkier).

Herbaceous - A class of vegetation dominated by non-woody plants known as herbs (graminoids, forbs and ferns). Herbs generally form at least 25% cover.

Trees, shrub and dwarf shrub generally have less than 25% cover. In rare cases, herbaceous cover exceeds the combined cover of trees, shrubs, dwarf shrubs, and non-vascular plants and is less than 25% cover. Height classes for the graminoids are short (<0.5 m), medium-tall (0.5-1 m) and tall (>1 m). Height classes for the forbs are low (<1 m) and tall (>1 m). For both graminoids and forbs, the height classes are measured when the inflorescences are fully developed.

Herbaceous Vegetation - Vegetation in which herbs (mostly graminoids, forbs, and ferns) form at least 25% cover, and woody vegetation has generally less than 25% cover; herbaceous cover may be less than 25% in cases where the cover of each of the other life forms present is less than 25% and herbaceous cover exceeds the cover of the other life forms.

Herbs - Non-woody vascular plants such as grasses, grass-like plants, and forbs.

Hydrophyte - A plant which has evolved with adaptations to live in aquatic or very wet habitats, e.g., cattail, water lily, water tupelo.

Hydromorphous Herbs - Herbaceous plants structurally adapted for life in water-dominated or aquatic habitats.

Intermittently Flooded - Substrate is usually exposed, but surface water can be present for variable periods without detectable seasonal periodicity. Inundation is not predictable to a given season and is dependent upon highly localized rainstorms. This modifier was developed for use in the arid West for water regimes of Playa lakes, intermittent streams, and dry washes but can be used in other parts of the U.S. where appropriate. This modifier can be applied to both wetland and non-wetland situations. Equivalent to Cowardin's Intermittently Flooded modifier.

Krummholz - Growth form assumed by tree species at the upper treeline or in the alpine zone; characterized by a creeping and multi-stemmed growth pattern due to desiccation and physical damage caused by wind and blowing ice crystals near the upper treeline; the same species grows as an erect, single-stemmed tree at lower elevation.

Landscaped Urban/Suburban/Rural - Areas consisting of partially or entirely planted vegetation which is intensively managed for aesthetics, erosion control, horticultural, and/or recreation. Examples include vegetated areas around residential dwellings, industry, golf courses, transportation right-of-ways, and nurseries.

Legend - The list of classification types that are portrayed on a map. The legend will contain a subset of the total classes in the overall classification standard.

Lichen - An organism generally recognized as a single plant that consists of a fungus and an alga or cyanobacterium living in symbiotic association.

Life Form (growth form) - A classification of plants based upon their size, morphology, habit, life span, and woodiness.

Lignified - A plant with woody tissue developed by secondary cell wall thickening by lignin and cellulose.

Low Forb - A broad-leaved herbaceous plant usually less than 1 meter or 3 feet tall when inflorescences are fully developed.

Lowland - A large land area with vegetation reflecting limits set by regional climate and soil/site conditions; an area where elevation is not the primary gradient affecting vegetation zonation.

Matted - A creeping plant that by reiterative growth has overlapping stems and forms a low, dense ground cover.

Medium-tall Grassland - Graminoid-dominated vegetation usually between 0.5 to 1 meter or 1.5 to 3 feet tall when inflorescences are fully developed in temperate zones and to 2 meters or 6 feet in tropical zones.

Metadata - Data about data. This describes the content, quality, condition, and other characteristics of data. Its purpose is to:

- help organize and maintain a organization's internal investment in spatial data
- provide information about an organization's data holdings to data catalogues, clearinghouses, and brokerages
- provide information to process and interpret data received through a transfer from an external source

Microphyllous - A plant with small leaves; individual leaf surface areas are less than 500 square millimeters or one square inch.

Mixed Evergreen-deciduous - Vegetation in which evergreen and deciduous species each generally contribute 25-75% to the total canopy cover.

Mixed Evergreen Deciduous Cover - A class of vegetation types where trees (or shrubs) are the dominant life form and neither deciduous nor evergreen species represent more than 75% of cover present.

Montane - The zone in mountainous regions where the influence of altitude (vertical relief) results in local climatic regimes that are sufficiently different from those in the adjacent lowlands as to cause a complex vertical climate-vegetation-soil zonation; includes vegetation at the base of a mountain when it is different from lowland vegetation.

Natural/Semi-natural - Areas dominated by native or established vegetation that has not been cultivated or treated with any annual management or manipulation regime. In cases where it cannot be assessed whether the

vegetation was planted or cultivated by humans, the vegetation is considered "Natural/Semi-Natural."

Needle-leaved - A plant with slender, elongated leaves; for example, pine and fir trees (*Pinus* and *Abies*).

Non-agricultural Disturbed Areas - Areas with little or no vegetation which have been disturbed by human activity other than for the production of agricultural crops. Examples include areas such as construction sites for urban and residential, mining operations, and landfills.

Non-vascular - Bryoids and lichens dominate with generally at least 25 % canopy cover, while trees, shrubs, dwarf shrubs, and herbs generally make up less than 25% cover. In some regions, non-vascular cover may exceed trees, shrubs, dwarf shrubs, and herbs and be less than 25% of the total cover.

Non-vascular Plant - A plant without specialized water or fluid conductive tissue (xylem and phloem); includes bryophytes, lichens, and algae.

Non-vascular Vegetation - Vegetation that is dominated by bryophytes and lichens, generally forming at least 25% cover, with other vegetation forming less than 25% cover; nonvascular cover may be less than 25% in cases where the cover of each of the other life forms present is less than 25% and nonvascular cover exceeds the cover of other life forms.

Non-vegetated - A class with less than 1 % of the surface area with vegetation cover naturally or from which vegetation is removed and replaced by man (human)-made surfaces or structures.

Open Tree Canopy - A class of vegetation types dominated by trees with crowns not touching, generally forming 25-60% cover. In rare cases, tree cover may exceed the combined cover of shrubs, dwarf shrubs, herbs and non-vascular plants and be less than 25% of the total cover.

Orchards and Groves - Areas dominated by fruit or nut trees planted on a regular and generally consistent row and plant spacing. Stands are planted for the purpose of producing a fruit or nut crop. Examples include areas used for the production of apples, peaches, oranges, pecans, walnuts, cherries, and bananas.

Order - This is a the next level in the hierarchy under Division. The Orders within the Vegetated Division are generally defined by dominant life form (tree, shrub, dwarf shrub, herbaceous, or non-vascular).

Pavement - A relatively flat surface of consolidated material, generally exposed bedrock.

Perennial - Plant species with a life-cycle that characteristically lasts more than two growing seasons and persists for several years.

Perennial Forb Close-Grown Crops - Perennial forbs which are drill-seeded or broadcast. Examples include alfalfa, clover, and lespedeza.

Perennial Forb Row Crops - Perennial forb vegetation planted in rows on a regular and generally consistent row and plant spacing. Examples include strawberries.

Perennial Grass Crops (hayland, pastureland) - Areas of dominantly perennial grasses, either native or non-native species, planted and/or intensively managed as pure or mixed-species stands. Stands often managed for the production of feed or seed, or are grazed. Examples include hayland, pastureland, and native pasture.

Perennial Herbaceous Vegetation - Associations that persist for several years and are dominated by herbaceous species.

Permanently Flooded - Water that covers the land surface at all times of the year in all years. Equivalent to Cowardin's (1979) "permanently flooded".

Permanently Flooded-tidal - Salt water that covers the land surface at all times of the year in all years. This modifier applies only to permanently flooded areas irregularly flooded by fresh tidal water. Equivalent to Cowardin's (1979) "permanently flooded/tidal".

Physiognomic Class - A level in the classification hierarchy defined by the relative percent canopy cover of the tree, shrub, dwarf shrub, herb, and nonvascular life form in the uppermost strata during the peak of the growing season.

Physiognomic Group - A level in the classification defined by a combination of climate, leaf morphology, and leaf phenology. Different variables are applied to this hierarchical level in the sparsely vegetated class.

Physiognomic Subclass - A level in the classification determined by the predominant leaf phenology of classes defined by tree, shrub, or dwarf shrub stratum (evergreen, deciduous, mixed evergreen-deciduous), and the average vegetation height for the herbaceous stratum (tall, medium, short). Different variables are applied to this hierarchical level in the sparsely vegetated class.

Physiognomy - The structure and life form of a plant community.

Plantations - Areas dominated by trees planted on a regular and generally consistent row and plant spacing. Stands are planted for the purpose of producing a crop of timber, Christmas trees, or other products. Examples include planted hardwood and softwood timber stands.

Planted/Cultivated - Areas dominated with vegetation which has been planted in its current location by humans and/or is treated with annual tillage, a modified conservation tillage, or other intensive management or manipulation. The majority of vegetation in these areas is planted and/or maintained for the

production of food, feed, fiber, or seed. This includes: vegetation planted in built-up settings, for recreation, erosion control, or aesthetic purposes, all areas used for the production of crops, such as corn, soybeans, vegetables, tobacco, cotton, wheat, and rice, grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, orchards, vineyards, and tree plantations planted for the production of fruit, nuts, fiber (wood), or ornamental. In cases where one can not assess whether it was planted by humans (e.g., some mature forests), the vegetation is consider "natural/semi-natural."

Plurality - The plant species that has the most numerous numbers on a site.

Polar - Geographically, the areas within the Arctic and Antarctic circles in which the sun is entirely not visible for six months and is constantly above the horizon for the next six months; climatically, polar regions are characterized by the lack of a period of warmth and by enduring cold; in polar climates the average temperature of each month is below 10º C (50º F).

Pulvinate Mosses - Mosses growing in cushion-like mats or clumps.

Rainforest - Vegetation in frost-free areas dominated by trees that are always wet from rain.

Repeatable Patterns of Assemblages - see **Cover Type**

Revolute - Rolled toward the lower surface of a leaf.

Rosulate - A plant with leaves arranged in rosettes (circular clusters).

Rounded-crowned - A needle-leaved evergreen tree with a basically semi-circular canopy or life form; for example, whitebark pine and alligator juniper (*Pinus albicaulis* and *Juniperus deppeana*).

Saltwater - Water with a salinity of greater than 30 parts per thousand.

Saturated - Surface water is seldom present, but substrate is saturated to surface for extended periods during the growing season. Equivalent to Cowardin's (1979) Saturated modifier.

Scale-leaved - A plant with small, overlapping leaves that usually lie flat on the stem; for example, eastern redcedar and western redcedar (*Juniperus virginiana* and *Thuja plicata*).

Sclerophyllous - A plant with usually evergreen leaves that are stiff and firm and retain their stiffness even when wilted; they are common in, but not restricted to, regions with a long summer drought and predictable yet limited winter rain.

Scree - A sheet of coarse rock debris covering a mountain slope without an adjacent cliff.

Scrub - Vegetation dominated by shrubs, including thickets.

Seasonal - Showing periodicity related to the seasons; applied to vegetation exhibiting pronounced seasonal periodicity marked by conspicuous physiognomic changes.

Seasonal Evergreen Vegetation - Associations in which most of the upper canopy plants retain leaves year-round and drop some leaves during unfavorable seasons.

Seasonally Flooded - Surface water is present for extended periods during the growing season, but is absent by the end of the growing season in most years. The water table after flooding ceases is very variable, extending from saturated to a water table well below the ground surface. Includes Cowardin's (1979) Seasonal, Seasonal-Saturated, and Seasonal Well Drained modifiers.

Semi-arid - A climatic region having an annual precipitation, usually between 25.4 and 50.8 centimeters or 10 and 20 inches, that is higher than a truly arid climate; typically, vegetation is composed of grasses with or without woody plant layers.

Semi-deciduous Vegetation - Associations (usually tropical and subtropical) in which most of the upper canopy trees are drought-deciduous and many of the understory trees and shrubs are evergreen. The evergreen and deciduous woody plants are not always separated by layers.

Semi-evergreen Vegetation - Associations in which evergreen and deciduous species each generally contribute 25-75% of total tree cover; specifically, this term refers to tropical and subtropical vegetation in which most of the upper canopy trees are evergreen mixed with drought-deciduous trees.

Semi-permanently Flooded - Surface waters persists throughout growing season in most years except during periods of drought. Land surface is normally saturated when water level drops below soil surface. Includes Cowardin's (1979) Intermittently Exposed and Semi-permanently Flooded modifiers.

Short Grassland - Graminoid-dominated vegetation usually less than 0.5 meters or 1.5 feet tall when inflorescences are fully developed.

Shrubland - A class of vegetation defined by areas dominated by shrubs generally greater than 0.5 m tall with individuals or clumps not touching to interlocking. Shrub canopy cover is generally greater than 25% while tree cover is generally less than 25%. In rare cases, shrub cover exceeds the tree, dwarf shrub, herb, non-vascular plant cover and is less than 25% cover.

Shrubs - Woody plants greater than 0.5 m in height that generally exhibit several erect, spreading, or prostrate stems; and have a bushy appearance. In instances where life form cannot be determined, woody plants greater than 0.5 m in height, but less than 5 m in height will be considered shrubs.

Sod Grass - A life form of graminoids that tends to develop a solid mat of grass, sedge, etc. over the ground by vegetative increase of rhizomes or stolons; resulting vegetation generally has few spaces between plants.

Sparsely Vegetated - A class of vegetation types that are defined as having a surface area with 1-10% vegetation cover over the landscape at the peak of the growing season.

Stomata - Pores or openings for gas exchange that are generally concentrated on leaf surfaces.

Subalpine - Upper mountain vegetation immediately below the cold limits of tree and tall shrub growth.

Subdesert - An area of xerophytic shrubby vegetation with a poorly-developed herbaceous layer.

Subgroup - A level of the hierarchy that splits Natural/Semi-Natural vegetation types from the Planted/Cultivated vegetation types.

Submontane - An area where the influence of altitude (vertical relief) does not result in local climate regimes that are sufficiently different from the adjacent lowlands as to cause a complex vegetation-climate-soil zonation; generally includes the foothills of a mountain range; the lowland vegetation at the base of a mountain that displays vegetation zonation.

Subpolar - Geographically, the region immediately equator-ward of the Arctic and Antarctic circles; climatically, winters are long and extremely cold, and summers are very short; only one month per year has a monthly average warmer than 10º C (50º F); as a rule, the ground is completely covered by snow for at least half a year; the region between the tundra and cold temperate forests or steppes.

Subtropical - Pertains to areas within tropical regions with variable (seasonal) temperature and moisture regimes; climatically, it has seasonal variation marked by dry/wet seasons rather than cold/hot seasons; parts of this region are subject to sub-0º C (32º F) temperatures but rarely have freezing periods of 24 hours or longer; in the United States this term includes southern Florida and the southern tip of Texas.

Succulent - A plant with fleshy stems or leaves with specialized tissue for the conservation of water; a xeromorphic strategy for tolerating long periods of drought.

Suffruticose - A somewhat shrubby plant in which the upper vegetative and flowering shoots die back to leave only the lower parts to survive unfavorable seasons.

Synusia - An association of plant species with a similar life form and similar ecological requirements occurring together in the same habitat; sometimes called a "union"; most habitats are occupied by several synusiae, which may grow above each other in layers, beside each other, or in mixture; for example, an open tree synusia or layer over a grass-dominated synusia or layer.

Tall Forb - Broad-leaved herbaceous plants usually greater than 1 meter or 3 feet tall when inflorescences are fully developed.

Tall Grassland - Graminoid-dominated vegetation usually over 1 meter or 3 feet tall when inflorescences are fully developed in temperate zones and greater than 2 meters or 6 feet in tropical zones.

Talus - A sloping accumulation of coarse rock fragments at the base of a cliff.

Temperate - A geographically, the region between the polar and tropical regions; climatically, the region is moderate with distinct seasons of alternating long, warm summers and short, cold winters.

Temporarily Flooded - Surface water present for brief periods during growing season, but water table usually lies well below soil surface. Often characterizes flood-plain wetlands. Equivalent to Cowardin's (1979) Temporary modifier.

Tidally Flooded - Areas flooded by the alternate rise and fall of the surface of oceans, seas, and the bays, rivers, etc. connected to them, caused by the attraction of the moon and sun [or by the back-up of water caused by unfavorable winds].

Trees - Woody plants that generally have a single main stem and have more or less definite crowns. In instances where life form cannot be determined, woody plants equal to or greater than 5 m in height will be considered trees.

Treeline - A zone where the normal growth of trees is limited, cold temperatures often combined with drought form the upper or arctic treeline, and drought combined with hot temperatures form lower or arid treeline.

Tropical - Geographically, the area between the Tropic of Cancer (23º 27' N) and the Tropic of Capricorn (23º 27' S), which includes tropical montane and alpine zones; climatically, the tropics are described as either the equatorial limits of freeze or, in temperate marine locations without freezing, the 65º F isotherm for the coldest month of the year; generally, tropical regions are characterized by high mean temperatures, small annual variation in temperature, and abundant rainfall throughout the year, although mountainous areas within the tropics are more variable.

Tuft-tree - Woody plant with large leaf-fronds or rosulate branches at the tips of major trunk(s); for example, palms and tree ferns.

Tundra - The treeless region north of the Arctic Circle (arctic tundra) or above the treeline of high mountains (alpine tundra) and on some sub-Antarctic islands; characterized by very low winter temperatures, short cool summers, permafrost

below a surface layer subject to summer melt, short growing season, and low precipitation.

Tussock - Graminoid life form consisting of bunch-like tufts, sometimes more than 1 meter or 3 feet tall, in which the hard, old, withered leaves are intermingled with the fresh, young, green leaves.

Vascular Plant - Plant with water and fluid conductive tissue (xylem and phloem); includes seed plants, ferns, and fern allies.

Vegetated - Areas having equal to or greater than 1% or more of the land or water surface with live vegetation cover at the peak of the growing season.

Vegetation - The collective plant cover over an area.

Vegetation Cover - Vegetation that covers or is visible at or above the land or water surface. It is a sub-category of Earth cover. The percentage of the ground covered by a vertical projection of the outermost perimeter of the natural spread of the foliage of plants.

Vegetation Data - The attributes of the vegetation that are used to classify and characterize the vegetation type and to map a vegetation stand. These data come from the interpretation of remotely sensed imagery, field work, and other thematic data sources.

Vegetation Stands - Contiguous areas that are homogenous with respect to the current condition of vegetation; that is, these are plant communities possessing sufficient uniformity in regard to composition and structure to be clearly different from adjacent areas.

Winter-rain - A climatic regime characterized by precipitation that occurs mostly as rain during cool winters that alternate with dry, hot summers; often associated with sclerophyllous vegetation.

Woody Plant - Plant species life form with woody tissue and buds on that woody tissue near or at the ground surface or above; plants with limited to extensive thickening by secondary woody growth and with perennating buds; includes phanerophytes and chamaephytes of Raunkier.

Woody - Containing lignified plant tissue.

Xeromorphic (Scleromorphic) - Having structural characteristics common among plants adapted to drought, i.e., small thick leaves with sunken stomata or revolute margins, surfaces that are heavily pubescent, waxy or highly reflective and small vein islets.

Chapter Four
Vegetation of the Caribbean Islands: Formations

TOTAL NUMBER OF FORMATIONS RECOGNIZED: 104

Order: ***TREE DOMINATED***
Class: ***I. CLOSED TREE CANOPY***
Subclass: ***I.A. EVERGREEN FOREST***

Group: ***I.A.1. Tropical and subtropical rain forest (mainly broad-leaved evergreen trees, neither cold- nor drought-resistant)***
Subgroup: ***I.A.1.N. Natural/Semi-natural***

Formations:

λ ***I.A.1.N.a.*** **Lowland rain forest**
Bosque pluvial de baja altitud
(Lowland Tropical or subtropical rain forest)[1]

λ ***I.A.1.N.b.*** **Submontane rain forest**
Bosque pluvial submontano
(Submontane Tropical or subtropical rain forest)

λ ***I.A.1.N.c.*** **Montane rain forest**
Bosque pluvial montano
(Montane tropical or subtropical rain forest)

λ ***I.A.1.N.d.*** **Cloud forest**
Bosque nublado
(Montane tropical or subtropical cloud forest)

λ ***I.A.1.N.f.*** **Seasonally flooded rain forest**
Bosque pluvial estacionalmente inundado
(Tropical or subtropical seasonally flooded rain forest)

λ ***I.A.1.N.j.*** **Solution-hole evergreen forest**
Bosque siempreverde de sumidero
(Solution-hole tropical or subtropical broad-leaved evergreen forest)[2]

λ ***I.A.1.N.k.*** **Riparian forest**
Bosque ripario
(Tropical or subtropical riparian forest)[3]

[1] The shorter term "forest" is preferred over the phrase "closed tree canopy". This lowland forest-type is here defined as having three canopy layers, the uppermost of which is completely closed and dominated by compound-leaves species often exceeding 30 m high. This formation occurs in areas of heavy rainfall, at least 2,000 mm of evenly distributed annual precipitation, mostly at elevations between 0 and 350-400 m . Corresponds to Borhidi's (1991) **Submontane rainforest** but not to Beard's (1944,1949, 1955) **Rainforest** or Dansereau's (1966) **Lowland rainforest**.

[2] New Formation (*sensu* Lindsay & Horwith 1997)

[3] New Formation.

Group: ***I.A.3. Tropical and subtropical seasonal evergreen forest (mainly broad-leaved evergreen trees with some foliage reduction in dry season)***
Subgroup: ***I.A.3.N. Natural/Semi-natural***

Formations:

- λ ***I.A.3.N.a.*** **Lowland seasonal evergreen forest**
  Bosque estacional siempreverde de baja altitud
  (Lowland tropical or subtropical seasonal evergreen forest)

- λ ***I.A.3.N.b.*** **Submontane seasonal evergreen forest**
  Bosque estacional siempreverde submontano
  (Submontane tropical or subtropical seasonal evergreen forest)

- λ ***I.A.3.N.e.*** **Seasonally/temporarily flooded seasonal evergreen forest**
  Bosque estacional siempreverde estacionalmente/temporalmente inundado
  (Seasonally or temporarily flooded tropical or subtropical seasonal evergreen forest)

Group: ***I.A.5. Tropical or subtropical broad-leaved evergreen sclerophyllous closed tree canopy forest***
Subgroup: ***I.A.5.N. Natural/Semi-natural***

Formations:

- λ ***I.A.5.N.a.*** **Lowland/submontane evergreen sclerophyllous forest**
  Bosque siempreverde esclerófilo de baja altitud/submontano
  (Lowland or submontane[4] tropical or subtropical broad-leaved evergreen sclerophyllous forest)

- λ ***I.A.5.N.d.*** **Semi-permanently flooded evergreen sclerophyllous forest**
  Bosque siempreverde esclerófilo semipermanentemente inundado
  (Semipermanently flooded tropical or subtropical broad-leaved evergreen sclerophyllous forest)

- λ ***I.A.5.N.e.*** **Mangrove**
  Manglar
  (Tidally flooded tropical or subtropical broad-leaved evergreen sclerophyllous forest)

Group: ***I.A.7. Tropical and subtropical needle-leaved (or needle-stemmed)[5] evergreen forest***
Subgroup: ***I.A.7.N. Natural/Semi-natural***

Formations:

- λ ***I.A.7.N.a.*** **Lowland/submontane pine forest**
  Bosque de pinos de baja altitud/submontano
  (Lowland or submontane tropical or subtropical needle-leaved evergreen forest)

Subgroup: ***I.A.7.C. Planted/Cultivated***

Formations:

- λ ***I.A.7.C.a.*** **Lowland/submontane pine forest plantation**
  Bosque plantado de pinos de baja altitud/submontano
  (Lowland or submontane tropical or subtropical needle-leaved evergreen forest plantation)

- λ ***I.A.7.C.b.*** **Casuarina forest plantation**
  Bosque plantado de Casuarina
  (Lowland or submontane tropical or subtropical needle-stemmed[6] evergreen forest plantation)

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[4] The term “submontane” is added, to include the lowland-submontane sclerophyllous evergreen oak forests of west Cuba.
[5] The phrase “or needle-stemmed” in parenthesis is added, to include the Australian “pine” forest plantations.
[6] New Formation, to include the needle-stemmed Australian “pine” forest plantations, under Subgroup C (Planted/Cultivated).

λ ***I.A.7.N.b.*** **Montane pine forest**
Bosque montano de pinos
(Montane or subalpine tropical or subtropical needle-leaved evergreen forest)

Group: ***I.A.10. Mixed tropical and subtropical needle-leaved-broad-leaved evergreen forest***[7]
Subgroup: ***I.A.10.N. Natural/Semi-Natural***

Formations:

λ ***I.A.10.N.a.*** **Mixed pine-broad-leaved forest**
Bosque mixto de pinos y latifolios
(Mixed tropical and subtropical needle-leaved-broad-leaved evergreen forest)[8]

Subclass: ***I.B. DECIDUOUS FOREST***

Group: ***I.B.1. Drought-deciduous forest***
Subgroup: ***I.B.1.N. Natural/Semi-natural***

Formations:

λ ***I.B.1.N.a.*** **Lowland/submontane drought-deciduous forest**
Bosque seco deciduo de baja altitud/submontano
(Lowland or submontane drought-deciduous forest)

Subclass: ***I.C. MIXED EVERGREEN-DECIDUOUS FOREST***

Group: ***I.C.1. Tropical or subtropical semi-deciduous forest***
Subgroup: ***I.C.1.N. Natural/Semi-natural***

Formations:

λ ***I.C.1.N.a.*** **Lowland semi-deciduous forest**
Bosque semi-deciduo de baja altitud
(Lowland tropical or subtropical semi-deciduous forest)

λ ***I.C.1.N.b.*** **Montane semi-deciduous forest**
Bosque semi-deciduo montano
(Cloud or montane tropical or subtropical semi-deciduous forest)

λ ***I.C.1.N.c.*** **Seasonally flooded/saturated semi-deciduous forest**
Bosque semi-deciduo estacionalmente inundado/saturado
(Seasonally flooded or saturated tropical or subtropical semi-deciduous forest)

Group: ***I.C.4. Xeromorphic mixed evergreen-deciduous forest***[9]
Subgroup: ***I.C.4.N. Natural/Semi-natural***

Formations:

λ ***I.C.4.N.b.*** **Xeromorphic semi-deciduous forest**
Bosque semi-deciduo xeromórfico
(Xeromorphic mixed evergreen-deciduous forest)[10]

[7] New Group.
[8] New Formation.
[9] The term “extremely” has been removed to distinguish the presence of two different formations (xeromorphic vs. extremely xeromorphic).
[10] New Formation, to include the semi-deciduous xeromorphic forests of central Cuba, which are physiognomically similar to the Brasilian “Cerrado” forests.

Class: ***II. OPEN TREE CANOPY (WOODLAND)***[11]
Subclass: ***II.A. EVERGREEN WOODLAND***

Group: ***II.A.1. Tropical or subtropical broad-leaved woodland***
Subgroup: ***II.A.1.N. Natural/Semi-natural***

Formations:

- ***II.A.1.N.a.*** **Evergreen woodland**
  Arboleda siempreverde
  (Tropical or subtropical broad-leaved evergreen woodland)

- ***II.A.1.N.b.*** **Seasonally/temporarily flooded evergreen woodland**
  Arboleda siempreverde estacionalmente/temporalmente inundada
  (Seasonally or temporarily flooded tropical or subtropical broad-leaved evergreen woodland)

- ***II.A.1.N.c.*** **Seasonally flooded/saturated evergreen woodland**
  Arboleda siempreverde estacionalmente inundada/saturada
  (Seasonally flooded/saturated tropical or subtropical broad-leaved evergreen woodland)

- ***II.A.1.N.d.*** **Semi-permanently flooded evergreen woodland**
  Arboleda siempreverde semi-permanente inundada
  (Semi-permanently flooded tropical or subtropical broad-leaved evergreen woodland)

- ***II.A.1.N.e.*** **Tidally flooded evergreen woodland**
  Arboleda siempreverde mareal
  (Tidally flooded tropical or subtropical broad-leaved evergreen woodland)

- ***II.A.1.N.f.*** **Hemisclerophyllous evergreen woodland**
  Arboleda siempreverde hemiesclerófila
  (Hemisclerophyllous tropical or subtropical broad-leaved evergreen woodland)[12]

- ***II.A.1.N.g.*** **Saturated evergreen woodland**
  Arboleda siempreverde saturada
  (Saturated tropical or subtropical broad-leaved evergreen woodland)

- ***II.A.1.N.h.*** **Solution-hole evergreen woodland**
  Arboleda de sumidero
  (Solution-hole tropical or subtropical broad-leaved evergreen woodland)[13]

Subgroup: ***II.A.1.C. Planted/Cultivated***

Formations:

- ***II.A.1.C.a.*** **Orchards**
  Frutales
  (Citrus, coconut and other fruit orchards)

Group: ***II.A.3. Tropical or subtropical needle-leaved (or needle-stemmed)***[14] ***evergreen woodland***
Subgroup: ***II.A.3.N. Natural/Semi-natural***

Formations:

- ***II.A.3.N.a.*** **Pine woodland**
  Arboleda de pinos
  (Tropical or subtropical needle-leaved evergreen woodland)

Subgroup: ***II.A.3.C. Planted/Cultivated***

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[11] The shorter term “woodland” is preferred over the phrase “open tree canopy”
[12] New Formation, to include Stoffer’s (1956) “Hippomane Woodlands”.
[13] New Formation.
[14] The phrase “or needle-stemmed” in parenthesis is added, to include the Australian “pine” woodland plantations.

Formations:

λ ***II.A.3.C.a*** **Casuarina woodland plantation**
Arboleda plantada de Casuarina
(Tropical or subtropical needle-stemmed[15] evergreen woodland plantation)

λ ***II.A.3.N.d.*** **Saturated pine woodland**
Arboleda de pinos saturada
(Saturated tropical or subtropical needle-leaved evergreen woodland)

Group: ***II.A.5. Extremely xeromorphic evergreen woodland***
Subgroup: ***II.A.5.N. Natural/Semi-natural***

Formations:

λ ***II.A.5.N.a.*** **Sclerophyllous extremely xeromorphic woodland**
Arboleda esclerófila extremadamente xeromórfica
(Sclerophyllous extremely xeromorphic evergreen woodland)

λ ***II.A.5.N.b.*** **Cactus woodland**
Arboleda de cactos
(Succulent extremely xeromorphic evergreen woodland)

Subclass: ***II.B. DECIDUOUS WOODLAND***

Group: ***II.B.1. Tropical or subtropical drought-deciduous woodland***
Subgroup: ***II.B.1.N. Natural/Semi-natural***

Formations:

λ ***II.B.1.N.a.*** **Lowland/submontane drought-deciduous woodland**
Arboleda seca decidua de baja altitud/submontana
(Lowland or submontane broad-leaved drought-deciduous woodland)

Subclass: ***II.C. MIXED EVERGREEN-DECIDUOUS WOODLAND***

Group: ***II.C.1. Tropical or subtropical semi-deciduous woodland***
Subgroup: ***II.C.1.N. Natural/Semi-natural***

Formations:

λ ***II.C.1.N.a.*** **Semi-deciduous woodland**
Arboleda semi-decidua
(Tropical or subtropical semi-deciduous woodland)

λ ***II.C.1.N.x.*** **Seasonally/temporarily flooded semi-deciduous woodland**
Arboleda semi-decidua estacionalmente/temporalmente inundada
(Seasonally/temporarily flooded tropical or subtropical semi-deciduous woodland)

Group: ***II.C.4. Extremely xeromorphic mixed evergreen-deciduous woodland***
Subgroup: ***II.C.4.N. Natural/Semi-natural***

Formations:

λ ***II.C.4.N.a.*** **Mixed evergreen-deciduous thorn woodland**
Arboleda espinosa mixta siempreverde-decidua
(Mixed evergreen-deciduous thorn woodland)

Order: ***SHRUB DOMINATED***
Class: ***III. SHRUBLAND (SCRUB)***
Subclass: ***III.A. EVERGREEN SHRUBLAND (SCRUB)***

[15] med Australian "pine" woodland plantations, under Subgroup C

Group: ***III.A.1. Tropical and subtropical broad-leaved evergreen shrubland***
Subgroup: ***III.A.1.N. Natural/Semi-natural***

Formations:

- λ ***III.A.1.N.a.*** **Evergreen shrubland**
  Matorral siempreverde
  (Tropical or subtropical broad-leaved evergreen shrubland. Includes bamboos and tuft-trees)

- λ ***III.A.1.N.b.*** **Hemisclerophyllous evergreen shrubland**
  Matorral siempreverde hemiesclerófilo
  (Hemisclerophyllous tropical or subtropical broad-leaved evergreen shrubland)

- λ ***III.A.1.N.c.*** **Sclerophyllous evergreen shrubland**
  Matorral siempreverde esclerófilo
  (Sclerophyllous tropical or subtropical broad-leaved evergreen shrubland)

- λ ***III.A.1.N.f.*** **Seasonally flooded evergreen shrubland**
  Matorral siempreverde estacionalmente inundado
  (Seasonally flooded tropical or subtropical broad-leaved evergreen shrubland)

- λ ***III.A.1.N.g.*** **Semi-permanently flooded evergreen shrubland**
  Matorral siempreverde semi-permanentemente inundado
  (Semi-permanently flooded tropical or subtropical broad-leaved evergreen shrubland)

- λ ***III.A.1.N.h.*** **Tidally flooded evergreen shrubland**
  Matorral siempreverde mareal
  (Tidally flooded tropical or subtropical broad-leaved evergreen shrubland)

- λ ***III.A.1.N.i.*** **Evergreen montane shrubland**
  Matorral siempreverde montano
  (Tropical or subtropical broad-leaved evergreen montane shrubland)[16]

- λ ***III.A.1.N.j.*** **Solution-hole evergreen shrubland**
  Matorral siempreverde de sumidero
  (Solution-hole tropical or subtropical evergreen shrubland)[17]

Group: ***III.A.4. Microphyllous evergreen shrubland***
Subgroup: ***III.A.4.N. Natural/Semi-natural***

Formations:

- λ ***III.A.4.N.a.*** **Lowland microphyllous evergreen shrubland**
  Matorral siempreverde micrófilo de baja altitud
  (Lowland microphyllous evergreen shrubland)[18]

- λ ***III.A.4.N.c.*** **Microphyllous montane fumarole shrubland**
  Matorral micrófilo montano de fumarolas
  (Microphyllous montane fumarole shrubland)[19]

- λ ***III.A.4.N.d.*** **Microphyllous montane shrubland with succulents**

[16] New Formation.
[17] New Formation.
[18] The term “lowland” is added.
[19] New Formation.

Matorral micrófilo montano con suculentas
(Microphyllous evergreen montane shrubland with succulents)[20]

Group: ***III.A.5. Extremely xeromorphic evergreen shrubland***
Subgroup: ***III.A.5.N. Natural/Semi-natural***

Formations:

- ***III.A.5.N.a.*** **Microphyllous evergreen extremely xeromorphic subdesert shrubland**
  Matorral subdesértico siempreverde micrófilo extremadamente xeromorfo
  (Broad-leaved microphyllous evergreen extremely xeromorphic subdesert shrubland – e.g. creosote bush)

- ***III.A.5.N.b.*** **Facultatively deciduous subdesert shrubland**
  Matorral subdesértico facultativamente deciduo
  (Facultatively deciduous extremely xeromorphic subdesert shrubland)

- ***III.A.5.N.c.*** **Succulent evergreen shrubland**
  Matorral siempreverde suculento
  (Succulent extremely xeromorphic evergreen shrubland)

- ***III.A.5.N.d.*** **Lowland/submontane serpentine shrubland**
  Matorral de baja altitud/submontano de serpentinas
  (Lowland or submontane evergreen extremely xeromorphic serpentine shrubland)[21]

- ***III.A.5.N.e.*** **Montane serpentine shrubland**
  Matorral montano de serpentinas
  (Montane evergreen extremely xeromorphic serpentine shrubland)[22]

- ***III.A.5.N.f.*** **Lowland wind-sculpted shrubland**
  Matorral ventoso-achaparrado de baja altitud
  (*Wind-sculpted lowland evergreen extremely xeromorphic shrubland)*[23]

Subclass: ***III.B. DECIDUOUS SHRUBLAND (SCRUB)***

Group: ***III.B.1. Drought-deciduous shrubland***
Subgroup: ***III.B.1.N. Natural/Semi-natural***

Formations:

- ***III.B.1.N.a.*** **Lowland drought-deciduous shrubland**
  Matorral seco deciduo de baja altitud
  (Lowland drought-deciduous shrubland)

Subclass: ***III.C. MIXED EVERGREEN-DECIDUOUS SHRUBLAND (SCRUB)***

Group: ***III.C.1. Mixed evergreen - drought-deciduous***

[20] New Formation.
[21] New Formation, to include the Cuban microphyllous/nanophyllous dense thorny shrublands on serpentine-derived soils.
[22] New Formation, to include the Cuban microphyllous dense montane shrublands on serpentine-derived soils, which correspond to a unique edaphic climax type developed under humid tropical rain forest climate.
[23] New Formation, to include the dense wind-sculpted shrublands of the coastal plain of Maisi, eastern end of Cuba. This Formation is characterized by a matted 1-3 m high shrub carpet with some leafless dwarf shrubs and sparse 8-25 m high emergent individuals of the palm species Coccothrinax alexandri. The occurrence of scattered globular, columnar and tree-shaped cacti is also characteristic.

Order: ***HERB/NON VASCULAR DOMINATED***
Class: ***V. HERBACEOUS***
Subclass: ***V.A. PERENNIAL GRAMINOID VEGETATION (GRASSLANDS)***

shrubland
Subgroup: ***III.C.1.N. Natural/Semi-natural***

Formations:

λ ***III.C.1.N.a.*** **Mixed evergreen - drought-deciduous shrubland with succulents**
Matorral mixto siempreverde-deciduo con suculentas
(Mixed evergreen - drought-deciduous shrubland with succulents)[24]

Class: ***IV. DWARF-SHRUBLAND (DWARF SCRUB)***
Subclass: ***IV.A. EVERGREEN DWARF-SHRUBLAND (DWARF-SCRUB)***

λ ***III.C.1.N.b.*** **Lowland/submontane mixed evergreen - drought-deciduous shrubland**
Matorral mixto siempreverde-deciduo de baja altitud/submontano
(Lowland or submontane mixed evergreen - drought-deciduous shrubland)[25]

λ ***III.C.1.N.c.*** **Seasonally flooded mixed evergreen - drought-deciduous shrubland**
Matorral mixto siempreverde-deciduo estacionalmente inundado
(Seasonally flooded tropical or subtropical mixed evergreen - drought-deciduous shrubland)[26]

Group: ***IV.A.2. Extremely xeromorphic evergreen dwarf-shrubland***
Subgroup: ***IV.A.2.N. Natural/Semi-natural***

Formations:

λ ***IV.A.2.N.c.*** **Tidally flooded evergreen dwarf-shrubland**
Matorral enano siempreverde mareal
(Tidally flooded needle-leaved or microphyllous evergreen dwarf-shrubland)

Subclass: ***IV.C. MIXED EVERGREEN-DECIDUOUS DWARF SHRUBLAND (DWARF SCRUB)***

[24] New Formation (FGDC has not defined Formations of Subgroup ***III.C.1.N.***).
[25] New Formation, to include the shrub-dominated forests of the Cuban "mogotes" on eroded limestone.
[26] New Formation (*sensu* Lindsay & Horwith 1997).

Group: ***IV.C.1. Mixed evergreen - drought-deciduous dwarf-shrubland***
Subgroup: ***IV.C.1.N. Natural/Semi-natural***

Formations:

λ ***IV.C.1.N.a.*** **Mixed evergreen - drought-deciduous dwarf shrubland**
Matorral enano mixto siempreverde-deciduo
(Mixed evergreen - drought-deciduous dwarf-shrubland)

λ ***IV.C.1.N.c.*** **Succulent-facultatively drought-deciduous dwarf shrubland**
Matorral enano suculento-facultativamente deciduo
(Succulent-facultatively drought-deciduous dwarf-shrubland)[27]

Group: ***V.A.1. Tropical or subtropical grassland***
Subgroup: ***V.A.1.N. Natural/Semi-natural***

Formations:

λ ***V.A.1.N.a.*** **Tall grassland**
Herbazal alto
(Tall tropical or subtropical grassland)

λ ***V.A.1.N.b.*** **Medium-tall sod grassland**
Herbazal cespitoso mediano-alto
(Medium-tall sod tropical or subtropical grassland)

λ ***V.A.1.N.c.*** **Medium-tall bunch grassland**
Herbazal de plantón mediano-alto
(Medium-tall bunch tropical or subtropical grassland)

λ ***V.A.1.N.d.*** **Short sod grassland**
Herbazal cespitoso corto
(Short sod tropical or subtropical grassland)

λ ***V.A.1.N.f.*** **Temporarily flooded grassland**
Herbazal temporalmente inundado
(Temporarily flooded tropical or subtropical grassland)

λ ***V.A.1.N.g.*** **Seasonally flooded grassland**
Herbazal estacionalmente inundado
(Seasonally flooded tropical or subtropical grassland)

λ ***V.A.1.N.h.*** **Semi-permanently flooded grassland**
Herbazal semi-permanentemente inundado
(Semipermanently flooded tropical or subtropical grassland)

λ ***V.A.1.N.i.*** **Tidally flooded grassland**
Herbazal mareal
(Tidally flooded tropical or subtropical grassland)

λ ***V.A.1.N.x.*** **Saturated grassland**
Herbazal saturado
(Saturated tropical or subtropical grassland)

Group: ***V.A.2. Tropical or subtropical grassland with a tree layer (generally 10-25%)***
Subgroup: ***V.A.2.N. Natural/Semi-natural***

Formations:

λ ***V.A.2.N.a.*** **Tall grassland with broad-leaved evergreen trees**

[27] New Formation (*sensu* Lindsay Y Horwith 1997).

Herbazal alto con árboles latifolios siempreverdes
(Tall tropical or subtropical grassland with mainly broad-leaved evergreen trees)

λ ***V.A.2.N.b.*** **Tall grassland with broad-leaved drought-deciduous trees**
Herbazal alto con árboles latifolios deciduos
(Tall tropical or subtropical grassland with broad-leaved drought-deciduous trees)

λ ***V.A.2.N.c.*** **Medium-tall grassland with broad-leaved evergreen trees**
Herbazal mediano-alto con árboles latifolios siempreverdes
(Medium-tall tropical or subtropical grassland with broad- leaved evergreen trees)

λ ***V.A.2.N.d.*** **Medium-tall grassland with broad-leaved drought-deciduous trees**
Herbazal mediano-alto con árboles latifolios deciduos
(Medium-tall tropical or subtropical grassland with broad-leaved drought-deciduous trees)

λ ***V.A.2.N.e.*** **Medium-tall grassland with needle-leaved evergreen or mixed trees**
Herbazal mediano-alto con árboles aciculifolios siempreverdes o mixtos
(Medium-tall tropical or subtropical grassland with needle-leaved evergreen or mixed trees)

λ ***V.A.2.N.f.*** **Medium-tall grassland with xeromorphic trees or succulents**
Herbazal mediano-alto con árboles xeromórficos o suculentas
(Medium-tall tropical or subtropical grassland with xeromorphic trees or succulents)

λ ***V.A.2.N.g.*** **Seasonally/temporarily flooded grassland with broad-leaved evergreen trees**
Herbazal estacionalmente/temporalmente inundado con árboles siempreverdes latifolios
(Seasonally/temporarily flooded tropical grassland with broad-leaved evergreen trees)

λ ***V.A.2.N.h.*** **Seasonally/temporarily flooded grassland with deciduous trees**
Herbazal estacionalmente/temporalmente inundado con árboles deciduos
(Seasonally/temporarily flooded tropical grassland with broad-leaved deciduous trees)

λ ***V.A.2.N.i.*** **Seasonally flooded/ saturated grassland with pine trees**
Herbazal estacionalmente inundado/saturado con pinos
(Seasonally flooded/saturated tropical or subtropical grassland with needle-leaved evergreen trees)

λ ***V.A.2.N.j.*** **Short grassland with pine or mixed trees**
Herbazal corto con pinos o árboles mixtos
(Short tropical or subtropical grassland with needle-leaved evergreen or mixed trees)[28]

λ ***V.A.2.N.k.*** **Short grassland with broad-leaved evergreen trees**
Herbazal corto con árboles latifolios siempreverdes
(Short tropical or subtropical grasslands with broad-leaved evergreen trees)[29]

Group: ***V.A.3. Tropical or subtropical grassland with a shrub layer (generally 10-25 %)***
Subgroup: ***V.A.3.N. Natural/Semi-natural***

Formations:

λ ***V.A.3.N.i.*** **Seasonally/temporarily flooded grassland with broad-leaved shrubs**
Herbazal estacionalmente/temporalmente inundado con arbustos latifolios
(Seasonally/temporarily flooded tropical or subtropical grassland with evergreen broad-leaved shrubs)

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[28] New Formation.
[29] New Formation.

Subclass: ***V.D. ANNUAL GRAMINOID OR FORB VEGETATION***

Group: ***V.A.4. Tropical or subtropical grassland with a dwarf-shrub layer (generally 10-25%)***
Subgroup: ***V.A.4.N. Natural/Semi-natural***

Formations:

λ ***V.A.4.N.b.*** **Forb-grassland with dwarf-shrubs and succulents**
Herbazal de dicotiledóneas y gramíneas con arbustos enanos y suculentas
(Tropical or subtropical forb-grassland with dwarf-shrubs and succulents)[30]

Subclass: ***V.B. PERENNIAL FORB VEGETATION***

Group: ***V.B.1. Tropical or subtropical perennial forb vegetation***
Subgroup: ***V.B.1.N. Natural/Semi-natural***

Formations:

λ ***V.B.1.N.b.*** **Low perennial forb vegetation**
Vegetacion perenne de herbáceas no graminoides
(Low tropical or subtropical perennial forb vegetation)

λ ***V.B.1.N.d.*** **Saturated perennial forb vegetation**
Vegetación saturada perenne de herbáceas no graminoides
(Saturated tropical or subtropical perennial forb vegetation)

λ ***V.B.1.N.e.*** **Tidally flooded perennial forb vegetation**
Vegetación mareal perenne de herbáceas no graminoides
(Tidally flooded tropical or subtropical perennial forb vegetation)

Subclass: ***V.C. HYDROMORPHIC VEGETATION***

Group: ***V.C.1. Tropical or subtropical hydromorphic[31] vegetation (without seasonal contrasts)***
Subgroup: ***V.C.1.N. Natural/Semi-natural***

Formations:

λ ***V.C.1.N.a.*** **Aquatic vegetation**
Vegetación acuática
(Permanently flooded tropical or subtropical hydromorphic[32] vegetation)

λ ***V.C.1.N.b.*** **Seagrass bed**
Pradera submarina
(Tidal permanently flooded tropical or subtropical hydromorphic rooted vegetation)

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[30] New Formation, to include Lindsay & Horwith's Lantana camara forb-grassland Alliance, and Beer's *et al.* Aristida-Tephrosia type.
[31] The term "rooted" was removed to include free-floating aquatic communities.
[32] The term "rooted" was removed to include free-floating aquatic plants/communities of lakes, rivers and ponds. This complex vegetation unit may consist of : (1) free-floating non rooted plants; (2) Rooted floating-leaf plants; (3) Rooted emergent plants; (4) rooted submerged plants, and/or (5) non-rooted submerged plants.

Group: ***V.D.1. Tropical or subtropical annual grasslands or forb vegetation***
Subgroup: ***V.D.1.N. Natural/Semi-natural***

Formations:

λ ***V.D.1.N.b.*** **Tall annual forb vegetation**
Vegetación alta anual de herbáceas no graminoides
(Tall tropical or subtropical annual forb vegetation)

λ ***V.D.1.N.d.*** **Tidal annual forb vegetation**
Vegetación mareal anual de herbáceas no graminoides
(Tidal tropical or subtropical annual forb vegetation)

Order: ***VEGETATION NOT DOMINANT***
Class: ***VII. SPARSE VEGETATION***
Subclass: ***VII.A. CONSOLIDATED ROCK SPARSE VEGETATION***

Group: ***VII.A.1. Sparsely vegetated cliffs***
Subgroup: ***VII.A.1.N. Natural/Semi-natural***

Formations:

λ ***VII.A.1.N.a.*** **Cliff vegetation**
Vegetación de acantilados
(Cliffs with sparse vascular vegetation)

Group: ***VII.A.2. Sparsely vegetated pavement***
Subgroup: ***VII.A.2.N. Natural/Semi-natural***

Formations:

λ ***VII.A.2.N.a.*** **Pavement vegetation**
Vegetación de costa rocosa
(Pavement with sparse vascular vegetation)

Subclass: ***VII.B. GRAVEL, COBBLE OR TALUS ROCK SPARSE VEGETATION***

Group: ***VII.B.1. Sparsely vegetated talus/scree slopes***
Subgroup: ***VII.B.1.N. Natural/Semi-natural***

Formations:

λ ***VII.B.1.N.a.*** **Talus/scree vegetation**
Vegetación de talud gravelítico
(Lowland or submontane talus/scree vegetation)

Group: ***VII.B.2. Sparsely vegetated rock flats ((boulders, cobble or gravel)***
Subgroup: ***VII.B.2.N. Natural/Semi-natural***

Formations:

λ ***VII.B.2.N.a.*** **Boulder field vegetation**
Vegetación sobre cantos rodados
(Boulder field vegetation)

Subclass: ***VII.C. UNCONSOLIDATED MATERIAL SPARSE VEGETATION***

Group: ***VII.C.1. Sparsely vegetated sand dunes***
Subgroup: ***VII.C.1.N. Natural/Semi-natural***

Formations:

λ ***VII.C.1.N.a.*** **Dunes with sparse vegetation**
Dunas con vegetación abierta
(Dunes with sparse herbaceous vegetation)

Group: ***VII.C.2. Sparsely vegetated sand flats***
Subgroup: ***VII.C.2.N. Natural/Semi-natural***

Formations:

λ ***VII.C.2.N.b.*** **Strand vegetation**
Vegetación de playa arenosa
(Intermittently flooded sand beaches and shores)

Group: ***VII.C.3. Sparsely vegetated soil slopes***
Subgroup: ***VII.C.3.N. Natural/Semi-natural***

Formations:

λ ***VII.C.3.N.c.*** **Submontane fumerole vegetation**
Vegetación de fumarola submontana
(Submontane fumeroles with sparse herbaceous vegetation)[33]

λ ***VII.C.3.N.d.*** **Montane fumerole vegetation**
Vegetacion de fumarola montana
(Montane fumeroles with sparse herbaceous vegetation)[34]

Group: ***VII.C.4. Sparsely vegetated soil flats***
Subgroup: ***VII.C.4.N. Natural/Semi-natural***

Formations:

λ ***VII.C.4.N.c.*** **Seasonally/temporarily flooded mud flats**
Lodazal estacionalmente/temporalmente inundado
Seasonally/temporarily flooded mud flats

λ ***VII.C.4.N.d.*** **Tidally flooded mudflat**
Lodazal mareal
(Tidally flooded mudflats)

[33] New Formation, to include the pioneer communities of submontane active fumeroles in the volcanic Lesser Antilles. The growth of plants and species composition is usually conditioned by the poisonous gases, the acidity of the soil, gas and other temperatures, and to other edaphic factors.
[34] New Formation, to include the pioneer communities of montane active fumeroles in the volcanic Lesser Antilles. Similar to the submontane type (VIII.C.3.N.c.), the vegetation is, however, less dry.

Conclusion

This document and accompanying Atlas contain the preliminary results of a major undertaking to classify and map Caribbean vegetation types. Both the classification system and the mapping are works in progress. The classification system has a number of units which are not currently, or are incompletely, described. The maps need to be refined with current information obtained from remotely sensed imagery.

With the help of a wide range of scientists, institutions, and organizations, we have completed what we see as the first phase of a two-part project. Phase One gathered a group of vegetation experts from across the region in an October 1998 workshop to review available data and refine maps as necessary. This Caribbean Vegetation Ecology Working Group (CVEWG) identified the International Classification of Ecological Communities (ICEC) as the standard from which to classify vegetation types of the Caribbean islands. This standardization allowed the relabeling of vegetation types from existing maps with standardized vegetation units. These maps were then compiled into the Caribbean Vegetation Atlas (a separate publication), an island-by-island set of maps using the best scale available.

In Phase Two, we will fill in our data gaps by acquiring the best and most current Landsat, Spot, or IRS imagery for the entire insular Caribbean. We will engage expert scientists to rectify, subset, and cluster the imagery we obtain, and field verify this imagery. With this new data, we may need to revise our initial classification. After this revision, we will reconvene the CVEWG to review our Phase Two maps and classification unit descriptions. A gap analysis will follow to determine the extent of the protection of vegetation types. These data will then be disseminated widely for use on the ground. This Phase Two product can serve as a framework for regional development planners, with utility in areas such as conservation and development planning, carbon budgeting, and disaster preparedness.

Appendix One
Vegetation of the Caribbean Islands: Descriptions of Alliances and Associations

I.A.1.N.a. Lowland tropical or subtropical rain forest[35]

Class: I. FORESTS
Subclass: I.A. EVERGREEN FOREST
Group: I.A.1. Tropical and subtropical rain forest (mainly broad-leaved evergreen trees, neither cold- nor drought-resistant)
Subgroup: I.A.1.N. Natural/Semi-natural

(LOWLAND RAIN FOREST)
(BOSQUE PLUVIAL DE BAJA ALTITUD)

***I.A.1.N.a. Carapa guianensis* Forest Alliance (Carapa guianensis lowland rain forests)**
CONCEPT: Rain forest community usually occurring below 400 m altitude, on yellowish-red mountain soils, with essentially monospecific 30-35 m tall upper canopy layer of *Carapa guianensis*, and a second and third species-rich canopy layers.
DISTRIBUTION: North-east Cuba: Sagua-Baracoa ranges.
SYNONYMY: Calophyllo-Dipholion (Borhidi *et al.* 1979; Borhidi 1991), in part.

***Carapa guianensis - Calophyllum utile* Forest**

DESCRIPTION: Closed upper canopy very strongly dominated by *Carapa guianensis*, or rarely mingled with some exceptionally tall individuals of the 20-25 m tall second canopy layer (e.g. *Calophyllum utile*). As opposed to the upper one, the second canopy layer is rich in species. Most common associates are *Calophyllum utile, Sloanea curatellifolia, Dipholis jubilla, Guarea guidonia, Cupania americana, Buchenavia capitata, Ficus wrightii*, and the Cuban royal palm *Roystonea regia.* Other palms (e.g. *Bactris cubensis, Prestoea montana,* and *Calyptronoma clementis ssp. orientensis*) are commonly found along creeks, between the second and third canopy layer. Most characteristic species of the 6-15 m tall third canopy layer are *Oxandra lanceolata, O. laurifolia, Cordia sulcata, Miconia elata, M. dodecandra, Cyathea araneosa* and *Hemitelia horrida.*
DISTRIBUTION: North-east Cuba: Moa region, and in the Toa, Jaguani and Duaba river basins.
COMMENTS: Although an essentially lowland community, the Carapa guianensis rain forest can also occur in a submontane situation, wherever annual precipitation exceeds 2,500 mm of evenly distributed rain throughout the year.
SYNONYMY: Manacales (León 1946), in part; Pluvisilva submontana (Areces-Mallea 1978); Bosque pluvial de llanura (Capote & Berazaín 1984); Bosque pluvial de baja altitud (Capote *et al.* 1989); Submontane rainforests (Borhidi 1991), in part; Calophyllo-Carapetum guianensis (Borhidi 1991).
REFERENCES: Borhidi (1991).

[35] The shorter term "forest" is preferred over the phrase "close tree canopy". This lowland forest-type is here defined as having three canopy layers, the uppermost of which is completely closed and dominated by compound-leaves species and often exceeds 30 m high. This formation occurs in areas of heavy rainfall, at least 2,000 mm of evenly distributed annual precipitation, mostly at elevations between 0 and 350-400 m . Corresponds to Borhidi's (1991) **Submontane rainforest**, in part, but not to Beard's (1944,1949, 1955) **Rainforest** or Dansereau's (1966) **Lowland rainforest.**

I.A.1.N.b. Submontane tropical or subtropical rain forest
(SUBMONTANE RAIN FOREST)
(BOSQUE PLUVIAL SUBMONTANO)

***I.A.1.N.b. Cecropia peltata-Ochroma pyramidale* Forest Alliance**
CONCEPT: These are disturbed successional forests, with *Cecropia* and *Ochroma* as major components.
DISTRIBUTION: Puerto Rico, Martinique, widepread in tropics.
REFERENCES: Kimber (1988); Dansereau (1966).

***Cecropia peltata - Andira inermis - Didymopanax morototoni* Forest**
DESCRIPTION: Successional forests. In Puerto Rico other associated species include *Andira inermis, Acrocomia aculeata, Erythrina poeppigiana, Didymopanax morototoni, Casearia spp.*, and *Ochroma pyramidale.*
DISTRIBUTION: Puerto Rico.
COMMENTS: This Alliance covers large portions of remaining forested lands in the lowland rain forest portions of Puerto Rico, at 0-250m in elevation.
SYNONYMY: Trumpet-wood forest (Dansereau 1966).
REFERENCES: Dansereau (1966).

***Cecropia peltata - Ochroma pyramidale - Sterculia caribaea* Forest**
DESCRIPTION: Forests of landslides, hurricane blowdowns, and other disturbed areas, dominated by *Cecropia peltata, Ochroma pyramidale, Sterculia caribaea, Sapium caribaeum, Chimarrhis cymosa*.
DISTRIBUTION: Martinique.
COMMENTS: Based on Kimber (1988).
SYNONYMY: Silverleaf-balsa Stands (Kimber 1988).
REFERENCES: Kimber (1988).

***I.A.1.N.b. Dacryodes excelsa - Sloanea berteriana* Forest Alliance (Dacryodes excelsa - Sloanea berteriana submontane rain forests)**
CONCEPT: Tropical forests dominated by *Dacryodes excelsa* and *Sloanea berteriana*, in Puerto Rico.
DISTRIBUTION: Puerto Rico.
COMMENTS: The floristic composition of these communities shows stronger relationships with the Greater Antilles than with the Lesser Antilles.
SYNONYMY: Rainforest-hygrophytia (Dansereau 1966).

***Dacryodes excelsa-Sloanea berteriana-Manilkara bidentata ssp. surinamensis* Forest**
DESCRIPTION: This forest typically has a dense canopy 20-30m tall. The forest is dominated by *Dacryodes excelsa, Sloanea berteriana, Manilkara bidentata ssp. surianamensis*, and *Magnolia splendens*, with as many as 150 other tree species present, including *Tetrazygia urbanii, Ormosia krugii, Tabebuia heterophylla, Prestoea montana, Inga fagifolia, Hirtella rugosa*, and many others.
DISTRIBUTION: Puerto Rico.
SYNONYMY: Rain forest (Gleason & Cook 1927), in part; Tabonuco forest (Dansereau 1966).
REFERENCES: Dansereau (1966); Chinea *et al.* (1993).

***I.A.1.N.b. Dacryodes excelsa - Sloanea massonii* Forest Alliance (Dacryodes excelsa - Sloanea massonii submontane rain forests)**
CONCEPT: Tropical submontane forests dominated by *Dacryodes excelsa, Sloanea massonii, Talauma dodecapetala Licania ternatensis* and a few other few species, in the Lesser Antilles.
DISTRIBUTION: Martinique, Guadeloupe, Dominica, Montserrat, St. Lucia, St. Vincent, Grenada, St. Kitts-Nevis and other islands in the Leser Antilles.
COMMENTS: The floristic composition of these communities is dominated by species endemic to the Lesser Antilles.
SYNONYMY: Lower montane rain forest (Beard 1944); Forêt hygrophytique (Stehlé 1945-1946); Lower montane forest (Dansereau 1966), in part; Rainforest (Kimber 1988).

***Dacryodes excelsa - Sloanea massonii - Talauma dodecapetala - Licania ternatensis* Forest**

DESCRIPTION: Lowland but mostly submontane rain forest of the Lesser Antilles, with *Dacryodes excelsa* and other tree species in the upper canopy, and a middle story of trees usually dominated by members of the Lauraceae, especially species of the genera *Nectandra* and *Ocotea.* In Martinique it formerly occupied large portions of the island, from 300-900 m elevation on the windward side and from 500-1000 m elevation on the leeward side, with an average yearly rainfall of 1500-2200mm. *Dacroydes excelsa* is fairly widespread in the Lesser Antilles; *Sloanea massonii, Talauma dodecapetala* and *Licania ternatensis* are endemic to the Lesser Antilles. Depending on the island, the very diverse canopy layers may include other species, e.g. *Sterculia caribaea* (Montserrat, Guadeloupe, Dominica, Martinique, St. Lucia, St Vincent, Trinidad-Tobago), *Tovomita plumieri* (Dominica, Martinique, St. Lucia), *Endlicheria sericea* (Guadeloupe, Marie Galante, Dominica, Martinique, St. Lucia, St. Vincent, Trinidad-Tobago), *Chimarrhis cymosa* (Antigua, Guadeloupe, Dominica, Martinique, St. Lucia, St. Vincent), *Byrsonima trinitensis* (Antigua, Guadeloupe, Dominica, Martinique, St. Lucia, St. Vincent, Grenada).
DISTRIBUTION: Lesser Antilles.
COMMENTS: Of all the above mentioned species, only *Dacryodes excelsa, Endlicheria sericea and Chimarrhis cymosa* are not endemic to the Lesser Antilles.
SYNONYMY: Dacroydes-Sloanea association (Beard 1949); Rainforest (Kimber 1988).
REFERENCES: Beard (1949); Kimber (1988).

***I.A.1.N.b. Hyeronima nipensis* Forest Alliance (Hyeronima nipensis submontane rain forests)**
CONCEPT: Tropical submontane rain forests dominated by *Hyeronima nipensis,* on acid ferralitic soils derived from serpentine bedrocks, in eastern Cuba.
DISTRIBUTION: East Cuba: Sierra de Nipe and Sierra Cristal.
SYNONYMY: Pluvisilva montana de las serpentinitas (Areces-Mallea 1978), in part; Bosque pluvial submontano (Capote *et al.* 1989); Podocarpo-Byrsonimion orientensis (Borhidi *et al.* 1979), in part; Semi-arid montane serpentine rainforests (Borhidi 1991), in part.

***Hyeronima nipensis - Sloanea curatellifolia - Byrsonima coriacea* Forest**

DESCRIPTION: Serpentine rainforest community with two canopy layers, a rather dense shrub layer, and a poorly developed herb layer. The 18-25 m high upper canopy is dominated by *Hyeronima nipensis,* or co-dominated by this former species and other associates such as *Sloanea curatellifolia, Byrsonima coriacea,* and *Chionanthus (Linociera) domingensis* This forest association is poor in tree-ferns, epiphytes, and bryophytes. Other common species may include, *Myrsine coriacea, Terminalia nipensis, Podocarpus ekmanii, Calophyllum utile, Ocotea cuneata, Coccoloba retusa, Chrysophyllum argenteum, Miconia serrulata, Dipholis cubensis,* etc.
DISTRIBUTION: East Cuba: Sierra de Nipe and Sierra Cristal, between 400 and 800 m elevation.
SYNONYMY: Hyeronimo-Sloanetum curatellifoliae (Borhidi 1991).
REFERENCES: Borhidi (1991).

***I.A.1.N.b. Laplacea haematoxylon* Forest Alliance (Laplacea haematoxylon submontane rain forests)**
CONCEPT: Submontane forest community co-dominated by *Laplacea haematoxylon,* occurring (at present) slightly above 600 m elevation in Jamaica, on dark-brown soils derived from shales or volcanic bedrocks.
DISTRIBUTION: Jamaica: The Blue Mountains.
SYNONYMY: Lower montane rain forest (Asprey & Robbins 1953; Grossman *et al.* 1993), in part.

***Laplacea haematoxylon - Solanum punctulatum - Turpinia occidentalis* Forest**

DESCRIPTION: Forest community with two tree strata, the 12-18 m upper one essentially co-dominated by three species: *Laplacea haematoxylon,*

Solanum punctulatum, and *Turpinia occidentalis* . The 4-10 m second canopy layer is richer in species: *Mecranium purpurascens, Psychotria corymbosa* and *Cestrum hirtum* are usually well represented, and tree-ferns are very frequent, particularly *Cyathea pubescens*. A characteristic diagnostic species of this association is *Boehmeria caudata,* which is absent from other forest types in the area. The shrub layer includes *Besleria lutea, Piper arboreum, Piper fadyenii, Acalypha virgata* and *Tournefortia glabra,* and the thick-stemmed woody climber *Marcgravia brownei* is present.
DISTRIBUTION: Jamaica: The Blue Mountains.
COMMENTS: The windward (north-facing) forests of this type differ from those in the leeward (south-facing) sides most noticeably in the abundance of pendent bryophytes and filmy ferns (Hymenophyllaceae), as well as a more hygrophilous ground flora.
SYNONYMY: Gully forest over shale or volcanic substrata (Grubb & Tanner 1976; Shreve 1914).
REFERENCES: Asprey & Robbins (1953); Grossman *et al.* (1993).

***Laplacea haematoxylon - Clethra occidentalis - Calophyllum calaba* Forest**
DESCRIPTION: Successional association established following disturbance of the former Laplacea-Solanum-Turpinia Forest, mostly by selective cutting of larger trees for timber. Small trees and tall weedy shrubs (e.g. *Piper* spp. and *Goldfusia colorata*) replace the original structure of the forest; the original association's species composition and coverage change by prevalence, under-representation, or absence of many of its associates. *Clethra occidentalis, Matayba apetala, Alchornea latifolia,* and small individuals of *Calophyllum calaba* are usually abundant. Other species may include *Laplacea haematoxylon, Guarea swartzii, Sapium jamaicense, Solanum punctulatum, Hedyosmum arborescens, Turpinia occidentalis,* and others.
DISTRIBUTION: Jamaica: The Blue Mountains range.
SYNONYMY: Disturbed gully forest (Grossman *et al.* 1993).
REFERENCES: Asprey & Robbins (1993); Grossman *et al.* (1993); Muchoney *et al.* (1994).

***I.A.1.N.b. Mora abbottii* Forest Alliance (Mora abbottii submontane rain forest)**
CONCEPT: Tall evergreen forests of Hispaniola dominated by *Mora abbotti,* occurring below 800 m altitude in areas with an average yearly rainfall of more than 2,400 mm.
DISTRIBUTION: Dominican Republic: Cordillera Septentrional; Cordillera Central.
SYNONYMY: Bosque de Mora abbottii (Hager & Zanoni 1993).

***Mora abbottii - Cyrilla racemiflora - Ocotea leucoxylon* Forest**
DESCRIPTION: A 25 m tall evergreen forest with emergent trees up to 35 m tall co-dominated by *Mora abbottii, Cyrila racemiflora,* and *Ocotea leucoxylon. Mora abbotti* is usually the prevalent species, sometimes covering 20% of the canopy strata. Other arboreal species may include *Pouteria domingensis, Calyptronoma dulcis, Carapa guianensis, Sloanea berteroana, Tabebuia sp.*, and many others. A very common epiphyte in this association is *Vriesea ringens.* Despite the dominance of *Mora abbottii,* this is a fairly rich community and about 40 species of trees have been reported in just one hectare of forest. However, the understory is poor and mostly formed by offspring of the canopy trees.
DISTRIBUTION: Dominican Republic: northeastern Cordillera Septentrional (Moca-Nagua); eastern Cordillera Central (Sierra Prieta, Loma Peguera, Bonao, Casabito, Pancholo-San Cristóbal, Banilejo-Rancho Arriba.
COMMENTS: This association is mostly found at 400-800 m elevation. However, some stands (i.e. Sierra Prieta and Loma Peguera/Bonao) may occurr at lower altitude (150 and 200 m, respectively).
SYNONYMY: Bosque de Mora abbottii (Hager & Zanoni 1993).
REFERENCES: Hager & Zanoni (1993).

***I.A.1.N.b. Oxandra laurifolia - Tetragrastis balsamifera* Forest Alliance (Oxandra laurifolia lowland rain forests)**

CONCEPT: Lowland forest community on red soils, occurring in small protected valleys alternating with the steep-sided (haystack) limestone mountains of northeastern Hispaniola, in areas with 2,000-2,200 mm of evenly distributed annual rainfall. Two closed canopy layers are present.
DISTRIBUTION: Hispaniola: Dominican Republic, in Los Haitises; Haiti? (Cape Jackson?).
SYNONYMY: Foresta udica a livello del mare (Ciferri 1936), in part; Bosque de Los Haitises (Hager & Zanoni 1993), in part.

***Oxandra laurifolia - Tetragrastis balsamifera - Dendropanax arboreus* Forest**

DESCRIPTION: The 25-30m tall upper canopy is mainly composed of *Oxandra laurifolia, Tetragrastis balsamifera, Dendropanax arboreus, Guarea guidonea, Sloanea berteriana* and *Ocotea spp.* Typical associates of the 5-15 m tall second canopy layer include small individuals of the above mentioned species, but also *Prestoea montana, Turpinia occidentalis, Cordia sulcata, Ormosia krugii, and Calyptronoma spp.*
DISTRIBUTION: North-east Hispaniola (Dominican Republic): Los Haitises range.
SYNONYMY: Foresta udica a livello del mare (Ciferri 1936), in part; Vegetación de los Valles, in Bosque de Los Haitises (Hager & Zanoni 1993).
REFERENCES: Hager & Zanoni (1993).

***I.A.1.N.b. Sloanea berteriana - Ormosia krugii* Forest Alliance (<u>Sloanea berteriana</u> submontane rain forests)**

CONCEPT: Submontane tropical forests of Hispaniola with a dense canopy dominated by *Sloanea berteriana, Ormosia krugii* and others, in areas of average yearly rainfall exceeding 2,000 mm. These rich communities seem to have formerly occupied large areas in the Cordillera Central (Dominican Republic).
DISTRIBUTION: Hispaniola.
SYNONYMY: Foresta udica su suolo acido (Ciferri 1936).

***Sloanea berteriana - Ormosia krugii - Laetia procera* Forest**

DESCRIPTION: Tall submontane forest with two canopy layers, the upermost may reach 25 m in hight or slightly more. This association is dominated by *Sloanea berteriana, Ormosia krugii,* and *Laetia procera.* Other tree species of the upper canopy include *Buchenavia tetraphylla, Tetragrastis balsamifera, Carapa guianensis, Oreopanax reticulatus* and many others. The second canopy layer may include *Byrsonima spicata, Ocotea leucoxylon, Guarea guidonia, Casearia arborea, Eugenia domingensis, Cyathea arborea, Bactris plumeriana, Prestoea montana, etc.* The shrub layer is mostly dominated by species of *Psychotria* such as *Psychotria uliginosa* and *Psychotria berteroana.*
DISTRIBUTION: Hispaniola: mostly in Cordillera Central.
COMMENTS: This community seems to be close to the submontane primeval forest association in central Hispaniola, which has been largely altered, or depleted. Small stands occur in Loma Herradura, south to Miches (Dominican Republic).
SYNONYMY: Associazione Sloanea-Ormosia (Ciferri 1936), in part; Bosque de la Cordillera Oriental (Hager & Zanonii 1993), in part.
REFERENCES: Ciferri (1936); Hager & Zanoni (1993).

***Didymopanax morototoni - Ormosia krugii - Inga fagifolia - Sloanea berteriana* Forest**

DESCRIPTION: Submontane forest community with two canopy layers, the uppermost 15-20 m high, with *Didymopanax morototoni, Ormosia krugii, Inga fagifolia, Sloanea berteriana, Zanthoxylum elephantiasis* and *Z. marticicense* as prevalent species. Tree-ferns (*Cyathea spp.*), palms, and lianas such as *Securidaca virgata, Paullinia pinnata, Marcgravia rectiflora,* and *Entada gigas,* are usually abundant, while in many places *Urera baccifera* dominates the shrub layer. *Scleria melaleuca* is often abundant.
DISTRIBUTION: Hispaniola: mostly in Cordillera Central.
COMMENTS: This is a successional forest established following disturbance of the <u>Sloanea-Ormosia-Laetia</u> association.
SYNONYMY: Associazione Sloanea-Ormosia (Ciferri 1936), in part; Bosque de la Cordillera Oriental (Hager & Zanoni 1993), in part.
REFERENCES: Ciferri (1936); Hager & Zanoni 1993).

***I.A.1.N.b. Thespesia grandiflora* Forest Alliance**
CONCEPT: Forests on hill slopes, dominated by *Thespesia (= Montezuma) grandiflora*. These uncommon forests are often nearly monospecific, and are particularly prevalent following disturbance. They seem to have formerly occupied larger areas in the past.
DISTRIBUTION: Puerto Rico.
COMMENTS: This forest type is limited to Puerto Rico (the dominant species is endemic).

I.A.1.N.c. Montane tropical or subtropical rain forest (MONTANE RAIN FOREST) (BOSQUE PLUVIAL MONTANO)

***I.A.1.N.c. Alchornea latifolia - Solanum acropterum* Forest Alliance (Alchornea latifolia - Solanum acropterum montane rain forests)**
CONCEPT: Tropical montane rain forests of Jamaica on limestone-derived soils, over 900 m elevation, with *Alchornea latifolia, Solanum acropterum, Calyptronoma occidentalis, Piper discolor*, and other species.
DISTRIBUTION: Jamaica: the John Crow Mountains.
SYNONYMY: Upper montane rain forest (Richards 1952; Grubb *et al.* 1963; Grossman *et al.* 1993), in part; Upper montane wet limestone forest (Grubb & Tanner 1976); Upper montane rain forest over limestone (Muchoney *et al.* 1994).

***Alchornea latifolia - Calyptronoma occidentalis - Solanum acropterum - Piper discolor* Forest**

DESCRIPTION: Rain forest community on limestone-derived light-brown clay loam, with a rather dense 8-11 m high canopy composed of *Alchornea latifolia, Solanum acropterum, Calyptronoma occidentalis, Clethra occidentalis, Piper discolor, P. arboreum, Laplacea haematoxylon, Hedyosmum arborescens, Guarea swartzii, Cleyera thaeoides, Conostogia montana*, and others. This association shares a number of species with the lower Psidium montanum submontane rain forests on limestone soils, e.g. *Calyptronoma occidentalis, Picramnia antidesma, Cordia elliptica, Ardisia brittonii, Psychotria discolor*, and *Syngonium auritum*, but the species *Solanum acropterum* has not been recorded in other montane forest types. Climbers are frequent and epiphytes abundant. The rather poor in species herb layer may be dominated almost exclusively by *Diplazium costale.*
DISTRIBUTION: Jamaica: the John Crow Mountains.
SYNONYMY: Upper montane wet limestone forest (Grubb & Tanner 1976); Typical variant of the upper montane rain forest over limestone (Muchoney *et al.* 1994).
REFERENCES: Grubb & Tanner (1976); Grossman *et al.* (1993); Muchoney *et al.* (1994)..

***Symphonia globulifera - Alchornea latifolia* Forest**

DESCRIPTION: Essentially similar in tree species composition to the Alchornea latifolia - Calyptronoma occidentalis - Solanum acropterum - Piper discolor Forest, but distinguished by its more open appearance, the presence of *Symphonia globulifera* and other species which favour soils with impeded drainage, and the much greater cover of the herb layer. This can be composed of *Scleria cubensis, Dicranpteris pectinata* and *Odontosoria jennmanii.* This association is dispersed in patches among the above mentioned forest, influenced by impeded drainage, on a dark-brown clay loam with massive structure.
DISTRIBUTION: Jamaica: The John Crow Mountains.
SYNONYMY: Edaphic variant of the upper montane rain forest over limestone (Muchoney *et al.* 1994).
REFERENCES: Muchoney *et al.* 1994.

***I.A.1.N.c. Bonnetia cubensis* Forest Alliance (Bonnetia cubensis montane rain forests)**

CONCEPT: Tropical montane rain forests dominated or co-dominated by *Bonnetia cubensis*, on rather poor acid ferralitic soils, in the serpentine plateaus of eastern Cuba between 800 and 900 m elevation.
DISTRIBUTION: East Cuba: Cuchillas de Moa and Toa.
SYNONYMY: Pluvisilva montana de las serpentinitas (Areces-Mallea 1978), in part; Podocarpo-Byrsonimion orientensis (Borhidi *et al.* 1991), in part; Semi-arid montane serpentine rainforests (Borhidi 1991), in part.

***Bonnetia cubensis - Pera ekmanii - Podocarpus ekmanii* Forest**

DESCRIPTION: Serpentine rainforest community of the high plateaus of the Cuchillas de Moa and Toa, in eastern Cuba. Characteristic species include *Bonnetia cubensis, Pera ekmanii, Podocarpus ekmanii, Moacroton ekmanii, Tabebuia dubia, T. clementis, Laplacea moaensis,* and *Purdiaea moaensis.* Other associates that may be locally abbundant include *Hyeronima nipensis, Jacquiniella globosa, Chionanthus (Linociera) domingensis, Matayba domingensis, Spathelia pinetorum, Tapura cubensis, Bactris cubensis,* and the tree-fern *Alsophila aquilina.*
DISTRIBUTION: East Cuba: Cuchillas de Moa and Toa ranges.
COMMENTS: This association shares many east-Cuban serpentine endemics with the Hyeronima nipensis submontane rain forests of Sierra de Nipe and Sierra Cristal.
SYNONYMY: Podocarpo-Bonnetietum cubensis (Borhidi 1991).
REFERENCES: Borhidi (1991).

***I.A.1.N.c. Cordia elliptica - Chimarrhis cymosa - Tovomita plumieri - Pouteria chrysophylloides* Forest Alliance**
CONCEPT: Montane rainforest of Martinique. Forests occupying small areas at elevations of 900-1000m on the windward side and 1000-1100m on the leeward side of Martinique. Two tree strata without an emergent layer are present, and the canopy averages 20m in height. Common tree species include *Cordia elliptica, Chimarrhis cymosa, Tovomita plumieri, Pouteria chrysophylloides, Ocotea dominicana (=Nectandra dominicana), Sterculia caribaea, Cecropia peltata, Poeteria dussiana, Podocarpus coriaceus, Clusia plukenetii, Prestoea montana, Inga coruscans, Calyptranthes fasciculata, Myrcia martinicensis, Freziera undulata var. elegans, Cyathea arborea, Cyathea muricata, Myrcia deflexa, Byrsonima martinicensis, Hedyosmum arborescens, Genipa americana, Ilex spp., Pouteria hahniana,* and *Rondeletia spp.*
DISTRIBUTION: Martinique.
COMMENTS: Based on Kimber (1988). Nominal species will likely need revision.
SYNONYMY: Montane Forest (Kimber 1988).

***I.A.1.N.c. Cyathea arborea* Forest Alliance**
CONCEPT: Tree-fern forests of Puerto Rico, dominated by the tree ferns *Cyathea arborea* and other tree ferns, including *Cnemidaria horrida*.
DISTRIBUTION: Martinique, Puerto Rico.
COMMENTS: Should this be combined with the next alliance?
SYNONYMY: Fern Scrub -- 77.4 (Dansereau 1966).
REFERENCES: Dansereau (1966); Kimber (1988).

***Cyathea arborea - Cnemedaria horrida / Dicranopteris nervosa - Sticherus bifidus* Forest**

DESCRIPTION: Other species include *Odontosoria aculeata, Palhinhaea cernua*.
DISTRIBUTION: Puerto Rico.
SYNONYMY: Fern Savana -- 77.3 (Dansereau 1966).

***Cyathea muricata - Cyathea arborea* Forest**

DESCRIPTION: The 5-10m tall canopy is dominated by combinations of *Cyathea muricata* and *Cyathea arborea*. Other typical species include *Oreopanax capitatum* and *Didymopanax urbanianum, Guzmania plumieri, Pitcairnia sp., Blechnum binervatum,* and abundant lycopods, mosses, and grasses.
DISTRIBUTION: Martinique.
COMMENTS: Based on Kimber (1988).

SYNONYMY: Tree Fern Colonies (Kimber 1988).

I.A.1.N.c. Cyrilla racemiflora - Micropholis spp. **Forest Alliance**
DISTRIBUTION: Puerto Rico.
REFERENCES: Weaver 1994.

Cyrilla racemiflora - Micropholis guyanensis - Micropholis garciniifolia - Ocotea spathulata **Forest**

DESCRIPTION: Other typical species include *Magnolia splendens* (in Luquillo Mountains), *Magnolia portoricensis* (in the central mountains), *Didymopanax gleasonii, Micropholis chrysophylloides, Croton poecilanthus, and Prestoa montana.*
DISTRIBUTION: Puerto Rico.
SYNONYMY: Colorado Forest.

I.A.1.N.c. Magnolia cubensis ssp. acunae **Forest Alliance (Magnolia cubensis ssp. acunae montane rain forests)**
CONCEPT: Humid montane rain forests of central Cuba forming a vegetation belt between 800 and 1,100 m, on yellow tropical soils. Characteristic trees are *Magnolia cubensis* ssp. *acunae, Ocotea acunaiana, Torralbasia lenticellata,* and others. This central-Cuban rain forest community is less rich and diverse than its climax equivalent in the ranges of eastern Cuba.
DISTRIBUTION: Central Cuba: Sierra del Escambray.
SYNONYMY: Pluvisilva montana de las rocas cuarcíferas (Areces-Mallea 1978), in part; Magnolion cubensis (Borhidi *et al.* 1979), in part; Bosque pluvial montano (Capote & Berazaín 1984; Capote *et al.* 1989), in part; Wet montane rain forests (Borhidi 1991), in part.

Magnolia cubensis ssp. acunae - Cyrilla racemiflora **Forest**

DESCRIPTION: Montane rain forest association characterized by *Magnolia cubensis* ssp. *acunae, Ocotea acunaiana, Ocotea floribunda, Torralbasia lenticellata, Miconia cubensis, Miconia albescens, Gesneria viridiflora ssp. colorata,* and others. The presence of submontane elements and some endemic taxa in the herb and shrub layers, such as *Pilea clarana, Pilea cellulosa, Pilea clementis,* and *Psychotria martii,* are also typical.
DISTRIBUTION: Central Cuba: Sierra del Escambray ranges.
COMMENTS: This association often occurs as extrazonal stands in the mountain ranges of Escambray.
SYNONYMY: Magnolio acunae-Cyrilletum racemiflorae (Borhidi 1991).
REFERENCES: Borhidi (1991).

I.A.1.N.c. Magnolia hamorii **Forest Alliance (Magnolia hamorii montane rain forests)**
CONCEPT: Montane rain forests dominated or co-dominated by *Magnolia hamorii,* on the exposed summits of Sierra de Bahoruco Oriental (Hispaniola), between 950 and 1,500 m elevation.
DISTRIBUTION: Hispaniola (Dominican Republic): Southwest to Barahona, in Sierra de Bahoruco Oriental.
SYNONYMY: Bosques de Ebano (Hager & Zanoni 1993), in part.

Magnolia hamorii - Oreopanax capitatus - Didymopanax tremulus **Forest**

DESCRIPTION: Rain forest community with a scattered 15-20 m high upper canopy co-dominated by *Magnolia hamorii, Oreopanax capitatus, Didymopanax tremulus, Ficus maxima, Ocotea leucoxylon, Ocotea sp., Persea krugii, Beilschmiedia pendula, Chionanthus ligustrinus, Anthirea oligantha, Chione sp.,* and *Obolinga Zanonii*. The denser 10-12 m high second canopy layer is formed by the offsprings of the tallest trees, and also by medium-size and small trees such as *Clusia clusioides, Prestoea montana, Miconia mirabilis, Myrsine coriacea, Ocotea nemodaphne,* and others. Shrubs include *Mecranium ovatum, Meriania involucrata, Cestrum daphnoides, Macrocarpea domingensis, Hedyosmum domingense, Psychotria berterii* and *Cyathea sp.*
DISTRIBUTION: Hispaniola (Dominican Republic): highlands between Loma Pie de Palo, Loma la Trocha de Rey (Monteada Nueva), Loma Remigio.
SYNONYMY: Bosque de *Magnolia hamorii* (Hager & Zanoni 1993), in part.

REFERENCES: S.E.A. (1990); Hager & Zanoni (1993).

***Magnolia hamorii - Brunellia comocladifolia - Alchornea latifolia* Forest**

DESCRIPTION: With a first canopy layer of rather dispersed tall trees (*Magnolia hamorii, Didymopanax tremulus*, and others), and a second canopy layer dominated by *Brunellia comocladifolia, Alchornea latifolia, Prestoea montana* and *Magnolia hamorii*. Bamboo-grass climbers (*Arthrostylidium* spp.) often become dominant in the understory.

DISTRIBUTION: Hispaniola (Dominican Republic): Highlands between Loma Pie de Palo, Loma la Trocha de Rey (Monteada Nueva), Loma Remigio.

COMMENTS: This is a successional community established in areas where the original Magnolia hamorii - Oreopanax capitatus - Didymopanax tremulus forest is disturbed, mostly because of mining and colonization.

SYNONYMY: Bosque de *Magnolia hamorii* (Hager & Zanoni 1993), in part.

REFERENCES: S.E.A. (1990); Hager & Zanoni (1993).

***I.A.1.N.c. Magnolia pallescens* Forest Alliance (Magnolia pallescens montane rain forests)**

CONCEPT: Rain forest vegetation dominated or co-dominated by *Magnolia pallescens*, on the exposed summits and ridges of the Cordillera Central (Hispaniola), between 1,100 and 1,600 m elevation, on reddish or yellowish acidic montane soils.

DISTRIBUTION: Hispaniola (Dominican Republic); eastern Cordillera Central.

SYNONYMY: Bosques de Ebano (Hager & Zanoni 1993), in part.

***Magnolia pallescens - Didymopanax tremulus - Prestoea montana* Forest**

DESCRIPTION: With a scattered, rather open 15-20 m high upper canopy layer dominated by *Magnolia pallescens* and *Didymopanax tremulus*, and a 10-12 m high second tree layer with *Prestoea montana, Haenianthus salicifolius, Myrsine magnolifolia, Clusia clusioides, Ocotea nemodaphne, Miconia mirabilis, Podocarpus hispaniolanus, Guatteria blainii, Hedyosmum nutans,* etc. Tree-ferns (i.e. *Cyathea parvula, C. fulgens*) are common. A well developed shrub layer composed of *Psychotria* ssp. *Palicourea alpina, Cestrum inclusum, Gomidesia lindeniana, Scolosanthus grandifolius, Lunania ekmanii,* and others, is also present.

DISTRIBUTION: Hispaniola (Dominican Republic): Loma Golondrina; Loma La Sal, southwards (Casabito).

COMMENTS: This montane association can be readily distinguished from the *Magnolia pallescens-Tabebuia vinosa* cloud forest, by the presence of the conspicuous montane palm *Prestoea montana*, which is totally absent in the latter.

SYNONYMY: Bosque de *Magnolia pallescens* (Hager & Zanoni 1993), in part.

REFERENCES: Hager & Zanoni (1993).

***I.A.1.N.c. Ocotea ekmanii - Magnolia cubensis ssp. cubensis* Forest Alliance (Ocotea ekmanii - Magnolia cubensis ssp. cubensis montane rain forests)**

CONCEPT: Humid montane rain forests of eastern Cuba forming a vegetation belt between 800 and 1600 m, on mountain yellow tropical soils. Prevalent trees in these forests are *Ocotea ekmanii* and *Magnolia cubensis* ssp. *cubensis*.

DISTRIBUTION: East Cuba: Sierra Maesta; Sierra del Purial.

SYNONYMY: Pluvisilva montana de las rocas cuarcíferas (Areces-Mallea 1978), in part; Magnolion cubensis (Borhidi *et al.* 1979), in part; Bosque pluvial montano (Capote & Berazaín 1984; Capote *et al*. 1989), in part; Wet montane rainforests (Borhidi 1991), in part.

***Magnolia cubensis ssp. cubensis - Laplacea angustifolia - Ocotea ekmanii* Forest**

DESCRIPTION: Rich montane forest with two canopy layers, in areas of 1,700-3,000 mm of yearly rainfall. The rather closed 20-25 m high upper canopy is co-dominated by *Magnolia cubensis* ssp. *cubensis* and *Laplacea angustifolia,* accompanied by many other tree-species such as *Ocotea ekmanii, Ocotea cuneata, Guatteria blainii, Freziera grisebachii, Laplacea urbanii, Cleyera nimanimae,* and *Cyrilla racemiflora*. The second canopy layer is dominated by Melastomataceae and tree-ferns. Epiphytes are abundant and diverse. Other characteristic species of this association include *Torralbasia cuneifolia, Solonia reflexa, Ditta maestrensis, Lasianthus lanceolatus,*

Graffenrieda rufescens, Ilex macfadyenii, Brunellia comocladifolia and *Weinmannia pinnata*.
DISTRIBUTION: East Cuba: Sierra Maestra; Sierra del Purial.
COMMENTS: This association represents the climax vegetation between 800 and 1,600 m, in southeastern Cuba.
SYNONYMY: High open forests (Seifritz 1943); Fangales (León 1946); Magnolio-laplacetum angustifoliae (Borhidi 1991).
REFERENCES: Seifritz (1943); León (1946); Borhidi (1991).

***Ocotea ekmani - Cyrilla racemiflora* Forest**

DESCRIPTION: Somewhat drier and less diverse montane forest community dominated by *Ocotea ekmanii* and other microphyllous sclerophyllous trees such as *Cyrilla racemiflora, Persea similis, Tabebuia oligolepis* and *Myrsine coriacea*, on the steep dry ridges and slopes of the Sierra Maestra range in eastern Cuba. Another diagnostic character of this community with respect to the former one, is the total absence of tree-ferns in the second canopy layer.
DISTRIBUTION: East Cuba: Sierra Maestra range.
COMMENTS: This association occurs in the same mountain range (Sierra Maestra), and at the same altitudinal level as the former one. However its occurrence is conditioned edaphically to the humid sandtone outcrops, or mesoclimatically to the dry ridges and steep slopes.
SYNONYMY: Ocoteo ekmanii-Cyrilletum racemiflorae (Borhidi 1991).
REFERENCES: Borhidi (1991).

***I.A.1.N.c. Ocotea krugii - Ocotea dominicana - Ocotea coriacea - Ocotea cernua* Forest Alliance**

CONCEPT: Laurel forests of montane situations in the Lesser Antilles. The concept and name may need some modification with additional information from more islands.
DISTRIBUTION: Martinique, others?

***Ocotea krugii - Ocotea dominicana - Ocotea coriacea - Ocotea cernua* Forest**

DESCRIPTION: Occurring in very limited areas on exposed spur ridges. Canopy 15-20m tall is dominated by evergreen, mesophyll trees of the Lauraceae. Dominant and characteristic tree species are *Ocotea krugii (=Ocotea globosa), Ocotea dominicana (=Nectandra dominicana), Ocotea coriacea, Ocotea cernua, Styrax glaber, Cinnamomum elongatum, Persea urbaniana, Beilschmiedea pendula*, and *Anida ramageana*. The shrub layer is sparse, and includes *Endlicheria sericea, Chrysobabanus cuspidatus, Dahlbergia monetaria, Hedyosmum arborescens, Clibadium erosum, Charianthus corymbosus, Cestrum alternifolium, Piper reticulatum, Piper dussii, Piper glabrescens, Piper aequale*. The herb layer is rich and dense, and includes *Eupatorium magdalenae, Heliconia bihai, Heliconia caribaea, Blechnum ryanii, Pteris biaurita, Pityrogramma chrysophylla*.
DISTRIBUTION: Martinique.
COMMENTS: Based on Kimber (1988).
SYNONYMY: Laural Forest (Kimber 1988).

***I.A.1.N.c. Prestoea montana* Forest Alliance**

Sierra Palm Forest Alliance; Palma de sierra Forest Alliance
CONCEPT: Forests on montane slopes dominated by *Prestoea montana*.
DISTRIBUTION: Cuba, Hispaniola, Puerto Rico, Martinique, [West Indies].
REFERENCES: Weaver 1994.

***Prestoea montana / Byrsonima martinicensis - Ilex sideroxyloides* Forest**

DESCRIPTION: This forest occurs at elevations of 250-800m in Martinique, on windward and interior, steep, very exposed slopes that are prone to landslide. The 3-8m tall canopy is dominated by *Prestoea montana*, with short, gnarled small trees of *Byrsonima martinicensis, Ilex sideroxyloides*, and *Hedyosmum arborescens*. Large herbs such as *Heliconia bihai, Anthurium spp*., and *Asplundia rigida* are common. Mosses, ferns, and lycopods are abundant and diverse.
DISTRIBUTION: Martinique.

SYNONYMY: Palm Brake, in part (Kimber 1988).

***Prestoea montana / Cordia borinquensis - Miconia sintenisii* Forest**

DESCRIPTION: This forest occurs at elevations of 500-1100m in Puerto Rico, on steeper slopes and wetter soils than the associated *Cyrilla racemiflora-Micropholis guyanensis-Micropholis garciniifolia-Ocotea spathulata* Forest. *Prestoea montana* dominates the 8-15m canopy, with lesser amounts of *Croton poecilanthus, Henriettea squamulosum, Cordia borinquensis, Psychotria berteriana, Hillia parasitica, Cecropia peltata, Ocotea leucoxylon, Micropholis garciniifolia*, and *Miconia sintenisii*. Understory trees and shrubs include *Daphnopsis philippiana, Comocladia glabra, Hedyosmum arborescens, Alsophila bryophila*, and *Cesneria sintenisii*. Woody vines include *Schlegelia brachyantha, Clusia gundlachii, Marcgravia sintenisii*, and *Ipomoea repanda*. Herbs include *Thelypteris deltoidea, Cyathea borinquena, Pilea krugii, Pilea inequalis, Begonia decandra, Ichnauthus pallens*, and *Scleria sp*. Epiphytes include *Nephrolepis rivularis* and *Guzmania berteroana*.
DISTRIBUTION: Puerto Rico.
COMMENTS: Based on Weaver (1994). Communities dominated by *Prestoea* occur on islands of the Lesser Antilles; their similarity to this community are uncertain.
SYNONYMY: Palm Brake (Beard 1949); Palm Forest (Weaver 1994); Sierra-palm Forest -- 88.1b (Dansereau 1966).

***I.A.1.N.c. Syagrus amara* Forest Alliance**
CONCEPT: Palm forests of the Lesser Antilles dominated by *Syagrus amara*.
DISTRIBUTION: Martinique.
COMMENTS: *Syagrus amara* is sometimes called *Rhyticocos amara*. This palm occurs on Montserrat, Guadeloupe, Dominica, St. Lucia, and Martinique; the community might also occur on other islands than Martinique. This community is restricted to small areas at mid-elevations on north-facing slopes in northern Martinique.
SYNONYMY: Palm Brake, in part (Kimber 1988); "petit coco".

I.A.1.N.d. Montane tropical or subtropical cloud forest **(CLOUD FOREST) (BOSQUE NUBLADO)**

***I.A.1.N.d. Clusia plukenetii* Forest Alliance**
CONCEPT: Cloud forests of Martinique.
DISTRIBUTION: Martinique.

***Clusia plukenetii - Charianthus nodosus - Rondeletia stereocarpa - Didymopanax attenuatum* Forest** -- G1

DESCRIPTION: Occupying very small areas (totalling less than one thosand acres) near the summits of the highest peaks of Martinique, Mont Pelée, Piton Géle, and the Carbet Pitons. The canopy is wind-sheared and tight, from 5-12m tall. Typical species are *Clusia plukenetii, Charianthus nodosus, Rondeletia stereocarpa, Didymopanax attenuatum, Prestoea montana, Podocarpus coriaceus, Cyathea arborea, Dunalia arborescens*.
DISTRIBUTION: Martinique.
COMMENTS: Based on Kimber (1988).
SYNONYMY: Elfin Woodland (Kimber 1988).

***I.A.1.N.d. Didymopanax tremulus - Podocarpus aristulatus* Forest Alliance (Didymopanax tremulus - Podocarpus aristulatus cloud forests)**
CONCEPT: Montane cloud forests co-dominated by *Didymopanax tremulus* and *Podocarpus aristulatus*, on the highlands of Hispaniola, between 1,600 and 2,200 m elevation.
DISTRIBUTION: Hispaniola (Dominican Republic): Cordillera Central, Sierra de Neiba, Sierra de Bahoruco.
SYNONYMY: Bosque nublado de la Zona Alta (Hager & Zanoni 1993), in part.

***Didymopanax tremulus - Podocarpus aristulatus - Ocotea wrightii* Forest**

DESCRIPTION: Montane cloud forest with a closed 8-13 m high canopy and scattered emergent *Didymopanax tremulus, Podocarpus aristulatus,* and *Ocotea wrightii* trees attaining 15, and eventually 20 m high. Most common species forming the dense 8-13 m tall tree layer are *Brunellia comocladifolia, Trema micrantha, Weinmannia pinnata, Oreopanax capitatus,* and the tree-ferns *Cyathea fulgens* and *Cyathea furfuracea*. Among the shrubs, probably *Miconia selleana* is most characteristic. All these component plants support an extensive layer of vascular and non-vascular epiphytes. *Arthrostylidium* sp. may become locally abundant, especially in disturbed areas.
DISTRIBUTION: Hispaniola (Dominican Republic): Sierra de Neiba Occidental; Sierra de Bahoruco; Cordillera Central.
SYNONYMY: Bosque de *Didymopanax tremulus* (Hager & Zanoni 1993).

REFERENCES: Hager & Zanoni (1993).

***Podocarpus aristulatus* Forest**

DESCRIPTION: Dense montane cloud forest dominated by *Podocarpus aristulatus,* or co-dominated by the former species and *Didymopanax tremulus,* on the summits of Sierra de Neiba and highlands of Cordillera Central, between 1,800 and 2,200 m elevation. Old trees may attain 25 m high with trunks ca. 1 m diameter at base. Other tree-species present in this association may include *Ocotea wrightii, O. cicatricosa* and *Persea krugii.* Vascular and non-vascular epiphytes are abundant.
DISTRIBUTION: Hispaniola (Dominican Republic): Sierra de Neiba; Cordillera Central, in La Nevera (Reserva de Valle Nuevo).
COMMENTS: Small patches of this vegetation type may be present in other high montane areas of Hispaniola.
SYNONYMY: Bosque de *Podocarpus aristulatus* (Hager & Zanoni 1993).

REFERENCES: Hager & Zanoni (1993).

***I.A.1.N.d. Magnolia pallescens - Tabebuia vinosa* Forest Alliance (Magnolia pallescens - Tabebuia vinosa cloud forests)**

CONCEPT: Montane cloud forests of Hispaniola, with *Magnolia pallescens* and other tree species dominating the canopy, on the exposed summits and ridges of Cordillera Central, over 1,700 m elevation.
DISTRIBUTION: Hispaniola (Dominican Republic): eastern Cordillera Central.
COMMENTS: Floristically related with the Magnolia pallescens montane forest alliance, however *Prestoea montana* is typically absent in this cloud forest alliance.
SYNONYMY: Bosques de Ebano (Hager & Zanoni 1993), in part.

***Magnolia pallescens - Tabebuia vinosa - Didymopanax tremulus* Forest**

DESCRIPTION: The 8-10 m tall canopy is dominated by *Tabebuia vinosa, Brunellia comocladifolia, Myrsine coriacea, Trema micrantha,* and others. Scattered emergent *Magnolia pallescens* and *Didymopanax tremulus* trees up to 15-18 m high are usually present. This association occurs on the yellowish acidic montane soils of eastern Cordillera Central, between 1,700 and 2,100 m elevation.
DISTRIBUTION: Hispaniola (Dominican Republic): South of Constanza, near Los Mañanguises, Los Montes Llanos, La Siberia, and Pinar Parejo.
COMMENTS: When this cloud forest community is degraded, usually a succesional mixed *Pinus occidentalis* forest establishes itself in the disturbed area.
SYNONYMY: Bosque de *Magnolia pallescens* (Hager & Zanoni 1993), in part.
REFERENCES: Hager & Zanoni (1993).

***I.A.1.N.d. Tabebuia rigida - Ocotea spathulata* Forest Alliance**

CONCEPT: Cloud forests of eastern Puerto Rico.
DISTRIBUTION: Puerto Rico.
REFERENCES: Weaver 1994.

***Tabebuia rigida - Ocotea spathulata - Eugenia borinquensis - Calyptranthes krugii* Forest**

DESCRIPTION: Forests dominated by *Tabebuia rigida*, *Ocotea spathulata*, and *Eugenia borinquensis*, with many other species as well, including *Clusia krugiana, Haenianthus salicifolius, Ilex sideroxyloides, Alsophila bryophila, Prestoea montana, Psychotria berteriana, Calyptranthes krugii, Marliera sintenisii, Miconia sintenisii, Henriettea squamulosum*, and *Weinmannia pinnata* (many of these species are endemic to the higher elevations of Puerto Rico).
DISTRIBUTION: Puerto Rico.
SYNONYMY: Dwarf Forest; Elfin Woodland; Mossy Forest; Montane Thicket.
REFERENCES: Weaver 1994.

I.A.1.N.f. Tropical or subtropical seasonally flooded rain forest
(SEASONALLY FLOODED RAIN FOREST)
(BOSQUE PLUVIAL ESTACIONALMENTE INUNDADO)

***I.A.1.N.f. Pterocarpus officinalis* Forest Alliance**
CONCEPT: Freshwater swamps associated with rivers, dominated by *Pterocarpus officinalis*.
DISTRIBUTION: Puerto Rico, Martinique.
COMMENTS: This forest can be also found in a permanently/semi-permanently flooded condition. *Manilkara bidentata* and *Calophyllum calaba* are often associated with *Pterocarpus officinalis* in non riparian basins, in Puerto Rico.
SYNONYMY: Pterocarpus Swamp -- 39.1 (Dansereau 1966); Pterocarpus Swamp Woodland (Kimber 1988); "mangle medaille".

***Pterocarpus officinalis* Forest**

DESCRIPTION:
DISTRIBUTION: Puerto Rico.

***Pterocarpus officinalis - Manilkara bidentata ssp. surinamensis - Calophyllum brasiliense* Forest**

DESCRIPTION: This association occurs in non-riparian basins in northern Puerto Rico. Other species may include *Roystonea sp*.
DISTRIBUTION: Puerto Rico.

I.A.1.N.j. Solution-hole tropical or subtropical broad-leaved evergreen forest[36]
(SOLUTION-HOLE EVERGREEN FOREST)
(BOSQUE SIEMPREVERDE DE SUMIDERO)

(TYPES TO BE DEFINED)

I.A.1.N.k. Tropical or subtropical riparian (gallery) forest[37]
(RIPARIAN FOREST)
(BOSQUE RIPARIO)

(TYPES TO BE DEFINED)

Group: ***I.A.3. Tropical and subtropical seasonal evergreen forest (mainly broad-leaved evergreen trees with some foliage reduction in dry season)***
Subgroup: ***I.A.3.N. Natural/Semi-natural***

[36] New Formation (*sensu* Lindsay & Horwith 1997).
[37] New Formation.

I.A.3.N.a. Lowland tropical or subtropical seasonal evergreen forest (LOWLAND SEASONAL EVERGREEN FOREST) (BOSQUE ESTACIONAL SIEMPREVERDE DE BAJA ALTITUD)

***I.A.3.N.a. Ceiba pentandra - Roystonea spp.* Forest Alliance (Ceiba pentandra - Roystonea spp. forests)**

CONCEPT: Lowland meso-macropyllous seasonal evergreen forests with *Ceiba pentandra* and *Roystonea* spp., extending to the lower zone of the middle ranges of the Antilles, conditioned by a seasonal tropical climate with 1,400-2,000 mm annual precipitation and 2-4 dry months. Two canopy layers are present, with emergent deciduous trees. In addition to *Ceiba pentandra* and *Roystonea* spp., other characteristic species may include *Mastichodendron foetidissimum, Guazuma ulmifolia, Zanthoxylum flavum, Z. martinicense, Cedrela odorata, Swietenia mahagoni, Bumelia salicifolia, Lonchocarpus* spp., and many others.
DISTRIBUTION: Greater and Lesser Antilles.
SYNONYMY: Guazumo-Cupanion (Borhidi *et al.* 1979);

***Ardisia obovata - Aechmea lingulata* Forest** (TNC 7572)
DESCRIPTION: Evergreen forest found in sheltered valleys above 200 m, in the southern hills of Antigua.
DISTRIBUTION: Antigua: northern slope of Sugarloaf Mountain
COMMENTS: Loveless (1960) labels this Seasonal Evergreen Formation
SYNONYMY: Seasonal Evergreen (Loveless, 1960)
REFERENCES: Lindsay & Horwith (1997).

***Cordia spp. - Inga laurina* Forest** (TNC 7573)
DESCRIPTION:
DISTRIBUTION: Antigua: Wallings Hill.
COMMENTS:
SYNONYMY:
REFERENCES: Lindsay & Horwith (1997).

***Guazuma ulmifolia - Ceiba pentandra - Roystonea regia* Forest**
DESCRIPTION: Lowland seasonal forest with two evergreen canopy layers; the 20-25 m high upper one is somewhat open while the 8-15 m high lower one is rather closed. The deciduous *Ceiba pentandra,* which may attain 30-40 m tall, is a typical emergent tree. Typical species include *Guazuma ulmifolia, Ceiba pentandra, Roystonea regia, Mastichodendron foetidissimum, Lonchocarpus domingensis, L. latifolius, Luehea speciosa, Spondias mombin, Ficus membranacea, Andira inermis, Chlorophora tinctoria, Cordia gerascanthus, C. collococca, Guarea guidonia, Cupania macrophylla,* and many others. Lianas are frequent and abundant, epiphytes occur rather rarely, and the herb layer is almost completely missing.
DISTRIBUTION: Cuba.
COMMENTS: This probably was the dominant zonal lowland forest community of Cuba, but it is everywhere destroyed and substituted by second-growth evergreen or deciduous forests, palm-brakes, savannas and sugarcane fields. The isolated remnant stands have slightly different species combination due to various kinds of natural causes and human impacts.
SYNONYMY: Guazumo-Ceibetum (Borhidi 1991).
REFERENCES: Borhidi 1991.

***Ocotea leucoxylon - Eugenia spp.* Forest** (TNC 7574)
DESCRIPTION:
DISTRIBUTION: Antigua: Boggy Peak/Dark Valley/Christian Valley, Dunning Valley, Blubber Valley.
COMMENTS:
SYNONYMY:
REFERENCES: Lindsay & Horwith (1997).

***Sideroxylon foetidissimum - Sideroxylon salicifolium - Roystonea regia* Forest**

DESCRIPTION: Seasonal evergreen forest community of the Cuban plains and hilly areas, on limestone-derived soils. The upper canopy layer is usually co-dominated by *Sideroxylon foetidissimum (= Mastichodendron foetidissimum), Sideroxylon salicifolium (= Bumelia salicifolia), Roystonea regia, Bursera simaruba* and *Ficus crassinervis.* Other common trees may include *Cordia gerascanthus, Zanthoxylum elephantiasis, Andira inermis, Cassine xylocarpa, Cecropia shreberiana, Exotea paniculata, Alophylus cominia, Cedrela odorata, Trichilia hirta, Celtis trinervia, Pseudolmedia spuria, Petitia domingensis, Citharexylum caudatum, Guazuma ulmifolia, Pithecellobium arboreum, Casearia hirsuta, Guettarda elliptica, Oxandra lanceolata, Eugenia maleolens, Savia sessiliflora, Adelia ricinella, Erythroxulon confusum, Pera bumeliaefolia* and *Schoepfia chrysophylloides.* Woody climbers such as *Cissus sicyoides, Gouania lupuloides, Platygyne hexandra,* and *Chiococca alba* are often present.
DISTRIBUTION: Cuba: widely distributed from the Guanacahabibes peninsula, south of Isle of Pines and in the foothills of the limestone middle ranges of west and central Cuba.
COMMENTS: Several subassociations may be be recognized in this community, with slighly different species combinations..
SYNONYMY: Mastichodendro-Dipholietum salicifoliae (Borhidi 1991).
REFERENCES: Borhidi (1991).

***Spondias mombin - Roystonea hispaniolana - Pithecellobium arboreum* Forest**

DESCRIPTION: Succesional evergreen seasonal forest with two canopy layers and *Ceiba pentandra* as emergent tree, in lowland areas of Hispaniola, on deep, limestone-derived soils. Common species may include *Spondias mombin, Roystonea hispaniolana, Pithecellobium arboreum, Andira jamaicensis, Bucida buceras, Sloanea amygdalina, Pseudolmedia spuria, Oxandra laurifolia, Nectandra coriacea, Calyptranthes suzygium, Myrciaria floribunda, Allophyllus cominia, Quararibaea turbinata,* and many others.
DISTRIBUTION: Hispaniola,Haiti and Dominican Republic.
COMMENTS: This association described by Ciferri as a lowland rainforest ("foresta udica a suolo neutro"), is obviously a second-growth forest community on the sites formerly occupied by evergreen seasonal forests.
SYNONYMY: Associazione Spondias-Oreodoxa (Ciferri 1936).
REFERENCES: Ciferri (1936).

***Spondias mombin - Roystonea regia - Guazuma ulmifolia* Forest**

DESCRIPTION: Succesional association established following disturbance of the former Guazuma ulmifolia - Ceiba pentandra - Roystonea regia seasonal evergreen forest in Cuba, mostly by selective cutting of trees for timber. The original association's species composition and coverage change by prevalence, under-representation, or absence of many of its associates. Different species combinations are recognizabe, due to different human interferences. Most common species usually include *Spondias mombin, Roystonea regia, Guazuma ulmifolia, Ceiba pentandra, Oxandra lanceolata, Crescentia cujete, Pithecellobium cubense, Samanea saman, Cecropia shreberiana, Cordia collococca, Nectandra coriacea, Bursera simaruba, Allophyllus cominia, Drypetes alba, Guettarda combsii, Ficus* spp., *Eugenia* spp., and others.
DISTRIBUTION: Cuba.
COMMENTS: This second-growth forest community represents the Cuban variant ot the Spondias mombin - Roystonea hispaniolana - Pithecellobium arboreum seral forest association of Hispaniola.
SYNONYMY: Spondiato-Roystonietum Ciferri (1936) *sensu* Borhidi (1991).
REFERENCES: Ciferri (1936); Borhidi (1991).

***Swietenia mahagoni - Ceiba pentandra - Roystonea hispaniolana* Forest**

DESCRIPTION: Seasonal evergreen forests of Hispaniola with a 15-20 m upper canopy and the deciduous *Ceiba pentandra* as emergent. Common species include *Swietenia mahagoni, Coccoloba diversifolia, Capparis frondosa, Celtis trinervia, Zanthoxylum elephantiasis, Z. martinicense, Guarea*

guidonia, Guazuma ulmifolia, Krugiodendron ferreum, Mastichodendron foetidissimum, Trichila hirta, T. pallida, and *Catalpa longissima.*
DISTRIBUTION: Hispaniola: Dominican Republic; Haiti?
COMMENTS: Hager & Zanoni's (1993) broadly defined "Bosques de *Swietenia-Coccoloba"* includes two different forest types which correspond to two different formations: The dry variant is obviously a lowland/submontane deciduous forest, while the humid one is the above described Swietenia-Ceiba-Roystonea seasonal evergreen forest community.
SYNONYMY: Bosques de *Swietenia-Coccoloba* (Hager & Zanoni 1993), in part (humid variant).
REFERENCES: Hager & Zanoni (1993).

***I.A.3.N.a. Cedrela mexicana - Andira inermis - Hymenaea courbaril* Forest Alliance**
CONCEPT: Seasonal forests of Martinique, at elevations of 10-500m, formerly occupying large portions of the island.
DISTRIBUTION: Martinique.

***Simarouba amara - Andira inermis - Manilkara bidentata ssp. surinamensis - Hymenaea courbaril* Forest**
DESCRIPTION: Seasonal forests of N. Martinique. Typical tree species include *Simarouba amara, Andira inermis, Manilkara bidentata ssp. surinamensis, Hymenaea courbaril, Calophyllum calaba, Sapium caribaeum, Ocotea martinicensis, Ocotea leucoxylon, Inga ingoides, Eugenia monticola, Eugenia lambertiana, Chimarrhis cymosa, Meliosma herbertii*.
DISTRIBUTION: Martinique.
COMMENTS: Based on Kimber (1988).
SYNONYMY: Seasonal Forest, in part (Kimber 1988).

***Andira inermis - Lonchocarpus pentaphyllus - Zygia latifolia - Cedrela mexicana - Hymenaea courbaril* Forest**
DESCRIPTION: Seasonal forests of S. Martinique. Typical tree species include *Andira inermis, Lonchocarpus pentaphyllus, Zygia latifolia, Cedrela mexicana, Hymenaea courbaril, Byrsonima coriacea,* and others.
DISTRIBUTION: Martinique.
COMMENTS: Based on Kimber (1988).
SYNONYMY: Seasonal Forest, in part (Kimber 1988).

***I.A.3.N.a. Guapira discolor - Pithecellobium keyense - Reynosia septentrionalis - Metopium toxiferum* Forest Alliance**
DISTRIBUTION: FL, Cuba, Bahamas.

***Reynosia septentrionalis - Sideroxylon americanum - Pithecellobium keyense - Jacquinia keyensis* Forest**
DISTRIBUTION: Bahamas.
SYNONYMY: Whiteland Community (Correll and Correll).

***I.A.3.N.a. Manilkara bidentata ssp. surinamensis* Forest Alliance (Manilkara bidentata surinamensis forests)**
CONCEPT: Lowland seasonal evergreen forest community dominated or co-dominated by *Manilkara bidentata ssp surinamensis*, occurring below 400 m altitude in areas of high rainfall, in Puerto Rico. *Dacryodes excelsa* is not present in this vegetation type.
DISTRIBUTION: Puerto Rico.
COMMENTS: Dansereau (1966:20) called this vegetation type a "lowland rainforest" . He used the term "seasonal evergreen forest" for a drier formation than Beard's (1944a) community of the same name. Dansereau's seasonal evergreen forest should be classified as a semi-deciduous forest. For further discussion see also Borhidi 1991.
SYNONYMY: Lowland rain forest (Dansereau 1966); Diospyros revoluta Forest Alliance (Weakley, in checklist of the vegetation of the West Indies, unpubl.).

***Manilkara bidentata ssp. surinamensis - Diospyros revoluta* Forest**
DESCRIPTION: Lowland seasonal evergreen forests with *Diospyros revoluta, Manilkara bidentata ssp. surinamensis, Pouteria multiflora, Mammea*

americana, Cassipourea elliptica, Faramea occidentalis, Petitia domingensis, Quararibaea turbinata, and presumably many other species, occurring at low elevations in areas of high rainfall.
DISTRIBUTION: Puerto Rico.
COMMENTS: This lowland seasonal evergreen forest association, which seems to have occupied very little area in Puerto Rico, has been largely depleted and cannot be observed anywhere in its primeval state. However, disturbed stands apparently belonging to this community can be seen at the present time at Dorado, and on the lower slopes of the Luquillo mountains.
SYNONYMY: Lowland rain forest (Dansereau 1966); Dry Rain Forest (Gleason & Cook); dry lowland rain forest; evergreen coastal forest; lowland coastal forest.
REFERENCES: Dansereau (1966).

I.A.3.N.b. Submontane tropical or subtropical seasonal evergreen forest (SUBMONTANE SEASONAL EVERGREEN FOREST) (BOSQUE ESTACIONAL SIEMPREVERDE SUBMONTANO)

I.A.3.N.b. Alchornea latifolia - Pseudolmedia spuria Forest Alliance (Alchornea latifolia - Pseudolmedia spuria forests)

CONCEPT: Seasonal evergreen forests with two canopy strata and scattered emergent trees, occurring between 300 and 800 m in western and central Cuba. Characteristic species of this community in Cuba are *Matayba oppositifolia, M. apetala, Alchornea latifolia, Pseudolmedia spuria, Trophis racemosa, Margaritaria nobilis, Tabebuia shaferi, Antirhea radiata, Terminalia intermedia, Sloanea amygdalina, Dendropanax arboreus, Zanthoxylum martinicense,* and *Z. ekmanii.*
DISTRIBUTION: Central America; west and central Cuba.
SYNONYMY: Alchorneo-Pseudolmedion spuriae (Borhidi *et al.* 1979).

Matayba oppositifolia - Pseudolmedia spuria Forest

DESCRIPTION: Submontane successional forest co-dominated by *Matayba oppositifolia* and *Psedolmedia spuria*, occurring at 200-600 m elevation in western Cuba. In the remaining stands of this forest community the tall emergent trees are usually absent and the most valuable timber-producing species such as *Cedrela odorata, Swietenia mahagoni, Manilkara grisebachii* and *Cynometra cubensis* are very rarely seen. This selective cutting and logging has lead to the overwhelming dominance of *Matayba* and *Pseudolmedia*, and the overrepresentation of *Roystonea regia* as well. *Cecropia shreberiana* also may become abundant in places.
DISTRIBUTION: West Cuba: Sierra del Rosario, Pinar del Rio prov.
SYNONYMY: Mataybaeo-Pseudolmedietum spuriae (Capote *et al.* 1985).
REFERENCES: Capote *et al.* (1985); Borhidi (1991).

I.A.3.N.b. Calophyllum calaba - Calyptronoma occidentalis Forest Alliance (Calophyllum calaba - Calyptronoma occidentalis submontane rain forests)

CONCEPT: Submontane forest community with *Calophyllum calaba* and *Calyptronoma occidentalis*, occurring between 500 and 800 m elevation in Jamaica, on yellowish-brown soils derived from limestone bedrocks.
DISTRIBUTION: Jamaica: John Crow Mountains
SYNONYMY: Lower Montane Rain Forest (Asprey & Robbins 1953; Grossman *et al.* 1993), in part.

Calophyllum calaba - Calyptronoma occidentalis - Symphonia globulifera - Drypetes alba Forest

DESCRIPTION: With two tree strata, the 26-28 m upper one with occasional huge emergent trees of *Psidium montanum* reaching up to 40 m high, sometimes accompanied by *Symphonia globulifera*. This upper canopy is not dense. A somewhat ill-defined second canopy layer occurs from 10-13 m, and include palms (*Calyptronoma occidentalis)*. A diagnostic species combination for this community is: *Calophyllum calaba, Calyptronoma occidentalis, Drypetes alba, Heliconia caribaea*, and *Cyathea grevilleana*. Other species

may include *Alchornea latifolia, Exothea paniculata, Guarea swartzii, Matayba apetala, Pithecellobium alexandri, Faramea occidentalis, Trophis racemosa,* and others. *Pilea* spp. are usually abundant in the herb layer.
DISTRIBUTION: Jamaica: western slopes of the John Crow Mountains.
COMMENTS: The John Crow Mountains of Jamaica form the eastern boundary of the low-lying humid Rio Grande Valley, where, according to Asprey & Robbins (1953), Tropical Lowland Rain Forest may have flourished in the past. This vegetation type, however, cannot be recognized in Jamaica today.
SYNONYMY: Lower wet limestone forest (Grubb & Tanner 1976); Wet limestone forest (Kelly *et al.* 1988).
REFERENCES: Adams (1972); Grubb & Tanner (1976); Grossman *et al.* (1993); Muchoney *et al.* (1994).

***Cecropia peltata - Calophyllum calaba - Nectandra spp.* Forest**

DESCRIPTION: A successional community established following disturbance of the Calophyllum - Calyptronoma - Symphonia - Drypetes Forest, mostly by selective cutting for timber. This association is charaterized by the strong presence of the opportunistic species *Cecropia peltata. Nectandra antillana* and *Nectandra coriacea* are usually present. Other characteristics of this association include a less diverse flora, a structurally diminished form of the original forest, and a strong presence of climbers. The climbers cover the tops of the trees, uniting adjacent individuals and forming a web of stems which droop to the ground.
DISTRIBUTION: Jamaica: the John Crow Mountains.
SYNONYMY: Disturbed wet limestone forest (Grossman *et al.* 1993), in part; Modified lower montane rain forest (Muchoney *et al.* 1994), in part.
REFERENCES: Asprey & Robbins (1953); Grossman *et al.* (1993); Muchoney *et al*. (1994).

***Calophyllum calaba - Hibiscus elatus - Cedrela odorata* Forest**

DESCRIPTION: Essentially a highly disturbed Calophyllum - Calyptronoma - Symphonia - Drypetes Forest with admixture of a few introduced timber species, primarily *Hibiscus elatus* and *Cedrela odorata.* These species may be sparsely scattered to dominant within the forest association. May include other non-native species of economic value such as *Cocos nucifera* and *Musa spp.*
DISTRIBUTION: Jamaica: the John Crow Mountains.
COMMENTS: In most cases this association represents old forestry plantations that have been idle for many years and are now reverting to secondary forests.
SYNONYMY: Disturbed wet limestone forest (Grossman *et al.* 1993), in part; Modified lower montane rain forest (Muchoney *et al.* 1994), in part.
REFERENCES: Grossman *et el.* (1993); Muchoney *et al*. (1994).

***I.A.3.N.b. Sideroxylon spp. - Roystonea regia* Forest Alliance (Sideroxylon spp. - Roystonea regia forests)**

CONCEPT: Submontane seasonal forest community with two evergreen canopy strata, and scattered deciduous emergent individuals of *Sideroxylon jubillum (= Dipholis jubilla), Sideroxylon salicifolium (= Dipholis salicifolia)* and/or *Cedrela mexicana,* accurring between 200 and 800 m elevation in Cuba, in areas with an annual rainfall of 1,400-1,800 mm and seasonal climate (1-3 dry months).
DISTRIBUTION: Cuba.
SYNONYMY: Calophyllo-Dipholion (Borhidi, in Borhidi *et al.* 1979), in part.

***Sideroxylon jubillum - Roystonea regia* Forest**

DESCRIPTION: With a 20-25 m high, rather closed upper canopy, and a 8-15 m high lower tree stratum. The buttressed *Sideroxylon jubillum (= Dipholis jubilla)* is the most common emergent tree in this forest. Characteristic species of the upper canopy layer are *Roystonea regia, Calophyllum calaba, Zizyphus rhodoxylon, Ficus berteroi, Zanthoxylum martinicense, Zanthoxylum cubense, Didymopanax morototoni, Sapium jamaicense, Faramea occidentalis, Guarea guidonia, Cupania glabra,* and *Cupania americana.* The lower tree stratum

may include *Oxandra lanceolata, Oxandra laurifolia, Chrysophyllum argenteum, Dendropanax arboreus, Lonchocarpus latifolius, Sloanea amygdalina, Wallenia laurifolia* and *Ateramnus lucidus.*
DISTRIBUTION: East Cuba: Sierra Maestra mountain range.
COMMENTS: This association only occurs on yellow-red mountain soils derived from andesite and/or granodiorite bedrocks.
SYNONYMY: Yayales (León 1946); Oxandro-Dipholietum jubillae (Borhidi 1991).
REFERENCES: León (1946); Borhidi (1991).

***Sideroxylon salicifolium - Cedrela odorata - Roystonea regia* Forest**

DESCRIPTION: This community is essentially similar in structure to the Sideroxylon jubillum - Rotstonea regia Forest that as the former association, it differs slightly in species composition, especially of the upper canopy layer. While in the Sideroxylon jubillum - Roystonea regia Forest *Sideroxylon jubillum (= Dipholis jubilla)* is the dominant emergent, or more often the only emergent tree, in this association the former species is replaced by *Sideroxylon salicifolium (= Dipholis salicifolia)* and *Cedrela mexicana*.
DISTRIBUTION: East Cuba.
COMMENTS: Because the forest zone to which it belongs is particularily suitable for tropical agriculture, undisturbed stands of this forest type are not commonly seen in Cuba, at present.
SYNONYMY: None.
REFERENCES: Borhidi (1991).

I.A.3.N.e. Seasonally/temporarily flooded tropical or subtropical seasonal evergreen forest

(SEASONALLY/TEMPORARILY FLOODED SEASONAL EVERGREEN FOREST)
(BOSQUE ESTACIONAL SIEMPREVERDE ESTACIONALMENTE/TEMPORALMENTE INUNDADO)

***I.A.3.N.e. Hibiscus elatus - Swietenia mahagoni* Forest Alliance (Hibiscus elatus - Swietenia mahagoni forests)**

CONCEPT: Seasonal evergreen forests of the regularly flooded alluvial plains and low, temporarily flooded basins at the edge of swamps in Cuba. This community depends upon the existence of a seasonal tropical climate with 2-4 dry months.
DISTRIBUTION: Cuba.
SYNONYMY: Hibisco-Swietenion mahagoni (Borhidi *et al*. 1979).

***Hibiscus elatus - Calophyllum calaba* Forest**

DESCRIPTION: Seasonally flooded evergreen forest community occuring on the somewhat higher plains of the swamp basins of Cuba, and in the supralittoral marsh-zone, mostly in the great flat peninsulas of quaternary limestone (Guanacahabibes, Zapata, south Isle of Pines), and along the low southern coastal area of the Cuban plain. This forest association is co-dominated by *Hibiscus elatus* and *Calophyllum calaba* and has a high frequency and abundance of macro- and mesophyllous climbers and xerophytic epiphytes (*Tillandsia spp*.).
DISTRIBUTION: Cuba.
SYNONYMY: Hibisco-Calophylletum antillanae (Borhidi 1991).
REFERENCES: Borhidi (1991).

***Lysiloma bahamensis - Metopium brownei - Swietenia mahagoni* Forest**

DESCRIPTION: Alluvial seasonal evergreen forest association on regularly flooded lowland limestone areas, with two canopy layers and some deciduous elements. Prevalent trees are *Lysiloma bahamensis, Metopium brownei*, and *Swietenia mahagoni.* Other speciest may include *Bucida buceras, Bursera simaruba, Linociera ligustrina, Nectandra coriacea, Chrysophyllum oliviforme,*

Erythroxylon rotundifolium, Ficus citrifolia, Gyminda latifolia, Ateramnus lucidus, Picrodendron macrocarpum, Pouteris dominguensis, Capparis cynophallophora, Capparis flexuosa, Eugenia ligustrina, Eugenia maleolens, Zanthoxylum fagara, Sabal parviflora, Myrica cerifera, and others. Xerophytic epiphytes (*Tillandsia* spp.) are particularly abundant.
DISTRIBUTION: Cuba.
SYNONYMY: Lysilomo-Metopietum brownei (Borhidi 1991).
REFERENCES: Borhidi (1991)

***Calophyllum calaba - Swietenia mahogani* Forest**

COMMENTS: This association was not described nor published *fide* Borhidi (1991).
SYNONYMY: Calophyllo-Swietenietum mahagoni del Risco (ined.)
REFERENCES: Borhidi (1991)

Group: *I.A.5. Tropical or subtropical broad-leaved evergreen sclerophyllous forest*
Subgroup: *I.A.5.N. Natural/Semi-natural*

I.A.5.N.a. Lowland/submontane[38] tropical or subtropical broad-leaved evergreen sclerophyllous forests

(LOWLAND/SUBMONTANE EVERGREEN SCLEROPHYLLOUS FOREST)
(BOSQUE SIEMPREVERDE ESCLERÓFILO DE BAJA ALTITUD/SUBMONTANO)

***I.A.5.N.a. Calophyllum calaba ssp. pinetorum* Forest Alliance (Calophyllum calaba pinetorum forests)**

CONCEPT: Evergreen tropical forests dominated by *Calophyllum calaba ssp. pinetorum*, and other sclerophyllous and microphyllous elements in the canopy and shrub layers. This vegetation occurs in West Cuba, on lixiviated yellowish-red fersiallitic soils derived from limestone but with substantial contributions from serpentine rocks.
DISTRIBUTION: West Cuba: Pinar del Rio prov.
SYNONYMY: Calophyllo-Guettardion valenzuelanae (Capote *et al.* 1985).

***Calophyllum calaba-ssp. pinetorum-Coccoloba retusa* Forest**

DESCRIPTION: Evergreen forest characterized by a great participation of sclerophyllous and microphyllous trees and shrubs. Prevalent elements in this association are *Calophyllum calaba* ssp. *pinetorum* and *Coccoloba retusa.* Other species may include *Dipholis neglecta, Zanthoxyllum cubense, Dendropanax cuneifolius, Pachyanthus tetramerus, Trichilia trachyantha, Picramnia reticulata, Calyptranthes caroli, Myrcia valenzuelana, Acunaeanthus tinifolius, Lagetta wrightiana, Malpighia wrightiana,* and others.
DISTRIBUTION: West Cuba: Pinar del Rio prov.
SYNONYMY: Calophyllo-Coccolobetum retusae (Capote *et al.* 1985).
REFERENCES: Borhidi (1991).

***I.A.5.N.a. Quercus oleoides ssp. sagraeana* Forest Alliance (Cuban oak forests)**

CONCEPT: Oak forests of west Cuba on deep, brownish-yellow soils derived from the "San Cayetano" slatey sandstone, rarely on white-sand areas.
DISTRIBUTION: West Cuba, Pinar del Rio prov.
SYNONYMY: Quercion sagraeanae (Borhidi *et al.* 1979).

***Quercus oleoides ssp. sagraeana - Miconia ibaguensis - Xylopia aromatica* Forest**

DESCRIPTION: With an essentially monodominant canopy of *Quercus oleoides ssp. sagraeana.* The understory consists of a mixture of both pine and semi-deciduous forest elements. Species commonly include *Miconia*

[38] The term "submontane" is added, to include the lowland-submontane sclerophyllous evergreen oak forests of west Cuba.

ibaguensis, Miconia splendens, Xylopia aromatica, Amaioua corymbosa, Byrsonima crassifolia, Clidemia hirta, Clidemia strigillosa, Hirtella americana, Brya ebenus, etc.
DISTRIBUTION: West Cuba, Pinar del Rio prov.
SYNONYMY: Miconio ibaguensi-Quercetum sagraeanae (Borhidi & Capote in Borhidi 1991).
REFERENCES: Borhidi (1991).

I.A.5.N.d. Semipermanently flooded tropical or subtropical broad-leaved evergreen sclerophyllous forest

(SEMIPERMANENTLY FLOODED EVERGREEN SCLEROPHYLLOUS FOREST)
(BOSQUE SIEMPREVERDE ESCLERÓFILO SEMIPERMANENTEMENTE INUNDADO)

***I.A.5.N.d. Annona glabra* Forest Alliance**
CONCEPT: Freshwater or very slightly brackish depression or swale wetlands dominated by *Annona glabra*. Physiognomy is variable, varying from dense canopies to open canopies, depending on hydrology and disturbance.
DISTRIBUTION: Puerto Rico, Martinique.
SYNONYMY: *Annona* Swamp Woodland (Kimber 1988); "mamain swamp".

***Annona glabra* Forest**
DISTRIBUTION: Puerto Rico.
COMMENTS: Bosque de Aguirre.

***Annona glabra - Conocarpus erectus / Acrostichum aureum* Forest**
DISTRIBUTION: Puerto Rico.
SYNONYMY: Pond-apple Swamp -- 38.2 (Dansereau 1966).

***Annona glabra / Cladium mariscus ssp. jamaicense* Forest**
DISTRIBUTION: Bahamas.

I.A.5.N.f. Tidally flooded tropical or subtropical broad-leaved evergreen sclerophyllous closed tree canopy

(MANGROVE)
(MANGLAR)

***I.A.5.N.f. Avicennia germinans* Forest Alliance (Black Mangrove Forest Alliance; Mangle prieto Forest Alliance)**
CONCEPT: Mangrove forests dominated by *Avicennia germinans*, sometimes with an admixture of *Rhizophora mangle*.
DISTRIBUTION: Cuba, Puerto Rico, Bahamas, Martinique, Caribbean.
SYNONYMY: Avicennion occidentalis (Cuatrecasas 1958); Black-mangrove Forest (Dansereau 1966); Mangrove Swamp Woodland (Kimber 1988), in part.

***Avicennia germinans* Forest** (TNC 4827)
DESCRIPTION: Dominated by *Avicennia germinans*. *Batis maritima* is usually a common acompanying species. Others may include *Baccharis halimifolia, Iva cheiranthifolia, Salicornia perennis, Heliotropium curassavicum, Distichlis spicata.*
DISTRIBUTION: Cuba, Puerto Rico, Bahamas, Martinique, Caribbean.
COMMENTS: Based on Borhidi (1991); Dansereau (1966).
SYNONYMY: Batidi-Avicennietum germinantis Borhidi & Del Risco, in Borhidi (1991); Black-mangrove forest (Dansereau 1966); Mangrove Swamp Woodland (Kimber 1988), in part.

***Avicennia germinans - (Rhizophora mangle) / Batis maritima* Forest** (TNC 7061)

DESCRIPTION: This is a black mangrove community described from the Florida Keys, Cuba, and Texas. Mangrove canopy usually four to ten meters high and irregular in density.
DISTRIBUTION: FL, TX, [Cuba].
COMMENTS: Documented in southeastern Cuba at Guantanamo Bay Naval Base.
Synonymy: *Batidi-Avicennietum germinantis* Association (Borhidi 1991); ESU 2--Peaty Mangrove Woodland, in part (Ross et al. 1992).
References: Borhidi 1991; Ross et al. 1992.

***I.A.5.N.f. Conocarpus erecta* Forest Alliance**
CONCEPT: Communities dominated by a 4-5 m tall *Conocarpus erecta* tree layer, at the inner side of the mangrove belt, mostly in lagoons with concentrated saltwater.
DISTRIBUTION: Cuba; Caribbean.
SYNONYMY: Conocarpo-Laguncularion (Borhidi *et al.* 1979).

***Conocarpus erecta* Forest Vegetation** (TNC 7600)
DESCRIPTION: With *Conocarpus erecta* as the dominant tree species (70-80% coverage), and the common presence of the fern *Acrostichum aureum* at the herb layer. Other species may include *Laguncularia racemosa, Acrostichum danaifolium,Cladium jamaicense, Fimbristylis spadicea, Schoenoplectus americanus, Eleocharis cellulosa, Baccharis halimifolia.*
DISTRIBUTION: Cuba; Caribbean.
COMMENTS: Based on Borhidi (1991).
SYNONYMY: Acrosticho-Conocarpetum erectae (Borhidi & Del Risco, in Borhidi 1991).

***I.A.5.N.f. Laguncularia racemosa* Forest Alliance (White Mangrove and Mixed Mangrove Forests)**
CONCEPT: Most inland mangrove forest, least frequently tidally flooded, dominated by *Laguncularia racemosa* or mixtures of various mangroves.
DISTRIBUTION: Cuba, Hispaniola, Jamaica, Puerto Rico, Bahamas, Martinique, Caribbean.
SYNONYMY: Mangrove (Ciferri 1936), in part; Mangrove, facies marine (Stehlé 1946); Mangrove Woodland (Asprey & Robbins 1953); Mixed Mangrove Forest (Dansereau 1966); Mangrove Swamp Woodland (Kimber 1988), in part.

***Laguncularia racemosa - Rhizophora mangle - Avicennia germinans - Conocarpus erectus* Forest**
DESCRIPTION: Typically dominated by mixtures of small stands (mosaics) of the four nominal species of Caribbean mangroves.
DISTRIBUTION: Cuba, Hispaniola, Jamaica, Puerto Rico, Bahamas, Martinique, Caribbean.
COMMENTS: This association has been relatively well studied in different localities. Beside floristic surveys, some reports on the growth and regeneration, ecology, and nutrient cycling are available.
SYNONYMY: Associazione Rhizophora-Avicennia-Laguncularia (Ciferri 1936), in part; Rhizophora mangle-Avicennia nitida assoc. (Stehlé 1946); Mangrove Woodland (Asprey & Robbins 1953); Mixed Mangrove Forest (Dansereau 1966); Mangrove Swamp Woodland (Kimber 1988), in part.

***I.A.5.N.f. Rhizophora mangle* Forest Alliance (Red Mangrove Forests)**
CONCEPT: Most oceanwards and frequently tidally flooded mangrove forest, dominated by *Rhizophora mangle*.
DISTRIBUTION: Cuba, Bahamas, Puerto Rico, Martinique, Caribbean.
SYNONYMY: Rhizophorion occidentalis (Cuatrecasas 1958), in part; Red-mangrove Forest (Dansereau 1966); Mangrove Swamp Woodland, in part (Kimber 1988).

***Rhizophora mangle - Dalbergia ecastophyllum - Pavonia spicata* Forest Vegetation**
DESCRIPTION: Dominated by *Rhizophora mangle,* this association forms a narrow fringe along the margins of lowland rivers near to their estuaries. A scarse shrub layer formed by *Dalbergia ecastophyllum* and *Pavonia spicata* are characteristic features of this community, as well as the presence of lianas

(*Rhabdadenia biflora, Sarcostemma clausum*). Scattered individuals of *Laguncularia racemosa, Conocarpus erecta, Bucida palustris, Tabebuia angustata, Roystonea regia and Sabal parviflora* may also occur.
DISTRIBUTION: Cuba
COMMENTS: Based on Borhidi (1991).
SYNONYMY: Dalbergio-Rhizophoretum manglis (Borhidi 1991); Manglar (Areces-Mallea 1978), in part; Bosques de Mangle (Capote *et al.* 1989).

***Rhizophora mangle* Forest**

DESCRIPTION: An essentially monospecific association, with the pioneer *Rhizophora mangle* as the sole dominant.
DISTRIBUTION: Cuba: often in keys; Bahamas, Puerto Rico,Caribbean.
COMMENTS: This association represents pure, somewhat extensive stands of the priserial *Rhizophora* belt.
SYNONYMY: Red-mangrove forest (Dansereau 1966); Manglar (Areces-Mallea 1978), in part; Bosques de mangle (Capote *et al.* 1989).
REFERENCES: Ciferri (1936); Stehlé (1945); Dansereau (1966); Asprey & Robbins (1953); Borhidi (1991).

***I.A.5.N.f. Thespesia populnea* Forest Alliance**

CONCEPT: Wetland short forests (generally 3-8 m tall, dominated by *Thespesia populnea*, typically associated with mangroves, often adjoining them on the inland side, and generally not tidally flooded, except by storm floods.
DISTRIBUTION: Puerto Rico, others.

Group: *I.A.7. Tropical and subtropical needle-leaved (or needle-stemmed)[39] evergreen forest*
Subgroup: *I.A.7.N. Natural/Semi-natural*

I.A.7.N.a. Lowland or submontane tropical or subtropical needle-leaved evergreen forest

(LOWLAND/SUBMONTANE PINE FOREST)
(BOSQUE DE PINOS DE BAJA ALTITUD/SUBMONTANO)

***I.A.7.N.a. Pinus caribaea var. caribaea* Forest Alliance (Pinus caribaea forests, on ferritic soils)**

CONCEPT: Pine forest with canopy dominated by *Pinus caribaea* var. *caribaea*, on the ferritic soils of western Cuba (Cajálbana hills).
DISTRIBUTION: West Cuba: Cajálbana
SYNONYMY: Neomazaeo-Pinion caribaeae (Borhidi *et al.* 1979; Borhidi 1991), in part.

***Pinus caribaea var. caribaea - Neomazaea phialanthoides* Forest**

DESCRIPTION: The common low-altitude pine forest covering all the ridges and slopes on the northern part of the Cajálbana range, on ferritic soils, with a close canopy strongly dominated by *Pinus caribaea var. caribaea*. Typical species include *Neomazaea phialanthoides, Coccothrinax yuraguana, Phania cajalbanica.* A well developed herb layer dominated by grasses (e.g. *Andropogon gracilis, Aristida refracta*) is present.
DISTRIBUTION: West Cuba: Cajálbana.
COMMENTS: Based on Borhidi (1991).
SYNONYMY: Pinetum caribaeae cajalbanensis typicum (Samek 1973), in part; Neomazaeo-Pinetum caribaeae (Borhidi *et al.* 1979), in part.

***Pinus caribaea var. caribaea - Guettarda valenzuelana* Forest**

DESCRIPTION: Humid lowland pine forest on ferritic soils, occurring on flat areas and along creeks, in Cajálbana. The close canopy is dominated by *Pinus caribaea var. caribaea,* with relatively strong participation of some broad-leaved tree species. The shrub layer is richer than the one occurring in the

[39] The phrase "or needle-stemmed" in parenthesis is added, to include the Australian "pine" forest plantations.

former association, whereas the herb layer is poorer. Characteristic species of this community are *Guettarda valenzuelana, Guettarda calyptrata, Cyrilla racemiflora, Calophyllum calaba ssp. pinetorum, Gesneria ferruginea, Comocladia dentata, Rondeletia odorata,* etc.
DISTRIBUTION: West Cuba: Cajálbana
COMMENTS: Based on Borhidi *et al.* (1979); Borhidi (1991).
SYNONYMY: Pinetum cajalbanensis comocladietosum (Samek 1973), in part; Guettardo-Pinetum caribaeae (Borhidi *et al.* 1979).

***I.A.7.N.a. Pinus caribaea var. caribaea - Pachyanthus poiretii* Forest Alliance (Pinus caribaea forests, on slately sandstone)**
CONCEPT: Submontane pine forests with canopy dominated by *Pinus caribaea* var. *caribaea*, on slately sandstone, in western Cuba.
DISTRIBUTION: West Cuba: Sierra de los Organos and Sierra del Rosario ranges, on typical "San Cayetano" Jurassic sandstone.

***Pinus caribaea var caribaea - Pachyanthus poiretii* Forest**
DESCRIPTION: With canopy dominated by *Pinus caribaea* var. *caribaea,* and a well developed shrub layer rich in Melastomataceae species such as *Pachyanthus poiretii, P. cubensis, Clidemia strigillosa, C. neglecta, Ossaea parviflora, Miconia ibaguensis, and M. prasina.*
DISTRIBUTION: West Cuba: Submontane sandstone belt of Sierra de los Organos and Rosario ranges, in Pinar del Rio prov.
COMMENTS: Based on Samek (1969); Borhidi (1991).
SYNONYMY: Pinetum caribaeae (Samek 1969); Pinares de las pizarras (local name).

***I.A.7.N.a. Pinus cubensis* Forest Alliance (Pinus cubensis lowland forests, on ferritic soils)**
CONCEPT: Lowland pine vegetation very rich in endemics, with a closed canopy strongly dominated by *Pinus cubensis,* on deep, acidic ferritic soils.
DISTRIBUTION: East Cuba: Sub-coastal plain between Moa and Baracoa.
SYNONYMY: Guettardo-Pinion cubensis (Borhidi *et al.* 1979), in part.

***Pinus cubensis - Dracaena cubensis* Forest** (TNC 7624)
DESCRIPTION: Rich pine forest with more than 70% of endemic species. The rather closed canopy is strongly dominated by *Pinus cubensis.* Other typical canopy species may be *Dracaena cubensis, Coccothrinax orientalis,* and *Guatteria moralesii.* Both the shrub and herbaceous layers are well developed in this community. Characteristic species are: *Schmidtottia sessiliflora, Schidtottia shaferi, Psidium parviflorum, Casearia moaensis, Casearia bissei, Myrtus ophiticola, Guettarda crassipes, Guettarda ferruginea, Bumelia cubensis, Cyrilla cubensis, Ossaea pauciflora, Jacquinia roigii, Rhynchospora lindeniana, Chaetocarpus oblongatus, Eugenia pinetorum, Phyllanthus myrtilloides ssp. erythrinus,* and *Callicarpa oblanceolata.*
DISTRIBUTION: East Cuba: Lowlands and foothills between Moa and Baracoa.
COMMENTS: Based on Borhidi (1991).
SYNONYMY: Dracaeno-Pinetum cubensis (Borhidi 1991).

***I.A.7.N.a. Pinus tropicalis - Pinus caribaea var. caribaea* Forest Alliance (Pinus tropicalis - Pinus caribaea forests)**
CONCEPT: Low-altitude pine forests of the hillsides of Isle of Pines (Cuba), dominated by *Pinus tropicalis* with substantial participation of *Pinus caribaea.*
DISTRIBUTION: Cuba: Isle of Pines.
SYNONYMY: Acoelorrapho-Pinion tropicalis (Samek in Borhidi *et al.* 1979), in part.

***Pinus tropicalis - Pinus caribaea var. caribaea* Forest**
DESCRIPTION: Pine forest with *Pinus tropicalis* dominating the canopy. *Pinus caribaea* is also present. Other characteristic species include *Byrsonima wrightiana, Tetrazygia delicatula, Clitoria laurifolia, phyllanthus junceus, Lyonia myrtilloides,* and *Trachypogon filifolius.*
DISTRIBUTION: Cuba: colline belt of Isle of Pines.

COMMENTS: Based on Borhidi (1991).
SYNONYMY: Pinetum tropicalis-caribaeae (Samek 1969).

I.A.7.N.b. Montane or subalpine tropical or subtropical needle-leaved evergreen forest (MONTANE PINE FOREST) (BOSQUE MONTANO DE PINOS)

***I.A.7.N.b. Pinus occidentalis* Forest Alliance (Pinus occidentalis high-altitude forests)**
CONCEPT: High-altitude montane pine forests with monospecific canopy of *Pinus occidentalis*, in the central range of Hispaniola.
DISTRIBUTION: Hispaniola
SYNONYMY: Belle forêts a pins (Sorre 1928), in part; Pinares (Hager & Zanoni 1993), in part

***Pinus occidentalis / Lyonia urbaniana - Lyonia tuerkheimii / Pteridium caudatum* Forest**

DESCRIPTION: With monospecific canopy of *Pinus occidentalis*, and endemic-rich understory dominated by shrubs and ferns, in humid locations. Prevalent species include *Lyonia urbaniana, Lyonia tuerkheimii, Gaultheria domingensis, Garrya fadyenii, Senecio fuertesii, Senecio picardae, Satureja alpestris, Baccharis myrsinites, Hypericum pycnophyllum, Weinmania pinnata, Miconia krugii, Miconia viscidula, Miconia sphagnicola, Pteridium aquilinum, Lophosoria quadripinnata, Plagyogyria semicordata.*
DISTRIBUTION: Hispaniola: Cordillera Central, over 2,200 m altitude.
COMMENTS: Based on Ciferri (1936); Hager & Zanoni (1993).
SYNONYMY: Pineto Alto (Ciferri 1936), in part; Pinares de la zona alta de la Cordillera Central (Hager & Zanoni 1993), in part.

***Pinus occidentalis / Danthonia domingensis* Forest**

DESCRIPTION: With monospecific canopy of *Pinus occidentalis*, and substantial ground coverage of grasses and other herbaceous plants, in drier and somewhat exposed areas. Some characteristic grasses include *Danthonia domingensis, Calamagrostis leonardii, Agrostis hyemalis,* and *Agristis perennis.*
DISTRIBUTION: Hispaniola: Cordillera Central, over 2,200 m altitude.
COMMENTS: Based on Ciferri (1936); Hager & Zanoni (1993).
SYNONYMY: Pineto Alto (Ciferri 1936), in part; Pinares de la zona alta de la Cordillera Central (Hager & Zanoni 1993), in part.

Group: *I.A.10. Mixed tropical and subtropical needle-leaved-broad-leaved evergreen forest*[40]
Subgroup: *I.A.10.N. Natural/Semi-Natural*

I.A.10.N.a. Mixed tropical and subtropical needle-leaved-broad-leaved evergreen forest[41] (MIXED PINE-BROAD-LEAVED FOREST) (BOSQUE MIXTO DE PINOS Y LATIFOLIOS)

***I.A.10.N.a. Pinus caribaea var caribaea - Quercus oleoides ssp. sagraeana* Forest Alliance (Pinus caribaea caribaea mixed forests)**
CONCEPT: Submontane pine-oak mixed forests with canopy co-dominated by *Pinus caribaea* var. *caribaea* and *Quercus oleoides* ssp. *sagraeana*, on the slatey sandstones of western Cuba.
DISTRIBUTION: West Cuba: Sierra de los Organos and Sierra del Rosario ranges, on typical "San Cayetano" Jurassic sandstone.
SYNONYMY: Pachyantho poiretii-Pinion caribaeae (Borhidi *et al.* 1979), in part.

***Pinus caribaea var. caribaea - Quercus oleoides ssp. sagraeana* Forest**

[40] New Group.
[41] New Formation.

DESCRIPTION: Pine-oak mixed forest, on slatey sandstone. The canopy typically shows strong admixture of broad-leaved evergreen *Quercus sagraeana* ssp. *oleoides.* Other arboreal species that may be well represented in the canopy layer are: *Calophyllum calaba* ssp. *pinetorum, Pinus tropicalis, Matayba oppositifolia, Xylopia aromatica,* and *Clusia rosea.* As in the former association, the understory is rich in Melastomataceae species. Other species present may include *Didymopanax morototoni, Guarea guidonia, Rhus copallina* ssp. *leucantha, Amaioua corymbosa, Tabebuia lepidophylla, Alsophila myosuroides, Byrsonima pinetorum, Psychotria revoluta, Eugenia farameoides,* etc.
DISTRIBUTION: West Cuba: Submontane sandstone belt of Sierra de los Organos and Rosario ranges, in Pinar del Rio prov.
SYNONYMY: Quercum-Pinetum caribaeae Borhidi & Capote in Borhidi (1991).
REFERENCES: Borhidi (1991).

***I.A.10.N.a. Pinus cubensis - Tabebuia dubia* Forest Alliance (Pinus cubensis mixed forests)**
CONCEPT: Montane mixed forests of *Pinus cubensis* and broad-leaved evergreen trees, in the serpentine ranges of eastern Cuba, on ferritic soils. The herb layer in this vegetation type is usually dense and tall. Characteristic canopy species include *Pinus cubensis, Tabebuia dubia, Hyeronima nipensis, Terminalia orientensis* and *Guatteria moralesii.*
DISTRIBUTION: Eastern Cuba: Sagua-Baracoa.
SYNONYMY: Andropogo-Pinion cubensis (Borhidi *et al.* 1979; Borhidi 1991).

***Pinus cubensis / Rhynchospora tenuis - Baccharis scoparioides - Vernonia urbaniana* Forest** (TNC 7626)
DESCRIPTION: Montane mixed pinewoods on relatively fertile, deep humid ferritic soils, in eastern Cuba. The herb layer is well developed and diverse, and may include *Andropogon gracilis, Andropogon reinoldii, Andropogon nashianus, Panicum aciculare, Panicum fusiforme, Panicum scoparium, Paspalum alainii, Aristida refracta,* and eight different species of *Rhynchospora.* Other prevalent associates are *Baccharis scoparioides, Vernonia urbaniana, Eupatorium polystictum, Dodonaea viscosa, Bactris cubensis, Casearia crassinervis,* and *Pteridium caudatum.*
DISTRIBUTION: East Cuba: Sierra de Nipe and Sierra Cristal.
SYNONYMY: Pinetum nipense typicum (Samek 1973), in part; Pinetum panicetusum (Samek 1973), in part; Rhynchosporo-Pinetum cubensis (Samek 1973, *sensu* Borhidi *et al.* 1979).
REFERENCES: Samek (1973); Borhidi *et al.* (1979); Borhidi (1991).

***Pinus cubensis / Bactris cubensis - Shafera platyphylla* Forest** (TNC 7627)
DESCRIPTION: Rich pine forest with a mixed upper canopy of *Pinus cubensis* and many evergreen trees, on deep, rather humid and fertile ferritic soils, in the high plateau of Moa (eastern Cuba). A second canopy layer composed of small trees such as *Bactris cubensis* and *Alsophila aquilina,* is always present. Other characteristic species include *Shafera platyphylla, Gomidesia lindeniana, Vaccinium alainii, Cordia toaensis, Lyonia glandulosa, Ficus wrightii, Ossaea navasensis, Ossaea pseudopinetorum, Gundlachia cubana, Clethra cubensis, Spirotecoma apiculata, Miconia cerasiflora,* etc.
DISTRIBUTION: East Cuba: Sierra del Maguey (Cupeyal del Norte).
SYNONYMY: Shafero-Pinetum cubensis (Borhidi & Muñiz in Borhidi 1991).
REFERENCES: Borhidi (1991).

***I.A.10.N.a. Pinus ×maestrensis* Forest Alliance (Pinus maestrensis mixed forests)**
CONCEPT: Montane mixed pinewoods rich in tree-ferns, on yellow acidic soils derived from sandstone and andesitic tuffs, in southeastern Cuba. The uppermost of the two canopy layers is formed by *Pinus ×maestrensis (Pinus cubensis* x *Pinus occidentalis),* accompanied by evergreen broad-leaved trees. This vegetation type shows affinities to Pinus tropicalis mid-altitude mixed forests of Hispaniola; both units occur within the montane rainforest zone, and are typically successional.
DISTRIBUTION: Southeast Cuba: Sierra Maestra range.
SYNONYMY: Pinion maestrensis (Borhidi *et al.* 1979).

***Pinus ×maestrensis / Clethra cubensis - Cyathea arborea* Forest**

DESCRIPTION: Montane mixed pinewoods occurring as isolated stands in the mountain ranges of southeastern Cuba. The upper canopy is dominated by *Pinus xmaestrensis,* with strong admixture of broad-leaved trees such as *Myrsine coriacea.* Smaller trees, *e.g. Weinmania pinnata, Garrya fadyenii, Ilex macfadyenii,* and others, are often common. Very characteristic of this association is the constant presence of tree-ferns (*i.e. Cyathea arborea, Alsophila aspera*) and typical southeastern Cuban montane rain forest species such as *Clethra cubensis, Vaccinium leonis, Lyonia calycosa,* and *Myrica punctata*.

DISTRIBUTION: Southeast Cuba: Sierra Maestra (northern slopes) and Gran Piedra ranges.

SYNONYMY: Clethro-Pinetum maestrensis (Borhidi 1991).

REFERENCES: Borhidi *et al.* (1979); Borhidi (1991).

***I.A.10.N.a. Pinus occidentalis - Ilex microwrightioides* Forest Alliance (Pinus occidentalis mid-altitude mixed forests)**

CONCEPT: Mid-altitude montane pine forests with canopy of *Pinus occidentalis* with admixture of broad-leaved tree species, in humid locations. Species of general distribution within this vegetation type include *Ilex microwrightioides, Ilex tuerckheimii, Eupatorium illitium, Gnaphalium eggersii, Calamagrostis leonardii, Vernonia stenophylla, Cordia dependens, Lyonia microcarpa, Satureja domingensis, Chamaecrista glandulosa var. picardae, Galactia rudolphioides var. haitiensis, Myrcia picardae, Psychotria dolichocalyx, Syderoxylon repens,* and *Buddleia domingensis.*

DISTRIBUTION: Hispaniola: Cordillera Central; Sierra de Bahoruco.

SYNONYMY: Pineto basso (Ciferri 1936), in part; Pinares de elevación intermedia (Hager & Zanoni 1993), in part.

***Pinus occidentalis / Tabebuia bullata - Eupatorium dictyoneurum* Forest**

DESCRIPTION: Mixed mid-altitude *Pinus occidentalis* forests of the central ranges of Hispaniola, on rather humid locations. A species-rich community with many associates coming from the neighboring rain forests. Characteristic species include *Tabebuia bullata, Eupatorium dictyoneurum, Mikania papillosa, Lyonia heptamera, Lyonia rubiginosa, Paepalanthus repens, Euphorbia tuerckheimii, Hypericum fuertesii, Hypericum constanzae, Hypericum polycladum, Satureja vimenca, Lepechinia urbanii, Salvia lavendula, Dendropemon pycnophyllus, Dendropemon constantiae, Alchemilla domingensis, Galium domingense, Scrophularia eggersii,* and *Viola domingensis.*

DISTRIBUTION: Hispaniola: Cordillera Central.

SYNONYMY: Pineto basso (Ciferri 1936), in part; Pinares de elevación intermedia (Hager & Zanoni 1993), in part; Pinares de la Cordillera Central (Hager & Zanoni 1993).

REFERENCES: S.E.A. (1990); Hager & Zanoni (1993).

***Pinus occidentalis / Senecio buchii - Tournefortia selleana* Forest**

DESCRIPTION: Mixed mid-altitude *Pinus occidentalis* forests, in Sierra de Bahoruco. Characteristic differential species include *Senecio buchii, Tournefortia selleana, Corcopsis buchii, Salvia bahorucana, Sophora albolineata, Polygala cruciancllloides, Mitracarpus bahorucana, Scrophularia bahorucana, Cestrum humile, Symplocos domingensis,* and *Duranta arida* var. *serpentina.*

DISTRIBUTION: Hispaniola: Sierra de Bahoruco.

SYNONYMY: Pineto basso (Ciferri 1936), in part; Pinares de elevación intermedia (Hager & Zanoni 1993), in part; Pinares de la Sierra de Bahoruco (Hager & Zanoni (1993).

REFERENCES: S.E.A. (1990); Hager & Zanoni (1993).

***I.A.10.N.a. Pinus occidentalis - Magnolia pallescens* Forest Alliance (Pinus occidentalis high-altitude mixed forests)**

CONCEPT: High-altitude mixed pine forests with canopy co-dominated by *Pinus occidentalis, Magnolia pallescens* and other broad-leaved tree species, on the exposed summits and ridges of Cordillera Central (Hispaniola), over 1,700 m elevation.
DISTRIBUTION: Hispaniola (Dominican Republic): eastern Cordillera Central.
SYNONYMY: Bosque de Magnolia pallescens (Hager & Zanoni 1993), in part.

***Pinus occidentalis - Magnolia pallescens - Didymopanax tremulus* Forest**

DESCRIPTION: Mixed *Pinus occidentalis* forests, with strong admixture of broad-leaved trees such as *Magnolia pallescens, Didymopanax tremulus, Tabebuia vinosa, Brunellia comocladifolia, Myrsine coriacea,* and *Trema micrantha*, on the yellowish acidic montane soils of eastern Cordillera Central (Hispaniola), between 1,700 and 2,100 m elevation.
DISTRIBUTION: Hispaniola (Dominican Republic): south of Constanza.
COMMENTS: This is a successional community established within the cloud forest belt, in areas where the original Magnolia pallescens - Tabebuia vinosa - Didymopanax tremulus cloud forests were disturbed.
SYNONYMY: Bosque de *Magnolia pallescens* (Hager & Zanoni 1993), in part.
REFERENCES: Hager & Zanoni (1993).

Subclass: ***I.B. DECIDUOUS FOREST***

Group: ***I.B.1. Drought-deciduous forest***
Subgroup: ***I.B.1.N. Natural/Semi-natural***

I.B.1.N.a. Lowland or submontane drought-deciduous forest (LOWLAND/SUBMONTANE DROUGHT-DECIDUOUS FOREST) (BOSQUE SECO DECIDUO DE BAJA ALTITUD/SUBMONTANO)

(TYPES TO BE DEFINED)

Subclass: ***I.C. MIXED EVERGREEN-DECIDUOUS FOREST***
Group: ***I.C.1. Tropical or subtropical semi-deciduous forest***
Subgroup: ***I.C.1.N. Natural/Semi-natural***

I.C.1.N.a. Lowland tropical or subtropical semi-deciduous forest (LOWLAND SEMI-DECIDUOUS FORESTS) (BOSQUE SEMI-DECIDUO DE BAJA ALTITUD)

(MOST TYPES TO BE DEFINED)

***I.C.1.N.a. Coccoloba diversifolia* Forest Alliance**
CONCEPT: Forests dominated or codominated by *Coccoloba diversifolia*. In Puerto Rico these forests occur at low elevations in NW. and NC. Puerto Rico on limestone hills (which make the vegetation somewhat xerophytic). In Puerto Rico other typical canopy species include *Bucida buceras, Quararibea turbinata, Guapira fragrans, Zanthoxylum martinicense,* and *Ficus citrifolia*. Terrestrial and epiphytic ferns are frequent and include *Blechnum occidentale, Tectaria heracleifolia, Cyclopeltis semicordata,* and *Adiantum tenerum*.
DISTRIBUTION: Puerto Rico.
SYNONYMY: Gateado forest -- 60.1 (Dansereau 1966); Llume - Gumbo-limbo Savana -- 62.3 (Dansereau 1966); Llume - Gumbo-limbo Scrub -- 62.4 (Dansereau 1966).
REFERENCES: Dansereau (1966).

***Coccoloba diversifolia - Bursera simaruba - Bucida buceras - Zanthoxylum martinicense* Forest**

DESCRIPTION: This is a characteristic forest of the mogote sides and tops, in northcentral and northwestern Puerto Rico. Other characteristic species include *Gaussia attenuata, Rondeletia inermis, Guettarda scabra, Eugenia confusa, Eugenia spp., Coccothrinax alta, Thrinax morrisii, Aiphanes acanthophylla.*
DISTRIBUTION: Puerto Rico.

***I.C.1.N.a. Lysiloma latisiliqua - Swietenia mahagoni - Peltophorum adnatum* Forest Alliance**
DISTRIBUTION:: Cuba.
COMMENTS: In southeastern Cuba (Guantanamo Bay).

***Lysiloma latisiliqua - Swietenia mahagoni - Peltophorum adnatum - Bucida spinosa - Pseudosamanea cubana / Tillandsia usneoides* Forest** (TNC 7605)
SYNONYMY: Legume forest.

***I.C.I.N.a. Phyllostylon brasiliensis* Forest Alliance**
DISTRIBUTION:: Cuba.
COMMENTS: In southeastern Cuba (Guantanamo Bay).

***Phyllostylon brasiliensis - Maytenus buxifolia - Pilososereus brooksianus - Amyris elemifera* Forest** (TNC 7606)
SYNONYMY: *Phyllostylon* forest.

***Phyllostylon brasiliensis - Senna insularis - Stenocereus peruvianus - Dendrocereus nudiflorus* Forest** (TNC 7607)
SYNONYMY: *Phyllostylon*-cactus forest.

***I.C.1.N.a.085. Tabebuia heterophylla - Pisonia subcordata* Forest Alliance**
CONCEPT:
DISTRIBUTION: Antigua and Barbuda.
REFERENCES: Lindsay and Horwith (1997).

***Tabebuia heterophylla - Pisonia subcordata* Forest** (TNC 7609)
DISTRIBUTION: Antigua and Barbuda.
REFERENCES: Lindsay and Horwith (1997).

***I.C.1.N.a. Tabebuia pallida - Coccoloba swartzii - Bursera simaruba* Forest Alliance**
CONCEPT: Semi-deciduous forests of Martinique (and possibly of wider occurrence in the Lesser Antilles), with a mixture of drought-deciduous and evergreen species in the canopy.
DISTRIBUTION: Martinique.

***Tabebuia pallida - Coccoloba swartzii - Bucida buceras - Bursera simaruba / Guettarda scabra - Zanthoxylum martinicense* Forest**
DESCRIPTION: Semi-deciduous forest of the s. coast of Martinique, restricted to small areas on gently sloping land over vertisols high in montmorillonitic clays. The average annual temperature is 26 degrees C, the average annual rainfall 1300-1700mm, with a dry season of 1-2 months with less than 50mm of precipitation. Common canopy species include the deciduous trees, *Tabebuia pallida* and *Bursera simaruba*, and evergreens *Coccoloba swartzii, Bucida buceras, Inga laurina, Simarouba amara, Pimenta racemosa, Citharexylum fruticosum*, and *Lonchocarpus benthamianus*. The evergreen understory typically has *Guettarda scabra, Picramnia pentandra, Zanthoxylum martinicense*, and *Myrcia citrifolia*. Shrubs include *Randia aculeata, Zanthoxylum spinifex, Croton bixoides, Croton hircinus, Ardisia obovata*, and *Coccoloba pubescens.* Herbs include *Sporobolus indicus, Chloris barbata, Scleria lithosperma, Dichromena nervosa*, and *Kalanchoe pinnata.*
DISTRIBUTION: Martinique.
COMMENTS: Based on Kimber (1988).
SYNONYMY: Semideciduous Forest (Kimber 1988).

***Tabebuia pallida - Calophyllum calaba - Coccoloba swartzii - Bursera simaruba - Hippomane mancinella - Coccoloba uvifera* Forest**

DESCRIPTION: Semi-deciduous forest originally occurring fairly extensively in a usually narrow band around the southern coast of Martinique. The average annual temperature is 26-27 debrees C, the average annual rainfall 900-1300mm, with occasional drought years with as little as 300-500 mm, and with a dry season in most years of 2-6 months with less than 50mm of precipitation. Canopy height ranges from 10-20m, with typical species including *Tabebuia pallida, Calophyllum calaba, Coccoloba swartzii, Bursera simaruba, Hippomane mancinella, Coccoloba uvifera, Lonchocarpus benthamianus, Pisonia fragrans, Erythrina berteroana, Capparis indica,* and *Thespesia populnea*. Understory vegetation is sparse.
DISTRIBUTION: Martinique.
COMMENTS: Based on Kimber (1988).
SYNONYMY: Littoral Woodland (Kimber 1988).

***Pisonia fragrans - Bursera simaruba - Tabebuia pallida - Ceiba pentandra / Pimenta racemosa - Cordia alliodora* Forest**

DESCRIPTION: Semi-deciduous forest originally occurring fairly extensively in a broad band around the southern coast of Martinique, inland from the *Tabebuia pallida - Calophyllum calaba - Coccoloba swartzii - Bursera simaruba - Hippomane mancinella - Coccoloba uvifera* Forest. The average annual temperature is 26-27 degrees C, the average annual rainfall 900-1300mm, with occasional drought years with as little as 300-500 mm, and with a dry season in most years of 2-6 months with less than 50mm of precipitation. Canopy height ranges from 20-25m, with typical species including *Pisonia fragrans, Bursera simaruba, Tabebuia pallida, Ceiba pentandra.* Shorter trees include *Pimenta racemosa, Cordia alliodora, Myrcia citrifolia,* and *Myrcia splendens*. A well-developed shrub layer includes species such as *Pithecellobium unguis-cati, Parkinsonia aculeata, Randia aculeata, Coccoloba swartzii, Rauvolfia viridis, Daphnopsis caribaea, Psychotria nervosa, Zanthoxylum punctatum, Capparis flexuosa, Croton spp., Acacia spp., Pilosocereus royenii*.
DISTRIBUTION: Martinique.
COMMENTS: Based on Kimber (1988).
SYNONYMY: Dry Woodland (Kimber 1988).

I.C.1.N.c. Seasonally flooded/saturated tropical or subtropical semi-deciduous closed tree canopy

(SEASONALLY FLOODED/SATURATED SEMI-DECIDUOUS FOREST)
(BOSQUE SEMI-DECIDUO ESTACIONALMENTE INUNDADO/SATURADO)

***I.C.1.N.c.002. Annona glabra - Bucida buceras* Seasonally Flooded Forest Alliance**
CONCEPT:
DISTRIBUTION: Antigua and Barbuda.
REFERENCES: Lindsay and Horwith (1997).

Class: ***II. WOODLAND***[42]
Subclass: ***II.A. EVERGREEN WOODLAND***
Group: ***II.A.1. Tropical or subtropical broad-leaved woodland***
Subgroup: ***II.A.1.N. Natural/Semi-natural***

II.A.1.N.a. Tropical or subtropical broad-leaved evergreen woodland

(EVERGREEN WOODLAND)
(ARBOLEDA SIEMPREVERDE)

[42] The shorter term "woodland" is preferred over the phrase "open tree canopy"

***II.A.1.N.a. Acoelorraphe wrightii* Woodland Alliance (Silver Saw Palmetto Woodlands, on white sands)**
CONCEPT: Palm-dominated community with *Acoelorraphe wrightii*, in the white-sand areas of Cuba.
DISTRIBUTION: West Cuba: Pinar del Rio prov., in white-sand areas.
SYNONYMY: Blechno-Acoelorraphion wrightii (Hadac in Hadac & Hadacova 1971), in part.

***Acoelorraphe wrightii - Blechnum serrulatum* Woodland**
DESCRIPTION: Community with an open canopy dominated by the clumping palm species *Acaoelorraphe wrightii*, in the humid sites of white-sand areas, usually along or near the drainage network surrounding shallow oligotrophic lakes. The fern *Blechnum serrulatum* often gives substantial coverage to the ground.
DISTRIBUTION: West Cuba: Pinar del Rio prov.
COMMENTS: Based on Hadac in Hadac & Hadacova (1971); Borhidi (1991).
SYNONYMY: Blechnum-Acoelorraphetum wrightii (Hadac in Hadac & Hadacova 1971).

***II.A.1.N.a. Coccothrinax barbadensis* Woodland Alliance**
CONCEPT:
DISTRIBUTION: Antigua and Barbuda.
REFERENCES: Lindsay and Horwith (1997).

***Coccothrinax barbadensis* Woodland** (TNC 7614)
DISTRIBUTION: Antigua and Barbuda.
REFERENCES: Lindsay and Horwith (1997).

***II.A.1.N.a. Colpothrinax wrightii* Woodland Alliance (Colpothrinax wrightii woodlands, on white sand)**
CONCEPT: Palm-dominated community with *Colpothrinax wrightii*, in the white-sand areas of Cuba.
DISTRIBUTION: West Cuba: Pinar del Rio prov., in white-sand areas.
SYNONYMY: Blechno-Acoelorraphion wrightii (Hadac in Hadac & Hadacova 1971, *sensu* Borhidi 1991), in part.

***Colpothrinax wrightii - Chrysobalanus icaco* Woodland**
DESCRIPTION: Open canopy dominated by the endemic palm species *Colpothrinax wrightii*, sometimes with scattered individuals of *Pinus tropicalis*, in white sand areas. *Crysobalanus icaco* is a major component of the tall shrub layer.
DISTRIBUTION: West Cuba: Pinar del Rio prov.
COMMENTS: Some of the extant stands of this rather broad-leaf association can be interpreted as being natural, but the majority of them are second-growth communities developed as a result of cutting and logging original pine woodlands.
SYNONYMY: Chrysobalano-Colpotrinacetum wrightii (Borhidi & Capote, as mentioned in Borhidi 1991).

***II.A.1.N.a. Hippomane mancinella - Coccoloba uvifera* Woodland Alliance**
CONCEPT: This alliance occurs in coastal areas, with trees often stunted from wind. Other species may include *Thespesia populnea, Hippomane mancinella, Conocarpa erecta, Cocos nucifera* (alien), *Coccoloba uvifera, Terminalia catappa* (alien), *and Cordia sebestena*.
DISTRIBUTION: Antigua and Barbuda.
REFERENCES: Lindsay and Horwith (1997).

***II.A.1.N.a. Randia aculeata - Didymopanax morototoni* Woodland Alliance**
DISTRIBUTION: Puerto Rico.
SYNONYMY: Second-growth Woodland -- 48.2 (Dansereau 1966); Second-growth Savana -- 48.3 (Dansereau 1966).

II.A.1.N.b. Seasonally/temporarily flooded tropical or subtropical broad-leaved evergreen woodland

(SEASONALLY/TEMPORARILY FLOODED EVERGREEN WOODLAND)
(ARBOLEDA SIEMPREVERDE ESTACIONALMENTE/TEMPORALMENTE INUNDADA)

(TYPES TO BE DEFINED)

II.A.1.N.c. Seasonally flooded/saturated tropical or subtropical broad-leaved evergreen woodland

(SEASONALLY FLOODED/SATURATED EVERGREEN WOODLAND)
(ARBOLEDA SIEMPREVERDE ESTACIONALMENTE INUNDADA/SATURADA)

***II.A.1.N.c. Sabal palmetto* Woodland Alliance**
DISTRIBUTION: Bahamas.

***Sabal palmetto* Bahamian Grove Woodland**
DESCRIPTION: *Sabal palmetto* groves occurring in isolated drainage basins with freshwater accumulation. A sparse herbaceous stratum is seasonally present.
DISTRIBUTION: Bahamas (except Andros).
SYNONYMY: 4.b. *Sabal palmetto* grove, in part (Freid 1998).

***Sabal palmetto - Conocarpus erecta* Woodland**
DESCRIPTION: Occurs in sandy soil, isolated drainage basins in the Exumas.
DISTRIBUTION: Bahamas (Exumas).
SYNONYMY: 4.b. *Sabal palmetto* grove, in part (Freid 1998).

II.A.1.N.d. Semi-permanently flooded tropical or subtropical broad-leaved evergreen woodland

(SEMI-PERMANENTLY FLOODED EVERGREEN WOODLAND)
(ARBOLEDA SIEMPREVERDE SEMI-PERMANENTEMENTE INUNDADA)

(TYPES TO BE DEFINED)

II.A.1.N.e. Tidally flooded tropical or subtropical broad-leaved evergreen woodland

(TIDALLY FLOODED EVERGREEN WOODLAND)
(ARBOLEDA SIEMPREVERDE MAREAL)

(TYPES TO BE DEFINED)

***II.A.1.N.f. Hemisclerophyllous tropical or subtropical broad-leaved evergreen woodland*[43]**

(HEMISCLEROPHYLLOUS EVERGREEN WOODLAND)
(ARBOLEDA SIEMPREVERDE HEMIESCLERÓFILA)

(TYPES TO BE DEFINED)

[43] New Formation, to include Stoffer's (1956) "Hippomane Woodlands"

II.A.1.N.x. Saturated tropical or subtropical broad-leaved evergreen woodland **(SATURATED EVERGREEN WOODLAND) (ARBOLEDA SIEMPREVERDE SATURADA)**

***II.A.1.N.x. Bucida spinosa* Woodland Alliance**
DISTRIBUTION: Bahamas.

***Bucida spinosa / Rhynchospora tenuis - Cladium mariscus ssp. jamaicense* Woodland**
DISTRIBUTION: Bahamas.

Group: ***II.A.3. Tropical or subtropical needle-leaved (or needle-stemmed)[44] evergreen woodland***
Subgroup: ***II.A.3.N. Natural/Semi-natural***

II.A.3.N.a. Tropical or subtropical needle-leaved evergreen woodland **(PINE WOODLAND) (ARBOLEDA DE PINOS)**

***II.A.3.N.a. Pinus tropicalis* Woodland Alliance (Pinus tropicalis woodlands, on white-sand or slates)**
CONCEPT: Open pine woodlands of western Cuba, on white-sand soils and hard slate rocks, with a canopy dominated by *Pinus tropicalis.*
DISTRIBUTION: Cuba: Pinar del Rio prov., and western Isle of Pines.
SYNONYMY: Acoelorrhapho-Pinion tropicalis (Samek in Borhidi *et al.* 1979), in part.

***Pinus tropicalis / -Byrsonima crassifolia - Tabebuia lepidophylla* Woodland**
DESCRIPTION: Open pine association on crystalline slates and white sand soils, with canopy dominated by *Pinus tropicalis.* Other species include *Colpothrinax wrightii, Byrsonima crassifolia, B. pinetorum, Tabebuia lepidophylla, Pachyanthus wrightii, Pachyanythus poiretii, Befaria cubensis, Brya depressa, Hyptis pedalipes, Aster grisebachii, Heptanthus cochlearifolius, Stenandrium ovatum, etc.*
DISTRIBUTION: Cuba: slate range of Sierra del Rosario, and white-sand area of south Pinar del Rio prov.
COMMENTS: Based on Borhidi & Capote in Borhidi (1991).
SYNONYMY: Byrsonimo-Pinetum tropicalis-caribaeae (Borhidi & Capote in Borhidi 1991).

***Pinus tropicalis / Eragrostis cubensis* Woodland**
DESCRIPTION: Open canopy dominated by *Pinus tropicalis*, on white-sand areas, with substantial coverage of the ground by *Eragrostis cubensis* and other grasses.
DISTRIBUTION: West Cuba: Remates de Guane.
COMMENTS: Based on Samek in Hadac & Hadacova (1971).
SYNONYMY: Eragrosti cubensi-Pinetum tropicalis (Samek in Hadac & Hadacova 1971).

***Pinus tropicalis / Paepalanthus seslerioides - Syngonanthus insularis* Woodland**
DESCRIPTION: Open pine association on white-sands, with the canopy dominated by *Pinus tropicalis.* Characteristic species are: *Paepalanthus seslerioides, Paepalabthus alsinoides, Syngonanthus insularis, Pachyanthus longifolius, Kalmiella aggregata, Kalmiella simulata.*
DISTRIBUTION: Cuba: western Isle of Pines.
COMMENTS: Based on Samek (1969); Borhidi (1991).
SYNONYMY: Paepalantho-Pinetum tropicalis (Samek 1969).

[44] The phrase "or needle-stemmed" in parenthesis is added, to include the Australian "pine" woodland plantations.

***II.A.3.N.a. Pinus caribaea var. bahamensis* Woodland Alliance (Pinus caribaea bahamensis woodlands, on limestone)**
CONCEPT: "Pineyards" of the Bahamas, on limestone, with essentially monospecific canopy of *Pinus caribaea var. bahamensis.* These communities occur near the conceptual boundary between wetland (saturated or seasonallt saturate) and upland situations.
DISTRIBUTION: Bahamas.
SYNONYMY: Pineyard, in part; Pineland, in part; Dry Pine Barren (Correll & Correll 1982).

***Pinus caribaea var. bahamensis / Coccothrinax argentea - Vernonia bahamense - Tabebuia bahamensis* Woodland (7620)**

DESCRIPTION: Pine woodlands of *Pinus caribaea* var. *bahamensis* , often with *Schizachyrium gracile*. Species that are more prevalent in this association are: *Coccothrinax argentea, Vernonia bahamense, Petitia domingensis, Duranta repens, Acacia choriophylla, Tetrazygia bicolor, Zanthoxylum fagara, Cordia bahamensis, Ernodea littoralis, Hypericum hypericoides, Turnera ulmifolia* and *Bletia purpurea.*
DISTRIBUTION: Bahamas: Grand Bahama, Abaco, New Providence, Andros, and Caicos Islands.
COMMENTS: Based on Correll & Correll (1982).
SYNONYMY: Dry Pine Barren (Correll & Correll 1982).

***Pinus caribaea var. bahamensis / Metopium toxiferum - Byrsonima lucida* Woodland (7628)**

DESCRIPTION: Prevalently associated to *Pinus caribaea* var. *bahamensis* in this woodland type are *Metopium toxiferum,* and *Byrsonima lucida*. Fewer palms than in *Pinus caribaea var. bahamensis / Coccothrinax argentea - Vernonia bahamense - Tabebuia bahamensis* Woodland (7620).
DISTRIBUTION: Bahamas: Grand Bahama, Abaco, New Providence, Andros.
COMMENTS: Many species occurring in this community are also found in the above described association. However, most of them are more prevalent in only but one of the two communities within the Alliance.
SYNONYMY: Wet Pine Barren (Correll & Correll 1882).

***II.A.3.N.a. Pinus occidentalis* Woodland Alliance (Pinus occidentalis woodlands)**
CONCEPT: Mid-altitude pine woodland with essentially monospecific canopy of *Pinus occidentalis.*
DISTRIBUTION: Hispaniola (Dominican Republic).
SYNONYMY: Pineto Basso (Ciferri 1936), in part; Pinares de Elevación intermedia (Hager & Zanoni 1993), in part.

***Pinus occidentalis* Woodland**

DESCRIPTION: Pine woodland with essentially monospecific canopy of *Pinus occidentalis,* at mid elevations, in slopes usually facing south. This community occurs in relatively dry, rocky substrate. The understory is poor in species, and a herbaceous layer of *Andropogon* spp. and other grasses is often present. Other species may include *Agave antillana, Salvia spp*. and the exotic *Melinis minutiflora.*
DISTRIBUTION: Dominican Republic (Cordillera Central; Sierra de Bahoruco).
COMMENTS: Based on Hager & Zanoni (1993).
SYNONYMY: Pinares Secos (Hager & Zanoni 1993).

***II.A.3.N.a. Pinus caribaea var. caribaea* Woodland Alliance (Pinus caribaea caribaea woodlands, on serpentines and ferritic soils)**
CONCEPT: Pine woodland with canopy dominated by *Pinus caribaea* var. *caribaea* on the ferritic soils and serpentine outcrops of western Cuba (Cajálbana hills).
DISTRIBUTION: West Cuba (Cajálbana).
SYNONYMY: Neomazaeo-Pinion caribaeae (Borhidi *et al.* 1979; Borhidi 1991), in part.

***Pinus caribaea var. caribaea / Aristida refracta - Andropogon gracilis* Woodland**

DESCRIPTION: Low-altitude pine woodland covering small areas of ridges and/or slopes on the northern part of the Cajálbana range, with an open canopy

dominated by *Pinus caribaea var. caribaea*, and substantial coverage by a grass-dominated herb layer.
DISTRIBUTION: West Cuba (Cajálbana).
COMMENTS: This community is basically a degraded *Pinus caribaea* var. *caribaea* forest on ferritic soils, with open canopy and well developed herb layer dominated by grasses.
SYNONYMY: Pinetum caribaeae cajalbanensis typicum (Samek 1973); Neomazaeo-Pinetum caribaeae (Borhidi *et al.* 1979), in part.

***Pinus caribaea var. caribaea / Agave cajalbanensis* Woodland**
DESCRIPTION: Pine community with open canopy dominated by *Pinus caribaea var. caribaea*, on the steep, rocky serpentine slopes of the Cajálbana range. This woodland is characterized by a number of heliophilous scrub elements rich in spiny species. Common associates include: *Agave cajalbanensis, Eugenia rigidifolia, Brya ebenus, Jacquinia brunnescens, Erythroxylon minutifolium, Malpighia horrida, Rheedia fruticosa, Lescaillea equisetiformis, Plumeria sericifolia, Garcinia serpentini, Buxus wrightii, Zanthoxylum dumosum, Machaonia dumosa, Plinia dermatodes, Scolosanthus acunae.*
DISTRIBUTION: West Cuba (Cajálbana).
COMMENTS: Based on Samek (1973); Borhidi (1991).
SYNONYMY: Agavo cajalbanensi-Pinetum caribaeae (Samek 1973).

***II.A.3.N.a. Pinus cubensis* Woodland Alliance (Pinus cubensis woodlands, on serpentine rocks)**
CONCEPT: Open woodlands with canopy dominated by *Pinus cubensis*, on bare serpentine rocks. *Coccothrinax orientalis* is usually present in the canopy. The species-rich, well developed microphyllous evergreen shrub layer is made up by the same endemic species found in the serpentine scrubs of eastern Cuba.
DISTRIBUTION: East Cuba (serpentine ranges of Sagua-Baracoa).
SYNONYMY: Guettardo-Pinion cubensis (Borhidi *et al.* 1979), in part.

***Pinus cubensis / Anemia coriacea - Anemia nipensis - Clerodendron nipense* Woodland** (TNC 7622)
DESCRIPTION: Xerophytic pine woodland community with canopy dominated by *Pinus cubensis*, on shallow ferritic soils often rich in hardpan on iron-oxide concretions, in the foothills and submontane serpentine belts of east Cuba. Characteristic species include *Pinus cubensis, Anemia coriacea, Anemia nipensis, Clerodendron nipense, Plumeria clusioides, Lyonia nipensis, L. macrophylla, Pachyanthus reticulatus, Tabebuia shaferi, Ouratea striata, Guettarda monocarpa, G. calyptrata, Casearia crassinervis, Vernonia urbaniana, Rondeletia myrtacea* and *Bletia floribunda.*
DISTRIBUTION: East Cuba (mainly in Sierra de Nipe, but also in the Sierra Cristal range).
REFERENCES: Samek (1973); Borhidi (1991).
SYNONYMY: Pinetum anemietosum Rhynchosia (Samek 1973); Anemio coriaceae-Pinetum cubensis (Borhidi *et al.* 1979).

***Pinus cubensis / Euphorbia helenae* Woodland** (TNC 7625)
DESCRIPTION: Pine woodland association with a 6-10 m tall canopy dominated by *Pinus cubensis*, on shallow, rather rocky ferritic soils, in the Sagua-Baracoa serpentine range of eastern Cuba. Dwarf palms are usually present in the well-developed shrub layer. Most characteristic species are: *Pinus cubensis, Coccothrinax yuraguana* ssp. *moaensis, Euphorbia helenae, Scaevola wrightii, Coccoloba oligantha, Croton monogynus, Eupatorium lantanifolium, Guettarda ferruginea, Gochnatia recurva, Hypericum styphelioides* ssp. *moaensis, Linodendron aronifolium, , Malpighia cnide, Tabebuia pinetorum, Byrsonima minutifolia, Vaccinium alainii* and *Vernonia wrightii.*
DISTRIBUTION: East Cuba (in all the range of the Sagua-Baracoa massif, but especially on the eroded rocky ridges of Moa).
REFERENCES: Borhidi (1991).

SYNONYMY: Euphorbio helenae-Pinetum cubensis (Samek 1973) *sensu* Borhidi *et al.* (1979).

***Pinus cubensis / Agave shaferi - Ariadne shaferi* Woodland** (TNC 7621)

DESCRIPTION: Open *Pinus cubensis* woodland on the rocky peaks and steep rocky slopes of the serpentine ranges of eastern Cuba (Nipe-Cristal). Characteristic species of this association include *Pinus cubensis, Agave shaferi, Ariadne shaferi, Coccothrinax orientalis, Aristida laevigata, Oplonia cubensis, Psychotria graminifolia, Callicarpa nipensis, Callicarpa lancifolia, Callicarpa cuneifolia, Clusia nipensis, Euphorbia podocarpifolia, Ossaea acunae, Phyllanthus shaferi, Xylosma buxifolium, Gesneria nipensis, Vaccinium cubense, Platygyne triandra,* and others.
DISTRIBUTION: East Cuba: Nipe and Cristal serpentine ranges.
REFERENCES: Borhidi (1991).
SYNONYMY: Agavo shaferi-Pinetum cubensis (Samek 1973) *sensu* Borhidi *et al.* (1979).

II.A.3.N.d. Saturated tropical or subtropical needle-leaved evergreen woodland
(SATURATED PINE WOODLAND)
(ARBOLEDA DE PINOS SATURADA)

***II.A.3.N.d. Pinus caribaea var. bahamensis* Woodland Alliance (Pinus caribaea bahamensis saturated woodlands)**
CONCEPT: Seasonally saturated "pineyards" of the Bahamas, limestone rocks, with essentially monospecific canopy of *Pinus caribaea var. bahamensis.*
DISTRIBUTION: Bahamas.
SYNONYMY: Pineyard, in part; Pineland, in part; Wet Pine Barren (Correll & Correll 1982).
REFERENCES: Correll & Correll 1982.

***Pinus caribaea var. bahamensis / Sabal palmetto* Woodland**

DESCRIPTION: Pine woodlands of *Pinus caribaea* var. *bahamensis*, associated to *Sabal palmetto* on typically honeycombed limestone strata.
DISTRIBUTION: Bahamas: Grand Bahama, Abaco, New Providence, Andros.
COMMENTS: Many species occurring in this community are also found in the association described below. However most of them are more prevalent in only but one of the two communities within the Alliance.
SYNONYMY: Wet Pine Barren (Correll & Correll 1982), in part.
REFERENCES: Correll & Correll 1982.

II.A.5. Extremely xeromorphic evergreen woodland
II.A.5.N. Natural/Semi-natural
II.A.5.N.b. Succulent extremely xeromorphic evergreen woodland
(CACTUS WOODLAND)
(ARBOLEDA DE CACTOS)

(MOST TYPES TO BE DEFINED)

***II.A.5.N.b. Stenocereus peruvianus* Woodland Alliance**
DISTRIBUTION: Cuba.
COMMENTS: Present in southeastern Cuba (Guantanamo Bay).

***Stenocereus peruvianus / Plumeria tuberculata - Neea shaferi - Capparis ferruginea* Woodland** (TNC 7631)

SYNONOMY: Cactus scrub.
REFERENCES: {Guant. Bay}

Subclass: *II.B. DECIDUOUS WOODLAND*

Group: ***II.B.1. Tropical or subtropical drought-deciduous woodland***
Subgroup: ***II.B.1.N. Natural/Semi-natural***

II.B.1.N.a. Lowland or submontane broad-leaved drought-deciduous woodland

LOWLAND/SUBMONTANE DROUGHT-DECIDUOUS WOODLAND)

(ARBOLEDA SECA DECIDUA DE BAJA ALTITUD/SUBMONTANA)

II.B.1.N.a. Bursera simaruba **Woodland Alliance**
CONCEPT: Common shrubs include *Pilosocereus royenii, Thouinia striata var. portoricensis, Plumeria alba, Croton lucidus, Pictetia aculeata, Comocladia dodonaea.*
DISTRIBUTION: Puerto Rico.
SYNONYMY: Gumbolimbo Savana -- 64.3 (Dansereau 1966).

Subclass: ***II.C. MIXED EVERGREEN-DECIDUOUS WOODLAND***
Group: ***II.C.1. Tropical or subtropical semi-deciduous woodland***
Subgroup: ***II.C.1.N. Natural/Semi-natural***

II.C.1.N.a. Tropical or subtropical semi-deciduous woodland

(SEMI-DECIDUOUS WOODLAND)
(ARBOLEDA SEMI-DECIDUA)

II.C.1.N.a. Bucida buceras **Woodland Alliance**
CONCEPT: Bucida buceras, with *Savia sessiliflora, Krugiodendron ferreum.*
DISTRIBUTION: Puerto Rico.
SYNONYMY: Bucaro Forest -- 64.1 (Dansereau 1966); Bucaro Woodland -- 64.2 (Dansereau 1966).

II.C.1.N.b. Seasonally flooded tropical or subtropical semi-deciduous woodland

(SEASONALLY FLOODED SEMI-DECIDUOUS WOODLAND)
(ARBOLEDA SEMI-DECIDUA ESTACIONALMENTE INUNDADA)

II.C.I.N.b. Bucida spinosa **Seasonally Flooded Woodland Alliance**
DISTRIBUTION: Cuba.
COMMENTS: Present in southeastern Cuba (Guantanamo Bay).

Bucida spinosa - Harrisia taylori / Cordia globosa - Lycium americanum **Woodland** (TNC 7634)
DISTRIBUTION: Cuba.
COMMENTS: Present in southeastern Cuba (Guantanamo Bay).
SYNONYMY: Bucida woodland.

Cordia dentata - Citharexylum fruticosum - Capparis ferruginea / Cordia globosa - Lycium americanum **Woodland** (TNC 7635
DISTRIBUTION: Cuba.
COMMENTS: Present in southeastern Cuba (Guantanamo Bay).
SYNONYMY: Bucida woodland.

II.C.1.N.x. Seasonally/temporarily flooded tropical or subtropical semi-deciduous woodland

(SEASONALLY/TEMPORARILY FLOODED SEMI-DECIDUOUS WOODLAND)
(ARBOLEDA SEMI-DECIDUA ESTACIONALMENTE/TEMPORALMENTE INUNDADA)

(TYPES TO BE DEFINED)

Class: ***III. SHRUBLAND (SCRUB)***
Subclass: ***III.A. EVERGREEN SHRUBLAND (SCRUB)***
Group: ***III.A.1. Tropical and subtropical broad-leaved evergreen shrubland***
Subgroup: ***III.A.1.N. Natural/Semi-natural***

III.A.1.N.a. Tropical or subtropical broad-leaved evergreen shrubland (includes bamboos and tuft-trees)

(EVERGREEN SHRUBLAND)
(MATORRAL SIEMPREVERDE)

***III.A.1.N.a. Cassia lineata* Shrubland Alliance**
DISTRIBUTION: Bahamas.

***Cassia lineata - Gundlachia corymbosa* Shrubland** (TNC XXXX)
DESCRIPTION: This community occurs on ocean shorelines. Typical species are *Suriana maritima, Strumpfia maritima, Antirhea myrtifolia, Cassia lineata, Salmia petrobioides, Gundlachia corymbosa*, and sometimes *Scaevola plumieri*.
DISTRIBUTION: Bahamas.
SYNONYMY: 1.a. Beach strand, in part (Freid 1998).

***III.A.1.N.a. Clusia minor - Clusia clusioides* Shrubland Alliance**
DISTRIBUTION: Puerto Rico.
SYNONYMY: Montane Broadleaf Scrub -- 87.4a (Dansereau 1966).

***III.A.1.N.a. Colubrina spp.* Shrubland Alliance**
CONCEPT: *Oplonia spinosa, Comocladia dodonaea, Reynosia uncinata, Bromelia pinguin*.
DISTRIBUTION: Puerto Rico.
SYNONYMY: Snake-bark Scrub -- 22.4 (Dansereau 1966).

***III.A.1.N.a. Croton lucidus* Shrubland Alliance**
DISTRIBUTION: Puerto Rico, Bahamas?
SYNONYMY: Firebrush Scrub -- 47.4 (Dansereau 1966).

***III.A.1.N.a. Dalbergia ecastaphyllum* Shrubland Alliance**
DISTRIBUTION: Puerto Rico.
SYNONYMY: Maray-maray Scrub -- 21.4 (Dansereau 1966)

***III.A.1.N.a. Eugenia borinquensis-Tabebuia rigida* Shrubland Alliance**
CONCEPT: Wind-sculpted scrub on summits of higher peaks in Puerto Rico, dominated by *Eugenia borinquensis, Tabebuia rigida*, and others.
DISTRIBUTION: Puerto Rico.

***Eugenia borinquensis-Tabebuia rigida-Marcgravia sintenisii* Shrubland**
DESCRIPTION: This 1-3m tall shrubland occurs on the highest peaks (at elevations of 900-1050m) in the Luquillo Mountains in eastern Puerto Rico, associated with *Tabebuia rigida-Ocotea spathulata-Eugenia borinquensis-Henriettea squamulosum* Forest. Dominant shrubs are *Eugenia borinquensis, Tabebuia rigida, Ocotea spathulata, Micropholis garciniifolia, Daphnopsis philippiana, Symphysia racemosa*, and *Ardisia luquillensis*. A dominant woody vine, often densely

draped over shrub species, is *Marcgravia sintenisii*. Other shrub and vine species include *Ilex sintenisii, Psychotria guadelupensis ssp. grosourdyana, Henriettea squamulosum, Miconia sintenisii, Miconia pachyphylla, Vriesea sintenisii, Sloanea berteriana, Cyathea borinquena, Alsophila bryophila, Ardisia luquillensis, Calyptranthes krugii, Ocotea leucoxylon, Mikania pachyphylla, Psychotria maleolens, Gesneria viridiflora ssp. sintenisii, Podocarpus coriaceus*, and *Prestoea montana*. Herbaceous species include *Guzmania berteroana, Olfersia cervina, Peperomia emarginella, Jacquemontia solanifolia, Pilea leptophylla, Diplazium lherminieri, Anthurium dominicense, Blechnum fragile, Thelypteris deltoidea, Isachne angustifolia*, and *Selaginella krugii*. Most of the dominant shrubs are endemic either to the Luquillo Mountains of eastern Puerto Rico, or somewhat more widespread endemics of montane Puerto Rico.

DISTRIBUTION: Puerto Rico.

SYNONYMY: High montane scrub -- 88.4b (Dansereau 1966).

***III.A.1.N.a. Gymnanthes lucida* Shrubland Alliance**

CONCEPT: Shrublands dominated by *Gymnanthes lucida*, 2-5m in height. In Puerto Rico these are developed in thin soils over limestone, in hills in NC. and NW. Puerto Rico. *Eugenia monticola* is often co-dominant.

DISTRIBUTION: Puerto Rico, Bahamas, [West Indies].

COMMENTS: *Gymnanthes lucida* is called *Ateramnus lucidus* in some literature.

SYNONYMY: Crabwood scrub -- 60.4 (Dansereau 1966).

***Gymnanthes lucida - Eugenia monticola* Shrubland**

DESCRIPTION: Shrublands dominated by *Gymnanthes lucida*, 2-5m in height. In Puerto Rico these are developed in thin soils over limestone, in hills in nc. and nw. Puerto Rico. *Eugenia monticola* is often co-dominant.

DISTRIBUTION: Puerto Rico.

SYNONYMY: Crabwood scrub -- 60.4 (Dansereau 1966).

***III.A.1.N.a. Pithecellobium unguis-cati* Shrubland Alliance**

CONCEPT: Dry shrublands in near-coastal areas of Martinique.

DISTRIBUTION: Martinique.

***Pithecellobium unguis-cati-Cordia spp.-Croton spp.-Lantana spp.* Shrubland**

DESCRIPTION: Typical species of this dry shrubland include *Pithecellobium unguis-cati, Cordia spp., Croton spp., Lantana spp., Crossopetalum rhacoma, Pimenta racemosa, Erythroxylum brevipes, Erythroxylum ovatum, Capparis spp.*

DISTRIBUTION: Martinique.

COMMENTS: Based on Kimber 1988).

SYNONYMY: Dry Bushland (Kimber 1988).

***III.A.1.N.a. Rondeletia martinicensis - Miconia martinicensis* Shrubland Alliance**

CONCEPT: Wind-sculpted scrub on summits of higher peaks in Martinique, dominated by the Martinique endemics *Rondeletia martinicensis, Miconia martinicensis*, and others. These shrublands are associated with cloud forests.

DISTRIBUTION: Martinique.

***Rondeletia martinicensis - Miconia martinicensis - Ilex macfadyenii* Shrubland**

DESCRIPTION: Cloud shrublands on the summits of the higher peaks of Martinique, the Carbet Pitons, Morne Jacob, and Mont Pelée. The 2-4m tall shrubland is dominated by *Rondeletia martinicensis, Miconia martinicensis, Ilex macfadyenii, Didymopanax attenuatum, Charianthus spp*., melastomes, and ericads. Branches are densely covered with bryophytes, bromeliads, and orchids.

DISTRIBUTION: Martinique.

COMMENTS: Based on Kimber (1988).

SYNONYMY: Montane Bushland (Kimber 1988).

***III.A.1.N.a. Schefflera gleasonii* Shrubland Alliance**

DISTRIBUTION: Puerto Rico.

SYNONYMY: Montane Maquis -- 87.4 (Dansereau 1966).

***III.A.1.N.a. Tabebuia heterophylla* Shrubland Alliance**

DISTRIBUTION: Puerto Rico.

SYNONYMY: Roble Prieto Scrub -- 63.4 (Dansereau 1966).

***III.A.1.N.a. Thrinax morrisii - Coccothrinax argentata* Shrubland Alliance**
CONCEPT:
DISTRIBUTION: Bahamas (Exumas, San Salvador, East Caicos).
REFERENCES: Freid (unpublished).

***Thrinax morrisii - Coccothrinax argentata* Shrubland (XXXX)**

Description: This shore-associated community occurs on sand substrate, on old (stabilized) sand beaches. The community is dominated by 2-3 meter high thickets of *Thrinax morrisii* and *Coccothrinax argentata*, sometimes also with *Pseudophoenix sargentii*. Occurs on old (stabilized) sand beaches. Herb stratum is sparse, occasionally with *Heliotropium nanum, Fimbristylis sp*., and occasionally with scattered shrubs *Reynosia septentrionalis* and *Bourreria ovata*.

Distribution: Bahamas (Exumas, San Salvador, East Caicos).
Synonymy: 4.a. *Thrinax/Coccothrinax* groves, in part (Freid 1998).

III.A.1.N.b. Hemisclerophyllous tropical or subtropical broad-leaved evergreen shrubland

(HEMISCLEROPHYLLOUS EVERGREEN SHRUBLAND)
(MATORRAL SIEMPREVERDE HEMIESCLERÓFILO)

***III.A.1.N.b. Coccoloba uvifera* Shrubland Alliance**
CONCEPT: Coastal strand or berm communities dominated by dwarfed *Coccoloba uvifera* and other salt aerosol sculpted shrubs.
DISTRIBUTION: Florida, Puerto Rico, Bahamas, Martinique.
SYNONYMY: Sea-grape Scrub -- 20.4 (Dansereau 1966)

***Coccoloba uvifera - Hura crepitans - Zanthoxylum spinifex* Shrubland**

DESCRIPTION: This community is a dense salt-pruned thicket oceanwards of the *Tabebuia pallida - Calophyllum calaba - Coccoloba swartzii - Bursera simaruba - Hippomane mancinella - Coccoloba uvifera* Forest. The primary species is *Coccoloba uvifera*, intermixed variously with *Hura crepitans, Zanthoxylum spinifex, Capparis baducca, Tabebuia pallida, Eugenia axillaris, Erithalis fruticosa, Maytenus laevigata,* and *Mancinella hippomane.*
DISTRIBUTION: Martinique.
COMMENTS: Based on Kimber (1988).
SYNONYMY: Littoral Hedge (Kimber 1988).

***Coccoloba uvifera - Thespesia populnea* Shrubland**
DISTRIBUTION: Puerto Rico.

III.A.1.N.c. Sclerophyllous tropical or subtropical broad-leaved evergreen shrubland

(SCLEROPHYLLOUS EVERGREEN SHRUBLAND)
(MATORRAL SIEMPREVERDE ESCLERÓFILO)

***III.A.1.N.c. Strumpfia maritima* Shrubland Alliance**
CONCEPT: Matted dwarf-shrubland, 1-5 dm tall, on flat to sloping limestome pavement on the coast of sw. Puerto Rico, dominated by old, salt-pruned *Conocarpus erectus*. Other species present include *Suriana maritima, Strumpfia maritima, Coccoloba uvifera,* and *Chamaesyce mesembrianthemifolia*.
DISTRIBUTION: Puerto Rico.
COMMENTS: Though stature indicates that this should be placed in dwarf-shrubland, it is not microphyllous, and is therefore placed (for now) in shrubland.
SYNONYMY: Button-mangrove Matted Scrub -- 15.9 (Dansereau 1966).

***Conocarpus erectus - Strumpfia maritima - Suriana maritima* Shrubland**
DISTRIBUTION: Puerto Rico.

III.A.1.N.f. Seasonally flooded tropical or subtropical broad-leaved evergreen shrubland

(SEASONALLY FLOODED EVERGREEN SHRUBLAND)
(MATORRAL SIEMPREVERDE ESTACIONALMENTE INUNDADO)

***III.A.1.N.f. Chrysobalanus icaco* Seasonally Flooded Shrubland Alliance**
Distribution: Puerto Rico.

***Chrysobalanus icaco / Blechnum serrulatum* Shrubland** -- G?
DISTRIBUTION: Puerto Rico.
SYNONYMY: Icaco Scrub -- 37.4 (Dansereau 1966).

***III.A.1.N.f. Thrinax morrisii - Coccothrinax argentata* Seasonally Flooded Shrubland Alliance**

***Thrinax morrisii - Coccothrinax argentata / Cladium mariscus ssp. jamaicense* Shrubland (XXXX)**
DESCRIPTION: Dominated by mixtures of *Thrinax morrisii* and *Coccothrinax argentata*. This community occurs in seasonally flooded and semipermanently saturated situations, associated with Cladium marsh. The herbaceous stratum is well-developed, and consists of *Eleocharis spp.* and *Cladium mariscus ssp. jamaicense*.
DISTRIBUTION: Bahamas (North Andros, possibly Abaco, possibly Freeport).
SYNONYMY: 4.a. *Thrinax/Coccothrinax* groves, in part (Freid 1998).

III.A.1.N.g. Semi-permanently flooded tropical or subtropical broad-leaved evergreen shrubland

(SEMI-PERMANENTLY FLOODED EVERGREEN SHRUBLAND)
(MATORRAL SIEMPREVERDE SEMI-PERMANENTEMENTE INUNDADO)

***III.A.1.N.g. Rhizophora mangle* Semipermanently Flooded Shrubland Alliance**
CONCEPT: Nontidal shrublands dominated by *Rhizophora*. Occurs in more stressed sites than *Rhizophora mangle* Forests and has shorter individuals (less than five meters, and usually only one-half to two meters tall) and often sparser as well.
DISTRIBUTION: FL, West Indies.
SYNONYMY: Scrub Mangrove Thicket (Hilsenbeck et al. 1979).

***Rhizophora mangle / Eleocharis cellulosa* Shrubland**
DESCRIPTION: Stunted *Rhizophora mangle* Shrubland, the mangroves typically 0.5 to 2.5 meters in height, and more likely to be intertwined by prop roots than by branches. This community occurs in seasonally to semipermanently flooded situations, in "gumbo marls" over oolite. Shrub cover is generally from 20-60 percent, and areas between the shrubs are dominated by *Eleocharis cellulosa*, with *Utricularia purpurea, Utricularia spp., Rhynchospora tracyi, Crinum americanum, Chara sp.*, and with a dense marl periphyton. Bromeliads (*Tillandsia paucifolia, Tillandsia flexuosa*) may be common on the mangroves.
DISTRIBUTION: FL, Bahamas, West Indies.
SYNONYMY: Scrub Mangrove Thicket (Hilsenbeck et al. 1979).

III.A.1.N.h. Tidally flooded tropical or subtropical broad-leaved evergreen shrubland

(TIDALLY FLOODED EVERGREEN SHRUBLAND)

(MATORRAL SIEMPREVERDE MAREAL)

***III.A.1.N.h. Avicennia germinans* Tidal Shrubland Alliance**
DISTRIBUTION: Florida, West Indies.
SYNONYMY: Black-mangrove Scrub -- 6.4 (Dansereau 1966).

***Avicennia germinans / Sarcocornia perennis* Shrubland**
DESCRIPTION: Mangrove communities growing on exposures of Miami Formation oolite in the lower Florida Keys. Dominated by a rather sparse stratum of *Avicennia germinans* (20-60 percent cover), mostly rooting in solution cavities, stunted by lack of soil and hypersaline conditions. Rarely *Laguncularia racemosa* may be present. *Sarcocornia perennis (=Salicornia virginica)* is scattered. No herbs are normally present. Oceanwards this community normally adjoins a deeper water *Rhizophora mangle* community. Landwards this community grades into a shrubless *Monanthochloe littoralis* community, which then grades into a *Conocarpus erectus* community.
DISTRIBUTION: Florida, West Indies.

***III.A.1.N.h. Conocarpus erectus* Tidal Shrubland Alliance**
CONCEPT: Natural salinas on the southwest (dry) coast of Puerto Rico, with high salt concentrations, dominated by shrubby *Conocarpus erectus*.
DISTRIBUTION: Puerto Rico.
COMMENTS: Known from the Bosque Estatal de Guánica.

***III.A.1.N.h. Rhizophora mangle* Tidal Shrubland Alliance**
CONCEPT: Shrublands dominated by *Rhizophora*. Occurs in more stressed sites than *Rhizophora mangle* Forests and has shorter individuals (less than 5 m, and usually only 0.5-2 m tall) and often sparser as well.
DISTRIBUTION: Florida, Puerto Rico, West Indies.
SYNONYMY: Tidal Swamp (FL 1990); ESU 3--Dwarf Mangrove Mudflats (Ross, O'Brien, and Flynn 1992).

***Rhizophora mangle* Shrubland**
DESCRIPTION: Generally monospecific shrublands in highly stressed situations (such as full saline, shallowly underlain by oolite). Sometimes grades landward to *Rhizophora mangle* Forest. Submerged for long periods, not on peats but on calcareous muds 2-30 cm deep over limestone. Structure varies from nearly closed to open (canopy closure 25-90 percent). Described from Florida Keys (Ross, O'Brien, & Flynn 1992). Other characteristic species include *Cladium mariscus ssp. jamaicense, Avicennia germinans, Salicornia virginica.*
DISTRIBUTION: Florida, Bahamas, West Indies, southwards.
SYNONYMY: Tidal Swamp (FL 1990); ESU 3--Dwarf Mangrove Mudflats (Ross, O'Brien, and Flynn 1992).

***Rhizophora mangle - Avicennia germinans* Shrubland**
DISTRIBUTION: Puerto Rico.
SYNONYMY: Red-mangrove Scrub -- 5.4 (Dansereau 1966).

***Rhizophora mangle - Avicennia germinans - Laguncularia racemosa / Batis maritima* Shrubland**
DISTRIBUTION: Puerto Rico.
SYNONYMY: Mixed Mangrove Scrub -- 7.4 (Dansereau 1966).

***III.A.1.N.h. Suriana maritima* Shrubland Alliance**
CONCEPT:
DISTRIBUTION: Puerto Rico.
SYNONYMY: Bay-cedar - Horse-bush Scrub -- 13.4 (Dansereau 1966); Bay-cedar Scrub -- 13.7 (Dansereau 1966).

***Suriana maritima - Gundlachia corymbosa - Borrichia arborescens - Conocarpus erectus* Shrubland**
DISTRIBUTION: Puerto Rico.
SYNONYMY: Bay-cedar - Horse-bush Scrub -- 13.4 (Dansereau 1966).

III.A.1.N.i. Tropical or subtropical broad-leaved evergreen montane shrubland[45]
(EVERGREEN MONTANE SHRUBLAND)
(MATORRAL SIEMPREVERDE MONTANO)

Group: ***III.A.4. Microphyllous evergreen shrubland***
Subgroup: ***III.A.4.N. Natural/Semi-natural***

III.A.4.N.a. Lowland microphyllous evergreen shrubland[46]
(LOWLAND MICROPHYLLOUS EVERGREEN SHRUBLAND)
(MATORRAL SIEMPREVERDE MICRÓFILO DE BAJA ALTITUD)

***III.A.4.N.a. Rhachicallis americana* Shrubland Alliance**

***Rhachicallis americana - Strumpfia maritima - Suriana maritima* Shrubland** (TNC XXXX)

DESCRIPTION: This community occurs on rocky (consolidated) limestone shores. The vegetation is dominated by *Rhachicallis americana*, *Strumpfia maritima*, and *Suriana maritima*. It is variable in height and density.

DISTRIBUTION: Bahamas, Greater Antilles (but not PR), US Virgin Islands.

SYNONYMY: Rocky shore (Freid 1998).

III.A.4.N.c. Microphyllous montane fumarole shrubland[47]
(MICROPHYLLOUS MONTANE FUMAROLE SHRUBLAND)
(MATORRAL MICRÓFILO MONTANO DE FUMAROLAS)

***III.A.4.N.c.* (Alliance name has not been defined yet)**
CONCEPT: Montane microphyllous shrubland of the active volcanic Lesser Antilles.
DISTRIBUTION: St. Kitts, Montserrat, Guadeloupe, Dominica, Martinique, St. Lucia, St. Vincent and Grenada(?).
COMMENTS: Occurring in proximity to fumeroles. Beard considers this a subclimax community due to a lack of soil development or as he calls it "pioneer communities of volcanic ejecta".
SYNONYMY: Pioneer communities of volcanic ejecta (Beard, 1949).

III.A.4.N.d. Microphyllous evergreen montane shrubland with succulents[48]
(MICROPHYLLOUS MONTANE SHRUBLAND WITH SUCCULENTS)
(MATORRAL MICRÓFILO MONTANO CON SUCULENTAS)

***III.A.4.N.c. Ilex turquinensis - Myrica cacuminis* Shrubland Alliance** (after Borhidi & Muñiz in Borhidi et al. 1979).
CONCEPT: Subalpine microphyllous shrublands of Cuba.
DISTRIBUTION: Cuba (1800-2000m altitude).
COMMENTS: Occurring at the summit of the highest mountains of Cuba slightly above the condensation belt, this vegetation type rich in herbaceous leaf-succulents and spiny plants is much drier than other West Indian non-microphyllous “elfin thickets” of the cloud zone, and thus treated separately.

[45] New Formation.
[46] The term “lowland” is added.
[47] New Formation.
[48] New Formation.

SYNONYMY: Alpine thicket (Seifritz 1943); Monte fresco in part (León 1946); Matorral fresco subalpino (Areces-Mallea 1978); Matorral sub-alpino (Capote & Berazaín 1984); Subpáramo (Capote et al. 1989); Elfin thicket (Borhidi 1991).
REFERENCES: Borhidi & Muñiz in Borhidi *et al.* 1979.

Ilex turquinensis - Myrica cacuminis - Lyonia calycosa - Persea similis **Shrubland**

DESCRIPTION: Dense thicket composed of 1.5-3 m tall shrubs occupying the summits of the Pico Turquino massif. Typical species are *Ilex turquinensis, Myrica cacuminis, Persea similis, Lyonia calycosa, Peratanthe cubensis, Lobelia cacuminis, Torralbasia cuneifolia, Ageratina paucibracteata (= Eupatorium), Vernonia parvuliceps* and *Vernonia praestans ssp. cacuminis.*

DISTRIBUTION: Southeastern Cuba.

Agave pendentata - Mitracarpus acunae - Peratanthe cubensis **Shrubland**

DESCRIPTION: Low 0.5-1m tall thicket on the rather exposed upper rocky slopes of the Turquino group, with an endemic *Agave* species and many shrubs and dwarf shrubs (e.g. *Ilex nanophylla, Ilex turquinensis, Mitracarpus acunae, Cassia turquinae, Micromeria bucheri, Shoepfia stenophylla, Vernonia praestans ssp. cacuminis*). The shrubs are often interwined by the lianes *Chusquea abietifolia* and *Arthrostylidium multispicatum.*

DISTRIBUTION: Southeastern Cuba.

Group: III.A.5. Extremely xeromorphic evergreen shrubland
Subgroup: III.A.5.N. Natural/Semi-natural

III.A.5.N.a. Broad-leaved microphyllous evergreen extremely xeromorphic subdesert shrubland (e.g. creosote bush)

(MICROPHYLLOUS EVERGREEN EXTREMELY XEROMORPHIC SUBDESERT SHRUBLAND)
(MATORRAL SUBDESÉRTICO SIEMPREVERDE MICRÓFILO EXTREMADAMENTE XEROMÓRFICO)

III.A.5.N.a. Capparis ferruginea - Citharexylum fruticosum **Shrubland Alliance**
DISTRIBUTION: Cuba.
COMMENTS: Present in southeastern Cuba (Guantanamo Bay).

Capparis ferruginea - Henoonia brittonii - Colubrina elliptica - Erythroxylum havanense - Randia aculeata **Shrubland** (TNC 7644)

DISTRIBUTION: Cuba.
SYNONYMY: Thorn scrub.

III.A.5.N.a. Coccothrinax fragrans - Croton (rosmarinioides, stenophyllus) **Shrubland Alliance**
DISTRIBUTION: Cuba.
COMMENTS: Present in southeastern Cuba (Guantanamo Bay).

Coccothrinax fragrans - Croton stenophyllus - Ateleia gummifera / Agave underwoodii **Shrubland** (TNC 7645)

DISTRIBUTION: Cuba.
SYNONYMY: Coccothrinax scrub.

Croton stenophyllus - Exostema caribaeum - Coccothrinax fragrans - Pithecellobium circinale **Shrubland** (TNC 7646)

DISTRIBUTION: Cuba.
SYNONYMY: Croton - Coccothrinax scrub.

III.A.5.N.b. Facultatively deciduous extremely xeromorphic subdesert shrubland

(FACULTATIVELY DECIDUOUS SUBDESERT SHRUBLAND)
(MATORRAL SUBDESÉRTICO FACULTATIVAMENTE DECIDUO)

(TYPES TO BE DEFINED)

III.A.5.N.c. Succulent extremely xeromorphic evergreen shrubland

(SUCCULENT EVERGREEN SHRUBLAND)
(MATORRAL SIEMPREVERDE SUCULENTO)

***III.A.5.N.c. Melocactus intortus* Shrubland Alliance**
DISTRIBUTION: Puerto Rico.

***Melocactus intortus - Opuntia rubescens - Pilosocereus royenii - Stenocereus hystrix - Oplonia spinosa - Conocarpus erectus* Shrubland** (TNC 7647)
DISTRIBUTION: Puerto Rico.
SYNONYMY: High Button-mangrove - Cactus Scrub -- 15.4 (Dansereau 1966); Sebucan - Tachuelo Thornscrub -- 16.4 (Dansereau 1966).

***Melocactus intortus - Conocarpus erectus - Krameria ixine - Comocladia dodonaea - Croton discolor* Shrubland** (TNC 7648)
DESCRIPTION: Sparse shrubland on limestone pavement, in sw. Puerto Rico.
DISTRIBUTION: Puerto Rico.
SYNONYM: Low Button-mangrove - Cactus Scrub -- 15.4a (Dansereau 1966).

***III.A.5.N.c. Pilosocereus royenii* Shrubland Alliance**
CONCEPT: Mixed cactus scrub on limestone pavement and receiving salt aerosol. Dominated by *Pilosocereus royenii* (=*Cephalocereus nobilis*), with thorny legumes, *Randia aculeata*, and *Croton spp*. Lower shrubs include *Opuntia spp*. and *Furcraea tuberosa*. Native grasses include *Dactyloctenium aegyptiacum, Cenchrus echinatus,* and *Sporobolus indicus.*
COMMENTS: Based on Kimber (1988). Needs to be assessed against other cactus scrub in the Greater and Lesser Antilles.
DISTRIBUTION: Martinique, Antigua and Barbuda.
SYNONYMY: Mixed Cactus Scrub (Kimber 1988).

Pilosocereus royenii - Agave karatto Shrubland (TNC XXXX)
DESCRIPTION: Typical species include *Pilosocereus royenii, Agave karatto, Pisonia subcordata, Pisonia aculeata, Capparis indica, Capparis cynophallophora, Leucaena leucocephala, Pithecellobium unguis-cati, Haematoxylon campechianum,* and *Clerodendrum aculeatum.*
DISTRIBUTION: Antigua, Barbuda.
SYNONYMY: *Pilosocereus royenii - Agave karatto* (Lindsay & Horwith 1997)
REFERENCES: Lindsay & Horwith (1997).

Subclass: *III.B. DECIDUOUS SHRUBLAND (SCRUB)*
Group: *III.B.1. Drought-deciduous shrubland*
Subgroup: *III.B.1.N. Natural/Semi-natural*

III.B.1.N.a. Lowland drought-deciduous shrubland

(LOWLAND DROUGHT-DECIDUOUS SHRUBLAND)
(MATORRAL SECO DECIDUO DE BAJA ALTITUD)

***III.B.1.N.a. Acacia macracantha - Acacia farnesiana* Shrubland Alliance**
CONCEPT: Thorn-scrub on rocky hillsides, following disturbance. May vary structurally towards woodland or savanna structure.
DISTRIBUTION: Martinique.
COMMENTS: Based on Beard (1949).

***III.B.1.N.a. Leucaena leucocephala* Shrubland Alliance**
CONCEPT:
DISTRIBUTION: Puerto Rico, Bahamas.
SYNONYMY: Leucaena Woodland -- 23.2 (Dansereau 1966); Leucaena Thicket -- 23.4 (Dansereau 1966).

Subclass: *III.C. MIXED EVERGREEN-DECIDUOUS SHRUBLAND (SCRUB)*
Group: *III.C.1. Mixed evergreen - drought-deciduous shrubland*
Subgroup: *III.C.1.N. Natural/Semi-natural*

III.C.1.N.a. Mixed evergreen - drought-deciduous shrubland with succulents[49] (MIXED EVERGREEN - DROUGHT-DECIDUOUS SHRUBLAND WITH SUCCULENTS) (MATORRAL MIXTO SIEMPREVERDE-DECIDUO CON SUCULENTAS)

***III.C.1.N.a. Tabebuia bahamensis - Psidium longipes - Stigmaphyllon sagraeanum* Shrubland Alliance**

***Tabebuia bahamensis - Psidium longipes - Stigmaphyllon sagraeanum - Manilkara bahamensis - Coccoloba northropiae - Coccoloba tenuifolia* Shrubland** (TNC XXXX)

DESCRIPTION: This community occurs on limestone pavement with sinkhole and dogtooth development, just above watertable. Characteristic species include *Pithecellobium bahamense, Guettarda scabra, Tabebuia bahamensis, Bursera simaruba, Psidium longipes, Coccoloba northropiae, Coccoloba tenuifolia, Bumelia americana, Stigmaphyllum sagraeanum, Manilkara bahamensis, Cephalocereus, Randia aculeata,* and *Cladium mariscus ssp. jamaicense*. Physiognomy is very variable, with some areas severely dwarfed (less than 2 decimeters), and other areas over 2 meters tall.

DISTRIBUTION: Bahamas (Andros, Exumas).
SYNONYMY: Open Scrub (Freid 1998).

***III.C.3.N.a. Colubrina elliptica* Shrubland Alliance**
DISTRIBUTION: Cuba.
COMMENTS: Present in southeastern Cuba (Guantanamo Bay).

***Colubrina elliptica - Stenocereus peruvianus - Plumeria tuberculata - Neea shaferi - Capparis ferruginea* Shrubland** (TNC 7649)

DISTRIBUTION: Cuba.
COMMENTS: Present in southeastern Cuba (Guantanamo Bay).
SYNONYMY: Colubrina scrub.

III. C. 1.N.b. Lowland or submontane mixed evergreen - drought deciduous shrubland (LOWLAND/SUBMONTANE MIXED EVERGREEN-DROUGHT-DECIDUOUS SHRUBLAND) (MATORRAL MIXTO SIEMPREVERDE-DECIDUO DE BAJA ALTITUD/SUBMONTANO)

(TYPES TO BE DEFINED)

[49] New Formation (FGDC has not defined Formations of Subgroup ***III.C.1.N.***).

III.C.1.N.c. Seasonally flooded tropical or subtropical mixed evergreen - drought-deciduous shrubland[50]

(SEASONALLY FLOODED MIXED EVERGREEN - DROUGHT-DECIDUOUS SHRUBLAND)
(MATORRAL MIXTO SIEMPREVERDE-DECIDUO ESTACIONALMENTE INUNDADO)

(TYPES TO BE DEFINED)

Class: ***IV. DWARF-SHRUBLAND (DWARF SCRUB)***
Subclass: ***IV.A. EVERGREEN DWARF-SHRUBLAND (DWARF-SCRUB)***
Group: ***IV.A.2. Extremely xeromorphic evergreen dwarf-shrubland***
Subgroup: ***IV.A.2.N. Natural/Semi-natural***

IV.A.2.N.c. Tidally flooded needle-leaved or microphyllous evergreen dwarf-shrubland

(TIDALLY FLOODED EVERGREEN DWARF-SHRUBLAND)
(MATORRAL ENANO SIEMPREVERDE MAREAL)

***IV.A.2.N.c. Batis maritima* Dwarf-shrubland Alliance**
CONCEPT: Salt flats dominated (usually essentially monospecific) dominated by *Batis maritima*.
DISTRIBUTION: Cuba, Puerto Rico, Bahamas, Jamaica, Martinique.
SYNONYMY: Saltwort Scrub -- 11.4 (Dansereau 1966).

***Batis maritima* Dwarf-shrubland**
CONCEPT: Salt flats (usually essentially monospecific) dominated by *Batis maritima*.
DISTRIBUTION: Cuba, Puerto Rico, Bahamas, Jamaica, Martinique.

***IV.A.2.N.c. Rhachicallis americana* Dwarf-shrubland Alliance**
CONCEPT: Monotypic stands dominated by *Rhachicallis americana*. Occurs in extensive tidal flat areas.
DISTRIBUTION: Bahamas (Andros, East Caicos).
SYNONYMY: *Rhachicallis americana* flats (Freid 1998).

***Rhachicallis americana* Tidal Dwarf-shrubland** (TNC XXXX)
DESCRIPTION: Monotypic stands dominated by *Rhachicallis americana*. Occurs in extensive tidal flat areas.
DISTRIBUTION: Bahamas (Andros, East Caicos).
SYNONYMY: *Rhachicallis americana* flats (Freid 1998).

Subclass: ***IV.C. MIXED EVERGREEN-DECIDUOUS DWARF SHRUBLAND (DWARF SCRUB)***
Group:: ***IV.C.1. Mixed evergreen - drought-deciduous dwarf-shrubland***
Subgroup: ***IV.C.1.N. Natural/Semi-natural***

IV.C.1.N.a. Mixed evergreen - drought-deciduous dwarf-shrubland

(MIXED EVERGREEN - DROUGHT-DECIDUOUS DWARF-SHRUBLAND)
(MATORRAL ENANO MIXTO SIEMPREVERDE-DECIDUO)

(TYPES TO BE DEFINED)

IV.C.1.N.c. Succulent-facultatively drought-deciduous dwarf-shrubland[51]

[50] New Formation (*sensu* Lindsay & Horwith 1997).
[51] New Formation (*sensu* Lindsay Y Horwith 1997).

(SUCCULENT-FACULTATIVELY DROUGHT-DECIDUOUS DWARF-SHRUBLAND)
(MATORRAL ENANO SUCULENTO FACULTATIVAMENTE DECIDUO)

(TYPES TO BE DEFINED)

Class: ***V. HERBACEOUS***
Subclass: ***V.A. PERENNIAL GRAMINOID VEGETATION (GRASSLANDS)***
Group: ***V.A.1. Tropical or subtropical grassland***
Subgroup: ***V.A.1.N. Natural/Semi-natural***

V.A.1.N.a. Tall tropical or subtropical grassland

(TALL GRASSLAND)
(HERBAZAL ALTO)

(TYPES TO BE DEFINED)

V.A.1.N.b. Medium-tall sod tropical or subtropical grassland

(MEDIUM-TALL SOD GRASSLAND)
(HERBAZAL CESPITOSO MEDIANO-ALTO)

V.A.1.N.b. Andropogon bicornis Herbaceous Alliance
CONCEPT:
DISTRIBUTION: Puerto Rico.
SYNONYMY: Bluestem Prairie -- 79.5 (Dansereau 1966).

***V.A.1.N.b. Arundinella confinis - Schizachyrium sanguineum var. sanguineum* Herbaceous Alliance**
CONCEPT:
DISTRIBUTION: Puerto Rico.
SYNONYMY: Rabo-de-gato Pasture -- 68.5 (Dansereau 1966).

***V.A.1.N.b. Axonopus compressus* Herbaceous Alliance**
CONCEPT:
DISTRIBUTION: Puerto Rico, Bahamas, Martinique?
SYNONYMY: Carpet-grass Sward -- 50.6 (Dansereau 1966).

***V.a.1.N.b. Bouteloua repens* Herbaceous Alliance**
CONCEPT:
DISTRIBUTION: Puerto Rico.
SYNONYMY: Grama-grass Steppe -- 66.7 (Dansereau 1966); Lamilla.

***V.A.1.N.b. Cenchrus myosuroides* Herbaceous Alliance**
CONCEPT: Maritime grasslands dominated by *Cenchrus myosuroides*, occurring in southwestern Puerto Rico.
DISTRIBUTION: Puerto Rico, Bahamas?, Cuba.

***Cenchrus myosuroides* Herbaceous Vegetation** (TNC 7651)
SYNONYMY: Sandspur Ruderal Grassland.

***V.A.1.N.b. Dichanthium annulatum* Herbaceous Alliance**
CONCEPT:
DISTRIBUTION: Puerto Rico.
SYNONYMY: Angleton-grass Sward -- 70.7 (Dansereau 1966).

***V.A.1.N.b. Spartina patens* Herbaceous Alliance**
CONCEPT:
DISTRIBUTION: Puerto Rico, Bahamas.
SYNONYMY: Salt-grass Prairie -- 18.5 Dansereau 1966); Salt-grass Steppe -- 18.7 (Dansereau 1966)

***V.A.1.N.b. Stenotaphrum secundatum* Herbaceous Alliance**
CONCEPT:
DISTRIBUTION: Puerto Rico, Bahamas.
SYNONYMY: St. Augustine Grass Sward -- 49.6 (Dansereau 1966).

V.A.1.N.c. Medium-tall bunch tropical or subtropical grassland
(MEDIUM-TALL BUNCH GRASSLAND)
(HERBAZAL DE PLANTÓN MEDIANO-ALTO)

***V.A.1.N.c. Leptochloopsis virgata* Herbaceous Alliance**
CONCEPT: Tall bunch grasslands dominated by *Leptochloopsis virgata*.
DISTRIBUTION: PR, Bahamas, Cuba.
SYNONYMY: Wire-grass Steppe -- 65.7 (Dansereau 1966).

***Leptochloopsis virgata* Herbaceous Vegetation** (TNC 7652)

***V.A.1.N.c. Leptocoryphium lanatum - Aristida portoricensis* Herbaceous Alliance**
CONCEPT:
DISTRIBUTION: Puerto Rico.
SYNONYMY: Lanilla Pasture -- 69.6 (Dansereau 1966).

***V.A.1.N.c. Schizachyrium gracile* Herbaceous Alliance**
DISTRIBUTION: Puerto Rico.
SYNONYMY: Wiry-beardgrass Sward -- 52.6 (Dansereau 1966).

***V.A.1.N.c. Sporobolus indicus* Herbaceous Alliance**
DISTRIBUTION: Puerto Rico, Bahamas.
SYNONYMY: Cerrillo-grass Sward -- 51.6 (Dansereau 1966).

V.A.1.N.d. Short sod tropical or subtropical grassland
(SHORT SOD GRASSLAND)
(HERBAZAL CESPITOSO CORTO)

***V.A.1.N.d. Isachne angustifolia - Scleria scandens* Herbaceous Alliance**
CONCEPT: Montane meadows and landslide scars at upper elevations of the Luquillo Mountains of eastern Puerto Rico. Dominant graminoids are *Isachne angustifolia* and *Scleria scandens* (= *Scleria canescens*). Other species include *Clibadium erosum* and *Phytolacca rivinoides*.
DISTRIBUTION: Puerto Rico.
REFERENCES: Guariguata 1990.

***Isachne angustifolia - Scleria scandens - Clibadium erosum - Phytolacca rivinoides* Herbaceous Vegetation** (TNC 7655)

DESCRIPTION: Montane meadows and landslide scars at upper elevations of the Luquillo Mountains of eastern Puerto Rico. Dominant graminoids are *Isachne angustifolia* and *Scleria scandens* (= *Scleria canescens*). Other species include *Clibadium erosum* and *Phytolacca rivinoides*.
DISTRIBUTION: PR.
REFERENCES: Guariguata (1990).

V.A.1.N.f. Temporarily flooded tropical or subtropical grassland

(TEMPORARILY FLOODED GRASSLAND)
(HERBAZAL TEMPORALMENTE INUNDADO)

***V.A.1.N.f. Cyperus heterophyllus* Temporarily Flooded Herbaceous Alliance**
CONCEPT: Human-altered grasslands dominated by *Cyperus heterophyllus*, along gravelly montane and submontane creeks and rivers in Cuba.
DISTRIBUTION: Cuba.

***Cyperus heterophyllus* Herbaceous Vegetation** (TNC 7657)
DESCRIPTION: Human-altered grasslands dominated by *Cyperus heterophyllus*, along gravelly montane and submontane creeks and rivers in Cuba.
DISTRIBUTION: Cuba.
COMMENTS: Based on Borhidi (1991).
SYNONYMY: *Cyperion heterophylli* (Borhidi 1991).
REFERENCES: Borhidi (1991).

V.A.1.N.g. Seasonally flooded tropical or subtropical grassland

(SEASONALLY FLOODED GRASSLAND)
(HERBAZAL ESTACIONALMENTE INUNDADO)

***V.A.1.N.g. Cladium mariscus ssp. jamaicense* Seasonally Flooded Herbaceous Alliance**
CONCEPT: Marshes (sometimes very extensive, such as the Everglades, though often much smaller) dominated by *Cladium mariscus ssp. jamaicense*, the alkaline chemistry provided by underlying calcareous rock (oolite) rather than by brackish tidal influence (contrast V.A.5.N.n.010).
DISTRIBUTION: Bahamas, Florida.
SYNONYMY: Sawgrass Marsh; Wet Prairie; Sawgrass Glade (Hilsenbeck et al. 1979).

***Cladium mariscus ssp. jamaicense - Bacopa caroliniana* Herbaceous Vegetation**
DESCRIPTION: Dense, tall (1-3 m) *Cladium mariscus ssp. jamaicense*, with some *Pontederia cordata* (*var. lancifolia*), *Sagittaria lancifolia, Eleocharis cellulosa, Proserpinaca palustris, Bacopa caroliniana, Bacopa monnieri, Ludwigia repens, Leptochloa fascicularis var. fascicularis,* and *Utricularia gibba (Utricularia biflora).* This community has a 5-10 month hydroperiod and occupies relatively deep organic soils.
DISTRIBUTION: Florida, Bahamas.
SYNONYMY: Sawgrass Marsh; Sawgrass Glade, in part (Hilsenbeck et al. 1979).

***Cladium mariscus ssp. jamaicense / algal periphyton* Herbaceous Vegetation**
DESCRIPTION: Sparse, fairly tall (0.7-1.5 m) *Cladium mariscus ssp. jamaicense*, much less productive than denser *Cladium* because of harsh site conditions, and with fewer other vascular plant species present. Algal periphyton is nearly continuous, and is beeter developed than in the *Cladium mariscus ssp. jamaicense - Bacopa caroliniana* Herbaceous Vegetation.
DISTRIBUTION: Florida, Bahamas.
SYNONYMY: Wet Prairie; Sawgrass Glade, in part (Hilsenbeck et al. 1979).

***V.A.1.N.g. Eleocharis interstincta - Sagittaria lancifolia* Herbaceous Alliance**
CONCEPT: Freshwater wetlands dominated by *Eleocharis interstincta* and *Sagittaria lancifolia*, in shallow waters of lakes, ponds, and boggy areas, on muddy and peaty substrates.
DISTRIBUTION: Puerto Rico, Bahamas, Cuba.
SYNONYMY: Sagittario-Eleocharetum interstinctae (Borhidi 1991); Spike-rush Marsh -- 34.5 (Dansereau 1966).

***Eleocharis interstincta - Sagittaria lancifolia* Herbaceous Vegetation**
DESCRIPTION: Freshwater wetlands dominated by *Eleocharis interstincta* and *Sagittaria lancifolia*, in shallow waters of lakes, ponds, and boggy areas, on muddy and peaty

substrates. Other species include *Pontederia lanceolata, Nuphar lutea ssp. macrophylla*, and *Nymphaea ampla*.

DISTRIBUTION: Bahamas, Cuba.

COMMENTS: Based on Borhidi (1991).

SYNONYMY: Sagittario-Eleocharetum interstinctae (Borhidi 1991).

***V.A.1.N.g. Gynerium sagittatum* Herbaceous Alliance**

CONCEPT: Riverside thickets dominated by *Gynerium sagittatum.*

DISTRIBUTION: Puerto Rico, Cuba.

***Gynerium sagittatum* Herbaceous Vegetation**

DESCRIPTION: Community dominated by the giant cane *Gynerium sagittatum*, in dense stands.

DISTRIBUTION: Puerto Rico, Cuba.

SYNONYMY: Rivercane Brake -- 36.5 (Dansereau 1966); Gynerietum sagittati (Borhidi 1991).

***V.A.1.N.g. Panicum hemitomon* Seasonally Flooded Tropical Herbaceous Alliance**

CONCEPT: Tropical wet prairies (marshes) dominated by *Panicum hemitomon*.

DISTRIBUTION: FL, [Bahamas].

***Panicum hemitomon* Herbaceous Vegetation**

DESCRIPTION: This tropical wet prairie community of southern Florida occurs on peat and marl-peat soils, with 6-11 month hydroperiod (generally greater than that of associated *Cladium mariscus ssp. jamaicense* and *Eleocharis cellulosa - Rhynchospora tracyi* communities). *Panicum hemitomon* dominates; other species present in small amounts are *Cladium mariscus ssp. jamaicense, Sagittaria lancifolia, Salix caroliniana, Nuphar lutea ssp. advena, Nymphaea odorata, Paspalidium geminatum var. paludivagum,* and *Typha domingensis*.

DISTRIBUTION: Bahamas, Florida.

COMMENTS: Needs additional data and assessment.

SYNONYMY: Wet Prairie; Maidencane Flat (Hilsenbeck et al. 1979).

***V.A.1.N.g. Phragmites australis* Herbaceous Alliance**

CONCEPT: Marshes dominated by *Phragmites australis.*

DISTRIBUTION: PR, Bahamas.

SYNONYMY: Reed-grass Marsh -- 33.5 (Dansereau 1966).

V.A.1.N.h. Semi-permanently flooded tropical or subtropical grassland

(SEMI-PERMANENTLY FLOODED GRASSLAND)
(HERBAZAL SEMI-PERMANENTEMENTE INUNDADO)

***V.A.1.N.h. Brachiaria mutica - Eriochloa polystachya* Herbaceous Alliance**

DISTRIBUTION: Puerto Rico.

SYNONYMY: Para-carib-grass Marsh -- 30.5 (Dansereau 1966).

***V.a.1.N.h. Hymenachne amplexicaulis - Panicum aquaticum* Herbaceous Alliance**

DISTRIBUTION: Puerto Rico.

SYNONYMY: Trompetilla-grass Marsh -- 31.5 (Dansereau 1966).

***V.A.1.N.h. Paspalidium geminatum var. paludivagum* Herbaceous Alliance**

CONCEPT: Monodominant community dominated by *Paspalidium geminatum var. paludivagum*, of semi-permanently flooded zones of freshwater lakes.

DISTRIBUTION: Bahamas?, Cuba.

COMMENTS: *Paspalidium geminatum var. paludivagum* has often been called *Panicum geminatum*; recently it has been proposed as *Setaria geminata var. paludivaga*.

REFERENCES: Borhidi (1991).

***Paspalidium geminatum var. paludivagum - Hydrocotyle umbellata* Herbaceous Vegetation**

DESCRIPTION: In shallower water than *Paspalidium geminatum var. paludivagum-Vallisneria americana* Herbaceous Vegetation.

DISTRIBUTION: Cuba.

SYNONYMY: Paspalidietum paludivagi subass. typicum (Borhidi 1991).

REFERENCES: Borhidi (1991).

***Paspalidium geminatum var. paludivagum - Vallisneria americana* Herbaceous Vegetation**

DESCRIPTION: In deeper water than *Paspalidium geminatum var. paludivagum-Hydrocotyle umbellata* Herbaceous Vegetation.

DISTRIBUTION: Cuba.

SYNONYMY: Paspalidietum paludivagi subass. vallisnerietosum (Borhidi 1991).

REFERENCES: Borhidi (1991).

***V.A.1.N.h. Typha domingensis* Herbaceous Alliance**

CONCEPT: Marshes dominated (usually in nearly pure stands) by *Typha domingensis*.

DISTRIBUTION: Puerto Rico, Bahamas.

SYNONYMY: Cattail Marsh -- 32.5 (Dansereau 1966).

V.A.1.N.i. Tidally flooded tropical or subtropical grassland
(TIDALLY FLOODED GRASSLAND)
(HERBAZAL MAREAL)

***V.A.1.N.i. Bothriochloa pertusa* Herbaceous Alliance**

CONCEPT: Littoral grasslands dominated by *Bothriochloa pertusa*, with scattered shrubs of *Capparis flexuosa, Lantana involucrata, Rauvolfia nitida, Coccoloba uvifera,* and *Sesuvium portulacastrum.*

DISTRIBUTION: Puerto Rico.

COMMENTS: Known from Reserva Natural Cabezas de San Juan.

***V.A.1.N.i. Cladium mariscus ssp. jamaicensis* Herbaceous Alliance**

DISTRIBUTION: Bahamas.

***V.A.1.N.i. Fimbristylis spadicea* Herbaceous Alliance**

CONCEPT:

DISTRIBUTION: Puerto Rico.

SYNONYMY: Salt-sedge Meadow -- 14.6 (Dansereau 1966).

***V.A.1.N.i. Sporobolus virginicus* Tidal Herbaceous Alliance**

DISTRIBUTION: Florida, Puerto Rico, Bahamas, Cuba, Martinique?, St. Kitts and Nevis.

SYNONYMY: Beach-grass Sward -- 19.6 (Dansereau 1966).

REFERENCES: Dansereau 1966.

***Sporobolus virginicus - Paspalum vaginatum* Herbaceous Vegetation** (TNC 7662)

DISTRIBUTION: Puerto Rico, Martinique?.

SYNONYNY: Beach-grass Sward -- 19.6 (Dansereau 1966).

***Sporobolus virginicus - Distichlis spicata* Herbaceous Vegetation** (TNC 7663)

DISTRIBUTION: Florida, Cuba.

V.A.1.N.x. Saturated tropical or subtropical grassland
(SATURATED GRASSLAND)
(HERBAZAL SATURADO)

***V.A.1.N.x. Kyllinga squamata-Isachne rigidifolia-Eleocharis spp.* Herbaceous Alliance**

CONCEPT: Montane wet meadows in Martinique.
DISTRIBUTION: Martinique.

***Kyllinga squamata-Isachne rigidifolia-Eleocharis spp.* Herbaceous Vegetation** (TNC 7656)

DESCRIPTION: Small areas at high elevations in the mountains of Martinique, dominated by *Kyllinga squamata, Isachne rigidifolia, Eleocharis spp.,* and *Dicranopteris bifida.*

DISTRIBUTION: Martinique.

COMMENTS: Based on Kimber (1988).

SYNONYMY: Montane Meadow (Kimber 1988).

REFERENCES: Kimber 1988.

***V.A.1.N.x.* (Alliance name has not been defined yet)**

CONCEPT: Permanently saturated herbaceous vegetation occurring in the splash or spray zone of waterfalls, streams and rivers.

DISTRIBUTION: St. Kitts, Montserrat, Guadeloupe, Dominica, Martinique, St. Lucia, St. Vincent and Grenada.

COMMENTS: This plant community is adapted to the wet, saturated conditions of waterfalls, rapids and streams. Plants can be found growing on the vertical rock faces of waterfalls or on large boulders in streams. However, the flora of this community differs from the true aquatic flora in the species composition and growth form. There is an abundance of ferns, mosses, lichens, bromeliads, short low shrubs and other herbaceous growth, and Lycopodium and Selaginella.

SYNONYMY: None.

REFERENCES: Lindsay (ined.).

Group: *V.A.2. Tropical or subtropical grassland with a tree layer (generally 10-25%)*
Subgroup: *V.A.2.N. Natural/Semi-natural*

V.A.2.N.a. Tall tropical or subtropical grassland with mainly broad-leaved evergreen trees (includes tuft plants and broad-leaved semi-evergreen trees)

(TALL GRASSLAND WITH BROAD-LEAVED EVERGREEN TREES)
(HERBAZAL ALTO CON ÁRBOLES LATIFOLIOS SIEMPREVERDES)

(TYPES TO BE DEFINED)

V.A.2.N.b. Tall tropical or subtropical grassland with broad-leaved evergreen drought-deciduous trees

(TALL GRASSLAND WITH BROAD-LEAVED DROUGHT-DECIDUOUS TREES)
(HERBAZAL ALTO CON ÁRBOLES LATIFOLIOS DECIDUOS)

(TYPES TO BE DEFINED)

V.A.2.N.c. Medium-tall tropical or subtropical grassland with broad-leaved evergreen trees (includes tuft plants and semi-evergreen trees)

(MEDIUM-TALL GRASSLAND WITH BROAD-LEAVED EVERGREEN TREES)
(HERBAZAL MEDIANO-ALTO CON ÁRBOLES LATIFOLIOS SIEMPREVERDES)

(TYPES TO BE DEFINED)

V.A.2.N.d. Medium-tall tropical or subtropical grassland with broad-leaved drought-deciduous trees

(MEDIUM-TALL GRASSLAND WITH BROAD-LEAVED DROUGHT-DECIDUOUS TREES)
(HERBAZAL MEDIANO-ALTO CON ÁRBOLES LATIFOLIOS DECIDUOS)

(TYPES TO BE DEFINED)

V.A.2.N.e. Medium-tall tropical or subtropical grassland with needle-leaved evergreen or mixed trees

(MEDIUM-TALL GRASSLAND WITH NEEDLE-LEAVED EVERGREEN OR MIXED TREES)
(HERBAZAL MEDIANO-ALTO CON ÁRBOLES ACICULIFOLIOS SIEMPREVERDES O MIXTOS)

(TYPES TO BE DEFINED)

V.A.2.N.f. Medium-tall tropical or subtropical grassland with xeromorphic trees or succulents

(MEDIUM-TALL GRASSLANDS WITH XEROMORPHIC TREES OR SUCCULENTS)
(HERBAZAL MEDIANO-ALTO CON ÁRBOLES XEROMÓRFICOS O SUCULENTAS)

(TYPES TO BE DEFINED)

V.A.2.N.g. Seasonally/temporarily flooded tropical grassland with broad-leaved evergreen trees (includes tuft plants)

(SEASONALLY/TEMPORARILY FLOODED GRASSLAND WITH BROAD-LEAVED EVERGREEN TREES)
(HERBAZAL ESTACIONALMENTE/TEMPORALMENTE INUNDADO CON ÁRBOLES SIEMPREVERDES LATIFOLIOS)

(TYPES TO BE DEFINED)

V.A.2.N.h. Seasonally/temporarily flooded tropical grassland with broad-leaved deciduous trees

(SEASONALLY/TEMPORARILY FLOODED GRASSLAND WITH DECIDUOUS TREES)
(HERBAZAL ESTACIONALMENTE/TEMPORALMENTE INUNDADO CON ÁRBOLES DECIDUOS)

(TYPES TO BE DEFINED)

V.A.2.N.i. Seasonally flooded/saturated tropical or subtropical grassland with needle-leaved evergreen trees

(SEASONALLY FLOODED/SATURATED GRASSLAND WITH PINE TREES)

(HERBAZAL ESTACIONALMENTE INUNDADO/SATURADO CON PINOS)

(TYPES TO BE DEFINED)

V.A.2.N.j. Short tropical or subtropical grassland with needle-leaved evergreen or mixed trees[52]

(SHORT GRASSLAND WITH PINE OR MIXED TREES)
(HERBAZAL CORTO CON PINOS O ÁRBOLES MIXTOS)

(TYPES TO BE DEFINED)

V.A.2.N.k. Short tropical or subtropical grasslands with broad-leaved evergreen trees[53]

(SHORT GRASSLAND WITH BROAD-LEAVED EVERGREEN TREES)
(HERBAZAL CORTO CON ÁRBOLES LATIFOLIOS SIEMPREVERDES)

(TYPES TO BE DEFINED)

Group: ***V.A.3. Tropical or subtropical grassland with a shrub layer (generally 10-25 %)***
Subgroup: ***V.A.3.N. Natural/Semi-natural***

V.A.3.N.i. Seasonally/temporarily flooded tropical or subtropical grassland with evergreen broad-leaved shrubs

(SEASONALLY/TEMPORARILY FLOODED GRASSLAND WITH BROAD-LEAVED SHRUBS)
(HERBAZAL ESTACIONALMENTE/TEMPORALMENTE INUNDADO CON ARBUSTOS LATIFOLIOS)

(TYPES TO BE DEFINED)

Group: ***V.A.4. Tropical or subtropical grassland with a dwarf-shrub layer (generally 10-25%)***
Subgroup: ***V.A.4.N. Natural/Semi-natural***

V.A.4.N.b. Tropical or subtropical forb-grassland with dwarf-shrubs and succulents[54]

(FORB-GRASSLAND WITH DWARF-SHRUBS AND SUCCULENTS)
(HERBAZAL DE DICOTILEDÓNEAS Y GRAMÍNEAS CON ARBUSTOS ENANOS Y SUCULENTAS)

(TYPES TO BE DEFINED)

Subclass: ***V.B. PERENNIAL FORB VEGETATION***
Group: ***V.B.1. Tropical or subtropical perennial forb vegetation***
Subgroup: ***V.B.1.N. Natural/Semi-natural***

[52] New Formation.
[53] New Formation.
[54] New Formation, to include Lindsay & Horwith's Lantana camara forb-grassland Alliance and Beers *et al.* Aristida-Tephrosia type.

V.B.1.N.b. Low tropical or subtropical perennial forb vegetation
(LOW PERENNIAL FORB VEGETATION)
(VEGETACIÓN PERENNE DE HERBÁCEAS NO GRAMINOIDES)

***V.B.1.N.b. Chamaesyce mesembrianthemifolia* Dwarf-shrubland Alliance**
CONCEPT: Rocky shores of limestone or sandstone, with moderately dense to very sparse pockets of shrubby and herbaceous plants.
DISTRIBUTION: Puerto Rico.
SYNONYMY: Spurge-sedge Mat -- 14.7 (Dansereau 1966); Spurge Desert -- 14.8 (Dansereau 1966).

***Chamaesyce mesembrianthemifolia - Fimbristylis spadicea* Dwarf-shrubland**
DESCRIPTION: Rocky shores of limestone or sandstone, with moderately dense to very sparse pockets of shrubby and herbaceous plants.
DISTRIBUTION: Puerto Rico.
SYNONYMY: Spurge-sedge Mat -- 14.7 (Dansereau 1966); Spurge Desert -- 14.8 (Dansereau 1966).

***V.B.1.N.b. Euphorbia blodgettii* Herbaceous Alliance**
CONCEPT: This community occurs in hard-packed sand areas behind dunes. Characteristic species are *Euphorbia blodgettii, Cassia lineata, Ambrosia hispida, Heliotropium nanum, Erithalis,* and *Ipomoea imperati.*
DISTRIBUTION: Bahamas.

***Euphorbia blodgettii* Sand Plain Herbaceous Vegetation** (TNC XXXX)
DESCRIPTION: This community occurs in hard-packed sand areas behind dunes. Characteristic species are *Euphorbia blodgettii, Cassia lineata, Ambrosia hispida, Heliotropium nanum, Erithalis,* and *Ipomoea imperati.*
DISTRIBUTION: Bahamas.
SYNONYMY: 1.c. Coastal herb/shrub plain (Freid 1998).

***V.B.1.N.b. Ipomoea pes-caprae* Vine-shrubland Alliance**
DISTRIBUTION: Puerto Tico, Hawaii, Bahamas, Martinique.
SYNONYMY: Morning-glory Festoon -- 17.6 (Dansereau 1966)

***Ipomoea pes-caprae - Canavalia rosea* Vine-shrubland Vegetation**
DISTRIBUTION: Puerto Rico, Bahamas.

***Ipomoea pes-caprae - Scaevola plumieri - Ambrosia hispida* Herbaceous Vegetation** (TNC XXXX)
DESCRIPTION: This community occurs on unconsolidated substrates on ocean shores. Characteristic species include *Ipomoea pes-caprae, Ambrosia hispida, Sporobolus virginicus, Scaevola plumieri,* and *Hymenocallis arenicola.*
Distribution: Bahamas.
Synonymy: 1.a. Beach strand, in part (Freid 1998).

***V.B.1.N.b. Sesuvium portulacastrum* Herbaceous Alliance**
CONCEPT:
DISTRIBUTION: Puerto Rico, Hawaii, Bahamas, Martinique.
SYNONYMY: Sea-purslane Mat -- 10.6 (Dansereau 1966); Littoral Meadow, in part (Kimber 1988).

V.B.1.N.d. Saturated tropical or subtropical perennial forb vegetation
(SATURATED PERENNIAL FORB VEGETATION)

(VEGETACIÓN SATURADA PERENNE DE HERBÁCEAS NO GRAMINOIDES)

***V.B.1.N.d. Diffenbachia seguine* Herbaceous Alliance**
CONCEPT: Permanently or semi-permanently saturated herbaceous community, usually in standing or slow moving water.
DISTRIBUTION: Antigua, Nevis(?), Guadeloupe, Martinique, St. Lucia, Grenada and St. Vincent.
COMMENTS: Diffenbachia may form pure stands, sometimes covering fairly extensive areas of the stream. Only the roots and lower stem are inundated. It may also grow in association with herbaceous ***Commelina*** spp.

V.B.1.N.e. Tidally flooded tropical or subtropical perennial forb vegetation

(TIDALLY FLOODED PERENNIAL FORB VEGETATION)
(VEGETACIÓN MAREAL PERENNE DE HERBÁCEAS NO GRAMINOIDES)

***V.B.1.N.e. Acrostichum aureum - Acrostichum danaeifolium* Herbaceous Alliance**
CONCEPTt: Marshes dominated by giant ferns, usually in association with mangrove shrublands or mangrove forests.
DISTRIBUTION: Puerto Rico, Bahamas, Martinique.
SYNONYMY: Salt-fern Prairie -- 12.5 (Dansereau 1966); Littoral Meadow, in part (Kimber 1988).

Subclass: ***V.C. HYDROMORPHIC VEGETATION***
Group: ***V.C.1. Tropical or subtropical hydromorphic[55] vegetation (without seasonal contrasts)***
Subgroup: ***V.C.1.N. Natural/Semi-natural***

V.C.1.N.a. Permanently flooded tropical or subtropical hydromorphic[56] vegetation

(AQUATIC VEGETATION)
(VEGETACIÓN ACUÁTICA)

***V.C.1.N.a. Cabomba piauhyensis* Herbaceous Alliance** (Cabomba piauhyensis freshwater vegetation)
CONCEPT: Vegetation dominated by the submerged Cabomba piauhyensis in lakes and ponds.
DISTRIBUTION: Western Cuba (Borhidi 1991); Jamaica (Grossman *et al.* 1993).
SYNONYMY: Ceratophyllo-Cabombion piauhyensis (Samek & Moncada 1971).

Cabomba piauhyensis Herbaceous Vegetation
DESCRIPTION: Essentially monodominant with *Cabomba piauhyensis*.
DISTRIBUTION: Western Cuba.
SYNONYMY: Cabombetum piauhyensis (Borhidi *et al.* 1983).
REFERENCES: Borhidi *et al.* (1983).

***Cabomba piauhyensis - Nymphaea odorata* Herbaceous Vegetation**
DESCRIPTION: Submerged and rooted aquatic vegetation of white sand wetlands of West Cuba. This community is strongly dominated by *Cabomba piauhyensis* in the first place, and *Nymphaea odorata* in the second place. Other species include: *Nymphoides aureum, Salvinia auriculata, Ludwigia inclinata* and *Hymenachne amplexicaulis.*
DISTRIBUTION: Western Cuba (Pinar del Rio prov.).
SYNONYMY: Nymphaeo-Cabombetum piauhyensis (Samek & Moncada 1971).

[55] The term "rooted" was removed to include free-floating aquatic communities.
[56] The term "rooted" was removed to include free-floating aquatic communities. This complex vegetation unit consists of : (1) free-floating non rooted communities; (2) Rooted floating-leaf communities; (3) Rooted underwater communities, and (4) non-rooted underwater communities.

REFERENCES: Samek & Moncada (1971); Borhidi (1991).

***V.C.1.N.a. Vallisneria americana* Herbaceous Alliance** (Vallisneria americana freshwater vegetation)
CONCEPT: Submerged aquatic freshwater communities dominated by *Vallisneria americana* (including *V. neotropicalis*).
DISTRIBUTION: West and central Cuba; Hispaniola (Ciferri 1936); south east U.S. and Florida (Borhidi 1991).
SYNONYMY: Vallisnerion americanae (Borhidi *et al.* 1983).

***Vallisneria americana* Herbaceous Vegetation**

DESCRIPTION: The aquatic community is strongly dominated by *Vallisneria americana*. Other species may include *Hydrocotyle umbellata, Potamogeton nodosus, Utricularia foliosa, Panicum geminatum*.

DISTRIBUTION: Cuba: Laguna del Tesoro, Rio Zaza; Hispaniola.

SYNONYMY: Vallisnerietum americanae (Borhidi *et al.* 1983); Vallisnerietum neotropicalis (Borhidi *et al.* 1983); Vegetazione delle lagune a caratteri intermediari (Ciferri 1936), in part.

REFERENCES: Ciferri (1936); Borhidi *et al.* (1983).

***V.C.1.N.a. Mayaca fluviatilis* Herbaceous Alliance** (Mayaca fluviatilis freshwater vegetation)
CONCEPT: Submerged or partially submerged communities along margins of montane creeks and oligotrophic lowland lakes. These communities are strongly dominated by two different ecotypes of *Mayaca fluviatilis: M. fluviatilis* var. *fluviatilis* and *M. fluviatilis* var. *wrightii.*
DISTRIBUTION: East and west Cuba.
SYNONYMY: Mayacion fluviatilis (Borhidi *et al.* 1983).

***Mayaca fluviatilis var. fluviatilis* Herbaceous Vegetation**

DESCRIPTION: Submerged rock pavement along margins of montane streams and rivers, in the mountains of eastern Cuba, especially over serpentine. *Mayaca fluviatilis* var. *fluviatilis* strongly dominates this community. Other species include: *Fimbristylis annua, Eleocharis elegans, Anemia nipensis, Utricularia pusilla, Heptanthus lobatus, Koehneola repens* (a number of which are Cuban endemics).

DISTRIBUTION: Mountain ranges of eastern Cuba.

SYNONYMY: Mayacetum fluviatilis (Borhidi *et al.* 1983).

REFERENCES: Borhidi (1991).

***Mayaca fluviatilis var. wrightii* Herbaceous Vegetation**

DESCRIPTION: Sandy littoral margins of white sand wetlands in western Cuba and the Isle of Pines, with *Mayaca fluviatilis* var. *wrightii* as the strong dominant. Other species include *Eleocharis interstincta, Eleocharis capillacea, Eleocharis minima, Eriocaulon lacustre, Pinguicula filifolia, Rhynchospora cyperoides, Websteria confervoides, Rhynchospora tracyi, Utricularia juncea, Andropogon sp.* This community shows strong affinities to Coastal Plain ponds of the se. United States.

DISTRIBUTION: Western Cuba: Pinar del Rio prov. and Isle of Pines.

SYNONYMY: Mayacetum wrightii (Borhidi *et al.* 1983).

REFERENCES: Borhidi (1991).

***V.C.1.N.a. Myriophyllum sparsiflorum* Herbaceous Alliance** (Myriophyllum sparsiflorum freshwater vegetation)
CONCEPT: Characteristic communities of the centers of shallow white sand lakes in western Cuba, dominated by *Myriophyllum sparsiflorum*.
DISTRIBUTION: Cuba: White sand wetlands of western Cuba.
SYNONYMY: Potamion illinoensis (Borhidi *et al.* 1983), in part.

***Myriophyllum sparsiflorum* Herbaceous Vegetation**

DESCRIPTION: Shallow water community dominated by *Myriophyllum sparsiflorum*, also with *Proserpinaca palustris, Cabomba piauhyensis, Utricularia foliosa, Utricularia mixta, Mayaca fluviatilis* var. *wrightii*.

DISTRIBUTION: Western Cuba: Pinar del Rio prov.

SYNONYMY: Myriophylletum sparsiflori (Borhidi *et al.* 1983).

REFERENCES: Borhidi (1991).

***V.C.1.N.a. Utricularia foliosa* Herbaceous Alliance** (Utricularia foliosa freshwater vegetation)
CONCEPT: Submerged or partially submerged plant community in deep water of dystrophic or eutrophic lakes with neutral to alkaline fresh water, with *Utricularia foliosa* as the dominant.
DISTRIBUTION: Western and central Cuba.
SYNONYMY: Aldrovando-Utricularion (Borhidi *et al.* 1983), in part.

***Utricularia foliosa - Utricularia mixta* Herbaceous Vegetation**

DESCRIPTION: Basically co-dominated by *Utricularia foliosa* and *Utricularia mixta.* Other species may include *Ludwigia erecta, Spirodela polyrrhiza, Salvinia auriculata.*

DISTRIBUTION: Cuba: Lake Ariguanabo and Zapata swamp.

SYNONYMY: Utricularietum foliosae (Borhidi *et al.* 1983).

REFERENCES: Borhidi *et al.* (1983); Borhidi (1991).

***V.C.1.N.a. Utricularia pumila* Herbaceous Alliance** (Utricularia pumila freshwater vegetation)
CONCEPT: Communities dominated by species of *Utricularia,* free-floating or partly rooted in shallow water of dystrophic or oligotrophic white-sand lakes with neutral to acidic fresh water.
DISTRIBUTION: West Cuba.
SYNONYMY: Aldrovando-Utricularion (Borhidi *et al.* 1983), in part.

***Utricularia juncea - Utricularia pumila - Utricularia pusilla - Utricularia virgulata* Herbaceous Vegetation**

DESCRIPTION: In shallow white-sand lakes of neutral or slightly acidic fresh water, with *Utricularia juncea* as a dominant to moderate component. Other species include *Utricularia pumila, Utricularia virgulata, Utricularia pusilla, Bulbostylis tenuifolia.*

DISTRIBUTION: West Cuba, in white-sand wetland areas.

SYNONYMY: Utricularietum junceae (Borhidi *et al.* 1983).

REFERENCES: Borhidi (1991).

***Utricularia resupinata - Utricularia pumila - Utricularia sclerocarpa* Herbaceous Vegetation**

CONCEPT: In shallow sublittoral sandy lakes of oligotrophic, acidic fresh water, dominated by *Utricularia resupinata*. Other species include *Utricularia pumila, Utricularia sclerocarpa, Bulbostylis tenuifolia, Bulbostylis areanaria, Caperonia cubana.*

DISTRIBUTION: West Cuba, in white-sand wetland areas.

SYNONYMY: Utricularietum resupinatae (Borhidi 1991).

REFERENCES: Borhidi (1991).

***V.C.1.N.a. Lemna perpusilla* Herbaceous Alliance** (Lemna perpusilla freshwater vegetation)
CONCEPT: Free-floating freshwater vegetation formed by Lemnaceae and small water ferns, covering the surface of lakes, ponds, and slow streams.
DISTRIBUTION: Cuba: Batabanó, Ariguanabo, Zapata swamp (Borhidi & Muñiz 1983); Jamaica (Asprey & Robbins 1953; Grossman *et al.* 1993); Puerto Rico (Dansereau 1966); Lesser Antilles (Lindsay & Harwith 1997).
SYNONYMY: Azollaeo-Salvinion (Borhidi & Muñiz 1979); Nymphaea-Nelumbo-Pistia Alliance (Lindsay & Harwith 1997), in part.

***Lemna perpusilla - Azolla caroliniana* Herbaceous Vegetation** (Duckweed Herbaceous Vegetation)

DESCRIPTION: Association dominated by the free-floating *Lemna perpusilla* and *Azolla caroliniana,* in the ponds and streams of the Batabanó swamp, and in lake Ariguanabo (west Cuba).

DISTRIBUTION: West Cuba (Habana prov.); Jamaica (Ferry River); Puerto Rico.

SYNONYMY: Lemno-Azolletum carolinianae (Borhidi & Muñiz 1983); Duckweed crust (Dansereau 1966).

REFERENCES: Borhidi & Muñiz (1983); Asprey & Robbins (1953); Dansereau (1966).

***Salvinia auriculata - Spirodela polyrrhiza - Lemna perpusilla* Herbaceous Vegetation** (Water-fern Herbaceous Vegetation)

DESCRIPTION: Floating vegetation composed of *Salvinia auriculata, S. rotundifolia, Lemna perpusilla, Spirodela polyrrhiza* and *Pistia stratiotes.*

DISTRIBUTION: Cuba: Zapata and Batabanó swamps, lake Ariguanabo.

SYNONYMY: Spirodelo-Salvinietum auriculatae (Borhidi & Muñiz 1983).
REFERENCES: Borhidi & Muñiz (1983).

***V.C.1.N.a. Pistia stratiotes* Herbaceous Alliance** (Pistia stratiotes freshwater vegetation)
CONCEPT: Floating or rooted (by stranding) aquatic vegetation occurring in slow-moving or stagnant tropical waters, dominated by *Pistia stratiotes.*
DISTRIBUTION: Florida, Cuba, Hispaniola, Jamaica, Puerto Rico, Lesser Antilles.
SYNONYMY: Eichhornion azureae (Borhidi *et al.* 1983), in part; Nymphaea-Nelumbo-Pistia Alliance (Lindsay & Harwith 1997), in part.

***Pistia stratiotes* Herbaceous Vegetation** (Water-lettuce Herbaceous Vegetation).
DESCRIPTION: Dominated (and often nearly monospecifically so) by *Pistia stratiotes*, sometimes also with *Salvinia auriculata, Spirodela polyrrhiza, Azolla caroliniana,* and other aquatics.
DISTRIBUTION: Cuba, Hispaniola, Jamaica, Puerto Rico.
SYNONYMY: Zona a Pistia (Ciferri 1936); Water-lettuce Mat (Dansereau 1966); Pistietum stratiotidis (Borhidi 1991).
REFERENCES: Ciferri (1936); Asprey & Robbins (1953); Dansereau (1966); Borhidi *et al.* (1983), Borhidi (1991); Hager & Zanoni (1993); Grossman *et al.* (1993).

***V.C.1.N.a. Eichhornia crassipes* Herbaceous Alliance** (Eichhornia crassipes freshwater vegetation)
CONCEPT: Floating or rooted (by stranding) aquatic vegetation in slow-moving or stagnant, usually eutrophic water of lakes, ponds and rivers, dominated by *Eichhornia crassipes*, and often essentially monospecific.
DISTRIBUTION: Florida, Cuba, Jamaica, Hispaniola, Puerto Rico, Bahamas, Lesser Antilles, Neotropics.
SYNONYMY: Eichhornion azureae (Borhidi *et al.* 1983), in part; Nymphaea-Nelumbo-Pistia Alliance (Lindsay & Harwith 1997), in part.

***Eichhornia crassipes* Herbaceous Vegetation** (Water-hyacinth Herbaceous Vegetation)
DESCRIPTION: Floating or rooted aquatic vegetation dominated by *Eichhornia crassipes*, and often essentially monospecific. Other species may include *Paspalidium geminatum, Lemna spp., Azolla caroliniana, Pistia stratiotes, Spirodela polyrrhiza, Salvinia auriculata.*
DISTRIBUTION: Florida, Cuba, Jamaica, Puerto Rico, Bahamas.
SYNONYMY: Eichhornietum crassipedis (Samek & Moncada 1971); Water-hyacinth Mat (Dansereau 1966); Vegetazione dei fiumi a lento corso (Ciferri 1936), in part; Vegetazione delle Isole galleggianti (Ciferri 1936), in part.
REFERENCES: Samek & Moncada (1971); Asprey & Robbins (1953); Borhidi (1991); Grossman *et al.* (1993).

***V.C.1.N.a. Eichhornia azurea* Herbaceous Alliance** (Eichhornia azurea freshwater vegetation)
CONCEPT: Floating or rooted (by stranding) aquatic vegetation of tropical areas, occurring in more oligotrophic situations than *Eichhornia crassipes* Herbaceous Vegetation.
DISTRIBUTION: Cuba, Hispaniola.
SYNONYMY: Eichhornion azureae (Borhidi *et al.* 1983), in part.

***Eichhornia azurea* Herbaceous Vegetation**
DESCRIPTION: Floating or rooted aquatic vegetation dominated by *Eichhornia azurea*, and often essentially monospecific. Other species may include *Pistia stratiotes, Azolla caroliniana, Salvinia auriculata, Panicum aquaticum, Polygonum spp*.
DISTRIBUTION: Cuba, Hispaniola.
SYNONYMY: Eichhornietum azureae (Borhidi *et al.* 1983); Vegetazione dei fiume a lento corso (Ciferri 1936), in part; Vegetazione delle isole galleggianti (Ciferri 1936), in part.
REFERENCES: Borhidi (1991); Ciferri (1936); Hager & Zanoni (1993).

***V.C.1.N.a. Potamogeton nodosus* Herbaceous Alliance** (Potamogeton nodosus freshwater vegetation)
CONCEPT: Submerged or slightly emerged rooted vegetation dominated by *Potamogeton* spp., often forming dense communities in slow-moving eutrophic freshwaters.
DISTRIBUTION: Cuba, Hispaniola, Jamaica.

SYNONYMY: Potamion illinoensis (Borhidi *et al*. 1983), in part; Zona a Nymphaea (Ciferri 1936), in part.

***Potamogeton nodosus - Potamogeton illinoensis* Herbaceous Vegetation**

DESCRIPTION: Rather dense aquatic community essentially formed by two co-dominant *Potamogeton* species. May include also *Utricularia foliosa, Hydrocotyle umbellata, Vallisneria neotropicalis, Paspalidium paludivagum.*

DISTRIBUTION: Cuba, Hispaniola, Jamaica, Puerto Rico?

SYNONYMY: Potametum illinoensi-nodosi (Borhidi *et al.* 1983); Zona a Nymphaea (Ciferri 1936), in part; Pondweed tangle? (Dansereau 1966).

REFERENCES: Ciferri (1936); Asprey & Robbins (1953); Dansereau (1966); Borhidi (1991); Grossman *et al.* (1993).

***Potamogeton nodosus - Nymphaea ampla - Utricularia foliosa* Herbaceous Vegetation**

DESCRIPTION: Occurring in shallower waters, this community prefers a muddier habitat. Other species may include *Sagittaria lancifolia, Utricularia mixta, Proserpinaca palustris.*

DISTRIBUTION: Cuba, Hispaniola.

SYNONYMY: Nymphaeo-Potametum nodosi (Borhidi *et al.* 1983); Zona a Nymphaea (Ciferri 1936), in part.

REFERENCES: Ciferri (1936); Borhidi *et al.* (1983); Borhidi (1991).

***V.C.1.N.a. Nymphaea ampla* Herbaceous Alliance** (Nymphaea ampla freshwater vegetation)
CONCEPT: This is a common alliance of waterlily mats and other rooted aquatic plants with floating or emerged leaves, characterized by dominance or strong presence of *Nymphaea ampla*, widespread in the Greater Antilles, Lesser Antilles, and Central and South America.
DISTRIBUTION: Cuba, Hispaniola, Jamaica, Puerto Rico.
SYNONYMY: Nelumbio-Nymphaeion amplae (Samek & Moncada 1971), in part.

***Nymphaea ampla* Herbaceous Vegetation**

DESCRIPTION: This community occurs in eutrophic and dystrophic lakes, ponds, and oxbows, in the lowlands of the Greater Antilles (and very likely more widespread). *Nymphaea ampla* usually dominates strongly, with other species including *Brasenia schreberi, Nuphar luteum ssp. macrophyllum, Potamogeton nodosus, Utricularia foliosa, Eleocharis interstincta, Ludwigia erecta.*

DISTRIBUTION: Cuba, Hispaniola, Jamaica? Puerto Rico.

SYNONYMY: Nymphaeetum amplae (Borhidi *et al.* 1983); Waterlily Mat (Dansereau 1966); Zona a Nymphaea (Ciferri 1936); Zona 3, Laguna Don Gregorio (Hager & Zanoni 1993).

REFERENCES: Ciferri (1936); Dansereau (1966); Borhidi (1991); Grossman *et al.* (1993); Hager & Zanoni (1993).

***Brasenia schreberi - Nymphaea ampla* Herbaceous Vegetation**

DESCRIPTION: With about the same species composition as the former neighboring unit, in this association, however, *Brasenia schreberi* tends to dominate over *Nymphaea ampla*. Often occurs in the inner side of the waterlily mats, in somewhat deeper waters. Besides *Brasenia* and *Nymphaea* other common associates are *Nuphar luteum ssp. macrophyllum, Potamogetum nodosus, Utricularia foliosa, Eleocharis interstincta, Scirpus confervoides.*

DISTRIBUTION: Cuba.

SYNONYMY: Brasenietum schreberi (Borhidi *et al.* 1983).

REFERENCES: Borhidi *et al.* (1983); Borhidi (1991).

***Nuphar luteum - Nymphaea ampla* Herbaceous Vegetation**

DESCRIPTION: Co-dominated by *Nuphar luteum ssp. macrophyllum* and *Nymphaea ampla*, with other common associates of the typical waterlily mat (i.e. *Potamogetum nodosum, Utricularia foliosa, Eleocharis interstincta*). In somewhat muddier sites and shallower, more dystrophic waters than the Nymphaea ampla Herbaceous Vegetation community, to which it is often in contact. Other species may include *Sagittaria lancifolia, Polygonum punctatum.*

DISTRIBUTION: Cuba.

SYNONYMY: Nupharetum macrophylli (Borhidi *et al.* 1983).

REFERENCES: Borhidi (1991).

***V.C.1.N.a. Nelumbo lutea* Herbaceous Alliance** (Nelumbo lutea freshwater vegetation)

CONCEPT: American lotus mat, characterized by the dominance of the emergent, large-leaved *Nelumbo lutea*, and the presence of other emerged and submersed aquatic plants in both eutrophic and oligotrophic freshwater lakes.
DISTRIBUTION: Cuba, Hispaniola, Lesser Antilles.
SYNONYMY: Nelumbio-Nymphaeion amplae (Samek & Moncada 1971), in part; Nymphaea-Nelumbo-Pistia Alliance (Lindsay & Horwith (1997), in part.

***Nelumbo lutea - Eleocharis interstincta - Nymphoides aureum* Herbaceous Vegetation**

DESCRIPTION: In oligotrophic lakes of Cuba, dominated by emergent *Nelumbo lutea*, with substantial coverage of other floating, emergent, and submersed species, such as *Eleocharis interstincta, Nymphoides aureum, Utricularia foliosa, Paspalidium geminatum, Rhynchospora cyperoides, and Panicum parvifolium.*

DISTRIBUTION: Cuba.

SYNONYMY: Nelumbonetum luteae (Samek & Moncada 1971) subass. eleochareotosum interstinctae (Borhidi 1991).

REFERENCES: Samek & Moncada (1971), Borhidi (1991).

***Nelumbo lutea - Nymphaea ampla - Utricularia foliosa* Herbaceous Vegetation**

DESCRIPTION: In eutrophic lakes of Cuba, dominate by emergent Nelumbo lutea, with substantial coverage of other floating, emergent, and submersed species, such as *Nymphaea ampla, Schoenoplectus tabernaemontani, Utricularia foliosa, and U. mixta.*

DISTRIBUTION: Cuba, Hispaniola?

COMMENTS: This association seems to occur also in The Dominican Republic (Laguna Saladillo).

SYNONYMY: Nelumbonetum luteae (Samek & Moncada 1971) subass. nymphaeetosum amplae (Borhidi 1991).

REFERENCES: Borhidi (1991); Hager & Zanoni (1993).

***V.C.1.N.a. Nymphoides aurea* Herbaceous Alliance** (Nymphoides aurea freshwater vegetation)
CONCEPT: With *Nymphoides aurea* as a dominant or strong component, and presence of other rooted aquatic plants with floating leaves. Free-floating and/or submersed species can also occur. Typical in lakes of the white-sand area of west Cuba, in slightly oligotrophic or eutrophic waters.
DISTRIBUTION: West Cuba: Pinar del Rio prov.
SYNONYMY: Nelumbio-Nymphaeion amplae (Samek & Moncada 1971), in part.

***Nymphoides aurea* Herbaceous Vegetation**

DESCRIPTION: In shallow, slightly oligotrophic water, strongly dominated by Nymphoides aurea, with little coverage of other associates such as *Nymphaea odorata, Ludwigia inclinata, L. erecta, Hymenachne amplexicaulis, Cabomba piauhyensis and Caperonia palustris.*

DISTRIBUTION: West Cuba.

SYNONYMY: Nymphoidetum aureae (Borhidi *et al.* 1991).

REFERENCES: Borhidi (1991).

***Nymphoides aurea - Salvinia auriculata - Eichhornia heterosperma* Herbaceous Vegetation**

DESCRIPTION: In slightly oligotrophic to eutrophic water, dominated by *Nymphoides aurea.* Other species include the diagnostic water fern *Salvinia auriculata, Eichhornia heterosperma,* and occasionally *Ludwigia inclinata*.

DISTRIBUTION: West Cuba.

SYNONYMY: Eichhornio heterospermae-Nymphoidetum aureae (Samek & Moncada 1971) subass. typicum (Borhidi 1991).

REFERENCES: Samek & Moncada (1971), Borhidi (1991).

***Nymphoides aurea - Marsilea polycarpa* Herbaceous Vegetation**

DESCRIPTION: Co-dominated by *Nymphoides aurea* and the aquatic fern *Marsilea polycarpa.* Other species include *Polygonum punctatum, Eichhornia heterosperma, Salvinia auriculata, Cabomba piauhyensis, Hymenachne amplexicaulis, Ludwigia inclinata.*

DISTRIBUTION: West Cuba.

SYNONYMY: Eichhornio heterospermae-Nymphoidetum aureae (Samek & Moncada 1971) subass. marsilietosum (Borhidi 1991).

REFERENCES: Samek & Moncada (1971); Borhidi (1991).

***Nymphoides aurea - Cabomba piauhyensis - Eichhornia heterosperma - Nymphaea odorata* Herbaceous Vegetation**

DESCRIPTION: Characteristic community of three major associates (*Nymphoides aurea*, *Cabomba piauhyensis*, and *Eichhornia heterosperma*), usually with the strong presence of *Nymphaea odorata*.

DISTRIBUTION: West Cuba.

SYNONYMY: Eichhornio heterospermae-Nymphoidetum aureae (Samek & Moncada 1971) subass. cabombetosum (Borhidi 1991).

REFERENCES: Samek & Moncada (1971); Borhidi (1991).

***V.C.1.N.a. Nymphoides grayana* Herbaceous Alliance** (Nymphoides grayana freshwater vegetation)

CONCEPT: A vicariant unit of the *Nymphoides aurea* Herbaceous Alliance, in the eutrophic water of the limestone pits of western Cuba. The differential dominant species is *Nymphoides grayana.*

DISTRIBUTION: West Cuba.

SYNONYMY: Nelumbio-Nymphaeion amplae (Samek & Moncada 1971), in part.

***Nymphoides grayana* Herbaceous Vegetation**

DESCRIPTION: *Nymphoides grayana* dominates strongly. Also with other species including *Cabomba piauhyensis, Nymphaea ampla, Hydrocotyle umbellata, Marsilea polycarpa, Salvinia natans.*

DISTRIBUTION: West Cuba: Guanacahabibes peninsula; southern Isle of Pines.

SYNONYMY: Nymphoidetum grayanae (Borhidi *et al.* 1983).

REFERENCES: Borhidi *et al.* (1983); Borhidi (1991).

***V.C.1.N.a. Hydrocotyle umbellata* Herbaceous Alliance** (Hydrocotyle umbellata freshwater vegetation)

CONCEPT: Aquatic vegetation composed of two dominant components, an emerged and a submerged one. The emerged dominant is *Hydrocotyle umbellata.* Usually occurs in the transitional zone between the water-lily or water-lettuce mats and the sedge marsh, in shallow, eutrophic waters.

DISTRIBUTION: Cuba, Hispaniola?, Jamaica?

SYNONYMY: Potamion illinoensis (Borhidi *et al.* 1983), in part.

***Hydrocotyle umbellata - Vallisneria neotropicallis* Herbaceous Vegetation**

DESCRIPTION: Co-dominated by the emerged *Hydrocotyle umbellata* and the submerged *Vallisneria neotropicalis.* Usually also with *Utricularia foliosa, Scirpus validus, Paspalidium paludivagum, Polygonum punctatum.*

DISTRIBUTION: Cuba.

COMMENTS: A different association within the same Alliance seems to occur in the Dominican Republic, in Zone 4 (in part.) of Laguna Don Gregorio.

SYNONYMY: Hydrocotyletum umbellati (Borhidi *et al.* 1983).

REFERENCES: Asprey & Robbins (1953); Borhidi (1991); Hager & Zanoni (1993).

***V.C.1.N.a. Limnocharis flava* Herbaceous Alliance** (Limnocharis flava freshwater vegetation)

CONCEPT: Emergent aquatic vegetation dominated by the yellow swamp lily *Limnocharis flava,* in the shallow eutrophic waters of slow-running rivers.

DISTRIBUTION: Cuba, Hispaniola.

SYNONYMY: Vegetazione dei fiumi a lento corso (Ciferri 1936), in part; Crino-Limnocharion flavae (Borhidi *et al.* 1979 *emend.* Borhidi 1983).

***Limnocharis flava - Fuirena umbellata - Crinum americanum - Rhynchospora cyperioides* Herbaceous Vegetation**

DESCRIPTION: Dense aquatic sward dominated by *Limnocharis flava,* on shallow waters, usually with strong participation of *Crinum* spp. and a number of species of Cyperaceae of relatively small size. Common associates may include *Crinum americanum, C. oliganthum, Fuirena umbellata, Rhynchospora cyperoides, R. stellata, Fimbristylis ovata, Eleocharis cellulosa,* and others.

DISTRIBUTION: Cuba, Hispaniola?

SYNONYMY: Limnocharietum flavae (Borhidi *et al.* 1983).

REFERENCES: Ciferri (1936); Borhidi (1991).

V.C.1.N.b. Tidal permanently flooded tropical or subtropical hydromorphic rooted vegetation

(SEAGRASS BEDS)
(PRADERA SUBMARINA)

***V.C.1.N.b. Ruppia maritima* Herbaceous Alliance** (Ruppia maritima seagrass beds)
CONCEPT: Estuarine and marine seagrass beds dominated by *Ruppia maritima*.
DISTRIBUTION: Cuba, Bahamas, Puerto Rico, Martinique, Barbuda, Antigua, Caribbean region.
SYNONYMY: Ruppion maritimae; Ruppia-Najas Alliance (Lindsay & Harwith 1997), in part.

***Ruppia maritima* Herbaceous Vegetation**

DESCRIPTION: Estuarine and marine seagrass beds dominated by *Ruppia maritima*, often nearly monospecific but sometimes with other species, including *Najas guadelupensis*, *Halodule beaudettii*, and *Cymodocea filiformis*.

DISTRIBUTION: Cuba, Bahamas, Puerto Rico, Lesser Antilles, Caribbean region.

COMMENTS: This vegetation type tolerates well the highly saline waters of shallow muddy lagoons not colonized by mangroves.

SYNONYMY: Halodulo-Ruppietum maritimae (Borhidi *et al.* 1983).

REFERENCES: Kimber (1988); Borhidi (1991).

***V.C.1.N.b. Thalassia testudinum* Herbaceous Alliance** (Thalassia testudinum seagrass beds)
CONCEPT: Estuarine and marine seagrass beds dominated or co-dominated by *Thalassia testudinum*, on seaward muddy bottoms.
DISTRIBUTION: Cuba, Hispaniola, Puerto Rico, Bahamas, Jamaica, Caribbean region.
SYNONYMY: Syringodio-Thalassion (Borhidi *et al.* 1983), in part.

***Thalassia testudinum* Herbaceous Vegetation**

DESCRIPTION: Estuarine and marine seagrass beds essentially monodominant with *Thalassia testudinum*, on muddy or sandy substrate.

DISTRIBUTION: Cuba, Puerto Rico; Caribbean region.

SYNONYMY: Turtle-grass bed (Dansereau 1966).

REFERENCES: Dansereau (1966); Areces-Mallea (1986).

***Thalassia testudinum - Cymodocea filiformis* Herbaceous Vegetation**

DESCRIPTION: Estuarine and marine seagrass beds co-dominated by *Thalassia testudinum* and *Cymodocea filiformis.* Occasionally may include *Halodule beaudettii.*

DISTRIBUTION: Cuba, Hispaniola, Jamaica, Caribbean region.

COMMENTS: This vegetation type, and the former one as well, often occur in dense, extensive stands along sandy beaches. As sea grasses are periodically uprooted by sea currents, turbulent waters, and exceptionally high tides, they are usually deposited in great masses on the beaches.

SYNONYMY: Associazione Thalassia-Cymodocea (Ciferri 1936), in part; Syringodio-Thalassietum (Borhidi *et al.* 1983), in part; Thalassia testudinum-Cymodocea filiformis colonies (Kimber 1988), in part.

REFERENCES: Ciferri (1936); Asprey & Robbins (1953); Areces-Mallea (1986); Kimber (1988); Borhidi (1991).

***V.C.1.N.b. Cymodocea filiformis* Herbaceous Alliance** (Cymodocea filiformis seagrass beds)
CONCEPT: Estuarine and marine seagrass beds dominated by *Cymodocea filiformis.*
DISTRIBUTION: Cuba, Bahamas, Caribbean region?.
SYNONYMY: Syringodio-Thalassietum (Borhidi *et al.* 1983), in part.

***Cymodocea filiformis* Herbaceus Vegetation**

DESCRIPTION: Essentially monodominant with *Cymodocea filiformis*, on seaward muddy bottoms.

DISTRIBUTION: Florida, Cuba, Hispaniola, Puerto Rico, Bahamas, Jamaica, Martinique, Caribbean region?.

COMMENTS: Often occurring in patches throughout the Thalassia testudinum-Cymodocea filiformis vegetation.

SYNONYMY: Associazione Thalassia-Cymodocea (Ciferri 1936), in part; Syringodio-Thalassietum (Borhidi *et al.* 1983), in part; Thalassia testudinum-Cymodocea filiformis colonies (Kimber 1988), in part.

REFERENCES: Ciferri (1936); Asprey & Robbins (1953); Areces-Mallea (1986); Kimber (1988); Borhidi (1991).

***V.C.1.N.b. Halodule beaudettii* Herbaceous Alliance** (Halodule beaudettii seagrass beds)
CONCEPT: Estuarine and marine seagrass beds dominated by *Halodule beaudettei.*
DISTRIBUTION: Florida, Bahamas, Caribbean?
SYNONYMY: None.

***Halodule beaudettii* Herbaceous Vegetation**

DESCRIPTION: Seagrass community with *Halodule beaudettii* as a major monodominant species.

DISTRIBUTION: Florida, Bahamas, Caribbean?

SYNONYMY: None.

REFERENCES: Borhidi (1991); Weakley's checklist of the vegetation of the West Indies (unpubl.).

***V.C.1.N.b. Limnobium laevigatum* Herbaceous Alliance** (Limnobium laevigatum seagrass beds)
CONCEPT: Marine seagrass beds dominated by *Limnobium laevigatum,* in shallow sublittoral zone of sandy beaches.
DISTRIBUTION: Cuba, Caribbean?
SYNONYMY: Syringodio-Thalassion (Borhidi *et al.* 1983).

***Limnobium laevigatum* Herbaceous Vegetation**

DESCRIPTION: Dominated by *Limnobium laevigatum.* Other species may include *Halodule wrightii, Cymodocea filiformis, Ruppia maritima, Halophila baillonis.*

DISTRIBUTION: Cuba, Caribbean?

SYNONYMY: Limnobietum laevigati (Borhidi *et al.* 1983).

REFERENCES: Borhidi (1991).

Subclass: *V.D. ANNUAL GRAMINOID OR FORB VEGETATION*
Group: *V.D.1. Tropical or subtropical annual grasslands or forb vegetation*
Subgroup: *V.D.1.N. Natural/Semi-natural*

V.D.1.N.b. Tall tropical or subtropical annual forb vegetation
(TALL ANNUAL FORB VEGETATION)
(VEGETACIÓN ALTA ANUAL DE HERBÁCEAS NO GRAMINOIDES)

(TYPES TO BE DEFINED)

V.D.1.N.d. Tidal tropical or subtropical annual forb vegetation
(TIDAL ANNUAL FORB VEGETATION)
(VEGETACIÓN MAREAL ANUAL DE HERBÁCEAS NO GRAMINOIDES)

(TYPES TO BE DEFINED)

Class: *VII. SPARSE VEGETATION*
Subclass: *VII.A. CONSOLIDATED ROCK SPARSE VEGETATION*
Group: *VII.A.1. Sparsely vegetated cliffs*
Subgroup: *VII.A.1.N. Natural/Semi-natural*

VII.A.1.N.a. Cliffs with sparse vascular vegetation
(CLIFF VEGETATION)
(VEGETACIÓN DE ACANTILADOS)

(TYPES TO BE DEFINED)

Group: ***VII.A.2. Sparsely vegetated pavement***
Subgroup: ***VII.A.2.N. Natural/Semi-natural***

VII.A.2.N.a. Pavement with sparse vascular vegetation
(PAVEMENT VEGETATION)
(VEGETACIÓN DE COSTA ROCOSA)

VII.A.2.N.a. Portulaca halimoides **Herbaceous Alliance**
CONCEPT: Rocky shores.
DISTRIBUTION: Martinique.
SYNONYMY: Portulaca Zone (Kimber 1988).

Subclass: ***VII.B. GRAVEL, COBBLE OR TALUS ROCK SPARSE VEGETATION***
Group: ***VII.B.1. Sparsely vegetated talus/scree slopes***
Subgroup: ***VII.B.1.N. Natural/Semi-natural***

VII.B.1.N.a Lowland or submontane talus/scree vegetation
(TALUS/SCREE VEGETATION)
(VEGETACIÓN DE TALUD GRAVELÍTICO)

(TYPES TO BE DEFINED)

Group: ***VII.B.2. Sparsely vegetated rock flats ((boulders, cobbel or gravel)***
Subgroup: ***VII.B.2.N. Natural/Semi-natural***

VII.B.2.N.a. Boulder field vegetation
(BOULDER FIELD VEGETATION)
(VEGETACIÓN SOBRE CANTOS RODADOS)

(TYPES TO BE DEFINED)

Subclass: ***VII.C. UNCONSOLIDATED MATERIAL SPARSE VEGETATION***
Group: ***VII.C.1. Sparsely vegetated sand dunes***
Subgroup: ***VII.C.1.N. Natural/Semi-natural***

VII.C.1.N.a. Dunes with sparse herbaceous vegetation
(DUNES WITH SPARSE VEGETATION)
(DUNAS CON VEGETACIÓN ABIERTA)

(TYPES TO BE DEFINED)

Group: ***VII.C.2. Sparsely vegetated sand flats***
Subgroup: ***VII.C.2.N. Natural/Semi-natural***

VII.C.2.N.b. Intermittently flooded sand beaches and shores

(STRAND VEGETATION)
(VEGETACIÓN DE PLAYA ARENOSA)

***VII.C.2.N.b. Cakile lanceolata* Herbaceous Alliance**
CONCEPT: Beach vegetation, with scattered *Cakile lanceolata*.
DISTRIBUTION: Puerto Rico, Bahamas.
SYNONYMY: Sea-rocket Strip -- 17.8 (Dansereau 1966)

Group: *VII.C.3. Sparsely vegetated soil slopes*
Subgroup: *VII.C.3.N. Natural/Semi-natural*

VII.C.3.N.c. Submontane fumeroles with sparse herbaceous vegetation[57]
(SUBMONTANE FUMEROLE VEGETATION)
(VEGETACIÓN DE FUMAROLA SUBMONTANA)

VII.C.3.N.c. (Alliance name has not been defined yet)
CONCEPT: Submontane microphyllous herbaceous community of the active, volcanic Lesser Antilles. Found around active fumeroles. The conditions may be somewhat drier than VII.C.3.N.d., but overall the vegetation is somewhat similar.
DISTRIBUTION: St. Kitts, Montserrat, Guadeloupe, Dominica, Martinique, St. Lucia, Grenada(?) and St. Vincent.
COMMENTS: Occurring in proximity to fumeroles. Beard considers this a subclimax community. Both this and VII.C.3.N.c. are quite similar but differ somewhat due to elevation and to a lesser extent, the species composition. This alliance is found at lower elevations where conditions may be somewhat drier. They are both pioneer communities, and the growth of plants and species composition may be limited by the poisonous gases, the acidity of the soil, gas and other temperatures, and to other edaphic factors.
SYNONYMY: Sub-climax community, fumerole vegetation (Beard, 1949).

VII.C.3.N.d. Montane fumeroles with sparse herbaceous vegetation[58]
(MONTANE FUMEROLE VEGETATION)
(VEGETACIÓN DE FUMAROLA MONTANA)

VII.C.3.N.d. (Alliance name has not been defined yet)
CONCEPT: Montane Microphyllous herbaceous community of active, volcanic Lesser Antilles. Found around active fumeroles.
DISTRIBUTION: St. Kitts, Montserrat, Guadeloupe, Dominica, Martinique, St. Lucia, Grenada(?) and St. Vincent.
COMMENTS: Both this and VII.C.3.N.c. are quite similar but differ somewhat due to elevation and to a lesser extent, the species composition. They are both pioneer communities, and the growth of plants and the species composition may be
limited by the poisonous gases, the acidity of the soil, gas and other temperatures, and to other edaphic factors.
SYNONYMY: Beard (1949) called this a "Sub-climax community, Fumerole Vegetation".

Group: *VII.C.4. Sparsely vegetated soil flats*
Subgroup: *VII.C.4.N. Natural/Semi-natural*

VII.C.4.N.c. Seasonally/temporally flooded mud flats
(SEASONALLY/TEMPORARILY FLOODED MUD FLAT)
(LODAZAL ESTACIONALMENTE/TEMPORALMENTE INUNDADO)

[57] New Formation.
[58] New formation.

(TYPES TO BE DEFINED)

VII.C.4.N.d. Tidally flooded mudflats
(TIDALLY FLOODED MUDFLAT)
(LODAZAL MAREAL)

(TYPES TO BE DEFINED)

EXOTIC AND ALTERED VEGETATION

***I.A.1.N.b. Bambusa vulgaris* Forest Alliance**
CONCEPT: Bamboo thickets dominated by the naturalized *Bambusa vulgaris*, generally very dense and nearly monospecific in the 10-25 m tall canopy.
DISTRIBUTION: Puerto Rico, Martinique.

***I.A.1.N.b. Mangifera indica* Forest Alliance**
CONCEPT: Forests dominated or codominated by the exotic *Mangifera indica*.
DISTRIBUTION: Puerto Rico.

***Mangifera indica - Artocarpus altilis / Musa spp.* Forest**
DESCRIPTION: Ruinate forests following disturbance and abandoned cultivation, dominated by exotic species.
DISTRIBUTION: Puerto Rico.

***I.A.1.N.b. Syzygium jambos* Forest Alliance**
CONCEPT: Short forests and thickets of the exotic *Syzygium jambos*.
DISTRIBUTION: Puerto Rico, Martinique.
SYNONYMY: Rose-apple Thicket -- 76.4 (Dansereau 1966).
COMMENTS: Based on Dansereau (1966), Beard (1949). *Syzygium jambos* is called *Eugenia jambos* in some older literature.

***I.A.1.N.b. Terminalia catappa* Forest Alliance**
CONCEPT: Disturbed areas, especially in lowland coastal areas, dominated by the exotic *Terminalia catappa*.
DISTRIBUTION: Puerto Rico, Bahamas.
SYNONYMY: Malabar-almond Scrub -- 26.4 (Dansereau 1966).

***I.A.1.N.c. Eucalyptus robusta* Forest Alliance**
CONCEPT: Forests in montane portions of Puerto Rico, dominated by the exotic (planted and naturalized) *Eucalyptus robusta*.
DISTRIBUTION: Puerto Rico.

***I.A.7.C.a. Pinus caribaea var. hondurensis* Forest Plantation Alliance** (Pinus caribaea hondurensis forest plantations)
CONCEPT: Pine forest plantations with *Pinus caribaea* var. *hondurensis* dominating the canopy.
DISTRIBUTION: Jamaica.
SYNONYMY: Commercial forest (pine) plantation (Grossman *et al.* 1993).

ONE ASSOCIATION:

***I.A.7.C.a. Pinus caribaea var hondurensis* Forest Plantation**
DESCRIPTION: Pine forest plantation with an essentially monodominant canopy of *Pinus caribaea* var. *hondurensis*. There is no understory, and the condition of the shrub and ground layers depend upon the prevailing forestry practices.
DISTRIBUTION: Jamaica: frequent in the Blue Mountains, and in central Jamaica.
COMMENTS: *Pinus caribaea* var. *hondurensis* is non-native to Jamaica.
SYNONYMY: Pine plantation (Grossman *et al.* 1993).
REFERENCES: (Grossman *et al.* 1993).

***I.A.7.C.b. Casuarina equisetifolia* Forest Plantation Alliance** (Australian pine forest plantations)
CONCEPT: Forests (varying to woodland structure) of the exotic *Casuarina equisetifolia*, generally in maritime situations, on beach sands.
DISTRIBUTION: Cuba, Bahamas, Puerto Rico.
SYNONYMY: Australian-pine Screen (Dansereau 1966), in part.

ONE ASSOCIATION:

***I.A.7.C.b. Casuarina equisetifolia* Forest Plantation**

DESCRIPTION: Commonly on disturbed sandy beaches, and essentially monodominant with *Casuarina equisetifolia.*
DISTRIBUTION: Cuba, Bahamas, Puerto Rico.
COMMENTS: Stands of nearly pure Australian "pines" are common on sandy beaches of many keys of the Cuban archipelago.
SYNONYMY: Australian-Pine Screen (Dansereau 1966), in part.

***I.C.1.N.b. Inga vera - Erythrina poeppigiana* Forest Alliance**
DISTRIBUTION: Puerto Rico.

***I.C.1.N.b. Inga vera - Erythrina poeppigiana / Coffea arabica* Forest**

DESCRIPTION: Forests altered/managed/planted for coffee.
SYNONYMY: Inga-coffee Forest -- 75.1 (Dansereau 1966).
DISTRIBUTION: Puerto Rico.

***II.A.1.C.a. Cocos nucifera* Woodland Alliance**
Coconut Forest Alliance; Coco Forest Alliance
CONCEPT: Forests (generally with a rather open canopy) of the exotic *Cocos nucifera*, generally occurring in maritime situations, such as beach sands.
DISTRIBUTION: Puerto Rico, Bahamas.
SYNONYMY: Coconut Plantation -- 24.2 (Dansereau 1966).

***II.A.3.C.a Casuarina equisetifolia* Woodland Alliance** (Australian pine woodland plantations)
CONCEPT: Woodlands (varying to forest structure) of the exotic *Casuarina equisetifolia*, generally in maritime situations, on beach sands.
DISTRIBUTION: Cuba, Bahamas, Puerto Rico.
SYNONYMY: Australian-pine Screen (Dansereau 1966), in part.

ONE ASSOCIATION:

***II.A.3.C.a. Casuarina equisetifolia* Woodland Plantation**

DESCRIPTION: Commonly on disturbed sandy beaches, and essentially monodominant with *Casuarina equisetifolia.*
DISTRIBUTION: Cuba, Bahamas, Puerto Rico.
COMMENTS: Open stands of nearly pure Australian "pines" are common on sandy beaches of many Keys of the Cuban archipelago.
SYNONYMY: Australian-pine Screen (Dansereau 1966), in part.

***II.B.1.N.a. Prosopis pallida-(Bucida buceras)* Woodland Alliance**
DISTRIBUTION: Puerto Rico.
SYNONYMY: Mesquite Savana -- 72.3 (Dansereau 1966); Bucaro - Mesquite Savana -- 72.3a (Dansereau 1966).

***Prosopis pallida / Panicum maximum* Woodland** -- GW

DESCRIPTION: Open to very open canopy dominated by *Prosopis pallida,* sometimes accompanied by other trees including *Crescentia cujete*. Herb layer dominated by *Panicum maximum*. Present in sw. Puerto Rico.
DISTRIBUTION: Puerto Rico.

***Prosopis pallida - (Bucida buceras) / Chloris barbata - Dichanthium annulatum* Woodland** -- GW

DESCRIPTION: Other woody species include *Achyranthes aspera var. aspera, Parkinsonia aculeata, Capparis flexuosa*.
DISTRIBUTION: Puerto Rico.

***III.A.1.N.a. Lantana camara* Shrubland Alliance**
CONCEPT: This shrubland, dominated by *Lantana camara*, is a disturbance type, following fire.
DISTRIBUTION: Bahamas, Martinique.
COMMENTS: Based on Beard (1949).

***III.A.1.N.a. Piper aduncum* Shrubland Alliance**
CONCEPT: Abandoned pastures and fields dominated by the shrub *Piper aduncum*.
DISTRIBUTION: Puerto Rico.
SYNONYMY: Pepper Scrub -- 46.4 (Dansereau 1966).

***III.A.1.N.a. Psidium guajava* Shrubland Alliance**
CONCEPT:
DISTRIBUTION: Puerto Rico.
SYNONYMY: Guava Scrub -- 45.4 (Dansereau 1966).

***V.A.1.N.c.003. Panicum maximum* Herbaceous Alliance**
CONCEPT: Herbaceous vegetation dominated by the exotic grass *Panicum maximum*. This vegetation now covers large parts of Puerto Rico, particularly in southwestern Puerto Rico.
DISTRIBUTION: Puerto Rico, Cuba.
COMMENTS: This is typically 1-2 m tall. If the criteria for tropical/subtropical tall vs. medium-tall grasslands are brought into agreement with the criteria for temperate/subpolar, this would be transferred to "tall."
SYNONYMY: Guinea-grass Prairie -- 67.5 (Dansereau 1966); Guinea-grass ruderal grassland.

***Panicum maximum* Herbaceous Vegetation** (TNC 7653)
DESCRIPTION: Vegetation usually strongly dominated by *Panicum maximum*. This community results from disturbance, and now covers large parts of Puerto Rico, particularly in southwestern Puerto Rico.
DISTRIBUTION: Puerto Rico.
SYNONYMY: Guinea-grass ruderal grassland.

***V.A.1.N.c.005. Rhynchelytrum repens* Herbaceous Alliance**
CONCEPT: Disturbed areas, such as old fields, vacant lots, roadsides, dominated by the exotic *Rhynchelytrum repens*.
DISTRIBUTION: Florida, Puerto Rico, Bahamas.

***Rhynchelytrum repens* Herbaceous Vegetation** (TNC 7654)
DESCRIPTION: Disturbed areas, such as old fields, vacant lots, roadsides, dominated by the exotic *Rhynchelytrum repens*.
DISTRIBUTION: Florida, Puerto Rico, Bahamas.

***V.B.1.N.d. Colocasia esculenta-Cyperus spp.* Herbaceous Alliance**
CONCEPT: This vegetation occurs in disturbed wetland areas.
DISTRIBUTION: Puerto Rico.
SYNONYMY: Aroid - sedge Belt -- 73.5 (Dansereau 1966).

***V.D.1.N.b. Cleome spinosa* Herbaceous Alliance**
CONCEPT: Disturbed areas.
DISTRIBUTION: Puerto Rico.
SYNONYMY: Spider-flower Flat -- 41.7 (Dansereau 1966).

Appendix Two
Caribbean Vegetation Classification
References

Reference list organized by country/island

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PUERTO RICO AND THE VIRGIN ISLANDS

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Appendix Three
Members of the Caribbean Vegetation Ecology Working Group

Alberto Areces-Mallea Institute of Systematic Botany **The New York Botanical Garden** Bronx, NY 10458-5126 (718) 817-8677 (718) 562-6780 fax aareces@nybg.org	Dayle Barry Coordinator Virgin Islands Conservation Data Center Eastern Caribbean Center University of the Virgin Islands No. 2 John Brewers Bay St. Thomas, USVI 00802 (340) 693-1030 (340) 693-1025 fax dbarry@uvi.edu
Luis D. Beltrán Burgos **Environmental Planner** Puerto Rico Natural Heritage Division Department of Natural and Environmental Resources P.O. Box 9066600 Puerta de Tierra Station San Juan, PR 00906-6600 (787) 724-8774 x2231 (787) 725-9526 fax dpn@caribe.net	Tim Boucher Landscape Ecology Assistant Conservation Science/LACR **The Nature Conservancy** 4245 N. Fairfax Dr., Suite 100 Arlington, VA 22203-1606 (703) 841-4117 (703) 841-2722 fax tboucher@tnc.org
Gary Breckon Biology Department University of Puerto Rico-Mayaguez MAPR Herbarium Biology Dept. P.O. Box 9012 RUM-UPR Mayaguez, PR 00681 (787) 832-4040 x3646	Olasee Davis University of the Virgin Islands Cooperative Extension Service P.O. Box 10000 Kingshill, St. Croix 00851 U.S. Virgin Islands (340) 778-5335 (340) 692-4085 fax

William Edwards Assistant Director International Institute of Tropical Forestry USDA Forest Service UPR Experimental Station Grounds Botanical Gardens Rio Piedras, PR 00927 (787) 766-5335 (787) 766-6302 fax donnabille@compuserve.com	**Julio C. Figueroa Colón** International Institute of Tropical Forestry USDA Forest Service UPR Experimental Station Grounds Botanical Gardens Rio Piedras, PR 00927 (787) 766-5335 (787) 766-6302 fax /S=J.FIGUEROA/OU1=R12@mhs-fswa.attmail.com
Ethan Freid Miami University Department of Botany Oxford, OH 45056 (513) 529-4200 (513) 529-4243 fax Freide@miamiu.muohio.edu	Elanor Gibney 3759 Round Top Dr. Honolulu, HI 96822 (340) 776-6748
Stevie Henry Virgin Islands Conservation Data Center Eastern Caribbean Center University of the Virgin Islands **No. 2 John Brewers Bay** St. Thomas, USVI 00802 (340) 693-1030 (340) 693-1025 fax shenry@uvi.edu	Richard A. Howard Harvard University Herbaria 22 Divinity Avenue Cambridge, MA 02138 (617) 496-8923
Duane Kolterman Biology Department University of Puerto Rico-Mayaguez MAPR Herbarium Biology Dept. P.O. Box 9012 RUM-UPR Mayaguez, PR 00681 (787) 832-4040 x3646	Xiaojun Li Chief Landscape Ecologist Conservation Science/LACR The Nature Conservancy 4245 N. Fairfax Dr., Suite 100 Arlington, VA 22203-1606 (703) 247-3745 (703) 841-2722 fax xli@tnc.org
Eric Lindsay Department of Planning and Natural Resources 6003 Anna's Hope Christiansed, St. Croix 00820 (340) 773-3450	Kevel Lindsay **Coordinator, Eastern Caribbean Biodiversity Program** Island Resources Foundation P.O. Box 2103 St. John's, Antigua-Barbuda West Indies (268) 460-1740 (268) 463-7740 fax klindsay@irf.org

Carol H. Mayes **Director, U.S. Virgin Islands Program** Caribbean Region The Nature Conservancy 14B Norre Gade, 2nd floor Charlotte Amalie St. St. Thomas, USVI 00802 (340) 774-7633 (340) 774-7736 fax chmayes@islands.vi	**Rudy O'Reilly** Soil Conservationist USDA/Natural Resources Conservation Science 5030 Anchor Way, Suite #2 Gallows Bay Christiansed, VI 00824 (340) 692-9662 (340) 692-9607 fax
Jeff Parrish Director, Site Conservation Program Conservation Science, LACR The Nature Conservancy 4245 N. Fairfax Dr., Suite 100 Arlington, VA 22203-1606 (703) 841-5248 (703) 841-2722 fax jparrish@tnc.org	George Proctor **Smithsonian Institution** 1311 Delaware Ave. SW Apt. S126 Washington, DC 20024 (202) 357-4808 (202) 786-2563 fax
Vicente Quevedo Bonilla Acting Chief, Studies and Data Analysis Secion Puerto Rico Natural Heritage Division Department of Natural and Environmental Resources P.O. Box 9066600 Puerta de Tierra Station San Juan, PR 00906-6600 (787) 724-8774 x2229 (787) 725-9526 fax dpn@caribe.net	Olga Ramos GIS Specialist International Institute of Tropical Forestry USDA Forest Service UPR Experimental Station Grounds Botanical Gardens Rio Piedras, PR 00927 (787) 766-5335 (787) 766-6302 fax iitf_gisgps@upr1.clu.edu
Gary Ray 3759 Round Top Dr. Honolulu, HI 96822 (340) 776-6748	Enrique del Risco Instituto de Investigaciones Forestales Calle d 174 No. 1723 e/17b y 17c Siboney Playa C. Habana Cuba (537) 21-0068

Carlos Rodriguez International Institute of Tropical Forestry USDA Forest Service UPR Experimental Station Grounds Botanical Gardens Rio Piedras, PR 00927 (787) 766-5335 (787) 766-6302 fax cardav@prtc.net	Roger Sayre Director Conservation Science, LACR The Nature Conservancy 4245 N. Fairfax Dr., Suite 100 Arlington, VA 22203-1606 (703) 841-4211 (703) 841-2722 fax rsayre@tnc.org
Susan Solander U.S. Fish & Wildlife Service Carr. 301, Km. 5.1 Bo Crozo Boquerón, PR 00622 (787) 851-7297	Larry Tieszen **Deputy Manager, International Program** USGS/EROS Data Center Mundt Federal Building 47914 252nd St. Sioux Falls, SD 57198 (605) 594-6056 (605) 594-6529 fax tieszen@edcmail.cr.usgs.gov
Alan S. Weakley Regional Ecologist The Nature Conservancy Southeast Regional Office 101 Conner Drive, Suite 302 Chapel Hill, NC 27514 (919) 967-5493 x128 (919) 967-1575 fax aweakley@tnc.org	

F.2 Environmental assessment for Buck Island Reef National Monument St. Croix, U. S. Virgin Islands: control and management of non-native invasive plants

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(DRAFT)

Environmental Assessment

for

Buck Island Reef National Monument
St. Croix, U. S. Virgin Islands



April 19, 2004 Updated

United States Department of the Interior
National Park Service

Prepared by
Daniel Clark, Supervisory Exotic Plant Specialist
Biological Resources Management Division
Florida/ Caribbean Exotic Plant Management Team

And

Zandy Hillis-Starr, Chief Resource Management
Christiansted NHS/Buck Island Reef NM/Salt River Bay NHP & EP
St. Croix, U. S. Virgin Islands

TABLE OF CONTENTS

I. PURPOSE AND NEED FOR ACTION 3

A. Need for Action 3
B. Background and exotic species present 3
C. Purpose and Need for the Environmental Assessment 10

II. ALTERNATIVES, INCLUDING THE PROPOSED ACTION 11

A. Alternative 1: No Action 11
B. Alternative 2: Phased Control and Management Using Current Staff and Funding 13
C. Alternative 3: The Proposed Action (Preferred Alternative) 14
D. Other Alternatives 17

III. AFFECTED ENVIRONMENT 19

A. Physical Environment 19
B. Vegetation 20
C. Wildlife, Endangered and Threatened 22
D. Human and Cultural Resources 23
E. Social Environment 23

IV. ENVIRONMENTAL CONSEQUENCES 24

A. Alternative 1: No Action 24
B. Alternative 2: Phased Control and Management Using Current Staff and Funding 25
C. Alternative 3: Proposed and Preferred Action 26

V. COMPLIANCE WITH ENVIRONMENTAL LAWS AND REGULATIONS 29

VI. CONSULTATION AND COORDINATION WITH OTHERS 30

VII. PLANNING TEAM / PREPARERS 31

VIII. BIBLIOGRAPHY 31

IX. APPENDIX 34

I. PURPOSE AND NEED FOR ACTION

A. Need for Action

Invasive non-native plant species' populations are expanding on Buck Island (the 176-acre terrestrial portion of the Buck Island Reef National Monument (BUIS)), and have the potential to greatly threaten the ecological integrity of the native flora and associated fauna. A recent park island-wide vascular plant inventory documented 8 previously undocumented non-native plants (Ray, 2002 unpublished; Woodbury & Little, 1976). To meet the management objective "to maintain the highest possible habitat quality for the park's endangered and rare species" the park must take action to control and eradicate non-native invasive plant species (BUIS General Management Plan, 1983, pp31). Of primary concern are impacts to native plant species directly and indirectly supporting endangered species currently utilizing the island such as the nesting hawksbill sea turtle (*Eretmochelys imbricata*) and the brown pelican (*Pelecanus occidentalis*), as well as the re-introduction of the endangered St. Croix ground lizard *(Ameiva polops)* not currently on Buck Island. To assure compliance with the U. S. Fish & Wildlife Service's Endangered Species Recovery Plan for the St. Croix Ground Lizard, invasive non-native plants must be controlled and populations properly managed on Buck Island prior to the re-introduction to improve this lizard's home range and ultimately their chances of survival in the Virgin Islands.

B. Background and exotic species present

Invasive species (plant and animal) are costing the world billions of dollars. In the United States alone, annual environmental damage and losses attributed to invasive species have been estimated at more than $138 billion (Pimentel et al. 2000). Pest plants in the continental U. S. include an estimated 5,000 introduced species (versus 17,000 native species) that have escaped and now maintain themselves in natural areas (Morse et al. 1995). In Florida, an estimated 900 species out of 25,000 species introduced have become established in natural areas (Frank and McCoy 1995, Frank et al. 1997, Simberloff et al. 1997). This is about 23 percent of the total flora (over 4,000 taxa) of ferns, fern allies, and seed plants native to or naturalized in Florida (Wunderlin 1998). The commercial importance of many agricultural introductions further complicates the issue (Stocker, 2001). For those introduced invasive species for which records exist, approximately 90% were introduced deliberately (Gordon and Thomas1997), and many of those were brought in for crop production and horticultural use.

Invasive non-native plant species displace native plant species (Callaway and Aschehoug 2000, Morse et al. 1995), alter species proportions (Callaway and Aschehoug 2000, Gould and Gorchov 2000), alter nutrient (Evans et al. 2001, Mack et al. 2001, Scott et al. 2001) and fire patterns, modify geomorphology, hydrology, and biogeochemistry (Gordon 1998), and reduce recreational use of resources (OTA 1993). Florida spends about 20 million per year to control a small proportion of the total invasive non-native plant species in natural areas.

On a lesser geographic scale, similar impacts are occurring in the Virgin Islands. The three islands of the U.S. Virgin Islands (St. Croix, St. Thomas, and St. John; 34,447 hectares total) are dominated by mountainous terrain and surrounded by coastal lowlands (Lewis 1989). On the

island of St. John, eleven vegetation types have been mapped, including mangroves, salt flats, pasture, upland moist forest, gallery moist forest, basin moist forest, dry evergreen forest, dry thicket and scrub, thorn and cactus, disturbed vegetation, and rock and coastal hedge (Acevedo-Rodriguez 1996). About 63% of the island is in the dry evergreen forest category and 17% in the combined moist forest category. The upland moist forest contains some virgin stands with minimal invasive non-native plant species impacts (Virgin Islands National Park 2001).

Similar historically to other Caribbean islands, European settlement patterns and plantation systems significantly altered the biology and ecology of the Virgin Islands by removing native forests, building structures, terraces, rock walls and roads, and importing vegetation and mammals. The National Park Service Organic Act (16 U.S.C. 1 et seq [1988], August 25, 1916, sc. 408, 39 Stat. 535) mandates the parks to "conserve the scenery and the natural and historic objects and the wildlife therein... {to} leave them unimpaired for the enjoyment of future generations." The Act authorizes the parks to eradicate exotic and invasive species. Many of the species introduced to the Virgin Islands are recognized as having "negative impacts on our indigenous species of plants and animals, however, these impacts have never been quantified. Quantification would enable NPS to realistically prioritize species in terms of threats and guide us in the development of management measures to address the threats" (Virgin Islands National Park 2001). Three U. S. federally listed endangered plant species occur in the Virgin Islands, but it is not known to what extent these species are impacted by invasive non-native species. The Government of the Virgin Islands has listed an additional forty-eight endangered plants species (Gibney et al. 1991). While invasive non-native plants have been recognized as a major impact to threatened and endangered plants (Ludlow 1995) and wildlife (Gaudet and Keddy 1988), nothing has been reported in the scientific literature on impacts in the Virgin Islands.

Many exotic plants in the Virgin Islands are and will remain benign in natural areas however, very little is known about what effect non-native plants exhibiting invasive characteristics have on native biological systems. Some non-native plants spread apparently slowly or not at all in what ecologists call a "lag phase" of growth. After this phase, some critical number of individuals may be reached or specific environmental condition potentially met to make the populations of non-native plants spread at exponential rates. Over the last 15 years, park staff have made antidotal observations on the frequency and impact of fires in coastal and uplands fields dominated by Guinea grass (*Urochloa maximum*) on the main island of St. Croix. Fire is not naturally part of the island ecology and during the dry season monotypic fields of Guinea grass burned from shoreline to ridgeline. These fires threaten wildlife, livestock, and structures and prevent the re-colonization of non-fire adapted native plant species.

Buck Island is primarily a tropical dry forest rising to 100 meters in elevation and is comprised of four distinct plant community types including scrub thicket, semi-deciduous dry woodland, mangroves, and a beach forest (Ray 2002 unpublished). Historic documentation states the island was originally covered by the tropical hard wood species lignum vitae (*Guaiacum officinale*), which was harvested in the late 1700s. During the nineteenth and twentieth centuries, several non-native plants and trees used for domestic purposes were introduced including African Guinea grass *(U. maximum),* tan-tan *(Leucaena leucocephala),* tamarind *(Tamarindus indica),* aloe *(Aloe vera),* and penguin (*Bromelia penguin*, a spiny bromeliad used to keep goats out of gardens), the island was grazed by goats and burned to improve forage, and severe changes in

annual rainfall coupled with exotic animal pest predation on fruits and seeds have impacted native plant survival. The park has been working on exotic pest control and native plant re-introduction since the 1960s and completed an island-wide mongoose/rat eradication project in 2000. The re-introduction of a highly endangered anole; the St. Croix ground lizard (*Ameiva polops*) is planned for 2005-2006.

Nineteen out of the 228 plant species are not native to Buck Island Reef NM (Woodbury and Little, 1976) (Survey by G. Ray, December 2002, unpublished). Six invasive non-native species on Buck Island are of immediate concern:

- *Urochloa maxima* (Guinea grass)
- *Leucaena leucocephala* (tan-tan, wild tamarind)
- *Tecoma stans* (cedar Thomas)
- *Bromelia penguin* (wild pineapple, penguin)
- *Boerhavia erecta* (boerhavia)
- *Aloe vera* (aloe)

Three species of exotics present and known to exhibit invasive characteristics in the region are:

- *Melicoccus bijugatus* (genip)
- *Thespesia populnea* (haiti-haiti, seaside maho)
- *Morinda citrifolia* (painkiller, noni)

One non-native plant species with historical consideration expanding its population on the island is *Tamarindus indica* (Tamarind tree). Current management goals are to preserve in place (no treatment or removal) several old, historic individuals on the north and west sides of Buck Island. Young trees and seedlings, mostly located in a drainage gut on the north shore of the island, would be controlled and populations managed as described in this document if approved.

Of the nineteen exotic species found on BUIS, the ten listed above have exhibited invasive characteristics throughout their ranges in the southeastern U.S. and the Caribbean. Their potential to disrupt the natural processes of Buck Island's tropical dry forest is high.

The following description of these species distribution on Buck Island is excerpt from Ray 2000 unpublished "Inventory of Vascular Plants on Buck Island Reef" – it provides some insight into the target species threat to the island plant ecology.

> "We assessed in detail the distribution of the non-native flora. Some of these plant species are recent introductions in adventitive (early) stages of invasion while others have longer histories dating to earlier human settlement. Not all of these species represent a serious threat to the stability of diverse native plant communities. A few that might present such a risk should receive urgent attention by land managers, whether the goal should be population growth containment, reduction, or complete eradication.
>
> Ginger thomas (*Tecoma stans*), a fast-growing shrub *not* recorded by Woodbury and Little in the 1970's, likely dispersed downwind in recent decades from St. Croix's east end. Presently, it occupies 8 of 34 mapping units, mostly on the south-facing slopes of the island's windward eastern flanks. Although its distribution is somewhat restricted at this

time, this species is likely to spread rapidly throughout the island in the coming decades. It grows in extremely high densities in some locations. Over the longer term, such "opportunists" are typically out-competed in species-rich native communities. However, in the wake of long periods of over-grazing and rat infestation, the present sparseness of the Buck Island canopy and its short stature offer this shade-intolerant species a relatively open niche.

By contrast, the population of Tan-tan (*Leucaena leucocephala*), despite its high levels of dispersion (present in 56% of the mapping grids), is represented by few saplings and seedlings and its standing population is likely to decline on its own in coming years. Like Ginger Thomas it is a prolific seed producer, but its thick seed coat and impressive longevity in the soil seed bank confers an added dimension to Tan-tan as an invasive threat. Any natural or anthropogenic disturbance that opens the canopy invites the spread of this species.

Wild pineapple (*Bromelia pinguin*) and Aloe (*Aloe vera*) were planted by some of Buck Island's earlier residents above the west beach (cell 2) for ornament, medicine or livestock management purposes. These plants are relatively slow spreading by virtue of the lack of seed set (by *Aloe vera*) and the dominance of proliferation by stolons rather than by sexual means. Despite the casual pace of dispersion, both species pose some threat to natural communities, as there seems to be little resistance to their advance on the part of their native competitors. Rather easily, *A. vera* may be completely eradicated by uprooting and bagging of individuals. Wild pineapple is well armed but has shallow fibrous roots. Removal of seed heads will slow its spread. Overturning it in the field during the dry season may be an alternative means of control if resources are unavailable for removing all bagged individuals from the island.

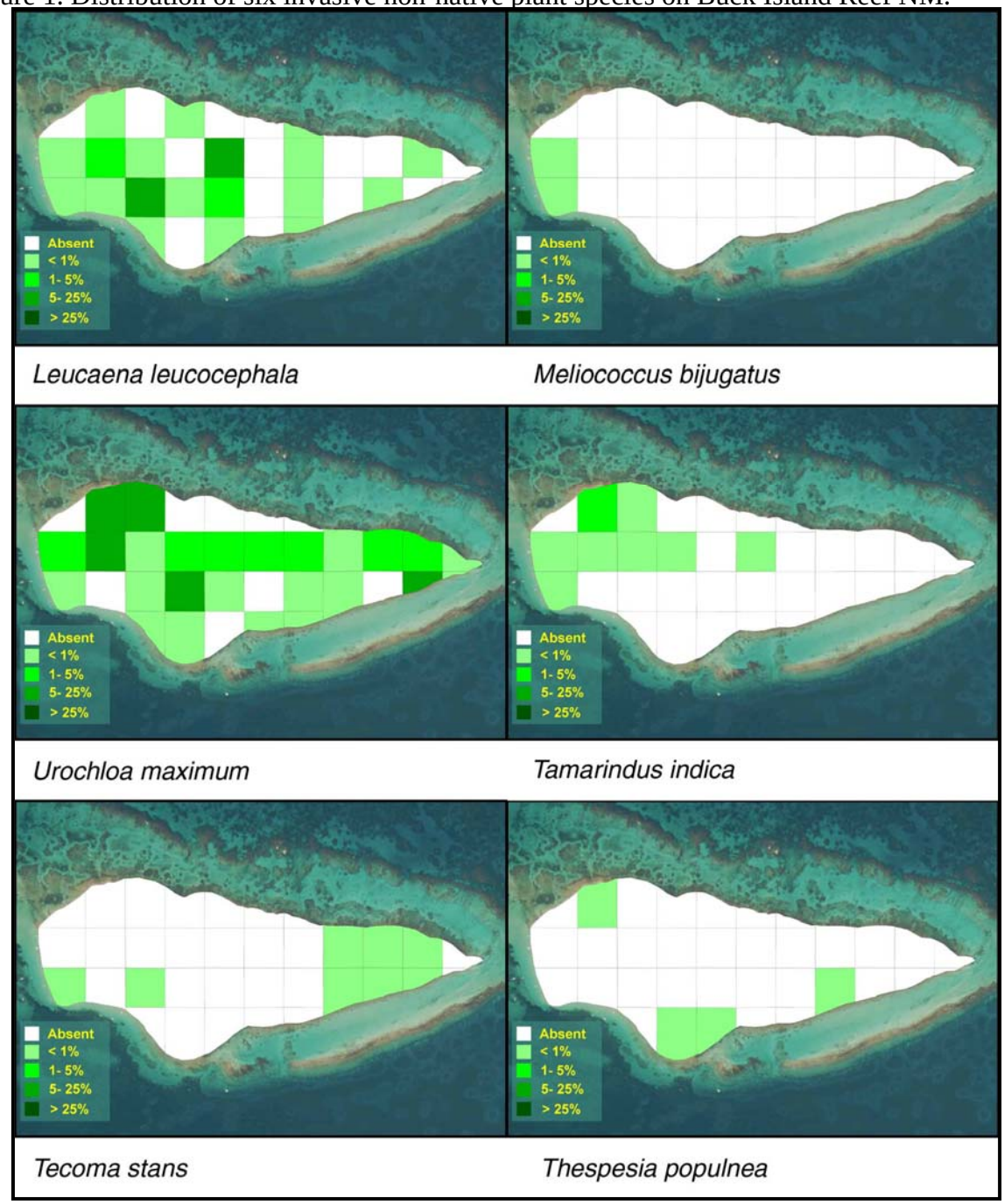
Prior to European contact, biogeographers believe aboriginal settlers from South America introduced the Genip (*Melicoccus bijugatus)* to the Virgin Islands. It is dispersed short distances by bats and pigeons, and greater distances by humans eating the fruit and throwing the seed out along the roadsides. The Buck Island population is small and concentrated in the vicinity of the west beach picnic area (cells 2 & 3), and is likely therefore to have been established by island visitors or previous residents. Eradication should not present a problem.

Tamarind (*Tamarindus indica*) is distributed in about 25% of the mapping cells – all in the western and central zones of the island. While their historic significance as survey-marker specimens of the 17th and 18th centuries activities on the island may present a management quandary for park officials, their great size and capacity to dominate locally are serious ecological concerns for the island's vegetation as a whole.

An occasional arrival on beachheads throughout the region, Painkiller (Morinda citrifolia) was introduced to the Virgin Islands during the plantation era. It becomes prolific in basin environments near the coast, but only sparsely escapes into dry scrub areas.

At least five species of grasses have invaded various natural communities on the island. Guinea grass (*Urochloa maxima*) is found throughout the island and its removal would pose a challenge to managers – although it is large and easy to locate."

Figure 1. Distribution of six invasive non-native plant species on Buck Island Reef NM.



Management and control of these invasive non-native plant species on Buck Island Reef NM is outlined in the Methodology description under Alternative 3.

The remaining ten non-native species are in low population densities and/or their invasive

potential has not been well documented to date. Park staff and visiting scientists will continue to monitor their status on Buck Island. These species include *Agave missionum* (century plant), which is probably not native to St. Croix or Buck Island but native to St. Thomas and St. John and the British Virgin Islands. *A. missionum* is currently being attacked by the introduced exotic sisal weevil *(Scyphophorus acupunctatus)*. Progeny/propagules of intact individuals on Buck Island may act as transplant material to areas affected by the weevil in the future. The remaining eight species: *Cocos nucifera* (coconut), *Abrus precatorius* (jumbie bead, crab's eye), *Bothriochloa pertusa* (hurricane grass), *Chloris barbata* (finger grass), *Cleome viscosa* (cleome), *Dactyloctenium aegyptium* (Egypt grass), *Mollugo nudicaulis* (mollugo), *Panicum chapmani* (Chapman's grass) will continue to be monitored and managed as need arises.

National Park Service-wide Non-native Plant Control Strategy

To effectively combat non-native plant species, the National Park Service's Biological Resources Management Division (BRMD) established the Exotic Plant Management Teams (EPMT) in 2000. The EPMTs are modeled after the coordinated rapid response approach used in the United States for wild land fire fighting. The first test of the EPMT concept was conducted in 1997 at Lake Mead National Recreation Area in Nevada and Arizona. The successes of that EPMT lead to the establishment of additional EPMTs funded by the Natural Resource Challenge Program. EPMTs are part of the long-term control of invasive plants set by the Natural Resource Challenge and contribute to individual park goals by, "containing exotic plant disturbances" (U.S. Department of Interior, 2003). They also satisfy the need for implementation of Executive Order 13112 on invasive species (February 3,1999). The success of the EPMTs is based on the team's ability to adapt to local conditions and needs. Each team employs the expertise of local citizens and the capabilities of local agencies. Each EPMT sets its own work priorities based on the severity of the threat to high quality natural areas and rare species, the extent of a target infestation, the probability of successful control and potential for restoration, the opportunities for public involvement, and the park's commitment to follow-up monitoring and treatment. Thus, each EPMT provides a highly trained, mobile strike force of invasive plant management specialists to assist NPS units with limited resources and expertise in the control of invasive exotic plants.

In 2003, the National Park Service's Florida Partnership Exotic Plant Management Team was expanded to include the Caribbean park units following the geographic boundaries of the NPS South Florida and Caribbean Inventory and Monitoring Network. The Caribbean extension of the team (Now collectively called the NPS Florida/Caribbean EPMT) operates from the same organization and budget as the original Florida team, which was founded in 1999. A NPS staff liaison in Florida and one in the U.S. Virgin Islands coordinates with staff of area National Parks and expert local citizenry to organize and prioritize invasive exotic plant removal projects in the parks. Contracted labor is utilized to conduct the work on the ground and the liaison supervises the contractor by acting as a Contracting Officer Technical Representative in the field to provide technical expertise in the exercising of the work contract.

In fiscal year 2001, Buck Island Reef NM received a base increase from the National Natural Resource Challenge enabling the park to hire two full time biological science technicians to carry out monitoring and control for endangered and non-native species. This staff increase has

enabled the park to maintain monitoring for introduced pests including tree rats (*Rattus rattus*) post-eradication and would provide the field support for the non-native invasive plant project as well as continuous plant monitoring and control. In the spring of 2003, Buck Island Reef National Monument Division of Resource Management competed for and was successful in attaining $25,000 of NPS Natural Resources Preservation Project funding to begin an invasive non-native plant control and management program on Buck Island. Coordination among Monument staff and staff of the Florida/ Caribbean EPMT led to the formulation of a project which received an additional $25,000 of funding from the Florida/Caribbean EPMT (for a total of $50,000) in August 2003. This document outlines the project as the preferred alternative.

The goals of control and management of invasive non-native plants on Buck Island are:

1. Initially treat and subsequently manage the populations of ten species of invasive non-native plants found on Buck Island.
2. Improve island-wide conditions for native flora and fauna including nesting habitat for endangered sea turtles, endangered brown pelicans, threatened least terns, and a locally rare cactus *Mamilliaria nivosa*
3. Ensure the survival of reintroduced lignum vitae trees and restoration of historic landscape.
4. Provide safe and suitable habitat for re-introduction of St. Croix Ground Lizard (*Ameiva polops*).
5. Increase the awareness of the public and territorial conservation agencies to potential threats from non-native plant species and environmentally sound management practices.

C. Project Scoping and Public Outreach

In preparation for this project several other federal and territorial agencies were contacted to discuss the project and alternatives. An agency scoping was conducted with U. S. Fish & Wildlife Service biologists and Government of the Virgin Islands Department of Planning and Natural Resources. Biologists discussed planned control of the target invasive non-native plant species and change, both short-term and long-term to the terrestrial community. Neither USFWS nor VIDPNR had any concerns for species discussed which included several bird species and nesting sea turtles. USFWS Sandy Point NWR is currently undertaking the control of non-native plants on their offshore cay, Green Cay NWR, located south of Buck Island Reef NM off the north coast of St. Croix, U.S. Virgin Islands to specifically improve endangered St. Croix Ground Lizard habitat. U. S. Department of Agriculture Natural Resource Conservation Center botanist was unable to attend the meeting due to a schedule conflict however he provided comment verbally and concurred with control of non-native target species and looks forward to working with the park on the monitoring post-control.

A Public Service Announcement was prepared and several territorial and federal conservation agencies (NPS, USFWS, VIDPNR – Division of Fish & Wildlife, USDA, VI Department of Agriculture, university (University of the Virgin Islands Cooperative Extension Service), non-governmental agencies (St. Croix Environmental Association, St. George's Botantical Garden), and media (St. Croix Avis, Daily News, St. Croix Source) were invited to a field trip to see the invasive non-native plant situation at Buck Island Reef NM and see a demonstration of the

proposed control methods. Over 20 persons attended the half-day trip. NPS Exotic Plant Specialist and NPS BUIS Resource Management Chief provided an overview of the project, goals for the project, chosen control alternative, and a demonstration of the herbicide application and effect. The field trip resulted in a number of good observations and input from the conservation community into the project and their was general agreement that it should be possible to control the six primary target species eventually provided the NPS remain committed to the project and continue control efforts. VI Department of Agriculture and the local botantical garden both thought that NPS should undertake some restoration work along with the control effort. The media documented the entire field trip. Our project message was broadcast on local radio, television, and in all newspapers and the on-line paper. Public reaction was good overall; the only negative reaction was from one person who called his local Senator to worried about "loosing his guinea grass that he needed to feed his goats". He did not understand that the project was only being undertaken on Buck Island Reef NM. After a discussion between RM Chief and the Senator's office the confusion was cleared up and no further problem was raised.

In addition three public scoping meeting were held at three locations on St. Croix to provide information to the public on invasive non-native plant threat, NPS exotic plant control program, the project design for Buck Island Reef NM and hear the public's thoughts and comments. Attendance was minimal however a nursery owner attended the afternoon meeting held at the historic site; they were interested in if they could provide NPS with native plants for restoration after the treatment. A landscaper was interested in how they could better utilize native plant species in landscaping and how to "sell" the use of these species to residents and hotels. A university researcher was interested in participating the follow-up monitoring after the project was completed. Two additional meetings were held one mid-island and another east end. Only one person attended the east end meeting and was a long –time visitor to Buck Island Reef; they just wanted to make sure that nothing about the project would affect the coral reef or their picnicking / boating activities at the park. University researchers and a nursery owner, attended the third and final meeting; their concern was whether or not the park should consider restoration post-control. There again was some discussion about whether or not the park should have cedar Thomas on the list of non-native invasive species to control because some consider it to be pan-tropical. In both cases the park feels 1) that there is enough of a mosaic of native plant species living side-by-side with the target non-natives that given the room to grow will fill in the void created by the controlled non-natives and 2) cedar Thomas may or may not be native but on Buck Island Reef NM it is invasive and growing in areas to the exclusion of native species. Especially since its current distribution is concentrated on the south side of the island it would be best to control it now before it continues to spread to the north side and into the brown pelican rookery. Overall the public had no complaint with the control of the invasive non-native plants on Buck Island Reef NM.

D. Purpose and Need for the Environmental Assessment

The purpose of this document is to evaluate the short- and long-term environmental consequences of controlling and managing the non-native invasive plant species populations within the Buck Island Reef National Monument, St. Croix, Virgin Islands, a unit of the National Park System, United States Department of the Interior.

National Park Service (NPS) guidelines for compliance with the National Environmental Policy Act (NEPA) require an analysis of potential impacts from the proposed activity on the effected environment. This environmental assessment reviews those potential impacts and the actions that will be taken to prevent any and all environmental damage from the proposed non-native invasive plant control and management project.

II. ALTERNATIVES, INCLUDING THE PROPOSED ACTION

This section describes the alternatives that were analyzed in this environmental assessment. The alternatives are (a) no action, (b) phased control and management of selected invasive non-native plant species using current staff and funding; (c) the proposed action – rapid initial control of selected invasive non-native plant species in cooperation with the Florida/Caribbean EPMT, and subsequent management of those populations at acceptable levels; (d) other alternatives.

A. Alternative 1: No Action

This "No Action" alternative implies that current levels of invasive non-native control and management would continue. Currently, neither control nor management of the ten non-native invasive plant species is being conducted on Buck Island. However a non-native coastal species, *Scaevola sericea*, which is used for landscape planting along the north shore of St. Croix is currently being managed by removal when discovered by park staff. *S. sericea* is similar to the native coastal species *Scaevola plumieri* (half flower or inkberry) which is critical to holding sand berm during high storm surge. Coconut palm *Cocos nucifera*, which local residence repeatedly reintroduce to the Buck Island is also removed if discovered by staff. These two coastal species occur in low numbers and can be hand-pulled or dug out as they occur by existing staff. An inventory of the vascular plants of Buck Island conducted in 2002 by Ray described eight non-native species not previously detected by Woodbury and Little in their 1976 flora survey of the island. Personal communication with local experts also indicates that some of the populations of these plants are expanding without the benefit of anthropogenic means. Based on these accounts, it is expected that the invasive non-native plants currently found on Buck Island would continue to expand in population size under the "No Action" alternative and may affect native flora and associated fauna. The detrimental affect of invasive non-native plants would continue and the island's ecological and physical function could be permanently altered. The invasive non-native plants would continue to expand in population size and be part of the island's terrestrial ecosystem. Examples of this potential continued spread of nonnative plant populations on Buck Island include the *L. leucocephala* along the hiking trail near the Coast Guard tower, the *T. stans* and *U. maxima* on the south slopes, and the *B. pinguin* and *A. vera* on the west end.



Figure 2., Buck Island South Slope *T. stans* and *U. maxima* above lagoon; *U. maxima* stand.

Storms and human disturbance, such as trail maintenance, have the ability to create suitable habitat and substrate for nonnative invasive plants such as *L. leucocephala* to establish and spread. Once established and left unmanaged, this species could continue spread outward from trails into less disturbed native habitats and compete with desirable native flora such as the pipe organ cactus *(Pilosocereus royenii)*, and Frangipani *(Plumeria alba)*. Buck Island's southern slopes are sculpted by the prevailing trade winds and exposure to storms. The habitats there are typically dominated by very low-growing scrubby plant species such as Turk's cap cactus *(Melocactus intortus)* and *Tournefortia microphylla*. The continued spread and formation of monotypic stands of *T. stans* and *U. maxima* has the potential to reduce floral and faunal diversity through competition. This competition may be direct such as covering or shading native species, or from the divergence of critical resources such as water. Germination of native



Figure 3. *L. Leucocephala* crowding out native cactus and *T. indica* shading water mampoo tree

plants, such as the water mampoo *(Pisonia subcordata),* required for nesting and roosting of the endangered brown pelican, may be inhibited through competition with these two invasive non-native plant species.

Finally, the clonal clumps of *B. pinguin* and *A. vera* located on the west end of Buck Island are situated amongst historical ruins and near the proposed location of the St. Croix ground lizard reintroduction. The continued spread of these two species could impact shallow artifacts and historic structures such as rock walls. The preferred habitat of the ground lizard, which is comprised of mixed leaf litter and mottled sunlight created by a variety of shrubby native tree



Figure 4. EPMT So/FL Caribbean Coordinator in A. vera clump and *B.. pinguin* stand above Buck Island's West Beach

and shrub over story could be easily impacted by the displacement of native plant species by these two invasive nonnative plant species. Although suitable habitat for the ground lizard currently exists on Buck Island near these invaded sites, the potential for the spread of the ground lizard after reintroduction and establishment may be reduced due to the invasive nonnative plant's presence and spread.

B. Alternative 2: Phased Control and Management Using Current Staff and Funding

Under this alternative, the National Park Service would initiate invasive non-native plant control and management work on selected high priority species [such as *Urochloa maxima* (Guinea grass) and *Leucaena leucocephala* (tan-tan, wild tamarind)] using current staff with approved techniques and park funding. This would involve use of EPA registered and NPS approved herbicides to treat plants in key areas of plant infestations as staff time and the Monument's Resource Management Division budget permits based on current workload. Staff would be required to receive basic training on herbicide application safety, the Monument infrastructure would be required to be modified to safely store the appropriate chemicals, and various materials and supplies would need to be purchased (such as compression sprayers, herbicides and adjuvants, and personal protective equipment) to conduct the work. Control work would be

coordinated with the Florida/Caribbean EPMT but conducted by park staff. Staff would prioritize plant species targeted and schedule visits to Buck Island for treatment. Perpetual management of the invasive non-native plant populations initially treated is essential to the success of the control effort. Periodic Monument staff visits to Buck Island would be utilized to determine when re-treatment of plants is required. These site visits and subsequent re-treatments would be dependent on staff time and Monument funding availability.

Due to the limited budget and staff currently employed by the Monument and the staff pre-existing workload monitoring the newly expanded park submerged lands (18,135 acres of submerged lands were added to the Monument in 2001 with no additional base funding or staff increase) endangered and threatened species (four species of sea turtle, two species of birds), and the coral reef / fisheries, it is unlikely that all of the priority plant populations could be treated island-wide. Since the biological characteristics establishing a plant as "invasive" or "weedy" include features such as high seed production, adaptability to a variety of physical conditions and high reproductive viability, it is expected that the targeted plants would increase in population size and density after initial treatment at a rate in excess of the staff's ability to maintain the populations at an acceptable level. This method may only provide temporary and sporadic control of a portion of the invasive non-native plants identified, and not meet the needs of the park resource management goals.

C. Alternative 3: The Proposed Action (Preferred Alternative)

Initial Rapid Control of Selected Invasive Non-native Plant Species in Cooperation with the Florida/Caribbean EPMT, and Subsequent Management of Those Populations at Acceptable Levels

The proposed action includes the utilization of an existing NPS contracted company to initially treat invasive non-native plants on Buck Island with an NPS Contracting Officer's Technical Representative in the field. Current levels of non-native plant infestation at Buck Island vary among species (Figure 1), with *Leucaena leucocephala*, wild tamarind or tan-tan, being the most widespread, including some monocultures. As a pro-active management action, an island-wide initial treatment of these and the additional eight invasive non-native plants described below in the Methodology section is proposed on Buck Island Reef National Monument, St. Croix, U. S. Virgin Islands.

The Florida/Caribbean EPMT has successfully used contracted labor on numerous NPS projects since 1999. Initial use of contract labor to treat the bulk of the invasive plants has been shown to reduce the overall cost of similar projects significantly in South Florida by reducing NPS staff time as well as the purchase of materials and supplies. Contracted companies employed by the Florida/Caribbean EPMT utilize the accepted, industry standard methodologies approved by the NPS and come with technical experience, training and certifications required for safe handling of the materials and supplies, as well as the supervision and administration critical to the project success. A detailed discussion of proposed herbicides is provided under the Environmental Consequences section of this document.

This initial control project has been funded through the NPS Natural Resource Preservation

Program and Florida/Caribbean EPMT for $50,000 and is expected to begin in 2004. Subsequent re-treatments are expected and should be accomplished in FY 2005 and 2006.

Methodology:

1. Utilizing the existing island-wide grid system (40 m x 40 m) established by the park for the tree rat eradication project (1999) and the existing trail system, the island would be systematically treated along the grid.

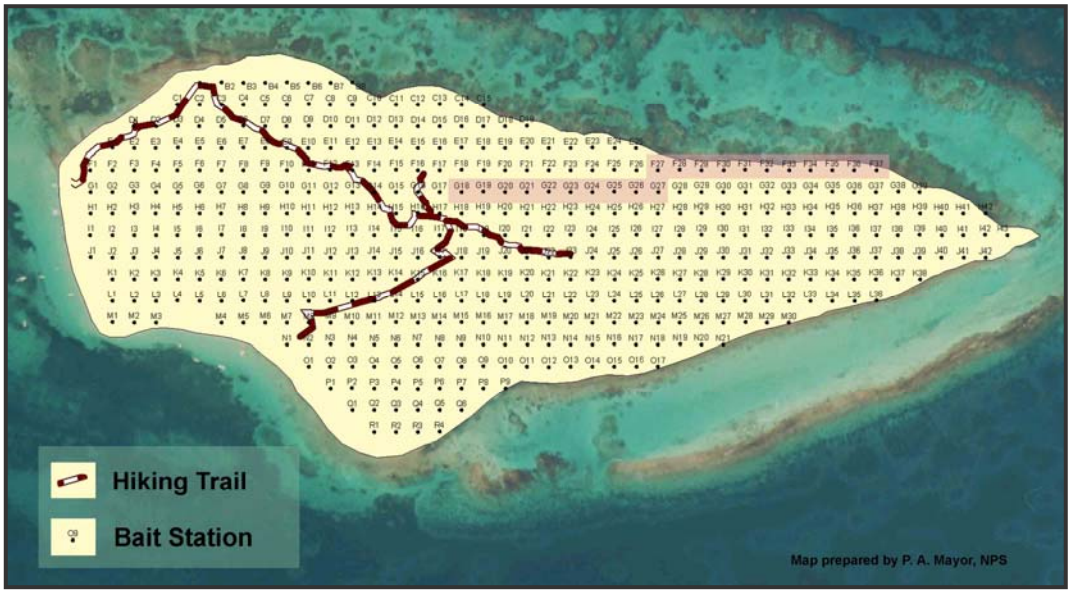


Figure 5. Island wide Rat Eradication Project Grid System (pink highlighted area where slope too steep for bait boxes and bait thrown into area), Buck Island Reef NM, 1999.

2. Re-dividing the island-wide grid system into thirty-four 160 x 160-meter plots all targeted non-native plants in one treatment grid would be removed and/or chemically treated before proceeding to the next grid.

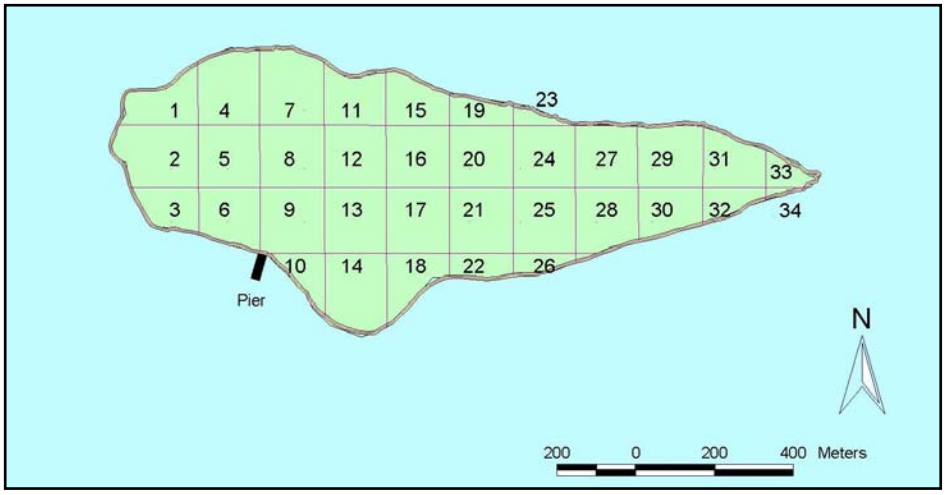


Figure 6. Island-wide Vascular Plant Inventory Grid, Buck Island Reef NM, Ray 2002.

3. To document the extent and location of several historically introduced non-native target species the COTR would be documenting the location and distribution using GPS tracking system. For example the wild pineapple found associated with historic ruins will be documented by GPS and photographed. Tamarind trees also associated with the historic homesite would be documented, treated, and cut down to protect the structures. Genip, a recent introduction to the beach area of the island, would be documented and treated.

4. The ten target species would be controlled by basal treatment or foliar application of herbicide. Method of treatment will vary according to targeted species but shall follow the guidelines listed and be in accordance with NPS Exotic Plant Management Program guidelines. Every effort shall be made to minimize non-target species damage during herbicide application and crew transit over the island. Crew will be working on foot traveling primarily along the one existing hiking trail and off trail along the former-rat eradication project bait/trap lines. No native vegetation will have to be cleared or removed to access and apply herbicides to target species. All herbicides and rates of usage would have prior approval from NPS Florida/Caribbean EPMT and Buck Island Reef National Monument Division of Resource Management. A detailed discussion of a soil erosion experiment associated with this project is provided under the Environmental Consequences section of this document.

- Grasses (*Urochloa maxima*) and Boerhavia (*Boerhavia erecta*): Foliarly spray to wet using compression or backpack sprayer with Glyphosate in water solution at a rate of 3%.

- Woody vegetation (*Leucaena leucocephala, Tecoma stans, Melicoccus bijugatus, Thespesia populnea, Tamarindus indica* and *Morinda citrifolia*): Basally apply Triclopyr (in vegetable oil carrier) to entire stem(s) circumference above ground (between where the foliage starts and ground) at a rate of 30% (using compression or backpack sprayer). Larger individual *T. indica* associated with historic structural ruins would be carefully cut down to prevent any damage to associated ruins. Wood would be left on the ground to decompose naturally.
- Aloe and wild pineapple (*Aloe vera* and *Bromelia penguin*): Apply Triclopyr (in vegetable oil carrier) at a rate of 30% to apical growth of each plant (using compression or backpack sprayer). The stands of *A. vera* and *B. penguin* occur in association with an area of important historic ruins. Both will be sprayed in place and left to die in-situ. No pulling or removal will be conducted to ensure the preservation of the cultural ruins in the vicinity. Native plants species in low numbers and surrounding these dense stands will re-seed the areas once the aloe and penguin die.

5. Two months following the completion of initial treatments, the contractor would revisit all treatment sites to ascertain that all plants have been removed/treated.

6. After initial treatment, long term monitoring would take place to avoid non-native vegetation from rooting again (by NPS staff).

7. The contractor would obtain treatment location coordinates using Global Positioning System (GPS), and record daily treatment information (number of stems and/or area treated and herbicide solution volume expended) for all treatment sites. Location coordinates would be

recorded in a Universal Transverse Mercator coordinate system and provided to the Resource Management Division for plotting on island-wide map.

8. Completed project would exceed park GPRA goal Ia1B by removing non-native plants from over 50 acres by September 2005.

9. The contractor would be accompanied in the field by the Contracting Officer's Technical Representative to ensure compliance with the contract and assist in technical issues related to the project. The Contracting Officer's Technical Representative would have extensive experience with natural area stewardship and management, protected species management, cultural resources management, and applied research related to tropical and sub-tropical invasive plant ecology, control and management. Academic background would include Master's of Science in Agronomy (with an emphasis on invasion biology). A COTR is currently duty stationed at Virgin Islands NP and could be on sight at Buck Island Reef NM for the duration of the project.

10. Project Treatment Signs would be placed in areas of public visitation nearest the densest stands of invasive non-native plants treated. The signs would inform the public about the on-going project and site conditions related to the control and management of the targeted plants.

If approved this project is anticipated to begin in 2004 and initial treatment is projected at five weeks of fieldwork. Funding encumbered for the project would be entirely used in FY 2004. Long-term success of the project would require follow-up treatments in perpetuity. The NPS Florida/Caribbean EPMT would assist in providing funding for two more phases of initial treatment follow-up in FY 2005 and FY 2006. The ultimate impetus of long-term management of the invasive non-native plants on Buck Island lies with the managing agency, NPS Buck Island Reef National Monument Division of Resource Management. By FY 2006, Buck Island Reef National Monument would attempt to acquire funding, staff training, to purchase and handle appropriate herbicides, materials and supplies and herbicide storage facilities to facilitate perpetual long-term management of invasive non-native plants in cooperation with the Florida/Caribbean EPMT outlined in this document.

D. Alternatives Considered But Dismissed

A number of other alternatives to the proposed action exist. Invasive non-native plants have been effectively and safely controlled and managed in other natural areas including NPS park units using mechanical, physical, cultural, and biological means. Additional chemical techniques also exist such as aerial and vehicle delivered herbicides. These additional alternatives are described below.

1. Mechanical – This method of treatment typically involves the removal of the targeted plant by mechanical means. It is often accomplished by the use of specialized mechanized equipment such as bulldozers or loaders equipped with a root rake, mowers, excavators, or tractors. A wide variety of "non standard" machines have also been successfully employed by land stewards based on local physical conditions and the targeted plant species. This method of treatment is often employed in monotypic stands of targeted plant species, and used in concert with chemical treatment methods when viable plant material remains on the site. This method was not

proposed for Buck Island for the following reasons: (1) Potential for non targeted species damage - native plants survive in a mosaic pattern in relatively close proximity to targeted invasive non-native plants; (2) Unconsolidated substrate – the soils present are loose and low in organic composition. Mechanical treatment could potentially impact or create bare and disturbed soil conditions leading to erosion problems; (3) Physical conditions – the existing trail system and habitats could not support the mechanized equipment required for effective treatment without negative impacts. Historical and pre-historic resources found on Buck Island would be negatively impacted and; (4) Cost/logistics – the logistics and associated cost of transporting to Buck Island Reef, an undeveloped offshore island, and utilizing mechanized equipment sufficient for treatment make this method prohibitive.

2. Physical – This method of treatment employs the application by man of natural processes to control plants. It has been accomplished with varying results using fire and flood. Other processes such as temperature are currently being experimented with in laboratory settings. This method of treatment is often employed to targeted plant species that are not adapted to the treatment in a setting where desirable flora and fauna are adapted to the treatment. Often times, the sites where physical control is attempted are highly disturbed and, the physical control is used in concert with other treatment methods (Integrated Pest Management) when viable plant material remains on the site. This method was not proposed for Buck Island for the following reasons: (1) Adaptation – the existing floral and faunal communities are neither adapted to fire nor flood and would potentially be destroyed; (2) Flooding – site conditions including topography, habitat types and substrate preclude artificial flooding for being a viable alternative; (3) Science-based knowledge – little is truly understood about physical control of invasive non-native plants and local staff experience/expertise is lacking, and; (4) Cost/logistics – the use or experimentation of physical treatment methods would require external experts. Since acceptable control of invasive non-native plants on Buck Island is not likely using only physical treatment methods, other treatment methods would be required to be employed.

3. Cultural – Cultural methods of plant control include the use of methodology often encountered in agricultural settings such as tilling and hoeing. This method was not proposed for Buck Island for the following reasons: (1) Historic use – although limited residential-sized agriculture occurred on Buck Island historically, cultural treatments of plant control would not be consistent with current NPS management goals of the site; (2) Efficacy - Since acceptable control of invasive non-native plants on Buck Island is not likely using only cultural treatment methods, other treatment methods would be required to be employed, and; (3) Cost/logistics – the equipment and manpower required to affect this treatment method preclude its use on Buck Island.

4. Biological – This treatment method uses plant “predators” such as pathogens, fungi, bacteria, and insects to control targeted plants. These predators called “agents” and are often initially encountered and studied in the targeted plant’s native range. Governmental processes associated with biological control are lengthy and include extensive experimentation, quarantine, and specific permission prior to any release. This method of plant control is a relatively new science as compared to the other alternatives mentioned and involves technical specialists in the field. Biological control agents often reduce reproductive fecundity by feeding on seeds and shoots, reduce growth by affecting apical meristems, and inhibit plant vigor through many other means.

Since most of these agents do not completely control targeted plants, land stewards use them in concert with other treatment methods to achieve acceptable control levels of targeted plants. This method was not proposed for Buck Island at this time for the following reasons: (1) Availability – biological control agents are either not yet available/discovered or not yet approved for release for the plant species targeted (Although agents may not be currently known or available, future use of invasive non-native plant biological control methodology may be found suitable for Buck Island); (2) Cost/logistics – agents (if available) would have to be transported live and released at multiple sites on the island, and; (3) Efficacy – agents alone may not control targeted plants at acceptable levels and additional treatment methods would be required.

5. Other Chemical – Many land stewards including those within the NPS have successfully accomplished the application of herbicide for the control of invasive non-native plants using a wide variety of delivery systems. Aerial application using rotary and fixed wing aircraft, and truck/ATV-mounted sprayers are two methods employed with regular frequency and success. These methods of delivering herbicide to targeted plants on Buck Island were not considered as the preferred alternative for the following reasons: (1) Size and composition of infestation – the areas containing invasive non-native plants on Buck Island are found in mosaic patches intermixed with desirable native plants. These patches are of small enough sizes to be more effectively and economically treated by ground crews with compression sprayers; (2) Physical conditions – prevailing trade winds in the area and steep topography are likely to inhibit the efficacy of these chemical delivery methods by having excessive non targeted species damage and targeted species misses; (3) Impacts of vehicles – negative impacts reported in the Mechanical treatment method above could be expected, and; (4) Cost/logistics – the cost of specialized equipment such as aviation and ground vehicles, even under contract, is prohibitive for this proposed project. The logistics involved in staging and operating the equipment described is excessive for the project size.

III. AFFECTED ENVIRONMENT

A. Physical Environment

The location of the proposed action addressed by this Environmental Assessment is Buck Island, the 176-acre terrestrial portion of Buck Island Reef National Monument. The Monument is located six miles east of Christiansted, off the north shore of St. Croix, U.S. Virgin Islands. The National Park Service, U. S. Department of the Interior, administers Buck Island Reef National Monument. The affected area is the 176-acre island including the beaches, shoreline, beach forest, and upland tropical dry forest habitats, as well as, the visitor day use facilities including the picnic areas and hiking trail

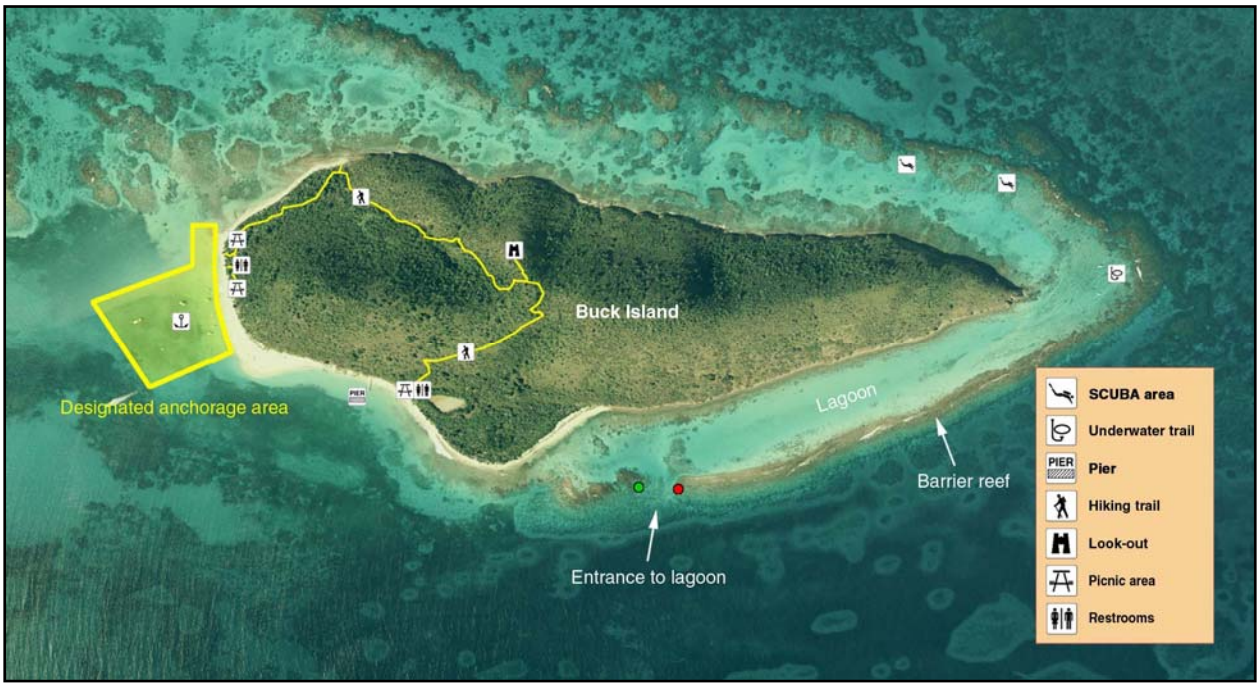


Figure 7. Buck Island Reef National Monument - location of park facilities and hiking trail.

Buck Island is 6000 feet long in an east-west direction, 2200 feet wide at it's widest and rises in a single east-west ridge to an elevation of 340 feet. It covers a land area of about 176 acres, nine tenths of which are slopes steeper than 30 percent. The two low, sandy beaches, one on the west end and the other, Dietrich's Point, on the south, possess recreational value as well as providing habitat for vegetation and wildlife. West Beach, a fine beach of white coral sand, extends for about 1000 feet on the southern side of the western end of the island and changes in shape and size with seasonal sand transport. Landward of West Beach and continuing along part of the north shore lies a fairly level beach forest area of about 10-acres. A small, rain-fed salt pond is located along the south side of the island. Buck Island's remaining two-thirds shoreline is gravelly and rocky and falls steeply into the sea.

B. Vegetation

Buck Island's vegetation is designated as subtropical dry forest, a bioclimatic life zone classification developed by Holdridge (1967). This forest system is similar to other well-preserved natural communities in the northern Virgin Islands (Ray et al. 1998; Ray and Brown 1995). The plant communities associated with dry forests in the Caribbean tropics, as elsewhere, are adapted to frequent drought and high evaporation rates associated with warm temperatures and windy conditions (Ray pers. comm.). Characteristic adaptations of plants in these conditions include deciduousness (leaf loss) small, thickened or pubescent (fuzzy or hairy) evergreen leaves often with recessed stomata (pores) to reduce moisture loss during photosynthesis, low growth habit, and numerous other physiological and anatomical features.

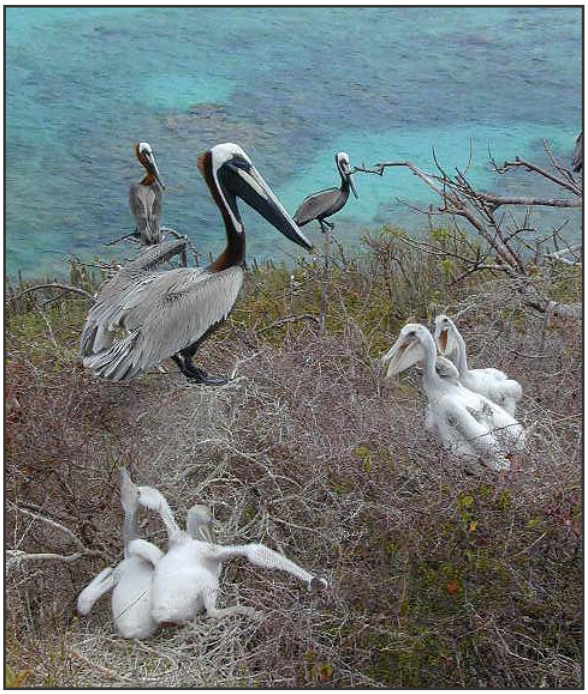


Figure 8. View of salt pond on south side of island from hiking trail. Orchid and Bromelid community on north slope.

In the unpublished Vascular Plant Inventory and Mapping of Buck Island, Ray (2002) describes four distinct plant communities. A scrub thicket (dense shrub land) consisting of shrubs under 2 meters high covers most of the island. A semi-deciduous dry woodland that features a full canopy 4-6 meters tall, but of very limited extent, is restricted to the banks of ravines and some basin areas. A mangrove community (with the red mangrove *Rhizophora mangle* absent) surrounds a small salt pond on the south shore. A beach forest is intermittent on a coastal sandy substrate on the island's west end. It includes a conspicuous manchineel-dominated *(Hippomane mancinella)* association as well as diverse inclusions of other taller trees. Other minor but distinct plant communities include beach strand or dune vegetation, a marsh-saltgrass glade at the perimeter of the salt pond, and a second manchineel community proximal to the mangrove and dune zone on the south shore. Topographic relief and slope aspect on the island produce an array of microhabitats, adding greatly to the plant species diversity (Ray unpublished). The south-facing slopes are drier and more sparsely covered by shrubs and small trees whereas the north slopes are more sheltered and contain higher shrub and tree density (Ray unpublished).

Two rare plant species existing on Buck Island are of note. The endemic *Malpighia infestissima* is a relatively common shrub on Buck Island but extremely rare or potentially absent from St. Croix (one record of collection on St. John in 1906 was made by West however, the species has not been documented since). The exceptionally restricted range of the species and apparent recruitment difficulties make this species suitable for federal listing due to the possibility of extinction. A single clump of wooly nipple cactus *(Mammilaria nivosa)* exists. The species has a broad geographic range but is restricted in habitat to rocky cliffs on shorelines. The species has sparse fruit production and dispersal of viable seed is extremely limited. Few, small clonal aggregations with little genetic diversity comprise the species distribution in the Virgin Islands.





C. Wildlife, Endangered and Threatened

Buck Island Reef's wildlife is composed of numerous birds, lizards, non-native house mouse (*Mus musculus*), various crabs, and nesting sea turtles. Egrets and herons *(Ardea spp.* and *Egretta spp.)* sand pipers *(Calidris spp.)*, stilts *(Himantopus mexicanus*) and Bahama ducks *(Anas bahamensis)* frequent the salt pond behind Diedrich's Point, which is bordered by mangrove and sea grape (*Coccoloba uvifera*). During the early spring pairs of Bahama white-cheeked pintail ducks nest in the shoreline vegetation, around the salt pond, and occasionally in the upland slopes. Overall the island has a mixed bird population including the bananaquit *(Coereba flaveola)*, hummingbirds *(Orthorhyncuc cristatus* and *Eulampis holosericeus)*, seasonal warblers *(Dendroica spp.)*, grassquits *(Tiaris bicolor)*, mangrove cuckoo *(Coccyzus minor)*, white crowned pigeon *(Columba leucocephala)*, ground dove *(Columbina passerine)*, pearly-eyed thrasher *(Margarops fuscatus)*, the Caribbean elaenia *(Elaenia martinica)* and kingfisher *(Ceryle alcyon)*. The northeastern slope of the island is an important rookery for the endangered brown pelican *(Pelecanus occidentalis)*. Twenty to forty individual adults nest there annually between September and February. The cliff site below the rookery is also used by the magnificent frigate bird *(Fregata magnificens)* for roosting. Frigate bird nesting has never been recorded. A colony of twenty to eighty federally threatened least terns *(Sterna antillarum* nest on West Beach annually. The Monument's beaches provide the only nesting site for the least tern in St. Croix protected from vehicular access, uncontrolled visitor activities, and domestic pets. A few raptors have been seen foraging over Buck Island including the red-tailed hawk *(Buteo jamaicensis)*, American kestrel *(Falco sparverius)*, and osprey *(Pandion haliaetus)*. Only rarely have the osprey over-wintered in the Virgin Islands.

A variety of small lizards *(Ameiva spp.)* and anoles (*Anolis spp.*) can be seen in the beach forest vegetation. The more cryptic geckos and lizard species, including *Sphaerodactylus* and

Hemidactylas species**,** can be found hiding under leaf litter or dead wood. Hermit crabs *(Coenobita clypeatus*) are found from the shoreline to the ridgeline. Ghost crabs (*Ocypode quadrata*) remain in their wet sand burrows at or above the high tide line. At least two genera of land crab (*Cardisoma* and *Ucides*) can be found in the low beach forest and higher elevations.

Three endangered species of sea turtle nest on Buck Island including the leatherback turtle (*Dermochelys coriacea*), green turtle (*Chelonia mydas*), and the hawksbill turtle (*Eretmochelys imbricata*). The U.S. Fish and Wildlife Service has identified Buck Island as an index beach for hawksbill sea turtle recovery where on-going research is providing critical information toward species recovery goals in the Caribbean.

The non-native tree or roof rat (*Rattus rattus*) and mongoose (*Herpestes auropunctatus*) have been successfully extirpated from Buck Island. Before eradication, these invasive mammal species severely altered the native flora and fauna, impacted threatened least tern and endangered sea turtle nesting by eating eggs and hatchlings, and regularly disturbed visitor activities in the picnic areas.

D. Human and Cultural Resources

The original inhabitants of these islands, Taino, Arawak, and Carib Indians, probably visited the island but left no lasting sign of their presence. There are conch middens indicating the island may have been used as a pre-historic fish camp. The Spanish, English, Dutch, French, and Knights of Malta all attempted to establish themselves permanently on St. Croix. Denmark held St. Croix the longest, through prosperity and poverty, from 1733 until 1917. Mr. Dietrich's, the Clerk of the Danish Court, owned Buck Island. He had a small farm on the northern side of the island and a small cottage above the beach at West Beach. The Danes also maintained a light tower at the top of the island to warn the main island of approaching ships and potentially to keep ships away from the reef. In 1917, the Danish Islands were purchased by the United States. Buck Island was part of the public, government, or crown lands ceded to the United States. During the 1920's the island was leased for goat grazing and fishermen frequented the surrounding waters. Under the Act of Congress of June 22, 1936, the island was placed under control of the Government of the Virgin Islands with legal title remaining in the United States. The local government recognized recreation value and by ordinance in 1948, established the island as Buck Island Park. An appreciation of the island and the uniqueness of the surrounding coral reef spread. Buck Island Reef National Monument was created by presidential proclamation on December 28, 1961, encompassing the island and its surrounding coral reefs.

E. Social Environment

Buck Island Reef NM is the largest area of its kind on or around St. Croix and fills an important recreational role for the community and island visitor. It is the most visited tourist destination for the island of St. Croix with an annual average of 40,000 to 60,000 visitors. Arrivals are by private boat or park concession vessels. As a public use area, Buck Island Reef NM is exposed to a large and growing number of visitors for the underwater snorkeling and diving experience, sailing and power boating, and hiking and picnicking. The bulk of the park's visitor activity occurs in the two picnic areas adjacent to the beaches. Park concession operations bring visitors

to the island on either half- or full-day charters, which include the boat trip to and from the island, snorkeling at the underwater trail and one to two hour visit on the island. Visitor activities include, swimming off the beach, sunbathing, snorkeling any of the numerous shoreline reefs or at the famous underwater trail, picnicking at one of the two picnic areas on the south side of the island or infrequently hiking the one overland trail (footpath). Barbeque grilling is a favorite past time for the local visitor. Frequently visitors plan entire family gatherings at the park and spend the entire day at the beach cooking lunch and dinner.

IV. ENVIRONMENTAL CONSEQUENCES

A. Alternative 1: No Action

Under the No Action Alternative, it is expected that invasive non-native plant populations would continue to thrive and expand on Buck Island and that associated terrestrial habitat function would continue to decline due to competition for space and available resources.
The detrimental affect of invasive non-native plants would continue and the island's ecological and physical function could be permanently altered. The invasive non-native plants would continue to expand in population size and be part of the island's terrestrial ecosystem. Examples of this potential continued spread of nonnative plant populations on Buck Island include the *L. leucocephala* along the hiking trail near the Coast Guard tower, the *T. stans* and *U. maxima* on the south slopes, and the *B. pinguin* and *A. vera* on the west end.

Storms and human disturbance, such as trail maintenance, have the ability to create suitable habitat and substrate for nonnative invasive plants such as *L. leucocephala* to establish and spread. Once established and left unmanaged, this species could continue spread outward from trails into less disturbed native habitats and compete with desirable native flora such as the pipe organ cactus *(Pilosocereus royenii),* and Frangipani *(Plumeria alba).* Buck Island's southern slopes are sculpted by the prevailing trade winds and exposure to storms. The habitats there are typically dominated by very low-growing scrubby plant species such as Turk's cap cactus *(Melocactus intortus)* and *Tournefortia microphylla.* The continued spread and formation of monotypic stands of *T. stans* and *U. maxima* has the potential to reduce floral and faunal





diversity through competition. Germination of native plants, such as the water mampoo *(Pisonia subcordata),* required for nesting and roosting of the endangered brown pelican, may be inhibited through competition with these two invasive non-native plant species. This competition may be direct such as covering or shading native species, or from the divergence of critical resources such as water

Finally, the clonal clumps of *B. pinguin* and *A. vera* located on the west end of Buck Island are situated amongst historical ruins and near the proposed location of the St. Croix ground lizard reintroduction. The continued spread of these two species could impact shallow artifacts and historic structures such as rock walls. The preferred habitat of the ground lizard, which is comprised of mixed leaf litter and mottled sunlight created by a variety of shrubby native tree

The NPS could fail to comply with Endangered Species Act, 1973, since these plants would be allowed to continue their expansion and impact native plant species and other biological trophic levels by eventually reducing the nest and hatch success of endangered sea turtles, brown pelicans, and threatened migratory sea birds. These turtle and bird species would likely continue to visit Buck Island, but with reduced nesting success, thereby lowering chances for recovery and stabilization in the Virgin Islands. Direct competition threats could jeopardize the survival of the two species of rare and endemic plants found on the island. Without action, it is also assumed that introductions of new invasive non-native plants would take place whether accidental or purposeful. With new introductions, the competition (and possibly allelopathy) with native species described above could be easily exacerbated. Potential threats to visitors from invasive non-native plant species currently existing on Buck Island are negligible. The future introduction of toxic or poisonous plant species may affect visitors to Buck Island however; the native flora is currently comprised of a significant number of species that are toxic, poisonous, or produce spines and/or prickles. The success of currently planned ecological restoration projects, including the re-introduction of the St. Croix Ground Lizard (*Ameiva polops*) and the native tropical hardwood tree lignum vitae *(Guaiacum officinale)* would likely be reduced without control and management of invasive non-native plants.

Buck Island Reef NM would fail to implement preservation mandates embodied in the National Park Service's Organic Act, the park's enabling legislation, the General Management Plan, 1983, and the Resource Management Plan, 1985 and fail to meet the parks projection for its Government Performance Result Act Goal Ia1B Control of Exotic Plant Species. All resource management programs working toward the ecological restoration of the Monument would fall short of their goal until these plant species were at an acceptable level of control. Finally, Buck Island Reef NM would fail to meet the mandate set forth by the United States Congress to "preserve and protect the natural resources for future generations" of park visitors.

B. Alternative 2: Phased Control and Management Using Current Staff and Funding

This alternative would require a commitment of funding, staff training, and materials/supplies to be purchased by Buck Island Reef NM. After being trained and equipped, staff would prioritize and treat invasive non-native plants on Buck Island using appropriate, approved herbicides in compression sprayers. Treatments would follow industry-accepted methodology including

herbicide choice based on species targeted and rates of mixture. Staff currently in the Maintenance and Resource Management Divisions would be likely choices to accomplish the treatments.

Due to absence of funding, the limited staff currently employed, and lack of training in the safe use of herbicides, the initial control of the plants (after prioritization) would not be expected to begin in FY 2004. Initial plant treatment using this alternative could potentially begin in FY 2005. However, staff limitations would relegate treatment to an "as available" basis. The Maintenance Division currently employs four staff members (not including Division Chief) that could potentially become trained and treat plants on Buck Island, however maintenance staff position descriptions, i.e. painter, painter helper, mason, and laborer, would preclude them from working on this project. The Resource Management Division currently employs two Biological Science Technicians who would be likely candidates to effect the treatment. Due to the staff responsibilities currently required of these two individuals, the treatment of invasive non-native plants would likely be sporadic and never completely accomplished.

Following this alternative, invasive non-native plant populations treated would likely regenerate more rapidly than current staff could effectively control and manage at acceptable levels. It is likely that the plants targeted by staff would remain in relatively constant or expanding populations. It is assumed that at best, ecological impacts could be stabilized (without being reduced over time) at the expense of funding and staff time. The sporadic treatment and re-treatment schedule would be a potentially perpetual cycle without achieving the goal of reduction, control and management of targeted species. It is understood that perpetual maintenance of these targeted plant populations (often including herbicide re-treatment) is required in a successful program. The proposed action differs from this alternative in that the initial treatment is very focused, thorough and rapid, is conducted by experienced personnel who are not staff of Buck Island Reef NM, and is funded from other than the Monument's general operating budget. While this alternative could be viewed as complying with Federal Acts associated with the protection of park resources, it is anticipated that acceptable management levels of invasive non-native plant species on Buck Island would not be reached.

C. Alternative 3: Proposed and Preferred Action

Initial Rapid Control of Selected Invasive Non-native Plant Species in Cooperation with the Florida/Caribbean EPMT, and Subsequent Management of Those Populations at Acceptable Levels

The initial herbicide treatment of ten (of the 19 identified) invasive non-native plant species is scheduled to commence January of 2004. The Florida/Caribbean Exotic Plant Management Team (NPS Biological Resources Management Division) in cooperation with the Resource Management Division (Buck Island Reef National Monument) have secured $50,000.00 to utilize the contracted company Earth Balance, Inc. to hand spray approved herbicides (Glyphosate and Triclopyr) on the targeted species island-wide. Earth Balance will provide all logistics, equipment, chemicals and a five–person crew in accordance with contract # C5120036300 (Contract on file with park and available upon request) while the Florida/Caribbean EPMT will provide the Caribbean Liaison (NPS Supervisory Exotic Plant

Specialist) on-site to act as the Contracting Officer Representative. Project methodology is outlined above in the Proposed Action Alternative section of this document.

The potential exists for non-targeted plant species damage caused by misapplication or drift of herbicide. It should be noted that this potential also exists for all alternative methods that include the use of herbicide. Non-targeted plant species damage has been minimized in this proposed action by several means: (1) using ground crews, on foot, with compression (backpack or hand-held) sprayers – The construction of these sprayers combined with use by trained personnel allows delivery of the minimum amount of chemical to a specific site. Native plants in close proximity can easily be avoided by careful use; (2) Selecting chemicals with relatively low toxicological concerns and ecological effects (discussed below); (3) the employment of experienced, licensed herbicide application contractors; and (4) the presence of a trained, experienced NPS staff member in the field with contracted crews for technical and contract guidance and assistance.

Answers to concerns about the use of chemicals on Buck Island Reef can be found in the Environmental Protection Agency's Registration Eligibility Decisions (RED) for the two chemicals proposed (EPA-738-F-93-011 for Glyphosate and EPA-738-F-98-007 for Triclopyr). Both terms are trade names for complex chemical molecules that act as the active ingredient in several commercially available herbicides (which are collectively a category of pesticides). Both are registered with the EPA and are non-restricted use pesticides (no license is required to purchase or use the herbicides in accordance with label specifications).

Glyphosate (isopropylamine salt) is a non-selective herbicide used on many food and non-food field crops as well as non-crop areas where total vegetation control is desired. Its mode of action is by inhibiting 5-enolpyruvylshikimate-3-phosphate (EPSP) synthase enzyme, which leads to the depletion of key amino acids necessary for protein synthesis and plant growth. EPSP synthase is only found in plants and not found in mammals, fish, reptiles, birds, or insects. Proven safe for applicators and the unlikely wildlife recipient of spray, Glyphosate is of relatively low oral and dermal acute toxicity (Category III with Category I being the highest and Category IV being the lowest), is not carcinogenic, and is non-volatile. Glyphosate adsorbs strongly to soil and does not move below the six-inch soil layer. Glyphosate is readily degraded by soil microbes into aminomethyl phosphonic acid (AMPA), and then degrades to carbon dioxide. Glyphosate has been found to be no more than slightly toxic to birds and is practically non-toxic to fish, aquatic invertebrates and honeybees.

Triclopyr (Triclopyr butoxyethyl ester or "BBE") products are used as selective herbicides to control broad leaf weeds and brush on a variety of sites including rights-of-way, pasture, rangelands, forests, rice, and turf, including home lawns. Its mode of action is the behavior as a phenoxy herbicide by mimicking the plant hormone auxin causing hypertrophy (excessive enlargement of cells). Auxin is strictly a plant hormone not found in mammals, fish, reptiles, birds, or insects. Like Glyphosate, Triclopyr is only slightly orally and dermally toxic and has also been placed in the toxicity Category III. Testing of acute toxicity with Triclopyr BBE has shown slight toxicity to birds and moderate to high toxicity to freshwater fish and estuarine/marine invertebrates, and high toxicity to estuarine/marine fish. The EPA's concern with regard to toxicity has been lessened since testing was conducted at worst-case exposure

levels and the results are unlikely under actual use conditions. For example, 0-hour chronic assessments were conducted with no account for Triclopyr degradation. Triclopyr is readily photodegraded in water and microbially degraded in soil into 3,5,6-trichloro-2-pyridinol (TCP), which is persistent and mobile. The EPA is requiring additional data of Triclopyr registrants with regard to the fate and chronic toxicity of TCP in the environment.

The proposed action includes the use of these two active ingredients to control targeted plant species. The rates of active ingredient proposed for application on Buck Island Reef non-native invasive plants are well below maximum rate per acre allowed by the label and law, and environmental toxicity concerns related to applicators, non-target wildlife species and the surrounding physical environment (marine habitats) are expected to be negligible. An herbicide containment Standard Operating Procedure developed by the Resource Management Division of Buck Island Reef NM in cooperation with the Florida/Caribbean EPMT to address specific issues of mixing, storage, transportation, and spill response related to this project is attached in Appendix A.

Three methods of accidental herbicide contamination to non-targeted species may occur: (1) drift during application; (2) spill in water or on soil, and/or, (3) soil erosion immediately following treatment. The possibilities of the first two have been mitigated by close supervision of herbicide applicators and mixers, safe herbicide storage and handling practices, and planning. Soil erosion following the treatment of invasive non-native plants on Buck Island would have the potential to introduce suspended sediment to coral reef habitat. Timing of herbicide application will alleviate the possibility of chemicals or their degradates entering the marine habitat on any soils. Sediment from erosion has the potential to negatively impact the surrounding marine habitat therefore; a replicated, applied field experiment was conducted on Buck Island to examine these effects following the herbicide treatment of Guinea grass *(U. maxima)* (Appendix A).

In summary, the results of this experiment indicated that soil erosion did not take place at a significant level after removing *U. maxima* by several treatment methods. These methods included cut only, cut and treated with herbicide, and treat foliarly with herbicide without cutting. A non-treatment control was also included in the experiment. Additionally, it was noted that treatments using herbicide were effective in controlling *U. maxima,* were not significantly different from each other and did not have excessive non-target damage (unintentional treatment and subsequent death of native vegetation).

The benefits gained from the control and management of invasive non-native plants on Buck Island include:

1. Increased habitat for native birds and endangered/threatened sea turtle, brown pelican, and least tern providing for increased nesting success.
2. Improved conditions for re-introduction of lignum vitae and island-wide restoration.
3. Improved reproductive success of native plants by substantially eliminating competition.
4. Improved habitat for re-introduction of St. Croix Ground Lizard providing necessary range extension of the species critical to the species survival and ultimate recovery (U.S. Fish and Wildlife 1984).
5. Enhancement of terrestrial invertebrate biomass, which forms the prey base of many of

the land birds and terrestrial reptiles, as well as the pollinators of some plant species.

6. Increase public and territorial conservation agencies' awareness to threats from exotic species.

V. COMPLIANCE WITH ENVIRONMENTAL LAWS AND REGULATIONS

The proposed island-wide control and management of invasive non-native plants within Buck Island Reef National Monument is a concept in keeping with the park's enabling legislation "…preserve this area of outstanding scientific, aesthetic and educational importance for the benefit and enjoyment of the people", and under the Historic Site and Monument Act of August 21, 1935 (49 Stat. 666; 16 U.S.C. 463) "…to protect the area to prevent further despoliation."

(a) **Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)** - The active ingredients in the herbicides proposed for use (Triclopyr and Glyphosate) are non-restricted uses pesticides registered by the Environmental Protection Agency for use on undesirable terrestrial grasses and woody vegetation. After consultation with the territorial government Department of Planning and Natural Resources, Division of Environmental Protection, no special territorial registration or permission is required to use these products on Buck Island and the use is consistent with the FIFRA. Buck Island Reef National Monument staff has obtained pesticide use approval through the Southeast Regional Integrated Pest Management Program (IPM) and the Washington IPM Office (Appendix E).

(b) **Endangered Species Act of 1973** - Buck Island Reef NM's north side brown pelican *(Pelecanus occidentalis)* rookery has been designated critical habitat for this endangered species. In addition the Monument has been designated an index beach for the recovery of the endangered hawksbill sea turtle (*Eretmochelys imbricata*) by U. S. Fish & Wildlife Service. The island is also the proposed location for the re-introduction of the St. Croix Ground Lizard *(Ameiva polops*). In order to comply with the ESA of 1973 the park must protect endangered species and their habitats. Prior to conducting the proposed action the park and Wildlife Services conducted informal consultation with USFWS, Ecological Services, Boqueron, Puerto Rico, and has been approved for the proposed action in regard to the endangered species at the Monument.

(c) **Migratory Bird Act of 1918** provides clear authority and direction for the proposed action.

(d) **Coastal Zone Act** (16 U.S.C. 1451 et seq.) "preserve, protect, develop and where possible to restore or enhance the resources of the Nation's coastal zones" supports the control and management of invasive non-native pest species that damage the coastal zone and the wildlife therein.

(e) **National Park Service Organic Act** (16 U.S.C. 1 [1916] et seq.) "to conserve the scenery and the natural and historic objects and wild life therein and to provide for the enjoyment of the same in such a manner and by such a means as will leave them unimpaired for the enjoyment of future generations."

(f) **General Management Plan**, Buck Island Reef NM, 1983 - non-native pests such as invasive

non-native plants are identified as a threat to native fauna and must be controlled.

VI. CONSULTATION AND COORDINATION WITH OTHERS

Personnel from the following agencies and organizations have been consulted or participated in the formulation of this proposal:

U.S. Department of the Interior

National Park Service

Chris Furqueron - Integrated Pest Management Coordinator
NPS Southeast Regional Office
100 Alabama St, SW - 1924 Building
Atlanta, GA 30303

Tony Pernas, Exotic Plant Management Specialist
Florida/Caribbean Exotic Plant Management Team
950 N. Krome Ave, 1st Floor
Homestead, Florida 33030

Joel A. Tutein - Superintendent, Christiansted NHS/ Buck Island Reef NM
Christiansted NHS/Buck Island Reef NM
2100 Church Street, Kings Wharf #100
Christiansted, St. Croix, Virgin Islands 00820-4611

U.S. Fish & Wildlife Service
Michael Evans, Refuge Manager Sandy Point NWR
U.S. Fish & Wildlife Service
Sandy Point NWR, Federal Building, Golden Rock, St. Croix, VI 00820

Jorge Salivas, Ecological Services, Endangered Species Section 7 Consultation
U.S. Fish & Wildlife Service
Boqueron Field Office, P.O. Box 491, Boqueron, Puerto Rico 00622

U.S. Department of Agriculture

Natural Resources Conservation Service
Rudy O'Reilly, Botanist, St. Croix, Virgin Islands
5030 Anchor Way, Gallows Bay, St. Croix, VI 00820-4692

Government of the Virgin Islands

Department of Planning & Natural Resources
Division of Fish and Wildlife
Doug B. McNair, Biologist

45 Mars Street, Frederiksted, VI 00846

Virgin Islands Coastal Zone Management
Ushi Anlauf, Resource Ecologist
45 Mars Street, Frederiksted, VI 00846

VII. PLANNING TEAM / PREPARERS

Zandy Hillis-Starr
Chief Resource Management
Christiansted NHS/Buck Island Reef NM/ Salt River Bay NHP & EP
National Park Service
2100 Church Street, #100
Christiansted, St. Croix, Virgin Islands 00820-4611

Daniel W. Clark
Supervisory Exotic Plant Specialist
Biological Resource Management Division
Florida/Caribbean Exotic Plant Management Team
c/o Virgin Islands National Park
1300 Cruz Bay Creek
St. John, VI 00830

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IX. APPENDIX

Appendix A. Examination of the effect of *Urchloa maxima* removal on physical conditions on Buck Island Reef NM.

U. maxima was selected as the best species for experimentation due to relatively large patches existing on the steep southern facing slopes of the island, and the plant's ability to assist in securing the substrate through a fine root mat. The experiment was established on October 28, 2003. Two sample sites (called "east" and "west") were selected on Buck Island where *U. maxima* was present in nearly monotypic stands large enough to facilitate removal emulating a control project. The sites were located contiguous with previously established island-wide grid for rat eradication and are on the slopes immediately above shoreline with adjacent tidal and coral reef areas. Each sample site contains three sets of four, 3m x 3m plots (in "one horizontal row") each horizontally separated by a 3m x 3m buffer and each row of plots vertically separated by an additional 6m buffer row. Plots within sample sites were located at approximately the same elevation to remove slope and aspect experimental error. Four treatments were applied after randomization to each of the three rows of plots in the sample site and are: (1) untreated control, (2) *U. maxima* cut to ground level, (3) *U. maxima* cut to ground level and stubble treated with a 2% Glyphosate solution and, (4) *U. maxima* uncut and treated with a 2% Glyphosate solution.

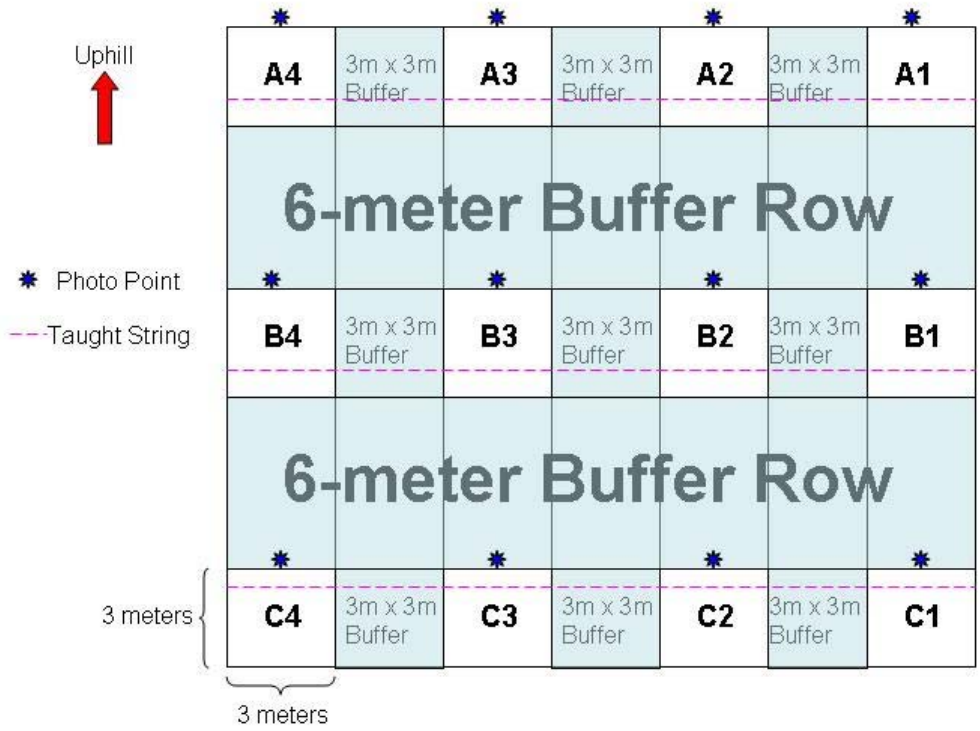


Figure 10. *U. maxima* treatment plot grid showing layout of four treatment types.

A 2% solution of Glyphosate was selected in this experiment rather than 3% (as required in the project contract for treatment) in order to test the efficacy of the lower rate on *U. maxima*. Plants existing on Buck Island are adapted to extreme, xeric environmental conditions. Under these conditions, land stewards often discover that herbicide efficacy is reduced due to plant stress. In

order to reduce or eliminate poor herbicide efficacy and better estimate cost of herbicide during the proposed project, the rate of 3% was recommended in the contract. This rate is within label specifications and can be adjusted to a lower rate (2%) based on experimental observations.

The experiment was designed to investigate three questions: (1) Would there be a difference or change in soil deposition among treatments, (2) Would there be a difference or change in plant species richness or cover, and to a lesser extent, (3) What was the most effective treatment method selected. In both east and west sample sites, a permanent section of rebar was approximately centered at the outer edge of the outermost plots where a string was placed taught between them at a fixed position (36 cm) on each rebar above the substrate. Each pink string was marked with black ink at 0.5-m increments. Measurements were taken at the 0.5-meter increments from left to right looking downhill, from the string to the surface of the substrate along the each string (42 measurements per string, 126 measurements total per sample site). Measurements were taken to determine soil deposition within the study sites over time. Plant species present and approximate coverage for each species within each of the twelve 3m x 3m plots were recorded prior to treatment and at one-month intervals to determine the efficacy of treatment method and examine new plant recruitment or existing plant loss. Photos of each of the twelve plots within each sampling site were recorded from the uphill, center of each plot prior to treatment and at one-month intervals (same as soil measures).

Figure 11. Experimental plat immediately after cutting and herbicide treatment and two months after treatment native flora exposed next to dead *U. maximum* bunches.



Immediately following the experiment's establishment and prior to the next data collection date (November 28, 2003), a record 20+" of rain fell on Buck Island. The potential for erosion was at an annual high during this period. Although the data have not been statistically analyzed to date, plot photographs, species present and coverage, and soil profiles appear to not have noticeably changed from the initial sample period. Native species observed being crowded by *U. maxima* in the plots where herbicide was used have been observed to be thriving and the substrate has remained intact. Since the *U. maxima* patches exist in a mosaic on the landscape scale and some native species exist within the patches, it is believed that the native plants persisting and the

remaining U. maxima root mats slowly decaying provide sufficient substrate stabilization. This simple test has provided some insight to the formulation of treatment techniques proposed and given Resource Management staff some assuredness that erosion will be a negligible factor to the project's success.

Appendix B. Standard Operating Procedure for Project Herbicides

The following procedures have been designed to ensure the safety of the applicator and environment during the use of herbicides for the Buck Island Reef Non-Native Invasive Plant Control Project, January 2004.

1. NPS Warehouse at Sion Ridge, St. Croix, Virgin Islands

NPS Facility Chief has designated NPS Warehouse at Sion Ridge as the bulk storage area for the herbicides and adjuvants for the duration of the project. Herbicides will be stored in original manufacturer plastic containers. Warehouse is a locked facility. Park contractor EarthBalance can access the storage area only with supervision from NPS staff and/or project NPS COTR Daniel Clark.

Water for mixing herbicides will be obtained from Sion Ridge park housing (cistern water) and put into 15-gallon storage containers for transport by vehicle to the marina.

Herbicides will not be mixed at Sion Ridge.

2. Transport by vehicle to Green Cay Marina, St. Croix, Virgin Islands

Herbicides will be transported to the marina by vehicle only in their original manufacturer containers to ensure safe transport. They will be carried in the back of either a NPS vehicle or contractor van to the marina. Crew using hand-truck will move herbicides from vehicle to the boat, and containers will be handed down into the boat by hand and secured in the boat for transport.

3. Transport by Boat to Buck Island Reef NM

Park boats are kept at a private marina, Green Cay Marina, on the north side of St. Croix, Virgin Islands. Travel from the marina to Buck Island Reef by boat is less than 10-15 minutes on a moderate day (wind less than 10 mph and seas less than 2 feet). All equipment and supplies for the project will be brought to the marina by passenger vehicle and transferred to NPS boat by hand.

The boat designated to carry crew, supplies, and equipment to the island is a 25 ft Boston Whaler with a large open deck space. The herbicides and water will be secured amidships so they will not tip during transport. Crew ride out on the boat either seated forward of the supplies (2 seats and 2 standing positions) or aft on the bench seat (3 persons). This distributes the weight evenly.
4. Buck Island Reef National Monument

a. Herbicide Storage, Mixing, and Maintenance

NPS boats dock at the 100 ft concrete pier located off the south side of the island. This pier is for NPS official use and for visitor drop-off and pick-up. Once the boat is secured crew off load equipment and supplies onto the pier by hand. Herbicide containers and water barrels are moved by hand-truck down the pier and along the shoreline to the storage shed. Equipment and supplies are stored in a lock area behind Dietrich's Shelter. The storage area is approximately 16 ft x 8 ft and is well ventilated. All products will be stored in original containers or in backpack sprayers. The herbicide will be secured in the shelter each night and keep in a vertical orientation. Access to the Shelter storage area is by NPS staff or contractor EarthBalance under supervision of NPS COTR Daniel Clark.

Herbicides, water, and adjuvants will be mixed to proper application rates inside the storage area. Mixing and pouring into backpack sprayers will be conducted over large plastic mixing trays to catch any spill that might occur. Any waste materials (rags and empty containers) generated will be disposed of properly on St. Croix. Herbicide rinsate will be temporarily stored in the storage shed on Buck Island and subsequently applied to target vegetation.

Each crewmember will be assigned a 4-gallon backpack sprayer and/or a 32-ounce industrial sprayer to use in the field for herbicide application. Sprayers and associated gaskets and straps will be checked and cleaned regularly to ensure the security of contents and to ensure proper application rate.

b. Application and Fieldwork

The crew consists of NPS COTR Daniel Clark, contractor EarthBalance Project Supervisor Donn Brown, and 3-4 field crewmembers with one crewmember typically acting as crew boss. Contracted crew are licensed Florida pesticide applicators and highly experienced in the field of invasive exotic plant treatment. The crew will systematically treat targeted plant species by aligning themselves linearly to create a "swath." Each crewmember will remain within sight or hearing distance of each other and the swath is approximately 60 meters in width. Two-way radios are in the possession of the contract project supervisor and crew boss to effectively communicate logistics during treatment. The NPS COTR is responsible for providing vessel transportation to and from Buck Island, technical guidance with respect to the completion of the contract's task order, and ensuring the contractor meets the conditions of the contract. The contracted crew will apply herbicide and ensure crew safety while working on slopes and around hazardous vegetation, such as cactus and manchineel.

Visiting public and park concession operations will be apprised of the work through public service announcements distributed by fax to media, and posted at marinas and dive shops. Park concession operation will receive handouts describing the project and target species to be posted on all park concession boats for visitor information. Work areas will be posted with signs for the visiting public so they can avoid application areas and be advised of the work area.

c. Safety and First Aid

Crew will wear long pants and long sleeved shirts, boots, hats, safety / sunglasses, and gloves during application to reduce exposure to herbicide and noxious native plants. Application of herbicides will be conducted in a manner that reduces drift and non-target damage. Crew field shirts will be removed and bagged following daily work for transportation and laundering. This reduces repeated contact with plant spines and oils that that often results in dermatitis. Straps and backpack sprayers will be wiped clean to remove any oils from noxious plants.

Each crew has a personal water supply that will be consumed regularly to avoid dehydration. An additional large cooler of drinking water is available for drinking water refill and for washing down in case of accidental exposure to herbicide or noxious plant. Each crewmember has pre- and post-contact skin cleanser available for personal use to further reduce the risk of exposure to noxious plants. Additional skin cleanser is available in the storage area first aid kit.

A first aid kit will be store in the Shelter for use by the field crew. The first aid kit has an eye and arm washing station, disposable gloves, bandages, antibiotic ointment, “after-contact” solution to treat contact with noxious plants (manchineel, Christmas bush, stingy nettle, etc), tweezers to remove spines and splinters, etc. Additional clothes are stored in the Shelter for the crew to change into incase of exposure to herbicide or noxious plants.

d. Accidental Herbicide Spill Mitigation Procedures

1. Land - In the event of a chemicals spill on land, absorbent rags will be used to wipe clean the area affected by herbicide and the area irrigated with fresh water. If the herbicide is spilled on the soil, the affected soil will be removed and placed into plastic bags, which will be transported to St. Croix for proper disposal.

2. In a vessel - In the event chemicals are spilled on a vessel on the water, absorbent rags will be placed in a manner that keeps the chemical from entering the vessel's bilge as best as practicable. The spill will then be cleaned with absorbent rags and the rags bagged and disposed of as outlined above. The bilge pump will not be operated. If underway, the vessel will heave to and remain in neutral (unless navigation considerations are critical) while the crew cleans the spill. If the spill is significant in size (more than approximately 5 gallons), in addition to the above steps, the vessel will be hauled out of the water and cleaned at an appropriate site prior to re-launching the vessel.

3. Into the water - All chemical containers will be transported with lids secure and containers clean. In the event chemicals are spilled into the water, the position will be noted by GPS and the incident reported to the US Coast Guard Resident Inspection Office on St. Croix, U. S. Virgin Islands. If the chemical spilled is oil based (JLB Oil carrier or Garlon 4), the crew will use absorbent rags on floating chemical as best as possible to clean the spill. Rags will be disposed of as described above.

Appendix C. Chemical Product Labels

Chemical Product Labels are available from Buck Island Reef NM Division of Resource Management for all products to be used during Buck Island Reef Non-Native Invasive Plant

Control Project. Copies of all Material Safety Data Sheets (MSDS) are on in park Master MSDS sheet logbook in Facilities Chief office and in Chief of Resource Management 0ffice, Christiansted NHS, St. Croix, Virgin Islands. Contractor will maintain a set of current MSDS sheets for chemicals being used on the work site. The crew shall know the location of these sheets.

1. AquaNeat™	EPA Reg. No. 228-365-4581	Cerexagri, Inc.
2. Induce®	EPA Reg. No. – None	Helena Chemical Co.
3. Garlon™ 4	EPA Reg. No. 62719-40	Dow AgroSciences LLC
4. JLB Oil Improved	EPA Reg. No. – None	Brewer International
5. Blazon™ Blue Spray	EPA Reg. No. – None	Milliken Chemical

F.3 Vegetation of Buck Island Reef National Monument

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Vegetation of Buck Island Reef National Monument

an Initial Reassessment

May, 1996

Prepared for the National Biological Service

and the Friends of the Virgin Islands National Park

Eleanor Gibney

P.O.Box 93

St. John, U.S. Virgin Islands

00831

Vegetation of Buck Island Reef National Monument

an Initial Reassessment

May, 1996

Buck Island, the terrestrial portion of Buck Island Reef National Monument, lies about 1.6 miles north of the eastern end of St. Croix, U. S. Virgin Islands. The area of the island is 176.4 acres (71.4 hectares), with the highest point reaching 340 feet (104 meters).

The vegetation of this seasonally dry island has been considerably altered by human use over three centuries; beginning with the first European settlement of St. Croix, by the French in 1650. Any valuable hardwoods were gradually removed, notably Guaiacum officinale, the lignumvitae, which was reported to have been a significant species in the original flora. The relatively moist and fertile west end of the island supported limited plantation agriculture, followed by subsistence farming up until the early 20th century. Additional trees were cut for charcoal production, and, certainly to the island's greatest detriment, goats and sheep roamed freely for decades, perhaps for centuries. In spite of all this, Buck Island remains rich in native plants, with relatively few exotic species established. Certainly the ratio of native to exotic species (if not individual plants) is higher here than in any area of comparable size on nearby St. Croix, a 45-square-mile island with a history of intense agricultural use.

In 1975, Woodbury and Little published the Flora of Buck Island Reef National Monument. This study was based on four collecting trips to Buck Island between 1966 and 1970. The document included a description of the island, historical data, brief vegetation classification and description, a statistical summary, notes on rare species, and an annotated species list. The list included 228 flowering plants in 171 genera and 63 families. No ferns were collected.

Since the last Woodbury and Little expedition in 1970, the vegetation of Buck Island has undergone severe stress. The last 26 years have included periods of extreme drought, several floods, and some effects from at least six tropical storms and hurricanes, most notably Hurricane Hugo in 1989,

(certainly the "storm of the century" for St. Croix) and Hurricanes Luis and Marilyn in 1995.

On May 5th and 6th, 1996, I made the first several intended expeditions to Buck Island to assess the vegetation, it's present condition, and any perceived management needs. Initial objectives included:

1. Comparison of present vegetation with Woodbury and Little's descriptions from the 1960's.
2. Re-inventory of plant species.
3. Assessment of the status of any rare and endangered species.
4. Assessment of exotic species, and potential control methods for invasive exotics.
5. Assessment of the potential for active restoration.
6. Examination of monitoring priorities.

While additional trips to the monument will be necessary to gain a complete re-inventory of the flora,the initial trip did provide a wealth of information in all of the categories above, as well as an opportunity to observe some unusual plant predation activities.

Vegetation descriptions

Woodbury and Little described only four plant communities on the island: Seasonal deciduous forest, referred to as an "upland" formation; shrub thickets, covering most other slopes; beach forest on the western coastal plain; and a narrow band of mangrove forest around the single salt pond.

Although these classifications are still valid in a broad sense, the shrub thicket classification covers a variety of types that differ in structure and dominant species. I have included three new classifications and eliminated "shrub thicket" as a community title.

Seasonal deciduous forest

Although this was designated as an upland forest, it is, at least today, poorly developed on the actual hill-tops and ridge-lines; it is best seen in the guts and ravines, the back side of the beach forest and on sections of the north-facing slopes. Dominant trees are still those listed by Woodbury and Little, namely Bursera,Bourreria,Pisonia,Cordia,Adelia and Piscidia. In moister areas, such as the back of the western valley, Tabebuia and the evergreen Guapira and Krugiodendron appear. Both Bursera and Pisonia, two signature trees of Eastern Caribbean dry forests, are seen as mature trees estimated as well over 100 years old. These soft-wooded trees were not cut for charcoal.

Shrubs include Samyda dodecandra, Schaefferia frutescens and Croton betulinus.

Thorn/Cactus

This is a tall open shrubland that may merge into the deciduous forest or the thicket scrub. The overall dominant species is the spiny Securinega acidoton, with Acacia tortuosa, Rochfortia acanthophora (seen as a small tree above the West Beach picnic area), and the tree-form cactus Pilosocereus royenii. This formation occupies much of the southwestern slope of the island, giving way to the thicket-scrub toward the eastern end.

Thicket-Scrub

The prevailing formation on the east and some south slopes, this is a low shrub association, still clearly showing the effects of long-term grazing in the mix of poisonous,spiny, and otherwise unpalatable species. Croton spp., Lantana involucrata, Cordia stenophylla, Heliotropium ternatum and Oplonia spinosa are interlaced with vines such as Stigmaphyllon periplocifolium and Jacquemontia spp. The ground may be covered with the brittle-jointed "sucker" cactus, Opuntia repens, or, on the seaward edge of the slopes, by Melocactus intortus the turk's-cap cactus.

Beach Forest

What remains of this formation is still the largest-statured forest on the island. This association has been heavily affected by the hurricanes, particularly Hugo in 1989. The large manchineel trees (Hippomane manchinella) were almost entirely leveled and killed by that storm. Much of the area where these large trees stood is now occupied by masses of six-year-old manchineel seedlings, mostly now in the 4-to-8-foot height range.

In at least one area, on the seaward side of the saltpond, the death of the mature manchineels and the loss of their binding root systems has led to rapid erosion of the beach berm. Planting 10 to 15 seagrape trees (Coccoloba uvifera) into this area as soon as possible would help stabilize the back-beach, especially if further major storms occur before the beach forest recovers.

The other two large trees seen in the beach forest are the water mampoos (Pisonia subcordata) and the naturalized non-native tamarind (Tamarindus indicus). On the south side of Diedrich's Point, the shrubby Eugenia axillaris is very common and appears to be benefiting from the brighter conditions in the absence of the manchineel canopy.

Coastal Thicket

This vegetation is limited to narrow strips of the upper beach and berm on the south and west shores.

Coccoloba uvifera, Erithalis fruticosa and Rauvolfia viridis are among the few woody species. Softer shrubs, herbs and vines are all well represented, including Ernodea littoralis, Scaevola plumieri, Sesuvium portulacastrum, Canavalia maritima, etc.

Mangrove Forest

Confined to the edges of the one small saltpond, this is made up of well-developed Avicennia germinans and Laguncularia racemosa (black and white mangroves, respectively). Conocarpus erectus, the buttonwood mangrove, was listed by Woodbury and Little but was not seen this trip. Only the south side of the pond was explored.

The small forest appears very healthy, with far less damage from the drought and hurricanes of 1994-1995 than is seen in the northern Virgin Islands.

Plants of Concern

1. Rare and/or Endangered Plants

In the global sense, the rarest plant found on Buck Island is certainly Malpighia pallens, stinging-bush, a large shrub endemic to St. Croix and Buck Island. This attractive plant has inconspicuous T-shaped stinging hairs un the underside of the shiny leaves. This was probably an effective deterrent to grazing livestock, but may also have made the plant very unpopular with humans, contributing to it's rarity on the mainland of St. Croix. Malpighia pallens appears to be vigorous and fairly common on Buck Island. Several dozen individuals were seen, spread through virtually all habitats. Some closely related malpighias, e.g. M. woodburyana on St. John, are suspected of forming large clonal populations by root-suckers. This does not seem to be the case here, since most individuals are fairly distant from one another.

Buck Island is an ideal refuge for this rare plant. There are no apparent threats to this population. However, no large number of seedling were observed, and nothing is known of the

reproductive biology and life span of the species. A base-line inventory would be achievable, with periodic (5 year ?) censusing to ensure that populations are not declining.

The only orchid species found on the island is Epidendrum bifidum. This is a species with extremely confused taxonomy that has been known by various other names at various times. As the species has been commonly defined, it is endemic to Puerto Rico, Hispanola and the V.I.

This beautiful orchid does not appear common in any of the parts of the island we visited. The species is frequently found in the dryer areas of the northern Virgin Islands, but is reported to be very rare on St. Croix — So much so that it is called the "Sandy Point orchid" from the one area where it is well known.

The main threat to the species on Buck Island would appear to be the attentions of "plant lovers" who may be easily tempted to remove entire plants for their garden or greenhouse. Fortunately, few visitors roam too far off the trails. The population of the interior slopes should be gradually recovering from the influences of fires and livestock predation.

The other locally protected species that historically occurred on the island was not exactly seen growing on this trip. Mammilaria nivosa, the wooly nipple cactus, was listed by Woodbury and Little as "local on rocky slopes." Two small clumps of this little cactus were found, washed up at the top of the wave line on the south and southwest shores. The usual habitat is steep rocky shorelines, where the cactus may form large mats over the surface of the rocks.

The mamillaria has a wide range in the West Indies, but is generally confined to small islands and cays. It does not occur on Puerto Rico, but it is found on Mona and Culebra.

As with the orchid, the primary predator on these attractive plants is probably the collector. Since the available habitat is relatively accessible along the shore, the locations should certainly be determined. Periodic monitoring could probably be done from a boat with binoculars once the location is known.

2.Exotic Plants

A number of non-native plants have been introduced to the island over the centuries, both purposely and accidentally. The majority are small weeds and grasses that are confined to the disturbed areas adjoining the trails and picnic areas. These are mostly annual plants with

little potential for serious invasion or competition.

Of the handful of known "problem plants" seen, two are new to the island since 1970 and one other was not seen by Woodbury and Little, although it was almost certainly present.

Agave missionum

Two plants seen near the bottom of the trail behind the Diedrich shelter. These very conspicuous plants could not have been missed by the botanical collectors of the late '60's. Probably planted deliberately, in the mid-to-late 1970's.

Endemic to Puerto Rico and the northern Virgins, this large "century plant" must be considered a dangerous exotic, since Buck Island appears to be perfect habitat for it. These two plants should not be allowed to reproduce. The best method of ensuring this would be to destroy the plants as soon as possible. Their once-in-a-lifetime blooming may still be 5 to 10 year away, but this issue might easily be lost to the institutional memory in the meantime. Buck Island appears to be the ideal location for the introduction or re-introduction of the extremely endangered Agave eggersiana, endemic to the east end of St. Croix. (See restoration discussion.)

Panicum maximum (Guinea grass)

Tall African fodder grass. Fairly confined to one area in the northwest part of the island. The population could be temporarily restrained by hand-digging and/or herbicide treatment, but seeds will probably continue to germinate over many years to come. Additionally, the soil in the particular area appears very different from that seen elsewhere on the island: a red hard-pan type that may have poor drainage and low fertility. Experimental planting of fast-growing native shrubs and trees, coupled with an on-going effort at removing the successive crops of Guinea grass as they emerge, seems the only long-term management option.

Tamarindus indicus (Indian tamarind)

These beautiful large shade trees are an important part of the historic and cultural landscape here, as they are elsewhere in the region. The consensus appears to be that the large trees are desirable in the historically lived-in area, but there is very valid concern over the obvious expansion up the guts and onto the entire island.

With many of the seedling trees already very well established, control here is a major undertaking. One possible approach would be to identify all areas where tamarinds would be prohibited, cut down the existing trees, and then treat the stumps with a commercial stump-killing preparation. After that, any future seedlings would be hand-dug or spot treated with herbicide.

Even in the historic sections of the island, seedlings need to be vigorously controlled to prevent large increases in the historic populations.

3. Leucaena leuccocephala (Wild tamarind, tan-tan)

The ultimate successful pioneer weed-tree of the tropical world, the leucaena has some very fortunate constrains on it's potential here. There is no recent non-natural disturbance of the soil; and despite the historic disturbances, most of the island has probably always been too dry to support leucaena on especially on the slopes. Historic populations were probably never great enough to allow vast quantities of seed to accumulate in the soil seed bank as occurred elsewhere in the region. Given the relatively small numbers here, it might be possible to eradicate the species from the island totally by repeated cutting and treating of stumps, with on-going surveillance of the trail sides and picnic areas.

5. Thespesia populnea (Otaheiti,seaside maho)

A highly competitive shoreline tree, the otaheiti has invaded the shores of tropical America, replacing both seagrape on sandy shores and mangrove species in wetlands.

Woodbury and Little reported two trees on Buck Island. Two individuals were also seen on this trip, but judging by their small size, these are less than 20 years old. Both of these were on sandy shore, one on the West Beach, the other on the far east end of the Diedrich's Point beach. The trees are small, but seem to have well-established root systems. Eradication would probably again require stump treatment, although perhaps the roots can be dug out from the sand.

6. Bromelia pinguin (Pinguin, wild pineapple)

Overlooked by Woodbury and Little, this well-established exotic has certainly been here for

decades, probably since the plantation era. The viciously spiny member of the bromeliad family was traditionally planted as a living fence around houses and gardens. The Buck Island conditions are definitely drier than the plant prefers, so the mass has been slow to spread and has remained somewhat patchy, rather than forming the impenetrable stand covering acres that may be seen on other islands. This will be a big and rather bloody job to eradicate, but not overwhelming. the only group seen is atop the cliff at the south end of West Beach. Pinguin are often shallow-rooted, and do not generally re-sprout from the root, once cut. The plants could be dropped over the cliff and heaped on the beach to dry until burnable.

7. Scaevola seriacea (Pacific scaevola, naupaka)

A very recent (1980's) introduction to the Caribbean, with potential for becoming one of the most invasive plants in the region. Planted as a salt-tolerant ornamental by island resorts in the mid-'80's. The sea-dispersed buoyant seeds began germinating on Virgin Islands beaches within two years of the introduction.

Fortunately, the plants are easily removed from the sand while they are young. The one plant seen, toward the east end of the sandy shore of the south side, should be destroyed immediately, as should be any that appear in the future. The plant can be readily distinguished from the native Scaevola plumieri which occurs naturally on this shore, by the larger, softer leaves with silvery white hairs. The S. plumieri has deeper green, waxy and shiny foliage.

Exotic Animal Problem

Since grazing ungulates were eliminated from the island years ago, it was very surprising to discover serious plant damage from an unforeseen source: rats.

Although it rained heavily during our visit to Buck Island, the preceding weeks had been unusually dry for spring. Rodents, presumably the tree rat (Rattus rattus) had been attacking certain plant species to an amazing and alarming degree. The most conspicuous victim was Bourreria succulenta, a tree in the borage family (Boraginaceae). The young branches, up to 1 cm. diameter, on almost every Bourreria on the island were chewed off.

Piles of twigs and foliage could be seen under every tree. Two other members of the borage family, Cordia rickseckerii and Tournefortia volubilis, were also being eaten, as well as a spurge family (Euphorbiaceae) member, Adelia ricinella. Some of the most distressing damage was to the turk's-cap cactus, Melocactus intortus. The reproductively mature plants have knobby tops covered with wool and relatively soft spines. These tops were being ripped open and the juicy interior of the cactus scooped out from above. In many cases, the plant was evidently dead or dying.

Based on the extent of the destruction across the entire island, the rat population is incredibly large. Beyond the obvious damage, there can be no doubt that the rodents must consume a major portion of the fruits and seeds produced by the native vegetation, probably severely effecting the natural regeneration of the vegetation. Control of the rats is certainly the number one management priority for the terrestrial portion of the Monument.

Restoration

Buck Island is less in need of large-scale restoration than many of the other small islands in the region. Both the diversity of native species and the relative scarcity of exotics indicate that natural recovery will slowly progress, especially if rats and exotic plants are actively controlled.

Since St. Croix and Buck Island are geologically separate from the northern Virgin Islands, there are distinct differences in the natural flora. As a result, there are no areas more pristine to accurately compare this flora to.

There have been several successful small-scale plantings of lignumvitae (Guaiacum officinale) on the island in recent years. Both seedlings out of pots and seed planted directly in the ground have had some degree of success.

The concept that immediately comes to mind is to use Buck Island as a refuge for the critically endangered plants of the dry regions of St. Croix. Margaret Hayes (Cruzan Gardens Nursery), Rudy G. O'Reilly Jr. (U.V.I. Cooperative Extension Service) and Ken Jones (St. George Village Botanic Garden) all have experience with the propagation and culture of most of these plants.

The species that suggest themselves are:

1. Agave eggersiana Eggers agave, St. Croix century plant.

Historically known from the dry regions of St. Croix and St. Thomas, now apparently confined to cultivation.

2. Buxus vahlii Vahl's boxwood.

Federal endangered species list. Known from Puerto Rico and St. Croix, with one population near Sandy Point at the west end, another near Christiansted.

3. Nashia inaquensis A shrub with mysterious distribution: Great Inagua island (Bahamas) and St. Croix,east end.

4. Catesbaea melanocarpa Taxonomically confused. Listed from Puerto Rico and some of the Lesser Antilles in previous centuries, present status unknown. Found on St. Croix in two locations: in cow pasture on the south shore and on the east end.

St. Croix's resident vegetation experts, listed above, might make additional suggestions. Buxus vahlii, as a federally listed endangered species, stands the best chance of receiving financial aid. However, the active St. Croix Environmental Association might provide enough volunteers for on-going small-scale planting projects.

In conclusion, Buck Island remains a rich and unique part of the V.I. National Park group. Due to the island's small size, some management plans that have been daunting on the larger scale of the main unit on St. John might be implemented with a high chance of success. The control of exotic species, for instance, is definitely achievable, although the Monument's dedicated but tiny staff would probably have to solicit major volunteer participation.

Additional visits to the island will be necessary to complete an up-to-date check list of the flora and determine the extent of change since the 1960's. Many species collected by Woodbury and Little were not seen, including a few that they described as common. A preliminary list of species new to the island is appended, no doubt this will be expanded with additional visits.

Additions to the Flora

of Buck Island Reef National Monument

1. Agave missionum Family: Agavaceae.

See exotic plant section. Introduced, new since 1970.

2. Scaevola seriacea Family: Goodeniaceae.

See exotic plant section. Seeds probably floated from St. Croix. Post-1970.

3. Bromelia pinguin Family: Bromeliaceae

See exotic plant section. Overlooked by Woodbury and Little. Probably 18th century introduction.

4. Eugenia cordata Family: Myrtaceae

Probably missed by Woodbury and Little. Only one seen, on the trail near the large gut, at the base of the hill northeast of West Beach. Small native tree, common in northern V.I.

5. Ipomoea alba Family: Convolvulaceae

Robust native vine. Common on seaside vegetation, sandy shores. The very large white nocturnal flowers are very distinctive. Annuals or short-lived perennials, sometimes disappearing for years. Probably dormant during the 1960's collecting expeditions.

6. Ipomoea pes-caprae Family: Convolulaceae

Native vine, spreading on sandy shores. Common on all tropical coasts, uncommon here on Buck Island. Seeds may have floated in post-1970.

7. Argusia (Tournefortia) gnaphalodes Family: Boraginaceae

Beautiful native sea-side shrub. Seen only on the far east end of Diedrich's Point. Uncommon in the northern V.I., with the exception of Anegada. A few large populations on St. Croix, probably the source of sea-borne seeds, post 1970.

8. Melothria pendula Family: Cucurbitaceae

Annual native vine in forests. Probably dormant or otherwise overlooked by Woodbury and Little.

F.4 U.S. Virgin Islands vegetation community classification: basic community descriptions – habitat mapping in support of land use and biodiversity planning in the Virgin Islands

Gibney, E., T. Thomas, R. O'Reilly, B. Devine. 2000. U.S. Virgin Islands vegetation community classification: basic community descriptions – habitat mapping in support of land use and biodiversity planning in the Virgin Islands. Eastern Caribbean Data Center.

U.S. Virgin Islands
Vegetation Community Classification
January 2000

Basic Community Descriptions

Habitat Mapping in Support of
Land Use and Biodiversity Planning
in the Virgin Islands

Prepared by: E. Gibney, Consultant
T. Thomas, Cooperative Extension Service, UVI.
R. O'Reilly, USDA.
B. Devine, Ph.D., Conservation Data Center, UVI.

U.S.V.I. Vegetation Community Classification
Basic Community Descriptions

Gibney, E.,Thomas, T.,O'Reilly, R. and Devine, B.
January 2000

Moist Forest

I.A.3.N.a. - Lowland tropical or subtropical seasonal evergreen forest.

Tropical and subtropical seasonal evergreen forests with mainly broad-leaved evergreen trees and some foliage reduction in the dry season. The moist forests develop in watershed basins along the coast, in riparian habitats associated with drainage guts and swales which carry runoff from upper elevations and on suitably elevated upland locations where the elevations are high enough to experience rainfall totals above 1200mm per year. A dry period of 2-4 months is common. These are the true forests of the islands where more than 100 species of trees may grow to heights of 10-30m. The taller formations of this type generally have 3 synusiae or canopy strata, while the shorter formations exhibit only two layers. Generally, 70% or more of the tree species are evergreen.

Upland Moist Forest (umf) - These forests are confined to the summits and upper north aspects of the taller mountains. Emergent trees may be 25m tall, although at present, they are often less. The continuous canopy forms at about 15m, with a small tree/tall shrub layer often found at 5-10m. Low shrubs, herbs and epiphytes may be very abundant to absent. Recent hurricane disturbance has temporarily increased vine, herb and small shrub growth.

Gallery Moist Forest (gmf) - These are riparian communities found in ravines and guts draining large upland watersheds. The moist ravines and guts with the gentlest slopes support the tallest trees on the islands, some over 30m. Although several emergent species are deciduous, the dominant species are generally evergreen. As a result of flash floods, more young trees are found and stratification is less pronounced than in the upland type. The shrub layer is extremely variable and fewer herbs, shrubs, epiphytes and vines persist. In many locations, the introduced, deciduous fruit tree Melicoccus bijugatus (Genip) may dominate.

Basin Moist Forest (bmf) - These forests are found in basins and lowland areas, generally along the coast, where runoff from large upland watersheds collects. These forest types are well represented on all the Virgin Islands. The basin forest emergent species may reach 25m or more and the forest is normally comprised of 3 synusiae. A continuous canopy is formed at 15-18m and a lower layer at 5-10m. A lower shrub layer may be common or moderately well developed. Herbs and vines are found in significant numbers in a well-developed community. Epiphytes and ferns are rare.

Dry Forest

I.C.1.N.a. Lowland tropical/subtropical semi-deciduous forest.
I.B.1.N.a. Lowland or submontane tropical/subtropical drought deciduous forest.

Vegetation communities of the dry forest are influenced by a number of factors. Prevailing wind patterns, wind velocity, length of the dry season or number of months with less than 50mm of rainfall, aspect and slope can all influence vegetation composition. These formations are found at lower elevations, generally below 300m with rainfall accumulation of 850 - 1100mm per year. Steep slopes and strong winds in the presence of heavy salt spray may reduce the height of the climax vegetation, altering the composition and diversity of the forest. Tree strata are generally limited to 2 layers with a maximum height of 15-20m. Following a gradient of increasing aridity, seasonal vegetation may exhibit leaf specialization, leaning toward deciduousness, while dry evergreen vegetation may exhibit greater degrees of sclerophylly. Forests of this type grade and mix with one another and may be difficult to distinguish, other than by quantitative sampling measures.

Gallery Semi-deciduous Forest (gsf) - This vegetation type is limited to the smaller riparian corridors such as ravines, guts and intermittent streams found within dry forest watersheds. Additional moisture is available to the vegetation as a result of runoff. The taller dry forest species find their maximum height in these locations. Shrub and herb community development are variable.

Semi-deciduous Forest (sdf) - Throughout the Virgin Islands, this is the dominant forest cover. On St. John, well over 50% of the island is vegetated with this cover type. A large percentage of the remaining undeveloped land on St. Thomas and a majority of the small quantity of remaining forest on northwestern hill slopes on St. Croix are classified as this forest type. This forest group contains a number of fairly distinct forest types, which vary in physiognomy, composition and in degree of human modification. In most cases these forests may be found on north facing hillsides of all main islands, upper southern facing elevations below 250 meters, in basins without large watersheds, along smaller guts and ravines and mixed with dry deciduous forests on lower south facing slopes.

Semi-evergreen Forest (sef) - This forest cover type is very similar in distribution to the semi deciduous type and in many locations grades into it. It is generally found above 250 meters in elevation, on northwest facing slopes below moist forest levels. Species composition changes to include a shift toward a greater majority of evergreen species. This type is found on all three main islands, but to a greater degree on St. Thomas west end.

Drought-deciduous Forest (ddf) - The drought deciduous forests are found on all three islands, but may be difficult to delineate other than during the annual dry season from January - May. Structure and species composition is much the same as semi-deciduous forests, but this type is characterized by greater than 75% deciduous species. Species may have differing leaf phenology under varying climatic conditions, being evergreen in one location and deciduous in another. The formation is found mainly at lower elevations below 250 meters, on south and southwest facing slopes toward the drier east end locations and in south and west aspects along the north shores. The forest is low in stature with emergent trees at 15 meters. The main canopy rises to 7-10 meters. Shrubs are moderately sparse to abundant while the herb layer is ephemeral, regularly dying back in drier weather.

Woodlands

II.A.1.N.a. Lowland tropical/subtropical broad-leaved evergreen woodland.
II.B.1.N.a. Lowland or submontane broad-leaved drought deciduous woodland.
II.C.1.N.a. Tropical or subtropical semi-deciduous woodland.

These forest types are characterized by an open tree canopy where the crowns are generally separated and cover is approximately 25-60 %. Many of these woodland areas throughout the islands are of anthropogenic origin. They are more common to St. Croix than to St. Thomas and St. John as a result of human activities a previous land use history. A substantial number of the same species found in the dry forests are also found here. Height of the canopy varies greatly depending on human modifications, effects of hurricanes and available soil moisture but may be from 8 - 20 meters. The cover types in this category grade into one another and are difficult to distinguish except by sampling and critical observation.

Evergreen Woodland (ew) - This vegetation cover type occurs as very small patches on steep northern slopes at low elevations. It is found on all three islands and on some of the offshore cays where landscape modifications have taken place. In a number of locations it may occur as a coconut palm woodland in basin or coastal areas.

Gallery Semi-deciduous Woodland (gsw) - St. Croix, as a result of extensive land clearing, may be the only island, which exhibits this cover type. It is primarily found in guts and ravines at low elevation and appears as strips of open canopy woodland where the guts pass through cleared areas.

Semi-deciduous Woodland (sdw) - Found primarily on abandoned agricultural land on St. Croix and also in central and eastern St. Thomas. The species composition is comprised mainly of common native and naturalized exotics. The size range varies considerably with past land use history and may range from 5-25 meters. Canopy cover is open, from 25 - 60% commonly. These areas are typically influenced by hurricane winds which reduce canopy cover temporarily.

Drought Deciduous Woodland (ddw) -This type occurs most commonly on St. Croix on the drier eastern hills and in patchy areas across the island. Species composition and community structure are very similar to other woodland types. Delineation is difficult.

Shrublands

III.A.1.N.b. Tropical/subtropical broad-leaved evergreen shrubland.
III.A.1.N.c. Sclerophyllous tropical/subtropical broad-leaved evergreen.
III.A.5.N.a. Broad-leaved microphyllous evergreen extremely xeromorphic sub-desert shrubland.
III.A.5.N.c. Succulent extremely xeromorphic evergreen shrubland.
III.B.1.N.a. Lowland drought deciduous shrubland.
III.B.3.N.a. Extremely xeromorphic deciduous sub-desert shrubland.
III.C.1.N.a. Mixed evergreen drought deciduous shrubland with succulents.
III.C.3.N.a. Extremely xeromorphic deciduous sub-desert shrubland with Succulents.
IV.C.1.N.b. Mixed evergreen drought deciduous dwarf shrubland.

Shrublands occur in dry locations at low elevations on all islands and offshore cays. These communities are at least 0.5 meters to 5 meters in height with 3 meter height typical. Shrubs are generally defined as multiple stemmed, bushy and interlocking in structure. Thorny shrubs and cactus species are common along with succulents in some locations. These vegetation types are quite difficult to distinguish between categories and vary in height, structure and species composition. Aspect, elevation and past land use history can have a profound effect. Due to severe environmental constraints of thin soils, strong winds and little moisture, vegetation height is limited. Land use history may impact many of these transitional communities where succession will create different cover types in the future.

Gallery Shrubland (gs) - These cover types are found most commonly in small guts and ravines where additional catchment and soil moisture prevail. Many evergreen species are common to these locations and height of the vegetation is typically at the taller end of the spectrum. They may form very dense communities in these areas and may remain as a result of land use history, being transitional stages to other community types.

Thicket/scrub (t/s) - This deciduous formation is quite common on all three islands and cays. It is characterized by thorny scrub communities which generally form a very dense, closed cover community. The height of the vegetation averages approximately 3-4 meters with occasional emergent trees. These communities may have uniform height as mono-specific stands or structural variety as a mixture of two species. This community type may also exist in many locations as a transitional seral stage to taller woodland or dry forest types. Land use history has great influence in the distribution of this cover.

Mixed Dry Shrubland (mds) - This vegetation cover is common to the drier parts of all three islands; east and south shores and low elevation locations. It may in some places extend as far up as 275 meters on south facing slopes. An extremely diverse community, Cacti and Agave are common though scattered, while vegetation height can range from 1-10 meters. The taller forms may consist of a canopy layer of larger individuals under slightly more moist conditions. The shorter forms are common to very exposed locations such as the east sides of headlands on the south shores.

Sclerophyllous Evergreen Shrubland (ses) - This formation type is less common than that described above and occurs mainly on St. Thomas and in certain east end locations on St. John. Slight changes in moisture regime and aspect, along with thin soils create conditions where other shrublands grade into this. Plants exhibit a strong degree of sclerophylly and evergreen species become somewhat more numerous. The distinction between this formation and coastal hedge can be extremely difficult to discern.

Coastal Hedge (ch) - shaped by wind shear and salt spray, these dense patch communities can be very low growing (less than 1 meter) or as tall as 3 meters. They are generally found on east, southeast or northeast coastal areas with exposure to prevailing winds. The limited species are generally wind and salt adapted. The formation may occur on the berms of beaches, seaward of salt ponds and flats or above rocky coasts or pavement. Hedge effect from wind is the prevailing structural architect for the environment as almost all of the species found here are capable of greater height in less hostile environments. The severe environment causes plants to produce small, succulent leaves which can be highly cutinized.

Herbaceous

V.A.1.N.a.	**Tall tropical/subtropical grassland.**
V.A.1.N.b.	**Medium tall sod tropical/subtropical grassland.**
V.A.1.N.c.	**Medium tall bunch tropical/subtropical grassland.**
V.A.1.N.d.	**Short sod tropical/subtropical grassland.**
V.A.2.N.b.	**Tall tropical/subtropical grassland with mainly broad-leaved Evergreen drought deciduous trees.**
V.A.2.N.d.	**Medium tall tropical/subtropical grassland with broad-leaved Drought deciduous trees.**
V.A.3.N.	**Tropical/Subtropical grassland with a shrub layer, natural or semi-natural.**
V.A.4.N.	**Tropical or subtropical grassland with a dwarf shrub layer, natural or semi-natural.**

Herbaceous communities occur in areas of very low rainfall, along the coast or in areas which have been subject to disturbance by human activities associated with agriculture and grazing of livestock. Many herbaceous communities may have

a small percentage of shrub species and broad-leaved evergreen and semi-deciduous trees as a component. These ecosystems are dominated by grasses and maintained by grazing and fire and are generally located on nearly flat or moderate slopes.

Pasture (p) - These are primarily grasslands with a very low (less than 10%) incidence of shrub and tree species occurring as part of the community. These can generally be classified as planted and cultivated areas subject to maintenance by grazing and fire.

Pasture mixed scrub (pms) - Grassland dominated communities with greater than 10 - 25% thorn/scrub vegetation. This community type results when grazing and fire maintenance have been discontinued and successional changes occur within the community.

Mixed Dry Grassland (mg) - Grassland dominated communities with greater than 25% shrub, tree and herbaceous species usually formed by selective grazing of livestock that shun spiny and/or poisonous plants.

Coastal Grassland (cg) - Extremes of wind, salt spray and low moisture sometimes combine to form communities of grasses adapted to these harsh conditions

Sparse Vegetation

VII.A.1.N.a. Cliffs with sparse vascular vegetation
VII.C.2.N.b. Intermittently flooded sand, gravel, cobble beaches

Rock Pavement (rp) - Coastal cliffs, rocky outcrops, boulder fields and landslide areas with less than 10% vegetative cover.

Beach (sand, cobble or gravel) (b) - Shoreline beaches of sand, cobble or gravel that exhibit less than 10% vegetative cover.

Wetlands

I.A.5.N.f. Tidally flooded tropical or subtropical broad-leaved evergreen Sclerophyllous closed tree canopy.
III.A.1.N.e. Seasonally flooded/saturated tropical/subtropical broad-leaved evergreen shrubland.
III.A.1.N.g. Semi-permanently flooded tropical or subtropical broad-leaved evergreen shrubland.
VII.C.4.N.b. Intermittently flooded mud flats.

Mangrove Forest (mf) - Mangrove forests dominated by Rhizophora mangle and other mangrove species exhibiting a closed tree canopy.

Mangrove Woodland (mw) - Similar to the above with a less dense association where the tree canopy is not closed. This woodland type lies at the shoreward extreme of the tidally flooded areas and may be dominated by Avicennia germinans, Laguncularia racemosa and Conocarpus erectus.

Mangrove Shrubland (ms) - Nontidal shrublands or scrub mangrove thickets dominated by Rhizophora mangle. Occurs in more stressed sites than mangrove forests and has shorter individuals (less than 5 meters and usually only one-half to two meters tall) and often sparser as well.

Fringing Mangrove (fm) - Shoreline and salt pond vegetation which is semi-permanently and tidally flooded. These areas are quite common to all islands

Mixed Swamp (msp) - Semi-permanently and tidally flooded communities composed of a mixture of mangrove and wetland tree and shrub species.

Salt Flat (sf) - Coastal pond areas, sand and mud flats behind barrier beaches.

Salt Pond (sp) - Permanently flooded coastal ponds.

Fresh pond (fp) - Permanent catchment and drainage areas of fresh water.

Cropland (c) - Agricultural areas and farm plots.

Developed Areas (d) - Areas permanently altered for the purpose of residential, commercial and industrial uses.

F.5 Vascular plant inventory and mapping of Buck Island Buck Island Reef National Monument St. Croix, U.S. Virgin Islands

Ray, G. 2003. Vascular plant inventory and mapping of Buck Island Buck Island Reef National Monument St. Croix, U.S. Virgin Islands. Cooperative agreement between the University of the Virgin Islands and U.S. Department of the Interior National Park Service South Florida / Caribbean Network. DRAFT.

Vascular Plant Inventory and Mapping of Buck Island

Buck Island Reef National Monument

St. Croix, U.S. Virgin Islands

Gary Ray

March 20, 2003

Task Order Number Two (2): J5000 01 0642

Under agreement between
The University of the Virgin Islands &
The National Park Service

(DRAFT VERSION SUBMITTED TO NPS)

[cover image: Buck Island from the southwest during rainy season]

CONTENTS

Introduction
- Overview of Prior Work 3
- The Physical Setting 3
- Objectives 9

Methods
- Species Abundance and Mapping 9
- Plant Community Assessment 10
- Voucher Collection Techniques 11
- Long-term Monitoring of Plant Community Change 12

Results
- Statistical Summary of the Flora 12
- Exotic Invasions 14
- Plant Community Structure 15
- Frequency 16
- Coverage 16

Discussion 18
- Rare Plant Considerations 19
- Bird Recovery 20
- Problems of Exotic Plants Management 22

References Cited 24

Appendix A -- Plant list 25

Appendix B – Sample species distribution map 30

INTRODUCTION

This report documents a terrestrial vascular flora of Buck Island, St. Croix, U.S. Virgin Islands, and it describes a digital mapping of the island's plant communities in order to track ecological change following the eradication of its large and destructive arboreal rat (*Rattus ratus*) population in 2000. The success of that eradication program has been well established by National Park Service resource managers with repeated trapping efforts subsequent to its completion. Numerical abundance data collected during this study, when organized spatially, can greatly facilitate land management, including exotic plant control or removal, rare plant conservation and restoration, long-term community monitoring and associated wildlife protection projects.

As our project began in June 2001, signs of vegetation recovery were everywhere in evidence. Trees consisting entirely of branches that had been severely pruned by gnawing of rats in recent years were beginning to form more natural, umbrella-shaped canopies. Plentiful fruit providing a diet for native birds and bats was maturing on the branches, and even falling to the ground to set the stage for seedling recruitment and regeneration became plentiful. Successful nesting of seabirds, shorebirds, and birds from wetlands and upland habitats substantiated our impressions. Future research and management efforts can build on these benchmark data, expanding upon our botanical focus to encompass the entirety of the biota and its ecology.

Overview of Prior Work

This report succeeds two recent documents, a detailed inventory completed more than 25 years ago by Roy O. Woodbury and Elbert E. Little entitled, "Flora of Buck Island Reef National Monument, U.S. Virgin Islands" (Woodbury and Little 1976), and a brief reassessment that included a listing of plants new to the island in 1996 (Eleanor Gibney, unpub. data). Historical floras of St. Croix also have been published (West 1793; von Eggers 1879; Millspaugh 1902; Britton 1918; Britton & Wilson 1923-30).

The existence of a population of a rare plant, Stinging bush, or *Malpighia pallens* (currently *M. infestissima*), was documented by Woodbury and Little (1976). Its presence was confirmed in the early 1990's by a field party that included Eleanor Gibney and the author. Another rarity, Wooly nipple cactus (*Mammilaria nivosa*), had been sighted in a coastal location. Vital to their protection, more detailed Information was needed on the population status of rare and endangered plant species. The current study has contributed to this conservation work.

The Physical Setting

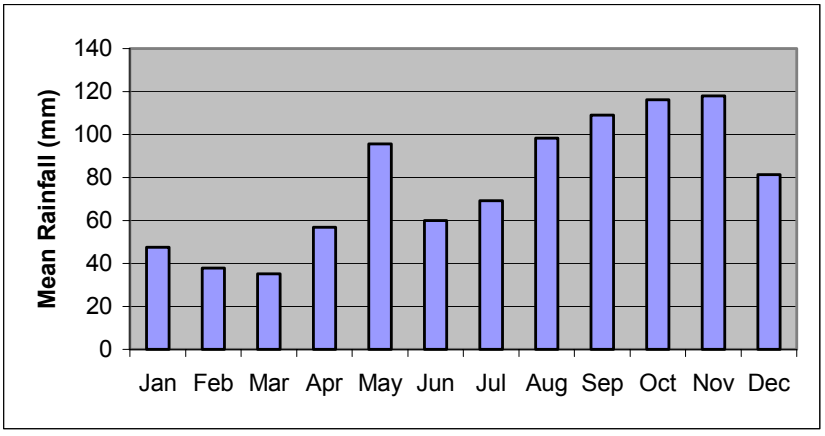
Buck Island's biotic communities cover 71.25 hectares of mostly sloping terrain. Its most prominent topographic feature is a single, 1.6-km ridgeline running approximately east-to-west. The ridge rather evenly divides it shrublands into north and south orientations, adding a measure of microclimatic variability to an otherwise uncomplicated environmental setting. It is located at 17^0 47' N, 64^0 37' W, and separated by a 3-km channel from the north shore of St. Croix off the main island's eastern section. Topographic relief and variation are low. The

highest point is just over 100 m, and nearly seventy percent of the island consists of slopes ranging from 20 – 70% (Davis 1998). Significant bottomlands include a basin mangrove swamp with a salt pond, perimeter saltgrass marsh and adjacent flatlands amounting to five hectares on the island's south-central coast, and a small coastal plain of 2.7 ha occupying the west to northwest coastline. The mean annual temperature in the Virgin Islands is 77^0 F (USDA, NRCS unpublished data). The mean monthly temperature varies only 5 to 7^0 F through the year (72^0 – 78^0 F), while mean daily maximum and minimum temperatures in warmest months range from 74^0 – 88^0 F and the coolest months from 68^0 – 82^0 F. Relative humidity (airport measures are typically drier than forests) is high year-round, with mean nighttime levels at 86% and mean daytime levels at 69%. Mean monthly nighttime relative humidity ranges from 81% in the driest months to 90% in the wettest months. Mean monthly daytime ranges are 63% in January (driest) to 73% in August and September (wettest). Northeast trade winds blowing in winter months at 10-20 knots for 60% of the time, and > 20-kt winds 25% of the time (increasing periodically with northerly Christmas winds) add greatly to desiccation effects. Trades are continuous most of the year, abating somewhat by middle to late summer and returning well by middle autumn.

Fig. 1. An aerial view of Buck Island, St. Croix, U.S. Virgin Islands

The projected mean annual rainfall accumulation is 925 mm, based on 36 years of complete monthly totals reported from East Hill, a NOAA weather station four kilometers south of the island on St. Croix (NOAA, unpublished data). While the temporal distribution pattern for rainfall is generally erratic, long term data indicate a bimodal trend, with peak rainfall in the months of August through November along with a brief rainy period in May (Fig. 2). Drought conditions predominate. Monthly totals of less than 100 mm (a commonly accepted tropical drought threshold), on average, occur in seven to eight months of the year.

Figure 2. Mean monthly rainfall in millimeters for East Hill, St. Croix (near Buck Island) based on the 36 years of complete data sets, 1956-1997. Total mean annual rainfall for these years is 925 mm.



The soils of Buck Island (*sensu* Davis 1998) are dominated by the Victory-Southgate complex (VsE and VsF) covering virtually all of its volcanic slopes and ridges – 68% of its land area. Victory–Southgate complex soils are very stony, shallow (depth to bedrock 0.5 – 1 m), well-drained, of moderate permeability and low to very lower water capacity. Natural fertility is low to moderate, and organic matter content is generally moderate.

Figure 3. Soil map of Buck Island from USDA-NRCS Digital Soil Survey of the Virgin Islands. A minor modification of soil series labeling for the salt pond and its perimeter (legend & details, Table 1).

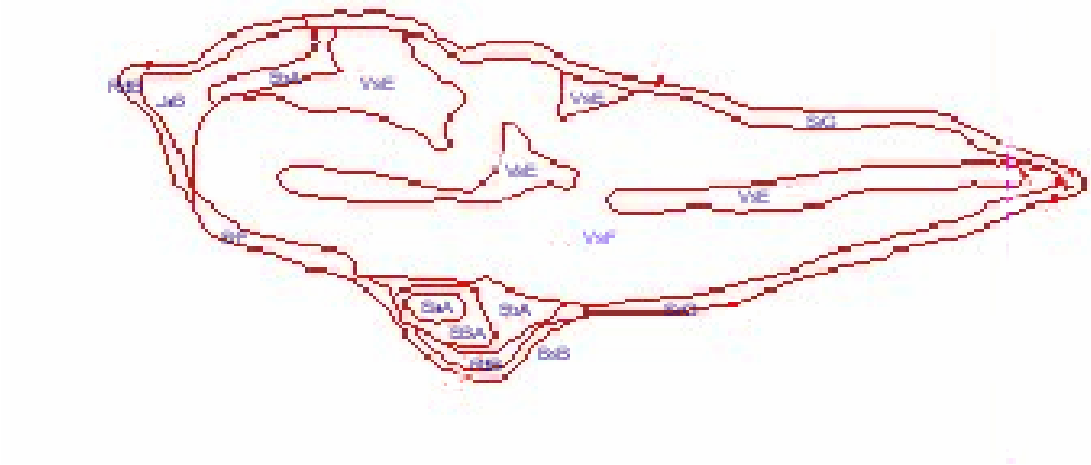


Table 1. Soil Series codes, descriptions and areal extent from the USDA-NRCS detailed soils map of Buck Island (see Fig. 3).

Series Code	Series description	Area (m^2)	Topographic description
SaA	Salt flats, ponded	5716	Salt pond
SBA	Sandy Point - Sugar Beach 0-2% freq flood	11034	Saltgrass marsh and pond perimeter
SoA	Solitude gravelly fine sandy loam 0-2% slope	15961	Dense thicket wrapping east and south
RdB	Red Hook extra stony sand 0-5% rarely flooded	8206	landward of sand beach
BsB	Beaches, sandy	9759	sand beach
RdB	Red Hook extra stony sand 0-5% rarely flooded	14605	Sandy beach west end
VsE	Victory-Southgate 20-40% slope	43122	Lower NW valley (above bottomland)
JaB	Jaucus sand 0-5% slope, rarely flooded	27032	Coastal flats west (beach forest)
SoA	Solitude gravelly fine sandy loam 0-2% slope	11135	NW access trail to coast
SrG	Southgate Rock outcrop complex 60-90% slope	68885	Shoreline N, E, S
SrF	Southgate Rock outcrop complex 40-60% slope	12731	Shoreline SW
VsF	Victory-Southgate 40-70% slope	409414	Slopes, north and south facing
VsE	Victory-Southgate 20-40% slope	6691	Ravine and slope, north central coast
VsE	Victory-Southgate 20-40% slope	37470	Ridgeline, central to east
VsE	Victory-Southgate 20-40% slope	30780	Ridgeline, center-west to west
		712541	**TOTAL AREA (m^2)**
		71.2541	**Total area (ha)**

Buck Island's vegetation is designated as subtropical dry forest, a bioclimatic life zone classification developed by Holdridge (1967). This forest system is similar to other well preserved natural communities in the northern Virgin Islands (Ray et al. 1998; Ray and Brown 1995). The plant communities associated with dry forest in the Caribbean tropics, as elsewhere, are adapted to frequent drought and high evaporation rates associated with warm temperatures and windy conditions. Characteristic adaptations to these conditions include deciduousness (leaf loss), small, thickened or pubescent evergreen leaves often with recessed stomata (pores) to reduce moisture loss during photosynthesis, low growth habit, and numerous other physiological and anatomical features. There are four distinct plant community types on the island. A scrub thicket (dense shrubland) consisting chiefly of shrubs under 2 m in height covers most of the island. A semi-deciduous dry woodland that features a full canopy 4-6 m tall, but of very limited extent, is restricted to the banks of ravines and some basin areas. A mangrove community, absent the red mangrove, surrounds a small salt pond. A beach forest is intermittent on a coastal sandy substrate on the island's west end. It includes a conspicuous, Manchineel-dominated (*Hippomane mancinella*) association, but more diverse inclusions of taller trees are also present. Minor but distinctive communities also include extensive beach strand vegetation, a marshy saltgrass glade at the perimeter of the salt pond, and a second Manchineel community proximal to both the mangrove and the back dune zone. Topographic relief and slope aspect act in concert to produce an array of microhabitats, adding greatly to the within-habitat and among-habitat species diversity. The south-facing slopes are drier and more sparsely covered by shrubs and some trees. The north side exhibits a generally higher shrub and tree canopy density.

Figure 4. Shrubland is the dominant plant community of Buck Island. This view is from central ridgeline (foreground) looking west. North-facing shrubland continues into distance along slope.



Figure 7. Interior, dry semi-deciduous woodland – featuring close-up of the trunk of *Eugenia rhombia*.



Figure 8. Salt pond at center of basin mangrove community, south shore of Buck Island.



Figure 9. Interior view of Manchineel-dominated beech forest of the southwest coastal plain of Buck Island.



Figure 10. Beach strand community of Buck Island – a low-growing association confined to the primary sand dune from the supratidal fringe zone to landward boundary of mineral soil.



Project Objectives

In collaboration with Zandy Hillis-Starr, chief resource manager for Buck Island Reef

National Monument (BUIS) we intended to produce a comprehensive list of vascular plant species for the island, collect and prepare voucher specimens for all non-threatened species, and create a database of abundance information for all species encountered. Near the completion of this study we took initial steps to establish a permanent monitoring program to document vegetation recovery, and to provide the NPS recommendations for exotic plant control. Data files were to be produced with sufficient integrity to be effectively used by BUIS land managers and NPS offices (including the South Florida / Caribbean Inventory and Monitoring Coordinator) to create ArcView shape files for myriad functions. With these products GIS experts from the National Park Service produce FGDC compliant metadata to describe the GIS data, and to transfer spreadsheets into an Access database for permanent archiving and convenient analysis.

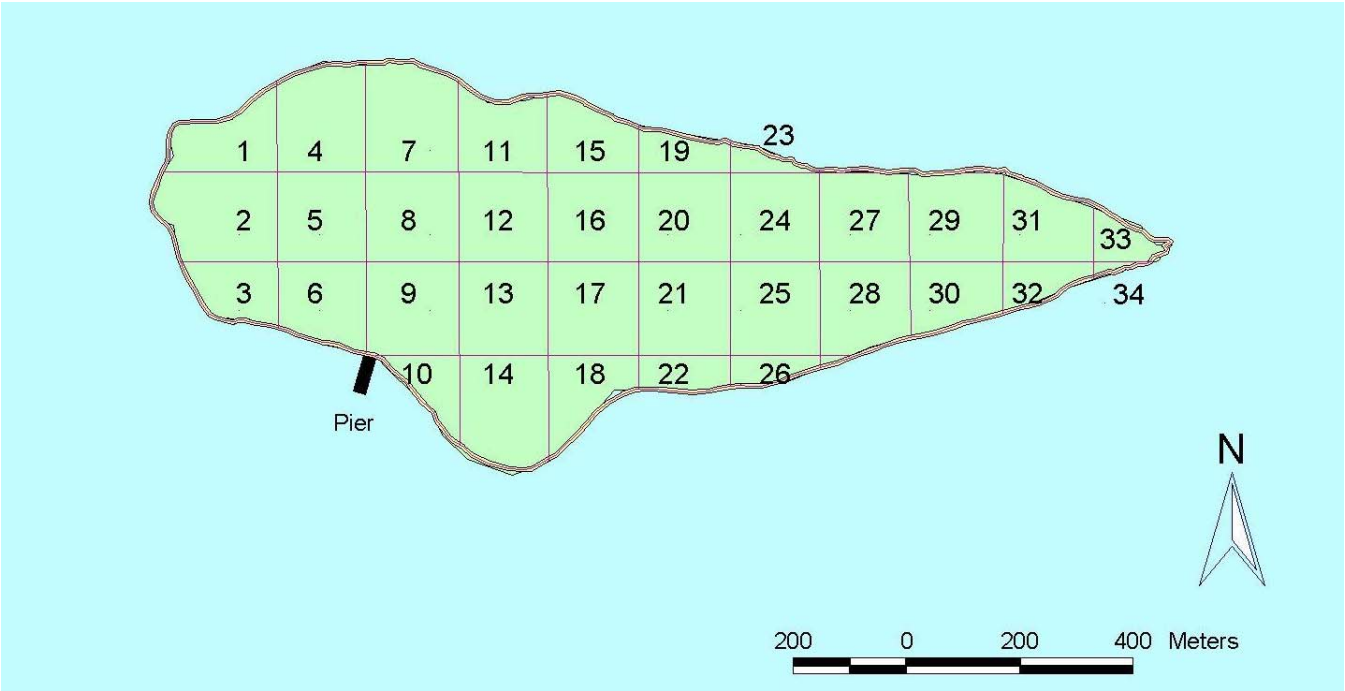
METHODS

Species Abundance & Mapping

The Mapping Grid

Building upon the existing 40-m square grid system utilized for the rat eradication project in 1999-2000, we constructed mapping units of 160-m X 160-m square cells. Each was produced by combining 16 of the 40-m x 40-m blocks already established on the ground. This procedure generated 34 mapping cells for the island as a whole. Latitude and longitude coordinates were recorded for cell corners using a GPS navigational device.

Figure 4. Locations of 160 m X 160 m mapping cells (total of 34) for Buck Island species abundance database.



Plant Community Assessment

Within these 34 cells, we traversed west-to-east and north-to-south most of the grid trails, recording each new species encountered. I scored each cell for canopy cover of every species, assigning each to an abundance category, using a modified Braun-Blanquette cover abundance scale (Table2).

Table 2. Categories for estimating percent canopy coverage for all plant species in each of 34 mapping cells during the Buck Island vegetation inventory and mapping project.

Cover class	Percent cover
1	< 1 %
2	1 – 5 %
3	6 -25 %
4	26 – 50 %
5	51 – 75 %
6	76 – 95 %
7	> 95 %

Each of the 34 mapping cells contains a species list with relative abundance based upon cover class estimates for every species. A comprehensive species table consisting of all vascular plant species and their corresponding cover class in each of 34 mapping cells is the composite raw data source for species distribution maps island-wide, and for species abundance analysis for the island flora.

Voucher collection techniques

Vouchers in duplicate of every species recorded on the island-wide list were collected to assure data integrity. The author (with field assistance from NPS staff, subcontractor and volunteer field crew members) assembled a duplicated collection of plant species encountered on Buck Island (BUIS) and entered these data into species abundance maps of the 34 mapping cell plant lists. Plants were pressed in the field, dried and identified to species. Specimens were shipped to the Fairchild Tropical Garden (FTG) in Coral Gables, FL for mounting. FTG and BUIS will each retain a full collection set. Label data for each specimen collected included collector, collection number, collection date, description of habit, reproductive condition, and morphology, habitat information, elevation, and locality data, specifically latitude and longitude coordinates.

Figure 4. Field collection of plant specimens ably assisted by James Rebholz.

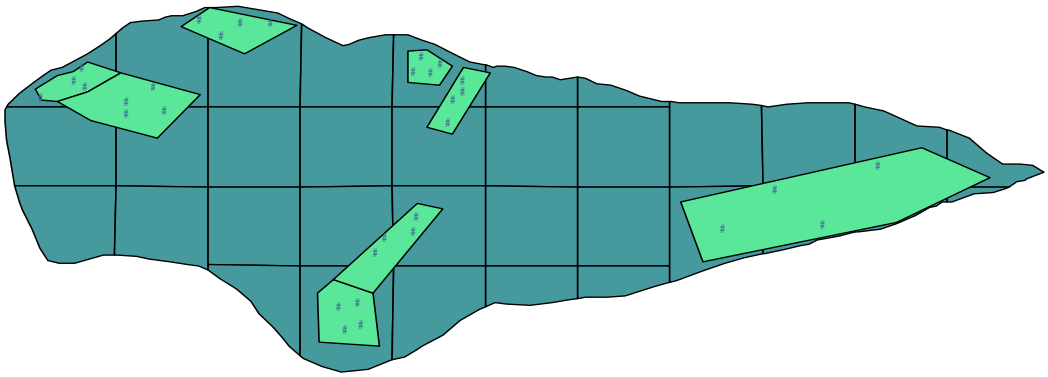


The author also produced digital photo-imagery, not included in a contractual agreement, of numerous selected plants, and will make copies available to the NPS upon request.

Long-term Monitoring of Plant Community Change

The field crew initiated the establishment of a series of 32 permanent monitoring plots designed to evaluate intensively the dynamics of plant community structure among the major vegetation types (Fig. 5). The study will yield a wealth of detailed information on present and future composition, growth rates, mortality and response to disturbance of constituent populations.

Figure 5. Distribution of monitoring zones (polygons) and randomly generated locations of permanent plots (points) among the 34 mapping units (bounded by grids) for Buck Island, St. Croix.



RESULTS

Statistical Summary of the Flora

The number of vascular plant species documented from Buck Island in this study was 164, (see Appendix 1). This number includes 143 (87%) native species and 21 (17%) naturalized exotics. This ratio closely matches the flora of St. John (Acevedo-Rodriques 1996), in which 86% of the flora is indigenous to that island. I recorded 132 genera from 55 flowering plant families in this inventory. I encountered no ferns or gymnosperms.

The mean number of species per family is 2.85; the mean number of genera per family is 2.40. Approximately 81% of the genera are monospecific (single taxon per genus). These data indicate that the taxonomic diversity is concentrated mainly at the generic level; indeed the ratio of species to genera is only 1.2. Also, family representation is remarkably high (30% of species richness) for a small island lacking in elevation and in topographic variation.

Although it is likely that the Buck Island flora has actually diminished since 1976, this is difficult to confirm due to differences between the two inventories with regard to collection schedules (both their timing and duration) and the variation of weather.

Table 3. Comparison of species richness among the best represented vascular plant families on Buck Island from Ray (2003) and Woodbury & Little (1976).

Plant Family	Species Richness (Ray 2003)	Species Richness (Woodbury & Little 1976)
Poaceae	14	22
Euphorbiaceae	12	17
Boraginaceae	8	9

Cactaceae	7	7
Verbenaceae	6	7
Rubiaceae	5	8
Asteraceae	4	9
Bignoniaceae	4	3
Capparaceae	4	5
Malpighiaceae	4	4
Malvaceae	4	9
Myrtaceae	4	3
Nyctaginaceae	4	5
Polygonaceae	4	4

A floristic inventory produced by Roy O. Woodbury and Elbert L. Little, Jr. (1976) totaled 228 vascular plant species. Woodbury and Little (1976) describe four collecting trips covering only seven days to assemble their flora: June 22, 1966, April 14, 1967 (exclusively Elbert Little's collections), June 9-10, 1969, and November 10-12, 1970 (Woodbury and Little as a team). They remark that their 1969 and 1970 collecting trips were subsequent to heavy rainfall periods and that specimen condition was near optimal (Woodbury & Little 1976).

This inventory was accrued in 25 field days: June 11-23, 2001, December 17-21, 2001, and May 17-23, 2002, with effort evenly divided between plant collecting and ecological sampling. The most favorable collecting conditions were met on the December 2001 trip, yet most of the work occurred during times of dormancy for many herbaceous plants. A comprehensive listing would require either more frequent wet-season collecting or a year-round sampling effort.

Of the current total of 164 species, 160 were sampled, pressed and identified in our voucher collection. Four species observed on the island were not collected for various reasons. *Mammillaria nivosa* was not collected its habitat is highly restricted to rocky coastal cliffs, and the clonal colony is one of only two known to exist on the island. Two exotic species, *Cocos nucifera and Agave missionum*, require specialized collecting and pressing techniques to convert them to herbarium specimens. Both species are destined for removal from the island. A fourth species, *Guapira fragrans*, was missed due to an error in handling. As a consequence of this effort to obtain high-quality herbarium specimens in flowering or fruiting stages, many species are represented more than once in this collection.

Fifteen new species not recorded by Woodbury & Little (1976) were encountered in this survey (Table 3). Eight of these were non-natives; three grasses among them. Two shrubs of the diverse Myrtle family, *Eugenia cordata*, and *E. procera*, were added to the Buck Island flora. The more common *E. axillaris* and *E. rhombea* having been documented previously brings the total *Eugenia* count to four. The Beach pea (*Ipomoea pes caprae*), common elsewhere in the tropics, had not been recorded previously by Woodbury & Little. It is uncommon, but was encountered in this study in two habitats – a beach strand and a north-facing slope.

Table 3. Vascular plant species not previously published as present on Buck Island.

No.	Scientific name	Author	Family	Status of Origin
1	*Agave missionum*	Trel.	*Agavaceae*	planted (N. VI)
2	*Bromelia pinguin*	L.	*Bromeliaceae*	exotic
3	*Chamaesyce mesembrianthemifolia*	(Jacq.) Dugand	*Euphorbiaceae*	indigenous
4	*Convolvulus nodiflorus*	Desr. In Lam.	*Convolvulaceae*	indigenous
5	*Dactyloctenium aegyptium*	(L.) Beauv.	*Poaceae*	exotic
6	*Dalbergia ecastaphyllum*	(L.) Taub.	*Fabaceae*	indigenous
7	*Digitaria insularis*	(L.) Nees.	*Poaceae*	exotic
8	*Eugenia cordata*	(Sw.) DC	*Myrtaceae*	indigenous
9	*Eugenia procera*	(Sw) Poir	*Myrtaceae*	indigenous
10	*Ipomoea pes caprae*	(L.) R. Br. In Tuckey	*Convolvulaceae*	indigenous
11	*Morinda citrifolia*	L.	*Rubiaceae*	exotic
12	*Panicum chapmani*	Vasey	*Poaceae*	exotic
13	*Plumbago scandens*	L.	*Plumbaginaceae*	exotic
14	*Sida repens*	Dombey *ex* Cav.	*Malvaceae*	exotic
15	*Tecoma stans*	(L.) Juss. *Ex* Kunth.	*Bignoniaceae*	exotic(?)

Exotic Invasions

Introduced species do not contribute significantly (5.94%) to species importance within the Buck Island plant community as a whole. In total, only 21 (13%) of 163 documented species were non-natives. Among the top 52 species (based on relative importance) only 2 species, Guinea grass (*Urochloa maxima*) and Tan-tan (*Leucaena leucocephala*), were non-native. Despite their low importance the spatial distribution of these two non-natives is widespread. Guinea grass was observed in nearly 75% of the mapping cells, and Tan-tan occurred in 19 (56%) of the cells. It should be noted that Tan-tan seeds are well represented in the soil seed bank in the Virgin Islands, owing to its popularity as a fodder crop for livestock locally, its resilient seed coat and a tendency to remain dormant for long periods. I collected 39 herbs, at least 27 of which were native to the region (a single herb has not been identified). All 14 herbaceous vines were indigenous to the island. We encountered one exotic and 8 indigenous woody vines (lianas).

Table 4. List of vascular plant species documented in this survey believed to have been introduced to Buck Island.

No.	Scientific name	Common name	Family	Origin	Habit	Relative Import
1	*Urochloa maxima*	guinea-grass	*Poaceae*	Africa	herb	1.66
2	*Leucaena leucocephala*	tan tan	*Fabaceae*	Mexico	tree	1.09
3	*Chloris barbata*	fingergrass	*Poaceae*	neotropics	herb	0.69
4	*Tamarindus indica*	tamarind	*Fabaceae*	India	tree	0.42
5	*Tecoma stans*	ginger thomas	*Bignoniaceae*	neotropics	shrub	0.40
6	*Panicum chapmani*	panic grass	*Poaceae*	Bahamas	herb	0.27
7	*Abrus precatorius*	jumbie bead	*Fabaceae*	Africa	vine	0.20
8	*Thespesia populnea*	Haiti-haiti,	*Malvaceae*	pantropical	tree	0.20

9	*Agave missionum*	century plant	*Agavaceae*	Northern VI	herb	0.15
10	*Boerhavia erecta*	alena	*Nyctaginaceae*	pantropical	herb	0.15
11	*Cocos nucifera*	coconut	*Arecaceae*	Pacific rim	tree	0.10
12	*Melicoccus bijugatus*	kenip	*Sapindaceae*	South America	tree	0.10
13	*Morinda citrifolia*	painkiller	*Rubiaceae*	W. Pacific	shrub	0.10
14	*Sida repens*	Creeping mallow	*Malvaceae*	Asia	herb	0.10
15	*Bromelia pinguin*	wild pineapple	*Bromeliaceae*	Gr. Antilles	herb	0.07
16	*Aloe vera*	aloe	*Liliaceae*	Mediterranean	herb	0.05
17	*Bothriochloa pertusa*	hurricane grass	*Poaceae*	Old World tropics	herb	0.05
18	*Cleome viscosa*	cleome	*Capparaceae*	Asia	herb	0.05
19	*Dactyloctenium aegyptium*	Egypt grass	*Poaceae*	Africa	herb	0.05
20	*Mollugo nudicaulis*	mollugo	*Molluginaceae*	Old World tropics	herb	0.05

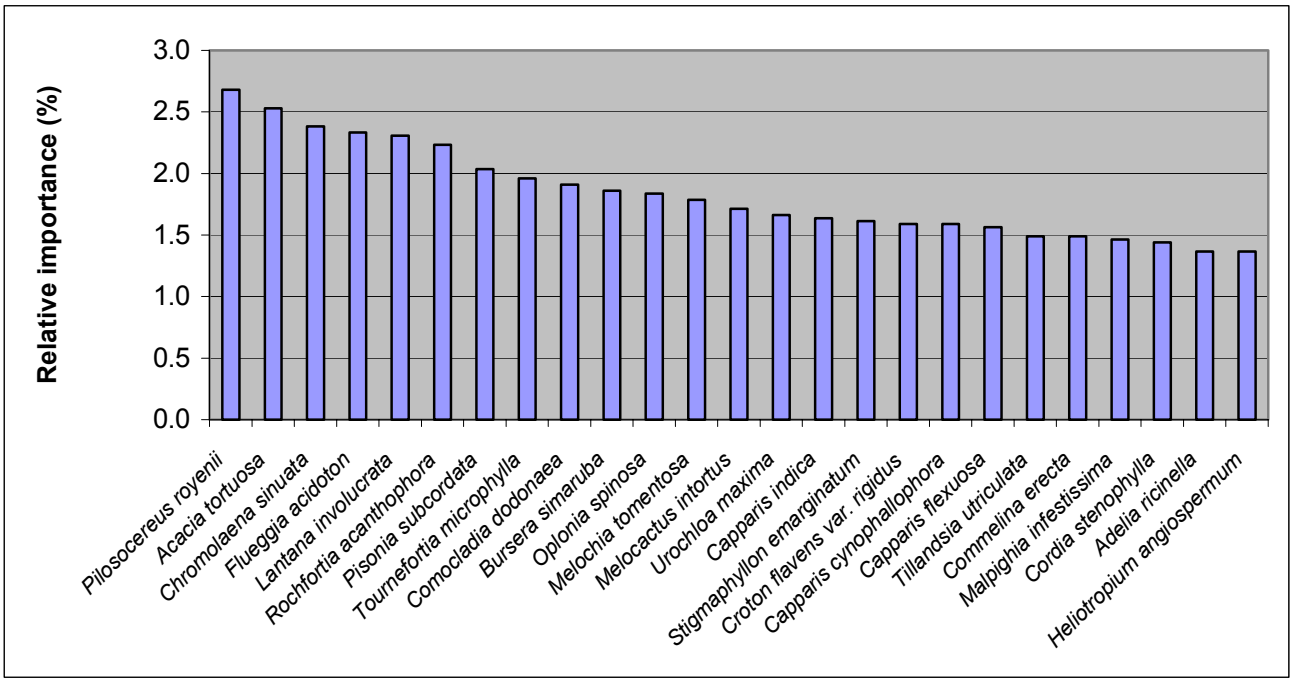
Plant Community Structure

Floristic Diversity

Shannon-Wiener diversity (H') island-wide is 4.57. This value is based on the use of species *cover class estimates* to calculate the 163 species proportions, rather than using species density. For a shrub-dominated community, this modification may well provide a better measure of species richness and relative abundance due to the relatively small size and resource demand of many of Buck Island's woody species.

In a manner similar to many tropical forest communities, and dry forest communities in particular, no species is clearly dominant over the remaining community members (Fig 3). The most abundant species represented only 2.75 % of the abundance rankings, and no two species differed in abundance (Importance Value, IV) by more than a fraction of a percent.

Figure 3. Species Importance, as a percentage of overall importance, for the 25 top-ranking species of the vascular plant community on Buck Island, St. Croix in June 2002. Importance Value, in this instance, was based on the summation of two abundance measures: relative frequency and relative dominance (estimated as canopy coverage class). Each absolute value for species importance was converted to a percentile to reflect its importance within the community of 163 documented plant species.



Frequency

Species *frequency* is a measure of how effectively a plant distributes itself across the landscape, regardless of microhabitat. Four plant species occur in all 34 mapping cells on the island. Type of dispersal mechanism is apparently of little consequence. Bird-, gravity-, and wind-dispersed plant species are all represented among the most ubiquitously distributed plants. These species are a tree cactus (*Pilosocereus royenii*) distributed by birds, a woody legume beset with large thorns (*Acacia macracantha*) an dispersed primarily by gravity, the wind-dispersed shrub (*Lantana involucrata*), and the bird-dispersed Turpentine tree (*Bursera simaruba*), a signature tree of the Virgin Islands dry forest.

Coverage

Canopy coverage and related measures such as basal area are ways of expressing community dominance of a particular species or cluster of species relative to its neighbors. The Pipe organ cactus (*Pilosocereus royenii*) ranked highest in cover as well as frequency. A couple more species, *Acacia tortuosa* and *Lantana involucrata*, also ranked very highly in both categories. However, other common species ranking much lower in frequency from one mapping cell to the next, exhibited greater dominance where they did occur. Examples are the spiny shrub, *Flueggia acidoton*, and a common large tree, Water mampoo (*Pisonia subcordata*).

Table 5. Top ten plant species on Buck Island ranked by dominance (based on canopy cover estimates) as compared to frequency rankings.

Scientific name	*Family*	Freq Rank	Dom Rank
Pilosocereus royenii	*Cactaceae*	1	1
Flueggia acidoton	*Euphorbiaceae*	23	2
Acacia tortuosa	*Fabaceae*	1	3
Chromolaena sinuata	*Asteraceae*	13	4
Lantana involucrata	*Verbenaceae*	1	5
Rochfortia acanthophora	*Boraginaceae*	8	5
Pisonia subcordata	*Nyctaginaceae*	21	7
Tournefortia microphylla	*Boraginaceae*	10	8
Comocladia dodonaea	*Anacardiaceae*	8	9
Oplonia spinosa	*Acanthaceae*	16	9

Table 6. Anti-herbivory defenses of fifteen species with highest importance values among 165 plants documented in this study.

No.	Scientific name	Family	Defense type	Common name	Form	Relative Importance (%)
1	*Pilosocereus royenii*	*Cactaceae*	physical	Pipe-organ cactus	shrub	2.68
2	*Acacia tortuosa*	*Fabaceae*	physical	Casha	shrub	2.53
3	*Chromolaena sinuata*	*Asteraceae*	2^0chem		shrub	2.38
4	*Flueggia acidoton*	*Euphorbiaceae*	thorns		shrub	2.33
5	*Lantana involucrata*	*Verbenaceae*	2^0chem	Sage	shrub	2.31
6	*Rochfortia acanthophora*	*Boraginaceae*	physical		shrub	2.23
7	*Pisonia subcordata*	*Nyctaginaceae*	none apparent	Water mampoo	tree	2.03
8	*Tournefortia microphylla*	*Boraginaceae*	none		vine	1.96
9	*Comocladia dodonaea*	*Anacardiaceae*	2^0chem	Christmas-bush	shrub	1.91
10	*Bursera simaruba*	*Burseraceae*	2^0chem	Turpentine tree	tree	1.86
11	*Oplonia spinosa*	*Acanthaceae*	physical		shrub	1.84
12	*Melochia tomentosa*	*Sterculiaceae*	2^0chem	Broom weed	shrub	1.79
13	*Melocactus intortus*	*Cactaceae*	physical	Turk's cap cactus	shrub	1.71
14	*Urochloa maxima*	*Poaceae*	none apparent	Guinea-grass	herb	1.66
15	*Capparis indica*	*Capparaceae*	none	White caper	shrub	1.64

Buck Island's dominant plant community, covering about three-fourths of the island, is a shrubland. It was classified by Woodbury and Weaver (1987) as "thorn scrub", a compositionally diverse formation composed primarily of low to tall thicket of shrub species (Fig. 4). Physiognomic variants of this shrubland are not always floristically distinct, although canopies from a shrubland in a south-facing or windward site may be barely 0.5 to 1m in height, while its neighboring association on a north slope or leeward of a ridge may range from 2-3 m tall. Shrublands intergrade with "dry semi-deciduous woodlands" where more moisture is within reach of the root zone. This occurs only along the banks of major guts (ravines) or on slopes below perched water tables (Fig. 5), amounting to less than 5% of the island's vegetation. Canopies of these drought-deciduous communities are intermittently open, typically reaching 4-5 meters in height, with scattered emergent trees to approximately 8 meters tall. A basin mangrove inclusive of a salt pond is a third type of Buck Island community (Fig. 6), occupying about 7% of island plant communities. The mangrove is not fully developed floristically – lacking red mangrove trees typical of larger swamps or those with more frequent surface and subsurface contact with the seawater. The pond is dry much of the year, leaving a salt flat absent of vegetation. Manchineel grove communities on Buck Island are associated with coastal fringe and back-dune environments, and occupy the one to two percent of the island's vegetation found on the perimeter of the mangrove swamp or in the beach forest (Fig. 7).

DISCUSSION

Seventy-seven plant species listed on the Woodbury & Little (1976) report were not documented in this study (Appendix A). Many (33) of these species are seasonal in their growth response. For example, a parasitic vine (*Cassytha filiformis*) grows profusely during rainy weather; dry periods prompt seed set followed by vegetative dormancy. Other species are intolerant of prolonged dry conditions, and Buck Island populations of these species may have suffered massive mortality since Woodbury's floristic inventory. These taxa may have been eliminated from the island flora as a consequence of the catastrophic drought of 1994-95, or perhaps lesser droughts since the mid- to late-1960's, when most of the Woodbury and Little (1976) collections were made. For instance, *Tetrazygia elaeagnoides*, a common tree of canopy gaps and north-facing forest edges, but rare to Buck Island in 1976, was killed in great numbers on St. John during the historic Virgin Islands drought of 1994-95.

It is clear that the total number of vascular plant species presently on Buck Island exceeds 164. The previous estimate of 228 species, however, may have been too high due to overestimates of the number of taxa recorded by Woodbury & Little (1976) within genera of weedy annuals, such as *Sida* (6 species) and *Chloris* (3 species). Yet it must be assumed that prior workers never encountered some minor fraction of the flora. Species richness has likely diminished since the previous inventory. The number of species recorded by Woodbury & Little (1976) not encountered in 2002 greatly outnumber new species listings from this inventory. Species extirpation due to drought (January 1994 to May 1995) combined with high browsing stress by the enormous rat population may well put the actual number of plant species today in the neighborhood of 200.

The flora of Buck Island, while diverse in many respects, has been shaped inextricably by its land use history. Anthropogenic alteration of natural plant communities regionally may be summarized in four categories: high-value timber extraction, cutting for charcoal, fire (to open the canopy for livestock) and intensive livestock pasturing. Goat grazing epitomizes disturbance to these native plant communities. Anti-herbivore defenses are a powerful presence, both physical and chemical. High densities of armed woody plants, spiny cacti, and toxin-laden leaves of many unpalatable shrub species have crowded out many taller shrubs and trees that typify Virgin Island shrub and woodland communities. In fact, of the most abundant 10 species with a mean distribution of 91% of all mapping grids, only one species, Water mampoo (*Pisonia subcordata*) lacks obvious anti-herbivore defenses. Plant species once termed "disturbance increasers" in the parlance of range science, are clearly prevalent, if not dominant as a group in the shrub communities of Buck Island. Responding positively to a history of disproportionate goat grazing and related perturbation against their competitors, shrub species such as *Acacia tortuosa*, *Chromolaena sinuata, Lantana involucrata, Flueggia acidoton*, *Rochefortia acanthophora, Oplonia spinosa,* and *Croton spp.* perhaps were left behind in high densities as a consequence. The question remains: how stable is this preponderance of armed and unpalatable species in the context of long term community floristics? The permanent monitoring work provides a means of addressing this and other questions of community change over time.

Rare Plant Considerations

The rarity of only two vascular plant species from Buck Island is of particular note*:* *Malpighia infestissima* and *Mammilaria nivosa* (Wooly nipple cactus)*.*

Malpighia infestissima is relatively common on Buck Island. It has been collected on St. Croix in the past. Apparently, however, the species no longer occurs there. It was collected by West in 1906 on St. John, but has not been seen in recent years (Acevedo 1996). *M. infestissima* is sufficiently restricted in geographic range to warrant federal listing as threatened or in danger of extinction. The population appears to demonstrate recruitment deficiencies in many areas, but it has withstood substantial browsing of branch tips by the throngs rats (*Ratus ratus*) in the years prior to this survey.

Wooly nipple cactus was observed in only a single clump of less than 0.25 m^2 on the island's south shoreline. A second tiny colony, sighted on the northwest coastline in 1995, was not subjected to a rigorous search during this study. For conservation reasons this species was not made part of the voucher collection. *M. nivosa* has a broad geographic range in the Caribbean. Its rarity lies mainly in its restricted habitat – rocky shorelines. Threats to its viability are mainly ecological – its weak dispersal capacity and its small genetic populations. Populations in the Virgin Islands tend toward asexual propagation in small, scattered clonal aggregations. Fruit production is typically very sparse.

Figure 9. Wooly nipple cactus (*Mammilaria nivosa*) with fruit on rocky coastal bluff, Buck Island, June, 2001.



Bird recovery

Based on years of observations by BUIS resource managers and researchers, the avifauna of Buck Island appears to be making an impressive recovery. Our systematic traverse of north- and south-facing slopes intercepted numerous active nests during the spring 2002 field excursions. We encountered three different bird species nesting in a single afternoon. These nests were created by the White crowned Pigeon (*Columba leucocephala*) nesting in a pipe organ cactus, White-cheeked Pintail duck (*Anas bahamensis*) ground-nesting beneath a dead bromeliad clump a considerable distance from the sea, and a Least Tern (*Sterna antillarum*) along the vegetation line on the south shore. The vegetation of the island and its relative isolation makes it an important rookery site for pelicans (*Pelecanus occidentalis*) and frigatebirds.

A large proportion of the Buck Island flora provides nutritional and nesting resources for birds, and is pollinated or dispersed by them. Frugivorous bats disperse *Cassine xylocarpa*, *Cordia rickseckeri* and other larger-fruited plant species. The return of birds and bats to Buck Island will be an important factor in the regeneration and recovery of its vegetation.

Figure 10. Eggs in nest White Crowned Pigeon (C*olumba leucocephala*) established in Casha tree (*Acacia tortuosa*) on Buck Island, mid-May 2002.



Figure 11. Immature Brown pelican (*Pelecanus occidentalis*) in scrub canopy of north central shrubland rookery of Buck Island, June 2001.



Problems of Exotics Management

We assessed in detail the distribution of the non-native flora. Some of these plant species are recent introductions in adventitive (early) stages of invasion while others have longer histories dating to earlier human settlement. Not all of these species represent a serious threat to the stability of diverse native plant communities. A few that might present such a risk should receive urgent attention by land managers, whether the goal should be population growth containment, reduction, or complete eradication.

Ginger thomas (*Tecoma stans*), a fast-growing shrub *not* recorded by Woodbury and Little in the 1970's, likely dispersed downwind in recent decades from St. Croix's east end. Presently, it occupies 8 of 34 mapping units, mostly on the south-facing slopes of the island's windward eastern flanks. Although its distribution is somewhat restricted at this time, this species is likely to spread rapidly throughout the island in the coming decades. It grows in extremely high densities in some locations. Over the longer term, such "opportunists" are typically out-competed in species-rich native communities. However, in the wake of long periods of over-grazing and rat infestation, the present sparseness of the Buck Island canopy and its short stature offer this shade-intolerant species a relatively open niche.

By contrast, the population of Tan-tan (*Leucaena leucocephala*), despite its high levels of dispersion (present in 56% of the mapping grids), is represented by few saplings and seedlings and its standing population is likely to decline on its own in coming years. Like Ginger Thomas it is a prolific seed producer, but its thick seed coat and impressive longevity in the soil seed bank confers an added dimension to Tan-tan as an invasive threat. Any natural or anthropogenic disturbance that opens the canopy invites the spread of this species.

Wild pineapple (*Bromelia pinguin*) and Aloe (*Aloe vera*) were planted by some of Buck Island's earlier residents above the west beach (cell 2) for ornament, medicine or livestock management purposes. These plants are relatively slow-spreading by virtue of the lack of seed set (by *Aloe vera*) and the dominance of proliferation by stolons rather than by sexual means. Despite the casual pace of dispersion, both species pose some threat to natural communities, as there seems to be little resistance to their advance on the part of their native competitors. Rather easily, *A. vera* may be completely eradicated by uprooting and bagging of individuals. Wild pineapple is well armed but has shallow fibrous roots. Removal of seed heads will slow its spread. Overturning it in the field during the dry season may be an alternative means of control if resources are unavailable for removing all bagged individuals from the island.

A third herbaceous monocot, the century plant (*Agave missionum*), was planted by NPS personnel working with volunteers in the early 1990's. This northern Virgin Islands native that does not occur naturally on St. Croix is an extremely important nectar source during the dry season for the indigenous fauna. *Agave missionum* is a sister species to *A. eggersiana*, a species deserving of federal listing as an endangered species. It is endemic to St. Croix. The exact rationale for planting *A. missionum* is unknown to the author, but for past several years Buck Island has served as a refuge for this species under siege by a parasitoid boll weevil introduced to the northern Virgins from Mexico, apparently via the Florida landscape industry. From the perspective of this author, establishing living collections, seed storage banks and

related ex situ conservation programs for *A. missionum* are appropriate management directions. Introducing *A. missionum* to one of the last protected refuges of its close relative, *A. eggersiana*, unnecessarily precludes a key conservation option for a critically imperiled species. The current distribution of *A. missionum* on the island (it occupies 3 mapping units) is limited and the size of most individuals is still manageable.

It is widely accepted by biogeographers that Genip (*Melicoccus bijugatus*) was introduced to the Virgin Islands prior to European contact by aboriginal settlers from South America. It is dispersed short distances by bats and pigeons. The Buck Island population is small and concentrated in the vicinity of the west beach picnic area (cells 2 & 3), and is likely therefore to have been established by island visitors or previous residents. Eradication should not present a problem.

Tamarind (*Tamarindus indica*) is distributed in about 25% of the mapping cells – all in the western and central zones of the island. While their historic significance as survey-marker specimens of the 17th and 18th centuries may present a management quandary for park officials, their great size and capacity to dominate locally are serious ecological concerns for the island's vegetation as a whole.

Coconut (*Cocos nucifera*) is a Pacific region species that is easily eradicated with a chain-saw. However, its popularity, ubiquity and ocean-dispersal characteristics all conspire to guarantee its return to the land manager's docket once it is removed.

An occasional arrival on beachheads throughout the region, Painkiller (Morinda citrifolia) was introduced to the Virgin Islands during the plantation era. It becomes prolific in basin environments near the coast, but only sparsely escapes into dry scrub areas.

At least five species of grasses have invaded various natural communities on the island. Guinea grass (*Urochloa maxima*) is found throughout the island and its removal would pose a challenge to managers – although it is large and easy to locate. Finger grass (*Chloris barbata*) and its close relatives reported from the island by Woodbury and Little, occur mostly along the trails and on the eastern slopes. Its slight habit makes its discovery more difficult. Panic grass (Panicum chapmani) and its relatives vary in size, but can be challenging to find as well. Hurricane grass tends to concentrate locally. It is small and probably more widespread than this study indicates because it was dormant during most field work. Egypt grass (*Dactyloctenium aegyptium*) is very small but probably not broadly distributed. It can be locally abundant in the picnic area.

ACKNOWLEDGEMENTS

I would like to express my appreciation to Zandy Hillis-Starr, Chief Resource Manager for the Buck Island Reef National Monument for the initial impetus for this project and her persistent encouragement throughout its implementation. I am most indebted to three field crew members, James Rebholz, Philippe Mayor, and Kim Woody for their energetic and enthusiastic assistance with plant collection, digital mapping and other technical challenges. Eleanor Gibney assisted with a number of species identifications, although I accept full responsibility for any errors in this regard.

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Appendix A. List of plant species recorded on Buck Island during this vegetation inventory.

No.	Scientific name	*Family*	Common name	Form
1	*Abrus precatorius*	*Fabaceae*	jumbie bead	liana
2	*Abutilon umbellatum*	*Malvaceae*		shrub
3	*Acacia tortuosa*	*Fabaceae*	twisted acacia	shrub
4	*Achyranthes aspera*	*Amaranthaceae*	better man better	shrub
5	*Adelia ricinella*	*Euphorbiaceae*	cotorro	tree
6	*Agave missionum*	*Agavaceae*	century plant	shrub
7	*Aloe vera*	*Asphodelaceae*	aloe	herb
8	*Amyris elemifera*	*Rutaceae*	torchwood	tree
9	*Antirhea lucida*	*Rubiaceae*	palo lloron	tree
10	*Argythamnia candicans*	*Euphorbiaceae*		shrub
11	*Avicennia germinans*	*Verbenaceae*	black mangrove	tree
12	*Ayenia insulaecola*	*Sterculiaceae*		shrub
13	*Boerhavia coccinea*	*Nyctaginaceae*	kalaloo bush	herb
14	*Boerhavia erecta*	*Nyctaginaceae*		herb
15	*Bothriochloa pertusa*	*Poaceae*	hurricane grass	herb
16	*Bourreria succulenta*	*Boraginaceae*	pigeon-berry	tree
17	*Bouteloua americana*	*Poaceae*	three-awn	herb
18	*Bromelia pinguin*	*Bromeliaceae*	wild pineapple	shrub
19	*Bunchosia glandulosa*	*Malpighiaceae*		tree
20	*Bursera simaruba*	*Burseraceae*	turpentine tree	tree
21	*Caesalpinia ciliata*	*Fabaceae*	yellow nicker	shrub
22	*Cakile lanceolata*	*Brassicaceae*		herb
23	*Canavalia rosea*	*Fabaceae*	bay bean	vine
24	*Capparis cynophallophora*	*Capparaceae*	Jamaica caper	tree
25	*Capparis flexuosa*	*Capparaceae*	limber caper	shrub
26	*Capparis indica*	*Capparaceae*	linguam, wh caper	tree
27	*Celosia nitida*	*Amaranthaceae*		shrub
28	*Celtis iquanaea*	*Ulmaceae*		liana
29	*Cenchrus echinatus*	*Poaceae*	sandbur	herb
30	*Centrosema virginianum*	*Fabaceae*		liana
31	*Chamaecrista glandulosa v. swartzii*	*Fabaceae*		shrub
32	*Chamaesyce mesembrianthemifolia*	*Euphorbiaceae*		subshrub
33	*Chloris barbata*	*Poaceae*	fingergrass	herb
34	*Chromolaena sinuata*	*Asteraceae*		shrub
35	*Cissus trifoliata*	*Vitaceae*	sorel vine	vine
36	*Cissus verticillata*	*Vitaceae*	pudding vine	vine
37	*Citharexylum fruticosum*	*Verbenaceae*	fiddlewood	tree
38	*Cleome viscosa*	*Capparaceae*		herb
39	*Clerodendrum aculeatum*	*Verbenaceae*	chuc chuc, haggarbush	shrub
40	*Coccoloba microstachya*	*Polygonaceae*	uvilla	tree
41	*Coccoloba swartzii*	*Polygonaceae*	ortegon	tree
42	*Coccoloba uvifera*	*Polygonaceae*	seagrape	tree
43	*Coccoloba uvifera x krugii*	*Polygonaceae*	hybrid seagrape	tree
44	*Cocos nucifera*	*Arecaceae*	coconut	tree
45	*Commelina erecta*	*Commelinaceae*	day-flower	herb
46	*Comocladia dodonaea*	*Anacardiaceae*	christmas-bush	shrub
47	*Conocarpus erectus*	*Combretaceae*	button-wood	tree
48	*Convolvulus nodiflorus*	*Convolvulaceae*		vine
49	*Corchorus hirsutus*	*Tiliaceae*	jack switch	shrub

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4	*Achyranthes aspera*	*Amaranthaceae*	better man better	shrub
5	*Adelia ricinella*	*Euphorbiaceae*	cotorro	tree
6	*Agave missionum*	*Agavaceae*	century plant	shrub
7	*Aloe vera*	*Asphodelaceae*	aloe	herb
8	*Amyris elemifera*	*Rutaceae*	torchwood	tree
9	*Antirhea lucida*	*Rubiaceae*	palo lloron	tree
10	*Argythamnia candicans*	*Euphorbiaceae*		shrub
11	*Avicennia germinans*	*Verbenaceae*	black mangrove	tree
12	*Ayenia insulaecola*	*Sterculiaceae*		shrub
13	*Boerhavia coccinea*	*Nyctaginaceae*	kalaloo bush	herb
14	*Boerhavia erecta*	*Nyctaginaceae*		herb
15	*Bothriochloa pertusa*	*Poaceae*	hurricane grass	herb
16	*Bourreria succulenta*	*Boraginaceae*	pigeon-berry	tree
17	*Bouteloua americana*	*Poaceae*	three-awn	herb
18	*Bromelia pinguin*	*Bromeliaceae*	wild pineapple	shrub
19	*Bunchosia glandulosa*	*Malpighiaceae*		tree
20	*Bursera simaruba*	*Burseraceae*	turpentine tree	tree
21	*Caesalpinia ciliata*	*Fabaceae*	yellow nicker	shrub
22	*Cakile lanceolata*	*Brassicaceae*		herb
23	*Canavalia rosea*	*Fabaceae*	bay bean	vine
24	*Capparis cynophallophora*	*Capparaceae*	Jamaica caper	tree
25	*Capparis flexuosa*	*Capparaceae*	limber caper	shrub
26	*Capparis indica*	*Capparaceae*	linguam, wh caper	tree
27	*Celosia nitida*	*Amaranthaceae*		shrub
28	*Celtis iquanaea*	*Ulmaceae*		liana
29	*Cenchrus echinatus*	*Poaceae*	sandbur	herb
30	*Centrosema virginianum*	*Fabaceae*		liana
31	*Chamaecrista glandulosa v. swartzii*	*Fabaceae*		shrub
32	*Chamaesyce mesembrianthemifolia*	*Euphorbiaceae*		subshrub
33	*Chloris barbata*	*Poaceae*	fingergrass	herb
34	*Chromolaena sinuata*	*Asteraceae*		shrub
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36	*Cissus verticillata*	*Vitaceae*	pudding vine	vine
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48	*Convolvulus nodiflorus*	*Convolvulaceae*		vine
49	*Corchorus hirsutus*	*Tiliaceae*	jack switch	shrub

Appendix A. List of plant species recorded on Buck Island during this vegetation inventory.

No.	Scientific name	*Family*	Common name	Form
50	*Cordia dentata*	*Boraginaceae*	toothed manjack	tree
51	*Cordia ricksecker*i	*Boraginaceae*	orange manjack	tree
52	*Cordia stenophylla*	*Boraginaceae*		shrub
53	*Crossopetalum rhacoma*	*Celastraceae*	Florida crossopetalum	shrub
54	*Croton astroites*	*Euphorbiaceae*	white maran	shrub
55	*Croton betulinus*	*Euphorbiaceae*	broom bush	shrub
56	*Croton discolor*	*Euphorbiaceae*		shrub
57	*Croton flavens var. rigidus*	*Euphorbiaceae*	yellow maran	shrub
58	*Cyperus ligularis*	*Cyperaceae*	sedge	herb
59	*Cyperus planifolius*	*Cyperaceae*	sedge	herb
60	*Dactyloctenium aegyptium*	*Poaceae*		shrub
61	*Dalbergia ecastaphyllum*	*Fabaceae*		shrub
62	*Dendropemon caribaeus*	*Loranthaceae*	mistletoe	herb
63	*Desmanthus virgatus*	*Fabaceae*		shrub
64	*Digitaria insularis*	*Poaceae*	Sourgrass	herb
65	*Distictis lactiflora*	*Bignoniaceae*		liana
66	*Duranta erecta*	*Verbenaceae*		shrub
67	*Erithalis fruticosa*	*Rubiaceae*	black torch	shrub
68	*Ernodea littoralis*	*Rubiaceae*		shrub
69	*Erythroxylum brevipes*	*Erythroxylaceae*	brisslet	tree
70	*Eugenia axillaris*	*Myrtaceae*	white stopper	tree
71	*Eugenia cordata*	*Myrtaceae*	heart-leaved eugenia	shrub
72	*Eugenia procera*	*Myrtaceae*		shrub
73	*Eugenia rhombea*	*Myrtaceae*	spiceberry eugenia	tree
74	*Exostema caribaeum*	*Rubiaceae*	princewood	tree
75	*Ficus citrifolia*	*Moraceae*	shortleaf fig	tree
76	*Flueggia acidoton*	*Euphorbiaceae*		shrub
77	*Galactia dubia*	*Fabaceae*	iron weed	vine
78	*Galactia striata*	*Fabaceae*		vine
79	*Guaiacum officinale*	*Zygophyllaceae*	lignumvitae	tree
80	*Guapira fragrans*	*Nyctaginaceae*	black mampoo	tree
81	*Gymnanthes lucida*	*Euphorbiaceae*	oysterwood	tree
82	*Helicteres jamaicensis*	*Sterculiaceae*	cow bush, cat's balls	shrub
83	*Heliotropium angiospermum*	*Boraginaceae*	eyebright	herb
84	*Heliotropium ternatum*	*Boraginaceae*		shrub
85	*Heteropteris purpurea*	*Malpighiaceae*		liana
86	*Hippomane mancinella*	*Euphorbiaceae*	manchineel	tree
87	*Hymenocallis caribaea*	*Amaryllidaceae*	spider-lily	herb
88	*Ipomoea eggersii*	*Convolvulaceae*	Eggers' morning glory	vine
89	*Ipomoea pes caprae*	*Convolvulaceae*	Beach morning glory	vine
90	*Iresine angustifolia*	*Amaranthaceae*		shrub
91	*Jacquinia arborea*	*Theophrastaceae*	barbasco	shrub
92	*Jatropha gossypifolia*	*Euphorbiaceae*	belly ache bush	shrub
93	*Krugiodendron ferreum*	*Rhamnaceae*	ironwood	tree
94	*Laguncularia racemosa*	*Combretaceae*	white mangrove	tree
95	*Lantana involucrata*	*Verbenaceae*	sage	shrub
96	*Lantana urticifolia*	*Verbenaceae*		shrub
97	*Launeae intybacea*	*Asteraceae*	wild lettuce	herb
98	*Leptochloa filiformis*	*Poaceae*	sprangletop	herb

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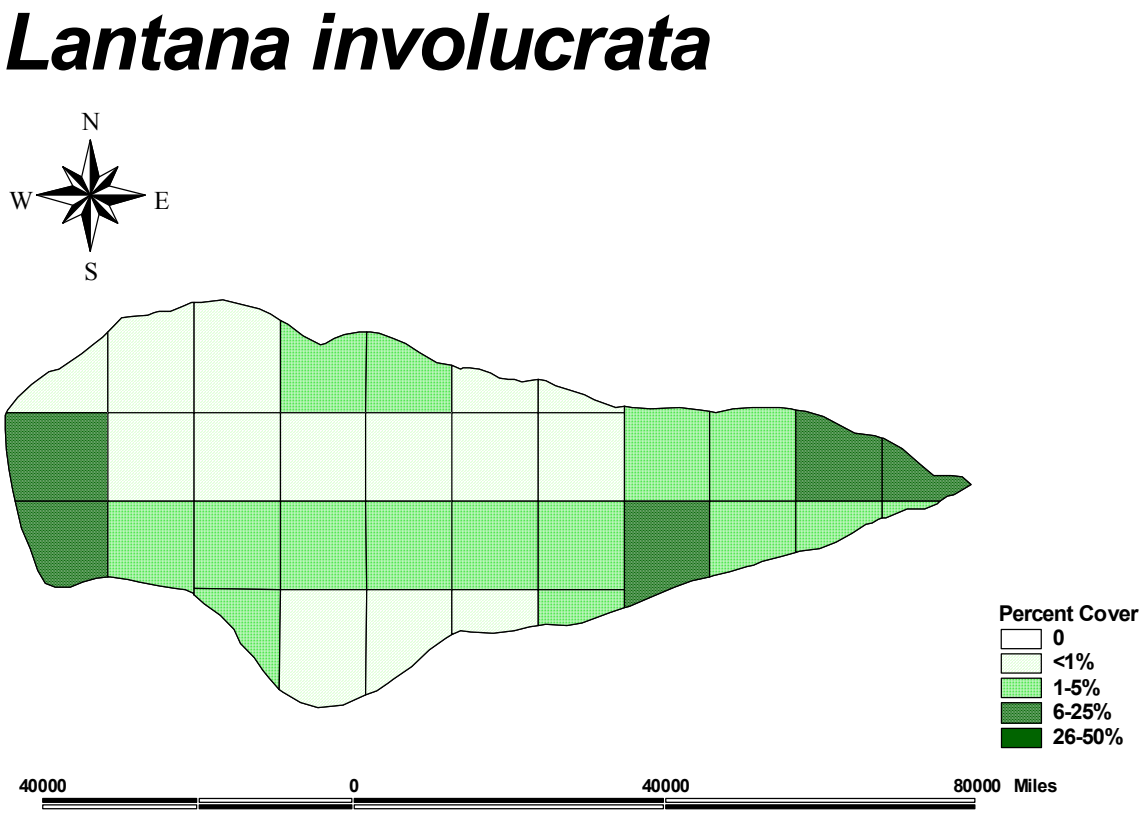
No.	Scientific name	*Family*	Common name	Form
99	*Leucaena leucocephala*	*Fabaceae*	tan tan, wild tamarind	tree
100	*Macfadyena unguis-cati*	*Bignoniaceae*	cat-claw, doxantha	liana
101	*Malpighia infestissima*	*Malpighiaceae*	stingingbush	tree
102	*Mammilaria nivosa*	*Cactaceae*	wooly-nipple cactus	herb
103	*Melicoccus bijugatus*	*Sapindaceae*	kenip	tree
104	*Melocactus intortus*	*Cactaceae*	turk's cap cactus	shrub
105	*Melochia tomentosa*	*Sterculiaceae*	broom weed	shrub
106	*Metastelma grisebachianum*	*Asclepiadaceae*		vine
107	*Mollugo nudicaulis*	*Molluginaceae*		herb
108	*Morinda citrifolia*	*Rubiaceae*	noni, painkiller	
109	*Oplonia spinosa*	*Acanthaceae*	espinosa	liana
110	*Opuntia dillenii*	*Cactaceae*	prickly pear	shrub
111	*Opuntia repens*	*Cactaceae*	jumping cactus	shrub
112	*Opuntia rubescens*	*Cactaceae*	tuna	tree
113	*Opuntia triacantha*	*Cactaceae*		shrub
114	*Panicum chapmani*	*Poaceae*		herb
115	*Paspalum laxum*	*Poaceae*		herb
116	*Pectis linifolia*	*Asteraceae*		herb
117	*Petiveria alliacea*	*Phytolaccaceae*		shrub
118	*Pilosocereus royenii*	*Cactaceae*	pipe-organ cactus	tree
119	*Piscidia carthagenensis*	*Fabaceae*	fish poison tree	tree
120	*Pisonia subcordata*	*Nyctaginaceae*	loblolly	tree
121	*Pithecellobium unguis-cati*	*Fabaceae*	bread-and-cheese	shrub
122	*Plumbago scandens*	*Plumbaginaceae*		shrub
123	*Plumeria alba*	*Apocynaceae*	frangipani, milktree	tree
124	*Portulaca oleracea*	*Portulacaceae*	purslane	herb
125	*Psychilus macconnelliae*	*Orchidaceae*		herb
126	*Rauvolfia viridus*	*Apocynaceae*	bitter bush	shrub
127	*Rhynchosia minima*	*Fabaceae*		vine
128	*Rivina humilis*	*Phytolaccaceae*		shrub
129	*Rochfortia acanthophora*	*Boraginaceae*		shrub
130	*Samyda dodecandra*	*Flacourtiaceae*	guayabilla	shrub
131	*Scaevola plumieri*	*Goodeniaceae*		shrub
132	*Schaefferia frutescens*	*Celastraceae*	Florida boxwood	tree
133	*Serjania polyphylla*	*Sapindaceae*	basket wiss	liana
134	*Sesuvium portulacastrum*	*Aizoaceae*	sea purslane	herb
135	*Setaria setosa*	*Poaceae*		herb
136	*Sidastrum multiflorum*	*Malvaceae*		shrub
137	*Sida repens*	*Malvaceae*		herb
138	*Sideroxylon obovatum*	*Sapotaceae*	mastic, arana gato	tree
139	*Siphonoglossa sessilis*	*Acanthaceae*		herb
140	*Solanum racemosum*	*Solanaceae*	cankerberry	shrub
141	*Spartina patens*	*Poaceae*		herb
142	*Sporobolus virginicus*	*Poaceae*	seashore dropseed	herb
143	*Stigmaphyllon emarginatum*	*Malpighiaceae*		liana
144	*Stylosanthes hamata*	*Fabaceae*		herb
145	*Suriana maritima*	*Simaroubaceae*	baycedar	shrub
146	*Tabebuia heterophylla*	*Bignoniaceae*	pink cedar	tree
147	*Talinum paniculatum*	*Portulacaceae*		shrub

Appendix A. List of plant species recorded on Buck Island during this vegetation inventory.

No.	Scientific name	*Family*	Common name	Form
148	*Tamarindus indica*	*Fabaceae*	tamarind	tree
149	*Tecoma stans*	*Bignoniaceae*	ginger thomas	shrub
150	*Tephrosia cinerea*	*Fabaceae*		vine
151	*Teramnus labialis*	*Fabaceae*	blue wiss	vine
152	*Thespesia populnea*	*Malvaceae*	Haiti-haiti, otaheita	tree
153	*Tillandsia recurvata*	*Bromeliaceae*	Old man hand	herb
154	*Tillandsia utriculata*	*Bromeliaceae*		herb
155	*Tournefortia microphylla*	*Boraginaceae*		vine
156	*Tragia volubilis*	*Euphorbiaceae*	bran nettle, 7-minute itch	vine
157	*Tragus berteronianus*	*Poaceae*	burgrass	herb
158	*Turnera diffusa*	*Turneraceae*	old woman broom	shrub
159	*Turnera ulmifolia*	*Turneraceae*	elm-leaved turnera	shrub
160	*Urochloa maximum*	*Poaceae*	guinea-grass	herb
161	*Wedelia fruticosa*	*Asteraceae*		shrub
162	*Zanthoxylum spinifex*	*Rutaceae*		shrub
	TOTALS			

total specimens collected = 262
total species collected = 158
Species encountered, not collected = 6 (Mammillaria nivosa, Cocos nucifera, Guapira fragrans, Agave missionum, Ipomoea triloba, Jacquemontia pentanthos)
Number of taxa documented 164

Appendix B. Distribution map of *Lantana involucrata*, showing relative coverage values among 34 mapping units on Buck Island, St. Croix in 2002.



F.6 The eradication of introduced rats at Buck Island Reef National Monument, St. Croix, U.S. Virgin Islands – Final Report

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THE ERADICATION OF INTRODUCED RATS AT BUCK ISLAND REEF NATIONAL MONUMENT, ST. CROIX, U.S. VIRGIN ISLANDS

FINAL REPORT

November 2002



SUBMITTED TO:

U.S. Department of Interior, National Park Service
Buck Island Reef National Monument
Christiansted, St. Croix, U.S. Virgin Islands

PREPARED BY:

U.S. Department of Agriculture
Animal and Plant Health Inspection Service
Wildlife Services

Gary W. Witmer
Frank Boyd
Earl Campbell, III
Joyce Wakefield

USDA National Wildlife Research Center
4101 La Porte Avenue
Fort Collins, CO 80521-2154

U.S. Department of the Interior
National Park Service
Buck Island Reef NM

Zandy Hillis-Starr

2100 Church Street, Lot #100,
St. Croix, U.S. Virgin Islands
00820-4611

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ABSTRACT

The US National Park Service (NPS) and Department of Agriculture Wildlife Services (WS) conducted an island-wide tree rat (*Rattus rattus*) eradication and established a rodent monitoring program at Buck Island Reef National Monument. These introduced rats caused substantial damage to the island's flora and fauna, including threatened and endangered species. An anticoagulant (0.005 % diphacinone) rodenticide bait-block was distributed in elevated bait stations on an island-wide grid. The bait stations were modified several times to assure ready access by rats while minimizing access by non-target animals. Post-project trapping sessions resulted in no rat captures, suggesting rats have been eradicated from the island. The baiting program had minimal impact on non-target species and a recovery of island's flora and fauna has been documented. Post-eradication rodent monitoring has revealed the presence of a growing house mouse, *Mus musculus*, population on the island. Threats and potential management strategies are being assessed.

TABLE OF CONTENTS

List of Tables iv

List of Figures v

List of appendices vi

Introduction 1

Background Preparation 5

Baiting Program 9

Preliminary Baiting 9

Island-wide Baiting 12

Post-baiting Observations 17

Monitoring Protocol 19

Conclusions 23

Acknowledgments 24

Literature Cited 24

Appendices 26

LIST OF TABLES

Table 1. Results of rat snap-trapping sessions during the Buck Island rat eradication project, 1998-2001..... 3

Table 2. Rodenticide bait block applications during the Buck Island rat eradication project, 1999-2000..... 11

Table 3. Bait station placements and modifications during the Buck Island rat eradication project, 1999-2000. 15

LIST OF FIGURES

Figure 1. Endangered hawksbill sea turtles at Buck Island: an adult female and hatchlings. 2

Figure 2. Threatened and endangered species impacted by rats at Buck Island. 2

Figure 3. Buck Island aerial view with the snap trap locations. 4

Figure 4. Rat bait station grid map at Buck Island Reef National Monument. 7

Figure 5. Flagging bait stations and cutting trails at Buck Island. 8

Figure 6. Hermit crabs in bait station. 10

Figure 7. Bait station E-2 on a tree and 0-2 on a wire platform. 11

Figure 8. Snap trap at station F-28 with a dead rat. 13

Figure 9. Bait station modifications to exclude hermit crabs and birds. 15

Figure 10. Mice (*Mus sp.*) caught in the rat snap-traps at Buck Island. 19

Figure 11. Juvenile and adult brown pelicans (*Pelecanus occidentalis*) in the north side rookery at Buck Island. 22

LIST OF APPENDICES

Appendix I. Public Service Announcement for April 12, 2000. ..... **Error! Bookmark not defined.**

Appendix II. Environmental Assessment for the Buck Island Reef National Monument Island-wide Rat Eradication Project. ..... **Error! Bookmark not defined.**

Appendix III. Finding of No Significant Impact Decision Record..... **Error! Bookmark not defined.**

Appendix IV. Eaton's Bait Blocks Rodenticide 24 (c) Registration Forms. ..... **Error! Bookmark not defined.**

INTRODUCTION

Once introduced to an island, non-native rodents can cause considerable damage to the native flora and fauna, including the endangerment of endemic species (Campbell 1989, Witmer et al. 1998). As a result, there have been numerous efforts in recent years to eradicate introduced rats (*Rattus* spp.) and house mice (*Mus musculus*) from islands around the world (e.g., Billing and Harden 2000, Buckle and Fenn 1992, Howald et al. 1999, Key and Hudson 2000).

Problems caused by introduced roof rats (*Rattus rattus*) at Buck Island Reef National Monument, St. Croix, U.S. Virgin Islands, have been documented by the U.S. National Park Service (NPS) for many years (see Witmer et al. 1998). Of particular concern have been the impacts on endangered and threatened species, such as the hawksbill turtle (*Eretmochelys imbricata*) (Fig. 1), the ground-nesting least tern (*Sterna antillarum*), and the brown pelican (*Pelecanus occidentalis*). Efforts to protect and to restore native vegetation such as the lignum vitae (*Guaiacum officinale*) are also being hampered by rat foraging (Fig. 2). Additionally, the NPS and the U.S. Fish and Wildlife Service (USFWS) have planned to reintroduce the endangered St. Croix ground lizard (*Ameiva polops*) to Buck Island as part of a recovery plan for that species (USFWS 1984). Rat predation poses a serious threat to lizards (Meier et al. 1990, Philobosin and Ruibel 1971) and the reintroduction plans. The rats also pose a human health threat to visitors to Buck Island because rats can harbor many diseases such as the tick-borne relapsing fever (caused by a *Borrelia spirochete* bacteria) that has been found to occur on Buck Island (Flanigan et al. 1991). An effort to control the introduced rats on Buck

Island would also increase public and territorial conservation agencies' awareness to threats from exotic pest species.



Figure 1. Endangered hawksbill sea turtles at Buck Island: an adult female and hatchlings.



Figure 2. Threatened and endangered species impacted by rats at Buck Island.

The NPS requested the U.S. Department of Agriculture Animal and Plant Health Inspection Service (APHIS) Wildlife Services' (WS) assistance to evaluate the potential for a rat eradication project on Buck Island in 1998. WS biologists visited the NPS in St. Croix and Buck Island in February 1998. The visit included meetings in St. Croix with personnel of several agencies and fieldwork on Buck Island. Using snap-traps attached to the trunks of trees and shrubs, 80 rats were captured (Table 1) from 3 trap lines (Dietrich's, Tower, and West lines) over a 3-night period (Fig. 3).

Table 1. Results of rat snap-trapping sessions during the Buck Island rat eradication project, 1998-2001.

Date	Location	No. of Snap Traps	No. of Nights	No. of Rats Caught	No. of Mice Caught
Feb-98	D, T, W lines*	45	3	80	0
Aug-99	D, T, W lines*	50	3	72	0
Oct-99	Beach and picnic areas	30	1	0	0
May-00	Island-wide	210	3	1	0
Aug-00	D, T, W, E, N lines*	93	3	0	0
Dec-00	D, T, W, E, N lines*	93	3	0	67
Apr-01	D, T, W, E, N lines*	93	3	0	104

*Code to snap trap lines: D = Dietrich's, T = Tower, W = West, E = East, N = North.

Consequently, a low-to-moderate density (by Caribbean standards), but healthy rat population was documented to exist on Buck Island and substantial damage to vegetation was noted (Witmer et al. 1998). A strategy to eliminate rats from Buck Island was formulated and proposed (Witmer et al. 1998). The NPS submitted a budget for the rat eradication project on April 23, 1998 that was approved in August 1998. NPS and WS completed a study plan for the eradication of rats on Buck Island in April 1999. An Interagency Agreement (No. 1443IA5000099005) between the NPS and WS was finalized in August 1999. Under this agreement, WS worked under NPS supervision to conduct an island-wide rat eradication project on Buck Island.

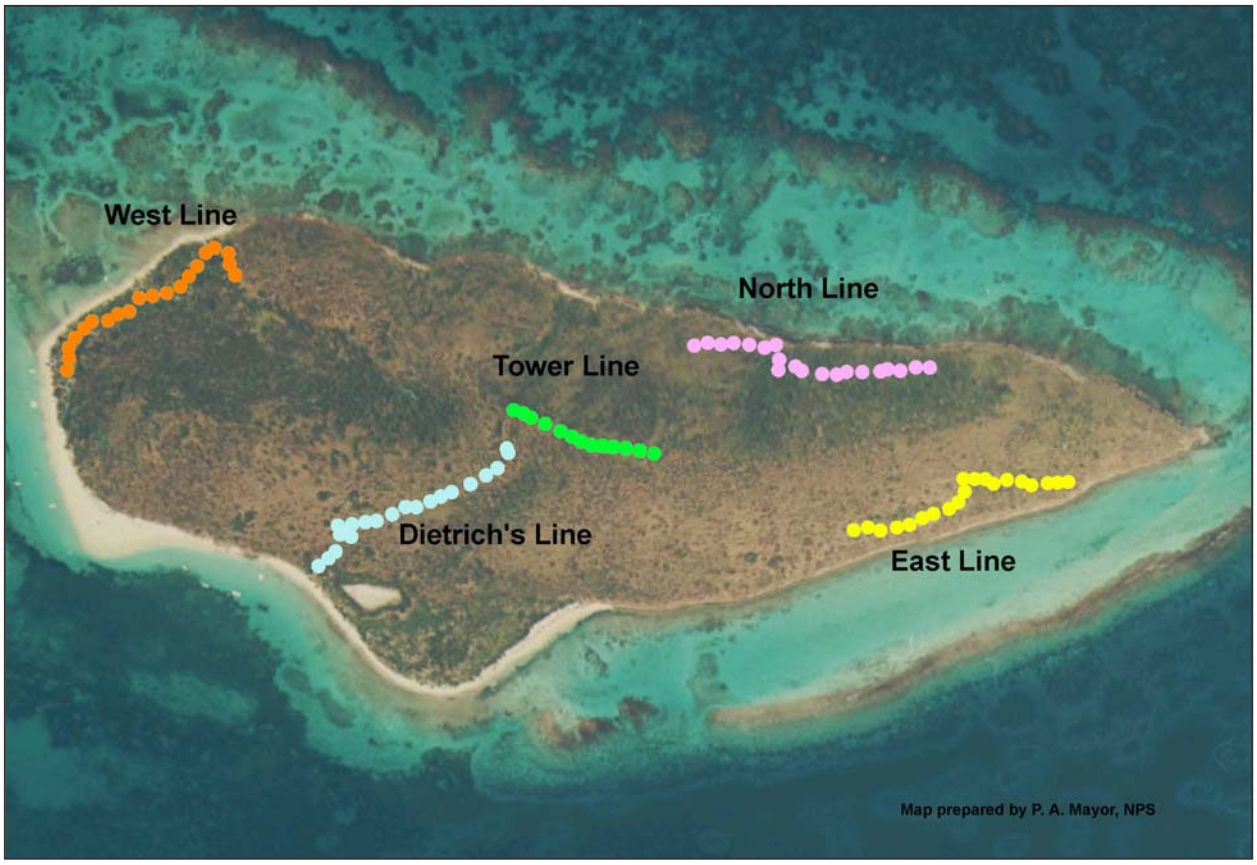


Figure 3. Buck Island aerial view with the snap trap locations. Dietrich, tower, and west trap-lines were used prior to baiting. North and east lines were added to facilitate rodent monitoring.

Prior to the start of this project the NPS instituted a "Pack-it-in, Pack-it-out" policy to reduce the rat problem on Buck Island. This action was taken to eliminate the trash generated by visitors in the picnic areas. These materials drew rats closer to the beach areas and provided a food source for rats. To inform the public about the new policy the NPS made public service announcements in local newspapers, radio programs, and television (Appendix I). Signs were posted in both picnic areas of Buck Island asking the public to take all their picnic trash off the island. The policy was implemented in August 1999, and WS field crew removed all trash receptacles from the island at this time.

This final report documents the details and results of the rat eradication project as conducted under the interagency agreement.

BACKGROUND PREPARATION

In compliance with the National Environmental Policy Act (NEPA), the NPS prepared an Environmental Assessment (EA) on the proposed rat eradication on Buck Island (Appendix II). It was distributed to the public for comment in August 1999. A public hearing was held in St. Croix on September 8, 1999. There was no attendance by the general public and no public comment was received. Comments from other groups or agencies (St. Croix Environmental Association, USFWS, U.S. Department of Agriculture Natural Resources Conservation Service, Virgin Islands DPNR Division of Fish and Wildlife) were in favor of the rat eradication project. The NPS issued a Finding-of-No-Significant-Impact (FONSI) on October 19, 1999 (Appendix III).

One of the first steps in the project was to obtain regulatory authority to use an anticoagulant rodenticide for the rat eradication, specifically for use on conservation lands. Background information along with discussions of the advantages and disadvantages of anticoagulants were presented in publications by Hadler et al. (1999), Timm (1994), and WHO (1995). It was necessary to apply for a registration with the U.S. Environmental Protection Agency (EPA) and the Government of the U.S. Virgin Islands, Department of Planning and Natural Resources (VIDPNR). The rodenticide bait selected was the J. T. Eaton Bait Block (EPA Reg. No. 56-42), a large, wax bait block containing 0.005% diphacinone that has been used in the U.S. for rodent control in and around buildings for many years. Registrations were sought for two formulations of bait

blocks (peanut butter/molasses flavored and fish flavored) to help assure that a flavor acceptable to the rats would be available. Some of the criteria and considerations in the selection and application of a rodenticide bait for rodent control in natural settings were summarized in Witmer et al. (1998). An application for registration was submitted to the VIDPNR in June 1999. Subsequently, two registrations were received: VI-970001 for the use of fish-flavored bait blocks and VI-970002 for peanut butter/molasses-flavored bait blocks (Appendix IV).

In preparation for the baiting program, a final check on the rat population was conducted in August 1999, using the same three snap-trap lines as used in the original survey (February 1998). Seventy-two rats were captured over the 3-night period (Table 1), whereas 80 had been captured in the first trapping session. These results indicated little to no change in the rat population from that documented in February 1998.

NPS worked with the WS team to develop a digital shoreline map of Buck Island. Using ArcView 3.2a (ESRI, Inc.), a 40 m by 40 m grid pattern was superimposed on this map. Each intersection point on the grid was labeled alphanumerically and became an individual bait station location (Fig. 4).

The bait stations were located using a handheld GPS unit. Initially a Trimble DGPS (Trimble Navigation, Inc., Sunnyvale, CA) was used. This was later replaced by a Garmin GPS 48 (GARMIN International, Inc., Olathe, KS) with a MBX-3 Beacon Receiver and MGL-3 GPS/DGPS Antenna (Communications Systems International, Inc., Calgary, Alberta), to lay out the grid. A database was created, using MS Access, to track rat bait consumption, habitat conditions, and vegetation surrounding each bait

station. Vegetation data were collected from each bait station location, prior to the first island-wide baiting, to determine if vegetation type and/or terrain might have an effect on the rat population distribution.

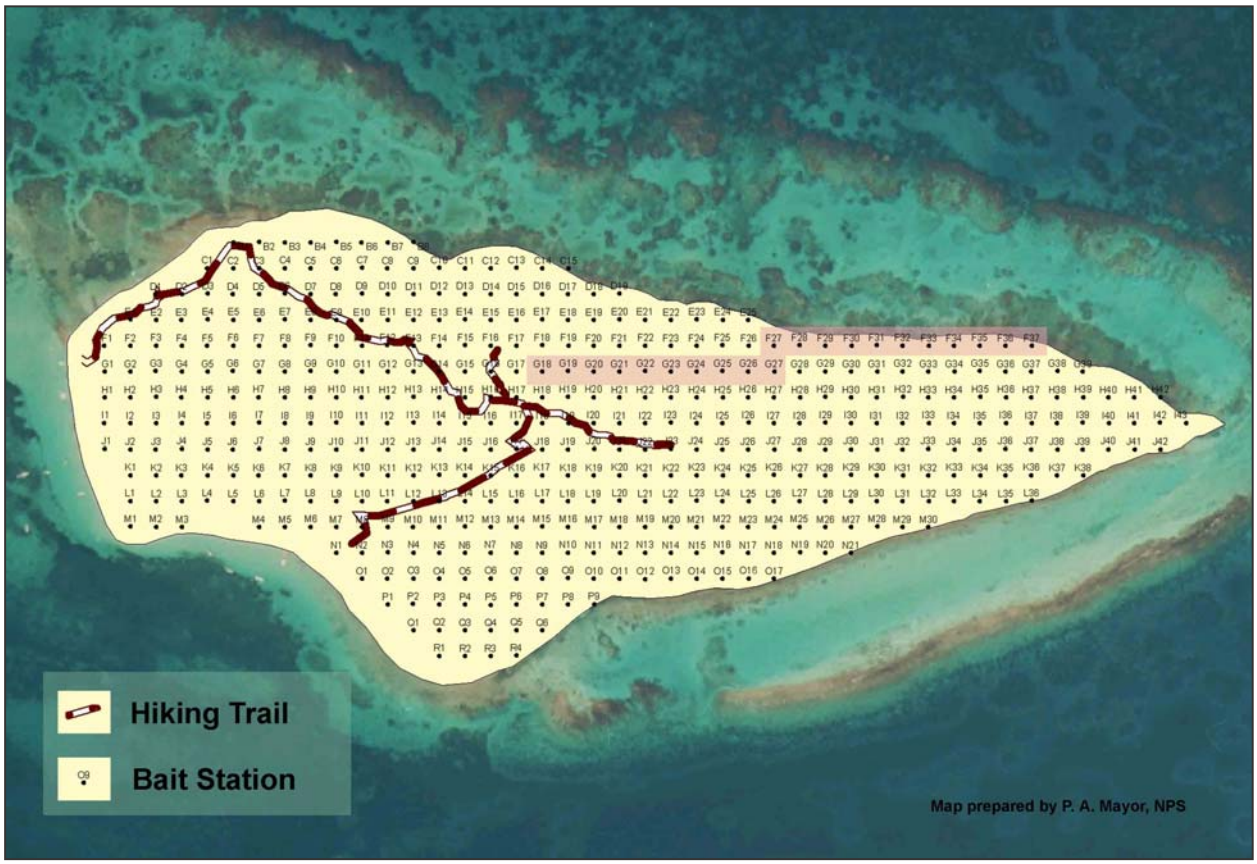


Figure 4. Rat bait station grid map at Buck Island Reef National Monument. Bait was thrown into pink areas.

Pending the registration for island-wide baiting, work was begun to mark and clear trails for the island-wide grid system for bait stations (Fig. 5). The use of gas-powered string trimmers fitted with special brush blades was necessary.



Figure 5. Locating and flagging bait stations with differential GPS and cutting trails.

Development of the trail system was an extremely laborious task and it was made even more difficult by the Island's steep slopes, the poisonous plant species, and the thorny thickets. Trail cutting was a four-person task: one person wearing the DGPS backpack unit, one person with machete and flagging tape, and two persons using brush cutters worked together to make narrow trails (maximum width was 1 meter) through the brush.

The task was begun in September 1999 and completed in February 2000, with intermittent breaks from the work because of problems with the GPS units and the occurrence of Hurricane Lenny in November 1999.

East-west parallel trails were cut across the island with each trail about 40 m from those adjacent to it. Bait stations were placed along each line at intervals of about 40 m. Trails were flagged with orange tape and bait station locations were identified by pink flagging tape. The bait station alphanumeric code was written on the flagging tape.

This activity resulted in the establishment of 428 bait stations. A portion of two grid lines (stations G19-G27 and F29-36) in the northeast part of the island occurred in a very steep area. Because it was considered unsafe for personnel to access those bait sites, bait blocks were thrown into those locations from corresponding stations above or below them (Fig. 4).

BAITING PROGRAM

Preliminary Baiting

Prior to cutting trails across the Island and beginning the island-wide baiting program, a preliminary baiting action was conducted along the shoreline turtle-nesting habitat. This action was taken 1) because the beach and picnic areas are critical nesting area for three species of sea turtle and the NPS sought relief from rat harassment of female turtles attempting to lay eggs and from the predation on eggs and hatchlings that follows, and 2) to assure that the bait blocks would be acceptable to, and effective on, the rats. Because the island-wide registration had been requested from the Virgin Island's Government, but not yet been obtained, only the beach and picnic areas were baited. These areas were within 40 meters of buildings or structures; such baiting was legal under an existing registration (EPA Reg. No. 56-42).

This first baiting was conducted in early October 1999 (Table 2). All bait station locations along the shoreline and one tier back from the shoreline were baited. Forty-four commercially available black plastic bait-stations ("Rodent Baiter" [Bell Laboratories, Inc., Madison, WI] measuring 23 by 18 by 10 cm with a 6.5 by 6.5 cm opening in each end) were initially placed on the ground. Four bait blocks (peanut

butter/molasses flavored) were placed in each station and maintained by checking the stations every day for two weeks and every three days thereafter. After the first three days of baiting, it was apparent that hermit crabs (*Coenobita clypeata*) were consuming the majority of the bait and possibly preventing rat access (Fig. 6). All bait stations were then moved to elevated locations. Bait boxes were stapled or cable-tied to tree trunks and tree limbs approximately 2 meters off the ground (Fig. 7). After two weeks of baiting, snap traps were set at every bait station location to determine the effectiveness of the baiting (October 14 - 15). No rats were captured suggesting that the bait was working to control rats along the shoreline areas. Hurricane Lenny, November 17, 1999, brought a halt to the baiting. When baiting was resumed, heavy concentrations of biting ants were a problem at many of the bait stations. There was concern that perhaps the ants were biting the rats when they attempted to access the bait. Bars of bait covered in ants were found in the bait stations and on the ground below the bait stations. This suggested that the rats had gotten to the bait, pulled it out of the boxes to get it away from the ants, and abandoned it because of the ants. Pending the decision on how to control the ants, all baiting was stopped. Ants were sent to experts at Auburn University and the University of Florida for identification; they were later identified as fire ants (*Solenopsis invicata*) and a treatment was recommended by the NPS Integrated Pest Management Program Coordinator in Atlanta and employed during the island-wide baiting that followed.



Figure 6. Hermit crabs in bait station.

Table 2. Rodenticide bait block applications during the Buck Island rat eradication project, 1999-2000.

Date	Location	No. of Bait Stations	Bait Station Placement and Type	No. of Bait Blocks (flavor)
Oct. '99 (6 wks)	Beach & picnic areas	44	On ground three days, then stapled to trees	4 (peanut butter/ molasses)
Apr. '00 (2 wks)	Island-wide	428	On wire platform, about 20 cm above ground	3 (peanut butter/ molasses)
May '00 (2 wks)	Island-wide	428	On wire platform, about 20 cm above ground	2 (peanut butter/ molasses)
June '00 (2 wks)	Island-wide	428*	Mounted on re-bar with PVC around it, about 26-30 cm above ground	2 (fish)
Sept.-Oct. '00 (2 wks)	Beach & picnic areas	52**	On wire platform for 2 days, then on re-bar as described in text	2 (peanut butter/ molasses) plus 2 fish

* Includes 77 bait stations with bird excluders. ** Includes 26 with bird excluders.



Figure 7. Bait station E-2 on a tree and 0-2 on a wire platform.

Island-wide Baiting

Prior to establishing all of the bait stations, a new station mount was created to try and deter crabs. The plastic bait stations were elevated to about 20 cm off the ground, using a wire platform (Fig. 7). This system also added consistency because some station locations were not near a tree or shrub to which the plastic bait station could be attached. Additionally, two insecticides (Amdro Fire Ant Insecticide Granules and Raid Ant and Roach Insecticide Spray) were used to reduce the ant problem. They were only used at stations with heavy concentrations of ant; their use seemed to help deter the fire ant problem.

The first island-wide baiting was conducted April 11 - 21, 2000 (Table 2). A crew of seven persons distributed bait to all the Island's bait stations numbering over 400. Three peanut butter/molasses-flavored blocks were added to each station and replenished as needed to maintain 3 blocks per station. Bait was checked in every station every day for ten days. The following data were collected: bait consumption (which was equal to the amount of bait added), animal visitations, and treatment (insecticide, non-target interference). Vegetation data were also collected in the vicinity of each bait station. Initially, the crew saw signs that rats were consuming the bait: stations emptied of bait, rat feces in the boxes, and fur on the bait station openings. The first dead rat was observed on April 16 and by day seven, the smell of decaying carcasses was apparent throughout the island.

During the "off period" snap traps were established at every other bait station totaling about 210 snap-traps, island-wide (Table 1). One trap was always placed at

each end of the grid line. The traps were operated for three consecutive nights and only 1 rat was captured (Fig. 8).



Figure 8. Snap trap at station F-28 with a dead rat.

The second island-wide baiting operation was conducted from May 2 - 14, using 2 bait blocks, of the same flavor (peanut butter/molasses), per station (Table 2). A team of four persons conducted the baiting, dividing the island in half (north to south) with half the island's bait stations being checked each day. In the beginning of this baiting period, there were signs of rats, but by the second week, evidence of rats was gone. During this baiting session hermit crabs and birds took the majority of the bait. On May 11, a pearly-eyed thrasher (*Margarops fuscatus*) was observed taking bait out of a bait station. It is possible that birds may have been a bigger consumer of bait than was suspected. During this baiting session least terns returned to the island and established a nesting colony on the open sand beach. On May 25, over 40 adults and 17 nests with 28 eggs were counted. WS crew looked repeatedly for any sign of rats in or near the colony and none was found. However, visitors and dogs repeatedly disturbed the colony (even

though dogs are not allowed on the island) and the nesting site was abandoned by the end of June. The colony failed not because of rats, which had been a significant problem in the past, but because of a lack of NPS control of visitors and their pets in the nesting area. This situation will be remedied with the return of ranger patrols in fiscal year ‘03.

Prior to undertaking the final island-wide baiting, the bait station mount was again modified to reduce access by hermit crabs and other terrestrial non-targets, specifically the pearly-eyed thrasher (Fig. 9, Table 3). Each bait station was affixed about 25 cm above the ground to one end of a vertical steel stake ("re-bar"; 60 cm long and 1 cm diameter) that was driven into the ground 10 cm leaving 0.5 m above the ground. Each box was attached to the rebar in a vertical orientation by cable ties held in place by steel washers, which prevented the plastic box from tearing in the wind. A section of PVC pipe (25 cm long and 6 cm diameter) was first placed over the steel stake. The PVC pipe, which has a smooth surface, prevented the hermit crabs from climbing up the rebar and into the bait station. On stations where birds were observed to be a problem, an additional section of PVC pipe was inserted into the bait box to reduce access to the bait by birds (primarily the pearly-eyed thrasher). A length of PVC pipe (30 cm long with 6 cm diameter) with a 9 by 6 cm diamond cut from the middle of its side was inserted horizontally through the bait station access holes, leaving 4 cm protruding from each end (Fig. 9). This device allowed rats to jump up to the bait station and access the bait while making it very difficult for birds landing on the bait station to get into the box. Tests with captive rats revealed that the rats could readily access the bait in the modified bait station with the bird and hermit crab excluder devices.

Table 3. Bait station placements and modifications during the Buck Island rat eradication project, 1999-2000.

Order of Use	Box Orientation	Description of Bait Station Used
1 (first)	Horizontal	Plastic bait box (commercially available; 23x18x10 cm with 6.5x6.5 cm opening on each end) placed on ground surface
2	Vertical	Plastic bait box (described above) stapled to tree
3	Horizontal	Plastic bait box (described above) on wire platform about 20 cm off ground
4	Vertical	Plastic bait box (described above) attached to re-bar (steel stake, 76 cm long, 1 cm diameter), vertically driven into ground with a 25 cm long PVC pipe, 6 cm diameter, placed around the re-bar) with cable ties, the box 26-30 cm above the ground
5 (last)	Vertical	As described above (4), but with "bird excluder" (25 cm long PVC pipe, 6 cm diameter, with a 5x5 cm diamond-shaped section cut out of the center) inserted through the openings in the bait box



Figure 9. Bait station modifications to exclude hermit crabs and birds.

The final island-wide baiting was conducted from June 9 - 22, 2000, using these newly modified station mounts. A team of three persons conducted the baiting by dividing the Island into three roughly equal areas with the bait stations of one area checked each day. Seventy-seven stations were fitted with bird excluder devices. The fish-flavored bait was introduced, using two bait blocks per station (Table 2). The bait "switch" was done so that any remaining rats that were not attracted to the original flavor (peanut butter/molasses) might be attracted to, and succumb to, the alternately flavored bait block. The only bait that was consumed occurred when a bait station lid detached and the bait fell onto the ground. It was believed that crabs then consumed the bait. On July 10 - 13, 2000, all bait was removed and bait remaining in each station was noted. On August 16 - 20, 2000, the 3 original rat snap-trap lines were run along with the addition of two new lines (North and East lines; Fig. 3). No rats were captured (Table 1). During both the May and June island-wide baitings, the WS crew observed white-crowned pigeons (*Columba leucophala*) and ground doves (*Columbaigalina passerina*) nesting throughout the island. The brown pelican (*Pelecanus occidentalis)* rookery was active with adult birds establishing nests. These wildlife observations were very encouraging.

During September 2000, NPS personnel were monitoring 1,500 meters of turtle-nesting shoreline at night. One technician momentarily observed a "rat" near the salt pond along the south-central shore of the island. As a result, the original bait stations (described under "Preliminary Baiting" above) around the beach and picnic areas were re-established along with an additional 8 bait stations around the salt-pond to ensure adequate coverage where the "rat" was observed. These bait stations were maintained

with 4 bait blocks each (2 of each flavor) until the end of October (Table 2). Initially, both platform and re-bar style station mounts were used, but the platform stations were changed to re-bar stations only after a few days because of the high number of crabs observed in the platform stations. Twenty-six of the stations also included bird excluder devices. All bait was removed from the island on November 15, 2000.

During the island-wide baiting operations, WS personnel spent considerable time walking the grid lines that extended over the entire island. Despite being instructed to look for them, no non-target carcasses (e.g. birds or crabs) were observed by personnel during the many months of work on the island.

The total weight of rodenticide bait purchased for the project was 754 kg with 208 kg remaining at the end of project. Consequently, about 546 kg of bait was applied on Buck Island to complete the rat eradication. This amount of rodenticide bait would contain about 0.027 kg (= 27 g) of active ingredient (diphacinone).

POST-BAITING OBSERVATIONS

The 5 rat snap-trap lines described above were operated again during December 15 -18, 2000 (Table 1). No rats were captured, suggesting that the rat population on Buck Island had been eliminated. However, part of the project strategy was to continue monitoring the island for the presence of rats, by use of the standardized rat snap-trap lines, because a small group of rats on some part of the island may have been missed or because they could, again, be accidentally introduced. The first post-project monitoring session was scheduled for April 2001.

During the December trapping session, NPS and WS personnel looked for fresh sign of rat gnawing on vegetation and also for signs of active burrows. No fresh gnawing was observed and no rat droppings were found on plants or at burrow or other openings into the soil. Indeed, the vegetation appeared very robust with much new growth and a profusion of flowers and fruits. Fruits and seeds were even observed, untouched, on the ground. There appeared to be more bird and lizard activity. Observations of this nature were very rare during past trips to the island. NPS personnel reported seeing more bird nesting activity than in the past. For example, nesting by ground doves (*Columbaigalina passerina*), white-crowned pigeons (*Columba leucophala*), and Bahama ducks (*Anas bahamensis*) were commonly observed. It is especially noteworthy that the sea turtle monitoring team reported no rat predation on sea turtle nests in the 2000 - 2001 nesting season, which ended in March 2001. It will require a period of monitoring to document whether the least tern population is benefiting from the rat eradication. Also during the December trip, very little trash was observed along the beach, trails, or at the picnic areas. It appears that the "Pack-it-in, Pack-it-out" strategy is being successful and the NPS is continuing the policy.

Interestingly, during the rat trapping session of December 2000, in which no rats were captured, 67 house mice were captured in the rat snap-traps (Table 1, Fig. 10). Mice were captured on all 5 snap-trap lines (range = 7 - 31 mice per line), suggesting an island-wide distribution. It is intriguing that during the entire previous rat trapping, no mice were captured and that mice had never been reported as occurring on the island. (In 1994, there was one unsubstantiated sighting of a “hopping mouse” on the over-island trail. At the time this was presumed to be a juvenile rat). Presumably, this

introduced rodent species has been present all along, but its population and activity was perhaps greatly suppressed by the rats. House mice are common on many of the islands and cays of the Caribbean (e.g., Dammann and Nellis 1992). They can cause considerable damage to vegetation and predation on eggs and very small animals, although probably not as severe as that caused by rats (Key et al. 1996, Miller and Miller 1995). The NPS may need to consider a project to further assess and monitor the house mouse population should future management action be required.



Figure 10. Mice (*Mus sp.*) caught in the rat snap-traps at Buck Island.

MONITORING PROTOCOL

In the original project proposal, it was strongly recommended that a rodent monitoring protocol be designed and implemented by the NPS for the indefinite future (Fig. 10). A monitoring protocol would serve several important functions. It would assure the NPS that the rats had, indeed, been eradicated from Buck Island. It would provide a long-term, consistent, systematic source of information on the rat and mouse

populations on Buck Island. The protocol could extend beyond rodent monitoring and include an assessment of the vegetation, noting especially any rodent damage. The monitoring protocol would provide the baseline information needed should any modification of the rodent management program be necessary. Finally, it would give the NPS time to respond to a new reintroduction of rats to the Island before the rat population becomes widespread and abundant, and substantial natural resource damage begins to occur.

For consistency, it is recommended that the 5 snap-trap lines (Fig. 3), used in the eradication project, be used by the NPS for the basis of the rodent monitoring protocol. The traps can be set, baited, and operated for 3 consecutive nights as had been done on several occasions before. The trap locations have been recorded by GPS and provided to the NPS for use in future monitoring. The traps could be removed at the end of each monitoring session so that they are not damaged or obtrusive to the public. It is recommended that, initially, the monitoring be conducted 3 - 4 times per year. After a year or so, this rate could be dropped to 2 times per year. The NPS should also establish one or more vegetation monitoring transects. Selected species of plants subject to rodent damage in the past along the transects should be permanently marked so that their condition and any damage can be recorded periodically. Elements of the vegetation monitoring should include an assessment of plant recruitment and changes in native/non-native plant community composition and abundance.

The first rodent monitoring session was conducted April 18 - 21, 2001. The park added additional funds to the WS agreement with the NPS so that WS could conduct the monitoring session. The 5 snap-trap lines were operated for 3 nights and no rats

were captured (Table 1). It is important to note, however, that 104 house mice were captured. This is about 50 % more than the 67 captured in December 2000, using the same trapping effort. During the trap session some gnawing of woody vegetation was observed along the East trap line, presumably by mice. In addition to food, the mice may have been seeking moisture from the plants, as the weather had been very dry for an extended period. Also, the grassy habitat where the gnawing occurred provides excellent habitat for mice and this area is where the highest rate of mouse capture occurred.

WS scientists also conducted a brief bait efficacy trial with some captive mice from Buck Island during the April 2001 rodent monitoring period. The objective of the trial was to determine if the house mice may have survived the rat baiting operations because of a resistance to the anticoagulant (diphacinone) toxicant used in the project. This outcome was recently documented as an unexpected result of a rat eradication project, using the anticoagulant warfarin, on an offshore-island of Australia (Billing 2000, Billing and Harden 2000). In the WS trial, 7 of 9 (78 %) treatment mice succumbed to the rodenticide bait, whereas 9 of 9 (100 %) control mice (fed a commercial rodent chow) survived the 7-day no-choice trial. This suggests that resistance to the bait used on Buck Island was not responsible for the survival and irruption of mice on Buck Island. Other possibilities include that the elevated bait stations were inaccessible to the mice or that rat activity and the small home ranges of the mice (relative to rats) precluded access by mice to the 40 x 40 m island-wide bait station grid set for rats.

During the April 2001, rodent trap monitoring session, field personnel noted a large expansion of the brown pelican (*Pelecanus occidentalis*) colony on the north side

of the island (Fig. 11). Many more adults, juveniles, and active nests were observed over the December 2000 visit to the area. Over the last ten years, seasonal nesting averaged 20 - 30 nests, whereas in April 2001 over 100 nests were counted with an average of 2 - 3 chicks per nest. It is unknown, however, whether or not this is related to the rodent control efforts and the subsequent recovery of vegetation.



Figure 11. Juvenile and adult brown pelicans (*Pelecanus occidentalis*) in the north side rookery at Buck Island.

CONCLUSIONS

The National Park Service, with Wildlife Service cooperators, made a planned and sustained effort to eradicate the introduced roof rats from Buck Island Reef National Monument from 1998 - 2000. The rats were causing substantial damage to a variety of Buck Island's floral and faunal resources. WS established an island-wide grid of elevated bait stations and used an anticoagulant (0.005 % diphacinone) rodenticide bait block to eradicate the rats. The bait stations were modified several times to assure ready access by rats while minimizing access by non-target animals. Several post-project snap-trapping sessions resulted in no rat captures, suggesting that, indeed, the rats had been eradicated from the Island. Field personnel observed no non-target losses as a result of the baiting program. They noted what appeared to be a rapid recovery of many of the Island's natural resources, both floral and faunal. Hence, it appears that all the objectives of this project have been achieved: the rats have been eradicated; the recovery of rare, endangered or threatened plant and animal species is occurring; the island can now be used as a re-introduction site for the St. Croix ground lizard; and the disease threat posed by rats and their ecto-parasites has been greatly reduced (although perhaps not eliminated because house mice may carry some of these same ecto-parasites).

It is also suspected that the press releases, processes, and outcomes of this project have heightened the public and agency awareness of threats posed by exotic, introduced species. A post-eradication rodent monitoring protocol has been implemented. Post-project monitoring sessions revealed the presence of a house mouse population (another introduced species) on the island. The threats posed by, and

potential management strategies for this introduced pest species should be assessed by the NPS.

ACKNOWLEDGMENTS

The fieldwork described in this report was carried out from August 1998 to April 2001 under Interagency Agreement No. 1443IA500009905 between the Division of Natural Resource Management, Buck Island Reef National Monument, USDI National Park Service, and Wildlife Services, USDA Animal and Plant Health Inspection Service. We would especially like to thank the Park Superintendent Joel A. Tutein for hosting WS and facilitating the work. The project was kept on budget through the dedication of Marianne Jensen, WS Budget Assistant. The project would never have seen completion without tireless efforts of the Wildlife Services field staff: Kelly Ladner, Chad Fuqua, Trae Noblett, Allen Gosser, Ashley Rossi, Pedro Quinones, Doug Hall, Ken Garner, Damon Hughes, and James Rebholz. Thank you also to NPS staff Kimberly K. Woody and Philippe A. Mayor. It is hoped that the success of this project, along with the analysis and reporting of the results will benefit many other island ecosystems.

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APPENDICES

Upon request.

F.7 Flora of Buck Island Reef National Monument (U.S. Virgin Islands)

Woodbury, R. and E. Little. 1976. Flora of Buck Island Reef National Monument (U.S. Virgin Islands). USDA Forest Service Research Technical Paper ITF-19. Institute of Tropical Forestry, Rio Piedras, Puerto Rico.

FOREST SERVICE RESEARCH PAPER ITF-19

AUGUST 1976

FLORA OF BUCK ISLAND REEF NATIONAL MONUMENT (U.S. VIRGIN ISLANDS)

BY ROY O. WOODBURY AND ELBERT L. LITTLE, JR.

8891



INSTITUTE OF TROPICAL FORESTRY

RIO PIEDRAS, PUERTO RICO

FOREST SERVICE

U. S. DEPARTMENT OF AGRICULTURE

RESUMEN

El Monumento Nacional del Arrecife de Buck Island es una isla de una milla de largo y queda a 1 2/3 millas al norte de la parte este de St. Croix, Islas Vírgines Americanas. Esta pequeña isla tiene una abundante flora de las caducifolias estacionales o bosque relativamente seco, zona tropical, haciendo un total de 228 especies de plantas productoras de semillas (incluyendo 17 especies introducidas). Allí no se encuentran helechos, y solamente hay una especie de orquídeas y 7 de cactos. Allí hay un total de 62 especies de árboles, de los cuales 6 son de especies introducidas. Estos datos sobre la presente flora podrían servir para hacer una comparación con otras áreas y para estudios futuros. Allí se provee protección para las especies endémicas, raras, y en peligro de extinción. Hay tres especies de árboles que son endémicos a Puerto Rico y las Islas Vírgenes, pero solamente una de las especies es rara y está en peligro de extinción. Dos especies de plantas más pequeñas son también de una zona limitada.

O.D.C. 174(729)

FLORA OF BUCK ISLAND REEF NATIONAL MONUMENT

(U.S. Virgin Islands)

By Roy O. Woodbury[1/] and Elbert L. Little, Jr.[2/]

Buck Island is located in the Caribbean Sea only 1 2/3 miles north of the eastern part of St. Croix and about 5 miles northeast of Christiansted, United States Virgin Islands (map, figure 1, and figure 2). This "beautiful little uninhabited island" scarcely 1 mile long and less than half as wide supports a rich and representative land flora of the seasonal or relatively dry forest, tropical zone, totaling 228 listed species of seed plants but no ferns.

A major objective of this study was to obtain records at Buck Island Reef National Monument for the 2-volume illustrated reference on the trees of Puerto Rico and the Virgin Islands (Little, Woodbury, and Wadsworth 1964, 1974). That publication cites distribution of each native species by public forests and parks as well as by islands. The expanded list of trees and other seed plants is published separately here because no previous study has been made.

This summary of the plant names and vegetation will be available to visitors, especially scientists and students, who are attracted in increasing numbers. An inventory of the land flora of Buck Island Reef National Monument is needed because the land and surrounding reefs will be preserved in their natural state indefinitely by the National Park Service. Thus, the island is a refuge for species which might be destroyed elsewhere. The natural area with its known flora will serve as a control or check plot for comparing other islands with different land use, past, present, and future. Similar plant lists of other localities when combined will aid in understanding present plant distribution and past history. Also, the record of the present flora will serve as a basis for future studies of possible changes, such as gradual restoration of the original vegetation, migration and invasion by other plant species, and possible extinction of some now present.

This flora is a contribution to the International Biological Program from the United States Department of Agriculture Forest Service project on forest trees of the Caribbean area. It follows one on the trees of Jost Van Dyke (British Virgin Islands) (Little 1969).

DESCRIPTION OF BUCK ISLAND

St. Croix is approximately 500 miles north of the coast of Venezuela in northern South America, the nearest continent, and about 1,100 miles southeast of Miami, Florida, in North America. The Virgin Islands of the West Indies in the Caribbean Sea are oceanic and volcanic in origin and never have been connected with a continent through their long geologic history.

Buck Island is slightly more than 1 mile long in east-west dimension and less than 1/2 mile

1/ Plant taxonomist, University of Puerto Rico, Río Piedras, Puerto Rico 00928.

2/ Chief dendrologist, Timber Management Research, Forest Service, United States Department of Agriculture, Washington, D.C. 20250.



Figure 1. Air photo of Buck Island surrounded by reefs, looking southeast, with the east end of St. Croix at far right. Sandy coastal plain with beach forest in foreground and salt pond at right. (By John E. Randall from National Park Service, Randall and Schroeder 1962.)

Permission for reproduction of photo and map granted by the International Oceanograph Foundation, Miami, Florida.

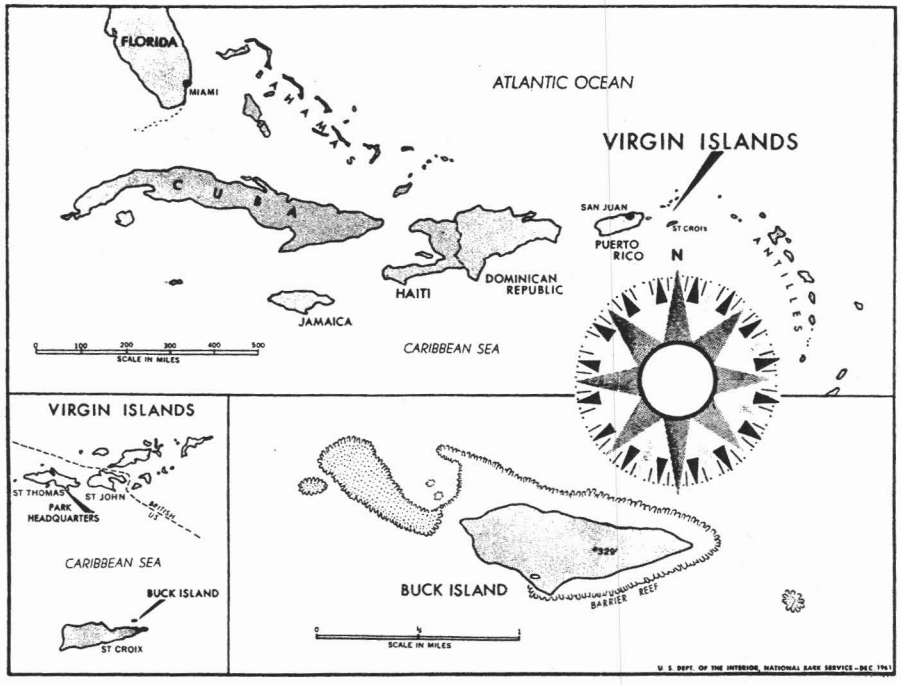


Figure 2. Map of Caribbean area showing location of Virgin Islands. Lower left, map of Virgin Islands. Lower right, Buck Island and reefs. (By Caroline G. Holcomb, National Park Service, Randall and Schroeder 1962.)

wide north-south and is 329 feet high. Precisely it is 2,000 yards long and 750 yards wide and has an area of 176.4 acres (71.4 hectares), according to the geographical reference by McGuire (1925). Its exact location is Lat. 17° 47' 08" to 31" N., Long. 64° 36' 41" to 37' 44" W. The island is surrounded by coral reefs except on the southwest side and is separated from St. Croix by a shallow channel scarcely 31 feet at its minimum depth.

These two islands probably were joined and slightly larger as recently as 10,000 years ago. At the time of maximum glaciation in the Pleistocene epoch, about 11,000 years ago, the ice sheets stored enough water to lower the sea level about 200 feet. A deep channel of 15,000 feet isolated St. Croix from the other Virgin Islands and Puerto Rico, which apparently were connected.

Buck Island with its reefs is shown from the air in figure 1. From rocky cliffs at the beach, gravelly slopes rise to a low east-west ridge along the summit. At the northwest end there is a sandy coastal plain and beach. Near the western end of the southern shore there is a salt pond about 400 ft. long and 150 ft. wide. Located at sea level, it contains brackish water with no outlet. There are no springs, streams, pools, or marshes of fresh water.

One derivation of the name was explained by McGuire. This small island was originally named Pocken-Eyland, because it was overgrown with Pokholt or Guayaco trees. With time, Pocken was changed to Bocken, Bokken, and Buck. Guayaco is a variation of guayacán, the Spanish name for common lignumvitae (*Guaiacum officinale* L.). That valuable self-lubricating wood was sold by weight for its special use in bearings and bushing blocks for steamship propeller shafts. Lignumvitae is not here now but has been nearly exterminated on the Virgin Islands except in cultivation (Little and Wadsworth 1964, p. 212).

Another version traces the name to the local term "buck" for the male goat. McGuire noted that several hundred wild goats formerly subsisted on the island. Incidentally, deer (including bucks) and other large land mammals are not native on these oceanic islands.

This National Monument is not to be confused with other small islands of the same name in the U.S. Virgin Islands, for example, one south of St. Thomas, where botanical collections were made earlier. Le Duck Island off Coral Harbor in St. John is sometimes called Buck.

Many centuries ago, groups of Arawaks and other Indians from northern South America migrated north into the West Indies and settled through the Virgin Islands. A shell mound on the eroding northwest tip of Buck Island indicates a considerable period of habitation by aboriginal peoples. Such natives practiced a limited agriculture, probably involving slash and burn. However, it is not known to what extent the vegetation was altered before Europeans arrived.

Christopher Columbus discovered the Virgin Islands on his second voyage in 1493. These small, accessible islands were settled by Europeans from several countries at early dates and were developed as colonies for their agriculture. The United States Virgin Islands, including St. Croix, St. John, St. Thomas, and a few adjacent isles, were purchased from Denmark in 1917 during World War I.

In 1754, Diedrichs Estate on Buck Island was patented. At the beginning of this century, according to old timers, a few persons still lived on the island. They grew sweet potatoes in a valley on the northwest side and cut trees for charcoal. Also, sheep and wild goats were present. Every year the exposed eastern part of the island burned, but the fire stopped at the wetter

western end. As recent as the 1920's, the island was leased for goat raising. Later notes were provided by Randall and Schroeder (1962).

The Virgin Islands Government obtained control of Buck Island in 1936 and in 1948 created Buck Island Park. After authorization by the Virgin Islands Legislature in 1961, Buck Island Reef National Monument became a unit of the National Park Service, United States Department of the Interior. The island and the surrounding barrier reefs contain 850 acres.

The National Park Service administers Buck Island in conjunction with the Christiansted National Historic Site at Christiansted, St. Croix, and under the Virgin Islands National Park on St. John (superintendent's office at Charlotte Amalie, St. Thomas). Self-guiding underwater nature trails, a beach, and a picnic area are maintained. However, there is no drinking water or other fresh water, and overnight camping is not permitted. Small ships and motor ferries from Christiansted bring visitors, mostly tourists, on scheduled daily trips. Others come in chartered or rented boats. There are no residents, but the National Park Service has a small building near the beach. A light tower of the U.S. Coast Guard is located on the highest point.



Figure 3. Buck Island from the southwest, with coastal plain at left.

CLIMATE

The climate of Buck Island is like that of other small West Indian islands of low altitude: tropical, warm, and slightly humid, with frequent brief showers and steady easterly trade winds (U.S. Dep. Commerce 1965). In the Virgin Islands, temperatures vary only 5° F. to 7° F. from the coolest to warmest month. A relatively dry season occurs in December and January, often with damaging drought, though there is no sharply defined period without precipitation. The heaviest rains generally are recorded from August to November at the height of the tropical storm season. Infrequent hurricanes during that period sweep directly over the islands, depositing torrential amounts of rain.

Weather records in nearby St. Croix may be noted in the absence of any from Buck Island (Smedley 1961). At Alexander Hamilton Field (airport) 7 miles west-southwest of Christiansted, the mean annual precipitation over a 10-year period was approximately 44 inches. However, at East Hill 4 miles east of that city and opposite Buck Island, the 5-year average was only about 36 inches. Mean annual temperature at the airport was 79.8° F. Mean daily maximum temperatures varied from 93° F. in August, the hottest month, to 88° F. in December and January, the coolest. Mean daily minimum temperatures ranged from 72° F. in August down to 61° F. in January.

STUDIES OF THE FLORA

The Virgin Islands were among the first in the Carribean to be explored by botanists. At the close of the 18th century a comprehensive flora of St. Croix was published in Danish and in German translation by H. West (1793), head of the Danish school there. Nearly a century ago, Henrik Franz Alexander von Eggers (1844-1903), Danish army captain in the Virgin Islands, prepared a flora of St. Croix and the other Virgin Islands, which was published in 1879 by the United States National Museum. Millspaugh (1902) wrote the third flora of St. Croix, based also upon large plant collections in 1895-96 by Alfred Edmund Ricksecker, college science professor from the United States, and his relatives.

Britton (1918) issued his flora of the American Virgin Islands the year after their purchase. The Virgin Islands, both United States and British, were covered in the descriptive flora of Puerto Rico and the Virgin Islands by Britton and Wilson (1923-30).

This annotated list of plant species is based upon four field trips to Buck Island in different years and seasons. The junior author collected three specimens on June 22, 1966 and April 14, 1967. Both authors made additional collections together on June 9-10, 1969 and November 10-12, 1970. At that time the senior author obtained specimens of shrubs and herbs to complete the list. The 1969 visit was made at an unusually favorable season. The vegetation was green and luxuriant following heavy rains (totaling 17 inches in May at St. Croix). Likewise, the 1970 trip coincided with continued high rainfall, and most plants, especially herbs, were in good condition for specimens. Credit is due the National Park Service for providing transportation by launch from Christiansted.

Herbarium specimens of nearly all species were collected and identified by the authors. Duplicate sets are being deposited in the U.S. National Herbarium (US), U.S. National Museum of Natural History, Washington, D.C., and Virgin Islands National Park, St. John, U.S. Virgin Islands. Additional tree specimens are being sent to the Arnold Arboretum (A), Harvard University Herbaria, Harvard University. Another set has been retained in herbaria at Río Piedras,

Puerto Rico, the tree specimens at the Institute of Tropical Forestry (RPPR) and the smaller plants at the University of Puerto Rico.

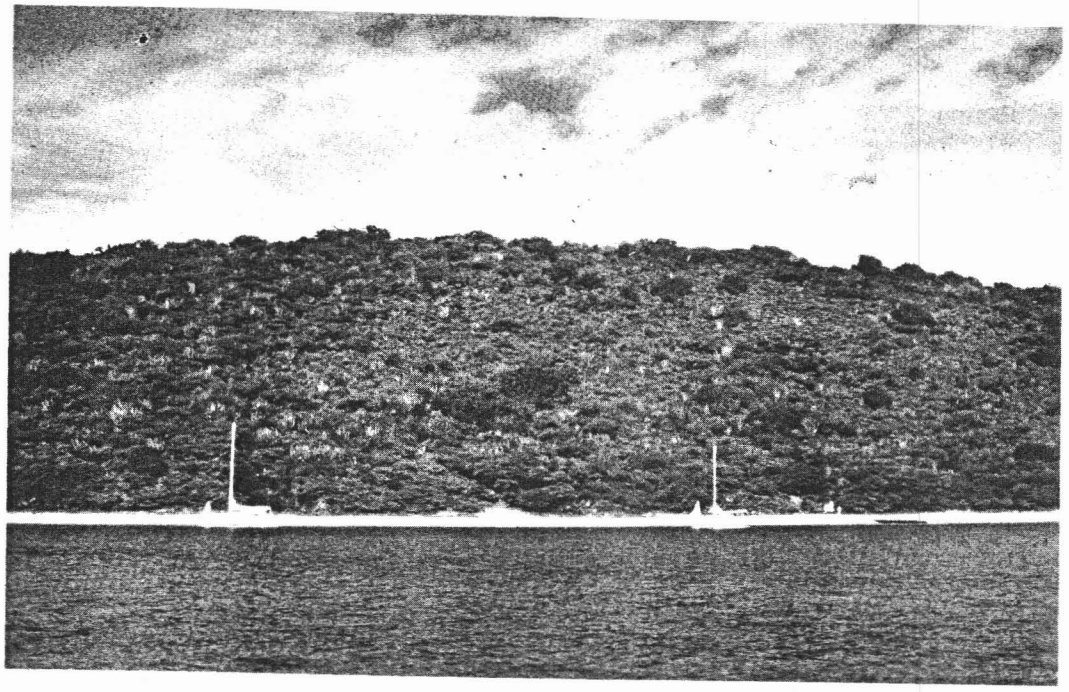


Figure 4. South slope showing shrub thicket of *Croton rigidus, Lantana involucrata, Acacia tortuosa,* **and the columnar tree cactus,** *Cephalocereus royenii.*

VEGETATION

The vegetation of Buck Island resembles that of other small West Indian islands. Most of the upland of Buck Island probably was once covered by a seasonal deciduous forest, tropical zone, like that described by Beard (1949) for the Windward and Leeward Islands. This type has been designated also as a dry forest in comparison with moist evergreen types such as the tropical rain forest. The vegetation is less luxuriant, because of the lighter rainfall, and the trees are not so tall.

Settlement of Buck Island produced changes in the original vegetation. Some of the forest was cleared and replaced by cultivated fields. Composition of tree species in the remaining forest may have been changed by heavy cutting through the centuries. Tree species left after logging generally have soft woods seldom used. Lignumvitae, *Guaiacum officinale*, and possibly other important timbers now absent might have become extinct here. Other trees were used for making charcoal.

Heavy grazing by goats and sheep probably caused a decrease in the wild forage plants and corresponding increase in nonpalatable shrubs. Introduced mongooses and rats destroyed wildlife, such as nesting birds and lizards. Annual fires through the exposed eastern slopes destroyed some vegetation.

This seasonal deciduous forest, a relatively dry forest, still occupies much of the upland of Buck Island. It is designated as upland forest in the annotated list. Rather open, it is composed of small, growing trees mostly about 20 ft. high and 1 ft. in trunk diameter at breast height (d.b.h.,

4 1/2 ft.) sometimes to 35 ft. high and 2 ft. in diameter. The trees have mainly small leaves. Some species shed their foliage in the dry season. Common tree species are *Pisonia subcordata, Piscidia carthaginensis, Adelia ricinella, Bursera simaruba, Bourreria succulenta,* and *Cordia alba.*

Shrub thickets still cover some upland areas, including exposed, wind-swept slopes on the eastern part of the island. This secondary type following destruction of the forest by cutting, cultivation, grazing, and burning undoubtedly has been more extensive and now is decreasing. The crowded shrubs are mostly 5-12 ft. high. The most common species are *Acacia tortuosa* (also a tree), *Croton rigidus, Opuntia rubescens,* and *Lantana involucrata.* On exposed ridges and steep slopes bordering the sea, *Plumeria alba* and *Cephalocereus royenii,* a columnar tree cactus, are conspicuous.



Figure 5. Large manchineel tree in the beach forest (with Woodbury).

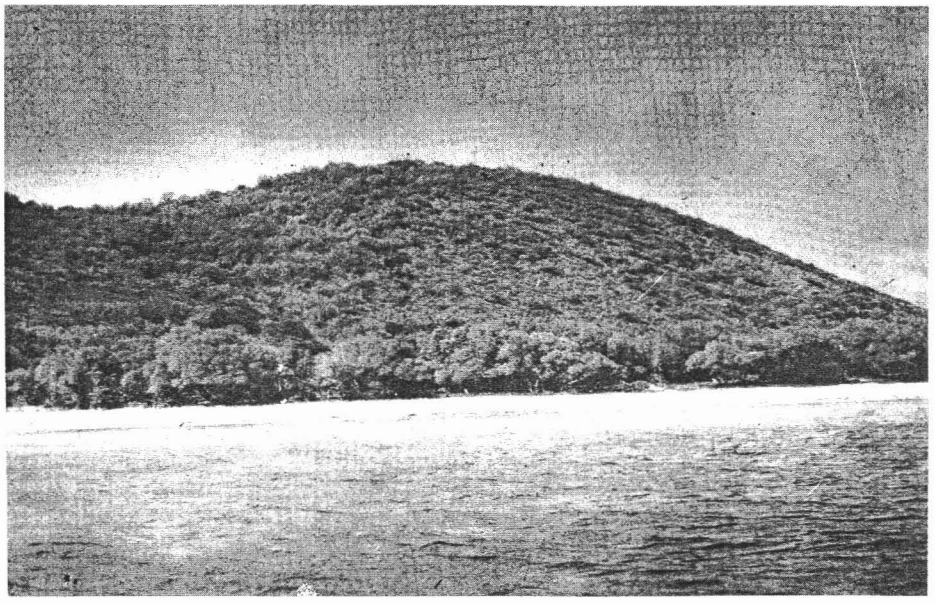


Figure 6. Beach forest of manchineel (*Hippomane mancinella*) on eroding sandy shore at west end, looking south. St. Croix at far right.

A coastal plain forest, or beach forest, occupies the sandy coastal plain at the western end of the island. This broad level area about 10 ft. above sea level probably was cleared and cultivated in the past. The large spreading trees attain 35 ft. in height and 2 ft. or more in trunk diameter. Characteristic tree species are *Hippomane mancinella* (figures 5,6), *Coccoloba uvifera, Pisonia subcordata, Ficus citrifolia,* and *Tamarindus indica* (introduced).

As the island has no silt shores, the only mangrove swamp forest forms a narrow zone around the salt pond. Three species of mangroves here, mostly 20-25 ft. high, are *Avicennia germinans* (most common), *Conocarpus erectus*, and *Laguncularia racemosa.* Red mangrove, *Rhizophora mangle* L., the most common species through the West Indies, is missing. Owing to the lack of suitable habitats, plants of fresh water and wet sites are also absent.

Introduced species are relatively few and include fruit trees on the coastal plain. The few coconuts, *Cocos nucifera*, are small and seem to be a recent introduction. One tree each were seen of lime, *Citrus aurantifolia*, and kinep or Spanish-lime, *Melicoccus bijugatus.* However, tamarind, *Tamarindus indica*, is common and both persistent around old home sites and naturalized.

STATISTICAL SUMMARY

The rich land flora of Buck Island Reef National Monument, as compiled here, contains 228 species of seed plants in 171 genera and 63 plant families. There are no native ferns.

As to size and habit or growth form, these 228 species may be classed as follows: trees, 62; shrubs, 68; vines (mostly woody), 15; herbs, 77; epiphytes, 3; and parasites, 3.

The division between these groups, especially between trees and shrubs, is not sharp. As defined here, trees are woody plants having one erect perennial stem or trunk at least 3 inches (7.5 centimeters) in diameter at breast height (d.b.h. or at 4 1/2 feet or 1.4 meters), a more or less definitely formed crown of foliage, and a height of at least 12 to 15 feet (about 4 meters). Several species of this list were not observed as large on Buck Island, though they probably were larger in the undisturbed vegetation and reach tree size elsewhere in the Virgin Islands. These species were counted as shrubs, though their occurrence on Buck Island is cited in tree ranges.

All except 17 species listed are native. Six of the 62 tree species are introduced, mostly planted for fruit, and are designated by an asterisk (*). Eleven herbaceous species are widespread introduced weeds likewise indicated (*). These species include 7 grasses, 2 shrubs, 1 vine, and 1 herb.

Largest families in numbers of species are:

Leguminosae (Legume family)	28
Gramineae (Grass family)	22
Euphorbiaceae (Spurge family)	17
Malvaceae (Mallow family)	9
Boraginaceae (Borage family)	9
Compositae (Composite family)	9
Rubiaceae (Madder family)	8
Amaranthaceae (Amaranth family)	7
Cactaceae (Cactus family)	7
Verbenaceae (Verbena family)	7

The remaining families have 5 or fewer species, many only 1 or 2. Largest families in numbers of tree species are Leguminosae, 5 species, and Boraginaceae, 4.

Largest genera are *Sida* with 6 species and *Chamaesyce, Cordia, Croton,* and *Opuntia*, 4 each. Most genera are represented by only 1 or 2 species. Genera with the most tree species are *Coccoloba, Capparis,* and *Eugenia*, 3 species each.

The 62 tree species are grouped in 51 genera (including 6 introduced) and 28 plant families (including 1 introduced). Most of these genera have only 1 native tree species here.

The richness of the tropical flora, even in a seasonal climate, is confirmed by the presence of 228 species of seed plants (all but 17 native) on this small island of only 176.4 acres. The seasonal or dry character of the vegetation is shown by the absence of ferns and presence of 7 species of cacti but only 1 of orchid. Representing the pineapple or bromeliad family are only 2 species, both mostly epiphytes or air plants. The only palms are a few small introduced coconuts.

Many species of seed plants of Buck Island are widely distributed. No unusual tree distribution records were found on this small island so near a larger one.

The seasonal deciduous forest, or dry forest, is widespread at low altitudes through the West Indies and extends northwest along the Greater Antilles and Bahama Islands to southern Florida. About 25 tree species of Buck Island, nearly one-half of the total, are native also in southern Florida. These are:

Ficus citrifolia
Coccoloba uvifera
Capparis cynophallophora
Capparis flexuosa
Pithecellobium unguis-cati
Amyris elemifera
Suriana maritima
Gymnanthes lucida
Hippomane mancinella
Bursera simaruba
Crossopetalum rhacoma
Schaefferia frutescens
Colubrina arborescens
Colubrina elliptica
Krugiodendron ferreum
Clusia rosea
Conocarpus erectus
Laguncularia racemosa
Eugenia axillaris
Eugenia rhombea
Avicennia germinans
Citharexylum fruticosum
Duranta repens
Erithalis fruticosa
Exostema caribaeum

ENDEMIC, RARE, AND ENDANGERED SPECIES

The National Monument provides protection for endemic, rare, and endangered species. Few native on Buck Island have limited distribution or would be classed as rare. All species of native seed plants cited here apparently are also on St. Croix. However, 7 species designated by a dagger (†) were not listed from St. Croix by Britton and Wilson (1923-30). All are on St. Croix.

Two tree species, noted below, are endemic or restricted to Puerto Rico and the Virgin Islands. Only the first is both rare and endangered. Additional species of valuable timbers not found here might possibly have been present in the natural forests of Buck Island. Two species of smaller plants have narrow ranges also.

Malpighia pallens, stingingbush, recorded by Britton and Wilson (1923-30; 6: 444) as endemic to St. Croix, is also on Buck Island and is both rare and endangered. This species known by its irritating hairs is perhaps most closely related and possibly derived from *M. fucata* Ker, of Vieques, Culebra, Puerto Rico, and east to Cuba. The stinging hairs make this tree objectionable and might lead to eradication on privately owned land. Thus, this species could easily become extinct on St. Croix and deserves protection on Buck Island.

Cordia rickseckeri, manjack, though not rare, is represented on Buck Island and St. Croix by the typical smooth-leaf form. On the other islands the upper leaf surfaces usually are very rough. This species with showy orange flowers like those of the related Geiger-tree, *Cordia sebestena* L., merits propagation as an ornamental. Cultivation would be further insurance against possible extinction.

Croton rigidus (Muell. Arg.) Britton, adormidera, also confined to the Virgin Islands and Puerto Rico, is a shrubby weed dominant in shrub thickets. Being unpalatable to livestock, it has increased in numbers, especially on areas cleared or heavily grazed in the past. This abundant weedy endemic species is an indicator of earlier overgrazing and obviously needs no protection.

Several tree species rare on Buck Island have wide distribution on other islands and thus are not endangered. For example, only 1 plant of *Zanthoxylum spinifex* was found on the island, and only 2 of *Colubrina arborescens*. Nevertheless, survival and perhaps increase on Buck Island may be expected and could be aided by removal of competing vegetation. Also, species that might disappear on other islands after intensive land use should be safe here.

Two species of smaller plants of Buck Island were cited by Britton and Wilson (1923-30) as endemic to Puerto Rico and the Virgin Islands. They are: *Alternanthera portoricensis*, a rare matted herb, and Opuntia repens, a common, low spreading pricklypear cactus. The first was recorded as far as Anegada and the second to Mona.

ANNOTATED LIST OF SPECIES

Scientific names of trees follow Little, Woodbury, and Wadsworth (1974). That reference and the earlier volume (Little and Wadsworth 1964) contain additional information, including other names, description, distribution, drawing, etc. As Buck Island now is uninhabited, local common names are lacking. English common names of trees are from the same reference, mostly those used on St. Croix and others of the Virgin Islands. For those tree species reaching Florida, common names accepted by the Forest Service have been added. Spanish names from Puerto Rico have been inserted in the absence of one in English. The reference cited lists Spanish common names in Puerto Rico and beyond. The articles by Liogier (1965, 1967) have been helpful in revision of the nomenclature of other plants from that of Britton and Wilson (1923-30). Names used by those authors have been added in parentheses.

Maximum heights and trunk diameters are given for trees observed on Buck Island. The forest or vegetation type is cited. Seventeen introduced species are indicated by an asterisk (*). Seven species not listed from St. Croix by Britton and Wilson (1923-30) and in part perhaps range extensions are designated by a dagger (†).

1. Gramineae (Grass family)

**Andropogon pertusus* (L.) Willd. A weedy uncommon introduced bluestem grass of trails and open areas and a pasture grass in the Antilles.

Anthephora hermaphrodita (L.) Kuntze. An uncommon grass of open woods.

Aristida adscensionis L., three-awn. A rather common grass of trails and open slopes.

Aristida cognata Trin., three-awn. A rare plant of slopes and ridges.

Cenchrus echinatus L., sandbur. A locally common grass of sandy beaches.

**Chloris ciliata* Sw. A rare fingergrass similar to the next species.

**Chloris inflata* Link. A rare weedy fingergrass of open areas.

**Chloris radiata* (L.) Sw. A very rare fingergrass found in only one location near the picnic area.

**Eleusine indica* (L.) Gaertn., goosegrass. An introduced weedy grass of the picnic area.

Eragrostis ciliaris (L.) Link, lovegrass. A common weedy grass of open areas.

Leptochloa filiformis (Lam.) Beauv., sprangletop. A very rare grass along one slope. St. Croix, according to Eggers (Britton and Wilson 1923-30; 5: 71).

Panicum adspersum Trin. A widespread grass but here rare in open coastal areas.

**Panicum maximum* Jacq., Guinea-grass. A common large introduced forage grass of open areas.

Panicum reptans L. A rare coastal grass.

Paspalum laxum Lam. (*P. glabrun* Poir.). A common native grass in all habitats of the island.

Setaria leiophylla (Nees) Kunth. Similar to the next species but with larger open flower clusters.

Setaria setosa (Sw.) Beauv. (*Chaetochloa setosa* (Sw.) Scribn.). An uncommon grass of trails and partly open areas.

†*Setaria utowanaea* (Scribn.) Pilger (*Panicum utowanaeum* Scribn.). A common forest grass.

Spartina patens (Ait.) Muhl. A tall grass of sandy beaches. Not common.

**Sporobolus indicus* (L.) R. Br. A weedy bunchgrass of trails.

Sporobolus virginicus (L.) Kunth, seashore dropseed. A common creeping grass of beaches and the salt pond.

Tragus berteronianus Schult. (*Nazia aliena* (Spreng.) Scribn.), burgrass. An uncommon native grass of partially open areas.

2. Cyperaceae (Sedge family)

Cyperus ligularis L. A rare sedge found in one location on the north beach.

Cyperus nanus Willd. (*C. granularis* (Desf.) Britton). A very rare fine-leaf sedge of ridges.

Cyperus planifolius L. C. Rich. A common sedge of coastal and sandy areas.

Scleria lithosperma (L.) Sw. A rare, white-fruited sedge of upper slopes.

3. *Palmae (Palm family)

**Cocos nucifera* L., coconut. Tree 20 ft. high, 10 in. d.b.h., uncommon on sandy beach, planted.

4. Bromeliaceae (Pineapple family)

Tillandsia recurvata L. A common epiphyte or air plant of upper slopes and ridges. Locally very abundant.

Tillandsia utriculata L. A common large epiphyte of upper slopes and ridges. Locally very abundant and even found in humus and on rocks.

5. Commelinaceae (Spiderwort family)

Commelina virginica L. (*C. elegans* H.B.K.), day-flower. A common succulent of forested areas.

6. Liliaceae (Lily family)

**Aloe vera* L., aloe. A rare and local succulent shrub of upper slopes near old homesite.

7. Amaryllidaceae (Amaryllis family)

Panchratium declinatum Jacq. (*Hymenocallis declinata* (Jacq.) M. Roem.), spider-lily. A rare lily of ornamental value found only on the north coast.

8. Orchidaceae (Orchid family)

Epidendrum brittonianum A. D. Hawkes (*E. bifidum* Sw., *Encyclia papilionacea* (Vahl) Schlechter). An uncommon orchid usually growing as an epiphyte near the bases of trees and shrubs.

9. *Casuarinaceae (Casuarina family)

**Casuarina equisetifolia* J. R. & G. Forst., Australian beefwood, horsetail casuarina. A very rare planted tree. One 20 ft. high in beach forest near the picnic area.

10. Piperaceae (Pepper family)

Peperomia humilis (Vahl) A. Dietr. A rare small succulent herb found only in thick humus.

11. Ulmaceae (Elm family)

Celtis iguanaea (Jacq.) Sarg. (*Momisia iguanea* (Jacq.) Rose & Standl.). An uncommon large woody and spiny vine of slopes and ridges.

12. Moraceae (Mulberry family)

Ficus citrifolia Mill. (*F. laevigata* Vahl), shortleaf fig. Tree 25 ft. high, 1 ft. d.b.h., with prop roots. One of the largest trees of beach and upland forests.

13. Loranthaceae (Mistletoe family)

Dendropemum caribaeum Krug & Urban (*Phthirusa caribaea* (Krug & Urban) Engler), mistletoe. A rare parasite on *Pisonia subcordata.*

14. Polygonaceae (Buckwheat family)

Coccoloba microstachya Willd. (*C. obtusifolia* auth.), uvilla. Tree 20 ft. high, 5 in. d.b.h. Rare at edge of beach forest.

Coccoloba swartizii Meisn. (*C. diversifolia* auth.), ortegón. Rare tree 25 ft. high, 8 in. d.b.h. A single tree seen on the north coast.

Coccoloba uvifera (L.) L., seagrape. Tree 30 ft. high, 1 ft. d.b.h., with edible fruit. Common in beach forest.

Coccoloba uvifera X *krugii.* Tree 20 ft. high, 6 in. d.b.h., regarded as a hybrid. Rare at edge of beach forest and in ravines.

15. Amaranthaceae (Amaranth family)

Achyranthes aspera L. (*Centrostachys aspera* (L.) Standl.). A rare weedy small shrub near the picnic grounds. Virgin Islands according to Eggers (Britton and Wilson 5: 278).

Alternanthera portoricensis Kuntze (*Achyranthes portoricensis* (Kuntze) Standl.). A rare matted herb of forested slopes. Endemic to Puerto Rico, smaller islands, and Virgin Islands to Anegada.

Amaranthus crassipes Schlecht. A rare herb of the beach forest.

Amaranthus gracilis Desf. Rare herb of beaches and beach forest, more weedy than the above species.

Celosia nitida Vahl. A rather common shrub, 3-4 feet, on the ridge running east.

Iresine angustifolia Euph. A weak shrub of local distribution.

Philoxerus vermicularis (L.) Nutt. A rare fleshy beach herb with prostrate habit.

16. Nyctaginaceae (Four-o'clock family)

Boerhaavea diffusa L. (*B. coccinea* Mill.). A rather common fleshy herb with small sticky fruit, on partly open weedy areas.

Boerhaavea erecta L. Similar to above but fruit not sticky.

†*Commicarpus scandens* (L.) Standley. A rare fleshy vinelike shrub.

Guapira fragrans (Dum.-Cours.) Little (*Torrubia fragrans* (Dum.-Cours.) Standley), black mampoo. Tree 30 ft., 8 in. d.b.h., upland and beach forests.

Pisonia subcordata Sw., water mampoo. Tree 40 ft. high, 2 ft. d.b.h., with enlarged base and with broad crown to 60 ft. wide, beach forest. Also common and dominant in upland forest.

17. Batidaceae (Saltwort family)

Batis maritima L., saltwort. An uncommon succulent shrub growing in mats near the salt pond.

18. Phytolaccaceae (Pokeweed family)

Petiveria alliacea L. A weedy small shrub near picnic area.

Rivina humilis L. A common small shrub of wooded areas.

19. Aizoaceae (Carpetweed family)

Mollugo nudicaulis Lam. A very rare herb on one ridge.

†*Mollugo verticillata* L., carpetweed. A very rare herb of open woods.

Sesuvium portulacastrum L. A common matted succulent herb of coastal areas.

20. Portulacaceae (Purslane family)

Portulaca oleracea L., purslane. A weedy succulent herb of trails and coastal areas.

Portulaca pilosa L. A very small succulent herb of rocky areas.

Talinum peniculatum (Jacq.) Gaertn. An uncommon succulent shrub of open wooded areas.

Talinum triangulare (Jacq.) Willd. Similar to the above species.

21. Lauraceae (Laurel family)

Cassytha filiformis L., love-vine. Parasitic greenish orange vine, herbaceous and leafless.

22. Cruciferae (Mustard family)

Cakile lanceolata (Willd.) O. E. Schulz, sea-rocket. Common annual beach shrub.

23. Capparidaceae (Caper family)

Capparis cynophallophora L., Jamaica caper. A glossy-leaved tree 20-30 ft. high, 6-8 in. d.b.h., of slopes and beach forest.

Capparis flexuosa (L.) L., limber caper. Vine and tree to 20 ft. high, 4 in. d.b.h., beach and upland forests.

Capparis indica (L.) Fawc. & Rendle, linguam. A frequent small tree 12 ft. high, of slopes, upland forest.

**Cleome viscosa* L. (*C. icosandra* L.). An uncommon viscous herb.

Morisonia americana L., rat-apple. Only one small tree seen on inner moist slope.

24. Leguminosae (Legume family)

Mimosoideae (Mimosa subfamily)

Acacia riparia H.B.K. A large spiny uncommon vine of slopes.

Acacia tortuosa (L.) Willd., twisted acacia. Shrub or tree 10-15 ft. high, sometimes to 30 ft., with several trunks to 6 in. d.b.h., and broad flat-topped crown. Common in upland, cutover forest, also in beach forest.

Desmanthus virgatus (L.) Willd. (*Acuan virgatum* (L.) Medic.). A frequent shrub of slopes and beach forest.

Leucaena latisquama (L.) W. T. Gillis (*L. leucocephala* (Lam.) de wit, *L. glauca* auth.), tantan. Tree 15 ft. high, 3 in. d.b.h., disturbed upland forest.

Pitehcellobium unguis-cati (L.) Benth., bread-and-cheese, catclaw. Tree 15 ft. high, upland forest. Spiny vinelike tree, not common.

Caesalpinioideae (Cassia subfamily)

Caesalpinia crista L. (*Guilandina crista* (L.) Small), gray nickerbean. A rather common very spiny woody vine with spiny gray-seeded fruit.

Caesalpinia divergens Urban (*Guilandina divergens* (Urban) Britton), yellow nickerbean. A very spiny shrublike vine with spiny yellow-seeded fruit.

Cassia occidentalis L. (*Ditremexa occidentalis* (L.) Britton & Rose). A rare weedy shrub near camp site.

Cassia swartzii Wickstr. (*Chamaecrista swartzii* (Wickstr.) Britton). A beautiful yellow-flowered shrub of open woods.

**Tamarindus indica* L., tamarind. Spreading tree to 40 ft. high, 3 ft. or more in trunk diameter, and 60 ft. in crown width. Naturalized in beach forest and on ridges.

Faboideae (Pea subfamily)

**Abrus precatorius* L. (*Abrus abrus* (L.) W. F. Wight), jumbie-bead. An uncommon weedy, slender vine. The small shiny red and black seeds are deadly poisonous.

Canavalia maritima (Aubl.) Thou. An annual large creeping vine of beaches.

Centrosema virginianum (L.) Benth. (*Bradburya virginica* (L.) Kuntze). A common small blue-flowered vine.

Cracca caribaea (Jacq.) Benth. (*Benthamantha caribaea* (Jacq.) Kuntze). An open shrub of forests.

Crotalaria incana L., rattlebox. A soft hairy small shrub of coastal woods and slopes.

Crotalaria latifolia L., rattlebox. A small shrub common on slopes.

Crotalaria retusa L., rattlebox. Showy yellow-flowered herb of open areas.

†**Crotalaria saltiana* Andr. (*C. striata* DC.), rattlebox. A large shrub rare to the island.

Desmodium molle (Vahl) DC. (*Meibomia mollis* (Vahl) Kuntze). A rare shrub near picnic area.

Galactia dubia DC. A common small vine of wooded areas.

Galactia striata (Jacq.) Urban. Similar to above but larger.

Indigofera suffruticosa Mill., indigo. A grayish shrub of beach forest and slopes.

Piscidia carthaginensis Jacq. (*Ichthyomethia piscipula* auth.), dogwood. Tree 30-40 ft. high, 1-2 ft. d.b.h., mostly in ravines of upland forest. Elsewhere the bark of this and other species of barbasco or fish-poison serves to stupefy fish. When ground bark is thrown into water, fish rise to the surface and are easily caught.

Rhynchosia minima (L.) DC (*Dolicholus minimus* (L.) Medic.). A weedy, small vine of open areas.

Rhynchosia reticulata (Sw.) DC. (*Dolicholus reticulatus* (Sw.) Millsp.). A small vine of wooded areas.

Stylosanthes hamata (L.) Taubert. A weedy herb of open areas.

Tephrosia cinerea (L.) Pers. (*Cracca cinerea* (L.) Morong.). A small grayish vine of beaches.

Teramnus labialis (L. f.) Spreng. A rare, twining, small vine of forested areas.

25. Erythroxylaceae (Coca family)

Erythroxylum rotundifolium Lunan (*E. brevipes* DC.), brisselet. Shrub or small tree to 15 ft. high, 4 in. d.b.h. Rare in upland and beach forests.

Zygophyllaceae (Caltrop family)

Guaiacum officinale L., common lignumvitae. Not seen. If formerly present, it has become extinct, as noted in the introduction. Recorded from St. Croix but nearly exterminated on Virgin Islands except where planted (Britton and Wilson 1923-30; 5: 435).

26. Malpighiaceae (Malpighia family)

Banisteria purpurea L. A small woody vine of forested areas.

Bunchosia glandulosa (Cav.) L. C. Rich., café forastero. Shrub or small tree to 15 ft. high, 4 in. d.b.h., upland forest.

Malpighia pallens Small, stingingbush. Tree to 25 ft. high, 3 in. d.b.h., scattered in beach forest. The English common name of a related species in the Virgin Islands is adopted here also for this species. Britton and Wilson (1923-30; 5: 444) stated: "The leaves are usually copiously armed beneath with long yellowish stinging hairs and contact with them is highly irritating." Actually, the lower leaf surfaces have many almost invisible needlelike hairs 2-branched or attached at middle and flat against leaf. A person touching the foliage is unaware of the source of the needles about 1/4 inch long that protrude painfully from his hand and fingers. However, these needlelike hairs do not inject a chemical into the flesh, as do nettles. Endemic to Buck Island and St. Croix and both rare and endangered.

Stigmaphyllon periplocifolia (Desf.) A. Juss. (*S. lingulatum* auth.). A very common yellow-flowered vine covering small trees.

S. emarginatum

27. Rutaceae (Rue family)

Amyris elemifera L., torchwood, sea amyris. Tree 15 ft. high, 4 in. d.b.h., upland forest.

**Citrus aurantifolia* (L.) Swingle, lime. One tree 12 ft. high seen in beach forest, introduced.

Zanthoxylum spinifex (Jacq.) DC. Shrub 12 ft. high, with several stems less than 2 inches in diameter (on other islands rarely a small tree). Rare in upland forest, only 1 plant seen.

28. Simaroubaceae (Ailanthus family)

Suriana maritima L., baycedar. Rounded shrub to 8 ft. high, rare and local at sandy beach

(elsewhere sometimes a small tree).

29. Burseraceae (Bursera family)

Bursera simaruba (L.) Sarg., gumbo-limbo, locally called "turpentine," from its resin. Tree 35 ft. high, with thick coppery smoothish trunk to 2 ft. d.b.h. Common and dominant in upland forest, also in beach forest.

30. Euphorbiaceae (Spurge family)

Adelia ricinella L. (*Ricinella ricinella* (L.) Britton), cotorro. Tree 25 ft. high, 3 in. d.b.h., upland forest.

Argythamnia candicans Sw. A small local shrub of slopes and ridges.
A. stahlii prostrate/recumbent
Chamaesyce articulata (Aubl.) Britton. A common milky-juiced shrub of slopes.

Chamaesyce buxifolia (Lam.) Small. (*Euphorbia buxifolia* Lam.). A very common beach herb.

Chamaesyce hirta (L.) Millsp. (*Euphorbia hirta* L.). A weedy plant near the picnic area.

Chamaesyce prostrata (Ait.) Small. (*Euphorbia prostrata* Ait.). A milky herb of open areas.

Croton astroites Dryand., marán. Common shrub, elsewhere reaching tree size.

Croton betulinus Vahl. A very common shrub of forested slopes.

Croton discolor Willd. A very common shrub of *Croton-Lantana* thickets.

Croton rigidus (Muell. Arg.) Britton, adormidera. Large shrub to 12 ft. high, common in shrub thicket. Endemic to Puerto Rico and Virgin Islands.

Euphorbia heterophylla L. (*Poinsettia heterophylla* (L.) Kl. & Garcke), wild poinsetta. A rare small shrub of weedy areas.

Gymnanthes lucida Sw., oysterwood. Tree to 20 ft. high, 5 in. d.b.h., upland forest.

Hippomane manchinella L., manchineel. Spreading tree 35 ft. high, 1-2 1/2 ft. d.b.h., and to 60 ft. in crown width. Abundant and dominant in beach forest. The yellowish applelike fruits tinged with pink are slightly fragrant but poisonous and have caused death when eaten, as explained in a large sign on the beach. Prompt treatment includes causing vomiting and use of a stomach pump. The milky sap is injurious both externally and internally.

Jatropha gossypifolia L. (*Adenoporium gossypifolium* (L.) Pohl). A rare weedy shrub.

Phyllanthus amarus Schum. & Thoms. (*Ph. niruru* auth.). A small herbaceous shrub of disturbed areas.

Securinega acidoton (L.) Fawcett & Rendle. Densely branched, very spiny shrub to 15 ft. high, on other islands sometimes a small tree.

Tragia volubilis L., seven-minute-itch. A common slender vine with stinging hairs.

31. Anacardiaceae (Cashew family)

Comocladia dodonaea (L.) Urban, Christmas-bush, chicharrón. Shrub or small tree to 20 ft. high, 5 in. d.b.h., with shiny spiny-margined leaflets and showy red fruits, common in upland forest. The watery sap which becomes blackish on drying is poisonous and irritating tothe skin of many persons, like the sap of poison-ivy and poison-sumac of the same family.

32. Celastraceae (Bittersweet family)

Crossopetalum rhacoma Crantz (*Rhacoma crossopetalum* L.). Florida crossopetalum. Tree 15 ft. high, 3 in. d.b.h., upland forest.

Schaefferia frutescens Jacq., Florida-boxwood. Tree 15 ft. high, 3 in. d.b.h., upland and beach forests.

33. Sapindaceae (Soapberry family)

**Melicoccus bijugatus* Jacq., kinep, Spanish-lime. One tree 35 ft. high, 16 in. d.b.h., at picnic grove, beach forest, apparently planted.

Serjania polyphylla (L.) Radlk. A rather common woody vine of wooded areas.

34. Rhamnaceae (Buckthorn family)

Colubrina arborescens (Mill.) Sarg. (*C. colubrina* (Jacq.) Millsp.), coffee colubrina. Rare tree (2 seen) in beach forest.

Colubrina elliptica (Sw.) Briz & Stern (*C. reclinata* (L'Hér.) Brongn.), mabí, soldierwood. Tree 15 ft. high, 4 in. d.b.h., upland forest, rare.

Krugiodendron ferreum (Vahl) Urban, leadwood. Tree 20-30 ft. high, 8-10 in. d.b.h., with very heavy wood (specific gravity 1.4). Upland forest. Ranges to Florida, where it is the heaviest native wood in continental United States.

35. Vitaceae (Grape family)

Cissus sicyoides L. An uncommon large vine of the beach forest.

Cissus trifoliata L. A rare to local fleshy vine.

36. Tiliaceae (Basswood family)

Corchorus hirsutus L. A common shrub of coastal areas.

37. Malvaceae (Mallow family)

Abutilon umbellatum (L.) Sweet. An uncommon small shrub of open woods.

Malvastrum corchorifolium (Desv.) Britton. A small weedy shrub.
M. americanum
Sida acuminata DC. A shrub to 6 feet, of open areas and slopes.

Sida acuta Burm.f. (*S. carpinifolia* L. f.). A small rare weedy shrub.

Sida cilaris L. An uncommon weedy herb of open areas.

Sida erecta Macf. A small, rare, weedy shrub of open areas.

Sida glabra Mill. A slender herb of open wooded slopes.

Sida procumbens Sw. A rare slender herb of eastern slopes.

**Thespesia populnea* (L.) Soland., otaheita, portiatree. Tree 15 ft. high, 3 in. d.b.h. Rare in beach forest at 2 localities on northwest and southern shores. Naturalized on tropical shores, native in Old World tropics.

38. Sterculiaceae (Chocolate family)

Ayenia pusilla L. An uncommon herb of open forest and trails.

Helicteres jamaicensis Jacq., cowbush. Shrub 8 ft. high, uncommon in upland and beach forests.

Melochia tomentosa L. (*Moluchia tomentosa* (L.) Britton). An uncommon or local shrub of thickets.

Waltheria indica L. (*W. americana* L.). An uncommon weedy shrub of slopes and trails.

39. Guttiferae (Mangosteen family)

Clusia rosea Jacq., wild-mammee, copey clusia. A rare tree on upper west slope.

40. Canellaceae (Canella family)

Canella winterana (L.) Gaertn., canella. A rare tree in beach forest.

41. Flacourtiaceae (Flacourtia family)

Samyda dodecandra Jacq., guayabilla. A large shrub rare on west slope.

42. Violaceae (Violet family)

Hybanthus linearifolius (Vahl) Urban (*Ionidium linearifolium* (Vahl) Britton). A rare small

herb on moist slopes.

43. Turneraceae (Turnera family)

Turnera diffusa Willd. A common shrub of open slopes.

Turnera ulmifolia L. An uncommon showy yellow-flowered shrub of ornamental value.

44. Passifloraceae (Passion-flower family)

Passiflora suberosa L. (*P. pallida* L.). An uncommon succulent vine of wooded areas.

45. Cactaceae (Cactus family)

Cephalocereus royenii (L.) Britton & Rose, dildo. Columnar tree cactus to 20 ft. high, rarely 25 ft., 1 ft. d.b.h. Common in shrub thickets, especially on rocky slopes.

†*Mammillaria nivosa* Link (*Neomammillaria nivosa* (Link) Britton & Rose), snow cactus. Local on rocky slopes.

Melocactus intortus (Mill.) Urban (*Cactus intortus* Mill.), Turks-cap cactus. Common along dry rocky shores.

Opuntia dillenii (Ker-Gawl.) Haw. A shrubby cactus with large pads.

Opuntia repens Bello, jumping cactus. A common, low spreading cactus with loose joints. Endemic to Puerto Rico and smaller islands to Mona and Virgin Islands.

Opuntia rubescens Salm-Dyck (*Consolea rubescens* (Salm-Dyck) Lemaire), pricklypear. Tree cactus 15 ft. high and 5 in. d.b.h., with oblong flat joints or pads. Common in shrub thickets.

Opuntia triacantha (Willd.) Sweet. A rare medium-sized cactus of slopes.

46. Malastomataceae (Melastome family)

Tetrazygia elaeagnoides (Sw.) DC., verdiseco. A single small tree 20 feet high on western slope.

47. Combretaceae (Combretum family)

Conocarpus erectus L., button-mangrove. Tree 20 ft. high, 6 in. d.b.h., in mangrove swamp forest at edge of salt pond.

Laguncularia racemosa (L.) Gaertn. f., white-mangrove. Tree 25 ft. high, 4 in. d.b.h. Common in mangrove swamp forest at edge of salt pond.

48. Myrtaceae (Myrtle family)

Eugenia axillaris (Sw.) Willd., grajo, white-stopper eugenia. Tree 25 ft. high, 6 in. d.b.h.,

beach and upland forests. Fruits green to orange, red, or black, edible but slightly bitter.

Eugenia ligustrina (Sw.) Willd., palo de muleta. A rare shrub of moist slopes.

Eugenia rhombea (Berg) Krug & Urban, spiceberry eugenia. Tree 20 ft. high, 3 in. d.b.h., beach and upland forests.

E. procera

49. Theophrastaceae (Theophrasta family)

Jacquinia arborea Vahl (*J. barbasco* auth.), barbasco. Rare shrub in beach forest, elsewhere a small tree.

Jacquinia berterii Spreng. A shrub of eastern slopes and ridges, elsewhere reaching tree size.

50. Sapotaceae (Sapodilla family)

Bumelia obovata (Lam.) A. DC., araña gato. Tree 30 ft. high, 1 ft. d.b.h., beach and upland forests.

51. Oleaceae (Olive family)

†*Forestiera eggersiana* Krug & Urban. A tree to 20 ft. tall, near the picnic area. Not recorded from St. Croix (Britton and Wilson 1923-30; 6: 77; Little, Woodbury, and Wadsworth 1974). Endemic to Puerto Rico and smaller islands from Desecheo to Virgin Islands, also St. Martin and St. Barts.

52. Apocynaceae (Dogbane family)

Plumeria alba L., frangipani, milktree. Tree 20 ft. high, 10 in. d.b.h., with showy, fragrant white flowers and abundant white sap or latex. Common in shrub thickets.

Prestonia agglutinata (Jacq.) Woods. (*Echites agglutinata* Jacq.). An uncommon semiwoody vine of coastal woodland.

Rauvolfia viridis Roem. & Schult. (*R. lamarckii* A. DC.), Bitterbush. Shrub 12 ft. high, 3 in. d.b.h., beach forest.

Urechites lutea (L.) Britton, wild allamander. A frequent shrublike vine with yellow flowers.

53. Asclepiadaceae (Milkweed family)

Cynanchium grisebachianum (Schltr.) Alain (*Metastelma decaisneanum* Schlechter). An uncommon high-climbing slender vine.

Matelia maritima (Jacq.) Woods. (*Ibatia maritima* (Jacq.) Dcne.). Rare vine of coastal forests.

54. Convolvulaceae (Morning-glory family)

†*Cuscuta indecora* Choisy. A rare herbaceous vine parasitic on shrubs in beach forest. Only 1

colony seen.

Ipomoea arenaria (Choisy) Steud. (*Exogonium arenarium* Choisy). A rare red-to-pink-flowered slender vine of ridges.

Ipomoea triloba L. A rare slender vine of beach forest.

Jacquemontia nodiflora (Desv.) G. Don. An uncommon shrublike vine of slopes.

Jacquemontia pentantha (Jacq.) G. Don. A common blue-flowered small vine.

55. Boraginaceae (Borage family)

Bourreria succulenta Jacq., pigeon-berry. Tree 25-40 ft. high, 6-12 in. d.b.h., with fragrant white flowers. Common and dominant in upland forest, also in beach forest.

Cordia alba (Jacq.) Roem. & Schult. (*Cerdana alliodora* Ruíz & Pav.), white manjack. Tree 25 ft. high, 8 in. d.b.h., common in upland forest. Cited from St. Croix by Little, Woodbury, and Wadsworth (1974) but not by Britton and Wilson (1923-1930).

Cordia stenophylla Alain (*C.*) *angustifolia* (West ex Willd.) Roem. & Schult., *Varronia angustifolia* West. An uncommon shrub to 10 ft. in shrubby areas.

Cordia polycephala (Lam.) Johnst. (*Varronia corymbosa* Desv.). A rare vinelike shrub to 15 ft. in beach forest.

Cordia rickseckeri Millsp. (*Sebesten rickseckeri* (Millsp.) Britton), manjack, Geiger-tree. Tree 30 ft. high, 18 in. d.b.h., beach and upland forests. These trees are the typical smooth-leaf form, named from St. Croix. Endemic to Puerto Rico and Virgin Islands but not cited from St. Croix by Britton and Wilson (1923-30; 6: 124).

Heliotropium angiospermum Murray (*Schobera angiosperma* (Murray) Britton). An uncommon herbaceous shrub of the beach forest and slopes.

Heliotropium ternatum Vahl. An uncommon low shrub of open slopes.

Rochefortia acanthophora (DC.) Griseb., juso. Shrub or small tree to 20 ft. high, 3 in. d.b.h., upland forest.

Tournefortia microphylla Bert. A common vinelike shrub of slopes.

56. Verbenaceae (Verbena family)

Avicennia germinans (L.) L. (*A. nitida* Jacq.), black-mangrove. Tree 25 ft. high, 6 in. d.b.h. The most common of the 3 mangrove species in the mangrove swamp forest at edge of salt pond.

Citharexylum fruticosum L., Florida fiddlewood. Tree 15-30 ft. high, to 6 in. d.b.h., upland forest.

Clerodendron aculeatum (L.) Schlecht. (*Volkameria aculeata* L.), haggarbush. Spiny woody vine in beach forest, treelike on other islands. One plant in east end of beach forest 4 inches in diameter and 20 feet high but vinelike.

Duranta repens L., skyflower. Woody vine and small tree 12 ft. high, upland forest.

Lantana involucrata L. Shrub to 12 ft. high, dominant in the shrub thicket on disturbed slopes.

†*Lantana urticifolia* Mill. A rare shrub of open slopes.

Stachytarpheta jamaicense (L.) Vahl (*Valerianoides jamaicense* (L.) Kuntze). A weedy low shrub of open areas.

57. Solanaceae (Nightshade family)

Capsicum frutescens L., red-pepper. A rare shrub of open forests.

Solanum persicifolium Dunal. Treelike shrub 15 ft. high, 2 in. d.b.h., beach forest.

58. Scrophulariaceae (Figwort family)

Capraria biflora L. A common shrub of coastal areas.

59. Bignoniaceae (Bignonia family)

Batocydia unguis (L.) Mart. A rare woody vine of upper moist slopes.

Distictis lactiflora (Vahl) DC. A woody vine, rather common on slopes.

Tabebuia heterophylla (DC.) Britton (*T. pallida* (Lindl.) Miers), locally called "white-cedar," "pink-cedar," and "cedar." Tree 20 ft. high, 6 in. d.b.h., beach forest.

60. Acanthaceae (Acanthus family)

Anthacanthus spinosus (Jacq.) Nees, espinosa. An uncommon but local spiny shrubby vine of coastal areas.

Justicia periplocifolia Jacq. A rare shrub of moist ravines.

Justicia sessilis Jacq. A rather common herb of open forests.

61. Rubiaceae (Madder family)

Antirhea lucida (Sw.) Benth. & Hook. f. (*Stenostomum lucidum* (Sw.) Gaertn. f.), palo llorón. Tree 15 ft. high, 3 in. d.b.h., upland forest. Cited from St. Croix by Little, Woodbury, and Wadsworth (1974) but not by Britton and Wilson (1923-30).

Erithalis fruticosa L., black torch. Shrub to 15 ft. high, beach forest, elsewhere becoming a

small tree.

Ernodea littoralis Sw. A locally common matted shrub of the beach zone.

Exostema caribaeum (Jacq.) Roem. & Schult., yellow-torch, Caribbean princewood. Tree 25 ft. high, 4 in. d.b.h., upland forest, apparently rare.

Guettarda parviflora Vahl, "blackberry." Tree to 20 ft. high, 4 in. d.b.h., upland forest.

Psychotria microdon (DC.) Urban (*Ps. pinularis* Sessé & Moc.). A rare vinelike shrub of moist ravines.

Psychotria nervosa Sw. (*Ps. undata* Jacq.). An uncommon shrub of all forests.

Spermacoce confusa Rendle (*S. tenuior* auth.). A rare herb of trails.

62. Goodeniaceae (Goodenia family)

Scaevola plumieri (L.) Vahl. A rare thick-leaf beach shrub.

63. Compositae (Composite family)

Bidens pilosa L. A weedy herb near the picnic area.

Borrichia arborescens (L.) DC., sea oxeye. A common shrub of rocky coasts.

Eupatorium sinuatum Lam. (*Osmia sinuata* (Lam.) Britton & Wils.). A shrub of open slopes locally common.

Lawanea
Lactuca intybacea Jacq. (*Brachyramphus intybaceus* (Jacq.) (DC.). wild lettuce. A rare thistlelike plant near the beach.

Pectis humifusa Sw. A rare prostrate herb of the moist beach zone.

Pectis linifolia L. A common herb of open slopes and trails.

Pluchea odorata L. A large to small shrub of coastal forests.

Vernonia cinerea (L.) Less. A weedy low shrub, common.

Wedelia calycina L. C. Rich. A rare shrub of the north slopes.

Also a single large woody vine with short branches, sterile and not identified to family. Just west of picnic area.

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National Park Service
U.S. Department of the Interior

Natural Resource Program Center
1201 Oakridge Drive, Suite 150
Fort Collins, CO 80525

www.nature.nps.gov