

CARIBBEAN ECOREGIONAL ASSESSMENT

Cuba Terrestrial Report

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INTRODUCTION

Physical Features

Cuba is the largest country in the Caribbean, with a total area of 110,922 km². The Cuba archipelago consists of the main island (105,007 km²), Isla de Pinos (2,200 km²), and more than one thousand cays (3,715 km²). Cuba's main island, oriented in a NW-SE direction, has a varied orography. In the NW the major mountain range is the Guaniguanico Massif stretching from west to east with two mountain chains of distinct geological ages and composition—Sierra de los Organos of ancient Jurassic limestone deposited on slaty sandstone, and Sierra del Rosario, younger and highly varied in geological structure. Towards the east lie the low Hills of Habana-Matanzas and the Hills of Bejucal-Madruga-Limonar. In the central part along the east coast are several low hills—from north to south the Mogotes of Caguaguas, Loma Cunagua, the ancient karstic range of Sierra de Cubitas, and the Maniabón Group; while along the west coast rises the Guamuhaya Massif (Sierra de Escambray range) and low lying Sierra de Najasa. In the SE, Sierra Maestra and the Sagua-Baracoa Massif form continuous mountain ranges. The high ranges of Sierra Maestra stretch from west to east with the island's highest peak, Pico Real (Turquino Group), reaching 1,974 m. The complex mountain system of Sagua-Baracoa consists of several serpentine mountains in the north and plateau-like limestone mountains in the south. Low limestone hills, Sierra de Casas and Sierra de Caballos are situated in the northeastern part of Isla de Pinos (Borhidi, 1991).

Located just south of the tropic of Cancer, Cuba is on the interface of tropical and temperate zones. Due to the warm north-equatorial current encircling the island, Cuba's climate is basically tropical with a dry season extending from November to April. Local climate differs considerably owing to varied topography. Prevailing winds blow from N to E-NE along the northern coast and inland, and from NE to SE along the southern coast. In the winter months (September-March) northern cold fronts affect the western two-thirds of the archipelago. The tropical storm season is between June and November with an average of one storm per year crossing Cuba. Storms are more frequent on the western third of the main island. The mean annual rainfall is 1,374 mm with a general tendency of increasing precipitation from the coast to the interior and from low to high altitudes. The greatest rainfall, exceeding 3,400 mm, occurs in the eastern-most Nipe-Sagua-Baracoa mountain ranges. The southern coast, east of Guantánamo, is the driest region with annual rainfall less than 200 mm. Another dry area occurs in the central western coast, E of Cienfuegos (Garrido & Kirkconnell 2000).

Terrestrial Biodiversity Overview

Cuba's complex orography creates numerous microclimatic conditions which are responsible for the development of diverse vegetation types varying from xeric scrub to rainforest. Its rich geological history with varied bedrock types—limestone, serpentine, dolomites, basalt, granite, diorite, gabbro, sandstone and slate—has led to a wide range of edaphic conditions (Borhidi, 1991). The diverse microclimate in combination with the complex geological composition and structure has resulted in 4 ecoregions with a biodiversity unsurpassed by any other islands in the Caribbean—moist broadleaf forest, dry broadleaf forest, coniferous forest, and xeric scrub (WWF ecoregion map, 2004), 40 ecosystem types or geoclimatic regions (**Table 1**), 25 vegetation formations (**Table 2**), +68 plant communities (Areces-Mallea et al. 1999), 6890 vascular plants species and 566 vertebrate species—343 bird species, 63 mammal species, 58 amphibian species and 102 reptile species. Endemism characterizes Cuba's rich terrestrial biota: amphibians (97%), reptiles (81%), mammals (22%), birds (9%), and vascular plants (50%) (See **Table 3**).

According to Garrido & Kirkconnell (2000), about 15% of endemic plant species are found at low elevation, 75% in highland regions. The Nipe-Sagua-Baracoa mountain system harbors a great number of endemic plants. Recent estimates of Cuba's forest cover range from 14 to 16 % of the total area, a significant reduction from 21%, a figure based on the 1989 vegetation map. There are 257 proposed and designated protected areas in Cuba, with a total area of 2,889,185 ha, that is, 26% of the country's territory. To learn whether all the representative conservation targets were included in the official protected areas system to a sufficient degree, gap analyses are necessary.

METHOD

Biodiversity Assessment: Conservation Targets

The coarse filter terrestrial ecosystem conservation targets and their occurrences were identified with the following three GIS overlays, (1) a Life Zones map; (2) a simplified geology map; and (3) a recent vegetation map. The Life Zones map was digitized. It is based on "the ecological map of Cuba according to Holdridge's life-zone system," published in Borhidi (1991). Borhidi's Life Zones map considers only Cuba's main island and Isla de Pinos. The Life Zones of the Cuba archipelago—Dry and Very Dry—were extrapolated from the Cuba vegetation map (Boucher et al. 1999). There are 8 Life Zones in Cuba—Thorn, Very Dry, Dry, Moist, Wet, Lower Montane-Moist, Lower Montane-Wet, and Montane-Wet. The simplified geology map was digitized. It is based on a set of maps of the bedrock geology of Cuba borrowed from Grenville Draper of Florida International University. The geological formations of Cuba were classified into a 6-class scheme (alluvial, limestone, non-calcareous sedimentary, extrusive igneous, intrusive igneous, and ultramafic), devised by Julio Figueroa for a geoclimatic model of Puerto Rico (Dan Morse, e-mail of August 27, 2003). Different generic geological parent rocks were grouped by virtue of their soil-producing characteristics—**extrusive** volcanic rocks producing clay soils, **intrusive** igneous rocks producing sandy soils, **calcareous sedimentary** rocks producing relatively basic soils, **non-calcareous sedimentary rocks** producing relatively acidic soils, **ultramafic** rocks producing nutrient deficient, weathered soils, and Quaternary **alluvial** deposits producing relatively nutrient-rich, loamy soils. The vegetation map (Boucher et al. 1999) illustrates 28

vegetation formations in Cuba. (See **Table 2** for a list of vegetation formations and total areas of individual vegetation formations; see also **Appendix 1** for descriptions of individual natural vegetation formations.) We further grouped 28 vegetation formations into 3 classes—natural vegetation, non-natural vegetation and non-vegetated areas.

The overlay of the simplified geology map (cu-geol-tnc.shp, 1:250,000, UTM17, NAD 83) on the Life Zones map (lifezones.shp) revealed 40 geoclimatic regions in Cuba and the archipelago (**Table 1**). The vegetation map (cuba_veg_utm.shp) was then overlaid on the map of geoclimatic regions to show the distribution of the currently remaining occurrences of terrestrial vegetation formations in each geoclimatic region (**Figure 1**).

Table 4 lists the amount of current vegetation formations in individual geoclimatic regions. The vegetation remnants in each geoclimatic region are here treated collectively. They serve as a coarse filter ecosystem-level conservation target, and the name of a geoclimatic region will stand for the ecosystem-level target. See **Appendix 2** for the distribution of vegetation patches of each coarse filter target. Mangroves and wetlands have been bracketed. Their distribution will be examined by the terrestrial as well as marine and freshwater teams. In Cuba and its archipelago, there are 39 terrestrial coarse filter targets (**Figure 1**).

Much species-level biodiversity, especially plant-species diversity, is captured by coarse filter targets. Species targets are those rare or threatened species identified by experts following the IUCN Conservation Status Category. Two taxonomic groups of Caribbean species—rare or threatened palms and endemic amphibians—have been considered during the Ecoregional Assessment Project of the Insular Caribbean. The conservation status of rare or threatened Caribbean palm species was assessed by Andrew Henderson of The New York Botanical Garden. According to Henderson et al. (1995), the palm flora of the Caribbean comprises 21 genera and 80 species. **The most important center of diversity of Caribbean palms is eastern Cuba.** This is also, unfortunately, an area that has been insufficiently collected. It includes many species of two very poorly known genera, *Copernicia* and *Coccothrinax*. Henderson (2003) examined the conservation status of the Caribbean palms and proposed 17 species for concerned protection effort. Six of the 17 species occur in Cuba. The six Cuban palm species—*Thrinax compacta*, *Roystonea maisiana*, *R. stellata*, *R. violacea*, *Gaussia spirituana*, and *Coccothrinax borhidiana*—are Cuban species conservation targets at regional scale (**Table 5**).

According to the most recent estimate (Young et al, 2004), 183 amphibian species (171 native species) occur in the Caribbean. Of the 171 native species, about 82% (140 species) are Caribbean endemics. Furthermore, of the 140 species 131 (94%) are endemic to single islands. The recently published *Disappearing Jewels: the Status of New World Amphibians* (Young et al, 2004) identifies important areas for amphibian conservation. The New World findings of the Global Amphibian Assessment indicate that Caribbean amphibians have diversified occurring on high mountain ranges and in sea-level mangrove swamps, with the highest species densities in moist mountain ranges. **Sierra Maestra and Macizo de Sagua Baracoa in southeastern Cuba are some of the amphibians' hot spots (Figure 2).** Blaire Hedge generously donated the Caribbean amphibian data set. The database (June 2003) lists 170 species of Caribbean amphibians. Fifty-three (53) amphibian species pertain to Cuba. (The most recent data suggest that 58 native species occur in Cuba [NatureServe, database of December 2004].) Forty-two (42)

of the 53 Cuban species are vulnerable or threatened by extinction. In this study we propose 20 species (**Table 6**) that were ranked “Endangered (12)” or “Critically Endangered (8)” as conservation targets.

Gap Analysis

The map of the official protected areas system was overlaid (one) on the coarse filter targets (40 ecosystem targets) and fine filter targets (6 palm species, and 20 amphibian species) distribution maps to examine biodiversity gaps.

RESULTS and DISCUSSION

Coarse Filter Targets

Overlaying the map of the protected areas system on individual coarse filter target distribution maps (see **Appendix 2**) shows that the vegetation remnants in 2 geoclimatic regions—LM-moist-alluvial and LM-moist-limestone (highlighted with **red** in **Table 7**)—are not included in any of the current protected areas. As there is no vegetation on LM-moist-limestone, the inclusion of LM-moist-alluvial in the protected areas system should be a top priority, labeled “1” in **Table 7**.

The vegetation remnants in another 5 geoclimatic regions—Dry-extrusive, Dry-intrusive, Dry-sedimentary, Moist-alluvial, and Very Dry-ultramafic (highlighted with **blue** in **Table 7**)—are not well represented in the protected areas system, that is, current vegetation remnants in the protected areas system make up less than 10 % of their current extent. To set aside sufficient areas representing the vegetation in Dry-extrusive, Dry-intrusive, Dry-sedimentary, Moist-alluvial and Very Dry-ultramafic for protection should be another priority, labeled “2” in **Table 7**.

The vegetation remnants in Very Dry-Sedimentary, mangrove, and aquatic vegetation (highlighted with **brown** in **Table 7**) have less than 10% of their historical extent (TNC conservation goal) included in the protected areas system. These targets are labeled “3” in **Table 7**.

Fine Filter Targets

The distribution map of the six threatened Cuban palms superimposed on the map of official protected areas indicates that except for *Thrinax compacta* and *Coccothrinax borhidiana* the other four species—*Roystonea maisiana*, *R. stellata*, *R. violacea*, and *Gaussia spirituana*—are included with at least one occurrence in the current protected areas system (**Figure 3**)

Overlaying the range distribution maps of the 12 “endangered” and 8 “critically endangered” Cuban amphibian species (database of Blaire Hedge, June 2003) on the map of protected areas system shows that except for *Eleutherodactylus orientalis*, *E. pezopetrus*, *E. rivularis* and *Bufo longinasus*, the other 16 species are included in the current protected areas system (**Figure 4**).

CONCLUSIONS

This preliminary study is based on published literature and the GIS data on hand, which include the Holdridge Life Zones map, geology map, vegetation map, protected areas map, rare/threatened palm occurrences map and amphibian species distribution range map. The gap analyses for the terrestrial targets show that on the whole Cuba has a good protected areas system. It should be noted, however, that one ecosystem target, LM-moist-alluvial, has not been included in the protected areas system; 5 ecosystem targets—Dry-extrusive, Dry-intrusive, Dry-sedimentary, Moist-alluvial and Very Dry-ultramafic—have insufficient areas in the current protected areas system; 3 targets—Very Dry-Sedimentary, Mangrove, and Aquatic vegetation—and the above mentioned 5 ecosystem targets failed to meet TNC conservation goal, 10% of historical extent.

The vegetation map of this study dates back to 1989. The image data source for the vegetation map would predate 1989. We hope that we will be able to work with Cuban scientists in the near future to update the GIS data and rare/threatened species data, and perform additional analyses, such as a viability analysis and a connectivity analysis, in order to further enhance biodiversity conservation through improved design of the protected areas system. The current report addresses only the aspect of terrestrial biodiversity. An integrated report that includes also freshwater and marine biodiversity would ensure a more holistic approach to the conservation of both landscape and seascape.

Table 1. Geoclimatic zones of Cuba and archipelago

Geology	Alluvial	Limestone	Sedimentary	Ultramafic	Volcanic- Extrusive	Volcanic- Intrusive
Life Zones						
Thorn	X	X	X	N/A	X	N/A
Very Dry	X	X	X	X	X	X
Dry	X	X	X	X	X	X
Moist	X	X	X	X	X	X
Wet	N/A	X	X	X	X	X
LM-Moist	X	X	X	X	X	X
LM-Wet	N/A	X	X	N/A	X	X
M-Wet	N/A	N/A	X	N/A	X	X

Table 2. Terrestrial vegetation formations of Cuba and the archipelago (Source: vegetation map of Cuba, Academic Society of Cuba, 1989, Terminology follows Arces-Mallea, et al. 1999)

Vegetation Formation (active or past land use are highlighted)	Total Area (Ha.)	Total area (Ha.) in the official protected areas system	% vegetation formation in protected areas system
Aquatic vegetation	93305.20	18314.18	19.63
Cloud forest	8010.51	7245.35	90.45
Commercial pine and broad-leaved timber plantations	96954.21	6710.04	6.92
Haystack mountain (Mogote) complex	76506.57	33536.25	43.83
Lowland rain forest	58829.82	57021.27	96.93
Lowland seasonal evergreen forest	150945.18	28621.60	18.96
Lowland semi-deciduous forest	387782.90	210620.26	54.31
Lowland/submontane evergreen sclerophyllous forest	178446.41	104519.44	58.57
Lowland/submontane evergreen serpentine shrubland	76710.25	20030.56	26.11
Mangroves	710021.37	416197.20	58.62
Marsh grasslands	192448.95	142298.40	73.94
Microphyllous montane shrubland with succulents	198.66	198.66	100.00
Mixed Planted/Cultivated woody and herbaceous crops	3238725.86	86065.26	2.66
Mixed pine-broad-leaved forest	7734.57	7254.40	93.79
Montane evergreen extremely xeromorphic serpentine woodland	33437.74	7621.57	22.79
Montane rain forest	70307.00	26163.09	37.21
Pine woodland	181580.14	11595.14	6.39
Sclerophyllous tropical or subtropical broad-leaved evergreen shrubland	7852.63	7839.72	99.84
Seasonally flooded/saturated semi-deciduous forest	225114.37	113082.65	50.23
Seasonally/temporarily flooded semi-deciduous woodland	28014.48	28014.48	100.00
Secondary or sucesional herbaceous and woody	621783.48	109163.20	17.56

vegetation			
Submontane rain forest	117027.73	89470.81	76.45
Submontane seasonal evergreen forest	150366.02	48114.56	32.00
Succulent evergreen woodland	34709.22	16125.08	46.46
Succulent extremely xeromorphic evergreen shrubland	75168.09	52356.18	69.65
Tall grassland	4022570.05	223194.07	5.55
Tropical or subtropical needle-leaved evergreen woodland	65191.36	18320.29	28.10
Xeromorphic mixed evergreen-deciduous forest	152717.62	82599.02	54.09
Total (excluding land use)	7104996.82	1316674.85	18.53

Table 3. Current diversity of Cuban native terrestrial biota

Group	Total # of native species	# of rare / threatened species	# of endemic species	% of Cuban endemic species	Source
Vascular Plant	6505	No data	3224	50	Davis, S.D., et al. 1997
Mammal	63	No data	14	22	NatureServe database, 2004
Amphibian	58	28	56	97	NatureServe database, 2004
Reptile	102	No data	83	81	Schwartz, A. & R. W. Henderson 1991
Birds	343	30	20	9	NatureServe database, 2004; Garrido & Kirkconnell 2000

Table 4. Cross-walk of Cuba geoclimatic zones to vegetation formations in the International Classification of Ecological Communities (ICEC) classification system (Areces-Mallea, et al. 1999)

Caribbean Ecological System Targets: geoclimatic regions	Vegetation Targets: remaining vegetation formations in each geoclimatic zone (Source: vegetation map of Cuba, Academic Society of Cuba, 1989, Terminology follows Areces-Mallea et al. 1999)	Area (Ha.)
Dry-Alluvial	Aquatic vegetation	22181.77
	Haystack mountain (Mogote) complex	64.71
	Lowland rain forest	176.95
	Lowland seasonal evergreen forest	5604.54
	Lowland semi-deciduous forest	28945.81
	Lowland/submontane evergreen sclerophyllous forest	14044.98
	Lowland/submontane evergreen serpentine shrubland	2784.08
	Mangroves	332215.19
	Marsh grasslands	171389.91
	Montane rain forest	310.81
	Pine woodland	18922.74
	Sclerophyllous tropical or subtropical broad-leaved evergreen shrubland	2343.08
	Seasonally flooded/saturated semi-deciduous forest	118772.27
	Seasonally/temporarily flooded semi-deciduous woodland	27982.58
Secondary or sucesional herbaceous and woody vegetation	74216.79	
Submontane seasonal evergreen forest	1483.04	

	Succulent evergreen woodland	107.69
	Succulent extremely xeromorphic evergreen shrubland	896.25
	Tall grassland	728812.70
	Tropical or subtropical needle-leaved evergreen woodland	256.98
	Xeromorphic mixed evergreen-deciduous forest	62935.75
Dry-Extrusive	Aquatic vegetation	8445.48
	Haystack mountain (Mogote) complex	2770.12
	Lowland rain forest	1735.24
	Lowland seasonal evergreen forest	6830.08
	Lowland semi-deciduous forest	5676.68
	Lowland/submontane evergreen sclerophyllous forest	1558.04
	Lowland/submontane evergreen serpentine shrubland	1815.66
	Mangroves	920.91
	Montane evergreen extremely xeromorphic serpentine woodland	1820.88
	Montane rain forest	4483.22
	Pine woodland	2643.14
	Secondary or successional herbaceous and woody vegetation	15609.85
	Submontane seasonal evergreen forest	8200.31
	Succulent extremely xeromorphic evergreen shrubland	178.18
	Tall grassland	330371.26
	Tropical or subtropical needle-leaved evergreen woodland	1745.71
Dry-Intrusive	Aquatic vegetation	1834.00
	Haystack mountain (Mogote) complex	11.03
	Lowland seasonal evergreen forest	127.08
	Lowland semi-deciduous forest	794.69
	Lowland/submontane evergreen serpentine shrubland	30.17
	Mixed pine-broad-leaved forest	7.11
	Montane rain forest	299.30
	Pine woodland	157.97
	Secondary or successional herbaceous and woody vegetation	11807.61
	Submontane seasonal evergreen forest	136.39
	Tall grassland	179217.84
	Tropical or subtropical needle-leaved evergreen woodland	32.86
	Xeromorphic mixed evergreen-deciduous forest	5077.39
Dry-Limestone	Aquatic vegetation	9364.51
	Haystack mountain (Mogote) complex	24295.20
	Lowland rain forest	143.93
	Lowland seasonal evergreen forest	26654.43
	Lowland semi-deciduous forest	220470.11
	Lowland/submontane evergreen sclerophyllous forest	54301.76
	Lowland/submontane evergreen serpentine shrubland	7216.29
	Mangroves	42548.22
	Marsh grasslands	19127.15
	Montane evergreen extremely xeromorphic serpentine woodland	48.33
	Montane rain forest	48.78
	Pine woodland	14133.40
	Sclerophyllous tropical or subtropical broad-leaved evergreen shrubland	4967.32
	Seasonally flooded/saturated semi-deciduous forest	76509.08
	Seasonally/temporarily flooded semi-deciduous woodland	16.32

	Secondary or succesional herbaceous and woody vegetation	141163.40
	Submontane rain forest	91.69
	Submontane seasonal evergreen forest	9439.75
	Succulent evergreen woodland	1614.50
	Succulent extremely xeromorphic evergreen shrubland	20894.98
	Tall grassland	1148111.06
	Tropical or subtropical needle-leaved evergreen woodland	107.80
	Xeromorphic mixed evergreen-deciduous forest	30650.55
Dry-Sedimentary	Aquatic vegetation	9119.42
	Haystack mountain (Mogote) complex	11830.67
	Lowland rain forest	443.14
	Lowland seasonal evergreen forest	12213.03
	Lowland semi-deciduous forest	11221.60
	Lowland/submontane evergreen sclerophyllous forest	3921.92
	Lowland/submontane evergreen serpentine shrubland	3218.73
	Mangroves	5388.25
	Montane evergreen extremely xeromorphic serpentine woodland	345.91
	Montane rain forest	12.50
	Pine woodland	82611.34
	Seasonally flooded/saturated semi-deciduous forest	1529.93
	Secondary or succesional herbaceous and woody vegetation	57494.02
	Submontane rain forest	931.90
	Submontane seasonal evergreen forest	4553.35
	Succulent evergreen woodland	694.81
	Succulent extremely xeromorphic evergreen shrubland	2112.33
	Tall grassland	517281.39
	Tropical or subtropical needle-leaved evergreen woodland	13.23
	Xeromorphic mixed evergreen-deciduous forest	1254.22
Dry-Ultramafic	Aquatic vegetation	2807.56
	Haystack mountain (Mogote) complex	1135.82
	Lowland rain forest	417.78
	Lowland seasonal evergreen forest	12072.38
	Lowland semi-deciduous forest	327.45
	Lowland/submontane evergreen sclerophyllous forest	113.49
	Lowland/submontane evergreen serpentine shrubland	28926.76
	Mangroves	137.10
	Montane evergreen extremely xeromorphic serpentine woodland	4674.51
	Pine woodland	3180.38
	Secondary or succesional herbaceous and woody vegetation	18124.54
	Submontane rain forest	812.31
	Submontane seasonal evergreen forest	877.28
	Tall grassland	132733.71
	Tropical or subtropical needle-leaved evergreen woodland	13491.26
LM-Moist-Alluvial	Lowland/submontane evergreen sclerophyllous forest	121.73
	Secondary or succesional herbaceous and woody vegetation	400.11
	Tall grassland	97.69
LM-Moist-Extrusive	Cloud forest	813.60
	Lowland/submontane evergreen sclerophyllous forest	870.98
	Microphyllous montane shrubland with succulents	135.61
	Mixed pine-broad-leaved forest	2450.94

	Montane evergreen extremely xeromorphic serpentine woodland	1.50
	Montane rain forest	10635.20
	Secondary or succesional herbaceous and woody vegetation	11494.82
	Submontane rain forest	39.11
	Submontane seasonal evergreen forest	5758.91
	Tall grassland	13142.77
LM-Moist-Intrusive	Cloud forest	20.78
	Lowland/submontane evergreen sclerophyllous forest	32.23
	Microphyllous montane shrubland with succulents	63.05
	Mixed pine-broad-leaved forest	510.36
	Montane rain forest	700.87
	Secondary or succesional herbaceous and woody vegetation	2702.20
	Submontane seasonal evergreen forest	364.82
	Tall grassland	2642.02
LM-Moist-Sedimentary	Cloud forest	129.16
	Secondary or succesional herbaceous and woody vegetation	1165.74
	Submontane rain forest	799.55
	Tall grassland	318.84
LM-Moist-Ultramafic	Cloud forest	789.49
	Montane evergreen extremely xeromorphic serpentine woodland	1463.40
	Submontane rain forest	1905.73
	Tall grassland	791.01
	Tropical or subtropical needle-leaved evergreen woodland	965.30
LM-Wet-Extrusive	Montane rain forest	757.59
	Secondary or succesional herbaceous and woody vegetation	1165.20
	Submontane seasonal evergreen forest	480.61
	Tall grassland	11.66
LM-Wet-Intrusive	Montane rain forest	153.52
	Submontane seasonal evergreen forest	9.78
LM-Wet-Limestone	Lowland semi-deciduous forest	0.57
	Montane rain forest	3657.71
	Secondary or succesional herbaceous and woody vegetation	96.86
	Submontane seasonal evergreen forest	221.08
LM-Wet-Sedimentary	Aquatic vegetation	22.77
	Lowland semi-deciduous forest	8.70
	Montane rain forest	1651.48
	Secondary or succesional herbaceous and woody vegetation	388.01
	Submontane seasonal evergreen forest	6807.44
M-Wet-Extrusive	Montane rain forest	416.34
	Secondary or succesional herbaceous and woody vegetation	2458.88
	Submontane seasonal evergreen forest	593.04
	Tall grassland	0.43
M-Wet-Intrusive	Secondary or succesional herbaceous and woody vegetation	864.27
	Submontane seasonal evergreen forest	2.27
	Tall grassland	2.12
M-Wet-Sedimentary	Secondary or succesional herbaceous and woody vegetation	163.91
Moist-Alluvial	Haystack mountain (Mogote) complex	1464.72
	Lowland rain forest	547.77
	Lowland seasonal evergreen forest	297.34
	Lowland semi-deciduous forest	4745.62

	Lowland/submontane evergreen sclerophyllous forest	80.01
	Lowland/submontane evergreen serpentine shrubland	798.41
	Mangroves	53.67
	Montane evergreen extremely xeromorphic serpentine woodland	92.94
	Montane rain forest	335.21
	Pine woodland	2828.18
	Secondary or successional herbaceous and woody vegetation	4124.27
	Submontane seasonal evergreen forest	102.90
	Succulent evergreen woodland	1.19
	Succulent extremely xeromorphic evergreen shrubland	126.90
	Tall grassland	39328.10
Moist-Extrusive	Aquatic vegetation	1661.93
	Cloud forest	2064.87
	Haystack mountain (Mogote) complex	3279.33
	Lowland rain forest	9034.97
	Lowland seasonal evergreen forest	22939.61
	Lowland semi-deciduous forest	9503.78
	Lowland/submontane evergreen sclerophyllous forest	794.56
	Lowland/submontane evergreen serpentine shrubland	543.72
	Mixed pine-broad-leaved forest	4109.96
	Montane evergreen extremely xeromorphic serpentine woodland	1738.18
	Montane rain forest	33390.23
	Secondary or successional herbaceous and woody vegetation	32109.89
	Submontane rain forest	4401.17
	Submontane seasonal evergreen forest	29307.07
	Succulent evergreen woodland	439.44
	Succulent extremely xeromorphic evergreen shrubland	3082.36
	Tall grassland	133725.25
	Tropical or subtropical needle-leaved evergreen woodland	6843.75
Moist-Intrusive	Cloud forest	18.59
	Haystack mountain (Mogote) complex	34.89
	Lowland seasonal evergreen forest	454.85
	Lowland semi-deciduous forest	217.57
	Mixed pine-broad-leaved forest	656.21
	Montane evergreen extremely xeromorphic serpentine woodland	196.54
	Montane rain forest	2424.90
	Secondary or successional herbaceous and woody vegetation	5549.22
	Submontane rain forest	1278.91
	Submontane seasonal evergreen forest	1551.71
	Succulent evergreen woodland	64.62
	Succulent extremely xeromorphic evergreen shrubland	185.97
	Tall grassland	13573.76
	Tropical or subtropical needle-leaved evergreen woodland	100.29
Moist-Limestone	Aquatic vegetation	793.27
	Haystack mountain (Mogote) complex	21773.86
	Lowland rain forest	48.21
	Lowland seasonal evergreen forest	19523.77
	Lowland semi-deciduous forest	16264.39
	Lowland/submontane evergreen sclerophyllous forest	715.39
	Lowland/submontane evergreen serpentine shrubland	159.47

	Montane evergreen extremely xeromorphic serpentine woodland	757.89
	Montane rain forest	7064.97
	Pine woodland	2234.49
	Secondary or succesional herbaceous and woody vegetation	56976.79
	Submontane rain forest	1387.80
	Submontane seasonal evergreen forest	36645.71
	Succulent evergreen woodland	182.34
	Succulent extremely xeromorphic evergreen shrubland	1200.81
	Tall grassland	71472.74
	Tropical or subtropical needle-leaved evergreen woodland	1759.32
Moist-Sedimentary	Aquatic vegetation	653.76
	Haystack mountain (Mogote) complex	5022.77
	Lowland rain forest	10442.40
	Lowland seasonal evergreen forest	23178.79
	Lowland semi-deciduous forest	11235.56
	Lowland/submontane evergreen sclerophyllous forest	5406.02
	Lowland/submontane evergreen serpentine shrubland	1146.51
	Montane evergreen extremely xeromorphic serpentine woodland	3431.31
	Montane rain forest	1752.49
	Pine woodland	53500.78
	Secondary or succesional herbaceous and woody vegetation	49523.84
	Submontane rain forest	21828.37
	Submontane seasonal evergreen forest	32113.17
	Tall grassland	68362.26
	Tropical or subtropical needle-leaved evergreen woodland	4309.72
Moist-Ultramafic	Cloud forest	114.43
	Haystack mountain (Mogote) complex	3571.36
	Lowland rain forest	7709.82
	Lowland seasonal evergreen forest	4741.21
	Lowland/submontane evergreen serpentine shrubland	10064.86
	Montane evergreen extremely xeromorphic serpentine woodland	17908.23
	Montane rain forest	176.49
	Pine woodland	11.33
	Secondary or succesional herbaceous and woody vegetation	2657.69
	Submontane rain forest	17090.42
	Submontane seasonal evergreen forest	7811.40
	Tall grassland	13948.13
	Tropical or subtropical needle-leaved evergreen woodland	28230.91
Thorn-Alluvial	Lowland semi-deciduous forest	705.32
	Lowland/submontane evergreen sclerophyllous forest	5173.68
	Mangroves	5994.93
	Secondary or succesional herbaceous and woody vegetation	6664.03
	Succulent evergreen woodland	1337.78
	Tall grassland	2122.07
Thorn-Extrusive	Mangroves	7.81
	Succulent evergreen woodland	42.85
Thorn-Limestone	Lowland/submontane evergreen sclerophyllous forest	295.61
	Mangroves	235.32
	Secondary or succesional herbaceous and woody vegetation	194.04
	Succulent evergreen woodland	3226.54

Thorn-Sedimentary	Lowland semi-deciduous forest	401.06
	Lowland/submontane evergreen sclerophyllous forest	5054.69
	Mangroves	1034.32
	Secondary or successional herbaceous and woody vegetation	4255.20
	Succulent evergreen woodland	2704.55
	Tall grassland	450.43
Very Dry-Alluvial	Aquatic vegetation	2273.52
	Lowland semi-deciduous forest	5890.47
	Lowland/submontane evergreen sclerophyllous forest	11829.55
	Lowland/submontane evergreen serpentine shrubland	29.81
	Mangroves	43989.73
	Seasonally flooded/saturated semi-deciduous forest	14545.64
	Secondary or successional herbaceous and woody vegetation	29532.56
	Submontane seasonal evergreen forest	29.75
	Succulent evergreen woodland	2374.12
	Succulent extremely xeromorphic evergreen shrubland	2274.92
	Tall grassland	234915.99
Xeromorphic mixed evergreen-deciduous forest	13656.73	
Very Dry-Extrusive	Aquatic vegetation	255.68
	Lowland semi-deciduous forest	2030.15
	Lowland/submontane evergreen sclerophyllous forest	1142.95
	Lowland/submontane evergreen serpentine shrubland	7.73
	Mangroves	40.53
	Secondary or successional herbaceous and woody vegetation	3585.20
	Submontane seasonal evergreen forest	901.20
	Succulent evergreen woodland	448.18
	Succulent extremely xeromorphic evergreen shrubland	1784.19
	Tall grassland	17742.58
Very Dry-Intrusive	Lowland semi-deciduous forest	244.74
	Lowland/submontane evergreen sclerophyllous forest	19.16
	Secondary or successional herbaceous and woody vegetation	3306.13
	Submontane rain forest	250.56
	Succulent extremely xeromorphic evergreen shrubland	4.21
	Tall grassland	4682.19
Very Dry-Limestone	Aquatic vegetation	1628.54
	Lowland seasonal evergreen forest	1666.74
	Lowland semi-deciduous forest	43867.11
	Lowland/submontane evergreen sclerophyllous forest	43887.96
	Lowland/submontane evergreen serpentine shrubland	3525.05
	Mangroves	36287.06
	Seasonally flooded/saturated semi-deciduous forest	4446.09
	Secondary or successional herbaceous and woody vegetation	46042.01
	Submontane seasonal evergreen forest	1540.59
	Succulent evergreen woodland	6352.72
	Succulent extremely xeromorphic evergreen shrubland	24262.99
	Tall grassland	226638.48
Xeromorphic mixed evergreen-deciduous forest	18837.92	
Very Dry-Sedimentary	Aquatic vegetation	205.74
	Lowland seasonal evergreen forest	1809.19
	Lowland semi-deciduous forest	3670.65

	Lowland/submontane evergreen sclerophyllous forest	8067.93
	Lowland/submontane evergreen serpentine shrubland	1067.95
	Mangroves	42.03
	Secondary or successional herbaceous and woody vegetation	6557.71
	Submontane rain forest	2233.62
	Succulent evergreen woodland	5201.35
	Succulent extremely xeromorphic evergreen shrubland	1217.57
	Tall grassland	56028.99
Very Dry-Ultramafic	Aquatic vegetation	293.16
	Lowland semi-deciduous forest	3445.89
	Lowland/submontane evergreen sclerophyllous forest	1281.88
	Lowland/submontane evergreen serpentine shrubland	13673.70
	Mangroves	830.93
	Secondary or successional herbaceous and woody vegetation	328.25
	Submontane rain forest	134.67
	Tall grassland	29160.51
Wet-Extrusive	Cloud forest	133.69
	Haystack mountain (Mogote) complex	705.74
	Lowland rain forest	8541.30
	Lowland seasonal evergreen forest	1981.73
	Submontane rain forest	3556.61
	Tropical or subtropical needle-leaved evergreen woodland	1011.73
Wet-Intrusive	Lowland rain forest	11.71
	Montane rain forest	198.64
	Submontane rain forest	1096.12
Wet-Limestone	Haystack mountain (Mogote) complex	63.69
	Lowland rain forest	103.72
	Lowland seasonal evergreen forest	23.73
	Montane rain forest	533.66
	Secondary or successional herbaceous and woody vegetation	3864.79
	Submontane rain forest	35.50
	Submontane seasonal evergreen forest	44.40
Wet-Sedimentary	Cloud forest	1043.91
	Lowland rain forest	13335.07
	Lowland seasonal evergreen forest	2425.18
	Montane rain forest	630.05
	Secondary or successional herbaceous and woody vegetation	4863.99
	Submontane rain forest	25066.96
	Submontane seasonal evergreen forest	1364.77
Wet-Ultramafic	Cloud forest	2881.99
	Haystack mountain (Mogote) complex	346.80
	Lowland rain forest	6131.83
	Lowland seasonal evergreen forest	8265.73
	Lowland/submontane evergreen serpentine shrubland	138.12
	Montane rain forest	673.06
	Secondary or successional herbaceous and woody vegetation	60.44
	Submontane rain forest	34026.88
	Tropical or subtropical needle-leaved evergreen woodland	6124.07

Table 5. Proposed Cuban palm taxa of conservation concerns. (Under the column heading “target” color of letters indicates degree of concerns. **Black:** at least one occurrence is in the protected areas; **Marron:** occurrences not found in the protected areas.)

Conservation concerns	ID	Target	Common Name	Range distribution comments
Not in protected areas, but 1 occurrence near La Mensura- Pilotos National Park, and another occurrence near La Caoba Managed Flora Reserve	6	<i>Thrinax compacta</i>	yarey, yuraguancillo	Borhidi (1996) considers the Sierra de Nipe a "center of flora development, being rich in endemics", and contains "the richest flora in the Caribbean". <i>Thrinax compacta</i> is a morphologically distinct species, very poorly known botanically. It is the largest-sized species in the genus.
One occurrence in Cuchillas del Toa Protected Area of Managed Resources and another in Maisí Ecological Reserve. One occurrence is outside but near Maisí-Yumurí protected Natural Land/seascape	11	<i>Roystonea maisiana</i> , <i>R. stellata</i> , <i>R. violacea</i>	<i>R. maisiana</i> = palma negra, <i>R. stellata</i> = palma blanca, <i>R. violacea</i> = palma morada	It is remarkable that these three species of <i>Roystonea</i> are known only from a small area of extreme eastern Cuba. This area is intensively used for agriculture and the habitat of the palms is greatly disturbed
Occurrences in Buena Vista Protected Area of Managed Resources	16	<i>Gaussia spirituana</i>	palma de sierra	The fifth, and most recent, species to be described in this strictly Caribbean genus. The population is very small and restricted, and consists of only about 100 individuals
Occurrences outside but near “Canasí Managed Flora Reserve”	19	<i>Coccothrinax borhidiana</i>	guano	This species has an extremely limited range in Cuba, and few plants exist at the site.

Table 6. Cuban amphibian species conservation targets (Source: database of Blaire Hedge, 2003)

Scientific Name	# of occurrence	Range (ha)	Conservation Status (IUCN category)
<i>Bufo longinasus</i>	3	44857.89	Endangered (EN)
<i>Eleutherodactylus bartonsmithi</i>	1	42337.44	Endangered (EN)
<i>Eleutherodactylus blairhedgesi</i>	1	15430.87	Critically Endangered (CR)
<i>Eleutherodactylus bresslerae</i>	2	57527.69	Endangered (EN)
<i>Eleutherodactylus cubanus</i>	1	4188.66	Critically Endangered (CR)
<i>Eleutherodactylus emiliae</i>	1	42096.71	Endangered (EN)
<i>Eleutherodactylus etheridgei</i>	1	16378.65	Endangered (EN)
<i>Eleutherodactylus iberia</i>	1	19549.67	Critically Endangered (CR)
<i>Eleutherodactylus intermedius</i>	1	63534.36	Endangered (EN)
<i>Eleutherodactylus jaumei</i>	1	11895.05	Endangered (EN)
<i>Eleutherodactylus klinikowskii</i>	1	20171.67	Endangered (EN)
<i>Eleutherodactylus melacara</i>	1	934.04	Endangered (EN)
<i>Eleutherodactylus orientalis</i>	1	12630.12	Critically Endangered

			(CR)
<i>Eleutherodactylus pezopetrus</i>	1	6634.39	Endangered (EN)
<i>Eleutherodactylus rivularis</i>	1	191.77	Critically Endangered (CR)
<i>Eleutherodactylus symingtoni</i>	1	0.00	Critically Endangered (CR)
<i>Eleutherodactylus tetajulia</i>	2	10994.51	Endangered (EN)
<i>Eleutherodactylus tonyi</i>	2	111240.52	Critically Endangered (CR)
<i>Eleutherodactylus turquinensis</i>	1	17875.92	Critically Endangered (CR)
<i>Eleutherodactylus zeus</i>	1	97379.92	Endangered (EN)

Table 7. Gap analysis of coarse filter targets (1= first priority; 2= second priority; 3= third priority).

Target name	Total target area (ha) with vegetation	Am't in Protected Areas System (ha)	% in protected areas system	Marxan area goal (hactare,10% geoclimatic region for all targets except for the followings: 65% for Mangrove; 25% for Aquatic vegetation and Marsh grasslands)	negative value: not meeting the 10% goal	Recommended priority for protection
Dry-Alluvial	1614448.62	533922.12	33.07	216662.27	317259.85	
Dry-Extrusive	394804.75	13029.31	3.30	54065.95	-41036.64	2
Dry-Intrusive	199533.43	1472.07	0.74	22234.30	-20762.24	2
Dry-Limestone	1851918.56	403912.85	21.81	293480.38	110432.46	
Dry-Sedimentary	726191.69	39489.66	5.44	113483.64	-73993.98	2
Dry-Ultramafic	219832.33	28978.71	13.18	26794.49	2184.21	
LM-Moist-Alluvial	619.53	0	0.00	81.55	-81.55	1
LM-Moist-Extrusive	45343.44	25613.19	56.49	4540.82	21072.37	
LM-Moist-Intrusive	7036.32	3274.63	46.54	706.77	2567.85	
LM-Moist-Limestone	0.00	0	0.00	8.60	-8.60	
LM-Moist-Sedimentary	2413.29	1190.31	49.32	244.26	946.04	
LM-Moist-Ultramafic	5914.94	4201.12	71.03	591.49	3609.63	
LM-Wet-Extrusive	2415.05	2415.05	100.00	241.50	2173.54	
LM-Wet-Intrusive	163.29	163.29	100.00	16.33	146.96	
LM-Wet-Limestone	3976.21	2673.12	67.23	409.33	2263.79	
LM-Wet-	8878.40	7448.26	83.89	913.70	6534.56	

Sedimentary						
M-Wet-Extrusive	3468.69	3468.69	100.00	346.87	3121.82	
M-Wet-Intrusive	868.66	599.06	68.96	86.87	512.20	
M-Wet-Sedimentary	163.91	163.91	100.00	16.39	147.52	
Moist-Alluvial	54927.22	4131.29	7.52	9404.41	-5273.12	2
Moist-Extrusive	298970.05	66730.43	22.32	32672.67	34057.76	
Moist-Intrusive	26308.03	6104.82	23.21	3312.87	2791.96	
Moist-Limestone	238961.19	59357.21	24.84	27562.97	31794.24	
Moist-Sedimentary	291907.73	59450.69	20.37	33993.64	25457.06	
Moist-Ultramafic	114036.29	55516.06	48.68	11686.86	43829.20	
Thorn-Alluvial	21997.80	2762.86	12.56	1677.33	1085.53	
Thorn-Extrusive	50.66	50.66	100.00	4.28	46.37	
Thorn-Limestone	3951.52	2632.34	66.62	435.51	2196.83	
Thorn-Sedimentary	13900.24	3928.79	28.26	1344.39	2584.40	
Very Dry-Alluvial	361342.79	80168.99	22.19	50142.47	30026.52	
Very Dry-Extrusive	27938.38	4272.96	15.29	4020.43	252.53	
Very Dry-Intrusive	8506.98	3422.27	40.23	1043.22	2379.05	
Very Dry-Limestone	458983.26	115761.09	25.22	63183.35	52577.74	
Very Dry-Sedimentary	86102.73	9418.36	10.94	10564.02	-1145.66	3
Very Dry-Ultramafic	49148.98	4730.62	9.63	7475.99	-2745.38	2
Wet-Extrusive	15930.80	14540.46	91.27	1593.43	12947.02	
Wet-Intrusive	1306.47	274.29	20.99	130.65	143.64	
Wet-Limestone	4669.49	2200.59	47.13	499.77	1700.82	
Wet-Sedimentary	48729.93	42165.52	86.53	4936.59	37228.93	
Wet-Ultramafic	58648.92	47193.06	80.47	5893.27	41299.79	
Mangroves	710021.37	416197.20	58.62	461513.89	-45316.69	3
Aquatic vegetation	93305.20	18314.18	19.63	23326.30	-5012.12	3
Marsh grasslands	192448.95	142298.40	73.94	48112.24	94186.16	

Figure 1. Terrestrial coarse filter conservation targets

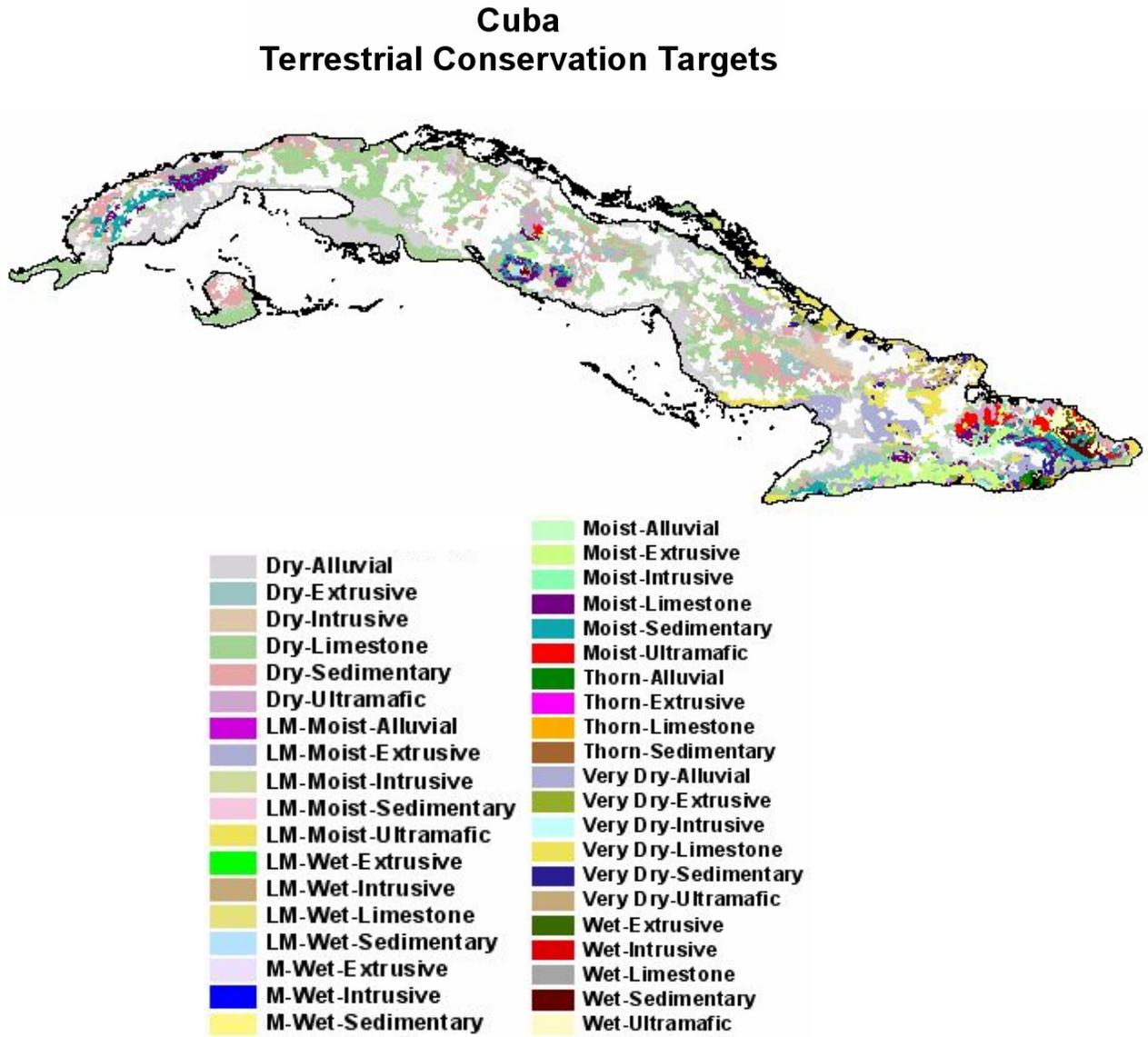


Figure 2. Cuban amphibian diversity (Source: Young, et al., 2004)



Figure 3. The occurrence map of proposed 4 threatened Cuban palms (red dots) superimposed with the map of official protected areas.

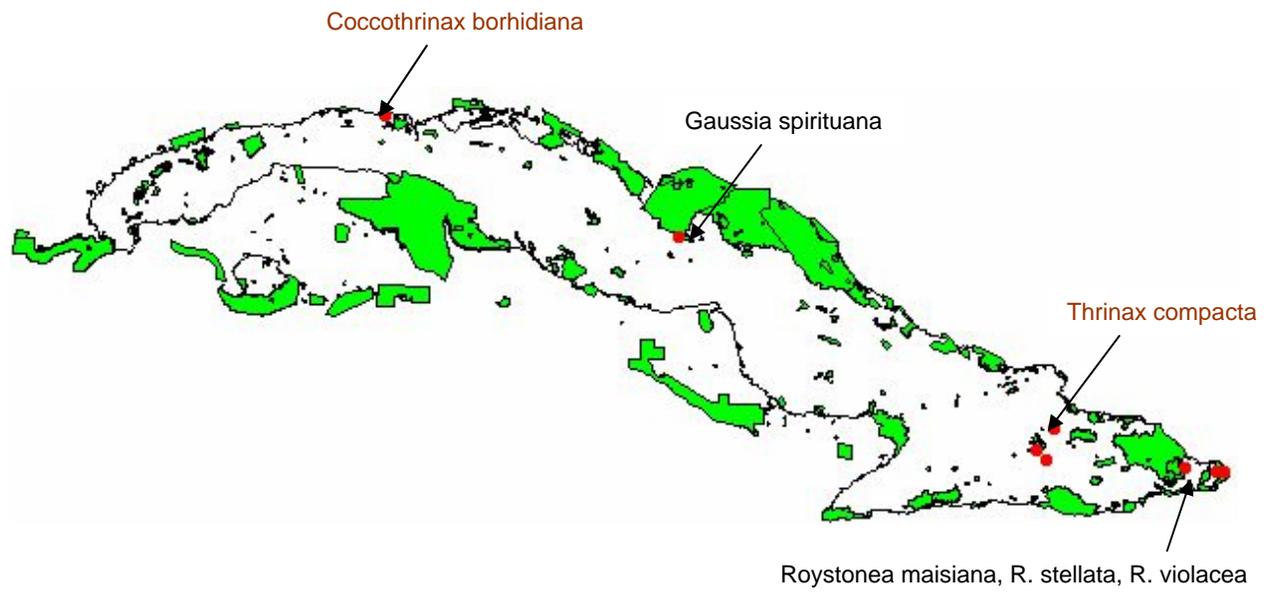
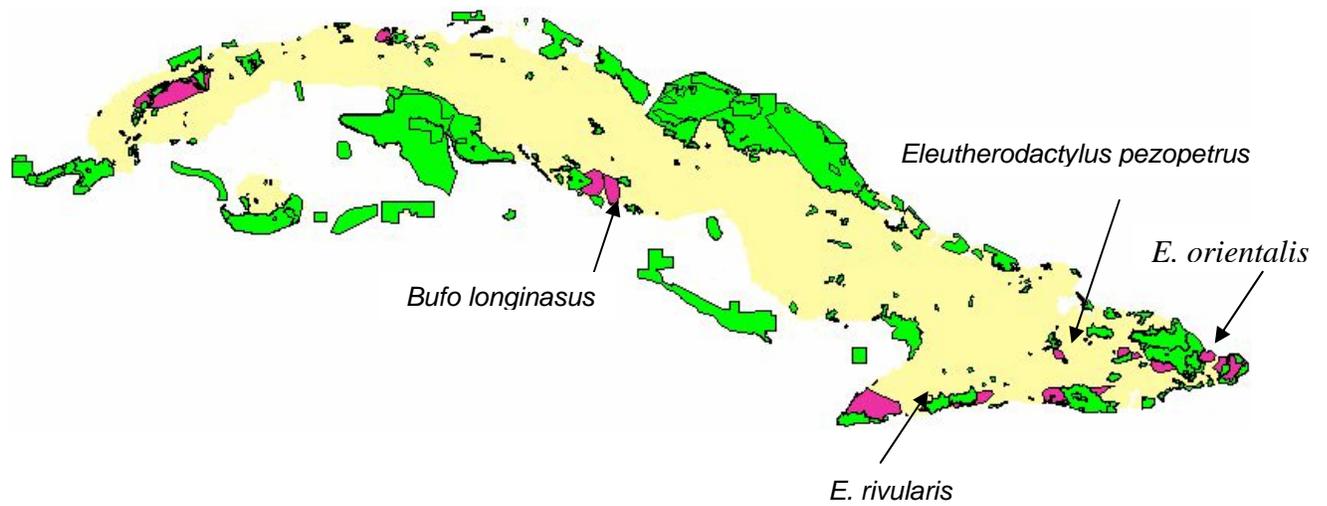


Figure 4. The map of official protected areas superimposed with the map of proposed 8 critically endangered and 12 endangered Cuban amphibian range distribution map (in pink).



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Appendix 1. Brief descriptions of Cuba vegetation formations (adapted from Areces-Mallea et al. 1999 and Borhidi 1991)

1. Aquatic vegetation (V.A.1.N.f., V.A.1.N.g., V.A.1.N.h.)

This vegetation includes **Temporarily Flooded Grassland, Seasonally Flooded Grassland, and Semi-permanently Flooded Grassland**

1.1. *Cyperus heterophyllus* Temporarily Flooded Herbaceous Vegetation

Human-altered grasslands dominated by *Cyperus heterophyllus*, along gravelly montane and submontane creeks and rivers in Cuba.

1.2. *Eleocharis interstincta* - *Sagittaria lancifolia* Seasonally Flooded Herbaceous Vegetation

Freshwater wetlands dominated by *Eleocharis interstincta* and *Sagittaria lancifolia*, in shallow waters of lakes, ponds, and boggy areas, on muddy and peaty substrates. Other species include *Pontederia lanceolata*, *Nuphar lutea ssp. macrophylla*, and *Nymphaea ampla*.

1.3. *Gynerium sagittatum* Seasonally Flooded Herbaceous Vegetation

Riverside thickets dominated by *Gynerium sagittatum*.

1.4. *Paspalidium geminatum* var. *paludivagum* Semi-permanently Flooded Herbaceous Vegetation

Monodominant community dominated by *Paspalidium geminatum* var. *paludivagum* (syn. *Panicum geminatum*, *Setaria geminata* var. *paludivagum*) occurs in semi-permanently flooded zones of freshwater lakes. ***Paspalidium geminatum* var. *paludivagum* - *Hydrocotyle umbellata* Herbaceous Association** occurs in shallower water, and ***Paspalidium geminatum* var. *paludivagum* - *Vallisneria americana* Herbaceous Association** in deeper water.

2. Cloud forest (Borhidi 1991)

It is also called mossy forest, found in montane regions of Sierra Maestra, between 1600-1900 m, with annual mean temperature 10-14⁰C and annual rainfall 2800-3200 mm. Close canopy layer, 6-12 m high, characteristic species include *Myrsine microphylla*, *Nectandra reticularis*, *Symplocos leonis*, *Weinmannia pinnata*, *Cyrtia racemiflora*, and tree ferns e.g., *Cyathea arborea*, *Cyathea minor*, *Alsophila aspera*, and *Lophosoria quadriadiata*. Dense shrub layer, common species are *Vaccinium leonis*, *Lyonia Calycosa*, *Ternstroemia monticola*, *Miconia turquinensis*, and *Hedyosmum cubense*. Ferns and lycopods dominate in the herb layer. The epiphyte stratum is rich in bryophytes and endemic orchids.

Distribution: Sierra Maestra, Pico Turquino, and Pico Bayamesa, between 1600-1900 m,

3. Haystack mountain (Mogote) complex (Borhidi 1991)

Vegetation occurs on shallow humic-carbonated rendzina or bare rocks of deeply eroded mountains and solitary cliffs of Jurassic and Triassic limestone. Vegetation types vary with soil depth. Forest is usually 5-10 m high with open canopy and closed herb layers (epiphytic bromeliads characterize the west Cuban mogotes, while *Pilea spp.* the east mogotes). Succulent agaves (e.g., *Agave tubulata*), epiphytic, columnar or liana-like cacti (e.g.,

Rhipsalis sp., *Leptocereus prostrates*, *Selenicereus* sp., *Pilosocereus* sp.), bromeliads (*Tillandsia* spp.), and trees with barrel-like trunks (e.g., *Bombacopsis cubensis*, *Gaussia princeps*) are common on rocks. In addition to the common species such as *Bursera simaruba*, *Ceiba pentandra*, *Roystonea regia*, characteristic species of mogote forests are *Bombacopsis cubensis*, *Thrinax morrisii* and *Rhytidophyllum exsertum* in western Cuba, and *Tabebuia bibracteolata*, *Coccothrinax elegans*, *Neobraccia susannina*, and *Malpighia acunana* in eastern Cuba. **The east Cuban mogote vegetation is very rich in species, endemics, and palms.**

Distribution: western Cuba (Sierra de Anafe, Mogotes de Jaruco, highlands of Habana and Matanzas) and central and eastern Cuba (Sierra de Emcambray, Sierra Maestra and limestone cliffs and ranges of the Sagua-Baracoa Massif).

4. Lowland rain forest: *Carapa guianensis* - *Calophyllum utile* Forest (I.A.1.N.a.):

Rain forest community occurring usually below 400 m altitude, or in a submontane situation, wherever annual precipitation exceeds 2,500 mm of evenly distributed rain throughout the year, and on yellowish-red mountain soils. The forest with closed upper canopy 30-35 m tall is very strongly dominated by *Carapa guianensis*, or rarely mingled with some exceptionally tall individuals of the 20-25 m tall second canopy layer (e.g. *Calophyllum utile*). As opposed to the upper one, the second canopy layer is rich in species. Most common associates are *Calophyllum utile*, *Sloanea curatellifolia*, *Dipholis jubilla*, *Guarea guidonia*, *Cupania americana*, *Buchenavia capitata*, *Ficus wrightii*, and the Cuban royal palm *Roystonea regia*. Other palms (e.g. *Bactris cubensis*, *Prestoea montana*, and *Calyptronoma clementis* ssp. *orientensis*) are commonly found along creeks.

Distribution: South-east Cuba—Sagua-Baracoa ranges, Moa region, and in the Toa, Jaguani and Duaba river basins.

5. Lowland seasonal evergreen forest (I.A.3.N.a.)

Lowland seasonal evergreen forests dominated by *Ceiba pentandra* and *Roystonea* spp., occur in tropical climate zones with 1,400-2,000 mm annual precipitation and 2-4 dry months. Two canopy layers are present, with emergent deciduous trees. The formation includes *Guazuma ulmifolia* - *Ceiba pentandra* - *Roystonea regia* Forest, *Sideroxylon foetidissimum* - *Sideroxylon salicifolium* - *Roystonea regia* Forest, *Spondias mombin* - *Roystonea regia* - *Guazuma ulmifolia* Forest, and *Guapira discolor* - *Pithecellobium keyense* - *Reynosa septentrionalis* - *Metopium toxiferum* Forest

5.1. *Guazuma ulmifolia* - *Ceiba pentandra* - *Roystonea regia* Forest

Two evergreen canopy layers are present—the 20-25 m high upper one is somewhat open while the 8-15 m high lower one is rather closed. The deciduous *Ceiba pentandra*, which may attain 30-40 m tall, is a typical emergent tree. Characteristic species include *Guazuma ulmifolia*, *Ceiba pentandra*, *Roystonea regia*, *Mastichodendron foetidissimum*, *Lonchocarpus domingensis*, *Lonchocarpus latifolius*, *Luehea speciosa*, *Spondias mombin*, *Ficus membranacea*, *Andira inermis*, *Chlorophora tinctoria*, *Cordia gerascanthus*, *Cordia collococca*, *Guarea guidonia*, and *Cupania macrophylla*. Lianas are frequent and abundant, epiphytes occur rather rarely, and the herb layer is almost completely missing.

This probably was the dominant zonal lowland forest community of Cuba, but it is everywhere destroyed and substituted by second-growth evergreen or deciduous

forests, palm-brakes, savannas and sugarcane fields. The isolated remnant stands have slightly different species combination due to various kinds of natural causes and human impacts.

Distribution: Cuba.

5.2. *Sideroxylon foetidissimum* - *Sideroxylon salicifolium* - *Roystonea regia* Forest

Seasonal evergreen forest community occurs in the Cuban plains and hilly areas, **on limestone-derived soils**. The upper canopy layer is usually co-dominated by *Sideroxylon foetidissimum* (= *Mastichodendron foetidissimum*), *Sideroxylon salicifolium* (= *Bumelia salicifolia*), *Roystonea regia*, *Bursera simaruba* and *Ficus crassinervis*. Other common trees may include *Cordia gerascanthus*, *Zanthoxylum elephantiasis*, *Andira inermis*, *Cassine xylocarpa*, *Cecropia shreberiana*, *Exotea paniculata*, *Alophylus cominia*, *Cedrela odorata*, *Trichilia hirta*, *Celtis trinervia*, *Pseudolmedia spuria*, *Petitia domingensis*, *Citharexylum caudatum*, *Guazuma ulmifolia*, *Pithecellobium arboreum*, *Casearia hirsuta*, *Guettarda elliptica*, *Oxandra lanceolata*, *Eugenia maleolens*, *Savia sessiliflora*, *Adelia ricinella*, *Erythroxulon confusum*, *Pera bumeliaefolia* and *Schoepfia chrysophylloides*. Woody climbers such as *Cissus sicyoides*, *Gouania lupuloides*, *Platygyne hexandra*, and *Chiococca alba* are often present.

Distribution: Widely distributed from the Guanacahabibes peninsula, south of Isle of Pines and in the foothills of the limestone middle ranges of west and central Cuba.

5.3. *Spondias mombin* - *Roystonea regia* - *Guazuma ulmifolia* Forest

Successional association established following disturbance of the former *Guazuma ulmifolia* - *Ceiba pentandra* - *Roystonea regia* seasonal evergreen forest in Cuba, mostly by selective cutting of trees for timber. Species combinations resulted from different human interferences are recognizable. Common species usually include *Spondias mombin*, *Roystonea regia*, *Guazuma ulmifolia*, *Ceiba pentandra*, *Oxandra lanceolata*, *Crescentia cujete*, *Pithecellobium cubense*, *Samanea saman*, *Cecropia shreberiana*, *Cordia collococca*, *Nectandra coriacea*, *Bursera simaruba*, *Allophylus cominia*, *Drypetes alba*, *Guettarda combsii*, *Ficus* spp., and *Eugenia* spp.

Distribution: Cuba.

5.4. *Guapira discolor* - *Pithecellobium keyense* - *Reynosia septentrionalis* - *Metopium toxiferum* Forest (no description)

Distribution: FL, Cuba, Bahamas

6. Lowland semi-deciduous forest (I.C.1.N.a.)

This forest type occurs in southeastern Cuba (Guantanamo Bay), including *Lysiloma latisiliqua* - *Swietenia mahagoni* - *Peltophorum adnatum* - *Bucida spinosa* - *Pseudosamanea cubana* / *Tillandsia usneoides* Forest, *Phyllostylon brasiliensis* - *Maytenus buxifolia* - *Pilosocereus brooksianus* - *Amyris elemifera* Forest, and *Phyllostylon brasiliensis* - *Senna insularis* - *Stenocereus peruvianus* - *Dendrocereus nudiflorus* Forest

7. Lowland/submontane evergreen sclerophyllous forest (I.A.5.N.a.)

This forest type includes *Calophyllum calaba*-ssp. *pinetorum*-*Coccoloba retusa* Forest and *Quercus oleoides* ssp. *sagraeana* - *Miconia ibaguensis* - *Xylopia aromatica* Forest

7.1. *Calophyllum calaba*-ssp. *pinetorum*-*Coccoloba retusa* Forest

Evergreen tropical forests dominated by *Calophyllum calaba* ssp. *pinetorum* and *Coccoloba retusa*. This vegetation occurs in West Cuba, on lixiviated yellowish-red **ferrosilicic soils derived from limestone** but with substantial contributions from **serpentine rocks**. The forest is characterized by a great number of sclerophyllous and microphyllous trees and shrubs in the canopy and understory. Species may include *Dipholis neglecta*, *Zanthoxylum cubense*, *Dendropanax cuneifolius*, *Pachyanthus tetramerus*, *Trichilia trachyantha*, *Picramnia reticulata*, *Calypttranthes caroli*, *Myrcia valenzuelana*, *Acunaeanthus tinifolius*, *Lagetta wrightiana*, and *Malpighia wrightian*.
Distribution: West Cuba, Pinar del Rio province.

7.2. *Quercus oleoides* ssp. *sagraeana* - *Miconia ibaguensis* - *Xylopia aromatica* Forest

Oak forests of west Cuba on deep, brownish-yellow soils derived from the “San Cayetano” slaty **sandstone**, rarely on white-sand areas. The canopy layer is completely dominated by *Quercus oleoides* ssp. *sagraeana*. The understory consists of a mixture of both pine and semi-deciduous forest elements. Species commonly include *Miconia ibaguensis*, *Miconia splendens*, *Xylopia aromatica*, *Amaioua corymbosa*, *Byrsonima crassifolia*, *Clidemia hirta*, *Clidemia strigillosa*, *Hirtella americana*, and *Brya ebenus*.
Distribution: West Cuba, Pinar del Rio province.

8. Lowland/submontane evergreen serpentine shrubland (Borhidi 1991)

This vegetation formation includes semi-dry and dry evergreen shrublands.

8.1. The semi-dry evergreen shrublands developed on the ferritic latosols of the coastal zone north of the Moa Mountains, and the semi-humid serpentine rendzinas in the hilly and lower montane zones of the Sagua-Baracoa range. The average annual precipitation is 1400-1900 mm with one or two dry months. In Cuba, **semi-dry shrubland formation is the richest in endemic species. About 75-85% of its flora is endemic.** Common elements include *Hemithrinax savannarum*, *Hemithrinax rivularis*, *Acrosynanthus minor*, *Tabebuia linearis*, *Antirhea abbreviate*, *Phyllanthus comosus*, *Purdiaea velutina*, and *Kodalyodendron cubense*.

Distribution: East Cuba—coastal zone north of the Moa Mountains, lower montane zones of the Sagua-Baracoa range

8.2. The dry evergreen shrublands occur on red ferrallitic soils derived from serpentine in several isolated spots from the Cajalbana Hills to the Holguin serpentine area in Oriente. The average annual precipitation is 1000-1600 mm with 1-2 to 5-6 dry months. Aridity increases eastward. Common characteristic species include *Tabebuia lepidota*, *Coccothrinax miraguama*, *Neobraccia valenzuelana*, *Phyllanthus orbicularis*, *Annona bullata*, *Rondeletia camarioca*, *Eugenia camarioca*, and *Malpighia nummulariifolia*. Stands of serpentine scrub are often alternate with small grassy clearings which can be transformed into dwarf-grass savannas by burning and grazing.

Distribution: West Cuba—isolated spots from the Cajalbana Hills to the Holguin serpentine area in Oriente.

9. Mangroves (I.A.5.N.f.)

Avicennia germinans, *Rhizophora mangle*, *Laguncularia racemosa*, and *Conocarpus erectus* are the four nominal species of Caribbean mangroves. Four mangrove forest types are recognized.

9.1. *Avicennia germinans* Forest (Black Mangrove Forest)

Mangrove forests dominated by *Avicennia germinans*, *Batis maritima* is usually a common accompanying species. Others may include *Baccharis halimifolia*, *Iva cheiranthifolia*, *Salicornia perennis*, *Heliotropium curassavicum*, *Distichlis spicata*.

9.2. *Conocarpus erecta* Forest

Communities dominated by a 4-5 m tall *Conocarpus erecta* tree layer, at the inner side of the mangrove belt, mostly in lagoons with concentrated saltwater. With 70-80% coverage of *Conocarpus erecta* and the common presence of the fern *Acrostichum aureum* at the herb layer. Other species may include *Laguncularia racemosa*, *Acrostichum danaifolium*, *Cladium jamaicense*, *Fimbristylis spadicea*, *Schoenoplectus americanus*, *Eleocharis cellulosa*, *Baccharis halimifolia*.

9.3. *Laguncularia racemosa* Forest (White Mangrove Forest)

Most inland mangrove forest, least frequently tidally flooded, dominated by *Laguncularia racemosa* or mixtures of various mangroves, e.g. *Rhizophora mangle*, *Avicennia germinans*, and *Conocarpus erectus*.

9.4. *Rhizophora mangle* Forest (Red Mangrove Forest)

Most oceanwards and frequently tidally flooded mangrove forest, dominated by *Rhizophora mangle*. *Rhizophora mangle* - *Dalbergia ecastophyllum* - *Pavonia spicata* Forest association forms a narrow fringe along the margins of lowland rivers near to their estuaries. A sparse shrub layer formed by *Dalbergia ecastophyllum* and *Pavonia spicata* are characteristic features of this community, as well as the presence of lianas e.g. *Rhabdadenia biflora*, *Sarcostemma clausum*. Scattered individuals of *Laguncularia racemosa*, *Conocarpus erecta*, *Bucida palustris*, *Tabebuia angustata*, *Roystonea regia* and *Sabal parviflora* may also occur.

10. Marsh grasslands (V.A.1.N.i.)

Tidally flooded grasslands e.g., *Sporobolus virginicus* - *Distichlis spicata* Herbaceous Vegetation occur in Cuba.

11. Microphyllous montane shrubland with succulents (III.A.4.N.d.)

This vegetation formation includes *Ilex turquinensis* - *Myrica cacuminis* - *Lyonia calycosa* - *Persea similis* Shrubland and *Agave pendentata* - *Mitracarpus acunae* - *Peratanthe cubensis* Shrubland

11.1. *Ilex turquinensis* - *Myrica cacuminis* - *Lyonia calycosa* - *Persea similis* Shrubland

This is subalpine microphyllous shrubland of Cuba, a dense thicket composed of 1.5-3 m tall shrubs occupying the summits of the Pico Turquino massif, the highest mountains of Cuba, slightly above the condensation belt. This vegetation type is rich in herbaceous leaf-succulents and spiny plants which grow in habitats much drier than non-microphyllous “elfin thickets” of the cloud zone. Typical species include *Ilex turquinensis*, *Myrica cacuminis*, *Persea similis*, *Lyonia calycosa*, *Peratanthe cubensis*, *Lobelia cacuminis*, *Torralbasia cuneifolia*, *Ageratina paucibracteata* (= *Eupatorium*), *Vernonia parvuliceps* and *Vernonia praestans* ssp. *cacuminis*.

Distribution: Southeastern Cuba (1800-2000m altitude),

11.2. *Agave pendentata* - *Mitracarpus acunae* - *Peratanthe cubensis* Shrubland

Low 0.5-1m tall thicket on the rather exposed upper rocky slopes of the Turquino massif, with an endemic *Agave* species and many dwarf shrubs (e.g. *Ilex nanophylla*, *Ilex turquinensis*, *Mitracarpus acunae*, *Cassia turquinae*, *Micromeria bucheri*, *Shoepfia stenophylla*, *Vernonia praestans* ssp. *cacuminis*). The shrubs are often intertwined by the lianes *Chusquea abietifolia* and *Arthrostylidium multispicatum*.

Distribution: Southeastern Cuba.

12. Mixed pine-broad-leaved forest (I.A.10.N.a)

This forest type includes *Pinus caribaea* var. *caribaea* - *Quercus oleoides* ssp. *sagraeana* Forest, *Pinus cubensis* / *Rhynchospora tenuis* - *Baccharis scoparioides* - *Vernonia urbaniana* Forest, *Pinus cubensis* / *Bactris cubensis* - *Shafera platyphylla* Forest, and *Pinus xmaestrensis* / *Clethra cubensis* - *Cyathea arborea* Forest

12.1. *Pinus caribaea* var. *caribaea* - *Quercus oleoides* ssp. *sagraeana* Mixed Forest:

Submontane pine-oak mixed forests with canopy co-dominated by *Pinus caribaea* var. *caribaea* and *Quercus oleoides* ssp. *sagraeana*, on the slaty sandstones of western Cuba. Other arboreal species that may be well represented in the canopy layer are: *Calophyllum calaba* ssp. *pinetorum*, *Pinus tropicalis*, *Matayba oppositifolia*, *Xylopia aromatica*, and *Clusia rosea*. The understory is rich in Melastomataceae species. Other species present may include *Didymopanax morototoni*, *Guarea guidonia*, *Rhus copallina* ssp. *leucantha*, *Amaioua corymbosa*, *Tabebuia lepidophylla*, *Alsophila myosuroides*, *Byrsonima pinetorum*, *Psychotria revoluta*, *Eugenia faramaeoides*, etc.

Distribution: West Cuba—Sierra de los Organos and Sierra del Rosario ranges, on typical “San Cayetano” Jurassic sandstone.

12.2. *Pinus cubensis* - *Tabebuia dubia* Mixed Forest:

Montane mixed forests of *Pinus cubensis* and broad-leaved evergreen trees, in the **serpentine** ranges of eastern Cuba, on relatively fertile, deep, and humid ferritic soils. Characteristic canopy species include *Pinus cubensis*, *Tabebuia dubia*, *Hyeronima nipensis*, *Terminalia orientensis* and *Gutteria moralesii*. The herb layer is well developed and diverse, and may include *Andropogon gracilis*, *Andropogon reinoldii*, *Andropogon nashianus*, *Panicum aciculare*, *Panicum fusiforme*, *Panicum scoparium*, *Paspalum alainii*, *Aristida refracta*, and eight different species of *Rhynchospora*. Other prevalent associates are *Baccharis scoparioides*, *Vernonia urbaniana*, *Eupatorium polystictum*, *Dodonaea viscosa*, *Bactris cubensis*, *Casearia crassinervis*, and *Pteridium caudatum*.

Distribution: South-east Cuba: Sierra de Nipe and Sierra Cristal.

12.3. *Pinus cubensis* / *Bactris cubensis* - *Shafera platyphylla* Forest : Rich pine forest with a mixed upper canopy of *Pinus cubensis* and many evergreen trees, on deep, rather humid and fertile ferritic soils, in the high plateau of Moa (eastern Cuba). Characteristic canopy species include *Pinus cubensis*, *Tabebuia dubia*, *Hyeronima nipensis*, *Terminalia orientensis* and *Guatteria moralesii*. A second canopy layer is composed of small trees such as *Bactris cubensis* and *Alsophila aquiline*. Other characteristic species include *Shafera platyphylla*, *Gomidesia lindeniana*, *Vaccinium alainii*, *Cordia toaensis*, *Lyonia glandulosa*, *Ficus wrightii*, *Ossaea navasensis*, *Ossaea pseudopinetorum*, *Gundlachia cubana*, *Clethra cubensis*, *Spirotecoma apiculata*, and *Miconia cerasiflora*, etc.

Distribution: East Cuba—Sierra del Cupeyal del Norte.

12.4. *Pinus maestrensis* Mixed Forest: Montane mixed pinewoods occurring as isolated stands in the **montane rainforest zone** of southeastern Cuba, on yellow acidic soils derived from sandstone and andesitic tuffs. **This vegetation type is typically successional.** The upper canopy is dominated by *Pinus* × *maestrensis* (*Pinus cubensis* × *Pinus occidentalis*) with strong admixture of broad-leaved trees such as *Myrsine coriacea*. Smaller trees, e.g. *Weinmania pinnata*, *Garrya fadyenii*, *Ilex macfadyenii* are common. Very characteristic of this association is the constant presence of tree-ferns (i.e. *Cyathea arborea*, *Alsophila aspera*) and typical southeastern Cuban montane rainforest species such as *Clethra cubensis*, *Vaccinium leonis*, *Lyonia calycosa*, and *Myrica punctata*.

Distribution: Southeast Cuba—Sierra Maestra (northern slopes) and Gran Piedra ranges.

13. Montane evergreen extremely xeromorphic serpentine woodland (Borhidi 1991)

This vegetation developed under a humid tropical rainforest climate on ferritic soils derived from serpentine bedrocks, is very rich in endemics. It consists of microphyllous and nanophyllous sclerophyll shrubs and stunted trees up to 4-6 m height, with emergent trees reaching 7-10 m height. The more moist association occurs in Moa and is characterized by *Ilex berteroi*, *Ilex victorini*, *Ilex hypaneura*, *Ilex shaferi*, *Laplacea moaënsis*, *Clusia moaënsis*, *Clusia callosa*, *C. monocarpa*, *Cyrilla cubensis* and numerous sclerophyllous lianas (e.g. *Arthrostylidium fimbriatum*, *Feddea cubensis*, *Rajania baracoënsis*, *Morinda moaënsis*, etc.). The more xeromorphic association with spinose elements and few lianas occurs in Nipe and Loma Mensur at 650-1000 m. Characteristic species are *Bourreria pauciflora*, *Myrcia retivenia*, *Coccoloba reflexa*, *Spathelia cubensis*, *Clusia nipensis*, *Jacaranda arborea*, and endemic liana *Harnackia bisecta*.

Distribution: East Cuba—Nipe, Cristal and Moa Mountains.

14. Montane rain forest (I.A.1.N.c.)

The montane rain forests include *Bonnetia cubensis* - *Pera ekmanii* - *Podocarpus ekmanii* Forest, *Magnolia cubensis* ssp. *acunae* - *Cyrilla racemiflora* Forest, *Magnolia cubensis* ssp. *cubensis* - *Laplacea angustifolia* - *Ocotea ekmanii* Forest, *Ocotea ekmani* - *Cyrilla racemiflora* Forest, and *Prestoea montana* Forest.

14.1. *Bonnetia cubensis* Forest: A **serpentine** rainforest community dominated or co-dominated by *Bonnetia cubensis*, on rather poor acid **ferrallitic soils**, occurs in the high plateaus of the Cuchillas de Moa and Toa, eastern Cuba between 800 and 900 m elevation. Characteristic species include *Bonnetia cubensis*, *Pera ekmanii*, *Podocarpus ekmanii*, *Moacroton ekmanii*, *Tabebuia dubia*, *T. clementis*, *Laplacea moaensis*, and *Purdiaea moaensis*. Other associates that may be locally abundant include *Hyeronima nipensis*, *Jacquiniella globosa*, *Chionanthus (Linociera) domingensis*, *Matayba domingensis*, *Spathelia pinetorum*, *Tapura cubensis*, *Bactris cubensis*, and the tree-fern *Alsophila aquilina*. **This association shares many east-Cuban serpentine endemics with the *Hyeronima nipensis* submontane rain forests of Sierra de Nipe and Sierra Cristal.**

Distribution: South-east Cuba—Cuchillas de Moa and Toa ranges.

14.2. *Magnolia cubensis* ssp. *acunae* Forest: This central-Cuban rain forests form a vegetation belt between 800 and 1,100 m, on yellow tropical soils. Characteristic trees are *Magnolia cubensis* ssp. *acunae*, *Ocotea acunaiana*, and *Torrabasia lenticellata*. Other typical species include *Ocotea floribunda*, *Miconia cubensis*, *Miconia albescens*, *Gesneria viridiflora* ssp. *colorata*, and endemic taxa in the herb and shrub layers, such as *Pilea clarana*, *Pilea cellulosa*, *Pilea clementis*, and *Psychotria martii*. This central-Cuban rain forest community is less rich and diverse than its climax equivalent in the ranges of eastern Cuba.

Distribution: Central Cuba—Sierra del Escambray ranges.

14.3. *Magnolia cubensis* ssp. *cubensis* Forest: Rich montane forests of eastern Cuba forming a vegetation belt between 800 and 1600 m, on mountain yellow tropical soils occur in areas of 1,700-3,000 mm of yearly rainfall. A forest with two canopy layers, the rather closed 20-25 m high upper canopy is co-dominated by *Magnolia cubensis* ssp. *Cubensis*, *Laplacea angustifolia* and *Ocotea ekmanii*, accompanied by many other tree-species such as, *Ocotea cuneata*, *Guatteria blainii*, *Freziera grisebachii*, *Laplacea urbanii*, *Cleyera nimanima*, and *Cyrilla racemiflora*. The second canopy layer is dominated by Melastomataceae and tree-ferns. Epiphytes are abundant and diverse. Other characteristic species include *Torrabasia cuneifolia*, *Solonia reflexa*, *Ditta maestrensis*, *Lasianthus lanceolatus*, *Graffenrieda rufescens*, *Ilex macfadyenii*, *Brunellia comocladifolia* and *Weinmannia pinnata*. **This association represents the climax vegetation between 800 and 1,600 m, in southeastern Cuba.**

Distribution: South-east Cuba—Sierra Maestra, Sierra del Purial.

14.4. *Ocotea ekmanii* Forest: On the humid sandtone outcrops or the steep dry ridges and slopes of the Sierra Maestra range in eastern Cuba. A somewhat drier and less diverse montane forest community dominated by *Ocotea ekmanii* and other microphyllous sclerophyllous trees such as *Cyrilla racemiflora*, *Persea similis*, *Tabebuia oligolepis* and *Myrsine coriacea*. Another diagnostic character is the total absence of tree-ferns in the second canopy layer.

Distribution: South-east Cuba—Sierra Maestra range.

14.5. *Prestoea montana* Forest: Forests dominated by palms *Prestoea montana* occur on exposed montane slopes that are prone to landslide.

15. Pine woodland (II.A.3.N.a.) [Followed by “Lowland/submontane pine forest (I.A.7.N.a.)”]

Pine woodlands include *Pinus tropicalis* woodlands /forests, *Pinus caribaea caribaea* woodlands/ forests, and *Pinus cubensis* woodlands /forests.

15.1. *Pinus tropicalis* woodlands, on white-sand or slates

Open pine woodlands of western Cuba, on white-sand soils and hard slate rocks, with a canopy dominated by *Pinus tropicalis*. There are three associations.

i. *Pinus tropicalis* / -*Byrsonima crassifolia* - *Tabebuia lepidophylla* Woodland

Associated species include *Colpothrinax wrightii*, *Byrsonima crassifolia*, *B. pinetorum*, *Tabebuia lepidophylla*, *Pachyanthus wrightii*, *Pachyanthus poiretii*, *Befaria cubensis*, *Brya depressa*, *Hyptis pedalipes*, *Aster grisebachii*, *Heptanthus cochlearifolius*, *Stenandrium ovatum*, etc.

Distribution: Slate range of Sierra del Rosario, and white-sand area of south Pinar del Rio province.

ii. *Pinus tropicalis* / *Eragrostis cubensis* Woodland

On white-sand areas, with substantial coverage of the ground by *Eragrostis cubensis* and other grasses.

Distribution: West Cuba—Remates de Guane.

iii. *Pinus tropicalis* / *Paepalanthus seslerioides* - *Syngonanthus insularis* Woodland

Occurs on white-sands. Characteristic species include *Paepalanthus seslerioides*, *Paepalanthus alsinoides*, *Syngonanthus insularis*, *Pachyanthus longifolius*, *Kalmiella aggregata*, *Kalmiella simulata*.

Distribution: Western Isle of Pines.

15.2. *Pinus tropicalis* - *Pinus caribaea* var. *caribaea* Forest (I.A.7.N.a.)

Low-altitude pine forests of the hillsides of Isle of Pines (Cuba), with canopy dominated by *Pinus tropicalis*. *Pinus caribaea* is also present. Other characteristic species include *Byrsonima wrightiana*, *Tetrazygia delicatula*, *Clitoria laurifolia*, *phyllanthus junceus*, *Lyonia myrtilloides*, and *Trachypogon filifolius*.

Distribution: Colline belt of Isle of Pines.

15.3. *Pinus caribaea caribaea* / *Aristida refracta* - *Andropogon gracilis* Woodlands, on serpentines and ferritic soils

Low-altitude pine woodland covering small areas of ridges and/or slopes on the northern part of the Cajálbana range, with an open canopy dominated by *Pinus caribaea* var. *caribaea*, and substantial coverage by a grass-dominated herb layer. This community is basically a degraded *Pinus caribaea* var. *caribaea* forest on ferritic soils, with open canopy and well developed herb layer dominated by grasses.

Distribution: West Cuba (Cajálbana).

15.4. *Pinus caribaea* var. *caribaea* Forest, on ferritic soils of Cajálbana hills with two associations.

i) *Pinus caribaea* var. *caribaea* - *Neomazaea phialanthoides* Forest

The common low-altitude pine forest covering all the ridges and slopes on the northern part of the Cajálbana range, on ferritic soils, with a **close** canopy strongly dominated by *Pinus caribaea* var. *caribaea*. Typical species include *Neomazaea phialanthoides*, *Coccothrinax yuraguana*, *Phania cajalbanica*. A well developed herb layer dominated by grasses (e.g. *Andropogon gracilis*, *Aristida refracta*) is present.

Distribution: West Cuba (Cajálbana).

ii) *Pinus caribaea* var. *caribaea* - *Guettarda valenzuelana* Forest

Humid lowland pine forest on ferritic soils, occurring on flat areas and along creeks, in Cajálbana. The **close** canopy is dominated by *Pinus caribaea* var. *caribaea*, with the presence of some broad-leaved tree species. The shrub layer is species rich, but the herb layer is poorly developed. Characteristic species of this community are *Guettarda valenzuelana*, *Guettarda calyprata*, *Cyrilla racemiflora*, *Calophyllum calaba* ssp. *pinetorum*, *Gesneria ferruginea*, *Comocladia dentata*, *Rondeletia odorata*, etc.

Distribution: West Cuba (Cajálbana).

15.5. *Pinus caribaea* var. *caribaea* - *Pachyanthus poiretii* Forest, on slaty sandstone

Submontane pine forests with canopy dominated by *Pinus caribaea* var. *caribaea*, and a well developed shrub layer rich in Melastomataceae species such as *Pachyanthus poiretii*, *P. cubensis*, *Clidemia strigillosa*, *C. neglecta*, *Ossaea parviflora*, *Miconia ibaguensis*, and *M. prasina*.

Distribution: West Cuba, in Pinar del Rio province—submontane sandstone belt of Sierra de los Organos and Sierra del Rosario ranges, on typical “San Cayetano” Jurassic sandstone.

15.6. *Pinus cubensis* Woodland, on serpentine rocks

Open woodlands with canopy dominated by *Pinus cubensis*, on bare serpentine rocks. *Coccothrinax orientalis* is usually present in the canopy. The species-rich, well developed microphyllous evergreen shrub layer is made up by the same endemic species found in the serpentine scrubs of eastern Cuba. Three associations are recognized.

i) *Pinus cubensis* / *Anemia coriacea* - *Anemia nipensis* - *Clerodendron nipense* Woodland

Xerophytic pine woodland community with canopy dominated by *Pinus cubensis*, on shallow ferritic soils often rich in hardpan on iron-oxide concretions, in the foothills and submontane serpentine belts of east Cuba. Characteristic species include *Pinus cubensis*, *Anemia coriacea*, *Anemia nipensis*, *Clerodendron nipense*, *Plumeria clusioides*, *Lyonia nipensis*, *L. macrophylla*, *Pachyanthus reticulatus*, *Tabebuia shaferi*, *Ouratea striata*, *Guettarda monocarpa*, *G. calyprata*, *Casearia crassinervis*, *Vernonia urbaniana*, *Rondeletia myrtacea* and *Bletia floribunda*.

Distribution: East Cuba (mainly in Sierra de Nipe, but also in the Sierra Cristal range).

ii) *Pinus cubensis* / *Euphorbia helenae* Woodland

Pine woodland association with a 6-10 m tall canopy dominated by *Pinus cubensis*, on shallow, rather rocky ferritic soils, in the Sagua-Baracoa serpentine range of eastern Cuba. Dwarf palms are usually present in the well-developed shrub layer. Most characteristic species are: *Pinus cubensis*, *Coccothrinax yuraguana* ssp. *moaensis*, *Euphorbia helenae*, *Scaevola wrightii*, *Coccoloba oligantha*, *Croton monogynus*, *Eupatorium lantanifolium*, *Guettarda ferruginea*, *Gochnatia recurva*, *Hypericum styphelioides* ssp. *moaensis*, *Linodendron aronifolium*, , *Malpighia cnide*, *Tabebuia pinetorum*, *Byrsonima minutifolia*, *Vaccinium alainii* and *Vernonia wrightii*.

Distribution: East Cuba (in all the range of the Sagua-Baracoa massif, but especially on the eroded rocky ridges of Moa).

iii) *Pinus cubensis* / *Agave shaferi* - *Ariadne shaferi* Woodland

Open *Pinus cubensis* woodland on the rocky peaks and steep rocky slopes of the serpentine ranges of eastern Cuba (Nipe-Cristal). Characteristic species of this association include *Pinus cubensis*, *Agave shaferi*, *Ariadne shaferi*, *Coccothrinax orientalis*, *Aristida laevigata*, *Oplonia cubensis*, *Psychotria graminifolia*, *Callicarpa nipensis*, *Callicarpa lancifolia*, *Callicarpa cuneifolia*, *Clusia nipensis*, *Euphorbia podocarpifolia*, *Ossaea acunae*, *Phyllanthus shaferi*, *Xylosma buxifolium*, *Gesneria nipensis*, *Vaccinium cubense*, *Platygyne triandra*, and others.

Distribution: East Cuba—Nipe and Cristal serpentine ranges.

15.7. *Pinus cubensis* - *Dracaena cubensis* Forest, on ferritic soils

Lowland pine vegetation on deep, acidic ferritic soils, with a closed canopy strongly dominated by *Pinus cubensis*, very rich in endemics, with more than 70% of endemic species. Other typical canopy species are *Dracaena cubensis*, *Coccothrinax orientalis*, and *Guatteria moralesii*. Both the shrub and herbaceous layers are well developed in this community. Characteristic species are: *Schmidtottia sessiliflora*, *Schidtotia shaferi*, *Psidium parviflorum*, *Casearia moaensis*, *Casearia bissei*, *Myrtus ophiticola*, *Guettarda crassipes*, *Guettarda ferruginea*, *Bumelia cubensis*, *Cyrilla cubensis*, *Ossaea pauciflora*, *Jacquinia roigii*, *Rhynchospora lindeniana*, *Chaetocarpus oblongatus*, *Eugenia pinetorum*, *Phyllanthus myrtilloides* ssp. *erythrinus*, and *Callicarpa oblanceolata*.

Distribution: East Cuba—lowlands and foothills between Moa and Baracoa.

16. Sclerophyllous tropical or subtropical broad-leaved evergreen shrubland [treated as Evergreen Woodland, II.A.1.N.a.]

It is a palm-dominated community, in the white-sand areas of Cuba.

16.1. *Acoelorrhaphe wrightii* - *Blechnum serrulatum* Woodland

Community with an open canopy dominated by the clumping palm species *Acoelorrhaphe wrightii*, in the humid sites of white-sand areas, usually along or near the drainage network surrounding shallow oligotrophic lakes. The fern *Blechnum serrulatum* often gives substantial coverage to the ground.

Distribution: West Cuba—Pinar del Rio province, in white-sand areas.

16.2. *Colpothrinax wrightii* - *Chrysobalanus icaco* Woodland

Open canopy dominated by the endemic palm species *Colpothrinax wrightii*, sometimes with scattered individuals of *Pinus tropicalis*, in white sand areas. *Crysobalanus icaco* is a major component of the tall shrub layer. Some of the extant stands of this rather broad-leaf association can be interpreted as being natural, but the majority of them are second-growth communities developed as a result of cutting and logging original pine woodlands.

Distribution: West Cuba—Pinar del Rio province, in white-sand areas.

17. Seasonally flooded/saturated evergreen forest (I.A.3.N.e.) [note: The mapped seasonally flooded/saturated **semi-deciduous forest is not listed in Areces-Mallea 1999, The report author (SK) changed it to Seasonally flooded/saturated **evergreen** forest]**

This evergreen forest type includes *Hibiscus elatus* - *Calophyllum calaba* Forest and *Lysiloma bahamensis* - *Metopium brownei* - *Swietenia mahagoni* Forest

17.1. *Hibiscus elatus* - *Calophyllum calaba* Forest

Seasonally flooded evergreen forest community occurring on the somewhat higher plains of the swamp basins of Cuba, and in the supralittoral marsh-zone, mostly in the great flat peninsulas of quaternary **limestone** (Guanacahabibes, Zapata, south Isle of Pines), and along the low southern coastal area of the Cuban plain. This forest association is co-dominated by *Hibiscus elatus* and *Calophyllum calaba* and has a high frequency and abundance of macro- and mesophyllous climbers and xerophytic epiphytes (*Tillandsia* spp.).

Distribution: Cuba

17.2. *Lysiloma bahamensis* - *Metopium brownei* - *Swietenia mahagoni* Forest

An alluvial seasonal evergreen forest association occurs on regularly flooded lowland **limestone** areas, with two canopy layers and some deciduous elements. Prevalent trees are *Lysiloma bahamensis*, *Metopium brownei*, and *Swietenia mahagoni*. Other species may include *Bucida buceras*, *Bursera simaruba*, *Linociera ligustrina*, *Nectandra coriacea*, *Chrysophyllum oliviforme*, *Erythroxylon rotundifolium*, *Ficus citrifolia*, *Gyminda latifolia*, *Ateramnus lucidus*, *Picrodendron macrocarpum*, *Pouteris dominguensis*, *Capparis cynophallophora*, *Capparis flexuosa*, *Eugenia ligustrina*, *Eugenia maleolens*, *Zanthoxylum fagara*, *Sabal parviflora*, and *Myrica cerifera*. Xerophytic epiphytes (*Tillandsia* spp.) are particularly abundant.

Distribution: Cuba.

18. Seasonally flooded semi-deciduous woodland (II.C.1.N.b.)

This vegetation formation occurs in southeastern Cuba (Guantanamo Bay), including *Bucida spinosa* - *Harrisia taylori* / *Cordia globosa* - *Lycium americanum* Woodland and *Cordia dentata* - *Citharexylum fruticosum* - *Capparis ferruginea* / *Cordia globosa* - *Lycium americanum* Woodland

19. Submontane rain forest (I.A.1.N.b.)

The submontane rain forest occurs between 400 and 800 m elevation in eastern Cuba, and on acid ferrallitic soils derived from serpentine bedrocks. It is a serpentine rainforest community with two canopy layers, a rather dense shrub layer, and a poorly developed herb layer. The 18-25 m high upper canopy is dominated by *Hyeronima nipensis*, or co-dominated

by *Sloanea curatellifolia*, *Byrsonima coriacea*, and *Chionanthus (Linociera) domingensis*. The ***Hyeronima nipensis* - *Sloanea curatellifolia* - *Byrsonima coriacea* Forest** association is poor in tree-ferns, epiphytes, and bryophytes. Other common species may include: *Myrsine coriacea*, *Terminalia nipensis*, *Podocarpus ekmanii*, *Calophyllum utile*, *Ocotea cuneata*, *Coccoloba retusa*, *Chrysophyllum argenteum*, *Miconia serrulata*, *Dipholis cubensis*, etc.
Distribution: South-east Cuba—Sierra de Nipe and Sierra Cristal.

20. Submontane seasonal evergreen forest (I.A.3.N.b.)

This forest formation includes ***Alchornea latifolia* - *Pseudolmedia spuria* Forest**, ***Matayba oppositifolia* - *Pseudolmedia spuria* Forest**, ***Sideroxylon jubillum* - *Roystonea regia* Forest**, and ***Sideroxylon salicifolium* - *Cedrela odorata* - *Roystonea regia* Forest**

20.1. *Alchornea latifolia* - *Pseudolmedia spuria* Forest

Seasonal evergreen forests with two canopy strata and scattered emergent trees, occurring between 300 and 800 m in western and central Cuba. Characteristic species of this community in Cuba are *Matayba oppositifolia*, *M. apetala*, *Alchornea latifolia*, *Pseudolmedia spuria*, *Trophis racemosa*, *Margaritaria nobilis*, *Tabebuia shaferi*, *Antirhea radiata*, *Terminalia intermedia*, *Sloanea amygdalina*, *Dendropanax arboreus*, *Zanthoxylum martinicense*, and *Z. ekmanii*.

Distribution: West and central Cuba.

20.2. *Matayba oppositifolia* - *Pseudolmedia spuria* Forest

Submontane **successional** forest co-dominated by *Matayba oppositifolia* and *Pseudolmedia spuria*, occurring at 200-600 m elevation in western Cuba. In the remaining stands of this forest community the tall emergent trees are usually absent and the most valuable timber species such as *Cedrela odorata*, *Swietenia mahagoni*, *Manilkara grisebachii* and *Cynometra cubensis* are rare. This selective cutting and logging has led to the overwhelming dominance of *Matayba* and *Pseudolmedia*, and the overrepresentation of *Roystonea regia* as well. *Cecropia shreberiana* also may become abundant in places.

Distribution: West Cuba—Sierra del Rosario, Pinar del Rio province.

20.3. *Sideroxylon jubillum* - *Roystonea regia* Forest

Submontane seasonal forest community occurs between 200 and 800 m elevation in Cuba, in areas with an annual rainfall of 1,400-1,800 mm and seasonal climate (1-3 dry months). Two evergreen canopy strata are present with scattered deciduous emergent individuals, a rather closed upper canopy, 20-25 m high and a 8-15 m high lower tree stratum. The buttressed *Sideroxylon jubillum* (= *Dipholis jubilla*) is the most common emergent tree in this forest. Characteristic species of the upper canopy layer are *Roystonea regia*, *Calophyllum calaba*, *Zizyphus rhodoxylon*, *Ficus berteroi*, *Zanthoxylum martinicense*, *Zanthoxylum cubense*, *Didymopanax morototoni*, *Sapium jamaicense*, *Faramea occidentalis*, *Guarea guidonia*, *Cupania glabra*, and *Cupania americana*. The lower tree stratum may include *Oxandra lanceolata*, *Oxandra laurifolia*, *Chrysophyllum argenteum*, *Dendropanax arboreus*, *Lonchocarpus latifolius*, *Sloanea amygdalina*, *Wallenia laurifolia* and *Ateramnus lucidus*. **This association only occurs on yellow-red mountain soils derived from andesite and/or granodiorite bedrocks.**

Distribution: East Cuba—Sierra Maestra mountain range.

20.4. *Sideroxylon salicifolium* - *Cedrela odorata* - *Roystonea regia* Forest

This community is essentially similar in structure to the *Sideroxylon jubillum* - *Rotstonea regia* Forest, but differs in species composition, especially the upper canopy layer which is dominated by *Sideroxylon salicifolium* (= *Dipholis salicifolia*) and *Cedrela mexicana*.

Because the forest zone to which it belongs is particularly suitable for tropical agriculture, undisturbed stands of this forest type are rare.

Distribution: East Cuba.

21. Succulent evergreen woodland [shrubland] (Borhidi 1991)

This vegetation type, also called “cactus scrub,” forms an unbroken stretch along the coast from the Guantánamo Bay to Imias. From Imias to Maisi are isolated patches. It is an open vegetation with succulents, mainly dominated or co-dominated by cacti in both shrub and canopy layers. On sandy soils dominant species include *Ritterocereus hystrix*, *Opuntia dillenii*, *Opuntia militaris*, *Cylindropuntia hystrix* and *Rhodocactus cubensis*. Most trees and shrubs are members of Caesalpiniaceae and Capparidaceae. On rocky habitats dominant species are *Consolea macracantha*, *Dendrocereus nudiflorus*, *Pilosocereus brooksianus*, *Harrisia fernowii*, *Agave albescens*, and *Melocactus acunae*. The shrub flora is very rich. Species of *Jacquinia*, *Gochnatia*, *Cordia*, *Guettarda*, and *Lantana* are abundant. *Coccothrinax* palms are emergent.

Distribution: South east Cuba—along the coast from the Guantánamo Bay to Imias (continuous), and from Imias to Maisi (fragmented).

22. Succulent extremely xeromorphic evergreen shrubland [woodland] (II.A.5.N.b, see also Succulent evergreen woodland [shrubland], Borhidi 1991)

Areces-Mallea et al. 1999 list only *Stenocereus peruvianus* / *Plumeria tuberculata* - *Neea shafari* - *Capparis ferruginea* Woodland that occurs in southeastern Cuba (Guantanamo Bay).

23. Tall grassland (V.A.1.N.b., V.A.1.N.c.)

It includes sandspur ruderal grassland dominated by *Cenchrus myosuroides* and tall bunch grasslands dominated by *Leptochloopsis virgata*

24. Tropical or subtropical needle-leaved evergreen woodland (See Pine woodland, II.A.3.N.a.)

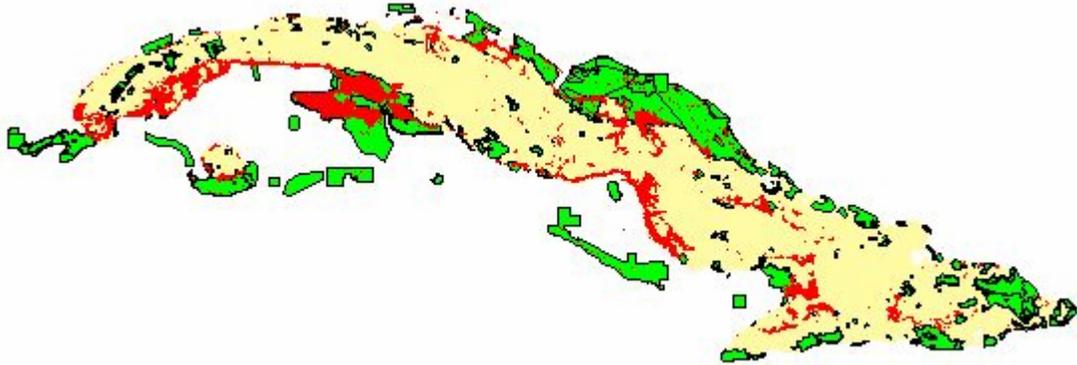
25. Xeromorphic mixed evergreen-deciduous forest (see Borhidi 1991, Semi-deciduous xerophytic forest)

Low forests of 12-15 m high grow on sandy or rocky acidic soils that are poor in nutrients. They occur in the lowlands and hills of the eastern part of central Cuba with annual precipitation 800-1200 mm and 5-6 dry seasons. The canopy layer is composed of up to 80% deciduous trees. Characteristic species are *Bursera simaruba*, *Cordia gerascanthus*, *Phyllostylon brasiliensis*, *Gossypiospermum praecox*, *Maytenus buxifolia*, *Belairia spinosa*, *Pisonia rotundata*, *Tabebuia anisophylla* and *Diospyros halesioides*. The shrub layer consists mainly of spiny sclerophylls, e.g., species of *Brya*, *Malpighia*, *Randia* and *Oplonia*. Natural stands are rare. Most stands have been replaced by secondary savannas dominated by *Copernicia* palms or deciduous trees as a result of burning and grazing.

Distribution: Eastern part of central Cuba.

Appendix 2. Gap analysis: the distribution map of each coarse-filter target (shown in red or red with pointer) was overlaid on the official protected areas map (shown in green with or without outline) to identify whether targets are included or sufficiently represented in the protected areas system.

Dry-alluvial + Protected Areas



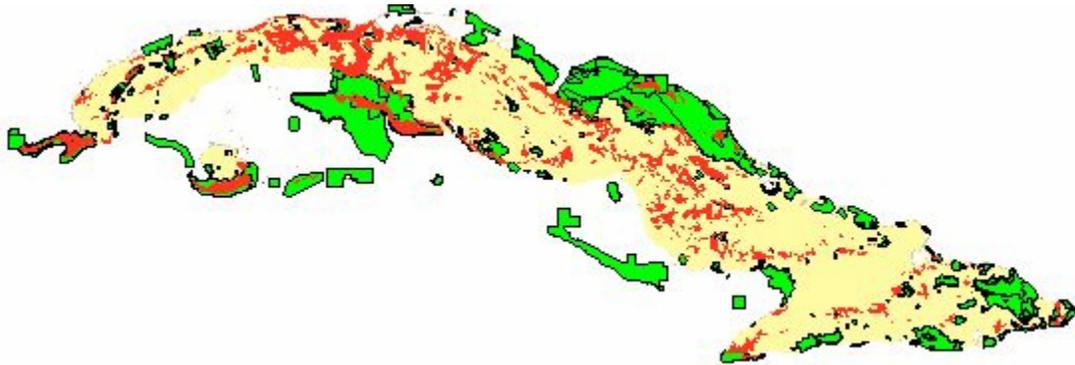
Dry-extrusive + Protected Areas



Dry-intrusive + Protected Areas



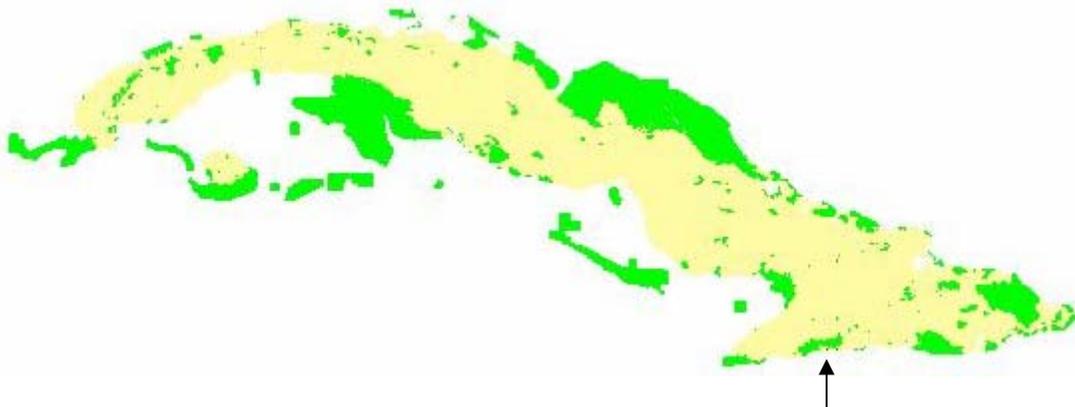
Dry-limestone + Protected Areas



Dry-sedimentary + Protected Areas



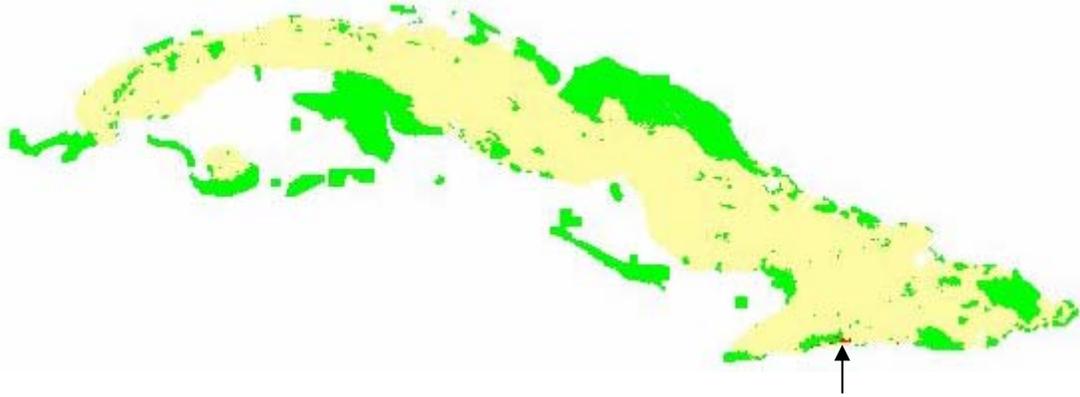
LM-Moist-alluvial + Protected Areas



LM-Moist-extrusive + Protected Areas



LM-Moist-intrusive + Protected Areas



LM-Moist-sedimentary + Protected Areas



LM-Moist-sedimentary + Protected Areas



LM-Wet-extrusive + Protected Areas



LM-Wet-intrusive + Protected Areas



LM-Wet-limestone + Protected Areas



LM-Wet-sedimentary + Protected Areas



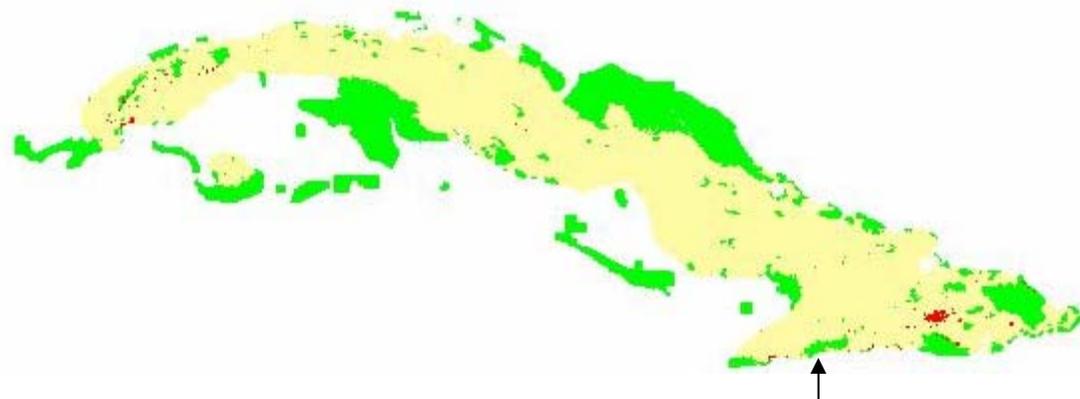
M-Wet-extrusive + Protected Areas



M-Wet-intrusive + Protected Areas



M-Wet-sedimentary + Protected Areas



Moist-alluvial + Protected Areas



Moist-extrusive + Protected Areas



Moist-intrusive + Protected Areas



Moist-limestone + Protected Areas



Moist-sedimentary + Protected Areas



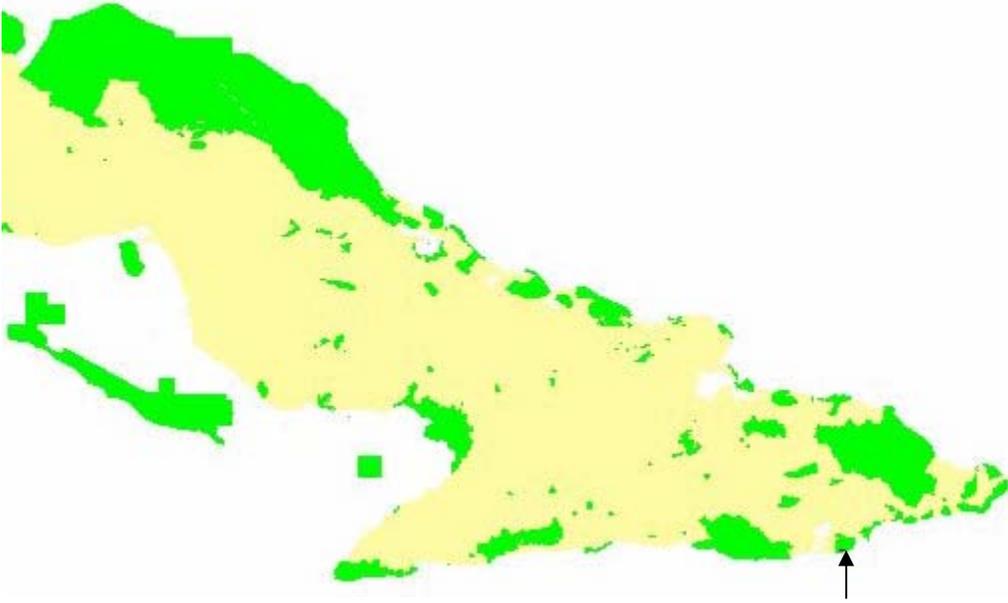
Moist-ultramafic + Protected Areas



Thorn-alluvial + Protected Areas



Thorn-extrusive + Protected Areas



Thorn-limestone + Protected Areas



Thorn-sedimentay + Protected Areas



Very Dry-alluvial + Protected Areas



Very Dry-extrusive + Protected Areas



Very Dry-intrusive + Protected Areas



Very Dry-limestone + Protected Areas



Very Dry-sedimentary + Protected Areas



Very Dry-ultramafic + Protected Areas



Wet-extrusive + Protected Areas



Wet-intrusive + Protected Areas



Wet-limestone + Protected Areas



Wet-sedimentary + Protected Areas



Wet-ultramafic + Protected Areas



Mangrove + Protected Areas



Wetlands + Protected Areas

