ORGANIZATION OF EASTERN CARIBBEAN STATES (OECS) SECRETARIAT

ENVIRONMENT AND SUSTAINABLE DEVELOPMENT UNIT (ESDU)

PROTECTING THE EASTERN CARIBBEAN REGION'S BIODIVERSITY (PERB) PROJECT

Biodiversity Inventory and Status Assessment Report for the Proposed Wallings Forest Protected Area (Antigua) and the Codrington Lagoon National Park (Barbuda)

GOVERNMENT OF ANTIGUA AND BARBUDA

Cover Photo:
Photo taken at Fig Tree Drive, looking northeast toward the proposed Wallings Forest Reserve

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ENVIRONMENT DIVISION
MINISTRY OF TOURISM, CIVIL AVIATION, CULTURE AND ENVIRONMENT

FORESTRY UNIT
MINISTRY OF AGRICULTURE, LANDS, MARINE RESOURCES AND AGRO-INDUSTRY

Biodiversity Inventory and Status Assessment Report for the Proposed Wallings Forest Protected Area (Antigua) and the Codrington Lagoon National Park (Barbuda)

PREPARED FOR OECS AND THE GOVERNMENT OF ANTIGUA AND BARBUDA BY:
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Biodiversity Inventory and Status Assessment Report for the Proposed Wallings Forest Protected Area (Antigua) and the Codrington Lagoon National Park (Barbuda)

SUMMARY

Island Resources Foundation (IRF) was retained by the Environment Division, Ministry of Tourism and the Environment, Antigua and Barbuda to undertake a biodiversity characterization of the proposed Wallings Forest Reserve (Antigua) and the Codrington Lagoon National Park (Barbuda). Wallings Forest, a secondary forest belt that was replanted around 1912 to protect the historical 100-year-old Wallings Reservoir, is located in the southern part of the island of Antigua. Codrington Lagoon, situated in Barbuda, is the largest system of its kind in the Lesser Antilles. These two survey efforts form part of the long-term planning and management thrust to ensure the sustainable management of two of Antigua and Barbuda's most recognizable and valuable natural symbols.

From October 20 to 23, and October 27 to 29, 2008, the project's Principal Investigator, Mr. Kevel Lindsay, along with volunteers, surveyed Wallings and surrounding areas. From October 24 to 26, 2008, Mr. Lindsay, and consultant, John Mussington of Barbuda, undertook field surveys in the Codrington Lagoon area.

Project activities included the following:

- Reviewing available project documents
- Undertaking field visits, surveys and observations
- Providing species lists, and characterizing the sites with respect to habitat, biodiversity, and existing threats and outstanding
- Providing an assessment of invasive species, including distribution
- Reporting on the findings and recommendations, including the following report components:
  - Existing conditions
  - Survey methodology
  - Observations
  - Natural disaster vulnerabilities
  - Recommendations for the management of biological resources.

Observations focused primarily on:

- The flora and vegetation communities
- The fauna (amphibians and reptiles, birds, mammals, fish and invertebrates)
- Species of special conservation concern
- Invasive species impacts and distributions
- Ecology and landscape issues
- Issues and concerns.

The report that follows is divided into two sections: ***Section A*** deals with the characterization of Wallings Forest, and ***Section B*** deals with the characterization of the Codrington Lagoon National Park.

RESULTS SUMMARY

Task 1 Preparation of a Work Plan

- A 21-page Inception report, which included a work plan, was prepared and submitted to the Environment Division on September 23, 2008.

Task 2 Identification of the Boundaries for the Study Areas

- The proposed boundaries for the Codrington Lagoon National Park and the Proposed Wallings Forest Reserve were identified through consultation with a number of key persons. The proposed boundaries for both sites have been mapped and sent out for review.

Task 3 Literature Review

- From September 23 to November 13, the team carried out an extensive literature search and review of available documentation, including visits to several key information repository institutions: the U.S. Library of Congress in Washington, DC, the Brooklyn Public Library and the Museum of Antigua and Barbuda.

- A 48-page report on the literature search and documentation review—"*Biodiversity Inventory and Status Assessment for the Codrington Lagoon National Park and the Proposed Wallings Forest Protected Area – Literature Review*", reviewing 44 documents and images on Wallings and Codrington Lagoon—was produced and submitted on November 14, 2008, to the Environment Division.

Task 4 Field Research on the Biological Resources within the Study Areas

PROPOSED WALLINGS FOREST RESERVE

- From October 20 to 23, Kevel Lindsay, along with three volunteers from the Environmental Awareness Group's (EAG) Plant Project, carried out surveys at Wallings Forest to assess the flora, vegetation communities, the fauna, disaster vulnerabilities, invasive species, issues and concerns, and outstanding features of the Wallings area.

- 320 species of plants were identified for the Wallings area.

- The team obtained information on five unknown and unidentified species. The status of these species is still being researched;

- 63 species of birds and eight species of reptiles and amphibians were identified for Wallings.

- Eight species of birds of "**special conservation concern**" were indentified for Wallings.

- All plant communities of "**special conservation concern**" were identified at Wallings.
- Ten vegetation community alliances and 12 associations were identified and mapped for Wallings.
- 16 species of mammals were identified for the Wallings area.
- On the night of October 21, Kevel Lindsay, along with four volunteers, carried out a survey of the bats of Wallings Forest. A total of seven species were captured, and this includes a new species recorded for Antigua, the **Tree Bat** (*A. nicholsi*).
- Two mammal species (bats) of "**special conservation concern**" that occur in and around the Wallings area were identified by the team.
- Eight key natural and cultural features have been identified for the Wallings Forest area.

CODRINGTON LAGOON NATIONAL PARK

- From September 24 to October 10, 2008, John Mussington carried out survey work on Codrington Lagoon and surrounding areas.
- From October 24 to 26, Kevel Lindsay, John Mussington and three volunteers from the EAG Plant Project carried out surveys of the Barbuda Lagoon and its surrounding areas. Assessments were made of the plant and vegetation communities; the fauna; disaster vulnerabilities; the impact of any invasive species identified; and of the outstanding features of the Lagoon ecosystem.
- 18 terrestrial vegetation community types (also referred to as alliances) and 20 associations have been identified and mapped for the Codrington Lagoon Protected Area.
- The critical coastal zone and marine ecosystems were identified for the Codrington Lagoon.
- 118 species of plants were identified by the team for the Codrington Lagoon area.
- All of the terrestrial plant communities at Palmetto Point and at Freshwater Pond area have been identified as requiring "**special conservation concern**".
- 99 species of birds have been identified for the Codrington Lagoon area.
- 14 species of reptiles and one amphibian have been identified within the Codrington Lagoon area.
- Marine turtle nesting beaches were identified and mapped for the Codrington Lagoon area.

- Five reptile species of "**special conservation concern**" were identified for the Codrington Lagoon area.

- Eight species of terrestrial mammals have been identified for the Codrington Lagoon area.

- Nine species of birds of "**special conservation concern**" have been identified for the Codrington Lagoon National Park area.

- The team has identified a number of areas of significant natural and cultural value within the boundaries of the Codrington Lagoon National Park.

- In consultation with key stakeholders, the team identified and mapped the proposed boundaries of the Codrington Lagoon National Park.

Task 5 Preparation and Submission of Final Project Report to the Environment Division

- Island Resources Foundation prepared and submitted this final project report, which includes all components indentified in the Terms of Reference for this project, to the Environment Division, Ministry of Tourism and the Environment, Antigua and Barbuda.

INTRODUCTION

The "*Biodiversity Inventory and Status Assessment Report for the Proposed Wallings Forest Protected Area and the Codrington Lagoon National Park"* is part of an effort by the Government of Antigua and Barbuda, in partnership with the Organization of Eastern Caribbean States' Environment and Sustainable Development Unit (OECS-ESDU) and the United States Agency for International Development (USAID), to improve biodiversity protection, management and conservation in Antigua and Barbuda.

The primary objective of this project was for Island Resources Foundation to:

> "*… prepare a biodiversity inventory and status assessment report for Antigua and Barbuda, specifically focusing on the Codrington Lagoon National Park on the island of Barbuda and the proposed Wallings Forest Protected Area on the island of Antigua.*"

This report details the results of the field surveys, literature research, discussions with key persons on the ground, and other information-gathering efforts during the course of the project.

As Antigua and Barbuda celebrates nearly 30 years of independence from Great Britain and moves forward as an independent country, it continues to confront the need to balance two equally compelling national goals: fostering economic growth while protecting the country's natural patrimony. The focus on Wallings Forest and the Codrington Lagoon is neither a surprise nor an accident. Both sites are natural-area icons; as national symbols of pride, they often illicit strong emotions and a sense of attachment in many Antiguans and Barbudans.

The historic dam infrastructure at Wallings has often been hailed as a fine example of Victorian Architecture. The author of *Heritage Landmarks*, the late historian Desmond Nicholson, says about the Wallings dam infrastructure: "[T]he workmanship of this fine example of Victorian industrial architecture is truly magnificent with its rounded capping and small round tower." Mr. Nicholson's praise of the Wallings dam infrastructure is quite understandable. A visitor, who for the first time happens upon this massive structure situated in the middle of a tropical forest, may conjure up images of a lost civilization.

The surrounding forest is no less impressive. Beneath its damp, musty, and decaying leaf litter lies a history of sad and regrettable mistakes, dating to a time when the British leveled what must have been a magnificent and ancient old-growth, tropical moist forest. The black and white photo below (Photo 1.0) of a proud Silk Cotton, perhaps over 100 years old to that day, lying on its side, is one of the few glimpses we still have of what Wallings might have been like before it succumbed to the cutlass blade and fire.

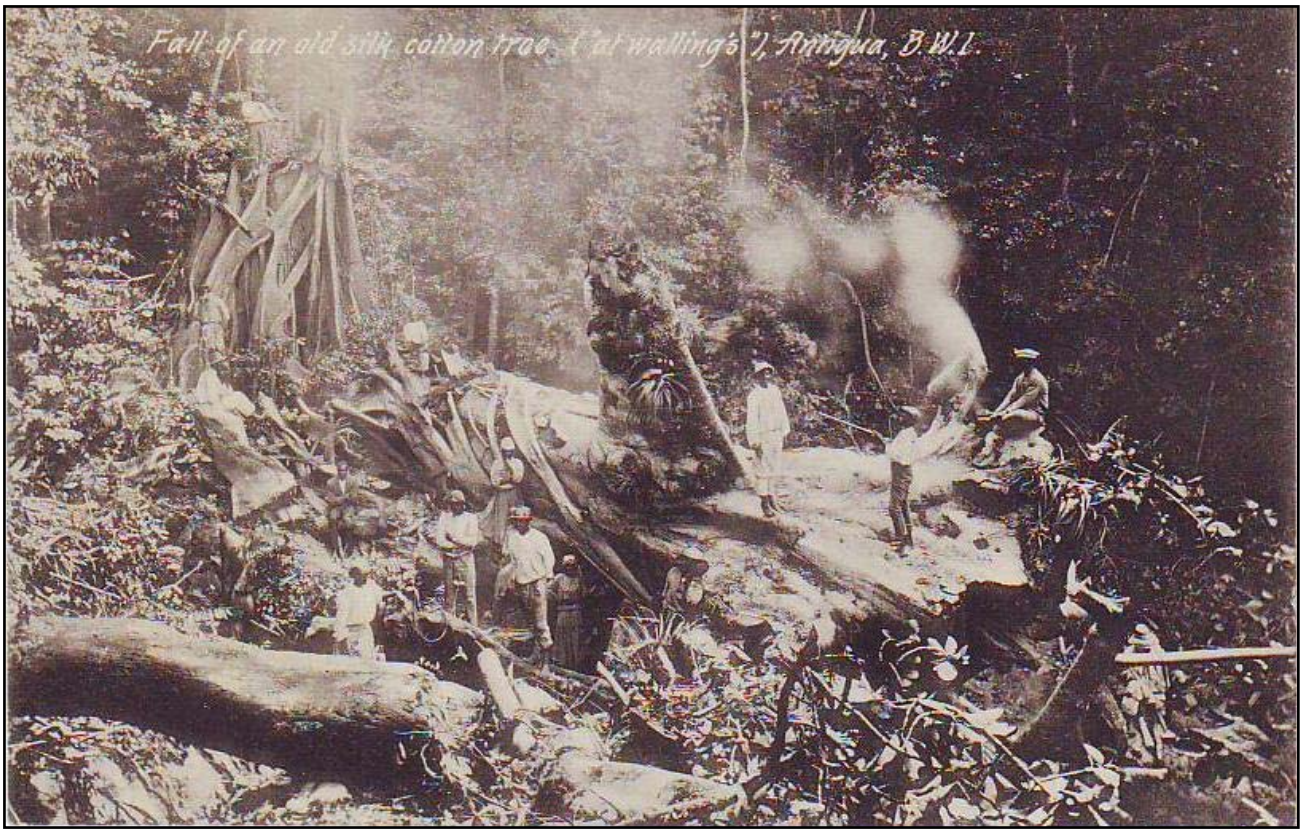

Photo 1.0. Fall of an old silk cotton, *circa* late 1800s, by John Anjo.
Source: Museum of Antigua and Barbuda.

It has been nearly 100 years since Wallings was replanted with a mixture of species to help arrest the loss of soil on the steep slopes surrounding the reservoir. But the push to reforest Wallings may have been somewhat self-serving. Many who supported the initial construction of the reservoir were disappointed when, after its completion, the structure would not hold water—that precious liquid the island's residents so desperately needed because Antigua then, like Antigua today, suffered frequent and severe droughts and water shortages. To convince skeptics that the system would not fail, supporters had to first convince the island Assembly not only to provide funds to line the reservoir with non-porous stone to better retain water but also to plant trees on the surrounding slopes.

Many can celebrate that the early champions of Wallings won that day for the area emerged as one of the first and most successful examples of reforestation in the Lesser Antilles. For biodiversity it has proven to be a boon. The forest is a sanctuary—not only a reservoir for the rain that collects in the cusp of the stone-line basin— and from this wooded area many species have been dispersed to colonize surrounding lands, as they travel further afield across the slopes and valleys of the Shekerley Mountains.

Today, old Silk Cottons once again reach for the sky in a tangle of vines, ferns, orchids and bromeliads. It is hard to imagine the landscape that we see today without the slopes and valleys

being clothed in the greenery that greets the eye as you stand on the earthen dam wall on the northern end of the reservoir. But, as has often been reported, history has a funny habit of repeating itself, and this project serves not only as a means to ensure the future protection and conservation of the Wallings Forest, but it is also a reminder that Antigua's natural landscapes have had a tortured and sad history, and that we can yet redeem that history and make things better for the future.

Codrington Lagoon (known to some Barbudans as the Barbudan Lagoon)—like Wallings—is larger than life. It is 11 Km (7 miles) long, it stretches to the horizon northward, and sometimes seems like a sea. Locals report that its ferocity during storms is not unlike an angry sea.

In *Six Months in the West Indies*, Coleridge (1825) said about the Lagoon: "[T]he Lagoon is a magnificent piece of brackish water seven miles square and communicating on by a long flash …" New visitors to the Lagoon often repeat this refrain, though not in such terms. One can imagine the days when Caribbean Flamingos (*P. ruber*), with their pink and red colors flashing brightly in the hot mid-day sun, would wade in the mud or stand guard at the mouth of the "river." Such sights are now gone, but much of the magnificence of this large marine "lake" remains even today, including the Frigatebirds—the pirates of the sky—as the males circle overheard guarding their mates or trying to find one.

Much of the Lagoon (and the recently declared National Park) is largely unpopulated. The land is wild and teeming with birds, insects and flowers. Goat and Kid Islands with their strange cacti formations (see Photo 2.0 below), and North Beach, the lonely peninsula outpost on the northeast, are reminders of a time when only the Amerindians with their canoes and paddles plied these waters. A walk on the beaches of this wild coast may take the visitor back eons, and it is this mixture of history, awe, ecological richness and potential that seems to be urging Antiguans and Barbudans to protect these two magnificent natural icons.

But despite the historical, cultural, economic and ecological significance of the Codrington Lagoon and Wallings Forest, not only to Antigua and Barbuda, but also to the Caribbean and the world, and despite the over 100 years of celebrated fame and notoriety that these places have enjoyed, so little is actually known and formally documented about them. Much of the information that has been pulled together for this report was collected from many disparate, far-flung sources.

For us to understand the inner workings, the cultural connections, the economic values of the natural services that these natural areas provide, and the history that has helped to define their landscapes, the country will have to invest in the kinds of long-term research and monitoring that are needed to answer many unresolved questions and to meet the future needs for conserving and managing the sites.

However, there is a lack of local expertise required to oversee the long-term science and management of these areas. This has always been a problem for small developing island states such as Antigua and Barbuda, but the country has to find an effective way to provide the trained expertise if the conservation and management of Codrington Lagoon and Wallings Forest are to succeed.

Photo 2.0. Multiple heads on an old Turk's Cap Cactus (*Melocactus intortus*) and colonies of the smaller *Mammillaria nivosa* on limestone pavement at Kid Island, Barbuda.

SECTION A — PROPOSED WALLINGS FOREST RESERVE (ANTIGUA)

LOCATION

The proposed Wallings Protected Area (WPA) lies in the southeast of St. Mary's Parish. The Wallings Reservoir is located at the center of the proposed protected area, and is approximately 9 km from St John's. The proposed boundaries are marked by Signal Hill to the east, John Hughes and Sage Hill to the north, Cade Peak to the west, and Tramontania and Claremont to the south. Fig Tree Drive divides the area in roughly two halves.

EXISTING CONDITIONS

The area is mostly woodland (secondary forest) with some minor land for crops and for grazing cattle and small ruminants. Main human settlements are limited to John Hughes to the north and Tramontania to the south, and to a lesser extent along Fig Tree Drive which links the villages.

A least four major vegetation community types are found in the area. They include:

1. Evergreen forest mostly found along Fig Tree Drive, Wallings Hill, the north side of Signal Hill and along the upper parts of a few ghuts;
2. Mixed evergreen and deciduous forest found in the areas of Doiggs, Claremont valley, Tremontania, Fishers, and Wallings Hill;
3. Mixed shrubland, which is widespread throughout the area, and usually in small patches;
4. Grassland communities which is especially common on the summit of Signal Hill and adjacent slopes.

Human land use activities in the area include fruit and vegetable gardening and herb crop farming. Some land clearing activity such as "slash and burn agriculture" to clear undesired vegetation and to promote growth of foraging vegetation continues to increase in a destructive matter.

CLIMATE AND WEATHER

As with most islands in the Lesser Antilles, Antigua is strongly affected by the Northeast Trade winds, which means winds approach with great constancy from directions between east-northeast and southeast. The average wind direction varies throughout the year according to the following pattern:

- December to February: winds blow from east-northeast (known locally as "Christmas Winds"),
- March to May: winds blow from easterly directions,
- June to August: winds blow from east to east-southeast directions,

- September to November: winds blow mainly from the east to southeast.

Normally, except for the occasional hurricane, highest wind speeds are experienced from December to February and again in June and July. Average wind speeds for the months of June – July are around 9m/sec (20 mph), while for October average wind speeds drop to 6m/sec (13.5 mph).

During the winter months, October to April, the island is occasionally influenced by frontal systems moving in an eastward direction across the southern part of the United States. The trailing edge of these fronts sometimes affects the Antigua and results in winds blowing from between northwest and northeast for short periods – usually no more than to two days. The area also lies within the hurricane belt. These intense storms occur between June and November, with September being the month when most tropical storms or hurricanes occur.

Temperature varies little throughout the year, with daytime temperatures that fall within the range 25°-29° C and usually drop 6° C at night. Temperatures average an annual 81° F (21.6° C), with the winter lows averaging 76° F (24° C), and the summer high reaching the mid to upper 80s. The temperature and climate are moderated by near constant on-shore breezes. Due to year-round high temperatures and nearly constant winds, the evapo-transpiration rate is generally high.

Heavy rainfall sometimes occurs during the passage of the easterly tropical waves, which are spurned off the West African coast from June to November of each year. Occasionally, these waves intensify into tropical depressions, tropical storms, or hurricanes.

GEOLOGY

The initial geological landscape of Antigua was created when volcanoes burst through the ocean floor some 40 million years ago. Eruptions continued sporadically for the next 10 million years, to built at least 5 clusters of volcanic cones, craters, domes and lava flows in a triangle between what is now Deep Bay, Shirley Heights and Johnson's Point. The following million years of weathering, landslides, mudflows, erosion and sedimentation has contributed to the landscape we see to date.

The dominant bedrock types in the area are andesite, which forms most of the domes and volcanic lava flows, and pyroclastic rocks associated with volcanic flows and ash fall. Basalt lava flow and dykes are also found but to a lesser extent.

DRAINAGE AND WATERSHEDS

The proposed WPA is characterized as hilly to mountainous topography. Signal Hill at 368 m (1207 feet) above sea level is the highest elevation within the area. The Wallings and Fig Tree Reservoirs are the two main water bodies and are located slightly below 500 (167 m) feet elevation. Numerous ghuts dissect the landscape. At least a third of the area (eastern portion) lies within the upper reaches of the Body Pond Watershed. The remaining area drains into Carlisle Bay and Rendezvous Bay.

METHODOLOGY

Most of the flora and fauna of Wallings are widely distributed throughout parts of the island, especially the southern hills. Some species, such as birds, are transient, some staying as long as food and shelter are available and others may only pass through on their way to more productive grounds. Some are seasonal migrants while others are year-long residents.

To provide the most representative and comprehensive picture of the natural life at Wallings, surveys required going beyond the boundaries of the proposed Reserve. The challenge was to assess the communities of plants and animals and not exclude or miss those features and assets that may lie just beyond the immediate boundaries, or those that may only occupy the area during periods convenient to the species, but not during our presence there.

Prior to and during the period of surveys of the sites, extensive reviews of existing literature, aerial imagery and baseline information relevant to the island and surrounding area were carried out.

Just days before fieldwork was to begin at Wallings, Hurricane Omar passed northwest of the northern Leeward Islands and dumped up to 36 cm (14 inches) of rain on the island. This weather phenomenon presented special opportunities and challenges for the team and for the assessment of Wallings. The severe flooding caused considerable damage to infrastructure in the area and washed away plants, features and swamped areas, making them inaccessible and dangerous.

However, it allowed the team members to witness the immediate aftermath of a relatively rare event, to assess and gage the natural disaster vulnerability of Wallings and the surrounding areas, and to learn how human and natural activities and services are interacting and impacting on Wallings.

Where possible, videos and still images were taken of many of the outcomes of this weather event and will be made available as part of this report.

During fieldwork, the team employed the use of Garmin Etrex Venture HC, a very sensitive Geographic Positioning System (GPS) handheld device, to take coordinates of species and other interests and to record the survey routes. The waypoints and trail outline is first loaded up onto a PC using the Garmin software. This allows the points and trail to be overlaid on Google Earth maps. These can be saved, printed and manipulated. The map of these routes is provided in Figure 1.0 below.

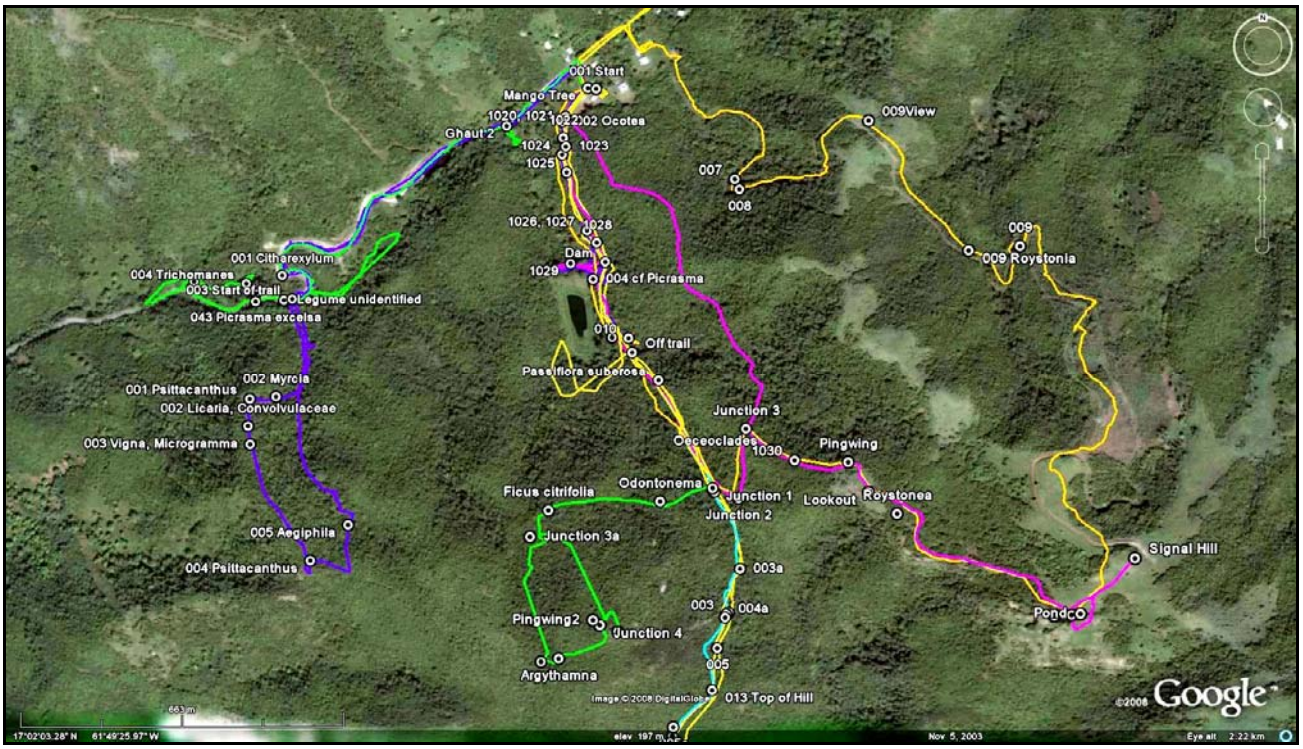

Figure 1.0. Google map overlaid with way points and survey trail outlines done at Wallings. Map created with Garmin Etrex Venture HC. Image courtesy Chris Pratt, 2008.

In pulling together the Literature Review, the IRF team researched and sourced extant literature, aerial imagery and available baseline data relevant to the project from various local and international institutions. The team examined and reviewed documentation and feedback available from the Environment Division (ED), the Forestry Unit, the Development Control Authority (DCA), the Lands Division, the Fisheries Division, the Port Authority, the Antigua Public Utilities Authority (APUA), the Barbuda Council, the Museum of Antigua and Barbuda library, and from other relevant institutions, such as the U.S. Agency for International Development (USAID), Food and Agricultural Organisation (FAO), the Organisation of American States (OECS), and the RAMSAR Secretariat.

The Foundation's project team also conducted on-line and on-site searches of the Library of Congress in Washington, DC and the Brooklyn and the New York Public Libraries in New York. The team also used the extensive resources of the Foundation's environmental reference libraries and tapped into local and regional marine and terrestrial biodiversity expert networks.

For the proposed boundaries of the Reserve, the team consulted with various local experts. The team also spoke at length with Mr. Adriel Thibou, the current head of the Forestry Division, and Lucia Mings of Environment Tourism Consulting (ETC), who is overseeing management of the project entitled "*Ecosystem Assessment and Participatory Land-use Zoning Plan for the Body*

Ponds Watershed" for the Environment Division[1]. The team also spoke extensively with McRonnie Henry, former Forestry Officer in the Forestry Division.

In selecting the boundaries, the team considered the core area of the original forest area around the main reservoir. We propose that the boundaries include the watershed of Wallings and the upper reaches of the Body Ponds Watershed, which start just below the northern slopes of Signal Hill, and west of Fig Tree to Sage Hill down to Tremontania, across to the slopes of Claremont and then back up to Signal Hill. The experts suggest including as much of the representative habitats within the boundaries, and also to include Fig Tree Drive and stream, as well as the key aesthetic landscapes and cultural sites. Figure 2.0 below shows the proposed boundaries of the Reserve along with some of the key natural and cultural features.

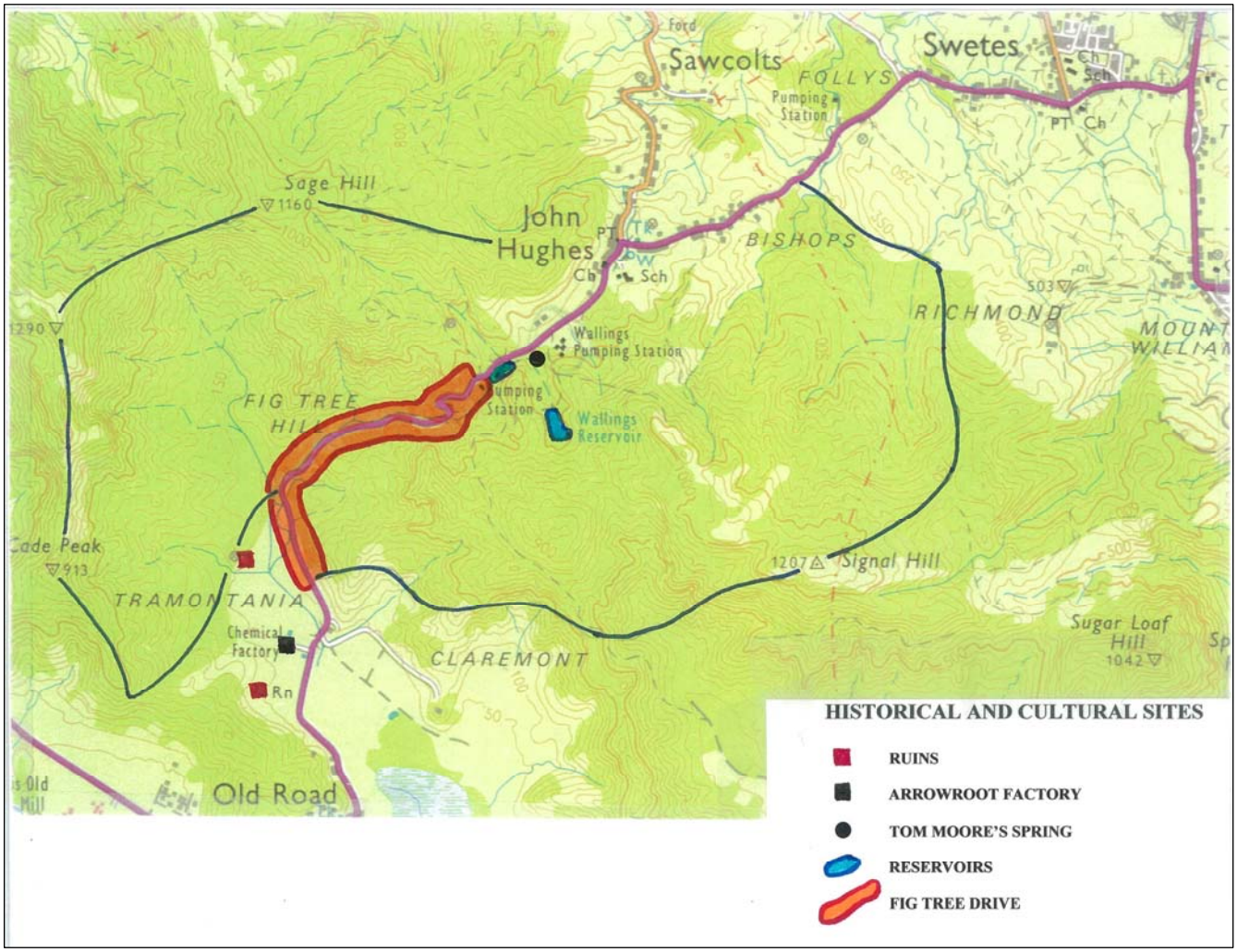

Figure 2.0. Proposed boundaries of the Reserve, as well as key natural and cultural features.

[1] The project deals with issues and long-term management options for the nearby Body Ponds Watershed. The beginning of the watershed starts at Signal Hill, an area that this project team is proposing be included within the boundaries of the proposed Wallings Forest Reserve.

Nevertheless, this is only a **proposed boundary**, and further discussion and considerations may be warranted to include areas down to Dunnings, Upper Christian Valley and Botts Peak to the west, and parts of Doiggs and the upper slopes of the hills situated west and south of Liberta Village. The Environment Division and the Ministry of Agriculture may want to use this opportunity to include as much of the Shekerley Mountains within this reserve as possible once this very critical opportunity arises. The project team listened to the suggestion of Forestry and others to only include the Wallings area within the "reserve" at this point because of their concern that many in the country may not yet have the appetite to include such a large area within the reserve. The team therefore leaves this up to the discretion of local authorities to make this decision.

In carrying out the characterizations of the biodiversity of both sites, the team was unable to undertake population estimates, including detailed distribution data, or provide population dynamics or any other systematic estimates, because the time, circumstances and resources of this exercise only allowed for a cursory study of the areas. For this information to be provided there would have to be more long-term population and habitat studies of specific taxa over many years. Where possible, the team made every effort to provide some information on the species' status, but this is based on local knowledge, historical accounts, and reports and on the species' biology. The status estimates are given as "common," "rare," "uncommon," "widespread," etc.

For the team to have given more concrete and accurate population estimates there would have had to be years of systematic surveys and monitoring carried out by trained personnel. Systematic surveys are based on protocols, methodologies and statistical analyses that provide spatial, ecological, biological and structural data that give managers critical information on the status and habits of species and ecosystems. This sort of information is usually impossible to be obtained within the short space of time that it took to complete this characterization.

The specific methods used to survey and assess the flora, fauna and environment of Wallings Forest are discussed below.

Survey of the Vegetation and Plants

The area being proposed as part of the Wallings Forest Reserve consists of steep valleys, rolling hills, rocky outcrops and cliffs, streams, ghuts, reservoir, forests, woodlands, villages, farms and grasslands. The area is quite extensive, and it would have proven impossible to conduct a comprehensive and detailed survey in the short space of time for the current effort and given the financial resources of the project. With this in mind, the team undertook targeted surveys of specific areas, with the assistance of volunteers from the EAG Plant Project and Adriel Thibou of the Forestry Division.

The flora was assessed by traversing some of the Forest's main and secondary trails, as well as by hiking along ghuts and drains, targeting outstanding areas and features such as grasslands, rocky outcrops, and areas thought to hold significant potential for yielding interesting species. The survey team also targeted specific plant communities and focused on unique features and characteristics. Specimens were identified on site, and, where and when necessary, photos and specimens were taken for further study and identification.

The team also used aerial imagery to determine past and current land-use, vegetation types and distribution, outstanding and special features, and the location of possible historical/archaeological sites.

Where possible, the team Gassed species of plants of special conservation concern, those that presented identification challenges, and those collected and pressed as specimens.

Survey of Terrestrial Vertebrates

The terrestrial macro vertebrate fauna of Wallings Forest is limited to native bats, the introduced Black and Norway Rats (*Rattus rattus and R. norvegicus)*, the House Mouse (*Mus musculus*), the introduced Indian Mongoose (*Herpestes javanicus*), birds and reptiles. In addition to these wild species, there are also a handful of donkeys, horses, free-roaming goats and wild pigs, most of which stay largely on the outskirts of the core area of the forest.

Reptiles were surveyed and assessed using a combination of incidental observations and encounters, targeted searches of habitats and specific sites/features, study of previous reports and records, and team expert knowledge and familiarity with the area.

Amphibians were similarly assessed.

Bats were surveyed by undertaking one night of observations and mist-netting at the main reservoir, and through incidental signs of bat activities. That one night produced 19 specimens representing seven species. Of these, six were previously recorded, and one species is an entirely new record for Antigua. The species is *Ardops nichollsi*, a Lesser Antillean endemic found from St. Martin to St. Vincent and Barbados. The specimen of a juvenile female was retained as a museum voucher, and is being analyzed by Dr. Gary Kwiecinski of Scranton University and Dr. Hugh Genoways, University of Nebraska State Museum, University of Nebraska-Lincoln. Their analysis of the specimen will be available in the coming months.

For birds, the survey team undertook roost surveys, the targeting of specific sites such as feeding areas, nesting activities, roosts, by incidental observations and from previous reports and records.

No specific surveys of aquatic vertebrates were carried out during this effort. The aftermath of the flooding proved too dangerous and made conditions to precarious to carry out surveys during the field visits to Wallings. However, from previous efforts, the team knew that there is at least two species of freshwater fish at Wallings, both introduced species. One is the small *Gambusia* sp., locally called “savage” because of it voracious appetite, and the other is a *Tilapia* sp., locally “calli.”

The Gambusia at Wallings may in fact be *Gambusia holbrooki* or *G. affinis*, commonly referred to as “mosquito fish” because of their habit of consuming the larvae of insects. Both species are native to watersheds that drain into the Gulf of Mexico. It is also possible that both species are present.

The term “calli” is a generic term applied to one or several species of the Cichlidae, a family

found primarily in Africa. It may in fact be possible that more than one species is present at Wallings.

Further work is needed to understand the species types that are present in the watershed, as well as the impacts that they may be having on local aquatic fish and invertebrates, as well as the long term ecology of the area.

Both species of these fish are found in the two reservoirs, as well as the stream along Fig Tree Drive.

Survey of Terrestrial Invertebrates

No surveys of terrestrial invertebrate were carried out. This was because the timeframe for the project, the very severe demands that invertebrate surveys and species identifications require, and the limited financial resources available for the project.

Survey of Aquatic Invertebrates

As with the aquatic vertebrates, no systematic survey of the freshwater invertebrates was carried out since this would be way beyond the scope of this project. However, the team notes that in the stream of Fig Tree Drive, *Macro brachium* species of shrimp and prawn have been observed in the past. None were observed during the field period of this project.

Survey of Threatened, Rare and Endangered Species and Habitats

Special and particular care was taken to locate and identify any critical species of plants, animals and habitats and determine the particular threats and issues relating to their conservation status.

GENERAL OBSERVATIONS

The proposed Wallings Forest Reserve is a complex of forests, woodlands, pastures, grasslands, reservoirs and other aquatic environments, small villages, farms, important tourist attractions, hiking trails, picnic facilities and a rainforest adventure enterprise, the “Antigua Rainforest Canopy Tour”.

Much of the area is situated on gentle to steep sloping hills and cliff faces. The villages are located at the northern and southern ends of the area, while the main road cuts through the center of the “reserve.”

The vegetation of Wallings consists of a mixture of evergreen and mixed evergreen forests along the wetter slopes surrounding the main reservoir, on slopes above Doiggs, and along Fig Tree Drive and other wet ghuts.

Along more exposed slopes, evergreen-deciduous woodlands and open woodlands persist.

On slopes and summits north of and near Signal Hill, and scattered in patches throughout the area, the invasive exotic introduce grass *C. citratus* or Lemon Grass dominates the landscapes, largely due to annual fires and to recent attempts to develop the area.

On more gentle slopes, limited farming of fruit trees and vegetable crops is carried out, especially near to the villages. In some areas, the grazing of livestock continues to preserve open and semi-open fields of grasses and low forbs, though these are slowly being encroached on by woodland and/or Lemon Grass.

Just above Wallings Reservoir No. 2, the historical and renowned spring, Tom Moore's Spring, bubbles up from below the earth of Wallings, trickles down into the reservoir, but goes largely unnoticed and forgotten. Once an important water source and meeting place, in recent years, road construction and infrastructure maintenance crews have abused the historic spring by ripping up the landscape surrounding it and dumping construction waste into it.

Fig Tree Drive, a natural icon that goes back over a 100 years, snakes its way along the main road, and follows the banks of the stream as it makes it way down to the mangroves at Old Road. Fig Tree Drive and Fig Tree Hill are said to be named after native figs and not because of the bananas that now grow there (see Lanagan 1844). In tales related to team member Kevel Lindsay, his father would recount on how dark and mysterious the place once was. Large trees with buttress roots lined both sides of the road and shut out much of the sunlight, giving the Drive a cool, dark and damp atmosphere. However, over the years, as the trees aged, many died, some were cut down, some bulldozed and many succumbed to the ravages of recent hurricanes.

After the passage of Hurricane Lenny in 1999, when the road had to be shifted to the west to reduce the impact of landslides and landslips, some of the large trees and other vegetation were bulldozed. Added to this is a recent increase in vegetation removal along the road and stream for fruit tree farming, which opens up the vegetation and reduces the once “rainforest-like” impressions that Antiguans often speak of.

As the stream makes its way down toward the old Arrowroot Factory that now sits derelict at Tramontania (referred to as the “Chemical Factory” on some maps), where another spring now sits capped by walls and a roof, providing potable water to the central water system of the island, the stream disappears completely. This occurs because much of the water seeps into deep sands, which were brought down from upstream and dumped at the foot of the valley. In addition, as the stream inches closer to Old Road, it becomes exposed to the drying winds and heat, whereas upstream it remains largely protected by the trees and other plants.

The flora and fauna of Wallings is representative of the dispersed nature of the Shekerley Mountains and of the relict vestiges of the once diverse and rich biodiversity of this island.

Many of the plant species are found through the wetter parts of these hills, though many are not represented in the same state and quantity as is to be found at Wallings, and none are as accessible to the viewer of nature as they are here.

The bird numbers and species fluctuate depending on the season, the amount of rains, the availability of food, and accessible nesting habitat. North American migrants arrive in full force in

late October and early November, some only stopping to gorge themselves on the fresh flush of insects, a population explosion which often happen as a result of the rains of this time of the year. Many of the birds continue southward to the Windward Islands, to Trinidad and to South America, Antigua a stepping stone on the way.

Some species of migrants may arrive as early as July and August. Species like the American Redstart (*Setophaga ruticilla*), the males and the juveniles often in the more drab and somber colors of the females, usually arrive earlier in the migration southward than other species, and stay longer in the spring.

Many of the birds of Wallings are some of the country's rarest, most colorful, curious and regional endemic species. These include the Scaly-napped Pigeon (*P. squamosa*), the Brown Trembler (*C. rauficauda*), the Antillean Euphonia (*E. musica*), the Scaly-breasted Thrasher (*A. fusca*) and the Purple-throated Carib (*E. jugularis*).

Above the canopy of the hills and often calling from the massive branches of the Silk Cotton trees one usually sees and hears Antigua's only endemic bird, the Broad-winged Hawk (*B. platypterus insulicola*). It's piercing scream and clicking whistles are distinctive. The species nests in the tall trees and rocky cliffs of Wallings.

In the summer and fall months, the Caribbean Martins (*P. dominicensis*) arrive and soar above the hills after insects. The constant twittering calls of these aerial acrobats are often heard long before the birds are seen. They migrate south to northern South America during the early winter months.

At night, if you sit at the main reservoir, you may hear the ghostly call of the Black or Yellow-crowned Night Herons (*N. nycticorax* & *N. violacea*) as they fly back and forth in search of fish. Then the sudden alarm call of the Green Heron (*B. viriscens*), emitted as it is startled from its fishing endeavors, will send any person into flight.

Aside from the birds, reptiles are the most obvious vertebrates to be found at Wallings. There are between six and seven species found there. One species is known to occur in the general area; it was not observed during the survey, but it is believed to be present. Of these species, one is a snake *T. monastus*, or the Blind Worm or Coffin Borer as it is commonly known. This species is not often observed because it lives in leaf litter, in soil, below logs and other decaying matter. Other species of snakes native to Antigua are now long gone from Wallings as a result of predation from the introduced Indian Mongoose.

The small terrestrial gecko *S. elegantulus*, an Antigua and Barbuda endemic species, is relatively rare at Wallings. These small geckos, which are among the smallest lizards in the world, can achieve super abundance in the leaf litter, and in many islands, such as on Guana Island in the British Virgin Islands, related species achieve some of the highest population densities of any vertebrate species in the world. However, in Antigua and at Wallings, this is not so. Though there could be various reasons for this, it is also just as plausible that this is caused in part by predation by the Indian Mongoose, combined with other natural factors that limit the species' natural populations.

At least one species of frog (*E. johnstonei*) and one toad, the introduced Marine Toad (*B. marinus*) are present there.

Feral and free-roaming domestic animals are found in Wallings, though some keep to the slopes about Signal Hill and others to the deep valleys. There are a few horses, donkeys, many goats, wild pigs, cats, and dogs. The horses, donkeys and sheep are found around Signal Hill while the wild pigs and dogs are found lower in the valleys down to Doiggs.

Feral cats are found throughout the area, and are likely a direct result of people discarding unwanted kittens into the "bush." The cats will often find food around garbage disposal sites such as the picnic area at the Reservoir.

Over the years, much effort has been made to attract visitors to Wallings. Facilities have been put in, the road to the reservoir has been widened, and the site has been vigorously promoted as an outdoors destination for both locals and foreign visitors to the island. However, since there is no policing of Wallings or execution of controls and monitoring, problems have arisen. Visitors often drive right up to the spillway, creating access problems for others, and undermining the road, especially in the wet season.

According to verbal reports from Adriel Thibou and from observation made on the slopes of Wallings, wattle and charcoal cutters have recently begun to clear cut some areas of the forest, and this is done very indiscriminately. These cutters are able to drive their vehicles up to the Reservoir at any time of the day and remove forest products. With unlimited access to the forest, these activities often go unnoticed, especially after it is too late to take action.

Garbage is disposed of indiscriminately, and hundreds of pounds of waste material have been dumped over the dam wall. Collected trash is also left unattended in bags for days or even weeks.

Barbecuing facilities have also been provided for picnickers at the Reservoir. However, given the lack of supervision and anecdotal reports of visitors abusing the facilities and forest, there is the strong possibility of fires getting out of control and causing considerable damage to the forest, especially in severe dry periods.

OBSERVATIONS: THE FLORA

Flora

Wallings is quite a diverse area of natural and human ecological communities, much, if not all, of it secondary and post-secondary in nature. Plant species compositions were assessed during both fieldwork sessions (October 2008). A total of 320 species of plants belonging to 84 different families were recorded. **Appendix III** provides a list of these species. Out of the total number of species recorded, about 267 (86%) species are considered native. The remaining 44 (14%) of species are introduced (or exotics). Table 1.0 below summarizes the breakdown of the number of species tallied.

Table 1.0. Physiognomic plant categories at Wallings.

Category	Numbers	Percentage
Herbs	114	36
Shrubs	54	17
Vines	36	11
Trees	116	36
Total	**320**	**100**

Several plant species in Wallings were a challenge for the EAG Plant Project and this survey team to identify. Every trip to Wallings yields at least one new and interesting plant species. On two previous trips, the Plant Survey team discovered a previously unknown Selaginella (primitive fern) and another species of filmy fern of the genus Trichomanes along Fig Tree. Photo 3.0 below shows the new species of Selaginella and Trichomanes for Antigua.

Photo 3.0. New species of Selaginella and Trichomanes ferns at Fig Tree, Wallings.

On the slopes above the Reservoir, the team found a tree that provides another identification challenge for the team; this species has not yet been assigned to a plant family. Though this species may eventually prove to be a known species for Antigua, the continuing uncertainty surrounding some plant identification highlights how much remains to be discovered in the hills and ghuts of Wallings and the surrounding area and how much work remains in order to protect these valuable species from possible extinction.

Vegetation Communities

There are 13 vegetation community types (also referred to as alliances) and 15 associations found within the Wallings area. The vegetation is largely secondary and the area was reforested with a variety of species, including a number of introduced species, back in the early 1900s after it was discovered that the newly constructed Wallings Reservoir was not holding water as was expected and large amounts of sediments were being washed into it after heavy rains. A summary of the vegetation community types are described below and their distribution illustrated in Figure 3.0. For the purpose of mapping, the communities mapped have been simplified under aggregate types.

Evergreen Closed Tree Canopy Communities

Ficus citrifolia-Ceiba pentandra-Roystonea oleracea Alliance

This community at Wallings is represented by scattered canopy emergents of *F. citrifolia, C. pentandra* and occasionally *R. oleracea*. The canopy emergents may reach up to 20-25 meters, the mid-level understory from 2-5 meters. There are abundant lianas, especially of *P. kohautiana* and *Ipomoea spp*., often climbing to the canopy. There are also abundant epiphytes, including bromeliads, orchids and ferns.

This alliance is to be found at Wallings Hill.

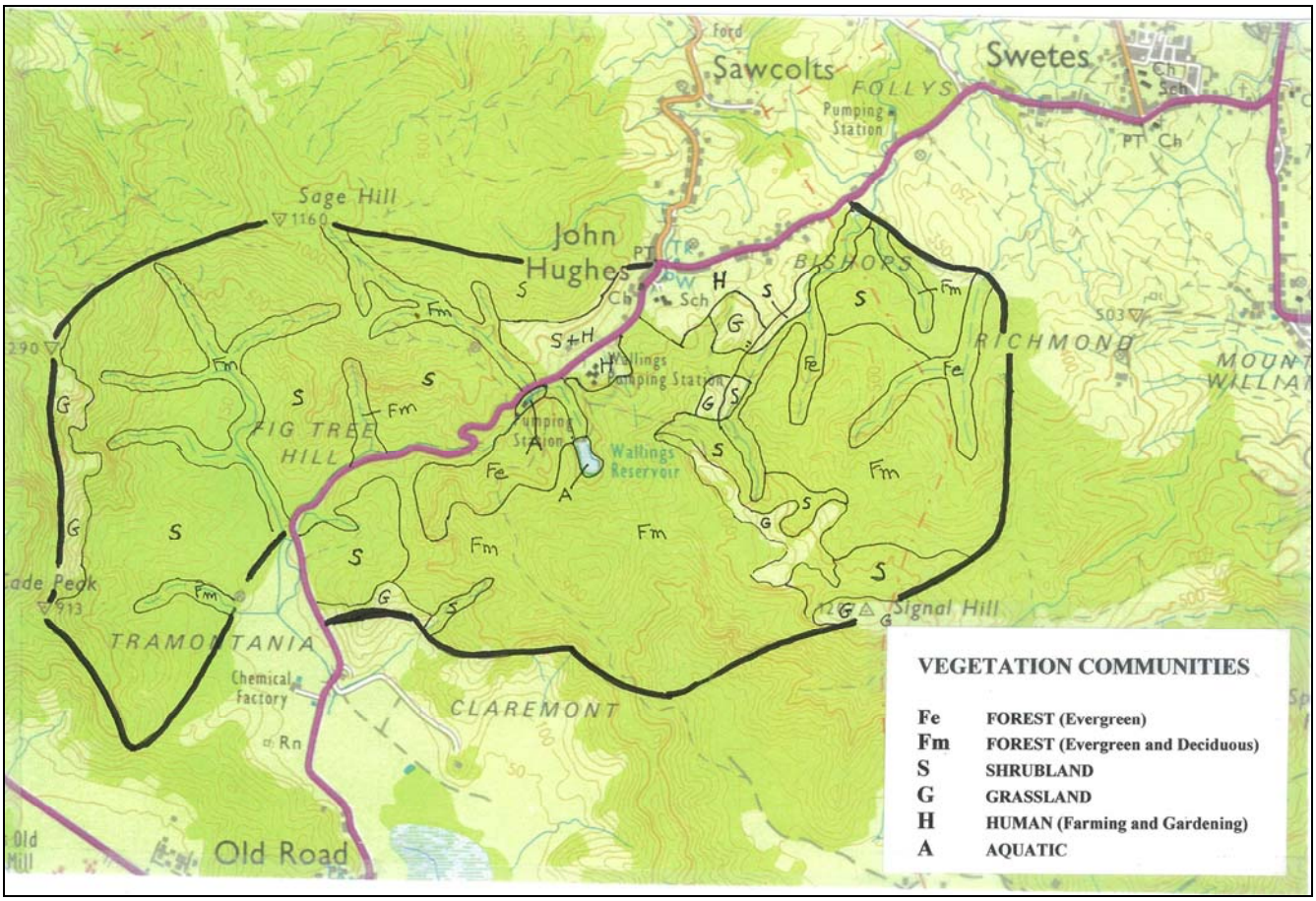

Figure 3.0. Wallings vegetation communities (communities have been simplified in this map).

Mangifera indica-Cocos nucifera-Bucida buceras Alliance

At Wallings, this community is found along steep wet ghuts, especially where there are springs providing water for most of the year, though this is not always the case. There are scattered canopy emergents of *C. pentandra, R. oleracea, C. nucifera, H. crepitans and B. buceras*. These emergents may reach 20-30 meters or sometimes more. Lianas are less common in the canopy of this alliance. In the mid to upper story, it is common to find relicts and escapes from past cultivation, including Citrus varieties and *S. jambos*. The understory is also usually sparse because of floods, and may consist mainly of seedlings of canopy species, ferns and other pioneers. This community often occurs as patches within seasonal forests like the *Coccoloba pubescens-Eugenia* spp. Mixed Evergreen-Deciduous Alliance, described below.

This alliance is to be found at Fig Tree Drive, the upper parts of the ghut draining into Rendevouz, and steep ghuts on the north side of Signal Hill.

Mixed Evergreen–Deciduous Closed Tree Canopy Communities

Coccoloba pubescens-Eugenia spp. Alliance

This community appears as drier "islands" within wetter forests, because of greater exposure to drying winds or location within rain shadows. For example, it can be found within *Ficus citrifolia-Ceiba pentandra-Roystonea oleracea* Alliance at Wallings Hill, showing more pronounced seasonality of leaf loss than the surrounding forest. May have emergents of *Ceiba pentandra, Hura crepitans* or *Spondias mombin;* canopy may reach 20 meters, but generally less than in wetter forests. In the past, much of the understory often was as a result of coppicing, as wattle and charcoal cutters harvested the poles.

Pisonia subcordata-Bourreria succulenta Alliance

This community is a two-storied forest with occasional emergents of *B. simaruba* and *T. heterophylla* above a 6-12 meter canopy. The trees are usually slender-stemmed, less than 15-20 cm, though emergents may be larger. The understory usually consists of dense, fairly impenetrable thickets, in part because of the extensive vines, including *Stigmaphyllon* and legume species, which is characteristic of this community. It occurs in dry areas and areas with shallow soils.

In the Wallings area it is found at Doiggs, Claremont, Tremontania and Fishers.

Mixed Evergreen Drought Deciduous Shrubland Communities

Acacia spp.-*Caesalpinia coriaria-Haematoxylon campechianum-Leucaena leucocephala* Alliance

This is a rather widespread community in Antigua. It contains a mixture of trees and shrubs, the ratio of which depends in part on the type and timing of human disturbance. The community usually reaches 5-10 meters. There is no defined community, though there may be an occasional emergent, usually of *T. heterophylla* and *P. subcordata*. The density of trees and shrubs is typically high, but varies considerably. The community is secondary in nature, which reflects succession on unmanaged pasture land (previously sugar cultivation, livestock or crop farming).

There are two associations of this community type found within the Wallings area, although they commonly intergrade with one another quite easily. These include the *Acacia* spp. Association and the *Haematoxylon campechianum* Association.

At Wallings, this community is found at Doiggs, in patches on slopes above Fig Tree, especially on the western side, above John Hughes on Western slopes, north of Signal Hill on exposed dry slopes and in patches above Claremont Valley.

Grassland Communities

Dichanthium aristatum Grassland with Broad-leaved Evergreen Trees Alliance

This grassland community has some forbs, with scattered shrubs and trees, providing a cover of generally 10-25%. None of these areas is natural, and are often in transition from grassland back to more woody communities. Many of these areas are maintained through grazing and fires.

In addition to whatever shrub and tree species are present, the dominant grass species is *Dichanthium aristatum*; other monocots include *Trimezia martinicensis*, and the following forbs: *Waltheria indica, Abutilon spp., Stylosanthes hamata, Chamaesyce hirta, Crotalaria retusa, Mimosa pudica, Neptunia* spp., *Desmodium incanum, Stachytarpetha jamaicensis*, and others.

At Wallings, this community is found in patches throughout the area, ranging from a few meters to one or two acres in size. This community is gradually disappearing as woodlands re-colonize these areas.

Cymbopogon citratus Grassland with Broad-leaved Evergreen Tree Alliance

This community is virtually monospecific stands of the introduced grass, *C. citratus*, locally called Fever Grass, Citronella or Lemon Grass. At Wallings, the community occurs in patches, ranging from a few meters in size to acres. It is maintained by fires that are deliberately set by wood cutters, livestock and crop farmers to gain access to the forest, get rid of weeds and problem plants, and to promote the growth of young palatable shoots.

At Wallings, this community is especially common on the summit of the Signal Hill area and the slopes to the north. Also occurs in small patches throughout the forests.

Human-Associated Communities

Fruit-tree and Crop Farming

This community is directly associated with daily human activities. The land is cleared and planted with a number of tree fruit crops, and may be mixed with vegetable and herb crop farming. Species include Citrus varieties and species, many Mango varieties, Pineapple, Banana varieties, Cacao, *Annona* spp., Spondias spp., and a variety of vegetable crops and root crops, as well as herbs for seasoning and medicinal purposes.

Gardens

This community is associated with homes and is planted mainly for their aesthetic values. It may consist of showy herbs, shrubs, small or large trees, including fruit trees and some vegetable, root and herbal crops. These are often planted around the home.
This community is found around most homes at John Hughes, Sawcolts and Old Road.

Aquatic Communities

There are two reservoirs and two ponds at Wallings. The reservoirs are Wallings Reservoir No. 1, found at the heart of the Wallings Forest area, and the much smaller Wallings Reservoir No. 2, located along the main road.

The two ponds are small water catchments near Signal Hill dug many years ago to provide water for livestock.

In most cases, these aquatic environments have few or little aquatic vegetation association with them, especially the main reservoir and the two ponds.

However, the small reservoir often has *Dieffenbachia sanguine*, *Ludwigia erecta*, the grass Job's Tears (*Coix lacryma-jobi*), among other species of plants.

OBSERVATIONS: THE FAUNA

Birds

Unlike most places on island, Wallings has enjoyed over 70 years of bird observations and reports. Though these are by no means complete, they do provide an invaluable resource and a window unto the vertebrate ecology of this important forest ecosystem.

Bird surveys were done along trails, ghuts, bird flyways and wherever the team ventured into the forest. The focal points for bird activity were along trails, pathways, forest edges, open patches in the forest, and wherever fruiting trees and large invertebrate populations occurred.

At least 64 species of terrestrial, wetlands and seabirds have been observed over the period of the survey and in previous surveys and reports (see **Appendix I**). The reservoir attracts gulls, frigatebirds, pelicans, herons and rails.

It is important to note that the number of species seen during field operations reflects a short time frame in the day and within the season, and offers only a sample of the numbers of species that may occur there throughout the year. The list will undoubtedly expand considerably if surveys were done more frequently covering all seasons, and as part of a systematic study, which would monitor the area's bird population.

Of notable absence during this field survey were the North American migrants. This survey was just at the beginning of the southward fall migration of birds, and most species had not yet arrived. However, American Redstarts (*S. ruticilla*), an early migrant, were seen and heard throughout the forest during the field visits.

At least 38 of the species recorded nest in the area. The remainder or 40% of the birds are transients and/or migrants.

Bird numbers and species fluctuate greatly, depending on the season, the amount of rain, the availability of food, and nesting habitat. North American migrants arrival on island during the fall

usually coincide with the heaviest rains of the year when there is an explosion of insects, foliage, young plant shoots, fruits and flowers.

On the northward migration in the spring, when species fly up the Lesser Antillean chain from South America, birds arrive at the end of the dry season and when the short but sustaining spring rains usually begin.

As Wallings Forest matures, many species of plants and animals increasingly rely on it for survival since it acts as an ecological anchor. The forest is older than most of the surrounding woodlands but provides a source for the re-colonization of many species to nearby young plant communities by dispersing its seeds to them, by helping to regulate and maintain moisture, wind, climate and other factors, and by acting as a nursery and sanctuary for animals.

Lindsay and Horwith, 2007, identified 40 species of birds of "**special conservation concern**" for Antigua and Barbuda. The IRF team has listed eight or 20% of these for Wallings. Though other species on the list occur at Wallings, the team decided on the eight most critical resident breeding species to highlight. These species are primarily regional endemics, and are relatively rare on island and throughout the Caribbean region. These species include:

The **White-crowned Pigeon** (***Patagioenas leucocephala***). Though widespread throughout Antigua, even occurring within St. Johns, this species is rare on most of the islands of the region and places like Wallings offer this species the sanctuary it needs. The species is a regional migrant, and disperses widely through the region, and birds born on Antigua may eventually colonize other islands from which it has disappeared due to over-hunting. It breeds at Wallings.

The **Scaly-naped Pigeon** (***Patagioenas squamosa***). This species is often mistaken by many Antiguans for its close relative *P. leucocephala*. It rarely occurs outside of the southern hills, it is at Wallings where the species seems to thrive most, and this may be due in part to the location of the reservoirs right within the confines of the forest. *P. squamosa* is far the rarer of the two species, and is very shy, always wary of hunters. It breeds at Wallings.

The **Ruddy Quail Dove** (***Geotrygon montana***). Though it is not a regional endemic, this species is one of Antigua's shiest and most retiring birds, rarely ever seen by anyone. Its mournful cries are often heard from the slopes around the reservoir. The species seems limited by the presence of the Mongoose and by increasing human presence in the forest.

The **Bridled Quail Dove** (***Geotrygon mystacea***). This species of bird closely resembles the above species, but has far more color in its plumage. The calls are somewhat similar though this West Indian endemic bird seems somewhat more common than the former. In habits and needs, these two species are very similar.

The **Purple-throated Carib** (***Eulampis jugularis***). This is Antigua's largest and most colorful hummingbird, with a black back and an iridescent scarlet throat. Though it is sometimes found outside of the southern hills, it primarily inhabits this area.
The **Antillean Euphonia** (***Euphonia musica***). The Euphonia is our only resident tanager. Quite colorful in its yellows, greens and blues, the species is extremely difficult to observe, but is often heard calling from the tree-tops as it searches for one of its favorite fruits, the mistletoe. However, it is usually quiet for most of the year. At Wallings, it found on the slopes and summits of moist

forests around the reservoir and along the wet valleys.

The **Scaly-breasted Thrasher** (***Allenia fusca***). The Scaly-breasted Thrasher and its close cousin, the Pearly-eyed Thrasher (*Margarops fuscatus*) are probably the most ubiquitous of our resident birds. They are mimids, relatives of the mockingbirds, and are intelligent, noisy, boisterous and inquisitive. They can often be heard as they tumble around in the undergrowth, fight amongst themselves, call from the tree-tops and come peering into your face as you squeal like a mouse. The Thrasher is a Lesser Antillean endemic that is restricted primarily to the southern hills, especially in more mature forests such as at Wallings.

The **Brown Trembler** (***Cinclocerthia ruficauda***). The Trembler is one of those enigmatic birds that seemed to have disappeared from Antigua for a number of years but only to reappear in recent years. Known from its habit of "trembling" hence the common name, this species is a very rare Lesser Antillean endemic, and is known from Wallings and Christian Valley.

It is also a close relative of *A. fusca* and *M. fuscatus*, though it does not have the boisterous personalities of these other species.

An interesting anecdotal story of an owl at Wallings was told to team member Kevel Lindsay by Mr. Peter Blanchette when they both worked in the Forestry Unit, Ministry of Agriculture back in the 1990s. Mr. Blanchette who was an avid hunter reports that back in the early 1980s while hunting pigeons and doves there, he shot what he believed to be an owl. He said that he mistook it for a game species but soon realized the mistake when he picked up the bird and saw the round face, light weight and the fact that at first, while perched, the bird's head seemed to move in a peculiar manner. The description provided by Mr. Blanchette seems to describe a Barn Owl (*Tyto alba*).

Curiously, birds thought to be owls are occasionally reported from Antigua, though officially the last known owls, the Burrowing Owl (*Athene cunicularia amaura*) went extinct soon after the introduction of the Mongoose. This species was last reported in 1859.

Of notable mention should be made of the Antiguan endemic form of the Broad-winged Hawk (*Buteo platypterus insulicola*). This is Antigua's only endemic bird species. It is not a species primarily confined to the southern hills, but is widely distributed throughout the island. However, the hawk is common at Wallings, and even nest in the area. It preys on pigeons and doves and needs large trees for roosting, nesting and from which to find prey.

Mammals

Bats are the only native mammals extant on Antigua today. Little is known about them. Previous to this survey, there were seven extant species of bats reported for the island. However, a new species record obtained during the one night of bat survey at Wallings, and this brings the total number of species to eight.
There are six species reported for Wallings:

1. The **Velvety Free-tailed Bat** (***Molossus molossus***), a widespread and relatively common species throughout Antigua;

2. The **Brazilian Free-tailed Bat** (***Tadarida brasiliensis***), less common than the former species, to which it is closely related, nevertheless, the species seems locally abundant in parts of the island;
3. The **Jamaican Fruit Bat** (***Artibeus jamaicensis***), a very common and widespread species in Antigua and throughout the Antilles;
4. The **Cave Bat** (***Brachyphylla cavernarum***), a rare, highly gregarious species that seems limited by the availability of hot humid caves;
5. The **Tree Bat** (***Ardops nichollsi annectens***), the capture of this species marks the first record for Antigua and Barbuda and a very important discovery for the island. This small Lesser Antillean member of the Phyllostomidae is the only member of its genus. *Ardops* roosts in trees, hence the name, and this suggests that mature forests like Wallings where large old trees are available is critical to the survival of this species on Antigua. The form caught in Antigua is endemic to Guadeloupe and Antigua. Photo 4.0 below shows the specimen of *A. nichollsi* taken at Wallings Forest near the main reservoir.
6. The **Fishing or Bulldog Bat** (***Noctilio leporinus***). This species is the largest bat of the Americas with a wingspan that can go to over 61 cm (2 ft). At Wallings, the Fishing Bat flies along paths as it makes it way to catch fish on the reservoir or to take a drink

Photo 4.0. *A. nichollsi annectens* juvenile female from Wallings Forest.

Bats are critical to the forest ecosystem health and wellbeing. These mammals are the primary pollinators, seed and beneficial insect dispersers of a number of species, and without them the forest ecosystem would almost certainly perish. Species of plants for which bats are critical include the Silk Cotton (*C. pentandra*), Locust or Tinking Toe (*H. courbaril*), Wild Figs (*Ficus* spp.), *Piper* spp., the Calabash (*C. cujete*) and a number of tree crops.

The survey team carried out visual, roost, and mist netting surveys during the field work period. No roosts were located during the survey. At the end of the capture period, after nets were dismantled, the team took wing measurements, the gender of each individual, breeding status, and general health conditions of the specimens. One specimen—a juvenile female of *A. nichollsi annectens*—was retained as a voucher, which has been sent to mammologist Dr. Gary Kwiecinski of Scranton University, Pennsylvania, for further study and analysis. The export of the species to Dr. Kwiecinski was necessary since he is one of the main experts on regional bats and his examination and study of the species was necessary to determine its identification and to understand the significance of this find.

The specimen was preserved in 151 Proof Cavalier Antigua Rum. Permission for the export of the specimen was sought and granted by the Livestock Division, with the cooperation and major assistance of Adriel Thibou and staff of the Forestry Division, and under the guidance of advice of Dr. Janil Gore, head of the Plant Protection Unit, Ministry of Agriculture.

The specimen will eventually be deposited in the Caribbean collection of The Museum of Texas Tech University in Texas, but as stipulated in the letter of consent and permission written by the Division, it remains the property of the Government of Antigua and Barbuda.

Further work is needed at Wallings to assess the population of this and other species of bats, how they are using the forest, their diets and the effects on the plant communities, the populations, roosting, and the importance of a healthy forest to the sustainability of the bats.

Other species of mammals known to occur within the Wallings area include the introduced and invasive Black Rat (*Rattus rattus*), the Norway or Brown Rat (*R. norvegicus*), the House Mouse (*Mus musculus*), the Indian Mongoose (*Herpestes javanicus*), feral House Cats (*Felis catus)* a small band of donkeys and a few feral horses at the Signal Hill area, goats, and wild pigs, which stay mostly down in Doiggs and Rendevouz Bay. There are also reports of feral dogs at Doiggs and Rendevouz.

These introduced species move throughout the Wallings area and undoubtedly have a major effect on the ecology of the forest. The Mongoose is known to predate on birds, amphibians, reptiles and invertebrates and will scavenge human waste and surroundings if available.

The rats and cats also have similar habits to the mongoose but mostly operate at nights, while the Mongoose is a diurnal forager.

Reptiles and Amphibians

There are 21 terrestrial reptiles and amphibians recorded for Antigua. Of these, four are extinct, three of which are known only from fossils (*Clelia clelia* and *Boa constrictor*, both snakes, and

Leocephalus cuneus, a lizard). The fourth species, the Lesser Antillean Iguana (*Iguana delicatissima)* was last seen in the mid 1980s, but is believed to be now extinct.

Two species are human-assisted introductions, both amphibians (the Marine Toad *Bufo marinus* and the Cuban Tree Frog *Osteopilus septentrionalis*), and one is a natural introduction, the Green (*Iguana iguana*) as a result of the passage of Hurricane Luis in September 1995, but may have died out soon after its arrival.

Of this total, the team recorded six species of reptiles and two amphibians at Wallings. These include:

1. *Anolis* (*bimaculatus*) *leachi* – Antigua or Tree Anole, endemic to Antigua and Barbuda. This species is common throughout Antigua and at Wallings.
2. *Anolis wattsi* – The Brown or Watts Anole, an Antiguan endemic. This species is rather common.
3. *Sphaerodactylus elegantulus* – The Dwarf Gecko, endemic to Antigua and Barbuda. Uncommon to relatively rare at Wallings.
4. *Hemidactylus mabouia* – House Gecko/Woodslave. Introduced. Common.
5. *Thecadactylus rapicauda* – The Forest or Tree Gecko. Population status unknown, but given its biology and ecological habits, it is believed to be locally common.
6. *Typhlops monastus* – The Blind Snake. This species is believed to be locally common, though this conclusion is based on knowledge of the species' habits throughout most of Antigua.

And two amphibians: the tree frog (*Eleutherodactylus johnstonei*) and the introduced South American Toad (*Bufo marinus*). Both species are common.

The other species of tree frog recorded for Antigua remains problematic since some authors argue that it is not present here (Kaiser, 1992). The species, *E. martinicensis* or the Martinique Tree Frog, has been shown to be easily introduced to islands in the region, and it very closely resembles its relative *E. johnstonei,* so distinguishing them in the field is very difficult. The species could possibly be present at Wallings but this is only speculative at this time.

All species of reptiles except *S. elegantulus* are relatively quite common and widely distributed throughout most of Antigua.

Spherodactylus elegantulus, an Antigua and Barbuda endemic species, is relatively rare at Wallings. These small geckos, which are among the smallest lizards in the world, can achieve super abundance in the leaf litter, and in many islands such as on Guana Island in the British Virgin Islands, related species achieve densities of about 67 600 ha^{-1}, one of the highest population densities of any vertebrate species in the world. However, in Antigua and at Wallings, this is not so. A search for species in all appropriate habitats may prove futile. Very often, the animal remains elusive. There could be various reasons for this; it is also just as plausible that this is caused in part by predation by the Indian Mongoose, combined with other natural factors that limit the species' natural populations.

The House Gecko or Wood Slave is believed to be a West African immigrant, arriving in the region via slave ships within the last 400 years.

Terrestrial Invertebrates

No surveys of terrestrial invertebrate were carried out. This was because the timeframe for the project, the very severe demands that invertebrate surveys and species identifications require, and the limited financial resources available.

However, invertebrates of special conservation concern or of particular interest were noted where possible.

INVASIVE SPECIES

There are three species of invasives that are of major concern in the Wallings area. The first species is the Lemon Grass (*C. citratus*), first introduced in 1902 to the banks of the Body Ponds as an erosion control measure. The species has since spread throughout the Shekerley Mountains and to a few small patches on the hills east of Liberta.

For the first 50 years or so, it is believed that the species did not move very far from its initial area of introduction. Just why its spread has accelerated may be due largely be due to two main factors. Charcoal burners often line their pits with bunches of fertile stems, which are harvested from infested areas on the lower plains, and carried to locations up in the hills. According to J.C. Cater in his 1944 report on Forestry in the Leeward Islands, "[*A*]*ntigua has the unenviable reputation of being, of all the West Indian Islands, the most prone to suffer so-called "bush fires*"." In the early parts of the 1900s, it seems that bush fires became a major environmental problem on Antigua. Landless and poor residents used fires to clear land, but also wanted to promote fresh growth of fresh succulent shoots, and for many years, a tradition was handed down that fires brought rains, a belief that still exists amongst some of the residents today.

Fires greatly accelerate the spread of this species by killing off competing species and creating fresh ground for its seedlings. Today, the fires are set by farmers, livestock owners, wood cutters and other persons to help maintain access to the forests and the hills, to control the grass, and to provide fresh succulent and palatable shoots for livestock during severe dry periods. As fires are set to the Citronella grasslands, the fires also destroy and fragment forests and woodlands, and opens up these areas to the invasion of the grass. Citronella is not shade tolerant and dies out as forest and woodland crowd out the species.

The spread of this species has also been assisted by periods of severe droughts when trees and shrubs die back and open up new areas to the invasion of the species. Citronella also spreads through direct human transport of cuttings from one area to the next, since the plant is prized for its herbal and medical uses.

It is also spread by livestock as they carry the seeds from place to place.

At Wallings, *C. citratus* is primarily found around Signal Hill and the slopes to the north. There are

other smaller patches scattered throughout the main area of Wallings. Other small patches are found on the slopes and ridges west of Fig Tree Drive.

One of the most effective ways to control Lemon Grass is to stop fires, and prevent further road construction and fragmentation of the forest and landscape within and around the forest. The species is an aggressive invasive and roads provide access for the species to invade new areas and freshly turned earth.

As the fires stop, pioneer shrubs and trees will colonize the grasslands and eventually shade out the grass. Figure 4.0 below provides a map of the Lemon Grass distribution at Wallings.

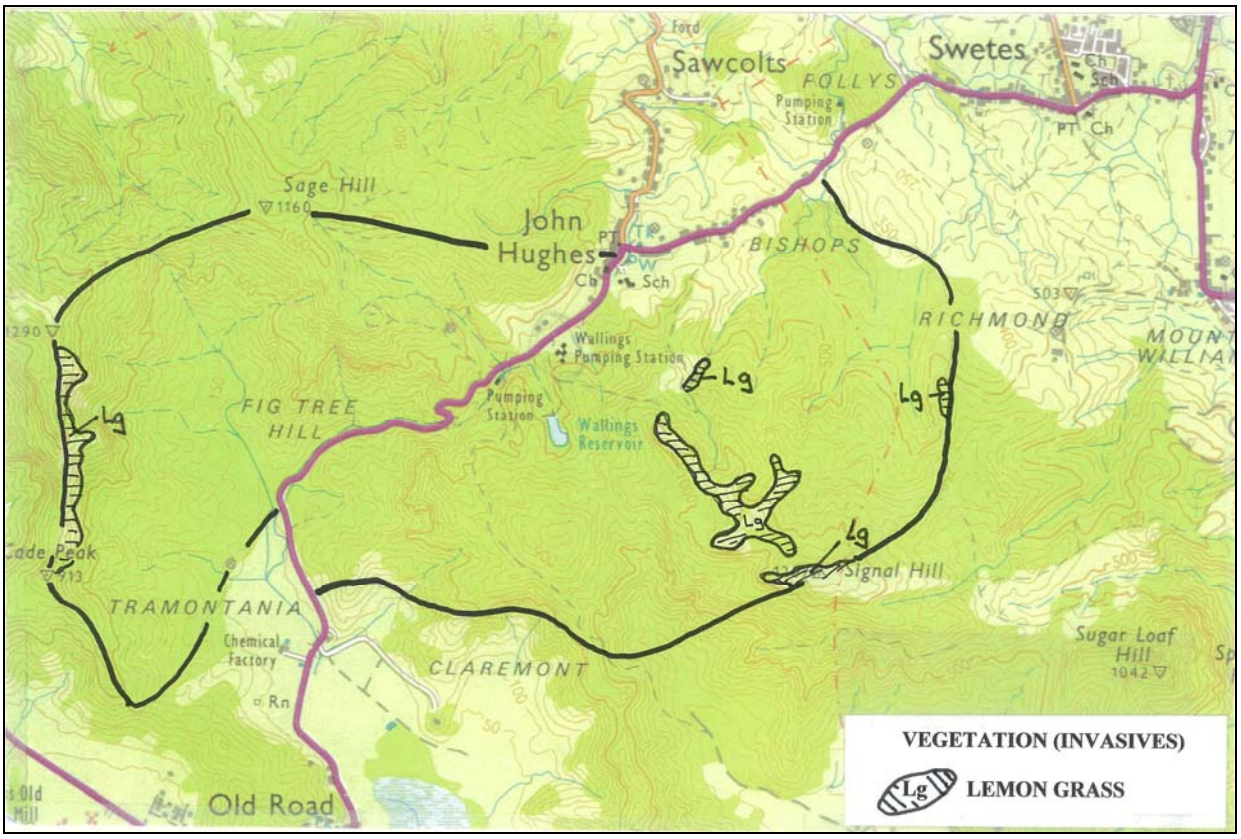

Figure 4.0. Lemon Grass distributions in the Wallings area.

The other two invasive species of concern are the goats and the introduced Indian Mongoose. Goats are a major problem in many parts of Antigua and Barbuda. They cause considerable damage to the landscape and biodiversity. They strip trees and other plants of foliage, prevent regeneration, and as the vegetation dies back, the soil becomes exposed and erodes. This then has a cascading or domino effect on all aspects of the ecology and economy of the area's landscape.

At Wallings, the goats are semi-wild, but are owned by various, but unknown persons, who occasionally corral the animals and take animals as they need. These free-roaming animals are to be found around the Signal Hill, area and the damage they cause to the landscape can be seen in the defoliation of trees, the lack of regeneration in the undergrowth, and erosion of the slopes. The goats may also be aiding the spread of the Lemon Grass by reducing the vegetation cover and by exposing bare earth, which is then easily colonized by the grass.

The Mongoose was introduced to Antigua in the 1800s at the behest of estate owners after they heard of the success that its introduction had had on controlling the rats that had been causing considerable damage in the cane fields of Jamaica. Its introduction soon had a disastrous effect on the native animals. Within a few years, the endemic Antigua Burrowing owl (*Athene cunicularia amaura*) became extinct, and so did the snake (*A. antiguae*) from the mainland. The snake is now found only on the offshore cays. The Mongoose undoubtedly caused the extinction of far more, but in those early years, relatively little was known and understood about the biodiversity of the island.

The Mongoose is very common throughout Antigua, though there are no estimates of population numbers. At Wallings, the species is commonly seen darting about in search of prey, and can often be observed around homes, garbage bins, along the main road, and areas around the main reservoir.

The species is known to be an aggressive and voracious predator and eats just about any vertebrate or invertebrate. Ground nesting birds and reptiles are especially vulnerable to this species. This is the reason that the endemic Antigua Ground Lizard (*A. griswoldi*) is rare on the island and entirely absent from Wallings and surrounding areas.

In the past, the government used to pay a bounty on the Mongoose and encourage residents to kill any captured. This practice has been long discontinued, but it was effective in localized areas in controlling the species' population numbers, thereby reducing its impact on the biodiversity.

SPECIES OF SPECIAL CONSERVATION CONCERN

There are several species of special conservation concern in the Wallings area.

For birds, the species are listed below. Much more details on each species has been discussed in the fauna section above:

- The **White-crowned Pigeon** (*Patagioenas leucocephala*) – locally common.
- The **Scaly-naped Pigeon** (*Patagioenas squamosa*) – uncommon to rare and restricted.
- The **Ruddy Quail Dove** (*Geotrygon montana*) – rare and restricted.
- The **Bridled Quail Dove** (*Geotrygon mystacea*) – rare and restricted.
- The **Antigua Broad-winged Hawk** (*Buteo platypterus insulicola*) – locally common and widespread

- The **Purple-throated Carib** (*Eulampis jugularis*) – rare and restricted.
- The **Antillean Euphonia** (*Euphonia musica*) - very rare and restricted.
- The **Scaly-breasted Thrasher** (*Allenia fusca*) – uncommon and relatively restricted.
- The **Brown Trembler** (*Cinclocerthia ruficauda*) – very rare and restricted.

For the mammals, the species of concern are:

- The **Cave Bat** (*Brachyphylla cavernarum) – rare and very restricted*.
- The **Tree Bat** (*Ardops nichollsi*) – believed to be very rare and quite restricted.

Details on these two and other bat species are discussed above in the section on fauna.

For amphibians, the species that is of some concern it the **Antigua Dwarf Gecko** (*S. elegantulus*). The introduced mongoose may be having some impact on the population and measures should be taken to control the mongoose.

Though no formal surveys of the invertebrates were undertaken, we are concerned about the native Macrobrachium shrimp and prawns in the Fig Tree stream. An assessment needs to be carried out to determine the species and ecological status of these animals.

AREAS OF SPECIAL CONSERVATION CONCERN

The areas of concern include natural plant communities, natural areas and historical, aesthetic and aquatic resources.

For plant communities, all natural plant communities are of major concern. The original core of Wallings is not very large, being just over 100 acres (40 ha) and this has increased over the years to 200-300 acres (80-120 ha). The plant communities within the Wallings area are vulnerable to development activities, erosion, flooding, uncontrolled farming, fires, invasives species, livestock and other factors, and the size of the area as well as its proximity to human settlements make these community even more acutely susceptible to potential adverse impacts.

For natural sites, these include the historic Tom Moore's Spring, situated just at the foot of Wallings Reservoir No. 2 next to the road. Over the years, the spring has been impacted by sediment disposal and pile up, bulldozing, vehicular traffic, road construction, farming and many other factors. The spring needs to be rehabilitated and protected.

The other site is Fig Tree Drive, a natural icon in Antigua. Despite its significance to the economy of the country, the area is seriously at risk and on the decline and steeps need to be made to protect and restore it. This area would include the Fig Tree stream as well.

For cultural sites, there is an urgent need to assess the vulnerability of both Wallings Reservoir No. 1 and No. 2, especially the dam wall of No. 2. Recent and past flooding, landslips and construction are having their toll. These sites need to be protected, restored and stabilized.

NATURAL DISASTERS AND VULNERABILITY RISKS

The Wallings Forest and surrounding area is very vulnerable to natural disasters. Prior to Hurricane Hugo in September 1995, it was assumed that such storms would result in tree fall, limb fall, leaf loss, damage to old and weak trees, some soil loss, flooding and some loss of fauna. The result was an eye-opener, because in addition to all the above, considerable damage also resulted from landslips, landslides, rock falls and from extensive flash-flooding.

Subsequent hurricanes and storm events, including Hurricane George in September 1998, Hurricane Lenny in 1999 and Hurricane Omar of October this year, 2008, have continued to demonstrate just how vulnerable the upslope environments are, as well as the ghuts and low-lying areas, to severe earth movements as result of huge rain events.

The field assessment during this past October came just after the passage of Hurricane Omar. The storm did not pass directly over Antigua but it outer bands dumped between 15 and 33 cm (6 and 14 inches) of rain (varying rainfall reports have been given by varying sources) over 24 hours. This intense rain event, along with tropical storm-force winds out of the southwest, resulted in severe flash floods that brought tons of sediments, washed out roads and culverts, damaged road and dam infrastructures, redistributed considerable amounts of solid materials around the Wallings-Fig Tree Watershed, caused landslips, landslides and opened up old fault areas. There was minor tree fall, as well as leaf and branch fall, especially on southwest facing slopes.

During the field visit, Wallings Reservoir No. 1 and Reservoir No. 2 were full to over-flowering. Reservoir No. 2 had considerable amounts of debris dumped into it as a result of the floods, much of this material originated from piles of limestone gravel used in the construction of the roads and new drains, as well as piles of this material left at the side of the road. There was also asphalt that was ripped from the roads by the water, as well as finer-grained sediments that had been used to fill trenches dug for pipes and other infrastructure developments. Some of this sediment was very visible at the foot of the reservoir. In addition to material from this storm, it is most likely that materials from past storm events remain at the bottom of the reservoir, and this accumulation of material poses a serious risk to the dam infrastructure. Photo 5.0 shows limestone gravel sediment at foot of Wallings Reservoir No. 2.

Landslips, landslides and rockfalls were quite evident after the passage of Hurricane Omar (October 2008). Many of these were relatively small and minor, but some were fairly extensive, and one in particular poses serious risk to people, property and infrastructure. This land-movement incident occurred just east of the road adjacent to the Antigua Rainforest Canopy Tour (see photo 6.0 below). This enterprise was built near to the Wallings Dam No. 2, and the structures are perched on the sides of a steep ghut and ravine that empties the overspill of the dam into the Fig Tree stream.

Before the storms of the 1990s and the following years, there were early warning signs that the land was slowing slipping into the ghut and ravine. This was evident by the extensive fissures and cracks that occurred along the eastern and southeastern sides of the road. During Hurricane Luis and subsequent storms, an extensive section of the slope of this entire side of the road slipped into the ghut and ravine below. The road was subsequently re-sited further inland as a result.

Photo 5.0. Gravel sediment in Wallings Reservoir No. 2.

Photo 6.0. Landslip along Wallings Road near Rainforest Adventures.

However, it was evident during Kevel Lindsay's years at the Forestry Unit in the 1990s, when clean-up efforts in the area by the Forestry staff focused on preventing the deposit of old cars in the ghut, that the site had always been extremely vulnerable to land movement and that such episodes had occurred in the past. The slope is constantly moving in order to stabilize itself and frequent but small landslips occur.

By putting extensive structures on the slope, developers may have exacerbated the situation, increasing the weight on the slope and endangering the dam wall. It was evident just from site views during the visit that the structure may be in danger of being undermined during future landslips.

In discussions with Adriel Thibou who currently heads the Forestry Unit, it was learnt that developers had also cleared some of the vegetation in the ghut for the construction of elevated platforms and for aesthetic purposes. The removal of vegetation has also compounded the already precarious situation, leaving the soil and rocks exposed, and creating additional debris in the ghut that would create mini-dams during floods.

The result during the flashfloods from Omar was that much of the undergrowth and small trees were washed away, large boulders and other sediment material scoured the sides of the ghut and took considerable other materials downstream. The loss of biodiversity, soil and other sediment material and the damage to the area's aesthetic value is incalculable.

HUMAN-CAUSED VULNERABILITIES

The greatest threat to Wallings Forest and surrounding areas come not from natural disasters, because these play a significant role in the development and evolution of the natural landscape and biodiversity, but from human activities that cause long-term and even permanent damage to the forest ecology, landscapes, biodiversity, natural services and aesthetics and even to human ecological systems.

As discussed above, human activities exacerbate natural disaster events by creating conflicts and adding to the potential risks that the storm events pose. By leaving construction materials along the road, these eventually get dumped into the reservoir, the ghuts and ravines, and create extensive flooding problems, block roads and streams, rip up infrastructure, destroy large trees, disrupt the natural cycles and pose considerable risks to human life and property.

Much of the infrastructure recently constructed along the road in John Hughes and Wallings was wholly inadequate to accommodate the volume of water, debris and sediment that such flashfloods cause.

The construction of the Antigua Rainforest Canopy Tour enterprise is another example of how land-use management in the area is critical to the protection of the rich natural resources of Wallings and the long-term sustainability of any economic development of the area. The development was built on a site of known landslips, and developers have put their business in danger as a result.

There is also the issue of road development and infrastructure, much of which seems poorly

conceived and executed, especially to the detriment of the forest and watershed. Aside from inadequate drainage along the main road, there were two previous attempts to develop condominium and hotels right up to the summit of Signal Hill. Extensive roads we cut into the slopes to the summit, much of these cuts done without any engineering input and proper planning. Today, erosion is quite evident, and the passage of Omar has resulted in landslips and soil movement. This material is a serious threat to Antigua's already dying or disappearing reefs and other marine ecosystems, as well as to reservoirs in Body Ponds and Wallings, to homes, farms, infrastructure and human lives.

Other human activities of serious threat include fruit and crop farming along the steep banks of the Fig Tree stream, the need for proper drainage along and across roads, dumping of solid waste in ghuts, ravines and along roadways, land clearing, forest harvesting and uncontrolled access to and use of the forest.

Though much of the land within Wallings and along Fig Tree is private, it is in the best interest of the forest ecosystem and the long-term preservation of these two natural icons that private interests also operate in concert with the best interest of the public good. A number of farmers along Fig Tree have cleared steep and unstable slopes along the stream banks and have planted bananas and other crops. These farmers slash and burn the natural vegetation, which had taken considerable time to recover after many years in pasture and open scrub, and also use diesel to kill persistent tree stumps (evident by the smell of the material, the stains on the trees and the spent containers), leaving the soil below the crops completely bare and open to the elements. This practice has resulted in the loss of soil and, trees, and it scars the landscapes. Photo 7.0 below shows the result of slash and burn agriculture and the after-effects of Hurricane Omar along Fig Tree Drive.

Photo 7.0. Slash and burn agriculture and resulting erosion along Fig Tree Drive.

There is an urgent need for proper drainage along the John Hughes, Wallings and Fig Tree Drive roads. An attempt at providing drains and sidewalk near John Hughes and at Wallings was very easily washed away and undermined in the recent storm events. This points to the need for proper and more careful planning, engineering and development of infrastructure in this area.

Where the Fig Tree stream crosses the road, the water scours the road, leaves extensive debris, washes out parts of the structure and poses serious risk to pedestrians, vehicles, farmers and to livestock. There is a need to raise the road in these areas to allow flood waters to pass freely below.

In a number of areas, there continues the age-old practice of indiscriminate dumping of solid waste along the ghuts, ravines and along roads (see photo 8.0 below). Much of this is construction waste, old vehicles and parts as well as tons of household trash. Apart from the unsightly and unhealthy considerations, the garbage finds its way down into the ghut and blocks the stream, thereby creating mini-dams, which create floods and silt up the streams.

Photo 8.0. Dumping of construction and other waste into Fig Tree stream.

As with road construction and development, there seems to be no control over land clearing in the Wallings watershed. Any private land owner or government entity may clear land without proper authority and permitting. This results in the loss of forest, erosion, landscaring and disruption to natural services, including natural aesthetics.

During the field visit and in conversations with Adriel Thibou, it became clear that forest harvesting may pose a serious threat to the resource if not properly and carefully managed. Wattle cutting is a traditional forest harvesting activity at Wallings and throughout the southern hills.

In the past, forest guards would oversee such activities, report issues arising out of conflicts, and work with wattle and charcoal cutters to minimize damage to the forest. The guards were familiar with many of the harvesters, farmers and private landowners in the area. However, today, there are no forest guards. Wattle and charcoal cutting declined in the later 1980s and 1990s, but seems to have picked up in intensity. As a result, clear-cut areas can again be seen inside the forest, a practice unknown prior to the late 1990s and early 2000s. Mr. Thibou highlights this as one of the activities of major concern and points to the need to manage it.

Access to Wallings is unrestricted, and, as a result, forest use is not properly managed or supervised. Dozens of visitors use the picnic area during the weekends, and the trails are popular as well. The project team received second-hand reports, though unsubstantiated, that crowds of up to 20 persons at the picnic site are known, with reports of loud music coming from a sound system with large speakers being run from a portable generator. The site of the picnic area, which sits on top of the Wallings Dam wall, is littered with garbage and other refuse dumped down the slope and hidden by the overgrowth. An investigation showed that much of this was composed of plastic plates, utensils, beverage containers, plastic bags, paper and materials related to picnicking (see photo 9.0 below).

Photo 9.0. Picnic garbage dumped at Wallings Reservoir.

In addition, garbage collected from waste bins is allowed to sit in garbage bags for days on end before being collected for proper disposal. During this time, the bag are often ripped open by cats, dogs, rats and mongooses, and with so much garbage around, it is most likely that this has increased the number of wild cats and rats in the area.

RECOMMENDATIONS FOR MANAGEMENT OF BIOLOGICAL AND HUMAN RESOURCES

1. **Develop a plan to carry out more systematic surveys of the flora and fauna of Wallings and the surrounding area**. The Proposed Wallings Forest Reverse area is an invaluable natural asset of Antiguans and Barbuda, one that is very rich in biodiversity. While the current effort is commendable, it unfortunately has not been comprehensive enough to include the full identification and documentation of many of the species that occur within the site. Other ongoing activities suggest that there are yet new discoveries to be made at Wallings and nearby forests and woodlands. A more systematic survey would encompass a detailed and long-term effort to study species population and biology, distribution, and ecology, and would include repeat such surveys over a two-to-three-year period.

2. **Take steps to have Wallings made an IUCN Category 1b Protected Area** and managed according to internationally agreed standards for such Protected Areas.

3. **Develop a conservation plan and management strategy for wildlife within the protected area.**

4. **Develop a similar plan for plant species and critical plant habitats**. This should include coordination of efforts with the ongoing EAG Plant Project, which has achieved a considerable amount of success to date. The effort will continue in 2009 with the eventual publication of a book on the native and naturalized plants of the country.

5. **Conduct an assessment of the structural integrity of the Wallings Reservoirs**, which would include an assessment of sediment build-up and a plan to address needed repairs and conservation of the historical structures.

6. **Install an effective vehicle-and-pedestrian, security-and-safety fence along the main road and at Wallings Reservoir No. 2**. The current barrier is badly damaged and ineffective for the protection and safety of people, livestock and vehicles.

7. **Rehabilitate the historic Tom Moore's Spring** and protect the site from future abuse and damage. The Spring could be developed as one of the major attractions of the area, with proper signage that details the history and use of the site.

8. **Undertake a disaster vulnerability and risk assessment for Wallings**, to include the communities of Swetes, John Hughes, Saw Colts and Old Road. The area is prone to serious flooding, landslides and rockfalls; roads often remain impassible to traffic for considerable periods of time. This assessment should include a disaster response plan and

should highlight the areas prone to landslides and severe erosion; such areas should be carefully mapped.

9. **Rehabilitate the ghut and ravine below Wallings Reservoir No. 2**. Over the years, a number of landslides and floods, as well as the removal of vegetation by Canopy Tour, have had a disastrous effect on the biodiversity, aesthetics and structural integrity of the site.

10. **Assess the need for proper and effective road and drainage infrastructure in the Wallings area**. This assessment must include a look at improving bridges and protecting the ecological integrity of ghuts and streams in the area.

11. **Work with private landowners along Fig Tree** to reforest and rehabilitate the historic natural attraction, including restoration of the stream. As an alternative, proper trails, signage, and visitor guide materials could be developed for Fig Tree to discourage the deforestation and abuse of the area's natural aesthetics and services.

12. **Plan for the addition of a trained biologist/ecologist to Forestry staff.** This staff member would, among other things, direct the development of site management plans, environmental monitoring regimes, and research studies within the Reserve and other protected areas in the country. Because of the financial constrains that limit hiring of this and other new staff at Forestry, it is recommended that the Environment Division and Forestry Division seek assistance from external donor and international technical assistance agencies, many of which support secondment of professional personnel to overseas postings, assignment of technical volunteers overseas, and staff training programs for developing country nationals at host-country institutions.

    Several U.S. federal government agencies have international programs that are relevant, such as the U.S. Department of Agriculture's Forest Service program based in Puerto Rico—the International Institute of Tropical Forestry. The Virgin Islands National Park in St. John, U.S. Virgin Islands, a part of the U.S. National Park Service, might be able to provide on-site training in land management, establishment of monitoring systems, or carrying out long-term research studies within a protected area framework. The U.S. Peace Corps has assigned technical volunteers to assist conservation and environment programs and institutions in the Caribbean. International non-government organizations (NGOs) have also provided similar services such as: the British organization Voluntary Services Overseas (VSO), the Canadian NGO CUSO, the U.S. NGO FAVACA (Florida Association for Volunteer Action in the Caribbean and the Americas), and the U.S.-based Caribbean Volunteer Expeditions (limited to the historic preservation aspects of the Wallings protected area).

    Such overseas assistance to the Forestry unit of government should be viewed as temporary, until such time as the Forestry Division has the capacity and resources to support its own fulltime biologist/ecologist professional.

13. **Hire and train forest guards for Wallings and nearby forests**. The guards should be carefully selected based on key skills such as ability to communicate effectively with local people and trained in areas including plant species identification, agro-forestry

techniques, working with communities and conflict resolution. The funding for this may prove difficult to access, but money to pay for the guards could be linked to revenues from eco-tourism, sale of visitor guide materials and guided tours.

14. **Hunting should not be permitted in the Reserve.** There are reports that hunting of wild birds is once again on the upswing on Antigua. Additionally, the hunting laws and regulations for Antigua and Barbuda need to be revised and updated.

15. **Prevent visitors to Wallings Forest and Reservoir from driving up to the dam area.** Appropriate rules and guidelines for the use of and access to the picnic site and forest should be put in place and enforced to reduce abuse of the area's natural amenities. Designated visitor parking and facilities should be sited away from the dam and picnic area, and visitors should be encouraged to experience the natural and historic surroundings without disturbing the experience of others, for example, by setting up sound systems or holding outdoor parties and fetes in the area.

16. **Prevent garbage and solid waste disposal in the ghuts and ravines of Wallings**, especially along Fig Tree Drive. Waste disposal laws and regulations need to be enforced, and forest guards need to be periodically employed in the area to reduce this practice. It is noted that the fees imposed on users depositing waste at the public facilities may be discouraging their use and increasing the use of ghuts of ravines. It is recommended that the Central Board of Health be encouraged to identify an effective and efficient system that encourages disposal of waste at officially designated waste facilities.

17. **Carry out reforestation at Wallings**, especially for steep upland areas west of Fig Tree Hill and along the main road that are prone to erosion and landslips.

18. **Discourage the setting of fires within the Reserve.** Barbecue pits should be removed from the picnic area because of the potentially high risk for forest fires that they represent, especially during very dry periods.

19. **Discourage the burning of lemon grass** as this would eventually permit the regeneration of the forest, which, in turn, will shade out this invasive species and help to stabilize the slopes. The presence of forest guards on patrol is essential to reducing these fires.

SECTION B — CODRINGTON LAGOON NATIONAL PARK (BARBUDA)

LOCATION

Barbuda is a limestone island approximately 160 km² and located 72 km (45 miles) north of Antigua. The proposed Codrington Lagoon Protected Area (CLPA) occupies the western half of the island. The lagoon itself averages about 2.5 km wide, and runs along most of the western side of the island. It is separated from the sea by a long, narrow sand spit often only a few meters wide, with a winding entry in the north.

EXISTING CONDITIONS

Barbuda is a limestone island with the presence of dunes that make up large sand fields. The coastline has no marked indentation. In comparison with Antigua, Barbuda's topography is considerably lower in elevation and has no volcanic mountains that define the western third of Antigua. Some variations in the do exist in the topography. The highlands, located in the east, reach elevations about 45 m; it has an abrupt escarpment on the north and west, a gentle slope on the south, and sea cliffs on the east. Although the rest of the island is only a couple of meters above sea level, two topographic levels can be distinguished, each containing numerous smaller depressions. Mixed (evergreen and drought deciduous) shrubland, and dwarf shrubland are the most common vegetation communities.

Barbuda is sparsely populated with about 1,400 inhabitants, which all live in Codrington, on the edge of Codrington Lagoon. Human land use activity in the area is associated with some land clearing for fruit, vegetable, and herb crop farming.

CLIMATE AND WEATHER

Barbuda lies to the west of the northeast trade winds system and within the latitudes of tropical storms. The average annual rainfall (based on data collected from 1993 to 2007) is 1,123 mm (44.2 inches); the historical average being 889 mm (35 inches). February and March are the driest months while the wet season occurs between August and November.

Temperature varies little throughout the year, with daytime temperatures that fall within the range 25°-29° C and usually drop 6° C at night. Temperatures average an annual 21.6° C (81° F), with the winter lows averaging 24° C (76° F), and the summer high reaching the mid to upper 80s. The temperature and climate are moderated by near constant on-shore breezes. Due to year-round high temperatures and nearly constant winds, the evapo-transpiration rate is generally high.

The area also lies within the hurricane belt. These intense storms occur between June and November, with September being the month when most tropical storms or hurricanes occur. Within recent years, several hurricanes passed sufficiently close to Antigua to cause significant damages, the most recent being Hurricane Omar in October 2008.

Heavy rainfall sometimes occurs during the passage of the easterly tropical waves, which are spurned off the West African coast from June to November of each year. Occasionally, these waves intensify into tropical depressions, tropical storms, or hurricanes.

Barbuda is flat, the highest point being 45 m above sea level. Consequently, the solar intensity reaching the land surface is relatively high. This combined with the prevailing trade winds leads to quick and excessive drying. Periods of drought are therefore common. The conditions of the Lagoon Protected area are determined by these weather conditions. During years of average rainfall the salinity of the Lagoon waters (42 parts per million) is higher than oceanic waters (35 parts per million). However, in years with exceptional rain events (*e.g.*, 1999, Hurricane Lenny) the salinity of the lagoon waters fall below that of oceanic waters and remain so for months. The effects on the ecosystems of the Lagoon Park are significant.

GEOLOGY

Geologically, Barbuda differs considerably from Antigua. Located to the northeast of the active volcanic line, Barbuda has remained a low-lying island which first appeared when a broad ridge of oceanic crust had buckled upwards close enough to the sea surface for coral reef to grow on top of it. Based on fossil records, it is estimated that Barbuda first emerged some 15 to 20 million years ago.

Barbuda can be distinguished in three geological regions:

1. The Highland limestone area, mostly of hard limestone which contain sink holes and caverns;
2. The Codrington Limestone region, which contains sandy and fossiliferous sediments less crystalline than the Highland limestone;
3. The Palmetto Point area, which overlies the part of the Highlands and Codrington formations in coastal areas especially between Palmetto Point and Sandy Ground and is composed of beach sands and ridges, with shelly strata.

DRAINAGE AND WATERSHEDS

Barbuda's landscape combined with a very arid condition is the reason that no discernable drainage pattern can be found on the island. The flat nature of the topography and permeable nature of soils make surface runoff minimal and surface catchment impractical. Rainfall rapidly seeps through the limestone and collects in sink holes.

METHODOLOGY

Much of the flora and fauna of the Codrington Lagoon area are very localized and not very widely distributed on. Some species, such as most birds are transient, some staying as long as food and shelter are available and others may only pass through on their way to more productive grounds. Some are seasonal migrants while others are year-long residents.

To provide the most representative and comprehensive picture of the natural life in the Codrington area, surveys required going beyond the proposed boundaries of the Park. The challenge was to assess the communities of plants and animals and not exclude or miss those features and assets that may lie just beyond the immediate boundaries, or those that may only occupy the property during periods convenient to them, but not during our presence there.

Prior to and during the period of surveys of the site, extensive reviews of existing literature, aerial imagery and baseline information relevant to the island and surrounding area were conducted.

For terrestrial habitats and species, the team conducted assessments and searches on foot. For marine habitats and to access areas on the western side of the Lagoon, as well as areas outside of North Beach and Kid Island, the team went by boat and spent a day doing this.

Detailed survey and assessment of the coastal/marine ecosystems of the lagoon was accomplished through a series of site visits. For the marine systems, snorkel dives were also employed.

Just days before field work was to begin at Codrington, Hurricane Omar passed northwest of the northern Leeward Islands and dumped up to 152 mm (6 inches) of rain on Barbuda. This weather phenomenon presented special opportunities and challenges for the team and for the assessment of the habitats and issues relative to the Lagoon. The severe flooding swamped areas, making many parts of the island virtually inaccessible and dangerous, and provided the habitat for millions of mosquitoes to breed. These insects infested Barbuda for weeks, and created a very severe nuisance and health hazard for the field team.

However, the floods allowed team members to see a relatively rare event and allowed the researchers to assess and gage the natural disaster vulnerabilities of the affected areas, and to learn how human and natural activities may interact and combine with extreme weather events and what impact this may have on Barbuda, especially the Lagoon.

During fieldwork, the team employed the use of Garmin Etrex Venture HC, a very sensitive Geographic Positioning System (GPS) handheld device to take coordinates of species and other interests, and the also used the device to record the survey routes. The waypoints and trail outline is first loaded up onto a PC using the Garmin software. This allows the points and trail to be overlaid on Google Earth maps. These can be saved, printed and manipulated. The map of these routes is shown in Figure 5.0 below.

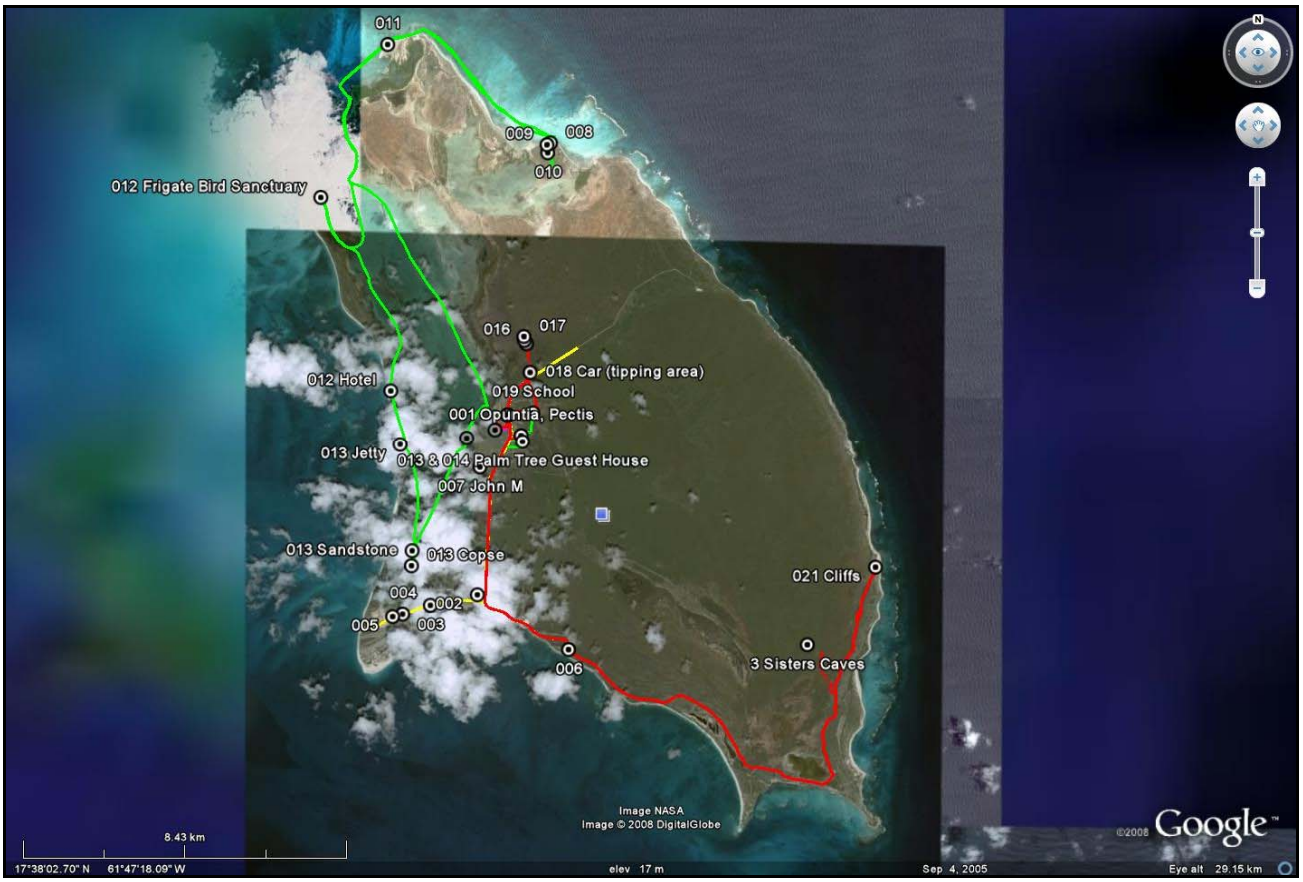

Figure 5.0. Google Earth overlay with the Garmin Etrex HC tracks and waypoints from some of the surveys on Barbuda. Photo courtesy of Chris Pratt, 2008.

The existing boundaries of the Park were the result of legislation enacted to bring the protected area into reality. The boundaries have been surveyed and gazetted. However, there are calls for other areas of the island to be included in the Park. To determine these proposed new additions to the boundaries of the Codrington Lagoon Park, the team discussed the issue of the needs of the Park with John Mussington, Calvin Gore (local Barbuda resident), Chris Pratt (Manager of the EAG Plant Project), Brian Cooper (President of the EAG), the Barbuda Council and Allen Putney (consultant for preparation of management and financial plans for the Codrington Lagoon National Park). The team also looked at recommendations from various studies and reports going back many years, examined on-the-ground circumstances and issues, considered historical, economic, cultural and long-term management factors, and overlaid this with the ecological significance and needs of the area. The proposed boundaries of the Codrington (Barbuda) Lagoon National Park are shown in Figure 6.0 below.

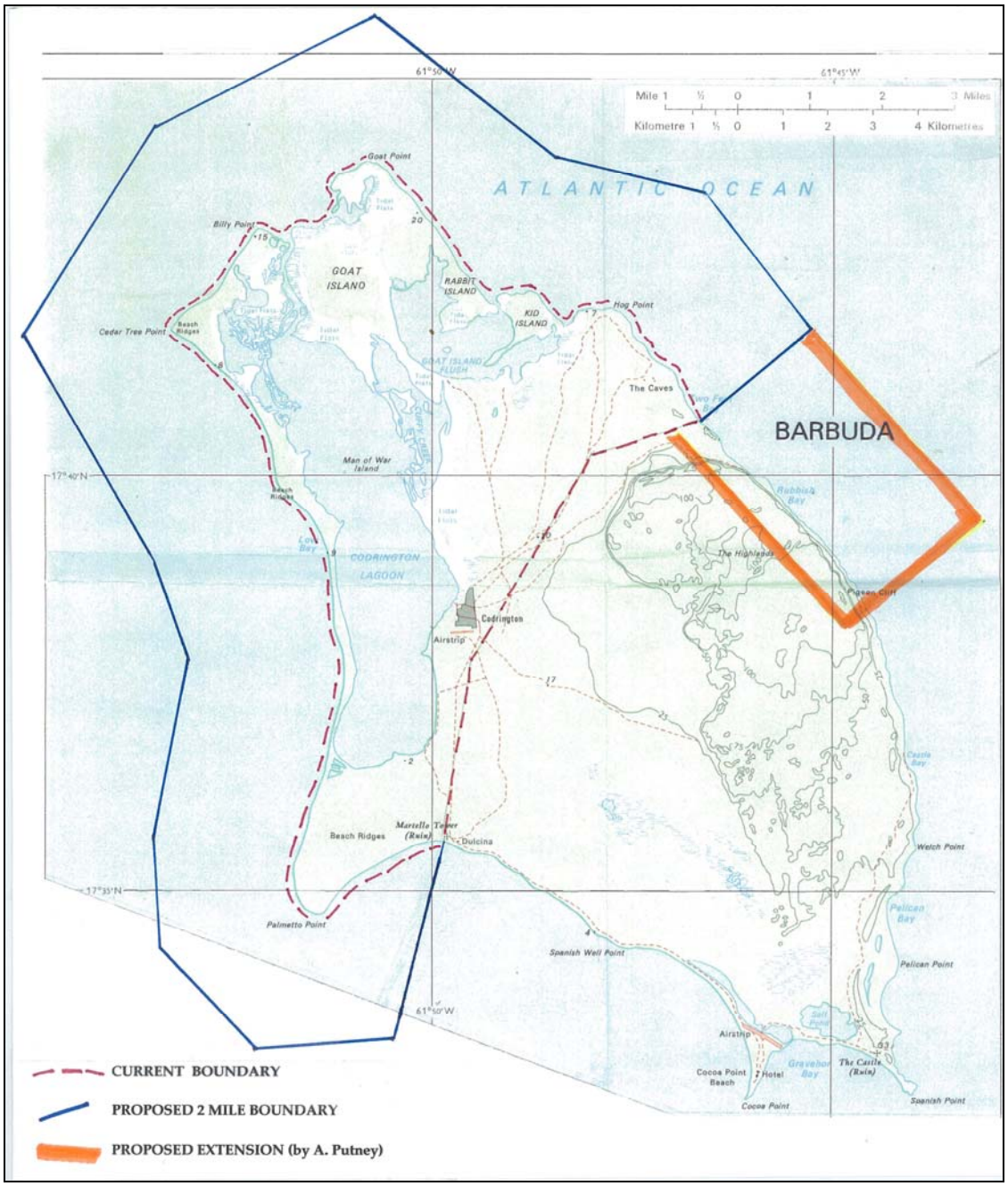

Figure 6.0. The proposed revision of the boundaries of the Codrington Lagoon National Park.

The Council and some residents, including Mr. Mussington, have proposed that the marine boundaries of the Park be extended out two miles from the shoreline. Mr. Putney has suggested that at some point the boundaries should be extended up to the Pigeon Cliffs area on the east coast. This area has considerable natural, historical, archaeological and aesthetic features, and these could prove a valuable asset in attracting foreign visitors to the Park and may help provide much needed income.

The specific methods used to survey and assess the flora, fauna and environment of Codrington Lagoon are discussed below.

Survey of the Vegetation and Plants

The current boundaries of the Park take up approximately a third or about 54 km^2 (21 sq. m) of the 161 Km^2 (62 sq. m) of Barbuda. The team made every attempt cover as much of this are as possible, conducting extensive and detailed surveys of the various habitat types and outstanding features. However, this exercise gave only a small glimpse into the true diversity of the Park. We were limited by logistical constraints, time constraints, and budgetary and human resources, since these factors only allowed for limited surveys.

Targeted surveys of specific areas were carried out with the assistance of volunteers from the EAG Plant Project, which consisted of Chris Pratt, Project Manager, Melanie Pearson and Carolyn Thomas, field assistants. John Mussington accompanied the team on each day that fieldwork was conducted.

The flora were assessed by traversing main and secondary trails, as well as by random hikes, by targeting outstanding areas and features such as grasslands, rock outcrops, and areas thought to hold significant potential to yield interesting species. The survey team also targeted specific plant communities and focused on the unique features and characteristics and species makeup. Specimens were identified on site, and where and when necessary, photos and specimens were taken for further study and identification.

The team also used aerial imagery to determine past and current land-use, vegetation types and distribution, outstanding and special features, and the location of possible historical, cultural and archaeological sites.

Survey of Terrestrial Vertebrates

The terrestrial macro vertebrate fauna of the Lagoon Protected Area is limited to native bats, the introduced Black and Norway Rats (*Rattus rattus and Rattus norvegicus)*, the House Mouse (*Mus musculus*), wild domestic cats, the introduced Fallow Deer (*Dama dama*), the Wild Boar (*Sus scrofa*), the Helmeted Guinea Hen (*Numida meleagris*), and other native birds and reptiles.

In addition to these wild species, there are also feral donkeys, horses, free-roaming and feral goats and sheep, most of which stay largely on the outskirts of the core area of the forest.

Reptiles were surveyed and assessed using a combination of incidental observations and encounters, targeted searches of habitats and specific sites/features, and from previous reports and records.

Amphibians were similarly assessed.

Mammals were not systematically surveyed, but the team relied on previous and expert knowledge of the habits and distribution the taxa on the island to make the best estimates of the distribution, abundance and habits of the species.

For birds, the survey team undertook roost surveys, the targeting of specific sites such as feeding areas, freshwater habitats, nesting sites, roosts, by incidental observations and from previous reports and records.

Survey of Terrestrial Invertebrates

No surveys of terrestrial invertebrate were carried out. This was because the time-frame for the project, the considerable demands of invertebrate surveys and species identifications, and the limited financial resources available.

However, invertebrates of special conservation concern or of particular interest were noted where possible.

Survey of Aquatic Invertebrates

No systematic survey of the freshwater invertebrates was carried out since this would be beyond the scope of the current project. Unique sink-hole systems can be found on Kid Island and at the Flashes area, and the survey team noted micro-crustaceans (and even tried to film these), but the collection, documentation and identification of invertebrates require considerable more time, expertise and resources than this project provided. There should be every effort to document the unique invertebrate fauna of the Lagoon and determine their status and long-term impacts on the ecology of the area.

Survey of Threatened, Rare and Endangered Species and Habitats

Special and particular care was taken to locate and identify any critical species of plants, animals and habitats and determine the particular threats and issues relating to their conservation status.

GENERAL OBSERVATIONS

The Codrington (Barbuda) Lagoon National Park is an expansive watery landscape that takes up more than a third of the Barbuda. It is the single most influential and imposing ecological system on Barbuda, and has helped to shape the landscape and culture of the Barbuda we see today.

The Lagoon, comprising wetland, seagrass, algae and other coastal marine ecosystems, is perhaps the most significant feature of the island, occupying about a third of the total land mass. It is entirely enclosed except for a narrow channel at the northern end which links it to the Caribbean Sea.

Historically, the lagoon plays a central role in determining the social organization of Barbuda's society. The resources of the lagoon provided livelihood opportunities, which include various fishing activities, subsistence agriculture, and charcoal burning. To a large extent, this role continues today with the addition of tourism related activities. Tours to the frigate bird sanctuary

is a case in point. In addition, the provision of various kinds of seafood for local consumption makes the lagoon a critical factor in food security for the community.

From a biological perspective, the lagoon is an estuarine system, which itself is a conglomeration of interrelated sub-systems. Some of the more prominent of these include: mangrove wetlands, submerged seagrass beds, algal mats, tidal mud flats (flashes) and coral reefs. Each subsystem is important in its own right, but they also interact closely, together forming the lagoon ecosystem with its unique set of qualities. It is these qualities which are responsible for the highly diverse and productive marine environment.

The mangrove wetlands that fringe most of the lagoon's perimeter are a critical subsystem. Most of these wetlands remain intact today, and it is in their shallow, nutrient-rich waters that the breeding and nursery areas for much of the marine and terrestrial wildlife are to be found. This includes the economically important species of fish and lobsters.

The lagoon waters and those of the wetland areas show a high degree of variability in physical factors such as temperature and salinity, both in time and space. In spite of this, a balance is achieved with the result that many different types of habitats are created and these support a highly diverse set of organisms. Unfortunately, this balance, having both physical and biological components, is delicate and complex. It is therefore subject to natural and man-induced disturbances. Furthermore, since all the subsystems involved in maintaining this balance are closely interrelated, a disturbance in one can ultimately have impacts on other subsystems and the entire lagoon ecosystem. Such impacts may vary in severity from mild to completely disastrous.

On the shore of the Lagoon, just mid-way on the eastern shore, sits Codrington Village, the only settlement of the island. About 1,400 people reside on the island, a population that has remained relatively stable over the last 20-30 years.

The village is a jigsaw puzzle of the modern, the old and the uniquely Barbudan, with old houses and structures bleached and washed by the Barbuda elements, and new homes sitting grand in their modern surroundings on the outskirts of the Village.

Vehicles and livestock find common ground on the roads, especially late at night. Free-roaming livestock compete with cars for space on the roads, and at night, as the heat dissipates from the soil, the animals find comfort on the warm asphalt.

A walk through the bush around the Village will reveal the old crumbling stone-walled livestock enclosures that once kept domestic farm animals from reverting to the thick bush of the interior. The lands around the Village were once used for crop and livestock farming, but in the 1960s and 70s, residents gradually dismantled a unique system of communal livestock corrals, the result of which was devastating to the unique ecosystems of the island.

North of Codrington, the sparsely scattered homes give way to a few crop farms, then to scrub and semi-evergreen woodlands. Here among the mangroves are a sad sign of modern excesses as a new solid waste dump has now appeared and threatens not only the biodiversity and landscape of the island, but also the health and wellbeing of the residents.

As one moves toward the north, the rim of the distant ancient sea cliffs appears when approaching Two Foot Bay with its caves, forests, camping grounds, Amerindian petroglyphs (so far, the only ones known in the state of Antigua and Barbuda), and ruins.

To the west of this area, the flat plains give way to open scrub and sparse vegetation, then to limestone pavement as one approaches the flashes of Goat Island and Cuff Creek. Here, shallow solution holes pock mark the landscape, and when peering into the saline and brackish pools, fish can be seen darting about among strange crustaceans, the identity of which remains unknown to this day.

Scattered between these plains and the mangrove edge are unique grassland and forb communities, much of which are severely impacted by feral livestock, pushing species to the brink of extinction. Here amongst the low shrubs there is a unique plant, the identity of which has puzzled many for over twenty years. During this survey, samples of this strange flood plain Malvaceae were collected and will be sent to the herbarium at the University of the West Indies at St. Augustine Trinidad for further study.

North of Codrington, the secondary woodlands stretch west to Martello Tower and then east along the Coco Point Road. Along the sides of the roads, pools of standing water harbor millions of mosquitoes, and, during the day, they blanket the plants in huge swarms.

Some of this is natural, but much of it is attributed to the fact that human land-use practices have been disrupting the sheet flow of natural runoff, and as a result, the water does not drain as it once did, but stands in stagnant pools where pests may breed.

At the Tower, the woodlands give way to the scrub, evergreen woodlands and the marshes of Palmetto Point. The once extensive stretches of Coco Plums have now been obliterated by a huge sand pit as a result of sand mining. Here, unique Caribbean plant communities have been sacrificed to the whims of the mining blades. These communities helped to define and distinguish Barbuda, but they are no more.

Across the Lagoon on the southwestern corner, the second largest Magnificent Frigatebird colony in the world hosts about 5,000 nesting pairs. Males circle above the mangroves, wooing females with their brilliant red throat-pouches, while visitors sit in tour boats awed by the spectacle before them.

At dusk, as the comfort of the highlands call, thousands of pigeons, doves and ducks swarm across the skies and head to their roosting sites in the interior. These are some of the last examples of the vast swarms of Caribbean avifauna left any where in the region, and sadly, even this is disappearing.

Barbuda is one of the last frontiers of the Caribbean of old—the hardscrabble place where nature abounded, time seemed to move a bit slower, and the people and the land were intertwined. The island offers the visitor and its residents an opportunity to bridge the old and the new; it demonstrates how best to balance these two for the benefit of Barbudans and its biodiversity.

OBSERVATIONS: THE FLORA

Flora

The landscapes within the boundaries and adjacent areas of the Codrington (Lagoon) National Park are a dynamic and complex assemblage of pieces that fit together like a puzzle. Though the team covered considerable ground, much of the Park area remains unstudied and un-assessed because the area is so large, so dynamic and even small parcels of land may potentially hold great new discoveries.

Plant species compositions were assessed during both fieldwork sessions (October 2008). A total of 124 species of plants belonging to 48 different families were recorded. **Appendix IV** provides a listing of the species recorded.

Out of the total number of species recorded, 110 (88%) species are considered native. The remaining 14 (13%) of species are introduced (or exotics). Table 2.0 below provides a further summary of the break down of the number of species tallied.

Table 2.0. Physiognomic plant categories at Codrington.

Category	Numbers	Percentage
Herbs	15	12
Shrubs	43	35
Vines	9	7
Trees	57	46
Total	**124**	**100**

One of the species that has stumped local experts and the Plant Project survey team is the new Malvaceae from north of Codrington Village, from the area near Freshwater Pond. Project team members Mussington and Lindsay first observed the species back in the mid-1990s.

The landscape where the species is found consists of low evergreen scrub and woodland interspersed by open ground. This woodland borders the edge of the mangroves and floods during the rains. Though very little is known about the species, it is believe to be native and possibly unique to Barbuda. It is only found in this area in all of Barbuda.

The Malvaceae remains unidentified, but from its growth habit and from the obvious signs of overgrazing in the area, this suggests that the feral livestock are having a major impact on the landscape, and hence much of what we see has obviously been severely retarded and restricted by these animals, which are alien to this ecosystem. As the plants are continuously browsed and eaten back, this severely limits the ecosystem and the species. Photo 10.0 below is of the new Malvaceae from Barbuda.

Photo 10.0. New Malvaceae from Freshwater Pond area, Barbuda.

Vegetation Communities

There are 18 terrestrial vegetation community types (also referred to as alliances) and seven related associations found within the Codrington Lagoon Park area.

Much of the terrestrial vegetation around Codrington Village and heavily disturbed sites such as the sand mined areas at Palmetto Point are largely secondary. A summary of the vegetation community types are described below and their distribution illustrated in Figure 7.0.

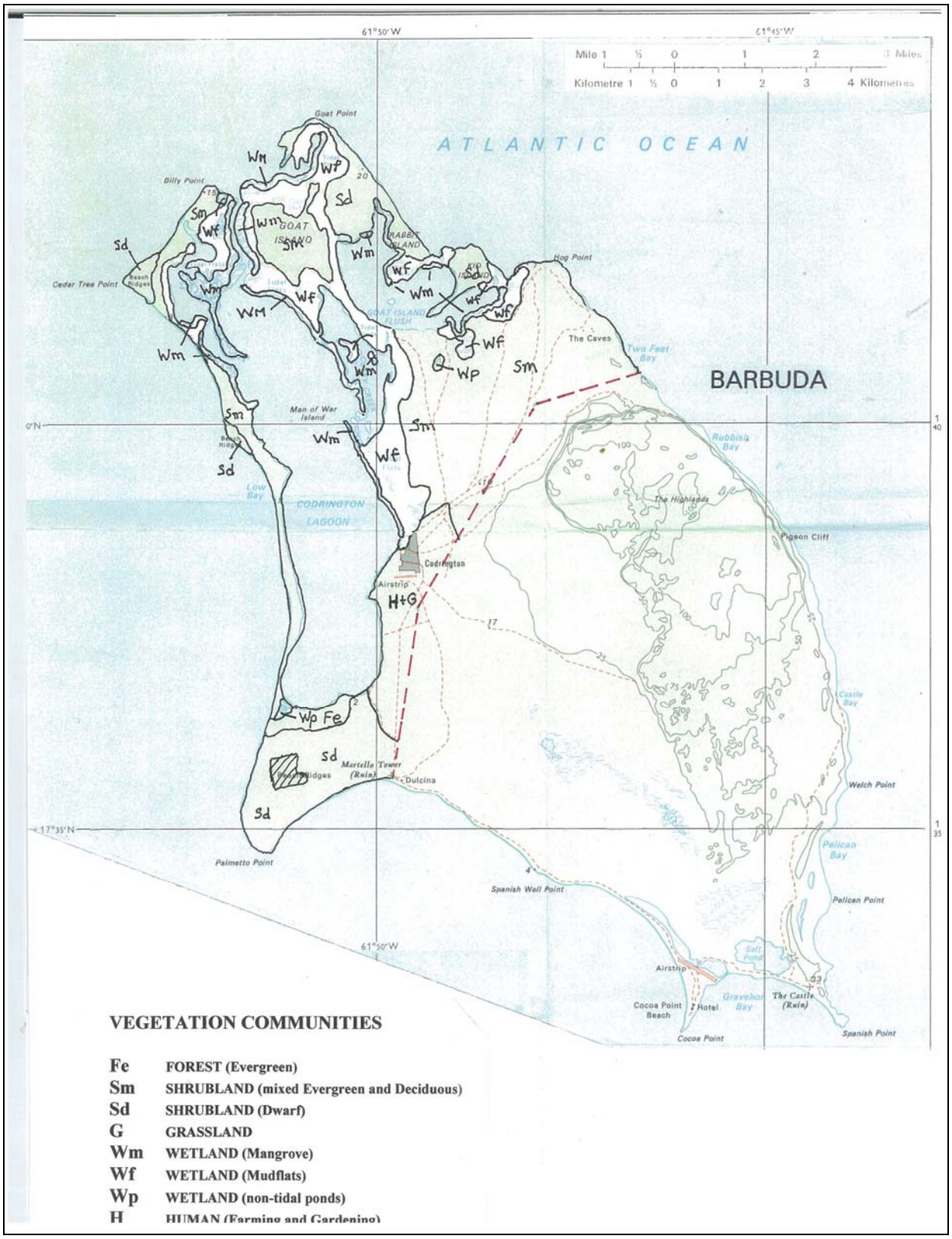

Figure 7.0. Vegetation communities of Codrington Lagoon Park, aggregated for mapping purposes.

Terrestrial Plant and Lagoon Marine Communities

The plant and lagoon coastal aggregate communities of the Codrington Lagoon area are divided into two sections: terrestrial communities and marine communities. The terrestrial communities are dealt with first.

TERRESTRIAL PLANT COMMUNITIES

Broad-leaved Evergreen Sclerophyllous Closed Tree Canopy Communities

Coccoloba uvifera-Canella winterana Lowland or Subtropical Broad-leaved Evergreen Sclerophyllous Closed Tree Canopy Alliance

This two-storied forest, which may be from 5-15 meters in height, is found in the depressions between sand dunes at Palmetto Point. Several species of trees and shrubs, including *Byrsonima lucida*, *Coccoloba uvifera* and *Trinax morrisii* show their most robust growth here because of the increased levels of moisture that collects here.

This community was the tallest, most diverse and luxuriant found at Palmetto Point. However, sand mining has obliterated between 90 and 99% of the community in this area. Only a small sliver of this community remains, and it is located close to the shore of the Lagoon.

In Lindsay and Horwith's 1997 work on vegetation classification, they indicated that this community is also found along the sand spit of the Lagoon and on the east coast, but the communities in these other locations is believed to be somewhat different.

Mixed Evergreen Drought Deciduous Shrubland Communities

Acacia spp.-Caesalpinia coriaria-Haematoxylon campechianum-Leucaena leucocephala

Tropical or Subtropical Mixed Evergreen-Drought Deciduous Shrubland Alliance

This community varies widely due to the fact that in some parts, it is found close to the mangroves at the edge of the Lagoon and here, soils are thin and saline. Where this occurs, the trees are more stunted and the vegetation thicker, but with bare patches of earth and flashes interspersed.

These bare patches may in fact be a natural occurrence and represent natural "grassy" glades, and can be considered savannas. However, this is only speculation at this point, and it needs much further study.

As indicated above, Kevel Lindsay and John Mussington, members of the current project team, discovered what seems to be a unique Malvaceae that is found only in this area of Barbuda. This is discussed further in the section under **Species of Special Conservation Concern**.

The further one moves away from the Lagoon the community is thicker and takes on the form of taller woodland, with a greater percentage of the trees being introduced exotics and greater stand density of *H. campechianum*.

The community seems heavily influenced by feral livestock, especially horses and donkeys.

Found in areas east, south and north of Codrington Village.

At Palmetto Point, due to sand mining, another community type or Association has invaded the areas once occupied by dunes. This is an Acacia spp. association, largely dominated by *Acacia macracantha*, but with other native species, including *Pluchea carolinensis*, which may form extensive stands. Some of these areas become flooded during heavy rains, but are largely dry for most of the year.

Dwarf Shrubland Communities

***Coccoloba* spp.*-Erithalis fruticosa* Tropical or Subtropical Mixed Evergreen-Drought Deciduous Dwarf-Shrubland Alliance**

This community alliance has two associations in the Codrington area. No particular species define the Alliance well, but either Coccoloba or Erithalis will be found in each. The community shows stunted trees and shrubs growing on the crest and slopes of dunes, and sometimes on flat sandy soils. The plants are widely spaced, with exposed sand between individuals trees or/or small vegetation clumps.

Many of the trees and shrubs are covered in the parasitic vine *Cassytha filiformis*.

The communities once integrated into the above community where the dunes were older and conditions in the sheltered depressions between dunes resulted in wetter environments.

The two associations found with the Codrington Lagoon area are:

Chrysobalanus icaco-Thrinax morrisii Association. Found at Palmetto Point, and the *Tabebuia heterophylla-Dodonaea viscosa* Association found at Cedar Tree Point and Low Bay Point.

Much of the very unique association at Palmetto Point has been bulldozed and completely destroyed as a result of sand mining.

***Pilosocereus royeni-Agave karatto* Facultatively Deciduous Extremely Xeromorphic Tropical or Subtropical Shrubland Alliance**

This community occurs in areas of low water availability (low rainfall, combined with poor thin soils and drying winds), which restricts the height of the woody species. This occurs near coast in the Codrington Lagoon Park area, including Rabbit Island.

Melocactus intortus-Jacquinia arborea Tropical or Subtropical Succulent-Facultatively Drought-Deciduous Dwarf Shrubland Alliance

This community consists of scattered and short shrubs and trees (Photo 11.0 below). There is considerable bare ground and weathered "limestone" pavement, sometimes, with a thin covering of soil that is often inadequate for normal root development. This community is found at Rabbit and Kid Island.

Photo 11.0. Cacti and shrub community on Kid Island, Barbuda.

Ipomoea pes-caprae-Canavalia rosea Dunes with Sparse Herbaceous Vegetation Alliance

Common along as an interface between the dunes and the bare sandy substrate of beaches, from just above the highwater mark landwards. There are low-lying grasses, sedges, vines and herbs, with some stunted woody species.

Found at Palmetto point and along beaches throughtout the Codrington Lagoon area.

Aquatic Plant Communities

Conocarpus erectus-Sedge Seasonally/Temporarily Flooded Tropical or Subtropical Broad-leaved Evergreen Open Tree Canopy Alliance

This community consists largely of pure stands of Conorcapus erectus and dense cover of sedges, one species of which may reach up to 4 meters in height. It is characterized by being dry most of the year, with seasonal flooding and occuring in depressions between dunes.

Vaguely reminiscent of saw-grass communities of Florida and the Bahamas. This community is unique to Barbuda in the Lesser Antilles, but has been mostly destroyed by sandmining.

This community is known only from Palmetto Point, in old, weathered dunes and near the tip or elbow of the Point.

Grassland Communities

Medium-Tall Tropical or Subtropical Grassland with Broad-leaved Evergreen Trees Alliance

This community largely consists of grasses with some forbs, with scattered trees and shrubs, providing a cover of generally 10-30%. This community is wholly artificial in nature and is maintained by the hundreds of feral and roaming livestock that populate the lands around Codrington Village.

Found around the Village, and in areas east, south, and north of the area. It may become flooded after heavy rains.

Non-vegetated Communities

Caves and Solution Holes

These are solution holes, which are either non-aquatic or aquatic. Many of these systems a filled with fine sediment but are always damp since the sit right above the water table. Some systems have water throughout the year and are mostly fresh to slightly brackish.

The limited sunlight, high humidity and water collecting in pools result in the presence of mosses, algae and lichens.

Found at Goat Island and along the bare limestone pavements east of Cuffy Creek and Goat Island Flash.

Freshwater Ponds and Mudflats

Non-Tidal Tropical or Subtropical Hydromorphic Rooted Vegetation Alliance

This community consists of temporary or permanent ponds, found largely around Codrington Village. Algae, the aquatic fern *Marsilea vestita*, grasses, sedges and other aquatic species, dominate it.

The construction of roads and infrastructure around the Village has disrupted the natural sheet flow of water. The roads and other structure cause a dam effect, and water puddles, forming temporary pools, ponds and flashes. These areas are often the breeding ground for millions of mosquitoes during the rainy season.

Human-Associated Communities

Fruit-tree and Crop Farming

This community is directly associated with daily human activities. The land is cleared and planted with a number of tree fruit crops, and may be mixed with vegetable and herb crop farming. In Barbuda, slash and burn is still practiced.

Fruit tree farming is very limited in Barbuda, but species and varieties may include citrus, Mango, Banana varieties, *Annona* spp., and a variety of vegetable crops and root crops, as well as herbs for seasoning and medicinal purposes.

Gardens

This community is associated with homes and is planted mainly for its aesthetic values. It may consist of showy herbs, shrubs, small or large trees, including fruit trees and some vegetable, root and herbal crops.

This community is found around most homes at Codrington Village.

LAGOON MARINE ECOSYSTEMS

Wetland Mangrove Ecosystems

The wetland mangrove ecosystem found in the Lagoon protected area can be grouped into 4 distinct types: Fringing Mangroves, Palisadoes, Flashes, and the Freshwater Ponds of Palmetto Point, Rabbit Island and Goat Island. The Fringing mangrove system can be further differentiated into two variations: the mangrove fringe system of the sand bar and that of the shores of the mainland.

Fringing Mangrove Ecosystem

This ecosystem comprises the transition zone where the land gives way to the waters of the lagoon. The island is flat and prone to flooding from rainfall runoff during the wet season (September to December) or tidal inundation during the high tides. The vegetation found in this zone is adapted to survive in waterlogged conditions where the soils have low oxygen levels, and/or high salinity. Mangrove plants are specially adapted to grow, and out-compete other plants in such conditions. The predominant species include the Red (*Rhizophora mangle*), Black (*Avicennia nitida*), and White (*Laguncularia racemosa*) mangroves and Buttonwood (*Conocarpus erectus*). The distribution of these species follows a characteristic pattern which is determined by environmental factors including salinity and substrate oxygen levels. Salinity is indirectly affected by rainfall (quantity of freshwater runoff that enters the system). Each of these four mangrove species utilizes different competitive strategies. It is their relative success that determines each species specific location. Red mangroves occupy the zone closest to the lagoon waters, often extending into the water with their prop roots. Black and White mangroves occupy areas closest to dry land with Black mangroves dominating in areas where salinities are highest (up to 70 parts per thousand in some areas). Buttonwoods are the least competitive and occupy those areas where the transition to strictly terrestrial species is occurring. Buttonwood may also be the dominant species in freshwater wetland ecosystems

On the sand bar, which forms the seaward shore of the lagoon, the fringing mangrove ecosystem differs from that found on the mainland shores. Here, the sand dunes associated with the beach create deeper soil that supports a different mix of plants. Mangroves dominate the areas closer to the water where high salt, low soil oxygen conditions are prevalent. Unlike the mainland shores, the freshwater runoff from rains is significantly lower. These factors determine the differences in the vegetation mix encountered.

The Flashes

This ecosystem is comprised of tidal mudflats where land water runoff accumulates after heavy rains. These areas are also flooded by high tides. Being prone to drying out during the dry months of the year, especially during the spring tides of January to April conditions can become hyper saline (exceeding 70 parts per thousand) and temperatures can exceed 40 degrees Celsius.

Black and White mangroves are the dominant plant species occupying this ecosystem. During the rainy season the mud bottom is covered in Shoal Grass (*Diplanthera wrightii*). Mangrove trees are often stunted due to the harsh conditions. Wildlife includes fiddler crabs, birds and

some fish. The flashes are critical habitats for ducks and other birdlife. The West Indian Whistling Duck and Barbuda Warbler are cases in point.

The Palisadoes

Palisadoes is the name given to mangroves that occur in virtually pure stands surrounded by water. Typically, Red mangroves are the dominant species since they out-compete the other species in those specific conditions that exist in the areas where the Palisadoes occur. This occurs at Cuffy Creek, the entrance to Goat Island Flash and Filimingo, and some small stands are found on the mainland shore of the southeastern section of the lagoon adjacent to the coconut plantation.

The Palisadoes wetland ecosystem is particularly productive, and they support the larger proportion of habitats important to commercially important species (lobster, fish, Frigate Birds) as well as species of critical biodiversity importance, such as the endangered West Indian Whistling Duck, White Crown Pigeon and Brown Pelican. The Frigate Bird sanctuary is located in this type of wetland system. The Palisadoes also include those aesthetically pleasing sections of the lagoon that have the highest potential for sustainable tourism use.

Fresh Water Mangrove Pond Ecosystem

This wetland ecosystem type is significant because it is based entirely on fresh water. The dominant mangrove species, which are found in the wetland systems described previously, are the ones present in the Freshwater Pond Ecosystem. Examples of this can be found on the southern sections of Palmetto Point, which have not been mined for sand, on Rabbit Island and Horse Pond in the vicinity of Goat Island. Details of the species classification of this system are dealt with in the terrestrial sections of this report.

Marine Ecosystems

Linked to the wetland ecosystems, by water, the marine ecosystems form their complement and together they are responsible for the integrity of the lagoon and its value in supporting biodiversity. The marine ecosystems include seagrass and algae beds, shoals consisting of coral, algae and seagrass; the sandy beach; and the open waters of the lagoon.

Seagrass and Algae Beds

Turtle grass (*Thalassia testudinum*) and Shoal grass (*Diplanthera wrightii*) can be found throughout the waters of the lagoon and in the wetland systems. The species can occur as thick beds of individual species. For example, many sheltered areas within the waters of the Palisadoes wetland system support pure stands of Turtle grass. In the shallow areas bordering the fringing mangroves of the mainland shores of the lagoon beds of predominantly manatee grass are common. However, both species are more commonly found growing together with algae and other benthic marine organisms. The species list in Table 3.0 shows a typical mix of organisms observed as part of the seagrass-algae-coral community.

Seagrass can be found in all areas of the lagoon however there are areas where extensive

populations exist. In such cases the resulting seagrass community supports important biodiversity hotspots. Examples of such areas can be found in Benny Bottom, Filimingo, Goat Island Flash, Cuffy Creek, The Cove and Man-o-War Island. Extensive seagrass beds occur around the entrance to the lagoon, along North Beach and along the nearshore areas bordering the sand bar extending from the north (Billy Point and Cedar Tree Point) and south to Palmetto Point. Seagrass beds are also significant components of the Shoals described in the next section.

Hard and soft corals are rare in the lagoon marine ecosystem. Only three species of stony corals are found: Finger, Starlet and Rose corals. The Starlet and Rose corals are found throughout the lagoon but Finger coral populations are restricted to those areas exposed to the prevailing winds and where there is sufficient water movement conducive to the growth of this species. Thus the shoals and western shores of the lagoon are the areas where Finger Coral is most commonly found.

Shoals

These are shallow areas of the lagoon, often exposed to prevailing winds and wave action and consist of marine communities with seagrass, algae, and coral. Shoals support some of the most productive communities of the lagoon and are particularly important due to the habitat and nursery functions they provide for commercially important marine species. In the lagoon the main shoals are found at Long Bank, Home Bank, Lobster Point, Man-O-War Island and South Bank in the southern sections of the Lagoon.

Table 3.0. Common marine species of the Codrington Lagoon.

The DAFOR is a subjective rating that provides an indication of whether an organism is:
***D**ominant, **A**bundant, **F**requent, **O**ccasional or **R**are in a particular ecosystem.*

Common Name	Scientific Name	DAFOR
Fish		**23 Species**
Flagfin Mojarra	*Eucinostomus melanopterus*	F
Mullet	*Mugil cephalus*	O
Ten Pounder	*Albula vulpes*	O
Tarpon	*Megalops atlanticus*	O
Porgy	*Calamus* sp.	R
Common Snook	*Centropomus undecimalis*	O
Forty (Jack)	*Caranx* sp.	O
Goatfish	*Mulloidicthys martinicus*	R
Damselfish	*Stegastes* sp.	R
Nurse Shark	*Ginglymostoma cirratum*	O
Silk Shark	*Carcharhinus* sp.	R
Spotted Moray	*Gymnothorax moringa*	R
Nassau Grouper	*Epinephelus striatus*	R
Bridled Goby	*Coryphopterus glaucofraenum*	O
Yellowfin Mojarra	*Gerres cinereus*	F
Bluestripe Grunt	*Haemulon sciurus*	O
Gray Snapper	*Lutjanus griseus*	F
Schoolmaster snapper	*Lutjanus apodus*	O
Great Barracuda	*Sphyraena barracuda*	O
Doctorfish	*Acanthurus chirurgus*	R
Sprat	Not identified	O
Hedgehog	*Diodon hystrix*	R
Lizardfish	*Synodus* sp.	R
Seagrass		**2 Species**
Turtle grass	*Thalassia testudinum*	D
Shoal Grass	*Diplanthera wrightii*	D
Crustaceans		**6 Species**
Spiny Lobster	*Panulirus argus*	O
Blue Crab	*Callinectes sapidus*	O
Shrimp	*Penaeus* sp.	O
Touloloo (Fiddler Crab)	*Uca* sp.	F
Hairy Land Crab	*Ucides cordatus*	R

Common Name	Scientific Name	DAFOR
Land Crab	*Cardisoma guanhumi*	O
Cnidarians		**3 species**
Upsidedown Jellyfish	*Cassiopea xamachana*	F
Turtle Grass Anemone	*Viatrix globulifera*	R
Banded Anemone	Not identified: order Actinaria	F
Feather Duster Worms		**2 species**
Banded	Not identified: family Serpulidae	A
Small calcareous	Not identified: family Serpulidae	F
Tunicates		**1 specie**
Flat tunicate	*Botryllus planus*	O
Sponges		**7 species**
Chicken Liver sponge	*Chondrilla nucula*	O
Heavenly sponge	*Dysidea etherea*	O
Loggerhead sponge	*Spheciospongia vesparium*	O
Stinker sponge	*Ircinia* sp	F
Black sponge	Not identified: family spongiidae	F
Black-Ball sponge	Not identified: class Demospongiae	O
Grey-Ball sponge	Not identified	O
Scleractinian (stony) corals		**3 species**
Starlet coral	*Siderastrea radians*	R
Rose coral	*Maniciana areolata*	R
Finger coral	*Porites* sp.	O
Mollusks		**15 species**
Atlantic Modulus	*Modulus modulus*	A
Common Dove Snail	*Columbella mercatoria*	O
False Cerith	*Batillaria minima*	A
Netted Olive	*Oliva reticularis*	F
Dwarf Olive	*Olivella* sp.	R
Striated Bulla	*Bulla striata*	R
Apple Murex	*Murex pomum*	O
West Indian Murex	*Murex brevifrons*	O
Keyhole Limpet	*Diodora cayenensis*	R
Atlantic Pearl oyster	*Pinctada radiate*	O
Mangrove Oyster	*Isognomon alatus*	F
Stocky Cerith	*Cerithium litteratum*	A
Cantharus	*Cantharus* sp.	O

Common Name	Scientific Name	DAFOR
Common Egg Cockle	*Laevicardium laevigatum*	R
Queen Conch	*Strombus gigas*	
Green Algae		**12 Species**
Mermaid's Wineglass	*Acetabularia calyculus*	A
Sea Lettuce	*Ulva lactuca*	O
Green moss	*Chaetomorpha linum*	F
Green moss	*Chaetomorpha crassa*	F
Caulerpa	*Caulerpa prolifera*	O
Caulerpa	*Caulerpa verticillata*	O
Caulerpa	*Caulerpa sertularioides*	O
Cat tail algae	*Bathophora oerstedii*	D
Mermaid's Shaving Brush	*Penicillus capitatus*	O
Halimeda	*Halimeda incrassata*	F
Halimeda	*Halimeda monile*	F
Mermaid's fan	*Udotea flabellum*	O
Brown Algae		**1 specie**
Dictyota	*Dictyota linearis*	
Red Algae		**4 species**
Acanthophora	*Acanthophora spicifera*	R
Laurencia	*Laurencia poitei*	O
Digenia	*Digenia simplex*	O
Red alga	*Ceramium nitens*	O

The Sandy Beach Ecosystem

The sandy beach is one of the more visible features of the Codrington Lagoon but is often taken for granted. It is in fact one of the critical ecosystems since it functions as a barrier and transition zone between the oceanic waters and those of the lagoon. The beach associated with the Protected Area extends from Fishing Creek on the north east coast to Palmetto Point and River beach on the south coast. The beach ecosystem also supports the other marine systems and is linked to them through the water.

On coral islands like Barbuda, sand is formed from the limestone skeletons of corals, marine calcareous algae and other marine organisms. The material is often light colored and appears white in bright sunlight. Barbuda's white sandy beaches are accented by the occurrence of "pink" sand which is formed from the remains of tiny bivalves of the genera: *Tellina* and *Strigilla*.

Lagoon and Nearshore Waters

Water is the medium which link all the ecosystems of the Lagoon Protected Area. It is also critical for the survival of living organisms. Since is totally enclosed except for the 150 m wide entrance to the north the waters of the lagoon differ from oceanic water in a number of parameters (salinity, dissolved oxygen, temperature and limiting nutrients). For example, the salinity of lagoon water is higher at 42 parts per thousand than ocean water at 35 parts per thousand. This is the case most of the time but the situation may reverse during catastrophic rain events such as during a hurricane. Then, the lagoon waters may have lower salinity. Confirmation of this was demonstrated in 2000 when water quality baseline data was obtained during a survey of the lagoon system (Jarecki, L. 2000). The same is true for Goat Island Flash.

Status of Wetland Mangrove Systems

The wetland ecosystems of the Lagoon Protected Area continue to exist in a relatively healthy state. There has not been a predominance of development activities which results in the wholesale clearing of wetland. Stresses do exist however. The fringing mangroves of the mainland shores are still being used as dump sites for solid waste as well as sewage pumped from septic tanks. The APUA power station located on the shoreline is a constant source of waste oil pollution as well as from fuel leakage. This is particularly evident after heavy rains.

Most of the freshwater wetland systems of Palmetto Point have been lost to the destructive effects of sand mining. Unmanaged tourism development on the sand bar is threatening wetland systems through land clearing. Table 4.0 presents a list of common species of plants found in the wetland areas.

Table 4.0. Land plant species list associated with wetlands at Codrington.

Common Name	Scientific Name	Location
Red Mangrove	*Rhizophora mangle*	Fringing shoreline
White Mangrove	*Laguncularia racemosa*	Tidal areas and mudflats
Black Mangrove	*Avicennia nitida*	Tidal areas and mudflats
Buttonwood	*Conocarpus erectus*	Occasionally wet areas
Poison Mangrove	*Bontia daphnoides*	Dry land
Cattle Tongue		Dry land
Marsh fleabane	*Pluchea odorata*	Dry land
Glasswort	*Salicornia bigelovii*	Tidal areas and shoals in Filimingo (bird sanctuary)
Saltwort	*Batis maritima*	Tidal areas
Sea Purslane	*Sesuvium portulacastrum*	Dry land
Seaside Marigold	*Borrichia arborescens* *B. frutescens*	Tidal areas and rocky shores
Salt grass	*Distichlis spicata*	Dry land and tidal areas
Salt grass	*Sporobolus virginicus*	Dry land and tidal areas
Spike Rush	*Fimbristylis cymosa*	Dry land and tidal areas
Coastal sedge	*Cyperus planifolius*	Dry land and tidal areas
Seaside Heliotrope	*Heliotropium curassavicum*	Dry land and tidal areas

Status of the Marine Ecosystems

All the marine ecosystems of the Lagoon Protected Area can be classified as being in a relatively healthy state. Sections of the beach which forms the sand bar on the western boundary may still be classified as pristine. However, those sections around Palmetto Point, Louis Beach Barbuda Outback Tours picnic area, Palm Beach (around Lighthouse Hotel) can no longer justify that classification. The presence of built developments, some clearly inappropriate for the site, have reduced the aesthetics of those areas. Unfortunately, the development activities have compromised the natural coastal processes which work to protect the coastline. Table 5.0 below lists areas of special value and provides an overview of special characteristics.

Water quality is increasingly being affected by those activities outlined in the section on wetland ecosystems. Unmanaged fishing activity is leading to overfishing in the commercially important fisheries. The decrease in the numbers of these species upset the balance of the overall system.

Table 5.0. Marine ecosystem areas of special value, Codrington Lagoon.

Site	Special Characteristics
Cuffy Creek	Palisadoes type wetland mangroves with channels, calm waters, seagrass communities. Area where lobster pelagic larvae first settle out into their adult forms before migrating into the lagoon.
Sand Bar Beaches	Examples of pristine beaches, pink sand, sea turtle nesting, excellent wilderness value.
Suking Hole	Areas of upwelling water which may be freshwater at certain times. Research and historic value.
Sand Stone	The last remaining sand dune type ecosystem in it intact state. Includes freshwater wetlands, sedge ponds. Nesting area for West Indian Whistling Duck, Barbuda Warbler. Excellent wilderness and research value.
Stinking Point	Located directly downwind (prevailing winds) from the edge of the Highlands. This creates a wind tunnel effect. Transition zone: calm sheltered waters to wind blown, rough waters. Frigate bird sanctuary located downwind and is probably one of the reasons for them to choose that site.
Rabbit Island	Outstanding wilderness value. Proximity to marine areas with coral and seagrass communities with excellent quality.
Filimingo	Site of the Frigate Bird sanctuary. The sheltered waters are among the most productive in the lagoon and supports large quantities of fish.
Fishing Creek	Located a short distance offshore from Rabbit Island. Hog Hole is a break through the barrier reef at this site and there is a constant stream of oceanic waters flowing into the sheltered lagoon. Water quality here is excellent and the coral reef diversity is higher here than most other nearshore locations around Barbuda.
The Beaches	Located on the sand bar forming the oceanic boundary of the Protected Area. These beaches have excellent scenic and wilderness value. The ecosystem functions they serve are also critical to the integrity of the Lagoon ecosystem.

OBSERVATIONS: THE FAUNA

Birds

The birds are the most visible vertebrate fauna of the Codrington Lagoon area. The Frigatebird Sanctuary, which attracts thousands of visitors, is perhaps the single most significant natural icon in the Park. It is also one of the most important breeding sites in the world breeding for this species.

Bird surveys were done along trails, bird flyways, at the Bird Sanctuary, along the shoreline, at areas where seabirds naturally congregate, and wherever the team ventured into the forest. The focal points for bird activity were along trails, pathways, forest edges, open patches of forest, and wherever fruiting trees and large invertebrate populations occurred.

At least 99 species of terrestrial, wetlands and seabirds have been observed over the period of the survey and in previous surveys and reports (see **Appendix II**). It is important to note that the number of species seen during field operations reflects a short time frame in the day and within the season, and offers only a sample of the numbers of species that may occur there throughout the year. The list will undoubtedly expand considerably if surveys were done more frequently covering all seasons, and as part of a systematic study, which would monitor the area's bird population.

Of notable absence during this field survey were the North American migrants. This survey was just at the beginning of the southward fall migration of birds, and most species had not yet arrived. No northern migrants were observed during this field visit, however, a number of previous reports highlight some of the migrants that visit the area.

Of the species recorded nest in the area, 56 of these birds, or 57%, are transients and/or migrants. This may be because the Lagoon is attracts a great diversity of species and provides the support they need for breed and/or their migration to and from North and South America.

Bird numbers and species fluctuate greatly, depending on the season, the amount of rain, the availability of food, and nesting habitat. North American migrant arrival during on island during the fall usually coincide with the heaviest rains of the year when there is an explosion of insects, foliage, young plant shoots, fruits and flowers.

On the northward migration in the spring, when species fly up the Lesser Antillean chain from South America, birds arrive at the end of the dry season and when the short but sustaining spring rains usually begin.

A number of species have become extinct on Barbuda over the past 200-300 years, though some species may continue to survive in the interior in low enough numbers to remain undetectable. Some of the species which have disappeared include the Caribbean Flamingo, which disappeared in the 1800s due to over-hunting and disturbance, the Brown Trembler, possibly the Scaly-breasted Thrasher, the Purple-throated Carib, the Tropical Mockingbird and the White-tailed Tropicbird.

A number of species have been introduced to the island. The first is the Helmeted Guinea Fowl,

a species native to eastern parts of Africa, and brought to the island by William Codrington in the 1700s to provide game. A more recent introduction is the Eurasian Collared Dove, a native of Eurasia, but it is likely that this is a natural expansion of this species across the Lesser Antilles. There have also been sightings of the House Sparrow, another species native to Eurasia. It was introduced into North American in the early 1800s and has since made its way down through Central America to South America and throughout the Caribbean. Its presence in Barbuda may be only as an occasional migrant.

Efforts should be made to develop conduct a more systematic survey over a two-year period, covering all seasons and conditions, which would provide an in-depth view of the species, breeding and nesting, their populations, distributions, threats, etc.

An interesting report is of the Lesser Antillean Saltator, a species not previously known north of Nevis. Endemic to the Lesser Antilles, the Saltator is a large finch, but one that is often overlooked and difficult to observe. The report mentions hearing the call of this species from around the Codrington are, but there are no sight records. Further study is needed to determine if this unique species is present on the island.

There are a number of species of birds of special conservation concern that occur within the Codrington Lagoon Park area. These species are primarily regional endemics, and are relatively rare on island and throughout the region. These species include:

The **White-tailed Tropicbird** (***Phaeton lepturus***) was reported to be a rare nester amongst the cliffs of the eastern coast. However, no recent sightings of this species have been made, though it is often difficult to distinguish this and the following species apart without good views.

Both species are competitors, and the Red-billed often successfully outcompetes the White-tailed for the scarce nest sites.

An option may be to provide artificial nest cavities for both species to help improve their numbers in the Park.

The **Red-billed Tropicbird** (***Phaeton aethereus***) is a rare nester in the cliffs of the eastern coast. An estimated 50 birds are believed to nest here. It is possible to increase nesting success of this species by eliminating specific threats such as feral cats, rats and by minimizing human disturbance.

The **Magnificent Frigatebird** (***Fregata magnificens***) nests by the thousands in the northwestern area of the Lagoon. This area is locally called the “Bird Sanctuary” by the local residents and is an important tourist attraction and an economic resource for the island.

A number of studies and reports (Diamond, 1972 & 74, Schreiber, 2000) have pointed to the fact that human disturbance as well as impact of hurricanes on the mangrove trees upon which the species relies for nesting have caused the species to shift the location of nesting activities over the past 40-50 years.

The colony requires freedom from harassment and long periods of low levels of disturbance in order to maintain and even increase breeding success.

The **West Indian Whistling Duck** (***Dendrocygna arborea***). This West Indian endemic has declined so dramatically in the region over the last 100 years that it is now listed as Vulnerable (V) under the International Union for the Conservation of Nature Species Survival Commission (IUCN SSC) categories.

The species needs wetlands, both fresh and marine-based, to survive and the habitats of the Lagoon and surrounding communities offer excellent opportunities for the species. However, the species remains exceedingly vulnerable to disturbance, hunting and harassment.

The **White-crowned Pigeon** (***Patagioenas leucocephala***. Though widespread throughout Antigua and Barbuda, occurring across most habitats on both islands, this species has become quite rare, and even extinct, on most of the other islands of the region. It finds sanctuary in the Lagoon and surrounding forests, from where thousands can be seeing moving back and forth in the evenings between the Lagoon and Palmetto Point (especially when sea grape fruits are ripe) and also the inland forests, as they leave their feeding grounds to their roosting sites. The species is a regional migrant, and disperses widely through the region and birds born on Barbuda will disperse to as far as Puerto Rico and other islands to the west, and will eventually colonize other islands from which it has disappeared due to over-hunting.

Prior to 1995 when the eye of hurricane Louis passed over Barbuda the pigeons were nesting and roosting in the Red mangrove palisades of Cuffy Creek in the thousands. This species was among the most devastated by the effects of the storm. Dead birds were scattered all over the wetland areas. White-crowned pigeons became rare. Over the years since then their numbers have gradually increased. The large numbers of communally nesting and roosting birds in the red mangrove Palisadoes have not returned however. The birds are now more commonly found in the various caves and sink holes in the Highlands.

The **Lesser Antillean Flycatcher** (***Myiarchus oberi***), is a Lesser Antillean endemic, and is not found in Antigua. In Barbuda, it is often heard but not seen, and at certain times of the year, the species seems to undergo local migration, moving from parts of the western half of the island to other areas. Why this occurs is unknown and needs careful study.

The species may often be seen in the secondary forests around Codrington Village, Palmetto Point, areas east and west of the lower Coco Point Road, Goat Island, Kid Island, Rabbit Island and around Two Foot Bay. It is rather secretive, and very difficult to observe. Very little is known about the habits and needs of the this species on Barbuda.

The **Antillean Euphonia** (***Euphonia musica***). The Euphonia is Antigua and Barbuda's only resident tanager. Quite colorful in its yellows, greens and blues, the species is extremely difficult to observe, but is often heard calling from the tree-tops as it searches for one of its favorite fruits, the mistletoe. However, it is usually quiet for most of the year. Within the Park, it is occasionally seen, but virtually nothing is known about its habits and needs.

The **Barbuda Warbler** (***Dendroica subita***). The Barbuda Warbler is endemic to this island. The species is one of only two resident breeding members of the New World warblers to breed on the island. The other is the Yellow Warbler (*D. petechia*), which is also found on Antigua.

This species is quite difficult to observe, and the observer usually only receives fleeting glances of

as it pops in and out of the brush in search of insects. The Warbler has a beautifully melodious thrill that it frequently utters as it moves about in search of food, calling to its competitors to announce its presence.

The Warbler is found throughout the Park, but was especially prevalent at Palmetto Point before the removal of the dune communities by sand mining. It is also fairly common in areas east of the Lagoon in the flashes and seasonally flooded plant communities of this area.

The species is listed as "Near threatened" on the IUCN Red List.

The **Lesser Antillean Saltator** (***Saltator albicollis***) was not previously reported for Barbuda, but a curious report suggests that the species may be present. Further efforts are needed to confirm the presence of this species on island and determine its conservation status.

Mammals

In the 1700s, when William Codrington took possession of Barbuda under a lease from the Crown, he stocked the island with game, including Fallow Deer (*Dama dama*), Wild Boar (*Sus scrofa*) and Helmeted Guinea Fowl (*Numida meleagris*). These species were hunted, and supplied to his estates in Antigua and maybe Barbados as well.

Prior to the late 60s, Barbuda had a system of corrals, which were used to raised livestock, including goats, sheep, cattle, donkeys and horses. Subsequent to this period, the system was relaxed and the animals were allowed to roam free. Today, the island is over-run with feral and semi-wild cattle, goats, donkeys, horses and sheep. These do considerable amounts of damage to the natural ecology of the island, and in fact, may be the single biggest threat to the biodiversity of the island. Many native systems and species may have disappeared or declined to virtually nothing because of these animals. These include native natural savannas, once described by J.S. Beard in now classic his 1949 work on the vegetation of the Leeward and Windward Islands. Beard provides photos for some of these areas in his book, and we now know that many of these vegetation systems have disappeared since.

Around the time of the arrival of Europeans to Barbuda in the 1600s, it is believed that the native endemic rodent, the Barbuda Giant Rice or Musk Rat (*Megalomys audreyae*) persisted in low numbers, but soon succumbed thereafter, perhaps because of new diseases brought by introduced rodents (*R. rattus, R. norvegicus* and *M. musculus*). The species is only known from archaeological middens and a holotype material found in cave breccias. Dating of some of this material puts it in line with the arrival of Europeans to the island.

The only native mammals extant on Barbuda today are bats. However, very little is known about them. The most recent report on the bats of Barbuda is by Perdersen *et al*., 2006. The report lists seven species of bats for the island, which is an increase over the previous record, which listed six. The new species was the discovery of the Flower Bat *Monophyllus plethodon* in 1994 by Morton and Lindsay.

The team did not carry out any bat surveys within the Codrington Lagoon area because the habitat and landscapes are difficult to survey, and given the flooding situation after the passage

of hurricane Omar and the limited timeframe and resources. this proved impractical.

However, based on the team's experience and knowledge, it is almost certain that the following species occur there:

1. The **Velvety Free-tailed Bat** (***Molossus molossus***), a widespread and relatively common species throughout Barbuda, especially around Codrington Village. I can be seen exiting the roofs of the old houses at dusk. Believed to be relatively common, though no actual population numbers are not yet, and only further study will be able to determine the population status of this species;
2. The **Brazilian Free-tailed Bat** (***Tadarida brasiliensis***), less common than the former species, to which it is closely related, nevertheless, the species seems locally abundant in parts of the island where suitable caves are to be found. Further work needs to be done to determine the population of this species;
3. The **Jamaican Fruit Bat** (***Artibeus jamaicensis***), a very common and widespread species, and perhaps the most common bat on Barbuda. Perhaps the most common bat species on the island. It is widespread and its population is believed to be stable;
4. The **Cave Bat** (***Brachyphylla cavernarum***), a rare species that seems limited by the availability of hot humid caves. This species depends on hot humid caves, which Barbuda possesses. However, a more careful study needs to be done to understand and determine the true nature of the population status of this species on this island;
5. The **Fishing or Bulldog Bat** (***Noctilio leporinus***). This species is the largest bat of the Americas with a wingspan that can go to over 2 ft (61 cm). It fishes on the waters of the Lagoon and can often be observed at night from the pier at Codrington. Very little is known about its local population numbers and further studies are needed to know its exact status on the island.

Bats are critical to the forest ecosystem health and wellbeing. These mammals are the primary pollinators, seed and beneficial insect dispersers of a number of species, and without them the forest ecosystem would almost certainly perish.

Other species of mammals previously mentioned that occur within the Codrington area include the introduced invasive Black Rat (*Rattus rattus*), the Norway or Brown Rat (*R. norvegicus*), the House Mouse (*Mus musculus*), feral House Cat (*Felis catus*), donkeys, horses, sheep, cattle, goats, Wild Boar and the Fallow Deer. The rats and mouse are all quite common and as in all areas where they are found, pose considerable health, economic and ecological risks. See section below on "Exotic Invasives" for a brief discussion of the potential impacts of these animals.

Reptiles and Amphibians

There are 15 species of terrestrial and marine reptiles and amphibians recorded for Barbuda. Of these, one is extinct and known only from fossils (*Leocephalus cuneus,* a lizard).

One species is a natural introduction, the Green Iguana (*Iguana iguana*) as a result of the passage of Hurricane Luis in September 1995. This species is becoming increasingly common on the island, including areas around the Lagoon. Photo 12.0 below shows a juvenile iguana from Barbuda. This is a species that requires further study to determine its spread across the island and the impacts that it may be having on the flora and fauna.

Photo 12.0. Green Iguana juvenile from Barbuda.
Photo courtesy, John Mussington, Codrington Barbuda, 2008.

Of this total, 10 species of reptiles and one amphibian are reported for the study area. These include:

1. *Anolis bimiculatus* – Antigua or Tree Anole, endemic to Antigua and Barbuda. Common.
2. *Anolis foresti* – The Brown or Watts Anole, endemic to Barbuda. Common.
3. *Ameiva griswoldi* – The Antigua Ground Lizard, endemic to Antigua and Barbuda. Common.
4. *Gymnophthalmus underwoodi* – Smooth-scaled Worm Lizard. Population status is unknown.
5. *Sphaerodactylus elegantulus* – The Dwarf Gecko, endemic to Antigua and Barbuda. Locally common.
6. *Hemidactylus mabouia* – House Gecko/Woodslave. Introduced and common.
7. *Thecadactylus rapicauda* – The Forest or Tree Gecko. Population status is unknown.
8. *Typholps monastus* – The Blind Snake. Believed to be common, though this is only based on anecdotal information and on the biology of this species.
9. *Iguana iguana* – The Green Iguana. Locally common.
10. *Geochelone carbonaria* – The Red-footed Tortoise or Land Turtle. Uncommon to rare and rapidly declining.

The only amphibian reported is the tree frog (*Eleutherodactylus johnstonei*), and this is common throughout most of Barbuda.

Photo 13.0 below is of a Red-footed Tortoise at Palmetto Point.

Photo 13.0. A Tortoise encountered at Palmetto Point on October 25, 2008.

There are three species of sea turtles reported for Barbuda: the Hawksbill (*Eretmochelys imbricata*), the Green (*Chelonia mydas*), and the Leatherback (*Dermochelys coriacea*). All three nest on Barbuda, and all three are known to nest within the park. All are relatively uncommon to rare. The Hawksbill and the Leatherback are listed as "Critically Endangered" by IUCN, and the Green is listed as "Endangered."

All species of reptiles except *S. elegantulus* are relatively quite common and widely distributed throughout most of Antigua.

The House Gecko or Wood Slave is believed to be a West African immigrant, arriving in the region via slave within the last 400 years.

Freshwater Fish

There are at least two species of freshwater fish found on Barbuda: the Guppy (*Poecilia reticulata*) and the Mangrove Rivulid (*Rivulus marmoratus*). Only the Rivulid is known to occur within the Codrington area. The Guppy occurs further inland. John Mussington reports that there may be another species of Rivulid with the protected area, but to date, no further work has been done to confirm the identity of this species.

The Rivulid can inhabit both marine and terrestrial fresh and brackish water environments. In the Codrington area, it is found in wells, solution holes, springs and ponds around Codrington and in

solution holes east of Cuffy Creek and the Goat Island Flush. Surprisingly, this fish survive in the flashes where salinities can reach 70 parts per thousand and extreme temperatures. During those months when the flashes dry out these fish have been observed surviving in moist mud under conch shells and stones. They have also been observed in hyper-saline, extreme-temperature pools on the sand bar which forms the seaward boundary of the lagoon

The Rivulid is a self-fertilizing hermaphrodite and has the ability to survive in moist substrate and hollowed out mangrove roots during dry or drought periods, and is even known to migrate between pools of water by leaping out and flipping on dry land until it reaches its destination.

All these species are locally common wherever they are found.

Terrestrial Invertebrates

No surveys of terrestrial invertebrate were carried out because of the timeframe constraints of the project, the very severe demands that invertebrate surveys and species identifications require, and the limited financial resources available.

However, invertebrates of special conservation concern or of particular interest were noted where possible.

INVASIVE SPECIES

The terms of reference which directed this survey made specific mention of invasive species. Barbuda is part of a region made up of a number of small island states. These islands are characterized by the presence of coastal marine ecosystems that form significant components of their overall island ecosystem. The concept of an invasive species must be applied with caution to these island systems. Oceanic systems are dynamic by nature, and for a particular species to be considered invasive, it would most likely originate outside the Atlantic basin.

Recently, questions were raised about a jellyfish species occurring in the Lagoon and the possibility of it being an invasive that was negatively impacting the fisheries. Unfortunately, the international concerns raised were unjustified and were the result of lack of knowledge on the part of the observer. The species in question was the upside down jellyfish that is a common resident of these islands and whose habitat includes the sheltered mangrove areas common in the lagoon. Attempts to link its abundance to certain negative impacts affecting the fisheries were also unfounded. The impacts on the fisheries and other systems of the lagoon are the result of several factors including climate and catastrophic weather events as well as anthropomorphic factors such as unmanaged fishing pressure as well as others that are not yet well understood.

Nevertheless, the question remains: are marine invasive species present in the Lagoon Protected Area? The short answer is: none has been observed. This answer must be qualified however. There have not been any investigations of microbiological plant and animal species. The status with respect to these therefore is unknown at this point. It is an area for further study which must begin with baseline inventories to be followed by ongoing monitoring for change.

In terms of terrestrial invasives, it has already been mentioned that feral and free-roaming livestock have had a serious and unmistakable impact on the species of plants and on the vegetation communities throughout the island of Barbuda. Once extensive grassland and forb aquatic communities have disappeared, and many of the woodlands and forests are very degraded due to years of over-browsing and poor seedlings recruitment and regeneration.

The impact of uncontrolled livestock on the ecology of any landscape and on human systems, especially a system where these animals are not ecologically alien, has been well documented throughout the world. However, for many Barbudans, these animals are as much a part of the landscape as the native species and controlling these animals would be a very hard task.

Nevertheless, free-roaming and feral livestock need to be controlled, not only for the biodiversity, but also for the long-term sustainability of the Park, and for the well-being of the residents of the island.

SPECIES OF SPECIAL CONSERVATION CONCERN

For the Codrington Lagoon National Park, the species of special conservation concern include:

- The **White-tailed Tropicbird** (*Phaeton lepturus*).
- The **Red-billed Tropicbird** (*Phaeton aethereus*).
- The **Magnificent Frigatebird** (*Fregata magnificens*).
- The **West Indian Whistling Duck** (*Dendrocygna arborea*).
- The **White-crowned Pigeon** (*Patagioenas leucocephala*).
- The **Lesser Antillean Flycatcher** (*Myiarchus oberi*).
- The **Antillean Euphonia** (*Euphonia musica*).
- The endemic **Barbuda Warbler** (*Dendroica subita*).
- The **Lesser Antillean Saltator** (*Saltator albicollis*).

Each species listed above is discussed in more detail in the fauna section above.

For reptiles, the species of concern would include the three species of nesting marine turtles, the Red-footed Tortoise (*G. carbonaria*), a species reportedly on a severe decline on the island according anecdotal reports, and the recently arrived Green Iguana (*I. iguana*).

EXOTIC INVASIVE FAUNA

As stated above, there are several introduced species of animals that are having a dramatic impact on the landscape and ecology as well as the economy of Barbuda. However, this statement is not based on concrete data obtained from on the ground research, but from anecdotal information, local knowledge, personal observations made on Barbuda for over 15 years, and from experience on other islands.

Aside from introduced rodents such as the Black and Brown Rats and the House Mouse, which undoubtedly cause considerable amount of ecological and financial damage on the island, there are also other species that are of major concern, and which may have just as much or even greater and impact on the landscape and the ecology.

The cat is becoming increasingly common in areas around the Village and at Palmetto, and has been observed taking nestlings in the wild.

There are no reliable estimates for the deer and boar populations since no formal surveys have been conducted. These species move in and out of the boundaries of the Protected area as food, shelter, water and sanctuary are available to them. Nevertheless, the fact that after more than 300 years, so little remains known about these species and their true impact on the island points to the need for systematic surveys to be carried out.

Virtually the same can be said for feral domesticated livestock (sheep, goats, pigs, cattle, donkeys and horses), though it is quite obvious by observations made in the woodlands and forests of the island that the animals are relatively common, and the impacts on the landscapes and ecosystem are quite dramatic. The team could not measure the impact that these animals have had on the ecosystems (and continue to have) and overall biodiversity of the island, but a review of Beard's assessment of the plant communities of Barbuda, and his photos of the native grasslands and the Bull Hole area show very dramatic differences between the landscapes in that period and those of today. All of the very unique natural savannas and flood communities of Barbuda are now gone.

AREAS OF SPECIAL CONSERVATION CONCERN

For plant communities, all plant systems within the Palmetto Point area of major concern due to the impact of sand mining. The threat is quite serious since much of the unique plant communities have been destroyed by this activity.

For the Freshwater Pond area we are concerned about the natural forb flood community that is being destroyed by free-roaming and feral livestock, and by the indiscriminate and dangerous disposal of solid waste in the area.

Concern remains over the viability of the Frigatebird Sanctuary due to human disturbance, compounded by impacts from natural disasters such as hurricanes.

All historic and archaeological sites at Two Foot Bay are threatened by quarrying, and historic buildings, architecture and sites within the Codrington Village are in danger of disappearing.

NATURAL DISASTERS AND VULNERABILITY RISKS

The visible scars that dot the landscape of the area can measure the vulnerability of the Codrington Lagoon and surrounding areas to natural disasters. The remains of two storm breaches along the western shores of the lagoon are quite obvious from a boat and as one flies over to land at the airport. The breaches happened during the passage of hurricanes Luis in 1995 and a hurricane in 1960. Both hurricanes opened up the Lagoon to the Caribbean Sea.

In October of 2005, and March 2008, 'ground swells,' which were the result of the passage of strong storms in the northern Atlantic, have pushed waves inland of the Palmetto Point area (John Mussington pers. comm.), and over the sandbar of the Lagoon. As the dunes were removed for sand mining then so were the natural barriers to the movement of waves.

Sand mining has also obliterated unique vegetation communities that were described in "A Vegetation Classification of Antigua, Barbuda and Redonda" done by Kevel Lindsay and Bruce Horwith in 1997. The decimation of these plant communities has resulted in the creation of seasonal flashes and freshwater wetlands.

The Palmetto Sand Dune system supported a unique type of plant association. There was also cultural significance to the area. For example, the numerous sea grape and coco plum trees provided a food source not only for wildlife such as the White-crowned pigeon but for the human population as well. Gathering these fruits was an integral part of the social interactions that were definitive of the Barbudan lifestyle. The Palmetto palm provided materials for construction of brooms and fish traps that were used in the Lagoon for catching a specific type of fish. The sand mining operation has obliterated most of this system.

The low lying area that remains is flood prone and leaves the southern section of the lagoon vulnerable to intrusion from storm surge. The change in the predominant species composition will impact the wildlife that is dependent for habitats, for example, the white-crowned pigeon and whistling duck populations.

In his March 2008 report in the *Barbuda Lagoon Risk Profile 2008*, Sherrod James outlined a number of vulnerability issues and risks within and adjacent to the boundaries of the Park. In the report, he highlighted issues and impacts related to the vulnerability of the sandbar on the western coast of the Lagoon to frequent breaches, the vulnerability of the power generating facility, solid waste disposal issues, the need for training and monitoring of tour operators, and other issues.

RECOMMENDATIONS FOR MANAGEMENT OF BIOLOGICAL AND HUMAN RESOURCES

1. **The biological systems identified in this survey should be used to inform the implementation of any zoning for special purposes within the lagoon protected area.**

2. **A "park biologist/ecologist" and a "park conservator" should be employed.** These two positions are critical to the proper management of Park resources. The biologist/ecologist would oversee the development of natural resources management, monitoring, conservation and research programs; while the conservator would oversee the cultural resources, including historical, architectural and archaeological (although this characterization was limited in scope and focused largely on the natural resources of the Park, the team does recommend that the Park Authority should also consider hiring a conservator to deal with historical and archaeological resources).

   Because of the financial constrains that limit hiring of new staff for the Park Authority, it is recommended that the Park Authority, the Barbuda Council, and the Environment Division seek assistance from external donor and international technical assistance agencies, many of which support secondment of professional personnel to overseas postings, assignment of technical volunteers overseas, and staff training programs for developing country nationals at host-country institutions.

   Several U.S. federal government agencies have international programs that are relevant, such as the U.S. Department of Agriculture, the U.S. Department of the Interior, and the U.S. Department of Commerce (NOAA). The Virgin Islands National Park in St. John, U.S. Virgin Islands, a part of the U.S. National Park Service, might be able to provide on-site training in land management, establishment of monitoring systems, or carrying out long-term research studies within a protected area framework. The U.S. Peace Corps has assigned technical volunteers to assist conservation and environment programs and institutions in the Caribbean. International non-government organizations (NGOs) have also provided similar services such as: the British organization Voluntary Services Overseas (VSO), the Canadian NGO CUSO, the U.S. NGO FAVACA (Florida Association for Volunteer Action in the Caribbean and the Americas), and the U.S.-based Caribbean Volunteer Expeditions (limited to the historic preservation aspects of the Codrington Lagoon area).

   Such overseas assistance to the Park Authority should be viewed as temporary, until such time as the Authority has the capacity and resources to support its own fulltime biologist/ecologist and conservator professionals.

3. **Monitoring of the physical parameters as well as the biological systems of the lagoon must be an integral part of the park management plan**. The shallow, enclosed nature of the lagoon's waters forms a complex, dynamic system. Its stability directly impacts the communities that are supported by the system. While fluctuations are normal, our understanding of these fluctuations, their impacts, and the measures that should be

taken should be the ultimate goal of management. This will only be possible with ongoing environmental monitoring. Designing and implementing a monitoring program is the first step in achieving this goal. The ecosystem monitoring plan commissioned by the Environmental Awareness Group in 2000 contains much of the needed groundwork and should be upgraded and modified where necessary and implemented.

4. **Systematic surveys of the flora and fauna of the Park and surrounding areas should be undertaken**. This is very important given the fact that this current effort was not comprehensive enough to examine many of the species that occur within the protected area. A systematic survey would be a more detailed and long-term effort; it would examine species' population, biology, distribution and ecology and would include repeated surveys over a two-to-three-year period.

5. **The Park authority should assess the potential for providing nesting habitat for seabirds**, such as the Sandwich, Common, Roseate and Least Terns, and the White-tailed and Red-billed Tropicbirds which do not seem to have adequate nesting habitat.

6. **An assessment of the impact of feral and free-roaming livestock on the site's ecosystems, natural services, human ecology and historical and archaeological resources should be undertaken, and a livestock management plan for the area should be developed.**

7. **At least two rangers should be trained in plant species identification and management, in conflict resolution, and in ecosystems management techniques**.

8. **A more systematic survey of the proposed two-mile marine zone needs to be completed** The current biodiversity characterization and assessment effort did not include a survey of the proposed marine zone as this task was beyond the scope of the project.

9. **A number of species and sites within and adjacent to the Park (*i.e.*, outside of the current, accepted boundaries of the Park) should be declared legally protected to ensure their long-term sustainability and survival**.

   The species include:

   – The endemic Barbuda Warbler

   – The Magnificent Frigatebird

   – The Lesser Antillean Flycatcher

   – The Red-footed Tortoise.

The sites include:

   – The petroglyphs and sea-cliffs from two Foot Bay northward. The historical and

archaeological sites in this area are threatened with quarrying.

10. **A survey of the historic buildings and architecture in Codrington should be carried out, and a plan and strategy to save and restore them should be developed**.

11. **The remaining old growth forest at Palmetto (near and around the Sandstone area) should be declared protected** to prevent the resource from being destroyed.

12. **The sand-mined areas at Palmetto Point should be rehabilitated and restored**. The area should be replanted with native species.

13. **Further removal of the natural protective costal vegetation on the western shore of the Lagoon should be prevented, and the now exposed areas should be replanted as soon as possible**.

14. **Disposal of solid waste in the Freshwater Pond area should be prohibited**. The practice is unhealthy and unsightly and is destroying unique species and plant communities. Solid waste needs to be properly disposed, and the materials already in the area should be removed and taken to a properly designed and maintained landfill;

15. **Road and other essential infrastructure need to be properly and carefully designed** to allow for the natural drainage of sheet flow. Much of the road design and construction at present is inadequate for the unique drainage of the lands in the Park and, in fact, may be increasing the number of mosquitoes on the island. Appropriate cross drains need to be put under roads, and the natural drains need to be restored.

16. **Regulations for park management need to be drafted and put in place**. Although the protected status of the Lagoon has been in effect since March of 2005, the necessary regulations needed to implement management policies and strategies are still not in place.

17. **The Barbuda Council, as the local government authority, needs to create an enabling environment for the operation of a fully functional Parks Authority and/or Lagoon Management Authority. This must take place within the context of the Barbuda Local Government Act (1976) and the Barbuda Land Act (2007).** Only the Barbuda Council can implement the provisions of these two pieces of legislation, and, as such, until the Council takes action, it will remain the primary impediment to successful management of the Protected Area.

All the major ecosystems found in the Lagoon Protected Area are interdependent, and a delicate balance is maintained to create the unique set of features that characterize the site. Livelihoods and food security continue to be dependent on this balance being maintained. Determining how best to confront the Increasing pressures from tourism and under-managed use of the area is the greatest *immediate* challenge facing the people of Barbuda.

DEFINITION OF TERMS

Alliance

Alliance refers to a plant or vegetation community and is the first floristic level in the classification of the community. The Alliance typically includes one or more characteristic species in its title, and provides an operational definition that allows it to serve as the basic unit for conservation management concerns.

Biodiversity

Biodiversity refers to the natural diversity of animals, plants, ecosystems, ecosystem functions, genetic diversity and landscapes in a given area.

Common

Common refers to a species of animal, plant or plant community that is widespread in distribution or size.

Community

Community refers to an association of plant species that form the vegetation (sometimes loosely called habitat type as well) of a given area. A "community association" is, in some cases, though not all "… an Alliance that may contain several Community Associations, which differ in species composition. The separation of Alliances into Associations is subject to the same prejudices that affect the "splitter versus lumper" debate in taxonomy; in general, we probably erred in the direction of splitting Alliances because the resulting Community Associations provide more information at the species level, and thus improve biodiversity conservation efforts" (Lindsay and Horwith, 1997: *A Vegetation Classification of Antigua, Barbuda and Redonda*).

Declining

Declining refers to a species, ecosystem, habitat or landscape that is reduced in numbers, capacity and ability over a time, from a position of previous stability or optimum capacity.

Endangered

Endangered refers to a species, ecosystem or landscape component in danger of becoming extinct in the wild.

Exotic invasive

Exotic invasive refers to a species that has been introduced to a given place within historic times that has had adverse effects on other species and/or human ecosystems and economies in that place.

Introduced

Introduced, as opposed to native and indigenous, refers to species that have been aided by human intervention and have been brought to a given place during recent historical times. Introduced species are often referred to as exotic, alien or non-indigenous, and may become an invasive at some point.

Invasive species

Invasive species usually refers to an introduced species that has had adverse effects on other species and/or on human ecosystems and economies. However, an invasive species can also refer to a native species that has adverse or negative effects on other species,

ecosystems, on human systems and economies. Invasive species usually result from direct human activity and interference that causes a disruption in the habits and functions of a species and/or its habitat.

Lagoon

Lagoon refers to a shallow enclosed body of salt or brackish water separated from the sea by a narrow sandbar, reef (alive or dead), coral rubble, or bank. In this report, lagoon refers to the Codrington Lagoon, also known as the Barbuda Lagoon.

Landscape

Landscape refers to the visible elements of plants, animals, vegetation communities, ecosystem functions, weather and climate, and human activities and functions that define the features of an area of land.

Least concern

Least concern refers to a species that is of low conservation and/or management needs.

Marine

Marine refers to or is related to the sea, and usually means species of animals, plants and natural systems that are primarily based in the sea.

Native

Native refers to a species of plant, animal, ecosystem or landscape component that has naturally developed, for example, evolved or occurred naturally in Antigua and Barbuda.

Natural disaster

Natural disaster refers to a natural hazard that affects human activities and has adverse effects on human ecosystems.

Rare

Rare refers to species that are severely restricted in distribution or size.

Special conservation concern

Special conservation concern is a term that refers to species of animals and plants, ecosystems, landscapes and habitat that are of greatest conservation priority and concern and in need of management intervention.

Systematic surveys/sampling

Systematic surveys/sampling refers to the undertaking and use of individual observations intended to provide information on the population and habits of a species and/or ecosystem and ecosystem function. Several properties or components are measured, including location, date, time, weather and climate, species, habitat, weight, genetics, sex, vocalization, etc.

Terrestrial

Terrestrial refers to primarily land-based species of animals and plants and to ecosystems that are primarily based there (as opposed to aquatic/marine).

Threatened

Threatened refers to a species, ecosystem or landscape component about which the best evidence suggests that the species or habitat is facing threats that may push it toward

extinction at some point.

Uncommon

Uncommon refers to a species of animal, plant or plant community that is moderately distributed in numbers or size.

Vulnerability risk

Vulnerability risk refers to the probable harmful consequence(s) that may result from or be exploited by weakness(es) in the infrastructure, activity, actions and human ecosystems.

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APPENDIX I

Birds of the Wallings Forest Reserve and Surrounding Areas

Common Name	Species	Family	Status & Range
Brown Pelican	*Pelicanus occidentalis*	PELECANIDAE - PELICANS	Tropical America, Lc
Magnificent Frigatebird	*Fregata magnificens*	FREGATIDAE - FRIGATEBIRDS	Tropical Atlantic & West Africa, Comm
Great Blue Heron	*Ardea heroidias*	ARDEIDAE -HERONS	Americas, UnC
Great Egret	*Ardea alba*		Americas & worldwide Lc
Little Blue Heron	*Egretta caerulea*		Americas, Lc
Tricolored Heron	*Egretta tricolor*		Americas, UnC
Cattle Egret	*Bubulcus ibis*		Tropical America, Africa, Asia and Pacific, Decl
Green Heron	*Butorides virescens*		Americas, Lc
Black-crowned Night Heron	*Nycticorax nycticorax*		Worldwide, Rare
Yellow-crowned Night Heron	*Nycticorax violacea*		Americas, Lc
White-cheeked Pintail	*Anas bahamensis*	ANATIDAE - DUCKS	Americas, Lc
Osprey	*Pandion haliaetus*	PANDIONIDAE - OSPREYS	Worldwide, Rare
Broad-winged Hawk	*Buteo platypterus*	ACCIPITRIDAE - HAWKS	Endemic subspecies B. p. insulicola
American Kestrel	*Falco sparverius*	FALCONIDAE - FALCONS	Americas, Lc
Merlin	*Falco columbarius*		America, Eurasia, Rare
Peregrine Falcon	*Falco peregrinus*		Worlwide, Rare
Common Gallinule	*Gallinula chloropus*	RALLIDAE - COOTS & GALLINULES	Americas, Lc
Solitary Sandpiper	*Tringa solitaria*	SCOLOPACIDAE -SANDPIPERS	Americas, UnC
Least Sandpiper ?	*Calidris minutilla*		Americas, UnC
Laughing Gull	*Larus atricilla*	LARIDAE - GULLS	Americas, Lc
White-crowned Pigeon	*Patagioenas leucocephala*	COLUMBIDAE - PIGEONS & DOVES	WI, Lc
Scaly-naped Pigeon	*Patagioenas squamosa*		WI, UnC

Common Name	Species	Family	Status & Range
Zenaida Dove	*Zenaida aurita*		WI, Comm
Common Ground Dove	*Columbina passerina*		NT, Comm
Bridled Quail Dove	*Geotrygon mystacea*		LA, Rare
Ruddy Quail Dove	*Geotrygon montana*		NT, Rare
Mangrove Cuckoo	*Coccyzus minor*	CUCULIDAE - CUCKOOS	WI, Comm
Purple-throated Carib	*Eulampis jugularis*	TROCHILIDAE - HUMMINGBIRDS	LA, Rare
Green-throated Carib	*Eulampis holosericeus*		LA, Comm
Antillean Crested Hummingbird	*Orthorhyncus cristatus*		LA, Comm
Belted Kingfisher	*Ceryle alcyon*	ALCEDINIDAE - KINGFISHERS	Americas, UnC
Guadeloupe Woodpecker	*Melanerpes herminieri*	PICIDAE - WOODPECKERS	Guadeloupe, UnC Vagrant
Caribbean Elaenia	*Elaenia martinica*	TYRANNIDAE - TYRANT FLYCATCHERS	WI, Comm
Gray Kingbird	*Tyrannus dominicensis*		WI, Comm
Caribbean Martin	*Progne dominicensis*	HIRUNDINIDAE - SWALLOWS	WI, UnC
Barn Swallow	*Hirundo rustica*		Americas, Lc
Scaly-breasted Thrasher	*Allenia fusca*	MIMIDAE - MIMIC THRUSHES	WI, UnC
Pearly-eyed Thrasher	*Margarops fuscatus*		LA, Unc
Brown Trembler	*Cinclocerthia ruficauda*		LA, Rare
Yellow-throated Vireo	*Vireo flavifrons*	VIRIONIDAE - VIREOS	Americas, Rare
Black-whiskered Vireo	*Vireo altiloquus*		WI, Comm
Black and White Warbler	*Miniotilta varia*	EMBERIZIDS	Americas, Rare
Northern Parula	*Parula americana*		Americas, Rare
Yellow Warbler	*Dendroica petechia*		Americas, Rare
Chestnut-sided Warbler	*Dendroica pensylvanica*		Americas, Rare
Magnolia Warbler	*Dendroica magnolia*		Americas, Rare
Cape May Warbler	*Dendroica tigrina*		Americas, Rare
Black-throated Blue Warbler	*Dendroica caerulescens*		Americas, Rare

Common Name	Species	Family	Status & Range
Black-throated Green Warbler	*Dendroica virens*		Americas, Rare
Bay-breasted Warbler	*Dendroica castanea*		Americas, Rare
Blackpoll Warbler	*Dendroica striata*		Americas, Rare
American Redstart	*Setophaga ruticilla*		Americas, Rare
Worm-eating Warbler	*Helmitheros vermivorus*		Americas, Rare
Ovenbird	*Seiurus aurocapillus*		Americas, Rare
Northern Waterthrush	*Seiurus noveboracensis*		Americas, Rare
Lousiana Waterthrush	*Seirus motacilla*		Americas, Rare
Kentucky Warbler	*Oporonis formosus*		Americas, Rare
Hooded Warbler	*Wilsonia citrina*		Americas, Rare
Bananaquit	*Coereba flaveola*		Americas, Comm
Antillean Euphonia	*Euphonia musica*		LA, Rare
Black-faced Grassquit	*Tiaris bicolor*		WI, Comm
Lesser Antillean Bullfinch	*Loxigilla noctis*		LA, Comm
Carib Grackle	*Quiscalus lugubris*		LA, UnC

Acronyns:

Comm=Common
Decl=Declining
LA=Lesser Antilles
Lc=Least Common
UnC=Uncommon
WI=West Indian

APPENDIX II

Birds of the Codrington Lagoon National Park and Adjacent Areas

Common Name	Species	Family	Status & Range
Pied-billed Grebe	Podilymbus podiceps	PODICIPEDIDAE	
Brown Booby	Sula leucogaster	SULIDAE	Tropical & subtropical oceans of the world, Mig, UnC
White-tailed Tropicbird	*Phaethon lepturus*	PHAETHONTIDAE - TROPICBIRDS	Tropical & sub-tropical oceans of the world, N, Rare to possibly extinct
Red-billed Tropicbird	*Phaethon aethereus*		Atlantic, Indian & Pacific Oceans, Very Rare
Brown Pelican	*Pelicanus occidentalis*	PELECANIDAE - PELICANS	Tropical America, Lc, N
Magnificent Frigatebird	*Fregata magnificens*	FREGATIDAE - FRIGATEBIRDS	Tropical Atlantic & West Africa, Comm, N
Snowy Egret	*Egretta thula*	ARDEIDAE -HERONS	Western Hemisphere, Rare, breeding?
Great Blue Heron	*Ardea heroidias*		Americas, UnC
Great Egret	*Ardea alba*		Americas & worldwide , Lc, breeding?
Little Blue Heron	*Egretta caerulea*		Americas, Lc, breeding?
Cattle Egret	*Bubulcus ibis*		Tropical America, Africa, Asia and Pacific, Decl
Green Heron	*Butorides virescens*		Americas, Lc, breeding
Black-crowned Night Heron	*Nycticorax nycticorax*		Worldwide, Rare, breeding
Yellow-crowned Night Heron	*Nycticorax violacea*		Americas, Lc, breeding?
Fulvous Whistling Duck	*Dendrocygna bicolor*	ANATIDAE - DUCKS	Americas, East Africa & India
West Indian Whistling Duck	*Dendrocygna arborea*		West Indian endemic
Green-winged Teal ?	*Anas crecca*		Northern Hemisphere
White-cheeked Pintail	*Anas bahamensis*		Americas, Lc
Osprey	*Pandion haliaetus*	PANDIONIDAE - OSPREYS	Worldwide, Rare
American Kestrel	*Falco sparverius*	FALCONIDAE - FALCONS	Americas, Lc
Merlin	*Falco columbarius*		America, Eurasia, Rare
Peregrine Falcon	*Falco peregrinus*		Worlwide, Rare
Sora	*Porzana carolina*	RALLIDAE - COOTS & GALLINULES	Americas, very Rare

Common Name	Species	Family	Status & Range
Clapper Rail	*Rallus longirostris*		Americas, UnC to Rare
Common Gallinule	*Gallinula chloropus*		Americas, Lc
Greater Flamingo	*Phoenicopterus ruber*		Western Hemisphere, extinct on Barbuda
Semipalmated Plover	*Charadrius semipalmatus*	CHARADRIIDAE - PLOVERS	Western Hemisphere, Lc
Wilson's Plover	*Charadrius wilsonia*		Western Hemisphere, breeds, UnC
Snowy Plover	*Charadrius alexandrinus*		Worldwide, UnC
Killdeer	*Charadrius vociferus*		Worldwide, UnC to Rare
Black-bellied Plover	*Pluvialis dominicus*		North & South America, Rare
American Oystercatcher	*Haemantopus palliatus*	HAEMATOPODIDAE-OYSTERCATCHERS	Americas, resident, breeds? Rare
Black-necked Stilt	*Himantopus mexicanus*	RECURVIROSTRIDAE - STILTS	Western Hemisphere, Lc
Ruddy Turnstone	*Arenaria interpres*	SCOLOPACIDAE -SANDPIPERS	Worldwide, UnC, breeds?
Solitary Sandpiper	*Tringa solitaria*		Americas, UnC
Spotted Sandpiper	*Actitis macularia*		Western Hemisphere, UnC
Lesser Yellowlegs	*Tringa flavipes*		Western Hemisphere, UnC
Greater Yellowlegs	*Tringa melanoleuca*		Western Hemisphere, Lc
Willet	*Catoptrophorus semipalmatus*		Western Hemisphere, UnC to Rare, breeds
Whimbrel	*Numenius phaeopus*		Worldwide, UnC to Rare
Hudsonian Godwit	*Limosa haemastica*		Western Hemisphere, Rare
Sanderling	*Calidris alba*		Worldwide, Rare
Least Sandpiper	*Calidris minutilla*		Americas, UnC
Semipalmated Sandpiper	*Calidris pusilla*		Worldwide, Lc
Stilt Sandpiper	*Calidris himantopus*		Western Hemispher, Rare
Common Snipe	*Gallinago gallinago*		Northern Hemisphere, UnC to Rare
Wilson's Snipe ?	*Galinago delicata*		North America, Rare
Laughing Gull	*Larus atricilla*	LARIDAE - GULLS	Americas, Lc, breeds
Royal Tern	*Sterna maxima*	LARIDAE - TERNS	Americas & west coast of Africa, UnC
Least Tern	*Sterna antillarum*		North America & Caribbean, breeds, Rare

Common Name	Species	Family	Status & Range
Sandwich Tern	*Sterna sandvicensis*		Atlantic Ocean, breeds, Rare
Common Tern	*Sterna hirundo*		Worldwide, breeds, Rare
Roseate Tern	*Sterna dougallii*		Worldwide, Rare, breeds?
Bridled Tern	*Sterna anaethetus*		Worldwide, Rare, breeds?
Brown Noody	*Anous stolidus*		Worldwide, Lc to Uncommon, breeds?
Helmeted Guineafowl	*Numida meleagris*	PHASIANIDAE - PARTRIGES, TURKEYS & QUAILS	East Africa. Introduced throughout the world, N
White-crowned Pigeon	*Patagioenas leucocephala*	COLUMBIDAE - PIGEONS & DOVES	WI, Lc
White-winged Dove	*Zenaida asiatica*		Americas, recent natural arrival, Rare, breeds?
Eurasian Collared-dove	*Streptopelia decaoto*		Eurasia, introduced throughout the world
Zenaida Dove	*Zenaida aurita*		Southeastern US & Caribbean, Comm
Common Ground Dove	*Columbina passerina*		NT, Comm
Antillean Nighthawk	*Chordeles gundlachii*	CAPRIMULGIDAE	North & South America, Rare, breeding?
Black-billed Cuckoo	*Coccyzus erythropthalmus*	CUCULIDAE - CUCKOOS	North America & northern South America, Rare
Mangrove Cuckoo	*Coccyzus minor*		WI, comm.
Purple-throated Carib	*Eulampis jugularis*		LA, rare or extinct
Green-throated Carib	*Eulampis holosericeus*		LA, comm.
Antillean Crested Hummingbird	*Orthorhyncus cristatus*		LA, comm.
Belted Kingfisher	*Ceryle alcyon*	ALCEDINIDAE - KINGFISHERS	Americas, UnC
Lesser Antillean Flycatcher	*Myiarchus oberi*	TYRANNIDAE - TYRANT FLYCATCHERS	LA endemic
Caribbean Elaenia	*Elaenia martinica*		WI, Comm
Gray Kingbird	*Tyrannus dominicensis*		WI, Comm
Caribbean Martin	*Progne dominicensis*	HIRUNDINIDAE - SWALLOWS	WI, UnC
Bank Swallow	*Riparia riparia*		Worldwide, Rare
Barn Swallow	*Hirundo rustica*		Americas, Lc
Scaly-breasted Thrasher	Allenia fusca	MIMIDAE - MIMIC THRUSHES	Last seen 100 years or so ago. May be extinct
Pearly-eyed Thrasher	*Margarops fuscatus*		West Indies, rare
Tropical Mockingbird	*Mimus gilvus*		Central & South America, Rare or extinct?

Common Name	Species	Family	Status & Range
Black-whiskered Vireo	*Vireo altiloquus*		WI, Comm
Black and White Warbler	*Miniotilta varia*	EMBERIZIDS	Americas, Rare
Northern Parula	*Parula americana*		Americas, Rare
Black-throated Green	*Dendroica virens*		Americas, Rare
Adelaide's Warbler	*Dendroica subita*		Barbuda endemic
Yellow Warbler	*Dendroica petechia*		Americas, Rare
Prairie Warbler ?	*Dendroica discolor*		Americas, Lc
Bay-breasted Warbler	*Dendroica castanea*		Americas, Rare
Cape May Warbler	*Dendroica tigrina*		Americas, Rare
American Redstart	*Setophaga ruticilla*		Americas, Rare
Northern Waterthrush	*Seiurus noveboracensis*		Americas, Rare
Lousiana Waterthrush	*Seirus motacilla*		Americas, Rare
Bananaquit	*Coereba flaveola*		Americas, Comm
Antillean Euphonia	*Euphonia musica*		LA, Rare
Scarlet Tanager	*Piranga olivacea*		Americas, Mig
Lesser Antillean Saltator ?	*Saltator albicollis*		Lesser Antilles, very rare
Black-faced Grassquit	*Tiaris bicolor*		WI, Comm
Lesser Antillean Bullfinch	*Loxigilla noctis*		LA, comm
Indigo Bunting	*Passerina cyanea*		US & Central America, Mig
Bobolink	Dolichonyx oryzivoru		Western Hemisphere, Mig
Carib Grackle	*Quiscalus lugubris*		LA, Unc
House Sparrow	*Passer domesticus*	PASSERIDAE - OLD WORLD SPARROWS	Native to Eurasia & Africa. Introduced to Americas

Acronyns:

Comm=Common
Decl=Declining
LA=Lesser Antilles
Lc=Least Common
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APPENDIX III

Plant Species of the Wallings Forest Reserve Area

Genus	Species epithet	Family - Howard	Common Name	Growth Habit	Origin
Blechum	*pyramidatum*	Acanthaceae	Rock balsam	H	N
Siphonoglossa	*sessilis*	Acanthaceae	Cossie balsam	H	N
Justicia	*carthaginensis*	Acanthaceae		S	N
Odontonema	*nitidum*	Acanthaceae		S	N
Thunbergia	*fragrans*	Acanthaceae	White Susan vine	V	N
Agave	*karatto*	Agavaceae	Century plant	H/S	N
Furcraea	*tuberosa*	Agavaceae		H/S	N
Hymenocallis	*caribaea*	Amaryllidaceae	Spider lily	H	N
Mangifera	*indica*	Anacardiaceae	Mango	T	I
Comocladia	*dodonaea*	Anacardiaceae	Pick Evil	S	N
Spondias	*mombin*	Anacardiaceae	Hog Plum	T	N
Selaginella	cf. *serpens*	Selaginellaceae		H	N
Anemia	*adiantifolia*	Anemiaceae	Flowering fern	H	N
Anemia	*hirta*	Anemiaceae	Streambank flowering fern	H	N
Annona	*muricata*	Annonaceae	Soursop	T	I?
Annona	*squamosa*	Annonaceae	Sugar apple	T	I?
Annona	*montana*	Annonaceae	Wild soursop	T	N
Asclepias	*curiassavica*	Apocynaceae	Scarlet milkweed	H	N
Rauvolfia	*viridis*	Apocynaceae	Bellyache bush	S	N
Tabernaemontana	*citrifolia*	Apocynaceae	Milky Bush	S	N
Matelea	*maritima*	Apocynaceae	Beach milk vine	V	N
Anthurium	*grandifolium*	Araceae		H	N
Anthurium	*scandens*	Araceae	Pearl laceleaf	H	N
Philodendron	*giganteum*	Araceae		H	N
Philodendron	*scandens*	Araceae	Heartleaf Philodendron	H	N

Genus	Species epithet	Family - Howard	Common Name	Growth Habit	Origin
Cocos	*nucifera*	Arecaceae/Palmae	Coconut	T	I
Elaeis	*guineensis*	Arecaceae/Palmae	African Oil Palm	T	I
Phoenix	*dactylifera*	Arecaceae/Palmae	Date palm	T	I
Coccothrinax	*barbadensis*	Arecaceae/Palmae	Palmetto (Bda), Silver palm	T	N
Roystonea	*oleracea*	Arecaceae/Palmae	Cabbage palm	T	N
Aristolochia	*trilobata*	Aristolochiaceae	Six sixty six	V	N
Aloe	*vera*	Asphodelaceae	Aloes, Sinkle bible	H	I
Asplenium	*pumilum*	Aspleniaceae	Dwarf spleenwort	H	N
Asplenium	*serratum*	Aspleniaceae	Birdsnest fern	H	N
Bidens	*cynapiifolia*	Asteraceae		H	N
Bidens	*reptans*	Asteraceae		H	N
Pseudelephantopus	*spicatus*	Asteraceae		H	N
cf. *Struchium*	*sparganophorum*	Asteraceae		H	N
Pluchea	*carolinensis*	Asteraceae	Cure-for-all, Cattle tongue	S	N
Pluchea	*odorata*	Asteraceae		S/H	N
Vernonia	*albicaulis*	Asteraceae		S	N
Wedelia	*calycina*	Asteraceae	Marigold, piss-a-bed	S	N
Crescentia	*cujete*	Bignoniaceae	Calabash	T	N
Tabebuia	*heterophylla*	Bignoniaceae	White cedar	T	N
Macfadyena	*unguis-cati*	Bignoniaceae	Cat's claw	V	N
Blechnum	*occidentale*	Blaechnaceae	Hammock fern	H	N
Cordia	*obliqua*	Boraginaceae	Clammy cherry	T	I
Cordia	*globosa*	Boraginaceae	Black sage	S	N
Cordia	*nesophila*	Boraginaceae	Black sage	S	N
Bourreria	*succulenta*	Boraginaceae	Chinkswood	T	N
Cordia	*alliodora*	Boraginaceae	Cypre, Spruce	T	N
Cordia	*collococca*	Boraginaceae	Manjack	T	N
Cordia	*curassavica*	Boraginaceae	Wild sage	T	N
Cordia	*dentata* ?	Boraginaceae		T	N
Cordia	*reticulata*	Boraginaceae		T	N

Genus	Species epithet	Family - Howard	Common Name	Growth Habit	Origin
Cordia	*sulcata*	Boraginaceae	Manjack	T	N
Aechmea	*lingulata*	Bromeliaceae	Wild pineapple	H	N
Bromelia	*plumieri*	Bromeliaceae	Plumier's pingwing	H	N
Catopsis	*floribunda*	Bromeliaceae	Strap airplant	H	N
Pitcairnia	*angustifolia*	Bromeliaceae		H	N
Tillandsia	*utriculata*	Bromeliaceae	Giant airplant	H	N
Bursera	*simaruba*	Burseraceae	Turpentine	T	N
Pilosocereus	*royeni*	Cactaceae	Dildo	T	N
Hylocereus	*trigonus*	Cactaceae	Night-blooming cactus	V	N
Canella	*winteriana*	Canellaceae	Cinnament, Cinnamon	T	N
Cleome	*rutidosperma*	Capparaceae		H	N
Morisonia	*americana*	Capparaceae	Rat apple, wild sapodilla	S	N
Capparis	*baducca*	Capparaceae	Rat bean	T	N
Capparis	*cynophallophora*	Capparaceae	Black willow	T	N
Capparis	*flexuosa*	Capparaceae	Dogwood	T	N
Capparis	*hastata*	Capparaceae	Broadleaf caper	T	N
Capparis	*indica*	Capparaceae	Willow	T	N
Carica	*papaya*	Caricaceae	Pawpaw, papaya	H/T	N
Crossopetalum	*rhacoma*	Celastraceae	Maidenberry	S	N
Schaefferia	*frutescens*	Celastraceae		S	N
Calophyllum	*calaba*	Clusiaceae		T	N
Clusia	*major*	Clusiaceae	Mountain cherry, Wild man support	T	N
Terminalia	*catappa*	Combretaceae	Indian almond	T	I
Bucida	*buceras*	Combretaceae	Whitewood	T	N
Callisia	*repens*	Commelinaceae	Inch vine	H	N
Commelina	*diffusa*	Commelinaceae	Climbing dayflower	H	N?
Commelina	*elegans*	Commelinaceae	Whitemouth dayflower	H	N?
Ipomoea	*repanda*	Convolvulaceae		V	N
Jacquemontia	*pentanthos*	Convolvulaceae		V	N
Merremia	*umbellata*	Convolvulaceae	Hog vine	V	N

Genus	Species epithet	Family - Howard	Common Name	Growth Habit	Origin
Bryophyllum	*pinnatum* ?	Crassulaceae	Love bush	H	I
Momordica	*charantia*	Cucurbitaceae	Maiden's blush	V	I?
Cayaponia	*americana*	Cucurbitaceae	Wild pumpkin	V	N
Cucumis	*anguria*	Cucurbitaceae	Wild cucumber	V	N
Dioscorea	*alata*	Dioscoreaceae	Water yam	V	I
Dioscorea	*bulbifera*	Dioscoreaceae	Air yam	V	N?
Sansevieria	*hyacinthoides*	Dracaenaceae	Iguana tail	H	I
Erythroxylum	*havanense*	Erythroxylaceae		T	N
Jatropha	*gossypiifolia*	Euphorbiaceae	Physic nut, bellyache bush	S	I?
Argythamnia	*polygama*	Euphorbiaceae	Silver wood	S	N
Bernardia	*corensis*	Euphorbiaceae		S	N
Croton	*astroites*	Euphorbiaceae	Balsam	S	N
Croton	*flavens*	Euphorbiaceae	Rock sage, nailpolish bush	S	N
Gymnanthes	*lucida*	Euphorbiaceae	Oyster wood	S	N
Pedilanthus	*tithymaloides*	Euphorbiaceae	Slipper plant, bleeding heart	S	N
Hura	*crepitans*	Euphorbiaceae	Sandbox	T	N
Sapium	*caribeaum*	Euphorbiaceae	Bird lime	T	N
Dalechampia	*scandens*	Euphorbiaceae	Bull nettle	V	N
Tragia	*volubilis*	Euphorbiaceae	Woman Stinging Nettle	V	N
Enicostema	*verticillatum*	Gentianaceae		H	N
Heliconia	*Bihai* ?	Heliconiaceae		H/S	N
Heliconia	*caribaea*	Heliconiaceae		H/S	N
Trichomanes	*krausii* ?	Hymenophyllaceae	Treemoss bristle fern	H	N
Trichomanes	sp.	Hymenophyllaceae		H	N
Trimezia	*martinicensis*	Iridaceae	Yellow iris	H	N
Leonotis	*nepetifolia*	Lamiaceae	Lord Lavington	H	I?
Hyptis	*pectinata*	Lamiaceae		H	N
Ocimum	*campechianum*	Lamiaceae	Basil, Nunu balsam	H	N
Persea	*americana*	Lauraceae	Avocado Pear	T	I
Licaria	*salicifolia*	Lauraceae	Puerto Rico cinnamon	T	N

Genus	Species epithet	Family - Howard	Common Name	Growth Habit	Origin
Nectandra	*membranacea*	Lauraceae	Sweetwood	T	N
Ocotea	*coriacea*	Lauraceae	Laurel, lancewood	T	N
Tamarindus	*indica*	Leguminosae-Caesalpinioideae	Tambrind	T	I
Senna	*occidentalis*	Leguminosae-Caesalpinioideae	Stinking weed	H	I?
Caesalpinia	*bonduc*	Leguminosae-Caesalpinioideae	Warri bush, grey nicker	S	N
Caesalpinia	*ciliata*	Leguminosae-Caesalpinioideae	Warri bush, yellow nicker	S	N
Chamaecrista	*glandulosa*	Leguminosae-Caesalpinioideae	Broom	S	N
Senna	*bicapsularis*	Leguminosae-Caesalpinioideae	Christmas bush, money bush	S	N
Bauhinia	*multinervia*	Leguminosae-Caesalpinioideae		T	N
Haematoxylon	*campechianum*	Leguminosae-Caesalpinioideae	Logwood	T	N
Hymenaea	*courbaril*	Leguminosae-Caesalpinioideae	Tinkin Toe	T	N
Indigofera	*suffruticosa*	Leguminosae-Faboideae	Indigo	S	I
Crotalaria	*retusa*	Leguminosae-Faboideae	Wild sweet pea, shack-shack, pop bush	H	N
Desmodium	*axillare*	Leguminosae-Faboideae	Cousin	H	N
Desmodium	*incanum*	Leguminosae-Faboideae	Tick clover	H	N
Desmodium	*tortuosum*	Leguminosae-Faboideae	Beggarweed, sweetheart	S	N
Indigofera	*tinctoria*	Leguminosae-Faboideae	Indigo	S	N
Machaerium	*lunamtum*	Leguminosae-Faboideae		S	N
Andira	*inermis*	Leguminosae-Faboideae	W.I. walnut	T	N
Lonchocarpus	*violaceus*	Leguminosae-Faboideae	Lancepod	T	N
Lonchocarpus	*hepthaphyllus*	Leguminosae-Faboideae		T	N
Piscidia	*carthagenensis*	Leguminosae-Faboideae	Dogwood	T	N
Abrus	*precatorius*	Leguminosae-Faboideae	Jumbie bead	V	N
Canavalia	cf. *campylocarpa*	Leguminosae-Faboideae		V	N
Centrosema	*pubesens*	Leguminosae-Faboideae	Snake plant, cowitch	V	N
Vigna	*luteola*	Leguminosae-Faboideae	Cow pea	V	N
cf. *Vigna*	sp.	Leguminosae-Faboideae		V	N
Acacia	*nilotica*	Leguminosae-Mimosoideae	Gum Arabic Tree	I	I
Acacia	*macracantha*	Leguminosae-Mimosoideae	Alabamba	T	I

Genus	Species epithet	Family - Howard	Common Name	Growth Habit	Origin
Acacia	*tortuosa*	Leguminosae-Mimosoideae	Twisted acacia	T	I
Albizia	*lebbeck*	Leguminosae-Mimosoideae	Shushel, woman's tongue, shak-shak	T	I
Leucaena	*leucocephala*	Leguminosae-Mimosoideae	Wild tamarind	T	I
Mimosa	*pudica*	Leguminosae-Mimosoideae	Sensitive plant	H	I?
Acacia	*farnesiana*	Leguminosae-Mimosoideae	Sweet acacia	T	I?
Acacia	*muricata*	Leguminosae-Mimosoideae	Spineless wattle	T	N
Inga	*laurina*	Leguminosae-Mimosoideae	Spanish oak, sac bean	T	N
Pithecellobium	*unguis-cati*	Leguminosae-Mimosoideae	Bread & Cheese	T	N
Acacia	*retusa*	Leguminosae-Mimosoideae	Catch & keep	V	N
Mimosa	*ceratonia*	Leguminosae-Mimosoideae	Ambret	V	N
Hippobroma	*longiflora*	Lobeliaceae	Star of Bethlehem	H	I?
Nephrolepis	*rivularis*	Lomariopsidaceae	Streamside sword fern	H	N
Psittacanthus	*martinicensis*	Loranthaceae	Man 'pon tree	H	N
Ammannia	cf. *latifolia*	Lythraceae		H	N
Bunchosia	*glandulosa*	Malpighiaceae	Cabrita, Elsie Bush	T	N
Byrsonima	*spicata*	Malpighiaceae	Shoemaker's bark	T	N
Heteropterys	*purpurea*	Malpighiaceae		V	N
Stigmaphyllon	*ciliatum* ?	Malpighiaceae		V	N
Stigmaphyllon	*emarginatum*	Malpighiaceae		V	N
Triumfetta	cf. *lappula*	Malvaceae		H	N
Malvastrum	*coromandelianum*	Malvaceae		H	N
Sida	*acuta*	Malvaceae	Wire Weed, sweet broom	H	N
Pavonia	*spinifex*	Malvaceae		S	N
Melochia	*pyramidata*	Malvaceae		S	N
Melochia	*tomentosa*	Malvaceae	Balsam, Sailor's broom	S	N
Waltheria	*indica*	Malvaceae	Velvet leaf	S	N
Ceiba	*pentandra*	Malvaceae	Silk Cotton	T	N
Ochroma	*pyramidale*	Malvaceae		T	N
Quararibea	*turbinata*	Malvaceae		T	N
Guazuma	*ulmifolia*	Malvaceae	Gunstock	T	N

Genus	Species epithet	Family - Howard	Common Name	Growth Habit	Origin
Marantha	*arundinacea*	Maranthaceae	Arrowroot	H	I?
Miconia	*laevigata*	Melastomataceae		S	N
Miconia	*mirabilis*	Melastomataceae		S	N
Swietenia	*mahagoni*	Meliaceae	West Indian Mahogany	T	I
Trichilia	*hirta*	Meliaceae		T	N
Cissampelos	*pareira*	Menispermaceae	Velvet leaf	V	N
Ficus	*citrifolia*	Moraceae	Strangler fig	T	N
Ficus	cf. *trigonata*	Moraceae	Black fig, banan	T	N
Musa	*sp.*	Musaceae	Banana	H/T	I
Ardisia	*obovata*	Myrsinaceae		T	N
Syzygium	*jambos*	Myrtaceae	Rose Apple	T	I
Eugenia	*cordata*	Myrtaceae	Lathberry	T	N
Eugenia	*ligustrina*	Myrtaceae	Black cherry	T	N
Eugenia	*monticola*	Myrtaceae		T	N
Myrcia	*citrifolia*	Myrtaceae	Red birch, guava berry	T	N
Pimenta	*racemosa*	Myrtaceae	Bay leaf, Christmas bush	T	N
Psidium	*guajava*	Myrtaceae	Guava	T	N
Salicornia	*perennis*	Chenopodiaceae	Glasswort	H	N
Guapira	*fragrans*	Nyctaginaceae	Black loblolly	T	N
Pisonia	*aculeata*	Nyctaginaceae	Cockspur	T	N
Pisonia	*subcordata*	Nyctaginaceae	Loblolly	T	N
Ouratea	*guildingii*	Ochnaceae		T	N
Schoepfia	*schreberi*	Olacaceae		T	N
Jasminum	*fluminense*	Oleaceae	Jasmine	V	I
Chionanthus	*compacta*	Oleaceae	Wild Olive	T	N
Ludwigia	*erecta*	Onagraceae		H	N
Epidendrum	*ciliare*	Orchidaceae	Christmas or eyelash Orchid	H	N
Epidendrum	*secundum*	Orchidaceae	Lopsided star orchid	H	N
Oncidium	*urophyllum*	Orchidaceae	Yellow dancing lady	H	N
Oeceoclades	*maculata*	Orchidaceae		H	N?

Genus	Species epithet	Family - Howard	Common Name	Growth Habit	Origin
Oxalis	*barrelieri*	Oxalidaceae		H	N
Oxalis	*corniculata*	Oxalidaceae	Sour grass	H	N
Passiflora	*laurifolia*	Passifloraceae	Wild passion flower	V	N
Passiflora	*rubra*	Passifloraceae	Passion flower, snakeberry vine	V	N
Passiflora	*suberosa*	Passifloraceae	Passion flower	V	N
Petiveria	*alliacea*	Phytolaccaceae	Garlic root	H	N
Rivina	*humilis*	Phytolaccaceae	Bloodberry	H	N
Trichostigma	*octandrum*	Phytolaccaceae	Hoopvine	S	N
Picramnia	*pentandra*	Picramniaceae	Bitter Bush	T	N
Peperomia	*emarginella*	Piperaceae	Guadeloupe peperomia	H	N
Peperomia	*glabella* ?	Piperaceae	Cypress peperomia	H	N
Peperomia	*humilis* ?	Piperaceae	Polynesian peperomia	H	N
Peperomia	*magnoliifolia* ?	Piperaceae		H	N
Peperomia	*myrtifolia*	Piperaceae	Myrtle-leaf peperomia	H	N
Piper	*amalago*	Piperaceae	Jointwood, lemon hihuillo	S	N
Piper	*aduncum*	Piperaceae		S	N
Piper	*dilatatum*	Piperaceae	Candle bush	S	N
Peperomia	*rotundifolia*	Piperaceae		V	N
Plumbago	*scandens*	Plumbaginaceae	Old woman's bush	S	N
Coix	*lacryma-jobi*	Poaceae/Graminiae	Job's Tears	H	I
Cymbopogon	*citratus*	Poaceae/Graminiae	Fever grass, Cironella, Lemon grass	H	I
Dichanthium	*aristatum*	Poaceae/Graminiae	Antigua hay grass	H	I
Panicum	*maximum*	Poaceae/Graminiae	Guinea grass	H	I
Bambusa	*vulgaris*	Poaceae/Graminiae	Bamboo	H/T	I
Lasiacis	*divaricata*	Poaceae/Graminiae		H	N
Coccoloba	*krugii*	Polygonaceae	Whitewood, wild grape	T	N
Coccoloba	*pubescens*	Polygonaceae	Ducana leaf	T	N
Coccoloba	*swartzii*	Polygonaceae	Swartz's pigeon plum	T	N
Coccoloba	*venosa*	Polygonaceae	Sugar grape	T	N
Campyloneurium	*phyllitidis*	Polypodiaceae	Birdsnest Fern	H	N

Genus	Species epithet	Family - Howard	Common Name	Growth Habit	Origin
Microgramma	*heterophylla*	Polypodiaceae	Clinging snake fern	H	N
Microgramma	*lycopodioides*	Polypodiaceae	Clubmoss snake fern	H	N
Microgramma	*piloselloides*	Polypodiaceae	Hairy snake fern	H	N
Neurodium	*lanceolatum*	Polypodiaceae	Ribbon fern	H	N
Phlebodium	*aureum*	Polypodiaceae	Golden polypody	H	N
Pleopeltis	*polypodioides*	Polypodiaceae	Resurrection fern	H	N
Polypodium	*triseriale*	Polypodiaceae	Anglevein fern	H	N
Portulaca	*oleracea*	Portulacaceae	Common purslane	H	N
Pteris	*biaurita*	Pteridaceae	Thinleaf brake fern	H	N
Adiantopsis	*radiata*	Pteridaceae		H	N
Adiantum	*latifolium*	Pteridaceae	Broadleaf maidenhair fern	H	N
Adiantum	*lucidum*	Pteridaceae		H	N
Adiantum	*tetraphyllum*	Pteridaceae	Fourleaf maidenhair fern	H	N
Adiantum	*villosum*	Pteridaceae	Wooly maidenhair fern	H	N
Doryopteris	*pedata*	Pteridaceae	Digit fern	H	N
Pityrogramma	*calomelanos*	Pteridaceae	Silverback fern	H	N
Ziziphus	*mauritiana* ?	Rhamnaceae	Dumps, Dums	T	I
Gouania	*lupuloides*	Rhamnaceae	toothbrush tree	V	I
Krugiodendron	*ferreum* ?	Rhamnaceae	Iron wood	T	N
Gonzalagunia	*hirsuta*	Rubiaceae		S	N
Palicourea	*crocea*	Rubiaceae	Red Palicourea	S	N
Psychotria	*microdon*	Rubiaceae		S	N
Psychotria	*nervosa*	Rubiaceae	St John's Bush	S	N
Exostema	*caribaeum*	Rubiaceae	Greenheart	T	N
Faramea	*occidentalis*	Rubiaceae	Wild coffee	T	N
Guettarda	*crispiflora*	Rubiaceae		T	N
Guettarda	*odorata*	Rubiaceae	Gunrod	T	N
Guettarda	*ovalifolia*	Rubiaceae		T	N
Guettarda	*scabra*	Rubiaceae	Black chink	T	N
Randia	*aculeata*	Rubiaceae	Ink berry, Fishing rod	T	N

Genus	Species epithet	Family - Howard	Common Name	Growth Habit	Origin
Chiococca	*alba*	Rubiaceae	Snowberry	V	N
Chiococca	*parvifolia*	Rubiaceae	Snowberry	V	N
Citrus	*aurantifolia*	Rutaceae	Lime	T	I
Citrus	*aurantium*	Rutaceae	Sour Orange	T	I
Amyris	*elemifera*	Rutaceae	Torchwood	T	N
Zanthoxylum	*flavum*	Rutaceae	Yellow sandalwood	T	N
Zanthoxylum	*martinicense*	Rutaceae	Prickly Ash. White prickle	T	N
Zanthoxylum	*monophyllum*	Rutaceae	Yellow prickle	T	N
Zanthoxylum	*spinifex*	Rutaceae	Ram goat	T	N
Casearia	*decandra*	Salicaceae		T	N
Casearia	*guianensis*	Salicaceae		T	N
Prockia	*crucis*	Salicaceae		T	N
Samyda	*dodecandra*	Salicaceae	Wild guava	T	N
Phoradendron	*trinervium*	Santalaceae	Angled mistletoe	H	N
Melicoccus	*bijugatus*	Sapindaceae	Genip	T	I
Sapindus	*saponaria*	Sapindaceae	Soapberry	T	N
Chrysophyllum	*argenteum*	Sapotaceae	Wild star apple	T	N
Sideroxylon	*foetidissimum*	Sapotaceae	Mastic	T	N
Sideroxylon	*obovatum*	Sapotaceae	Boxwood	T	N
Sideroxylon	*salicifolium*	Sapotaceae	Sweetwood	T	N
Capraria	*biflora*	Scrophulariaceae	Wild tea	H	I
Picrasma	*excelsa*	Simaroubaceae	Bitter ash	T	N
Capsicum	*annuum*	Solanaceae	Hot pepper	S	N
Cestrum	*diurnum*	Solanaceae		S	N
Cestrum	*laurifolium* ?	Solanaceae	Candlewood	S	N
Solanum	*americanum*	Solanaceae	Nightshade	S	N
Solanum	*racemosum*	Solanaceae	Dolly tomato	S	N
Solanum	*torvum*	Solanaceae		S	N?
Tectaria	*incisa*	Tectariaceae	Incised halberd fern	H	N
Thelypteris	*patens*	Thelypteridaceae	Gridscale maiden fern	H	N

Genus	Species epithet	Family - Howard	Common Name	Growth Habit	Origin
Thelypteris	*quadrangularis*	Thelypteridaceae		H	N
Thelypteris	*tetragona*	Thelypteridaceae	Freetip maiden fern	H	N
Thelypteris	cf. *kunthii*	Thelypteridaceae		H	N
Jacquinia	*armillaris*	Theophrastaceae	Torchwood	T	N
Daphnopsis	*americana*	Thymelaeaceae	Bitter mahoe	T	N
Celtis	*iguanaea*	Ulmaceae	Iguana hackberry	S	N
Trema	*micrantha*	Ulmaceae	Trema	T	N
Pilea	*herniarioides* ?	Urticaceae	Clearweed	H	N
Stachytarpheta	*cayennensis*	Verbenaceae	Vervain shrub	H	N
Stachytarpheta	*jamaicensis*	Verbenaceae	Vervain	H	N
Aegiphila	*martinicensis*	Verbenaceae		S	N
Clerodendrum	*aculeatum*	Verbenaceae	Privet	S	N
Lantana	*camara*	Verbenaceae	Sage	S	N
Lantana	*involucrata*	Verbenaceae	Sage	S	N
Citharexylum	*fruticosum*	Verbenaceae	Fiddlewood	T	N
Duranta	*erecta*	Verbenaceae	Golden dewdrop, pigeon berry	T	N
Petrea	*kohautiana*	Verbenaceae	Purple wreath	V	N
Cissus	*verticillata*	Vitaceae	Pudding bush, rope vine, snake vine	V	N
unknown	unknown	unknown		T	N

Acronyms:
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- I=Introduced
- N=Native
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Notes:
- Species with cf. - the ID is not yet determined
- Species with "?" - the occurrence of the species in the area may be questionable
- Species with N? or I? - the species may be native or it may be introduced

APPENDIX IV

Plant Species of the Codrington Lagoon National Park and Adjacent Areas, Including Areas within the Newly Proposed Boundaries

Genus	*Species epithet*	Family - Howard	Common Name	Growth Habit	Origin
Agave	*karatto*	Agavaceae	Century plant	H/S	N
Comocladia	*dodonaea*	Anacardiaceae	Pick Evil	S	N
Annona	*muricata*	Annonaceae	Soursap	T	I?
Annona	*squamosa*	Annonaceae	Sugar Apple	T	I?
Asclepias	*curiassavica*	Apocynaceae	Scarlet milkweed	H	N
Metastelma	*parviflorum*	Apocynaceae		V	N
Plumeria	*alba*	Apocynaceae	Wild frangipani	T	N
Rauvolfia	*viridis*	Apocynaceae		S	N
Coccothrinax	*barbadensis*	Arecaceae/Palmae	Palmetto (Bda), Silver palm	T	N
Cocos	*nucifera*	Arecaceae/Palmae	Coconut	T	I
Thrinax	*morrisii*	Arecaceae/Palmae	Pimetta (Bda), Thatch palm	T	N
Borrichia	*arborescens*	Asteraceae	Seaside Tansy	S	N
Borrichia	*Frutescens(?)*	Asteraceae	Seaside Marigold	S	N
Gundlachia	*corymbosa*	Asteraceae	Yam bush	S	N
Pluchea	*carolinensis*	Asteraceae	Cure-for-all, Cattle tongue	S	I?
Pluchea	*odorata*	Asteraceae	Cattle tongue (herb)	S	N
Sphagneticola	*trilobata*	Asteraceae	Carpet Daisy	H	N
Wedelia	*calycina*	Asteraceae	Marigold, piss-a-bed	S	N
Avicennia	*germinans*	Avicenniaceae/Acanthaceae	Black mangrove	T	N
Tabebuia	*heterophylla*	Bignoniaceae	White cedar	T	N
Tecoma	*stans*	Bignoniaceae	Tecoma	S	N
Argusia	*gnaphalodes*	Boraginaceae	Sea lavendar	S	N
Bourreria	*succulenta*	Boraginaceae	Chinkswood	T	N
Cordia	*curassavica*	Boraginaceae	Wild sage	T	N

Genus	*Species epithet*	Family - Howard	Common Name	Growth Habit	Origin
Cordia	*globosa*	Boraginaceae	Black sage	T	N
Cordia	*obliqua*	Boraginaceae	Clammy cherry	T	N
Tournefortia	*microphylla*	Boraginaceae		V	N
Tillandsia	*utriculata*	Bromeliaceae	Giant airplant	H	N
Bursera	*simaruba*	Burseraceae	Turpentine	T	N
Mammillaria	*nivosa*	Cactaceae		H	N
Melocactus	*intortus*	Cactaceae	Turk's cap cactus	H	N
Opuntia	*dillenii*	Cactaceae	Prickly pear	S	N
Opuntia	*rubescens*	Cactaceae	Prickly pear	S	N
Opuntia	cf. *dejecta*	Cactaceae	Prickly pear	S	N
Pilosocereus	*royeni*	Cactaceae	Dildo	T	N
Canella	*winteriana*	Canellaceae	Cinnament, Cinnamon	S	N
Capparis	*flexuosa*	Capparaceae	Dogwood	T	N
Capparis	*indica*	Capparaceae	Willow	T	N
Cassine	*xylocarpa*	Celastraceae		T	N
Crossopetalum	*rhacoma*	Celastraceae	Maidenberry	S	N
Gyminda	*latifolia*	Celastraceae		S	N
Chrysobalanus	*icaco*	Chrysobalanaceae	Coco plum	S	N
Bucida	*bucera*	Combretaceae	Whitewood	T	N
Conocarpus	*erectus*	Combretaceae	Button mangrove	T	N
Laguncularia	*racemosa*	Combretaceae	White mangrove	T	N
Terminalia	*catappa*	Combretaceae	Almond tree	T	N
Ipomoea	*pes-caprae*	Convolvulaceae	Sea wisse	V	N
Jacquemontia	*cayensis ?*	Convolvulaceae		V	N
Jacquemontia	*havanensis ?*	Convolvulaceae		V	N
Cyperus	*planifolius*	Cyperaceae	Coastal sedge	H	N
Distichilis	*spicata*	Cyperaceae	Saltgrass	H	N
Fimbristylis	*cymosa*	Cyperaceae	Spike Rush	H	N
Erythroxylum	sp.	Erythroxylaceae/Rhizophoraceae		T	N

Genus	*Species epithet*	Family - Howard	Common Name	Growth Habit	Origin
Chamaesyce	*articulata*	Euphorbiaceae	Milk shrub	S	N
Croton	*astroites*	Euphorbiaceae		S	N
Hippomane	*mancinella*	Euphorbiaceae	Machioneel	T	N
Jatropha	*gossypiifolia*	Euphorbiaceae		S	I?
Pedilanthus	*tithymaloides*	Euphorbiaceae	Slipper plant, bleeding heart	S	N
Cassytha	*filiformis*	Lauraceae	Love vine	V	N
Ocotea	*coriacea*	Lauraceae		T	N
Chamaecrista	*glandulosa*	Leguminosae-Caesalpinioideae	Broom	S	N
Haematoxylon	*campechianum*	Leguminosae-Caesalpinioideae	Logwood	T	I?
Parkinsonia	*aculeata*	Leguminosae-Caesalpinioideae	Parkinsonia	T	I?
Senna	*obtusifolia*	Leguminosae-Caesalpinioideae	Java bean	S	I?
Senna	sp.	Leguminosae-Caesalpinioideae		S	N
Tamarindus	*indica*	Leguminosae-Caesalpinioideae	Tamarind	T	I?
Pictetia	*aculeata*	Leguminosae-Faboideae		T	N
Sesbania	*sericea*	Leguminosae-Faboideae		S	N
Acacia	*farnesiana*	Leguminosae-Mimosoideae		T	I?
Acacia	*macracantha*	Leguminosae-Mimosoideae	Alabamba	T	I?
Caesalpinia	*bonduc*	Leguminosae-Mimosoideae		S	N
Leucaena	*leucocephala*	Leguminosae-Mimosoideae	Wild tamarind	T	I?
Neptunia	*sp.*	Leguminosae-Mimosoideae		H	N
Pithecellobium	*unguis-cati*	Leguminosae-Mimosoideae	Bread & Cheese	T	N
Byrsonima	*lucida*	Malpighiaceae	Clam cherry	T	N
Malpighia	*linearis*	Malpighiaceae	Stinging Bush	T	N
Stigmaphyllon	*emarginatum*	Malpighiaceae		V	N
Gossypium	*barbadense*	Malvaceae	Cotton	S	N
Melochia	*pyramidata*	Malvaceae		S	N
Melochia	*tomentosa*	Malvaceae	Balsam, Sailor's broom	S	N

Genus	*Species epithet*	Family - Howard	Common Name	Growth Habit	Origin
Unknown	Unknown	Malvaceae	"Swamp Malvaceae"	H	N
Azadirachta	*indica*	Meliaceae	Neem	T	I
Ficus	*citrifolia*	Moraceae		T	N
Eugenia	*biflora*	Myrtaceae	Wattle	T	N
Eugenia	*cordata*	Myrtaceae	Wattle	T	N
Myrtifolia	sp. ?	Myrtaceae		T	N
Psidium	*longipes*	Myrtaceae	Mangrove berry	T	N
Guapira	*fragrans*	Nyctaginaceae	Black loblolly	T	N
Pisonia	*subcordata*	Nyctaginaceae	Loblolly	T	N
Schoepfia	schreberi	Olacaceae		T	N
Tetramicra	*caniculata*	Orchidaceae	Wallflower orchid	H	N
Tolumnia	*urophyllum*	Orchidaceae	Yellow dancing lady	H	N
Passiflora	*suberosa*	Passifloraceae	Passion flower	V	N
Phyllanthus	*amarus*	Phyllanthaceae	Seed-under-leaf	S	N
Phyllanthus	*epiphyllanthus*	Phyllanthaceae	Billbush	S	N
Sporobolus	*virginicus*	Poaceae	Saltgrass	H	N
Coccoloba	diversifolia	Polygonaceae		T	N
Coccoloba	*krugii*	Polygonaceae	Whitewood, wild grape	T	N
Coccoloba	*uvifera*	Polygonaceae	Sea grape	T	N
Colubrina	*arborescens*	Rhamnaceae	Mauby, Soap bush	S	N
Ziziphus	*mauritania*	Rhamnaceae	Dumps	T	I
Ziziphus	*reticulata*	Rhamnaceae		T	N
Antirhea	*coriacea*	Rubiaceae	Mutton polly	S	N
Erithalis	*fruticosa*	Rubiaceae	Candlewood	S	N
Ernodea	*littoralis*	Rubiaceae	Cough bush, wild pomegramma	S	N
Exostema	*caribaeum*	Rubiaceae	Greenheart	T	N
Randia	*aculeata*	Rubiaceae	Fishing rod	S	N
Strumpfia	*maritima*	Rubiaceae	Seaside Rosemary, Seagull food	S	N
Zanthoxylum	*flavum*	Rutaceae	Yellow sandalwood	T	N
Zanthoxylum	*spinifex*	Rutaceae		T	N

Genus	*Species epithet*	Family - Howard	Common Name	Growth Habit	Origin
Dodonaea	*viscosa*	Sapindaceae	Hop bush	S	N
Sideroxylon	*obovatum*	Sapotaceae	Boxwood	T	N
Capraria	*biflora*	Scrophularlaceae		H	I
Castela	*erecta*	Simaroubaceae	Goat bush	S	N
Solanum	*racemosum*	Solanaceae	Dolly tomato	S	N
Suriana	*maritima*	Surianaceae		S	N
Jacquinia	*armillaris*	Theophrastaceae	Torchwood	T	N
Citharexylum	*fruticosum*	Verbenaceae	Fiddlewood	T	N
Citharexylum	*spinosum* ?	Verbenaceae	Fiddlewood	T	N
Duranta	*erecta* ?	Verbenaceae	Golden dewdrop, pigeon berry	T	N
Lantana	*involucrata*	Verbenaceae	Sage	S	N
Phoradendron	*trinervium*	Viscaceae	Angled mistletoe	H	N
Cissus	*obovata*	Vitaceae		V	N
Guaiacum	*officinale*	Zygophyllaceae	Lignum vitae	T	N

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