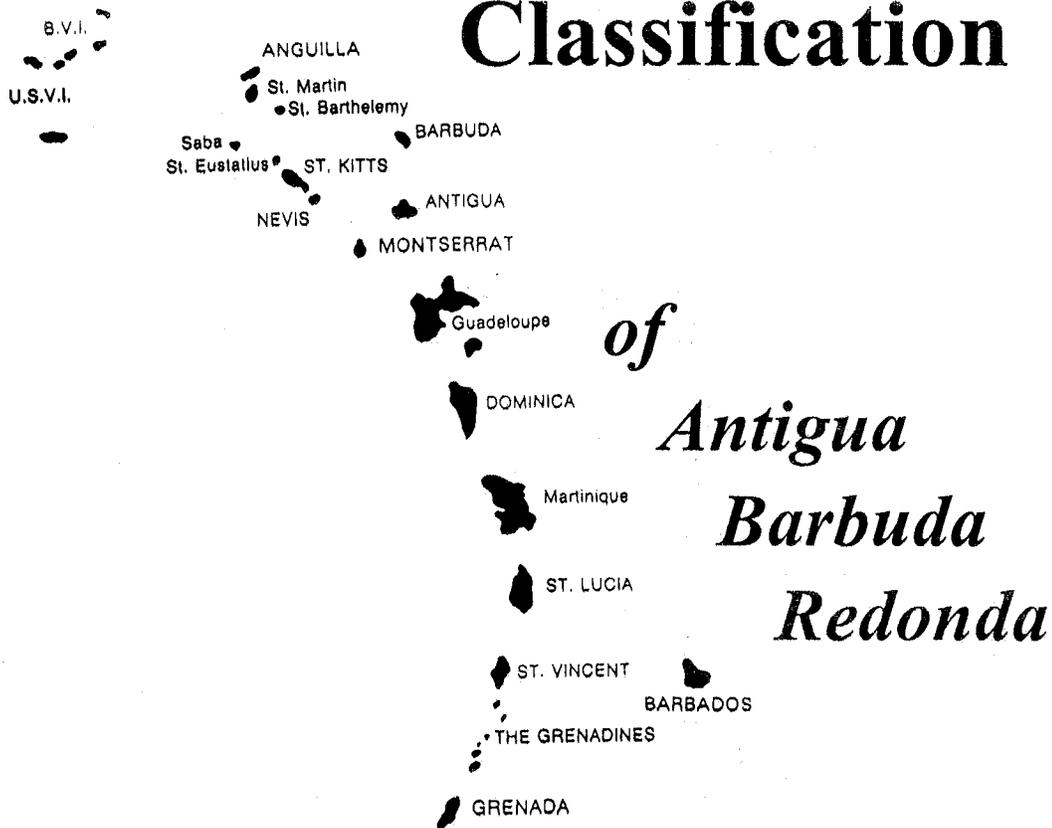


A Vegetation Classification



May 1997

Kevel Lindsay and Bruce Horwith
Island Resources Foundation
Eastern Caribbean Biodiversity Programme

A Vegetation Classification of Antigua-Barbuda-Redonda: Implications for Conservation

Prepared by Kevel Lindsay and Bruce Horwith

island resources
FOUNDATION

*Eastern Caribbean Biodiversity Programme
Biodiversity Publication #2*

Table of Contents

Table of Contents	1
Abstract	2
Introduction	3
Methodology	3
Antigua-Barbuda-Redonda Classification	7
Conservation Implications	54
Acknowledgments	59
Literature Cited	60

List of Tables

1 Plant Species in the Antigua-Barbuda-Redonda Vegetation Classification	50
2 Comparison of Vegetation Classifications for Antigua-Barbuda-Redonda	55
3 Conservation Status of Vegetation Types in Antigua-Barbuda-Redonda	56

ABSTRACT

This report presents a vegetation classification system for Antigua-Barbuda that was developed by Island Resources Foundation's Biodiversity Programme staff to guide biodiversity conservation efforts in that country. Fifty-four Alliances and Associations were identified; these are based on the proposed National Vegetation Classification System under preparation by the United States Federal Geographic Data Committee. This U.S. national effort is part of a global initiative to characterize land cover and land use in a standardized manner.

The classification presented in this report differs from previous vegetation studies:

- (1) in emphasizing *existing* rather than *potential* vegetation, and
- (2) by refining the coarser level classifications to produce a more detailed system intended for conservation management purposes.

The report includes a table attempting to reconcile our classification with the major classifications that preceded it.

The conservation status of each of the 54 Alliance/Associations is identified using a two-tier labeling system modified from the Red Data Book Categories of the World Conservation Union (IUCN). Sixteen Alliances/Associations are classified as Rare (very restricted in distribution and/or size); and five of these are also considered Endangered (in danger of extirpation).

INTRODUCTION

This vegetation classification for Antigua-Barbuda has been developed as a management tool to assist the country in conserving its biodiversity. Ideally, such conservation efforts would be prioritized and guided by information on distribution and abundance at the species level; but as a first step we have used the less resource-intensive approach of working at a community level.

This classification identifies 54 Alliances and Associations (defined below), which are sufficiently different from one another to be fairly easily distinguishable in the field. The "*Location*" heading identifies where to find particularly good examples of each vegetation type, which can be visited to reinforce the descriptions. Where possible, we also comment on how widespread the Alliance or Association is in each island (primarily Antigua and Barbuda, with Redonda included with less detail); in some cases, we identify all known sites. In the future, Island Resources Foundation investigators plan to add information on fauna associated with these communities.

An obvious conservation priority for Antigua-Barbuda is to ensure that at least a few sites of each of the natural communities are protected. Not only would this protect the country's biodiversity at the ecosystem level, but at the species level it should provide substantial protection of much of the flora and fauna. A conservation status summary follows the classification below.

METHODOLOGY

This investigation was undertaken with the expectation that our task would be to update one of several earlier vegetation studies of the country. We found, however, that none of these classification systems was adequate to meet our current needs. One important difference between our classification system and the previous efforts of most other researchers (*e.g.*, Loveless, 1960, which is based on the work of Box and Charter during the period from 1932-38; Cater, 1944; Beard, 1949; and Harris, 1965) is that the earlier efforts emphasized vegetation categories that were believed to exist before Europeans disrupted the landscape. In a country where landscape has been as severely impacted as it is in Antigua-Barbuda, this emphasis obscures the biological realities of both islands today (although their work does raise interesting possibilities for restoration efforts). [One previous researcher, working in Antigua-Barbuda in the early 1980s, developed an ecological classification in response to the fact that much of the natural vegetation had been altered beyond recognition by human manipulation. While agreeing with this perspective, we found Morello's (1983) categories difficult to identify in the field and inadequate for our conservation concerns.]

VEGETATION CLASSIFICATION OF ANTIGUA-BARBUDA-REDONDA

For our purposes, another shortcoming of these previous vegetation studies, and other influential regional-level studies such as Beard (1955), Stehle (1945) and Howard (1973), is that their categories are defined at too coarse a level (floristically and geographically) to address national biodiversity conservation and management objectives.

The system that is used in this document is based on the proposed National Vegetation Classification System being prepared by the United States Federal Geographic Data Committee (FGDC, 1996); more specifically, we referenced the *Vegetation of the West Indies*, an application of the FGDC system to the Caribbean by the Southeast Regional Office of The Nature Conservancy (Weakley, 1996).

As stated in the Federal Geographic Data Committee document, the

overall objective . . . is to support the production of uniform statistics on vegetation resources at the national level [as] part of a larger effort . . . to create a global system to characterize land cover and land use.

The proposed hierarchy for the National Vegetation Classification System is as follows:

DIVISION

ORDER

PHYSIOGNOMIC CLASS

PHYSIOGNOMIC SUBCLASS

PHYSIOGNOMIC GROUP

SUBGROUP

physiognomic level FORMATION

floristic level ALLIANCE

COMMUNITY ASSOCIATION

There are seven upper levels:

Division. This separates Earth cover into either vegetated or non-vegetated categories based on whether the vegetation cover is less than or greater than 1%; in the Antigua-Barbuda report, only the description of "caves" refers to a situation where the vegetation cover is less than 1%.

Order. This describes the dominant life form (*i.e.*, tree, shrub, dwarf-shrub, herb, non-vascular).

Class. This refers to the relative percent canopy cover of the life form in the uppermost strata during the peak of the growing season. The Classes include:

- I. **Closed tree canopy.** Trees with their crowns interlocking (generally forming 60-100% cover).
- II. **Open tree canopy.** Open stands of trees with crowns usually not touching (generally forming 25-60% cover). Canopy tree cover (rarely) may be less than 25% but it exceeds that of the other life-forms.
- III. **Shrubland.** Shrubs generally greater than 0.5m tall with individuals or clumps not touching to interlocking (generally forming >25% canopy cover, and tree cover generally <25%). Shrub cover (rarely over) may be less than 25% but it exceeds that of the other life-forms.
- IV. **Dwarf-shrubland.** Low growing shrubs and/or trees usually under 0.5m tall. Individuals or clumps not touching to interlocking (generally forming >25% cover, and trees and shrubs generally <25% cover). Dwarf-shrub cover (rarely) may be less than 25% but it exceeds that of the other life-forms.
- V. **Herbaceous.** Herbs (graminoids, forbs and ferns) dominant (generally forming >25% cover and trees, shrubs and dwarf-shrubs generally <25% cover). Herbaceous cover (rarely) may be less than 25% but it exceeds that of the other life-forms.
- VI. **Non-vascular.** Non-vascular cover (bryophytes and lichens) dominant (generally forming >25% cover; and trees, shrubs, dwarf-shrubs and herbs generally <25% cover). Non-vascular cover (rarely) may be less than 25% but it exceeds that of the other life-forms. Crustose lichen-dominated areas should be placed in the Sparsely Vegetated Class.

VII. **Sparsely Vegetated.** Vegetation is scattered or nearly absent, between 1-10% cover.

Subclass. This is determined by the predominant leaf phenology (evergreen, deciduous, mixed evergreen-deciduous), and the average height of the herbaceous stratum. Different variables are applied to this hierarchical level in the Sparsely Vegetated Class.

Group. This is defined by a combination of climate, leaf morphology and leaf phenology. Different variables are applied to this hierarchical level in the Sparsely Vegetated Class.

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

Formation. This is based on ecological groupings of vegetation units with broadly defined environmental and additional physiognomic factors in common.

There are two lower levels:

Alliance. This is the first floristic level and includes data on height of vegetation strata. The Alliance typically includes one or more characteristic species in its title, and together with the description under "*Concept*", it provides an operational definition that allows it to serve as the basic unit for conservation management concerns.

Community Association. In some, but not all, cases an Alliance 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 improves biodiversity conservation efforts.

It is interesting to note that the FGDC system proposes that the lower levels (*i.e.*, the Alliances and Associations) be based on data collected in the field using standard documented sampling methods; however, even though these have not yet been defined, we had little difficulty in using the system to prepare the Antigua-Barbuda classification. Perhaps our experience may be an artifact of working on a small island and gaining a subsequent familiarity with the landscape, but we find that the existing level of detail in the FGDC system already provides adequate criteria to identify Alliances and Associations.

ANTIGUA-BARBUDA-REDONDA CLASSIFICATION¹

- I.A. Evergreen closed tree canopy
- I.A.1. Tropical or subtropical broad-leaved evergreen closed tree canopy
- I.A.1.N.a. Lowland tropical or subtropical broad-leaved evergreen closed tree canopy
- I.A.1.N.a.(1) *Ficus citrifolia*-*Ceiba pentandra*-*Roystonea oleracea* lowland tropical or subtropical broad-leaved evergreen closed tree canopy Alliance
- I.A.1.N.a. (1.a) *Ardisia obovata*-*Aechmea lingulata* Association
- (1.b) *Cordia spp*-*Inga laurina* Association
- (1.c) *Ocotea leucoxyton*-*Eugenia spp* Association

CONCEPT:

This Alliance contains three Associations in Antigua-Barbuda that differ primarily in their dominant species. Scattered canopy emergents of *Ficus citrifolia*, *Ceiba pentandra* and *Roystonea oleracea*; 20m plus canopy; mid-level understory from 2-5m is discernible; abundant lianas, often climbing to canopy; abundant epiphytes, bromeliads and ferns. Loveless (1960) labels this Evergreen Seasonal forest (sensu Beard, 1949), noting that it is less mesophytic than Beard's Tropical Rain forest and lacks the latter's characteristic species (especially the *Dacryodes-Slonea* association). However, some "rainforest" species do occur (e.g., *Ocotea leucoxyton*, *Simarouba amara*), and it is more mesophytic than Beard's Semi-Evergreen Seasonal forest.

SPECIES:

Canopy: *Sideroxylon foetidissimum*, *Clusia sp.*, *Lonchocarpus violaceus*, *Cordia spp.*, *Zanthoxylum flavum*, *Chionanthus compacta* [= *Linociera caribea*], *Mangifera indica*, *Hymanea courbaril*, *Simarouba amara*, *Ficus trigonata*, *F. nymphaeifolia*, *Ocotea leucoxyton*.

Mid-level understory: *Zanthoxylum martinicense*, *Guettarda scabra*, *G. ovalifolia*, *G. crispifolia*, *Bauhinia multinervia*, *Eugenia spp.*, *Inga laurina*, *Tabernaemontana citrifolia*, *Picramnia pentandra*, *Coccoloba pubescens*, *Daphnopsis americana*, *Nectandra guianensis*, *Ardisia obovata*, *Chrysophyllum argenteum*, *Palicourea crocea*, *Psychotria nervosa*, and *Sapium caribaeum*, and several species in the Melastomataceae.

¹ For list of plant species included in this classification, see Table 1.

Lianas and climbing epiphytes: *Acacia retusa*, *Macfadyena unguis-cati*, *Pereskia aculeata* (rare), *Petrea kohautiana*, *Philodendron giganteum*, *P. scandens*, *Monstera adansonii*, *Peperomia rotundifolia*, *Hylocereus trigonus*.

Ground cover: Numerous ferns—*Asplenium serratum* (rare), *A. cristatum*, *Thelypteris tetragona*, *Adiantum villosum*, *A. tetraphyllum*, *Trichomanes kraussii* and *Vittaria lineata* (rare); *Anthurium spp*; *Aechmea lingulata*.

(Loveless also lists: *Heliconia caribbea*, *Guarea macrophylla*, *Oreopanax capitatus*, *Cissampelos pareira*, *Cissus verticillata*, *Heteropterys purpurea*, *Ipomoea repanda*, *Stigmaphyllon emarginatum*, *Pristimera caribaea* [rare], *Hyperbaena domingensis* [rare]).

LOCATION:

Not found in Barbuda. In Antigua, in small patches (none larger than 200m², most less than 40m²), above 150m elevation.

Ardisia obovata-*Aechmea lingulata* Association: northern slope of Sugarloaf Mt.

Cordia spp-*Inga laurina* Association: Wallings Hill.

Ocotea leucoxydon-*Eugenia spp* Association: in Boggy Peak/Dark Valley/Christian Valley, Dunning Valley, Blubber Valley.

I.A.1.N.a.(2) *Mangifera indica-Cocos nucifera-Bucida buceras* lowland tropical or subtropical broad-leaved evergreen closed tree canopy Alliance

CONCEPT:

Steep wet ghauts; often with freshwater springs. Scattered canopy emergents of *Ceiba pentandra*, *Roystonea oleracea*; *Cocos nucifera*, and *Bucida buceras*; 20m plus canopy; mid-story (and vines) less dense than Alliances I.A.1.N.a.(1.a-c). Both emergents and canopy often contain remnants of cultivation. Understory is sparse because of floods, consisting mainly of seedlings of the canopy species (which often are swept away during heavy rains), plus ferns and others adapted to periodic flash flooding. Often occurs as patches within seasonal forests (I.C.1.N.a.(1) *Coccoloba pubescens-Eugenia* spp mixed evergreen-deciduous Alliance).

SPECIES:

Canopy: *Hura crepitans*, *Cocos nucifera*, *Bucida buceras*, *Andira inermis*, *Terminalia catappa*, *Mangifera indica* and *Bambusa* spp.

Mid-story: *Crescentia cujete*, *Chrysophyllum argenteum*, *Guazuma ulmifolia*, *Vitex divericata*, *Coccoloba venosa*, *Inga laurina*, *Quararibea turbinata*, *Bauhinia multinervia*, *Ficus citrifolia*, *F. trigonata*, *Citrus* spp, *Annona* spp., *Syzygium jambos* and *Casearia guianensis*.

Ground cover: *Polypodium* spp., *Acrostichum danaefolium*.

LOCATION:

Not found in Barbuda. In Antigua, main examples are Wallings (including Fig Tree Drive), Christian Valley, Sugar Loaf, Hamilton's and Brecknocks, Signal Hill, Richmond Hill and Windy Ridge areas.

I.A.1.N.j Solution-hole tropical or subtropical broad-leaved evergreen closed tree canopy

I.A.1.N.j.(1) *Coccothrinax barbadensis* solution-hole tropical or subtropical broad-leaved evergreen closed tree canopy Alliance

CONCEPT:

Found in solution-hole situations where water is available most of the time. In other cases (I.C.1.N.a.(3) *Tabebuia heterophylla*-*Pisonia subcordata* lowland tropical or subtropical mixed evergreen-deciduous closed tree canopy Alliance), the solution-holes do not retain enough water to support this alliance. Well-defined canopy (although considerable destruction evident from the 1995 hurricanes) and mid-level understory.

SPECIES:

Canopy: *Coccothrinax barbadensis*, *Sideroxylon obovatum* (common at Bryant Cave), *Sideroxylon* sp. (common at Darby Cave).

Mid-level understory: Seedlings of the canopy species plus *Capparis indica*, *Capparis cynophallophora*, *Canella winterana*, *Ficus citrifolia*.

LOCATION:

Restricted to Highlands of Barbuda.

I.A.5. Tropical or subtropical broad-leaved evergreen sclerophyllous closed tree canopy

I.A.5.N.a. Lowland tropical or subtropical broad-leaved evergreen sclerophyllous closed tree canopy

I.A.5.N.a.(1) *Calliandra purpurea-Hylocereus trigonus* lowland tropical or subtropical broad-leaved evergreen sclerophyllous closed tree canopy Alliance

CONCEPT:

Two-storied forest with emergents of *Pisonia subcordata* and *P. fragrans*, *Tabebuia heterophylla*, *Coccoloba diversifolia*, *C. pubescens*, *C. uvifera*, *Hymanea courbaril* above 12m canopy. Dense understory and concentrations of epiphytic species. Thick humus over rocks and thin soil layer.

SPECIES:

Canopy: *Pisonia subcordata*, *P. fragrans*, *Tabebuia heterophylla*, *Coccoloba diversifolia*, *C. pubescens*, *Amyris elemifera*, *Gymnanthes lucida*, *Clusia major*.

Understory: *Chamaecrista glandulosa* var. *swartzii*, *Guerttarda scabra*, *Ardisia obovata*, *Gymnanthes lucida*, *Tetrazygia* sp., a number of *Eugenia* spp. (unidentified), *Calliandra purpurea*, *Coccoloba pubescens*, *C. uvifera*, *Ouratea guildingii*, *Clusia major*, *Brunfelsia* sp., *Capparis hastata*, *Comocladia dodonea*, *Phyllanthus epiphyllanthus*, *Canella winterana*, *Hylocereus trigonus* (very common). The bromeliad *Aechmea lingulata* forms dense ground cover as well as growing on trees, *Tillandsia utriculata*, three species of *Polypodium* ferns, and three species of orchids—*Epidendrum ciliare*, *Oncidium urophyllum* and *Tetramicra caniculata*.

LOCATION:

West of Freeman's Village and All Saints (although most of this forest has been destroyed), Olivers (St. Clare's Estate), Buckleys.

I.A.5.N.a.(2) *Tillandsia usneoides*-*Morisonia americana* lowland tropical or subtropical broad-leaved evergreen sclerophyllous closed tree canopy Alliance

CONCEPT:

Two-storied forest with emergents of *Bursera simaruba* and *Pisonia subcordata* above a 15m canopy. The canopy is festooned with curtains of the abundant *Tillandsia usneoides*. Dense ground cover of *Hylocereus trigonus*, *Agave karatto*, *Aechmea lingulata* and *Celtis iguanaea* occur over frequent rocky outcrops.

SPECIES:

Canopy: *Morisonia americana*, *Pisonia subcordata* and *P. fragrans*, *Ficus citrofolia*, *Eugenia* spp.

Understory: *Capparis baducca*, *C. indica*, *C. cynophallophora*, *Pilosocereus royeri*, *Eugenia* spp.

Ground cover: *Pisonia aculeata*, *Rhipsalis baccifera* [rare], *Hylocereus trigonus* [rare], *Tragia volubilis*, *Aechmea lingulata*, *Tillandsia utriculata*, *Celtis iguanaea*, *Agave karatto*.

LOCATION:

Sleeping Indians and northeast face of Sugarloaf.

I.A.5.N.a.(3)

***Coccoloba uvifera*-*Canella winterana* lowland tropical or subtropical broad-leaved evergreen sclerophyllous closed tree canopy Alliance**

CONCEPT:

Two-storied forest of trees 5-15m, found in dune depressions. Several species (e.g., *Byrsonima lucida*, *Thrinax morrisii*) show their most robust growth here because of the water that collects in the depressions.

SPECIES:

Coccoloba uvifera, *Canella winterana*, *Tabebuia heterophylla*, *Byrsonima lucida*, *Zanthoxylum flavum*, *Thrinax morisii*, *Jacquinnia armillaris* and a number of species in the Myrtle family.

LOCATION:

Not found in Antigua. In Barbuda, it is most extensive at Palmetto Point, and it also occurs on sand spit west of Codrington Lagoon (from Palm Beach to Cedar Tree Point), and the southeast coast. The forest on the north and east coasts is of a lower stature due to the prevailing Trade winds.

I.A.5.N.d Seasonally flooded/saturated tropical or subtropical broad-leaved evergreen sclerophyllous closed tree canopy

I.A.5.N.d.(1) *Rhizophora mangle* seasonally flooded/saturated tropical or subtropical broad-leaved evergreen sclerophyllous closed tree canopy Alliance

CONCEPT:

The various traditional categories used by researchers to refer to mangroves and associated salt flats/salt ponds fall into 5 of the 7 "classes" recognized by the FGDC (1996). The most comprehensive list of these habitats for Antigua and Barbuda is provided by Bacon (1991), who notes 36 sites in Antigua comprising 559 hectares and 9 sites in Barbuda comprising 617 hectares. We have reviewed Bacon's list and placed as many of the sites as possible within the appropriate FGDC classification. At least one site is identified for each classification to serve as a representative. Future field work will allow us to classify the remaining sites. This Alliance consists of land-locked mangrove systems and is therefore free of the direct influence of the sea.

SPECIES:

Rhizophora mangle, Avicennia germinans, Laguncularia racemosa, Conocarpus erectus, Annona glabra, Acrostichum danaefolium.

LOCATION:

In Barbuda, Bull Hole and areas east of Bull Hole, Freshwater Pond, and some solution holes in eastern Highlands (e.g., Box Cave and Round Cave). Not in Antigua.

I.A.5.N.e. Tidally flooded tropical or subtropical broad-leaved evergreen sclerophyllous closed tree canopy

I.A.5.N.e.(1) *Rhizophora mangle* tidally flooded tropical or subtropical broad-leaved evergreen sclerophyllous closed tree canopy Alliance

CONCEPT:

As compared to I.A.5.N.d., this Alliance is not land-locked and is influenced by sea tides.

SPECIES:

Rhizophora mangle, *Avicennia germinans*, *Laguncularia racemosa*, *Conocarpus erectus*.

LOCATION:

Not in Barbuda. In Antigua, Flashes, Urlings, Cades Bay, Carlisle Bay, Falmouth Harbour, English Harbour, Indian Creek, Christian Hill, Ayer's Creek, Fitches Creek.

- I.C. Mixed evergreen-deciduous closed tree canopy
- I.C.1. Tropical or subtropical mixed evergreen-deciduous closed tree canopy
- I.C.1.N.a. Lowland tropical or subtropical mixed evergreen-deciduous closed tree canopy
- I.C.1.N.a.(1) *Coccoloba pubescens*-*Eugenia* spp lowland tropical or subtropical mixed evergreen-deciduous closed tree canopy Alliance

CONCEPT:

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 I.A.1.N.a.(1.b) *Cordia* spp-*Inga laurina* Association in 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 20m, but generally less than in wetter forests; understory often from coppicing.

SPECIES:

Canopy: *Pisonia fragrans*, *P. subcordata*, *Coccoloba diversifolia*, *C. pubescens*, *Swietenia mahagoni*, *Zanthoxylon martincensis*, *Bursera simarouba*, *Tabebuia heterophylla*.

Understory: *Eugenia* spp., *Guettarda scabra*, *Erythroxylum havanense*, *Coccothrinax barbadensis* (rare in Antigua, and generally 10m or less in height compared to 30m plus specimens in Barbuda).

LOCATION:

Wallings, Christian Valley, Signal Hill, southern slope of Boggy Peak, Dark Valley, and western slope of Sugarloaf.

I.C.1.N.a.(2) *Pisonia subcordata*-*Canella winterana* lowland tropical or subtropical mixed evergreen-deciduous closed tree canopy Alliance

CONCEPT:

Offshore island dry forest with *Pisonia subcordata* and *Canella winterana* as the most conspicuous canopy species, reaching heights of around 10m. *Pithecellobium unguis-cati* and *Agave karrato* abundant in undergrowth, but vegetation not distinctively separated into stories. Included in Loveless' "Dry evergreen thicket".

SPECIES:

Canopy: *Pisonia subcordata*, *P. fragrans*, *Canella winterana*, *Tabebuia heterophylla*, *Capparis indica* and *C. cynophallophora*, *Malphigia emarginata*, *M. linearis*, *Sideroxylon obovatum*, *Krugiodendron ferreum*, *Pilosocereus royeri*; the bromeliad *Tillandsia utriculata* occurs on trees.

Understory: *Pilosocereus royeri*, *Chamaecrista glandulosa* var. *swartzii*, *Pithecellobium unguis-cati*, *Agave karatto*, *Jacquinia armillaris*, *Erithalis fruticosa*, *Comocladia dodonaea*. Vines of *Stigmaphyllon langulatum*.

LOCATION:

Offshore islands of Antigua, especially western third of Great Bird Island, Green Island, ridge of Crump Island, patches on Guiana Island, Hawes Island, both Maiden Islands (in North Sound and Hanson's Bay), Pelican Island, Laviscount Island, Little Island and Long Island.

I.C.1.N.a.(3) *Pisonia subcordata*-*Bouyeria succulenta* lowland tropical or subtropical mixed evergreen-deciduous closed tree canopy Alliance

CONCEPT:

Two-storied forest with occasional emergents of *Bursera simaruba* and *Tabebuia heterophylla* above a 6-12m canopy of slender-stemmed trees (less than 15-20cm); understory of dense, fairly impenetrable thickets, in part because of the extensive vines characteristic of this alliance. Occurs in dry areas and/or areas with shallow soils. Includes Loveless' "Dry evergreen thicket".

SPECIES:

Canopy: *Tabebuia heterophylla*, *Plumeria alba*, *Amyris elemifera*, *Pisonia subcordata*, *Capparis indica* and *C. cynophallophora*, *Malphigia emarginata*, *M. linearis*, *Canella winterana*, *Piscidia carthagenensis* [= *P. piscipula*], *Pisonia fragrans*, *Sideroxylon obovatum*, *Krugiodendron ferreum*; the bromeliad *Tillandsia utriculata* occurs on trees.

Understory: *Pilosocereus royeri*, *Chamaecrista glandulosa* var. *swartzii*, *Pithecellobium unguis-cati*, *Agave karatto*, *Leucaena leucocephala*, *Acacia* spp., *Gymnanthes lucida*, *Haematoxylum campechianum*, *Jacquinia armillaris*, *Guettarda parviflora*, *Erithalis fruticosa*, *Comocladia dodonaea*, *Zanthoxylum spinifex*, *Randia aculeata*, *Colubrina arborescens* (in open patches or forest edge), and several unidentified myrtle species. Vines of *Pisonia aculeata*, *Stigmaphyllon langulatum*, *Gouania lupuloides*, *Passiflora suberosa*, *Galactia dubia*, *Heteropterys purpurea*, *Macfadyena unguis-cati*, *Ipomea tiliacea*, *Jasminum fluminense*, *Cardiospermum halicacabum*, and *Trichostigma octandrum*.

LOCATION:

Not in Barbuda. In Antigua, New Winthropes, Barnes Hill, Santa Maria Hill, Weatherill's, St. Phillips, Freetown, Brown's Bay, Mill Reef, Willikies and Seatons, Picadilly, Savanna, Urlings, Crab Hill, Old Road, Doiggs, Shirley Heights, Five Islands area.

I.C.1.N.a.(4) *Tabebuia heterophylla*-*Pisonia subcordata* lowland tropical or subtropical mixed evergreen-deciduous closed tree canopy Alliance

CONCEPT:

Two-storied forest with occasional emergents of *Ficus citrifolia*, *Bursera simaruba* and *Tabebuia heterophylla* above a 10-15m canopy; dense understory. Beard and Loveless suggest that the lower intensity of grazing and better-drained soils account for the difference between this Alliance and the shrub alliance, but better soil studies are needed. [Part of Beard's Evergreen Bushland and the Loveless' Evergreen Woodlands.]

SPECIES:

Canopy: *Tabebuia heterophylla*, *Bucida buceras*, *Pisonia subcordata*, *P. fragrans*, *Zanthoxylum flavum*, *Pilosocereus royeri*, *Lonchocarpus latifolius* (listed by Beard, but not in Howard for Antigua or Barbuda), *Sideroxylon salicifolium*, *S. obovatum*, *Piscidia carthagenensis*, *Coccothrinax barbadensis*

Understory : *Coccoloba krugii*, *Malphigia linearis*, *Plumeria alba*, *Canella winterana*, *Bourreria succulenta*, *Comocladia dodonaea*, *Jacquinia amillaris*, *Pithecellobium unguis-cati*, *Gyminda latifolia*, *Eugenia axillaris*, *E. sintenisii*, *E. bahamensis* [listed in Beard, but not in Howard], *Phyllanthus epiphyllanthus*, *Capparis cynophallophora*.

LOCATION:

Common in Barbuda Highlands, and occasionally in Lowlands (e.g., Bull Hole area) and southwest of the Highlands.

I.C.1.N.c. Seasonally flooded/saturated tropical or subtropical mixed evergreen-deciduous closed tree canopy

I.C.1.N.c.(1) *Annona glabra-Bucida buceras* seasonally flooded/saturated tropical or subtropical mixed evergreen-deciduous closed tree canopy Alliance

CONCEPT:

Two storied forest: canopy to 15m, understory of varying heights and not dense. Characterized by presence of alkaline standing freshwater or soil that is saturated much of the year. The water movement is slow and could be considered part of a stream system (other than during floods) and the ground is seldom dry. Referred to as Riparian Forest by Beard, Loveless and Harris.

SPECIES:

Canopy: *Hippomane mancinella*, *Bucida buceras*, *Terminalia catappa*, *Sapindus saponaria*, *Cordia obliqua*, *Tamarindus indica*.

Understory: *Thespesia populnea*, *Annona glabra*, *Cordia obliqua*, *Thevetia peruviana* [rare], *Acrostichum danaefolium*, *Nymphaea* spp.

LOCATION:

Not in Barbuda and only remaining sites in Antigua are along Black Ghaut and Bristol Ghaut between Collins Reservoir and Gaynors, the North Sound stream which drains into Fitches Creek and small patches in the Fitches area.

II.A. Evergreen open tree canopy

II.A.1. Tropical or subtropical broad-leaved evergreen open tree canopy

II.A.1.N.a. Tropical or subtropical broad-leaved evergreen open tree canopy

II.A.1.N.a.(1) *Phoenix dactylifera* tropical or subtropical broad-leaved evergreen open tree canopy Alliance

CONCEPT:

Scattered individual trees—primarily of this species—occur in grasslands.

SPECIES:

Phoenix dactylifera, *Pisonia subcordata*, *Azadirachta indica*, *Psidium guajava*,
Eugenia spp., *Cordia curassavica*, *Paspalum* spp.

LOCATION:

In Antigua, All Saints, Freemans Village and Buckleys . Not found in Barbuda.

II.A.1.N.a.(2) *Coccothrinax barbadensis* tropical or subtropical broad-leaved evergreen open tree canopy Alliance

CONCEPT:

Scattered individual trees—primarily of this species—occurs in thin woodlands of trees and shrubs. Often, bordered by the I.C.1.N.a.(3). *Tabebuia heterophylla-Pisonia subcordata* lowland tropical or subtropical mixed evergreen-deciduous closed tree canopy Alliance.

SPECIES:

Coccothrinax barbadensis (individuals do not reach the height attained in the I.A.1.N.j.(1) *Coccothrinax barbadensis* solution-hole tropical or subtropical broad-leaved evergreen closed tree canopy Alliance), *Canella winterana*, *Ficus citrifolia*.

LOCATION:

Fairly continuous belt running east to west in the south-east section of the Highlands.

II.A.1.N.a.(3) *Hippomane mancinella-Coccoloba uvifera* tropical or subtropical broad-leaved evergreen open tree canopy Alliance

CONCEPT:

Occurs along the coast, where the trees often are stunted due to winds. Form thin strips that run parallel to the coast.

SPECIES:

Thespesia populnea, *Hippomane mancinella*, *Conocarpus erectus*, *Cocos nucifera*, *Coccoloba uvifera*, *Terminalia catappa*, *Cordia sebestena* and occasional shrubs such as *Acacia*.

LOCATION:

In Antigua, common in Indian Creek area, Pigeon Beach, and Willoughby Bay. In Barbuda, Two Foot Bay and other areas of the north and east coast.

II.A.1.N.b. Seasonally/temporarily flooded tropical or subtropical broad-leaved evergreen open tree canopy

II.A.1.N.b.(1) *Conocarpus erectus*-sedge Seasonally/temporarily flooded tropical or subtropical broad-leaved evergreen open tree canopy Alliance

CONCEPT:

Almost monospecific stands of *Conocarpus erectus* and dense sedges, one species which attains heights of 3-4m. Characterized by being dry most of the year, with seasonal flooding; and by the dune substrate.

SPECIES:

Conocarpus erectus, *Thrinax morisi*, sedge species.

LOCATION:

Only known from Palmetto Point in Barbuda, in old, weathered dunes in the north-west section and the southwestern section.

II.A.1.N.d. Semipermanently flooded tropical or subtropical broad-leaved evergreen open tree canopy.

II.A.1.N.d.(1) *Rhizophora-Avicennia-Laguncularia* Semipermanently flooded tropical or subtropical broad-leaved evergreen open tree canopy Alliance

CONCEPT:

Similar to I.A.5.N.d., but more open tree canopy.

SPECIES:

Rhizophora mangle, *Avicennia germinans*, *Laguncularia racemosa*, *Conocarpus erectus*.

LOCATION:

In Antigua, McKinnon's Salt Pond, Valley Church Bay, Goat Head at Cades Bay, Jabberwock. In Barbuda, Bull Hole and areas east of Bull Hole, Freshwater Pond, Pelican Bay and Pelican Point, Rubbish Bay, and west of Castle Bay.

II.A.1.N.e. Tidally flooded tropical or subtropical broad-leaved evergreen open tree canopy.

II.A.1.N.e.(1) *Rhizophora-Avicennia-Laguncularia* tidally flooded tropical or subtropical broad-leaved evergreen open tree canopy Alliance

CONCEPT:

Similar to I.A.5.N.e., but more open tree canopy.

SPECIES:

Rhizophora mangle, *Avicennia germinans*, *Laguncularia racemosa*,
Conocarpus erectus.

LOCATION:

In Antigua, south and east sides of Flashes as you move inland from the water, Cades Bay, Carlisle Bay, Ayer's Creek, Fitches Creek, Jabberwock.

- II.C. Mixed evergreen-deciduous open tree canopy
- II.C.1. Tropical or subtropical mixed evergreen-deciduous open tree canopy
- II.C.1.N.x. Seasonally/temporally flooded tropical or subtropical mixed evergreen-deciduous open tree canopy
- II.C.1.N.x.(1) *Cordia obliqua* seasonally/temporally flooded tropical or subtropical mixed evergreen-deciduous open tree canopy Alliance

CONCEPT:

Generally exists as thin belt of vegetation associated with streams, ghauts and pond edges. Under natural conditions, the vegetation differs from that on adjoining lands because of greater water availability; but frequently confined by cultivation. Distinguishable from I.A.1.N.a.(2) *Mangifera indica-Cocos nucifera-Bucida buceras* low-land tropical or subtropical broad-leaved evergreen closed tree canopy Alliance by a lower, less dense and distinct canopy (around 15m), undefined understory, trees often covered by vines of *Ipomoea* spp and *Stigmaphyllon* spp. Most trees confined to banks above standing water, exceptions being *Annona glabra* and *Elaeis guineensis*, which are adapted to standing water.

SPECIES:

Canopy: *Cordia obliqua*, *Prosopis juliflora*, *Pisonia subcordata*, *Phoenix dactylifera*, *Terminalia catappa*, *Elaeis guineensis* (especially at Body Ponds), *Cocos nucifera*, *Tabebuia heterophylla*, *Coccoloba diversifolia*, *Ficus citrifolia*, *Bucida buceras*, *Hippomane mancinella*, *Delonix regia*, *Bambusa* spp.

Understory: *Psidium guajava*, *Annona glabra*, *Thespesia populnea*.

LOCATION:

Throughout central and southern plains of Antigua, with the best examples in All Saints, Body Ponds, Swetes and Burkes. Not in Barbuda.

II.C.1.N.x.(2) ***Annona glabra* seasonally/temporally flooded tropical or subtropical mixed evergreen-deciduous open tree canopy Alliance**

CONCEPT:

Within this formation, this Alliance and the next show the greatest tolerance for standing water.

SPECIES:

Annona glabra, *Cordia obliqua*, *Thespesia populnea*, *Laguncularia racemosa*, *Conocarpus erectus*, and *Acrostichum danaefolium*, *Wedelia calycina*, sedges and a few grass species.

LOCATION:

In Antigua, there is one small example of this community remaining in the Pigotts/Fitches Creek. It lies southwest of airport runway and north of Piggotts Quarry.

II.C.1.N.x.(3) ***Annona glabra-Conocarpus erectus* tropical or subtropical mixed evergreen-deciduous open tree canopy Alliance**

CONCEPT:

As with the above Alliance, this one shows the greatest tolerance for standing water within this formation.

SPECIES:

Conocarpus erectus, *Laguncularia racemosa*, *Annona glabra*. Aquatic plants include *Nymphaea ampla*, *Acrostichum danaefolium*, *Ceratophyllum demersum*, *Limnobium laevigatum*, and *Ruppia maritima*. There are also a number of unidentified grasses and sedges.

LOCATION:

In Barbuda, around the Bull Hole.

III.A. Evergreen shrubland

III.A.1. Tropical or subtropical broad-leaved evergreen shrubland

III.A.1.N.g. Semipermanently flooded tropical or subtropical broad-leaved evergreen shrubland

III.A.1.N.g.(1) *Rhizophora-Avicennia-Laguncularia* semipermanently flooded tropical or subtropical broad-leaved evergreen shrubland Alliance

CONCEPT:

Similar to I.A.5.N.d., but mangroves occur more as shrubs.

SPECIES:

Rhizophora mangle, *Avicennia germinans*, *Laguncularia racemosa*,
Conocarpus erectus.

LOCATION:

In Antigua, McKinnon's Salt Pond, Yeptons, Galley Bay, Pinching Bay, Valley Church Bay, Goat Head at Cades Bay, Jabberwock. In Barbuda, Freshwater Pond areas east of Freshwater Pond, Pelican Bay and Pelican Point, Rubbish Bay, and west of Castle Bay, Gravenor Bay Salt Pond.

III.A.1.N.h. Tidally flooded tropical or subtropical broad-leaved evergreen shrubland

III.A.1.N.h.(1) *Rhizophora-Avicennia-Laguncularia-Conocarpus* tidally flooded tropical or subtropical broad-leaved evergreen shrubland Alliance

CONCEPT:

Similar to I.A.5.N.d., but mangroves occur more as shrubs. This Alliance can contain any or all of the mangrove species listed.

SPECIES:

Rhizophora mangle, *Avicennia germinans*, *Laguncularia racemosa*,
Conocarpus erectus.

LOCATION:

Flashes as you move furthest inland, Cades Bay, Carlisle Bay, Falmouth Harbour, English Harbour, Indian Creek, Bethesda, Ayer's Creek, Seaton's Harbour, Guiana Bay, Parham Harbour, Fitches Creek, Jabberwock. In Barbuda, Codrington Lagoon and Creek, Goat Island, Coco Point.

- III.A.5. Extremely xeromorphic evergreen shrubland
- III.A.5.N.b. Facultatively deciduous extremely xeromorphic tropical or subtropical shrubland
- III.A.5.N.b.(1) *Pilosocereus royeri*-*Agave karatto* facultatively deciduous extremely xeromorphic tropical or subtropical shrubland Alliance

CONCEPT:

The cactus and thorn scrub vegetation occurs in areas of low water availability (low rainfall combined with poor soils and drying winds), which restricts the height of the woody species. Often occurs near coast, but is not restricted to it.

SPECIES:

Pilosocereus royeri, *Agave karatto*, *Pisonia subcordata*, *P. aculeata*, *Capparis indica*, *C. cynophallophora*, *Leucaena leucocephala*, *Pithecellobium unguis-cati*, *Haematoxylon campechianum*, *Clerodendrum aculeatum*.

LOCATION:

In Antigua, occurs in Picadilly area, Devil's Bridge, Willikies and other small pockets on eastern side of the island, Savanna area, Crab Hill, Mt. Caramel, Urlings. On offshore islands: Rabbit Island, Red Head Island, Galley Islands, Guiana Island, Crump Island, Pelican Island, Codrington Island (and the unnamed island to the west), Laviscount Island, Green Island, York Island, Smith Island, Bird Island, and Little Bird Island. In Barbuda, occurs on northern and northeastern face of the Sea Cliffs.

III.C. Mixed evergreen-deciduous shrubland

III.C.1. Tropical or subtropical mixed evergreen-drought deciduous shrubland

III.C.1.N.a. Tropical or subtropical mixed evergreen-drought deciduous shrubland
[This could have a further definer, but FGDC has not defined formations]

III.C.1.N.a.(1) *Coccoloba krugii-Comocladia dodonaea* tropical or subtropical
mixed evergreen-drought deciduous shrubland Alliance

CONCEPT:

Individuals and small clumps of trees occur in soil-filled depressions, but the general impression is of dense shrubland (reaching 2-3m). Vegetation is interspersed with bare limestone outcrops.

SPECIES:

Emergents: *Tabebuia heterophylla*, *Bucida buceras*, *Plumeria alba*, *Canella winterana*, *Pisonia subcordata*, *Ficus citrifolia*, *Malphigia linearis*, *Bourreria succulenta*, *Byrsonima lucida*, *Bunchosia glandulosa*, *Zanthoxylum flavum*, *Pilosocereus royeri*.

Shrubs: *Coccoloba krugii*, *Comocladia dodonaea*, *Lantana involucrata*, *Solanum racemosum*, *Jacquinia amillaris*, *Clerodendrum aculeatum*, *Psidium longipes*, *Sophora* sp.

Ground cover: *Tetramicra caniculata*, *Tillandsia utriculata*, and various grasses.

LOCATION:

Fairly common, from 0.4 hectare to large tracts within the Barbuda Highlands.

III.C.1.N.b. Seasonally flooded tropical or subtropical mixed evergreen-drought deciduous shrubland

III.C.1.N.b.(1) *Croton flavens- Lantana involucrata* seasonally flooded tropical or subtropical mixed evergreen-drought deciduous shrubland Alliance

CONCEPT:

Dense shrubland (2-8 m), supporting some isolated trees (but these are not associated with soil-filled depressions as in III.C.1.N.a.(1) *Coccoloba krugii-Comocladia dodonaea* tropical or subtropical mixed evergreen-drought deciduous shrubland Alliance. Numerous patches of bare soil (some as large as 1000m²) and low-lying grasses and herbs. This Alliance, in particular the patches, seem to be created and maintained by overgrazing and seasonal standing water.

SPECIES:

Emergents: *Tabebuia heterophylla, Bucida buceras, Plumeria alba, Canella winterana, Pisonia subcordata, Ficus citrifolia, Malphigia linearis, Bourreria succulenta, Byrsonima lucida, Bunchosia glandulosa, Zanthoxylum flavum, Pilocereus royeri.*

Shrubs: *Croton flavens, Coccoloba krugii, Comocladia dodonaea, Lantana involucrata, Solanum racemosum, Jacquinia amillaris, Clerodendrum aculeatum, Psidium longipes, Sophora sp.*

Ground cover: *Tetramicra caniculata, Tillandsia utriculata,* and various grasses.

LOCATION:

Only in the Barbuda Lowlands, east to southeast and south to southwest of the Highlands.

- III.C.1.N.c.(1) *Acacia spp-Caesalpinia coriaria-Haematoxylon campechianum-Leucaena leucocephala* tropical or subtropical mixed evergreen-drought deciduous shrubland Alliance

CONCEPT:

This widespread Alliance contains four Associations in Antigua and Barbuda. All contain a mixture of trees and shrubs, with the ratio depending in part on the type and timing of human disturbance. Heights generally to 5m, but can reach to 10m; no defined canopy. Density of trees and shrubs typically high, but varies considerably. Believed to be secondary in nature, reflecting succession on unmanaged pasture land (much of the pasture land was preceded by sugarcane cultivation). Beard described this as Deciduous Seasonal Forest associated with human interference; Loveless also emphasized the "interference by man and his animals" and variously labeled the communities as "grasslands", "waste bushlands" or "weeds of cultivated land".

- III.C.1.N.c.(1.a) *Acacia spp* tropical or subtropical mixed evergreen-drought deciduous shrubland Association

SPECIES:

Acacia farnesiana, A. macracantha, A. tortuosa, A. nilotica, Pithecellobium unguis-cati, Prosopis juliflora, Haematoxylon campechianum, Pilosocereus royeri, Pisonia aculeata, Capparis flexuosa.

LOCATION:

Common in Antigua, examples in Piggots, Fitches Creek, Pares, All Saints, Jonas, Bethesda, New Field/St Phillip area, Mount Pellier, Doiggs, Rendevouz Bay, New Division. Occurs in isolated patches in Barbuda, where the plants typically are more stunted (often less than 5m).

III.C.1.N.c.(1.b) *Acacia-Caesalpinia coriaria* tropical or subtropical mixed evergreen-drought deciduous shrubland Association

SPECIES:

Acacia spp, *Caesalpinia coriaria*, *Prosopis juliflora*, *Haematoxylon campechianum*, *Pilosocereus royeri*, *Pisonia aculeata*, *Capparis flexuosa*..

LOCATION:

Only in Five Islands area of Antigua, where it has been recorded at least for 35 years (Loveless).

III.C.1.N.c.(1.c) *Haematoxylon campechianum* tropical or subtropical mixed evergreen-drought deciduous shrubland Association

SPECIES:

Haematoxylon campechianum.

LOCATION:

In Antigua (where it tends to form more monospecific stands than in Barbuda), occurs in All Saints, Sandersons, Burkes, Bethesda. In Barbuda, occurs east of Cordington, the fields along the road to Coco Point and areas where the vegetation has been cleared.

III.C.1.N.c.(1.d) *Leucaena leucocephala* tropical or subtropical mixed evergreen-drought deciduous shrubland Association

SPECIES:

Leucaena leucocephala, *Pisonia subcordata*, *Acacia* spp, *Capparis flexulosa*.

LOCATION:

In Antigua, has similar geographic range as *Haematoxylon* Association. Not known to occur in Barbuda.

IV.C. Dwarf-shrubland

IV.C.1. Tropical or subtropical dwarf-shrubland

IV.C.1.N.a. Tropical or subtropical mixed evergreen-drought deciduous dwarf-shrubland.

IV.C.1.N.a.(1) *Coccoloba spp-Erithalis fruticosa* tropical or subtropical mixed evergreen-drought deciduous dwarf-shrubland Alliance

CONCEPT:

This Alliance contains three fairly distinct Associations in Barbuda. No particular species define the Alliance well, but either *Coccoloba* or *Erithalis* will be found in each Association. More characteristically, the Alliance shows stunted trees and shrubs growing on the crests of dunes. The plants are widely spaced, with exposed sand between individuals. Beard refers to this Alliance as "dune vegetation".

IV.C.1.N.a.(1.a) *Chrysobalanus icaco-Thrinax morrisii* tropical or subtropical mixed evergreen-drought deciduous dwarf-shrubland Association

SPECIES:

Chrysobalanus icaco, *Coccoloba krugii*, *Phyllanthus epiphyllanthus*, *Byrsonima lucida*, *Tabebuia heterophylla*, *Thrinax morrisii*, *Zanthoxylum flavum*, an unidentified *Eugenia*, *Erithalis fruticosa*, *Comocladia dodonea*, *Colubrina arborescens*, *Dodonaea viscosa*, *Canella winterana*, *Lantana involucreta*, *Ernodea littoralis*.

LOCATION:

Palmetto Point in Barbuda.

IV.C.1.N.a.(1.b) *Hippomane mancinella-Gundlachia corymbosa* tropical or subtropical mixed evergreen-drought deciduous dwarf-shrubland Association

SPECIES:

Hippomane mancinella, *Caesalpinia pulcherrima*, *Erithalis fruticosa*, *Gundlachia corymbosa* on disturbed sites, *Opuntia* spp.

LOCATION:

Northeast coast of Barbuda.

IV.C.1.N.a.(1.c) *Tabebuia heterophylla-Dodonaea spp* tropical or subtropical mixed evergreen-drought deciduous dwarf-shrubland Association

SPECIES:

Tabebuia heterophylla, *Erithalis fruticosa*, *Coccoloba uvifera*, *Dodonaea viscosa*, *D. elaeagnoides*.

LOCATION:

Cedar Tree Point and Low Bay Point in Barbuda.

IV.C.1.N.c. Tropical or subtropical succulent-facultatively drought-deciduous dwarf-shrubland

IV.C.1.N.c.(1) *Melocactus intortus-Jacquinia arborea* tropical or subtropical succulent-facultatively drought-deciduous dwarf-shrubland Alliance

CONCEPT:

Scattered cacti and short shrubs and trees; considerable bare ground and weathered "pavement" (often limestone), with a thin covering of soil that often is inadequate for normal root development. Cliffs, especially on sea coast, exposed to high winds and/or sea blasts thus limiting the growth of trees and shrubs.

SPECIES:

Mammillaria nivosa, *Melocactus intortus*, *Opuntia* spp, *Tillandsia utriculata* (common at Mill Reef), *Croton astroites*, *Phyllanthus epiphyllanthus*, *Jacquinia arborea*, *Lantana involucrata*, *Chamaecrista glandulosa* var. *swartzii*, *Castela erecta*, *Pithecellobium unguis-cati*, *Dodonaea viscosa*, *Erithalis fruticosa* and *E. odorifera*, *Pilosocereus royeri*, *Agave karatto*, *Talinum* sp? [rare, on North Sound Islands only].

LOCATION:

In Antigua, Willoughby Bay, Mill Reef. Offshore islands: Five Islands, Maiden Island (on the west coast), Great Bird Island, Rabbit Island, Red Head Island, Guiana Island, Lobster Island, Exchange Island, Crump Island, Pelican Island, Codrington Island (and the unnamed island to the west), Green Island, York Island, Smith Island, Bird Island, and Little Bird Island. In Barbuda, occurs on northern and northeastern face of the Sea Cliffs, and in southwest area (east of Goat Island) and Spanish Point.

V.A. Perennial grassland

V.A.1. Tropical or subtropical perennial grassland

V.A.1.N.c. Medium-tall bunch tropical or subtropical perennial grassland.

V.A.1.N.c.(1) *Paspalum* medium-tall bunch tropical or subtropical perennial grassland Alliance

CONCEPT:

Poor drainage on thin soils subject to seasonal flooding result in an herbaceous community that Beard considered to be the only natural savannas in the Lesser Antilles. Presently, this grassland shows the short growth typical of overgrazing by livestock.

SPECIES:

Paspalum spp [Beard lists *P. bakeri* as being common, but Loveless listed *P. pleostachyum*, formerly *P. secans*, as the common grass species].

LOCATION:

Within the Lesser Antilles, occurs only in Barbuda southeast of the Bull Hole.

V.A.1.N.g. Seasonally flooded/saturated tropical or subtropical grassland.

V.A.1.N.g.(1) *Eleocharis cellulosa* seasonally flooded/saturated tropical or subtropical grassland Alliance

CONCEPT:

One or more grass or sedge species occurring in standing water and/or saturated soil for much of the year; vegetation typically less than two feet in height.

SPECIES:

Eleocharis cellulosa, *Fimbristylis ferruginea*; *Ceratophyllum demersum*, *Nymphaea* spp.

LOCATION:

In Antigua, parts of the Flashes, pasture northwest of Paynters and west of Airport Road, Freetown, Montpellier and Browne's Bay. In Barbuda, parts of Bull Hole.

- V.A.2. Tropical or subtropical grassland with a tree layer (generally 10-25%)
- V.A.2.N.b. Medium-tall tropical or subtropical grassland with broad-leaved evergreen trees [unlike FGDC, we include grasslands with shrub or tree layers, whether evergreen or deciduous].
- V.A.2.N.b.(1) *Dichanthium aristatum* medium-tall tropical or subtropical grassland with broad-leaved evergreen trees Alliance

CONCEPT:

Grassland, with some forbs, with scattered shrubs and trees providing a cover of generally 10-25%. Probably none of these areas in Antigua are natural, but rather are in transition from artificially created grassland back to more woody communities and may also be maintained by grazing and frequent fires. The same is true of most cases of this Alliance in Barbuda, although natural grasslands do occur on that island as described previously.

SPECIES:

In addition to whatever shrub and tree species are present, the dominant grass species is *Dichanthium aristatum*; other monocots include *Trimezia martinicensis*, *Spiranthes lanceolata* and *S. torta*; and the following forbs: *Waltheria indica*, *W. glabra*, *Abutilon* spp., *Ludwigia octovalvis*, *Stylosanthes hamata*, *Chamaesyce hirta*, *Euphorbia cyathophora*, *Crotalaria retusa*, *Mimosa pudica*, *Neptunia* spp [N. plena?, N. pubescens?], *Amaranthus* spp., *Desmodium incanum*, *Stachytarpheta jamaicensis*.

LOCATION:

Occurs throughout Antigua and to a lesser extent, Barbuda.

V.A.2.N.b.(2) Medium-tall tropical or subtropical grassland with broad-leaved evergreen trees Alliance

CONCEPT:

Grassland, with some forbs, with scattered shrubs and trees providing a cover of generally 10-25%. Differs from preceding, in species composition, and the fact that these grasslands seem to be a result of thin, rocky and/or sandy soils; wind and salinity—not grazing.

SPECIES:

Trees and shrubs include *Coccoloba uvifera*, *Borricea arborescens* and *Sesuvium portulacastrum*; herbaceous species include *Spartina patens*, *Sporobolus virginicus*, *Cyperus panifolius*, *Fimbristylis cymosa*.

LOCATION:

On offshore islands: Great Bird Island, Hell's Gate Island, Guiana Island.

V.A.2.N.b.(3) Upland medium-tall tropical or subtropical grassland with broad-leaved evergreen trees Alliance

CONCEPT:

Usually less than 0.4 hectare in size, these sites are early successional stages following clearing of moist forest above 235m elevation. If no further disturbance occurs, the woody species of the adjoining forest replace the herbs.

SPECIES:

Trimezia martinicensis, *Spiranthes lanceolata*, *S. intorta*, *Hypoxis decumbens*, *Desmodium incanum*, numerous sedge and a few grass species.

LOCATION:

Does not occur in Barbuda. In Antigua, in western Shekerley Mountains.

V.A.2.N.b.(4) *Cymbopogon citratus* medium-tall tropical or subtropical grassland
with broad-leaved evergreen trees Alliance

CONCEPT:

Virtually monospecific stands of this introduced grass, often 20 hectares or more in size, exist where moist forest has been cleared. Maintained by fires that are deliberately set by landless livestock owners, farmers and wood cutters to promote growth of young palatable shoots and to rid the land of this invasive and difficult "weed".

SPECIES:

Cymbopogon citratus.

LOCATION:

Does not occur in Barbuda. In Antigua, occurs mostly in south with good examples in Body Ponds, Brecknock, Hamiltons, McNish, Christian Valley and Dunnings Valley, Liberta (above village on Hillside), and Swetes Village.

- V.A.4. Tropical or subtropical grassland with a dwarf-shrub layer (generally 10-25%)
- V.A.4.N.x. Tropical or subtropical forb-grassland with dwarf-shrubs
- V.A.4.N.x.(1) *Lantana camara* tropical or subtropical forb-grassland with dwarf-shrubs Alliance

CONCEPT:

Only occurs in Redonda. Despite our placement of this Alliance here within the FGDC system, our use of this Alliance differs in that its (i) herbaceous cover is comprised of approximately equal amounts of forbs as grasses, and (ii) dwarf-shrub layer coverage often exceeds 25% (to 50%).

SPECIES:

Dwarf-shrubs: *Lantana camara* [a red variety not found in Antigua], *L. involucrata*, *Agave karatto*, *Pilosocereus royeri*, *Opuntia antillana*, *O. triacantha*, *O. sp.*, *Jatropha gossypifolia*, *Croton flavens*.

Herbs: *Peperomia myrtifolia*, *Pilea microphylla*, *Iresine angustifolia*, *Hedyotis corymbosa*, *Pterocaulon alopecuroides*, *Justica periplocifolia*, *Amaranthus dubius*, *Cleome viscosa*, *Tephrosia cenerea*, *Chamaesyce hirta* [formerly *Euphorbia hirta*], *Euphorbia heterophylla*, *Phyllanthus amarus*, *Hyptis pectinata*, *Wedelia calycina*.

Ferns: *Pityrogramma calomelanos*, *P. chrysophylla*.

Vines: *Metastelma parviflorum* [formerly *Cynanchum parviflorum*], *Galactia striata*, *G. sp.*

Grasses and sedges: *Paspalum luxum*, *Rhynchelytrum repens*, *Cyperus sphacelatus*.

LOCATION:

On and around the 300m summit of Redonda.

V.C. Hydromorphic rooted vegetation

V.C.1. Tropical or subtropical hydromorphic rooted vegetation

V.C.1.N.a. Non-tidal tropical or subtropical hydromorphic rooted vegetation

V.C.1.N.a.(1) *Ruppia-Najas* non-tidal tropical or subtropical hydromorphic rooted vegetation Alliance

CONCEPT:

This Alliance refers to saltwater/brackish ponds; surprisingly, the FGDC includes both freshwater ponds and saltwater/brackish ponds under the same "formation".

SPECIES:

Ruppia cirrhosa [formerly called *R. spiralis*; Howard questions Box's record of this from Antigua], *R. maritima*, *Najas guadalupensis*, *N. marina*, *Nymphaea ampla* var *speciosa*, *Cyperus articulatus*, and algae species.

LOCATION:

Salt ponds throughout both islands.

V.C.1.N.a.(2) *Nymphaea-Nelumbo-Pistia* non-tidal tropical or subtropical hydromorphic rooted vegetation Alliance

CONCEPT:

This Alliance refers to freshwater ponds, and stagnant water in ghauts. As mentioned previously, the FGDC includes both freshwater ponds and saltwater/brackish ponds under the same "formation".

SPECIES:

Submerged plants: *Chara zeylanica*, *Nitella cernua*, *N. oligospira*, *Echinodorus berteroi* [formerly *E. cordifolius*], *Utricularia obtusa*, *Ceratophyllum demersum*.

Surface plants: *Nymphaea ampla* [either two species or varieties], *Nelumbo nucifera*, *Pistia stratiotes*, *Eichhornia crassipes*, *Lemna perpusilla*, *L. trisulca* [not recorded since Grisebach, 1859-64], *Limnobium laevigatum*, *Neptunia* spp [Box recorded it, but may be rare], *Marsilea vestita* [rare and only found in seasonal pools in the Bull Hole area] *Paspalum distichum* [Howard did not list this species for Antigua], *Paspalidium germinatum* [formerly called *Panicum germinatum*], *Cyperus* spp., *Eleocharis* spp, *Vigna luteola* [formerly called *V. repens*], *Polygonum densiflorum*.

Pond edges: *Heliotropium* sp., *Lippia* sp., *Jacquemontia ovalifolia*.

LOCATION:

Fresh water ponds throughout both islands.

VII.A. Sparsely vegetated (1-10%) consolidated rocks

VII.A.1. Sparsely vegetated cliffs

VII.A.1.N.x.(1) Sparsely vegetated cliffs Alliance

CONCEPT:

Redonda and many of the offshore islands are surrounded almost entirely by steep cliffs. Although the vegetation cover is sparse, several species occur, including trees.

SPECIES:

Ficus citrifolia, Peperomia myrtifolia, Pilea microphylla, Boerhavia coccinea, Portulaca oleracea, P. halimoides, Talinum fruticosum, Trianthema portulacastrum, Croton lobatus, Jathropa gossypifolia, Pilocereus royeni, Melocactus intortus, Opuntia triacantha, Plumbago scandens, Metastelma parviflorum [formerly, Cynanchum parviflorum], Wedelia calycina.

LOCATION:

Virtually the entire coast of Redonda and many of the offshore islands.

VII.B. Sparsely vegetated (1-10%) boulder, gravel, talus rocks

VII.B.1. Sparsely vegetated talus/scree slopes

VII.B.1.N.a.(1) Sparsely vegetated talus/scree slopes Alliance

CONCEPT:

Gullies located on the eastern and western coastlines of Redonda.

SPECIES:

Argenome mexicana

VII.B.2. Sparsely vegetated rock flats

VII.B.2.N.a.(1) Sparsely vegetated boulder field Alliance

CONCEPT:

Large boulders occur throughout Redondo, but form fields in the eastern third of the island.

SPECIES:

Tillandsia recurvata, *Pityrogramma chrysophylla*, *P. calomelanos*, *Polypodium aureum*, lichens.

VII.C. Sparsely vegetated unconsolidated material

VII.C.1. Sparsely vegetated sand dunes

VII.C.1.N.a. Dunes with sparse herbaceous vegetation

VII.C.1.N.a.(1) *Ipomoea pes-caprae*-*Canavalia rosea* dunes with sparse herbaceous vegetation Alliance

CONCEPT:

Common along beaches, from just above high water mark inland as far as sand extends. Low-lying grasses, vines and herbs, with some stunted woody species.

SPECIES:

Canavalia rosea, *Ipomoea pes-caprae*, *Argusia gnaphalodes*, *Ernodea littoralis*, *Borrchia frutescens*, *Sesuvium portulacastrum*, *Strumpfia maritima*, *Suriana maritima*, *Coccoloba uvifera*, *Blutaparon vermiculare*, *Spartina patens*, *Cenchrus* spp.

LOCATION:

Common on Antigua, the offshore islands of Great Bird Island, Guiana Island, Long Island, Maiden Island (in North Sound), Green Island, Prickly Pear and Sandy Island; and Barbuda.

VII.C.4. Sparsely vegetated soil flats

VII.C.4.N.c. Seasonally/temporally flooded mud flats

VII.C.4.N.c.(1) *Salicornia-Batis-Sesuvium* salt tolerant herb seasonally/temporarily flooded mud flats Alliance

CONCEPT:

This land-locked Alliance is referred to as "salt marsh" by Bacon who describes it as "areas dominated by low, salt tolerant herbs, . . . frequently interspersed with scrub mangrove".

SPECIES:

Batis maritima, Salicornia perennis, Sesuvium portulacastrum, Rhizophora mangle, Avicennia germinans, Laguncularia racemosa, Conocarpus erectus.

LOCATION:

Most mangrove systems have at least some "salt marsh" associated with it, but some of the more distinctive sites include: in Antigua, parts of the Flashes, Christian Hill, Parham; in Barbuda, east of Freshwater Pond.

VII.C.4.N.c.(2) Algae-dominated seasonally/temporarily flooded mud flats Alliance

CONCEPT:

This land-locked Alliance is referred to as "salina" by Bacon who characterizes it as "areas of hypersaline soils, frequently dry with a crust of salt; un-vegetated, except for algae."

SPECIES:

Algae species.

LOCATION:

In Antigua, parts of the Flashes, Christian Hill, Parham. In Barbuda, east coast of Codrington Lagoon, Goat Island, Gravenor Salt Pond.

VII.C.4.N.d. Tidally flooded mudflats.

VII.C.4.N.d.(1) *Rhizophora-Avicennia-Laguncularia-Conocarpus* tidally flooded mudflats Alliance

CONCEPT:

This Alliance is characterized by sparse mangrove vegetation and either bare ground or shallow water over bare ground.

SPECIES:

Rhizophora mangle, *Avicennia germinans*, *Laguncularia racemosa*,
Conocarpus erectus.

LOCATION:

In Antigua, Hanson's Bay. In Barbuda, Codrington Lagoon and Creek, Goat Island, Rabbit Island, Kid Island, Coco Point.

Division 2. Non-vegetated (< 1% vegetation cover)

VIII. Caves

CONCEPT:

Two basic types occur: solution holes and sea-weathered cliff openings, but several caves are a mixture of both. Despite their lack of vegetation, we include them in this classification system because of our intention to expand it at some point to cover ecosystems not just vegetation.

SPECIES:

Limited sunlight, high humidity and water dripping into and collecting in pools, result in abundant mosses, algae and lichens.

LOCATION:

Few in Antigua, and fairly well-known; common in Barbuda (see Morton, 1994).

VEGETATION CLASSIFICATION OF ANTIGUA-BARBUDA-REDONDA

Table 1. Plant species included in the Antigua-Barbuda-Redonda Vegetation Classification.

<i>Abutilon</i> spp.	<i>Capparis baducca</i> (Rat bean)
<i>Acacia farnesiana</i> (Cassie)	<i>C. cynophallophora</i> (Black willow)
<i>A. macracantha</i> (Cassie)	<i>C. flexuosa</i>
<i>A. nilotica</i> (Cassie)	<i>C. hastata</i>
<i>A. retusa</i> [= <i>A. riparia</i>] (Pull-me-back)	<i>C. indica</i> (Black willow)
<i>A. tortuosa</i> (Cassie)	<i>Cardiospermum halicacabum</i>
<i>Acrostichum danaeifolium</i> (Swamp fern)	<i>Casearia guianensis</i> (Honey tree)
<i>Adiantum tetraphyllum</i>	<i>Ceiba pentandra</i> (Silk cotton)
<i>A villosum</i>	<i>Celtis iguanaea</i> (Cockspur)
<i>Aechmea lingulata</i>	<i>Cenchrus</i> spp
<i>Agave karatto</i> (Dagger plant)	<i>Ceratophyllum demersum</i>
<i>Amaranthus dubius</i>	<i>Chamaecrista glandulosa</i> var. <i>swartzii</i>
<i>Amaranthus</i> spp. (Spinach)	<i>Chamaesyce hirta</i> [= <i>Euphorbia hirta</i>]
<i>Amyris elemifera</i> (Torchwood)	<i>Chara zeylanica</i>
<i>Andira inermis</i> (Angelin)	<i>Chionanthus compacta</i> [= <i>Linociera caribea</i>] (Mountain parry)
<i>Annona glabra</i> (Ghaut or Pond apple)	<i>Chrysobalanus icaco</i> (Coco plum)
<i>Annona</i> spp	<i>Chrysophyllum argenteum</i> (Star apple)
<i>Anthurium</i> spp (Anthurium)	<i>Cissampelos pareira</i>
<i>Ardisia obovata</i>	<i>Cissus verticillata</i> [= <i>Cissus sicyoides</i>]
<i>Argenome mexicana</i>	<i>Citrus</i> spp
<i>Argusia gnaphalodes</i> (Seaside lavender)	<i>Cleome viscosa</i>
<i>Asplenium cristatum</i>	<i>Clerodendrum aculeatum</i>
<i>A. serratum</i>	<i>Clusia major</i> (Mountain cherry)
<i>Avicennia germinans</i> (Black mangrove)	<i>Clusia</i> sp.
<i>Azadirachta indica</i> (Neem)	<i>Coccoloba boxii</i> (Grape; may be a hybrid)
<i>Bambusa</i> spp. (Bamboo)	<i>C. diversifolia</i> (Chili grape)
<i>Batis maritima</i>	<i>C. krugii</i> (Wild grape)
<i>Bauhinia multinervia</i> [= <i>Bauhinia megalandra</i>] (Mountain ebony)	<i>C. pubescens</i>
<i>Blutaparon vermiculare</i>	<i>C. uvifera</i> (Sea grape)
<i>Boerhavia coccinea</i>	<i>C. venosa</i>
<i>Borrichia frutescens</i> (Sea Daisy)	<i>Coccothrinax barbadensis</i>
<i>Bourreria succulenta</i>	<i>Cocos nucifera</i> (Coconut)
<i>Brunfelsia</i> sp (unidentified)	<i>Colubrina arborescens</i> (Mauby tree)
<i>Bucida buceras</i> (Whitewood)	<i>Comocladia dodonaea</i> (Hogwood)
<i>Bunchosia glandulosa</i>	<i>Conocarpus erectus</i> (Buttonwood)
<i>Bursera simaruba</i> (Turpentine tree)	<i>Cordia curassavica</i>
<i>Byrsonima lucida</i> (Shoemaker bark)	<i>C. obliqua</i> (Clammy cherry)
<i>Caesalpinia coriaria</i>	<i>C. sebestena</i> (Scarlet cordia)
<i>C. pulcherrima</i> (Warri)	<i>Crescentia cujete</i> (Calabash)
<i>Calliandra purpurea</i>	<i>Crotolaria retusa</i> (Shack-shack)
<i>Canavalia rosea</i> (Sea or Beach bean)	<i>Croton astroites</i>
<i>Canella winterana</i> (Wild cinnamon, Silamint)	<i>C. flavens</i>

VEGETATION CLASSIFICATION OF ANTIGUA-BARBUDA-REDONDA

Table 1 (continued). Plant species included in the Antigua-Barbuda-Redonda Vegetation Classification.

<i>C. lobatus</i>	<i>Gundlachia corymbosa</i>
<i>Cymbopogon citratus</i> (Lemon grass, Fever grass)	<i>Gyminda latifolia</i>
<i>Cyperus articulatus</i>	<i>Gymnanthes lucida</i>
<i>C. planifolius</i>	<i>Haematoxylon campechianum</i> (Logwood)
<i>C. sphacelatus</i>	<i>Hedyotis corymbosa</i>
<i>Cyperus</i> spp	<i>Heliconia caribea</i> (Heliconia or Balisier)
<i>Daphnopsis americana</i> (Mahoe)	<i>Heliotropium</i> spp
<i>Delonix regia</i>	<i>Heteropterys purpurea</i>
<i>Desmodium incanum</i> (Sweetheart)	<i>Hippomane mancinella</i> (Manchineel)
<i>Dichanthium aristatum</i>	<i>Hura crepitans</i> (Sandbox)
<i>Dodonaea elaeagnoides</i>	<i>Hylocereus trigonus</i> [= <i>Cereus antiguensis</i>]
<i>D. viscosa</i> (Hop shrub)	<i>Hymanea courbaril</i>
<i>Echinodorus berteroi</i> [= <i>E. cordifolius</i>]	<i>Hyperbaena domigensis</i>
<i>Eichhornia crassipes</i> (Water hyacinth)	<i>Hypoxis decumbens</i>
<i>Elaeis guineensis</i> (Oil palm)	<i>Hyptis pectinata</i>
<i>Eleocharis cellulosa</i>	<i>Inga laurina</i> (Spanish oak)
<i>Eleocharis</i> spp	<i>Ipomoea pes-caprae</i> (Beach morning glory)
<i>Epidendrum ciliare</i>	<i>I. repanda</i>
<i>Erithalis fruticosa</i> (Candlewood)	<i>I. tiliacea</i>
<i>E. odorifera</i> (Torchwood)	<i>Ipomoea</i> spp.
<i>Ernodea littoralis</i>	<i>Iresine angustifolia</i>
<i>Erythroxylum havanense</i> [= <i>E. ovatum</i>]	<i>Jacquemontia ovalifolia</i>
<i>Eugenia axillaris</i>	<i>Jacquinia armillaris</i>
<i>E. bahamensis</i>	<i>Jasminum fluminense</i>
<i>E. sintenisii</i>	<i>Jathropa gossypifolia</i>
<i>Eugenia</i> spp.	<i>Justica periplocifolia</i>
<i>Euphorbia cyathophora</i> (Wild poinsettia)	<i>Krugiodendron ferreum</i>
<i>E. heterophylla</i>	<i>Laguncularia racemosa</i> (White mangrove)
<i>Ficus citrifolia</i> (Strangler fig)	<i>Lantana camara</i> (Sage)
<i>F. nymphaeifolia</i> [= <i>F. urbaniana</i>] (Wild fig)	<i>L. involucrata</i> (White sage)
<i>F. trigonata</i> (Wild fig)	<i>Lemna perpusilla</i>
<i>Fimbristylis cyomosa</i>	<i>L. trisulca</i>
<i>F. ferruginea</i>	<i>Leucaena leucocephala</i> (Wild tamarind)
<i>Galactia dubia</i>	<i>Limnobium laevigatum</i>
<i>G. striata</i>	<i>Lippia</i> sp
<i>Galactia</i> spp	<i>Lonchocarpus latifolius</i>
<i>Gouania lupuloides</i>	<i>L. violaceus</i>
<i>Guarea macrophylla</i> [= <i>G. perrottetiana</i>]	<i>Ludwigia octovalvis</i>
<i>Guazuma ulmifolia</i>	<i>Macfadyena unguis-cati</i> (Cat's claw)
<i>Guettarda crispifolia</i>	<i>Malpighia emarginata</i> (West Indian cherry)
<i>G. ovalifolia</i>	<i>M. linearis</i> (Ram goat cherry)
<i>G. parviflora</i> , (White wattle)	<i>Mammillaria nivosa</i> (Pope's head cactus)
<i>G. scabra</i>	<i>Mangifera indica</i> (Mango)

VEGETATION CLASSIFICATION OF ANTIGUA-BARBUDA-REDONDA

Table 1 (continued). Plant species included in the Antigua-Barbuda-Redonda Vegetation Classification.

<i>Marsilea vestita</i>	<i>Pilea microphylla</i>
<i>Melocactus intortus</i> (Turk's cap cactus)	<i>Pilosocereus royeni</i> (Dildo cactus)
<i>Metastelma parviflorum</i> [= <i>Cyanchum parviflorum</i>]	<i>Piscidia carthagenensis</i> [= <i>P. piscipula</i>]
<i>Mimosa pudica</i> (Sensitive plant)	<i>Pisonia aculeata</i> (Black thorn)
<i>Monstera adansonii</i>	<i>P. fragrans</i>
<i>Morisonia americana</i> (Rat apple)	<i>P. subcordata</i> (Loblolly)
<i>Nagas guadalupensis</i>	<i>Pistia stratiotes</i> (Water lettuce)
<i>N. marina</i>	<i>Pitcairnia angustifolia</i>
<i>Nectandra guianensis</i>	<i>Pithecellobium unguis-cati</i> (Bread & cheese)
<i>Nelumbo nucifera</i> (Lotus)	<i>Pityrogramma calomelanos</i>
<i>Neptunia</i> spp [probably <i>N. plena</i> or <i>N. pubescens</i>]	<i>P. chrysophylla</i>
<i>Nitella cernua</i>	<i>Plumeria alba</i> (Wild frangipani)
<i>N. oligospira</i>	<i>Plumbago scandens</i> (White plumbago)
<i>Nymphaea ampla</i> var. <i>speciosa</i>	<i>Polygonum densiflorum</i>
<i>Nymphaea</i> spp. (Water lilies)	<i>Polypodium aureum</i>
<i>Ocotea leucoxydon</i>	<i>Polypodium</i> spp
<i>Oncidium urophyllum</i>	<i>Portulaca halimoides</i>
<i>Opuntia antillana</i>	<i>P. oleracea</i> (Pussley)
<i>O. triacantha</i>	<i>Pristimera rotundifolia</i> [= <i>P. caribaea</i> ?]
<i>Opuntia</i> spp	<i>Prosopis juliflora</i> (Prosopis)
<i>Oreopanax capitatus</i> [= <i>Oreopanax capitatum</i>]	<i>Psidium guajava</i> (Guava)
<i>Ouratea guildingii</i>	<i>P. longipes</i>
<i>Palicourea crocea</i>	<i>Psychotria nervosa</i>
<i>Paspalum bakeri</i>	<i>Pterocaulon alopecuroides</i> [<i>P. virgatum</i>]
<i>P. distichum</i>	<i>Quararibea turbinata</i>
<i>P. luxum</i>	<i>Randia aculeata</i>
<i>P. pleostachyum</i>	<i>Rhipsalis baccifera</i>
<i>P. secans</i>	<i>Rhizophora mangle</i> (Red mangrove)
<i>Paspalum</i> spp (Hay grass)	<i>Rhynchelytrum repens</i>
<i>Paspalidium germinatum</i> [= <i>Panicum germinatum</i>]	<i>Roystonea oleracea</i> (Royal palm)
<i>Passiflora suberosa</i>	<i>Ruppia cirrhosa</i>
<i>Peperomia myrtifolia</i>	<i>R. maritima</i>
<i>P. rotundifolia</i>	<i>R. spiralis</i>
<i>Pereskia aculeata</i>	<i>Salicornia perennis</i>
<i>Petrea kohautiana</i> (Petrea)	<i>Sapindus saponaria</i> (Soapberry)
<i>Philodendron giganteum</i> (Elephant ear)	<i>Sapium caribaeum</i>
<i>P. scandens</i>	Sedge spp.
<i>Phoenix dactylifera</i> (Date palm)	<i>Sesuvium portulacastrum</i> (Seaside purslane)
<i>Phyllanthus amarus</i>	<i>Sideroxylon foetidissimum</i> [= <i>Mastichodendron foetidissimum</i>] (Mastic)
<i>P. epiphyllanthus</i>	<i>S. obovatum</i> [= <i>Bumelia obovatum</i>] (Boxwood)
<i>Picramnia pentandra</i>	<i>S. salicifolium</i>

Table 1 (continued). Plant species included in the Antigua-Barbuda-Redonda Vegetation Classification.

<i>Sideroxylon</i> sp?	<i>Terminalia catappa</i> (Indian almond)
<i>Simarouba amara</i> (Whitewood)	<i>Tetramicra caniculata</i>
<i>Solanum racemosum</i> (Canker berry)	<i>Thelypteris tetragona</i>
<i>Sophora</i> spp.	<i>Thespesia populnea</i> (Seaside mahoe)
<i>Spartina patens</i>	<i>Thevetia peruviana</i>
<i>Spiranthes lanceolata</i> (Ground orchid)	<i>Thrinax morrisii</i> (Palmetto palm)
<i>S. torta</i> (Ground orchid)	<i>Tillandsia recurvata</i>
<i>Spondias mombin</i>	<i>T. usneoides</i> (Old man's beard)
<i>Sporobolus virginicus</i>	<i>T. utriculata</i> (Wild pine)
<i>Stachytarpheta jamaicensis</i> (Vervain)	<i>Tragia volubilis</i>
<i>Stigmaphyllon emarginatum</i> [= <i>S. lingulatum</i>]	<i>Trianthema portulacastrum</i>
<i>S. lingulatum</i>	<i>Trichomanes kraussii</i>
<i>Stigmaphyllon</i> sp	<i>Trichostigma octandrum</i>
<i>Strumpfia maritima</i> (Rosemary)	<i>Trimezia martinicensis</i> (Yellow iris)
<i>Stylosanthes hamata</i> (Mother sigil)	<i>Utricularia obtusa</i>
<i>Suriana maritima</i>	<i>Vigna luteola</i> [= <i>V. repens</i>]
<i>Swietenia mahagoni</i>	<i>Vitex divericata</i>
<i>Syzygium jambos</i> (Rose Apple)	<i>Vittaria lineata</i>
<i>Tabebuia heterophylla</i> (White cedar)	<i>Waltheria glabra</i>
<i>Tabernaemontana citrifolia</i> (milk tree)	<i>W. indica</i>
<i>Talinum fruticosum</i>	<i>Wedelia calycina</i> (Piss-a-bed)
<i>Tamarindus indica</i> (Tamarind)	<i>Zanthoxylum flavum</i> (White prickle)
<i>Tephrosia cineria</i>	<i>Z. martinicense</i> (Yellow prickle)
	<i>Z. spinifex</i>

CONSERVATION IMPLICATIONS

Table 2 compares the current vegetation classification with three major efforts that preceded it: Beard (1955), Loveless (1960), and Harris (1965). These three researchers identify 7, 12 and 8 vegetation categories, respectively; in comparison, the 54 identified by the current authors substantially refines the level of detail of earlier systems.

An attempt was made to identify the conservation status of each Alliance and Association (Table 3), using a two-tier labeling system that was modified from the Red Data Book Categories of the World Conservation Union (IUCN). The Alliance or Association is classified as:

- *Common* (widespread in distribution and/or large size), or
- *Uncommon* (moderately restricted in distribution and/or size), or
- *Rare* (very restricted in distribution and/or size)

AND

- *Stable* (no apparent danger), or
- *Endangered* (danger of extirpation), or
- *Vulnerable* (likely to move into Endangered category if causal factors continue to operate), or
- *Not known* (suspected, but not known, to belong to Vulnerable category).

Subjective rather than quantitative measures were used in this categorization. In order to aggregate data from different nations to compile transboundary statistics (whether at the Caribbean regional level, or any other level, including global), it will be necessary to have quantitative criteria. However, even if this is eventually attempted, it still will be useful to have national classifications based either on subjective criteria such as those used herein, or nationally-defined (rather than globally-defined) quantitative criteria. For example, we label the *Rhizophora-Avicennia-Lanularia* tidally-flooded tropical or subtropical broad-leaved evergreen open tree canopy Alliance [II.A.1.N.e.(1)] as “Uncommon, Vulnerable” in Antigua-Barbuda. If this Alliance had the same distribution and/or size in Colombia, it might be considered “Common, Stable”. We argue that despite its subjectivity—or perhaps, in part, because of it—the “conservation status” categorization can make a significant contribution to biodiversity efforts in Antigua-Barbuda.

VEGETATION CLASSIFICATION OF ANTIGUA-BARBUDA-REDONDA

Table 2. Comparison of vegetation classifications for Antigua-Barbuda-Redonda. The three rightmost columns are from Harris, 1965. The first column refers to "Formations" defined by the U.S. Federal Geographic Data Committee, as applied by Island Resources Foundation.

Island Resources Foundation 1997	Harris, 1965	Beard, 1955	Loveless, 1960
I.A.1.N.a; I.A.1.N.j I.A.5.N.a	Evergreen Woodland	Dry Evergreen Thicket Evergreen bushland	Dry Evergreen Thicket Evergreen bushland
I.C.1.N.a; III.C.1.N.a III.C.1.N.b; III.C.1.N.c	Mixed evergreen-deciduous forest	Evergreen seasonal forest Semi-evergreen seasonal forest Deciduous seasonal forest	Evergreen seasonal forest Semi-evergreen seasonal forest Deciduous seasonal forest
I.C.1.N.c; II.A.1.N.b; V.C.1.N.a II.C.1.N.x	Riparian woodland, pond, and fresh-water swamp vegetation		Riparian Woodland Inland aquatic vegetation
V.A.1.N.c; V.A.1.N.g V.A.2.N.b; V.A.4.N.x III.A.5.N.b; IV.C.1.N.a IV.C.1.N.c; V.A.4.N.x	Grassland		Grassland Waste bushland
II.A.1.N.a II.A.1.N.d; II.A.1.N.e III.A.1.N.g; III.A.1.N.h; VII.C.4.N.c; VII.C.4.N.d; I.A.5.N.d; I.A.5.N.e VII.C.1.N.a VII.A.1.N.x; VII.B.1.N.a; VII.B.2.N.a	Coastal vegetation Manchineel groves Mangrove swamps Strand vegetation Rock pavement vegetation	Mangrove forests Rock pavement vegetation	Mangrove vegetation Strand vegetation Littoral rock pavement vegetation
VIII			

VEGETATION CLASSIFICATION OF ANTIGUA-BARBUDA-REDONDA

Table 3. Conservation status of vegetation types in Antigua-Barbuda-Redonda.

Columns 1, 4: Alliance/Association
 Columns 2, 5: Conservation Status:
 Common, (widespread in distribution and/or large size)
 Uncommon, (moderately restricted in distribution and/or size)
 Rare, (very restricted in distribution and/or size)
 Stable (no apparent danger)
 Endangered (danger of extirpation)
 Vulnerable (likely to move into Endangered category if causal factors continue to operate)
 Not known (suspected, but not known, to belong to Vulnerable category)
 Columns 3, 6: Primary causal factors threatening biodiversity conservation

ALLIANCE/ ASSOCIATION	STATUS	CAUSAL FACTORS	ALLIANCE/ ASSOCIATION	STATUS	CAUSAL FACTORS
I.A.1.N.a.(1)			III.C.1.N.a.(1)	C, V	livestock grazing
I.A.1.N.a.(1.a)	R, N	charcoal, livestock	III.C.1.N.b.(1)	C, V	livestock grazing
I.A.1.N.a.(1.b)	R, N		III.C.1.N.c.(1)		
I.A.1.N.a.(1.c)	U, S		III.C.1.N.c.(1.a)	C, S	
I.A.1.N.a.(2)	U, S		III.C.1.N.c.(1.b)	U, V	development, livestock
I.A.1.N.j.(1)	R, S		III.C.1.N.c.(1.c)	U, S	
I.A.5.N.a.(1)	R, E	residential development	III.C.1.N.c.(1.d)	C, S	
I.A.5.N.a.(2)	R, V	residential development	IV.C.1.N.a.(1)		
I.A.5.N.a.(3)	R, E	sand mining	IV.C.1.N.a.(1.a)	R, E	sand mining
I.A.5.N.d.(1)	U, V	livestock grazing	IV.C.1.N.a.(1.b)	R, V	
I.A.5.N.e.(1)	C, V	coastal development	IV.C.1.N.a.(1.c)	U, V	
I.C.1.N.a.(1)	U, S		IV.C.1.N.c.(1)	U, S	
I.C.1.N.a.(2)	U, V	development	V.A.1.N.c.(1)	R, E	livestock grazing
I.C.1.N.a.(3)	U, V	residential development	V.A.1.N.g.(1)	U, V	development, livestock
I.C.1.N.a.(4)	C, V	livestock grazing	V.A.2.N.b.(1)	C, S	
I.C.1.N.c.(1)	R, E	development, livestock	V.A.2.N.b.(2)	R, V	
II.A.1.N.a.(1)	C, S		V.A.2.N.b.(3)	U, S	
II.A.1.N.a.(2)	R, V	livestock grazing	V.A.2.N.b.(4)	C, S	
II.A.1.N.a.(3)	U, V	coastal dev., sand mining	V.A.4.N.x.(1)	R, V	
II.A.1.N.b.(1)	R, V	sand mining	V.C.1.N.a.(1)	U, V	
II.A.1.N.d.(1)	U, V	coastal development	V.C.1.N.a.(2)	C, V	
II.A.1.N.e.(1)	U, V	coastal development	VII.A.1.N.x.(1)	U, S	
II.C.1.N.x.(1)	U, V	residential development	VII.B.1.N.a.(1)	U, S	
II.C.1.N.x.(2)	R, V		VII.B.2.N.a.(1)	U, S	
II.C.1.N.x.(3)	R, V	livestock grazing	VII.C.1.N.a.(1)	C, V	coastal development
III.A.1.N.g.(1)	U, V	coastal development	VII.C.4.N.c.(1)	U, V	coastal development
III.A.1.N.h.(1)	U, V	coastal development	VII.C.4.N.c.(2)	U, V	coastal development
III.A.5.N.b.(1)	C, S		VII.C.4.N.d.(1)	U, V	coastal development
			VIII.	U, V	

Of the 54 Alliances and Associations listed in Table 3:

- 16 are Rare,
- 26 are Uncommon, and
- 12 are Common.

Almost by definition, most of the Alliances and Associations that are Rare also are Endangered (all 5 Endangered groups are Rare) or Vulnerable, the only exception being a Rare Alliance associated with solution-holes in Barbuda which is considered Stable because of its inaccessibility. Half of the 12 Common Alliances and Associations are Stable; the remainder are considered Vulnerable.

In Antigua, the main threats to biodiversity result from expanding residential and coastal development (primarily commercial resorts, with isolated impacts from sand mining). Coastal development is a conservation threat in Barbuda as well, but there sand mining is on a larger scale and represents a much greater impact. An additional factor impacting vegetation in Barbuda is widespread, uncontrolled livestock grazing.

A primary biodiversity conservation objective for the country should be to ensure the continued existence of representatives of each of the vegetation types.

Less than one-third of the Alliances or Associations are considered Stable (16 of 54); and the challenge of conserving the 38 other Alliances and Association represents a significant challenge for Antigua-Barbuda, especially through the existing institutional framework. A National Park Authority is in charge of the country's one national park—Nelson's Dockyard National Park—which comprises some 8% of the country's land mass. Nevertheless, even within this protected area, the natural landscape is under-promoted, and none of the park area is being actively managed to conserve its biological diversity.

Outside of the park, work is underway to improve protection of some of the rich moist forests in the southwest of Antigua. The proposed Wallings Conservation Area, to be managed by a body comprised of public and private sector interests under the leadership of the Forestry Division, would contribute substantially to biodiversity conservation.

Protection of the offshore islands is another key to conserving the biodiversity of the country. As the plight of the Antiguan Racer illustrates, offshore islands are sometimes "repositories" for species that once existed more plentifully on the mainland. Great Bird Island and some of the other offshore islands are critical to the survival of the West Indian Whistling Duck and the Tropical Mocking Bird, as well as the Antiguan Racer and numerous species of plants. They contain some of the best examples of dry forest and other native vegetation. In some

cases, the offshore islands and cays serve as yardsticks, allowing us to measure the changes that have affected the rest of the Caribbean over time. Accordingly, they could be developed as valuable conservation tools, and as refuges and outdoor laboratories and classrooms for teaching, training and educating the public on environmental issues.

Antigua's small islands and cays, like many offshore islands throughout the Caribbean, have escaped much of the development associated in recent decades with "mainland" larger islands. Yet, too often, the importance of the smaller islands and cays is recognized only when they become the last stronghold for rare and endangered biodiversity. Clearly, much more can be done to take advantage of the conservation potential of these important natural areas.

If a protected areas system that safeguards the biological heritage of the country is to be developed, additional sites will need to be better defined and targeted for conservation. Given the financial constraints facing the public sector, and the fact that several biologically important areas are under private ownership, it is clear that this challenge will require new alliances and the participation of many people and institutions to be successful.

ACKNOWLEDGMENTS

The authors would like to acknowledge the invaluable contribution of the authors of previous vegetation studies of Antigua, Barbuda and Redonda, as well as the regional documents and reports cited in the literature section. Each offers critical historical data, and collectively they provide the broad framework that guided our current effort and supported the additional layers of detail provided in this classification.

Support and assistance from *The Nature Conservancy* made it possible for us to revise our classification and reconcile it to the proposed U.S. National Vegetation Classification System.

Finally, without the generous support of the *Moriah Fund*, and its sustained commitment to assisting biodiversity conservation efforts in the eastern Caribbean, this research and publication would not have been possible.

LITERATURE CITED

- Bacon, P. R. 1991. The status of mangrove conservation in the CARICOM islands of the Eastern Caribbean. Report to the Commission of the European Communities as part of the Tropical Forestry Action Plan for the Caribbean Region. 211 pp.
- Beard, J. S. 1949. The natural vegetation of the Windward and Leeward Islands. Oxford For. Mem. 21. Oxford, UK: Oxford University. 192 pp.
- Beard, J. S. 1955. The classification of tropical American vegetation-types. *Ecology* 36: 89-100.
- Federal Geographic Data Committee. 1996. FGDC Vegetation Classification and Information Standards. Draft. 35 pp.
- Francis, J., C. Rivera and J. Figueroa. 1994. Toward a woody plant list for Antigua and Barbuda: past and present. Gen. Tech. Rep. SO-102. New Orleans, LA: US Dept of Agriculture, Forest Service, Southern Forest Experiment Station. 28 pp.
- Harris, D. R. 1965. Plants, animals, and man in the Outer Leeward Islands, West Indies: An ecological study of Antigua, Barbuda and Anguilla. University of California Press. Berkeley and Los Angeles. 184 pp.
- Henderson, A., G. Galeano and R. Bernal. 1995. Field guide to the palms of the Americas. Princeton University Press. 352 pp.
- Howard, R. 1973. The vegetation of the Antilles. *In*: A. Graham (ed.), Vegetation and vegetational history of Northern Latin America, pp. 1-38. Elsevier Scientific Publishing Company. New York.
- Howard, R. 1974. Flora of the Lesser Antilles: Leeward and Windward Islands. Volume 1. Orchidaceae by L. Garay and H. Sweet. Arnold Arboretum, Harvard University.
- Howard, R. 1977. Flora of the Lesser Antilles: Leeward and Windward Islands. Volume 2. Pteridophyta by G. Proctor. Arnold Arboretum, Harvard University.
- Howard, R. 1979. Flora of the Lesser Antilles: Leeward and Windward Islands. Volume 3. Monocotyledoneae. Arnold Arboretum, Harvard University.
- Howard, R. 1988. Flora of the Lesser Antilles: Leeward and Windward Islands. Volume 4. Dicotyledoneae—Part 1. Arnold Arboretum, Harvard University.

- Howard, R. 1989. Flora of the Lesser Antilles: Leeward and Windward Islands. Volume 5. Dicotyledoneae—Part 2. Arnold Arboretum, Harvard University.
- Howard, R. 1989. Flora of the Lesser Antilles: Leeward and Windward Islands. Volume 6. Dicotyledoneae—Part 3. Arnold Arboretum, Harvard University.
- Little, E. L. and F. H. Wadsworth. 1974. Common trees of Puerto Rico and the Virgin Islands. Second Volume. Washington, DC.
- Little, E. L. and F. H. Wadsworth. 1989. Common trees of Puerto Rico and the Virgin Islands. Revision of First Volume. Washington, DC.
- Loveless, A. 1960. The vegetation of Antigua, West Indies. *Journal of Ecology* 48: 495-527.
- Morello, J. 1983. Ecological diagnosis of Antigua and Barbuda. Organization of American States, Dept. Reg. Dev., Washington, DC.
- Morton, M. 1994. A short survey of the bats of Antigua & Barbuda. Unpublished.
- Stehle, H. 1945. Forest types of the Caribbean Islands. *Caribb. For.* 7 (supplement): 273-408.
- Weakley, A. S. 1996. Vegetation of the West Indies (Cuba, the Greater Antilles, the Lesser Antilles, and the Bahamas. Draft.