

A Biodiversity Profile



Antigua

Barbuda

Redonda

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Antigua-Barbuda-Redonda Biodiversity Profile

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Table of Contents

Table of Contents	1
Introduction	2
The Setting	2
Flora	3
Vegetation	3
Floristics	5
Pteridophytes	5
Flowering Plants	7
Marine Plants	12
Fauna	13
Vertebrates	13
Freshwater Fish	13
Marine Fish	14
Amphibians	14
Reptiles: Terrestrial	14
Reptiles: Marine	17
Birds	17
Mammals: Terrestrial	22
Mammals: Marine	23
Invertebrates.....	24
References	35

List of Tables:

1 Pteridophytes of Antigua-Barbuda-Redonda	6
2 Antigua-Barbuda-Redonda Flowering Plant Species of Special Conservation Concern	7
3 Antigua-Barbuda-Redonda Bird Species of Special Conservation Concern	20
4 Bats of Antigua-Barbuda-Redonda	23
5 Invertebrates: Global and Country Estimates.....	25
6 Data from Beetle Studies in the West Indies	29
7 Environmental Treaties Signed and Not Signed by Antigua-Barbuda	30

INTRODUCTION

This *Biodiversity Profile for Antigua-Barbuda-Redonda* was prepared by the Antigua Office of Island Resources Foundation and is a product of the Foundation's Biodiversity Conservation Programme for the Eastern Caribbean. In a companion report, a national *vegetation classification system* has been prepared for the country. Together, the two documents represent the first major publications issued under the auspices of the Eastern Caribbean Biodiversity Programme. They are important benchmarks for the Programme, drawing together earlier research and data-gathering efforts and presenting these in a more comprehensive "state of knowledge" format.

The *Biodiversity Profile* is a definitive report, summarizing for the first time what is known about the flora, fauna and ecosystems of Antigua-Barbuda, and their conservation status. It is based on the *Antigua-Barbuda Vegetation Classification*, data from previous studies (conventional literature searches and Internet inquiries), and fieldwork conducted by Biodiversity Programme staff and other researchers. It should be used as a key reference for further conservation, research and development planning efforts in the country.

The reader is also referred to the *Antigua and Barbuda Environmental Profile*, published in 1991 by the Caribbean Conservation Association and Island Resources Foundation. The 1991 *Profile* provides an overview of the country's environmental resource base; identifies major issues, conflicts and priorities; and discusses the institutional context within which biodiversity conservation must occur. The current *Biodiversity Profile* supplements this earlier work, but its primary function is as a research and conservation tool, and a reference document that assembles and summarizes in one report what is, and is not, known about the biodiversity of Antigua-Barbuda-Redonda.

THE SETTING

Antigua-Barbuda-Redonda are a part of the Lesser Antillean Archipelago, a chain of islands separated from the Greater Antilles (Cuba, Jamaica, Hispaniola, Puerto Rico and the Virgin Islands) by the Anegada Passage, and extending from Anguilla in the north (18°30'N) to Grenada in the south (12°N). The Lesser Antilles arc stretches 850 km, actually forming a double arc approximately midway, just past Dominica: the inner (western) chain is a continuation of the southern portion of the arc to include the islands of Basse Terre, Montserrat, Redonda, Nevis, St. Kitts, St. Eustatius and Saba; the outer (eastern) chain consists of Marie Galante, Grande Terre, La Desirade, Antigua, Barbuda, St. Barthelemy, St. Martin, Anguilla, and Sombrero.

The political union of Antigua, Barbuda and Redonda as one country brings together islands from both of these double arcs with their different geological histories and topographies. Antigua and Barbuda are typical of the other Limestone Caribbees—low-elevation compositions of older volcanics overlain by carbonates; Redonda consists of newer volcanic rock and is a scaled-down version (2.4 km long and 0.48 km wide; 297 meters high) of the characteristically steep, mountainous islands of the inner chain of the Lesser Antilles (Martin-Kaye, 1959, 1969; Pregill *et al.*, 1994).

FLORA

Vegetation

Lindsay and Horwith (1997a) describe 54 vegetation types in the *Antigua-Barbuda Vegetation Classification*, following the U.S. National Vegetation Classification System developed by the U.S. Federal Geographic Data Committee (FGDC, 1996). The *Antigua-Barbuda Vegetation Classification*, which was developed as a conservation management tool, builds on, but differs from, the previous efforts of Loveless (1960, based on the unpublished work of Box and Charter from 1932-38), Cater (1944), Beard (1949) and Harris (1965), all of which emphasized vegetation categories that were believed to have existed before Europeans disrupted the landscape. One previous researcher (Morello, 1983) did develop an ecological classification that takes into account the extensive human manipulation that has occurred in Antigua and Barbuda, but his categories are difficult to identify in the field and inadequate to address biodiversity conservation management objectives.

Information on all 54 of the vegetation communities—including descriptions, lists of many of the species, locations, and conservation status—are presented in the *Antigua-Barbuda Vegetation Classification* (Lindsay and Horwith; 1997a). The conservation status is defined in terms of a two-tier labeling system modified from the Red Data Book Categories of the International Union for Conservation of Nature and Natural Resources.

Rare,	(very restricted in distribution and/or size)
Uncommon,	(moderately restricted in distribution and/or size)
Common,	(widespread in distribution and/or large size)
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)
Stable	(no apparent danger)

Sixteen communities are classified as Rare, and 5 of these, listed below, are also considered Endangered. [The common names of many of the plant species are provided in the *Antigua-Barbuda Vegetation Classification*.]

***Calliandra purpurea-Hylocereus trigonus* lowland tropical or subtropical broad-leaved evergreen sclerophyllous closed tree canopy.**

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

Conservation status: Rare and Endangered.

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

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. 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.

Conservation status: Rare and Endangered.

***Annona glabra-Bucida buceras* seasonally flooded/saturated tropical or subtropical mixed evergreen-deciduous closed tree canopy.**

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. 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.

Conservation status: Rare and Endangered.

***Chrysobalanus icaco-Thrinax morrisii* tropical or subtropical mixed evergreen-drought deciduous dwarf-shrubland.**

Concept: One of 3 fairly distinct Associations within an Alliance found only 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 grow-

ing on the crests of dunes. The plants are widely spaced, with exposed sand between individuals. *Location*: Palmetto Point in Barbuda. *Conservation status*: Rare and Endangered.

***Paspalum* medium-tall bunch tropical or subtropical perennial grassland.**

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

Conservation status: Rare and Endangered.

Floristics

Lindsay and Horwith (1997b) list all plant species known to occur in each of the three islands of Antigua, Barbuda and Redonda. The nomenclature and ordering of the taxa follows Howard (1974, 1977, 1979, 1988, 1989a, 1989b) where possible. To this base, we added species identified by Francis *et al.* (1994) and those known to the authors. Several landscape species are included, but their coverage is not comprehensive.

The list contains 1158 species (149 families) of plants: 45 species of ferns and fern-allies (5 families); 4 species of gymnosperms (3 families), and 1109 species of Angiosperms (141 families).

Pteridophytes

Forty-three pteridophyte species (fern and fern-allies) are known for Antigua, 2 for Barbuda (1 of which occurs there, but not in Antigua), and 3 for Redonda (1 of which occurs there, but not in Antigua; Lindsay and Horwith, 1997b). The major collections are from Box in the 1930s and Proctor in the 1960s; none of the 3 islands have been studied in detail for more than 30 years. None of the species are endemic to the Lesser Antilles, but many are considered Rare, and either Endangered or Vulnerable within the country. (See Table 1.)

ANTIGUA-BARBUDA-REDONDA BIODIVERSITY PROFILE

Table 1. Pteridophytes of Antigua-Barbuda-Redonda.

*Antigua, Barbuda, Redonda indicated by A, B and R; if no initials are given, the species is only known to be in Antigua.
Species of Special Conservation Concern (Rare; and/or Endangered or Vulnerable) are marked by an asterisk.*

Psilotaceae		* <i>Tectaria heracleifolia</i>
* <i>Psilotum nudum</i>	(A, R)	* <i>T. incisa</i> [= <i>T. martinicensis</i>]
Schizaeaceae		Polypodiaceae-Thelypteridoideae
* <i>Anemia hirta</i>		* <i>Thelypteris dentata</i> [= <i>Dryopteris mollis</i>]
<i>A. adiantifolia</i>		* <i>Thelypteris patens</i> var. <i>patens</i> [= <i>Dryopteris patens</i>]
		* <i>T. poiteana</i> [= <i>Dryopteris poiteana</i>]
Hymenophyllaceae		* <i>T. quadrangularis</i> var. <i>quadrangularis</i>
* <i>Trichomanes krausii</i>		* <i>T. tetragona</i> var. <i>tetragona</i> [= <i>Dryopteris subtetragona</i>]
		<i>Thelypteris</i> sp. (B)
Polypodiaceae-Pteridoideae		
* <i>Pteridium aquilinum</i> var. <i>caudatum</i> [= <i>P. caudatum</i>]		Polypodiaceae-Asplenoideae
<i>Pteris vittata</i>		* <i>Asplenium serratum</i>
* <i>P. biaurita</i>		* <i>A. trichomanes-dentatum</i>
<i>Acrostichum danaeifolium</i>		<i>A. pumilum</i>
		* <i>A. cristatum</i>
Polypodiaceae-Blaechnoideae		
<i>Blechnum occidentale</i>		Polypodiaceae-Polypodiaceae
		<i>Neurodium lanceolatum</i> [= <i>Paltonium lanceolatum</i>]
Polypodiaceae-Adiantoideae		<i>Polypodium polypodioides</i>
<i>Pityrogramma calomelanos</i>	(A, R)	<i>P. aureum</i> var. <i>aureum</i> (A, R)
* <i>P. chrysophylla</i>	(R)	<i>P. piloselloides</i>
<i>Doryopteris pedata</i>		<i>P. heterophyllum</i>
<i>Cheilanthes microphylla</i>		<i>P. lycopodioides</i>
* <i>Adiantopsis radiata</i>		* <i>P. latum</i>
<i>Adiantum lucidum</i>		* <i>P. repens</i>
<i>A. latifolium</i>		<i>P. phyllitidis</i>
* <i>A. tetraphyllum</i>		* <i>P. triseriale</i> [<i>P. brasiliense</i>]
<i>A. tenerum</i>		
* <i>A. villosum</i>		Polypodiaceae-Vittarioideae
		* <i>Vittaria lineata</i>
Polypodiaceae-Dryopteridoideae		
<i>Nephrolepis rivularis</i>		Marsiliaceae
<i>N. biserrata</i>		* <i>Marsilea vestita</i> (B)

Flowering Plants

Table 2 lists 197 species considered to merit Special Conservation Concern, because each is considered endangered or vulnerable within Antigua-Barbuda-Redonda. These include 22 species identified by Howard as endemic to the Lesser Antilles (one of which, *Pectis ericifolia*, may be endemic to Barbuda); and 5 species that within the Lesser Antilles only occur in Barbuda. An additional 73 species are classified as rare in the country; this includes several species that are believed to have become extirpated.

Table 2. Antigua-Barbuda-Redonda Flowering Plant Species of Special Conservation Concern.

All species listed are endangered or vulnerable. All endemics are included (includes species listed by Howard (1974; 1977, 1979, 1988, 1989) for which the only entry under general distribution is the Lesser Antilles, even if Howard did not specify it as endemic.

"LA"=Lesser Antilles; "WI"=West Indies; "R"=Rare; "?"=questionable record. "Believed extirpated": includes species listed for Antigua-Barbuda by previous researchers, but presumed by the authors to be absent from the country today. If this is followed by (IITF), it means that the International Institute of Tropical Forestry team (Francis et al., 1994) also noted its absence.

"Loveless"=listed in Loveless (1960) as rare. "Danforth"=Listed by Howard (1979) to have been collected by Danforth in Barbuda, representing the only known occurrence in the Lesser Antilles.

<i>Acmella iodiscaea</i> , W.I. (only Barbuda in LA)	<i>Acrocomia aculeata</i> , LA
<i>Aechmea lingulata</i> , R	<i>Agave dussiana</i> , LA
<i>Alectra fluminensis</i> , R	<i>Ampelopsis arborea</i> , only Barbuda in LA
<i>Andira sapindoides</i> , R	<i>Annona montana</i> , R
<i>Anthurium grandifolium</i> , R	<i>Antirhea acuta</i>
<i>A. coriacea</i>	<i>Ardisia escallonioides</i> , only Barbuda in LA
<i>Aristolochia littoralis</i>	<i>A. rugosa</i>
<i>A. trilobata</i>	<i>Asclepias</i> sp., R
<i>Avicennia schaueriana</i>	<i>Ayenia insulaecola</i> , WI
<i>Baccharis dioica</i>	<i>Batis maritima</i>
<i>Bauhinia aculeata</i> , R	<i>B. multinervia</i>
<i>Beilschmiedia pendula</i> , Believed extirpated (IITF)	<i>Bixa orellana</i> , extinct in the wild
<i>Bontia daphnoides</i> , R	<i>Bouchea prismatica</i> , R
<i>Brassavola cucullata</i> , R	<i>Bromelia pinguin</i>
<i>B. plumieri</i>	<i>Brunfelsia</i> sp.
<i>Buchenavia tetraphylla</i> , Believed extirpated	<i>Bucida buceras</i>
<i>Byrsonima trinitensis</i> , LA	<i>Calliandra purpurea</i>
<i>Callophyllum calaba</i> , R	<i>Canna indica</i> , Rare in the wild
<i>Cassine xylocarpa</i>	<i>Catopsis floribunda</i> , R
<i>Cecropia schreberiana</i> , Believed extirpated (IITF)	<i>Cedrela odorata</i>

ANTIGUA-BARBUDA-REDONDA BIODIVERSITY PROFILE

**Table 2 (continued).
Antigua-Barbuda-Redonda Flowering Plant Species of Special Conservation Concern.**

<i>Centropogon cornutus</i> , R	<i>Cestrum laurifolium</i> , WI
<i>Cheilanthes microphylla</i>	<i>Chimarrhis cymosa</i> , ?
<i>Chiococca parvifolia</i>	<i>Chione venosa</i>
<i>Clidemia hirta</i>	<i>Clusia major</i> , LA
<i>Clusia rosea</i> , R	<i>Coccoloba pubescens</i>
<i>Coccothrinax barbadensis</i> , R (Loveless)	<i>Cordia laevigata</i>
<i>Coutoubea spicata</i> , R	<i>Crescentia cujete</i>
<i>Cydista aequinoctialis</i>	<i>D. stramonium</i>
<i>Dacryodes excelsa</i> , Believed extirpated (IITF)	<i>Datura metel</i>
<i>Dieffenbachia seguine</i>	<i>Drypetes serrata</i> , LA
<i>Echites umbellata</i> , only Barbuda in the LA	<i>Elephantopus mollis</i>
<i>Eleutherine bulbosa</i> , R	<i>Epidendrum difforme</i> , R
<i>E. secundum</i>	<i>Erithalis odorifera</i>
<i>Ernordea littoralis</i>	<i>Eryngium foetidum</i>
<i>Eulophia alta</i> , R	<i>Eupatorium dussii</i> , LA
<i>Ficus americana</i>	<i>F. trigonata</i>
<i>Furcrea tuberosa</i> , LA	<i>Galactia longifolia</i> , LA
<i>Galactia rubra</i> , LA	<i>Geophila repens</i> , ?
<i>Guaiacum officinale</i> , Believed extirpated in Antigua; extant on Barbuda	<i>Guarea macrophylla</i> , R
<i>Habenaria alata</i> , R	<i>Habenaria dussii</i>
<i>Habeneria monorrhiza</i> , R	<i>Hamelia patens</i>
<i>Hedyosmum arborescens</i>	<i>Heliconia bihai</i> , Believed extirpated
<i>H. caribaea</i> , Believed extirpated	<i>Heteranthera reniformis</i> , R
<i>Homalium racemosum</i> , ?	<i>Hylocereus trigonus</i> , R (Loveless)
<i>Hyperbaena domingensis</i> , R (Loveless)	<i>Ipomoea hederifolia</i>
<i>Ixora ferrea</i>	<i>Jacquinia berterii</i> , R
<i>Justica eustachiana</i> , LA	<i>J. pectoralis</i>
<i>J. sessilis</i>	<i>Lantana urticifolia</i> , R
<i>Laportia aestuans</i>	<i>Lemna perpusilla</i> , R
<i>L. trisulca</i> , Believed extirpated	<i>L. valdiviana</i> , R
<i>Lepianthes peltata</i>	<i>Limnobium laevigatum</i>
<i>Lycium americanum</i>	<i>Macgravia umbrellata</i> , LA
<i>Malphigia martinicensis</i> , LA	<i>Manilkara bidentata</i> , ?
<i>Marila racemosa</i> , LA	<i>Martynia annua</i> , ?
<i>Melochia nodiflora</i> , ?	<i>M. pyramidata</i>
<i>M. tomentosa</i>	<i>Miconia prasina</i> , R
<i>M. striata</i> , LA	<i>M. trichotoma</i> , LA
<i>Micropholis guyanensis</i> , R	<i>Mimosa ceratonia</i> , R
<i>Monstera adansonii</i> , R	<i>Mouriri dominigensis</i> , R
<i>Myrcia citrifolia</i> var. <i>imrayana</i>	<i>Myrcianthes fragrans</i>
<i>Myrciaria floribunda</i>	<i>Neptunia</i> spp, Loveless

ANTIGUA-BARBUDA-REDONDA BIODIVERSITY PROFILE

**Table 2 (continued).
Antigua-Barbuda-Redonda Flowering Plant Species of Special Conservation Concern.**

<i>Nespera aquatica</i> , R	<i>Ochroma pyramidale</i> , New natural introduction (IITF)
<i>Ocotea floribunda</i>	<i>O. leucoxydon</i>
<i>O. membranacea</i>	<i>O. patens</i>
<i>Oncidium urophyllum</i> , LA	<i>Oplonia macrophylla</i>
<i>Opuntia curassavica</i>	<i>O. elatior</i>
<i>Oreopanax capitatus</i>	<i>Ouratea guildingii</i>
<i>Palicourea crocea</i>	<i>Paspalum bakeri</i> , only Barbuda in LA (Danforth)
<i>Paspalum distichum</i> , R (Loveless)	<i>Pavonia paludicola</i>
<i>P. spinifex</i>	<i>Pectis ericifolia</i> , Endemic to Barbuda?
<i>Pereskia aculeata</i> , R (Loveless)	<i>Philodendron scandens</i>
<i>Pimenta racemosa</i>	<i>Piper dilatatum</i>
<i>P. dilatatum</i>	<i>P. dussii</i>
<i>P. reticulatum</i>	<i>Piriqueta cistoites</i> , ?
<i>Pisonia discolor</i> , R	<i>Pitcairnia angustifolia</i> , WI
<i>Pristimera rotundifolia</i> , R (Loveless)	<i>Prockia crucis</i> , R
<i>Psychotria dominicensis</i>	<i>P. microdon</i>
<i>P. nervosa</i>	<i>P. tenuifolia</i>
<i>Rauvolfia viridis</i>	<i>Renealmia occidentalis</i> var. <i>occidentalis</i> , Believed extirpated
<i>Rhabdadenia biflora</i> , R	<i>Rhipsalis baccifera</i> , R (Loveless)
<i>Rhoeo spathacea</i>	<i>Roystonea oleracea</i>
<i>Rudgea citrifolia</i> , LA	<i>Ruellia tuberosa</i>
<i>Salvia micrantha</i>	<i>S. occidentalis</i>
<i>S. serotina</i>	<i>Samyda dodecandra</i> , R
<i>Sapindus saponaria</i>	<i>Sapium caribaeum</i> , Believed extirpated (IITF)
<i>Scutellaria purpurascens</i>	<i>Sesbania emerus</i> , R
<i>Sideroxylon salicifolium</i>	<i>Spermacoce berteriana</i> , LA
<i>Spiranthes elata</i> , R	<i>S. lanceolata</i>
<i>S. polyantha</i> , R	<i>S. torta</i> , R
<i>Stenandrium tuberosum</i> , ?	<i>Tabebuia lepidota</i> , R
<i>Talinum paniculatum</i>	<i>Talinum</i> sp., R (offshore islands)
<i>Tamonea boxiana</i> , Endemic to PR, VI and Antigua, Barbuda	<i>Teliostachya alopecuroides</i>
<i>Ternstroemia elliptica</i> , LA	<i>Ternstroemia peduncularis</i>
<i>Tetrazygia discolor</i> , LA	<i>Thevetia peruviana</i>
<i>Thrinax morrisii</i>	<i>Tillandsia</i> sp.
<i>Turbina corymbosa</i>	<i>Utricularia obtusa</i>
<i>Vanilla planifolia</i> , Perhaps introduced; believed extirpated	<i>Vitex divaricata</i> , Believed extirpated (IITF)
<i>Vriesia guadelupensis</i> , LA	<i>Zanthoxylum punctatum</i> , R
<i>Ziziphus reticulata</i>	

Conservation Implications

Of the 54 vegetation communities identified for the country, 16 are Rare, 26 are Uncommon and 12 are Common. Almost by definition, most of the Rare communities 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 vegetation communities are Stable; the remainder considered Vulnerable.

When one considers that two-thirds of the vegetation communities are endangered or vulnerable (5 endangered, 31 vulnerable; see Lindsay and Horwith, 1997a), it is not surprising that nearly 20% of the flora are considered conservation concerns. In Antigua, the main threats to the flora 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 the vegetation in Barbuda is widespread, uncontrolled livestock grazing.

A primary conservation objective should be to ensure the continued existence of representatives of each of the vegetation types. Clearly, the 5 Rare and Endangered communities listed above are conservation priorities. But less than one-third of all the vegetation communities in the country are considered Stable (16 of 54); and the challenge of conserving these other 38 represents a significant challenge for Antigua-Barbuda.

A National Park Authority is in charge of the country's one national park. The Nelson's Dockyard National Park comprises some 8% of the country's land mass, but even here the natural landscape is under-promoted and none of the park area is being actively managed to conserve its biological diversity.

Outside of the national 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 group of small islands off the coast of Antigua is another key to conserving the biodiversity of the country. Five different vegetation communities are represented in the North Sound offshore islands; the two below only occur there:

Medium-tall tropical or subtropical grassland with broad-leaved evergreen trees.

Concept: Grassland, with some forbs, with scattered shrubs and trees providing a cover of generally 10-25%. Differs from other grasslands

occurring in Antigua in species composition, and the fact that they seem to be a result of thin, rocky and/or sandy soils; wind and salinity—not grazing. *Location*: On offshore islands: Great Bird Island, Hell's Gate Island, Guiana Island.

Conservation status: Rare and Vulnerable.

***Pisonia subcordata*-*Canella winterana* lowland tropical or subtropical mixed evergreen-deciduous closed tree canopy forest.**

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.

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.

Conservation status: Uncommon, Vulnerable.

The offshore islands are especially valuable for conserving the animal and plant biodiversity of the country. As the plight of the Antiguan Racer snake (discussed below) on Great Bird Island illustrates, offshore islands are sometimes "repositories" for species that once existed more plentifully on the mainland. In some cases, these small islands serve as yardsticks, allowing for the measurement of changes that have affected the rest of the Caribbean over time.

These islands, similar to many offshore islands and cays elsewhere in the region, have escaped much of the ravages of development and related human impacts. They can be valuable conservation tools, as sanctuaries and as outdoor laboratories and classrooms for teaching, training and educating the public on environmental issues. But, too often, their importance is recognized only when threatened and at the crisis stage. Clearly, much more can be done to take advantage of the conservation potential of these important natural refuges.

Great Bird Island, and its immediate environs, has already been proposed as a reserve. Many of the steps required for its establishment, including preparation of a management plan, have been completed (Island Resources Foundation, 1997b). The Government could consider the possibility of including other offshore islands as part of a protected areas system, using several legal options to provide varying degrees of protection.

Additional areas throughout the country will need to be better defined and then targeted for conservation if national system of protected areas system is to be developed, with one objective being to safeguard the biological heritage of the country. 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.

Marine Plants

Humann (1993) lists 62 marine plants for the Caribbean region. This is probably a vast underestimate since this information is from a field guide targeted to the general public, and it is only included here for general comparative purposes. Little is known of the conservation status of this group, but the conservation of marine resources is discussed briefly in regard to corals in the section on invertebrates below.

FAUNA – VERTEBRATES

Freshwater Fish

Although the freshwater fish fauna of the Antilles consists of 71 "mostly endemic" species (primarily in Cuba and Hispaniola), the Lesser Antilles apparently has only one endemic species, *Rivulus cryptocallus*, from Martinique (Burgess and Franz, 1989). Bauchot (1959) lists 8 families occurring in the Lesser Antilles—Poeciliidae, Anguillidae, Gobiidae, Eleotridae, Mugilidae, Gerridae, Centropomidae, and Carangidae—all of which can move between fresh and salt water, and some of which spawn at sea. Lee *et al.* (1983) describe the native fish fauna of the Lesser Antilles as "sparse", noting that only 5 native species are known, but Burgess and Franz (1989) think that three of these—*Poecilia vivipara*, *P. reticulata* and *Synbranchus marmoratus* (a swamp eel)—are introduced.

The freshwater fish fauna of Antigua—and the rest of the Lesser Antilles—is not well studied. We have not found accounts of any comprehensive surveys for Antigua or Barbuda; in fact, the only publication encountered is Hoedemann's (1958) study of Rivulid fishes, which lists *Rivulus marmoratus* for Barbuda [*Rivulus marmoratus* is expected to soon be synonymized to *R. ocellatus*]. Some recent collections have been made in Antigua (Lindsay and Blackman, 1996), but none of the specimens have been looked at yet by a specialist. Lindsay and Blackman (1997) list two of the native/introduced species mentioned above—*Rivulus marmoratus* and *Poecilia reticulata*—and expect that a third also occurs (*Poecilia vivipara* is listed for the Leeward Islands, but the citation does not specify which islands). Their list includes more than 20 possible species, but they are quick to note that almost half of these may be lesser taxonomic categories, possibly even polymorphic variations. Several of the species are known to have been deliberately introduced for aquaculture, while several others appear to be "aquaria" fish that have been naturalized in ponds and waterways after being discarded.

Conservation Implications

The collections and notes of Lindsay and Blackman represent a good start that can be strengthened by:

- (i) having a specialist identify the Antigua-Barbuda collection,
- (ii) mapping all known and potential sites supporting freshwater fish (this could be done in conjunction with Dr. David Bass' proposed research on freshwater invertebrates), and
- (iii) identifying priority sites and actions needed to ensure their protection.

Marine Fish

A separate list of the marine fish that occur in the waters of Antigua-Barbuda-Redonda does not exist, but for comparative purposes, there are some 400 species included in fish guides for the Caribbean (Humann, 1993; Stokes, 1984). Data on the status of any marine fish species occurring in national waters are sparse and lack a baseline to suggest trends [but see discussion below on coral reefs].

Amphibians

There are 2 species of amphibians known for Antigua: a tree frog (*Eleutherodactylus johnstonei*), formerly a Lesser Antillean endemic (now introduced and naturalized in Jamaica, Bermuda and parts of northern South America), which also occurs in Barbuda; and the marine toad (*Bufo marinus*), which is an introduced species, widespread in the Caribbean. Another tree frog (*Eleutherodactylus martinicensis*) had been listed (Schwartz, 1967), but Pregill *et al.* (1988) believe this to be mistaken identification of *E. johnstonei*. Similarly, fossil remains that formerly had been considered to belong to an extinct species, *Hyla barbudensis*, are also now classified as *E. johnstonei*. An unidentified tree frog, believed to be one of the Cuban tree frogs, has been collected from Long Island, suspected to have been brought there inadvertently along with imported landscaping plants. The crapaud (*Leptodactylus fallax*), a large edible frog, was listed as an historical record for Antigua (Harris, 1965 based on Dunne, 1934), but a careful study by Kaiser and Hardy (1994, based, in part, on Lynne, 1957) notes that the historical record is weak and does not include a voucher specimen. The crapaud does still exist in Montserrat and Dominica. No amphibians are known from Redonda.

Reptiles: Terrestrial

Twenty terrestrial reptile species or sub-species have been recorded, 4 of which are extinct (this count includes *Iguana delicatissima*, but see discussion below). The extinction or extirpation of several species in Antigua has been attributed to the introduction of the Indian Mongoose (*Herpestes auro-punctatus*) towards the end of the last century. Fortunately, mongooses do not occur in Barbuda.

The tortoise (*Geochelone carbonaria*) occurs throughout much of tropical America. Presumed to have been introduced from South America by Amerindians, it is still fairly common in Antigua and Barbuda, but less so than in the past.

Three species of gecko have been recorded on Antigua, and all are common: the Common Woodslave (*Hemidactylus mabouia*) and Giant Woodslave (*Thecadactylus rapicauda*) occur throughout the Lesser Antilles (although the former has not been recorded for Barbuda); the Dwarf Woodslave (*Sphaerodactylus elegantulus*) is

endemic to Antigua and Barbuda. An unidentified species or sub-species of *Sphaerodactylus* has been collected from Redonda.

A slipperyback skink (*Mabuya mabouya mabouya*), is recorded for Redonda.

The large native lizard (*Iguana delicatissima*) may have become extirpated due to loss of habitat and predation by mongoose, although there are periodic reports of iguana sightings. Most often, these are of *Iguana iguana*, probably escaped pets introduced from Montserrat although this is a widespread species of the Lesser Antilles and other parts of tropical America. However, some of the descriptions of iguana in Antigua fit *Iguana delicatissima*, and these refer either to a possible Antiguan remnant population or to introductions from Dominica. Unidentified iguana remains for Barbuda are described by Etheridge (1964) and further discussed in Pregill *et al.* (1994). An unidentified species of iguana has been reported on Redonda, but no sightings have been reported in over 50 years (Underwood, 1962; K. Lindsay, *pers. comm.*).

Three anolis lizards occur in Antigua and Barbuda, both common: Green lizard (*Anolis bimaculatus leachi*) is a subspecies endemic to Antigua and Barbuda (and introduced to Bermuda); *A. wattsi wattsi* is an Antiguan endemic subspecies (but introduced and established in the St. Lucia Botanical Gardens) and *A. wattsi forresti* is a Barbudan endemic subspecies. Lazell and Williams' (1962) splitting of *A. wattsi* into *A. wattsi* and *A. alter* does not seem to have been retained in the scientific literature. *Anolis nubilus* is endemic to Redonda. An extinct lizard, *Leiocephalus cuneus*, has been recorded from Antigua (Watters *et al.*, 1984) and Barbuda (Etheridge, 1964).

An endemic Ground Lizard (*Ameiva griswoldi*) is common throughout Barbuda, but only in selected sites in Antigua. An endemic sub-species of Ground Lizard (*Ameiva pluvianotata atrata*) has been recorded for Redonda.

Gymnophthalmus underwoodi, ranging from Antigua in the north to the South American mainland, has only recently been recorded in the country, but it is believed to be fairly widely distributed in Antigua and Barbuda (Censky and Lindsay, 1997).

There are anecdotal reports of a shiny greenish colored lizard about 0.6 meters in length. One was reportedly run over by a car (Gonzalves, *pers. comm.*); and we include mention of it here because there are reports by several people over many years of such a lizard, making it less likely that the road kill specimen was a lone introduction from another island.

Our account would not be complete without mentioning an interesting and amusing description that appeared in the natural history section of a publication from the mid-1800s (Lanagan, 1844):

The ground-lizard is considerably larger than the tree-lizard. It is of a greenish brown hue, with a blood-red stripe running longitudinally down each side. The head ending in a pointed snout, is also of the same color which gives the animal altogether a disgusting appearance. The mouth is armed with an infinite number of sharp, slender teeth, the bite from which is supposed to be very venomous on account of their often leaving such weapons in the wound they have infected. The negroes have a superstitious notion, that as soon as this reptile has bitten anyone it immediately makes the best of its way to the sea-side, and as the only means of preventing any ill-consequences to itself, bathes in the water, and the wounded person receives the punishment in the shape of leprosy. If, on the contrary, the individual bitten can reach the sea and perform the ablution necessary, before the lizard has time to gain the spot, the reptile pays the penalty, falling a prey to the effects of its own venom. The tail of the ground-lizard is of extreme length, and trails along the ground, giving the creature, when walking, a kind of snake-like motion; when, however, it is attacked by a dog, or frightened by the sound of approaching footsteps, it throws this unwieldy member over its back, and starts away with the greatest activity. It holds its prey firmly with its fore-feet, while it tears it to pieces with its teeth, and then swallows it with much apparent gusto, putting out its long slender red tongue, in the manner of a dog.

Today, there is no lizard in the country that even comes close to matching this rather detailed description. The extant tree lizard and ground lizard are similar in size, neither has any red on its body, and neither lifts its tail as described. Lanagan's description sounds more like a curly-tailed lizard, 1 species of which is known from the fossil record for Antigua-Barbuda (*Leiocapthalus cuneus*); the genus was last collected in the Lesser Antilles from Martinique in the 1800s. The closest extant relatives are located in Hispaniola (Schwartz and Henderson, 1991).

A pinkish-colored blind snake (*Typhlops monastus*) is fairly common, even if not commonly seen, in both Antigua and Barbuda. The species occurs in Montserrat, Barbuda, Antigua, St. Kitts and Nevis—*T. monastus geotomus* being the subspecies occurring in this country, as well as in St. Kitts-Nevis. There are anecdotal reports of a larger, gray blind snake, but this has not been collected. There is an Antiguan record of a snake that occurs in Trinidad and South America, *Leptotyphlops tenella*, but this is its only record in the Antilles, making it very "questionable" according to Schwartz and Henderson (1991). A Racer snake, *Alsophis antiguae*, was once classified as a subspecies of *Alsophis antillensis*. Now extinct on the Antiguan mainland and in Barbuda, *A. antiguae* is endemic to one of Antigua's North Sound islands, existing as a population estimated to be less than 100. The snake is the focus of a conservation program involving several organizations, and several young have resulted from a recently begun captive breeding program. Fossil remains have been collected of *Boa constrictor* from Antigua and *Clelia clelia* from Barbuda (Auffenberg, 1958; Steadman *et al.*, 1984; Pregill *et al.*, 1994).

Conservation Implications

With the exception of the Racer snake, which is the focus of an ongoing conservation project, the terrestrial herpetofauna of Antigua and Barbuda can be considered secure from a conservation perspective. All species (with the exception of the iguana if any indigenous ones remain) are either common and/or occur in habitat that is not at risk.

Reptiles: Marine

Three species of endangered sea turtle are known to nest in Antigua and Barbuda: the hawksbill (*Eretmochelys imbricata*), the green (*Chelonia mydas*) and the leatherback (*Dermochelys coriacea*). The loggerhead (*Caretta caretta*), considered globally vulnerable, is not known to nest here, but is occasionally caught in open waters. Neither of the remaining two species of sea turtle occurring in the Caribbean—the Kemp's Ridley (*Lepidochelys kempi*) and the Olive Ridley (*Lepidochelys olivacea*)—has ever been documented in Antiguan waters, although there are anecdotal accounts of the latter being caught in Barbuda (Widecast, 1992).

Conservation Implications

The greatest threat facing sea turtles probably is lost of nesting habitat, but other threats include hunting of eggs and adults, and deterioration of the reefs.

Antigua-Barbuda is not a signatory to CITES, but it is to the Cartagena Convention Protocol Concerning Specially Protected Areas and Wildlife (SPAW Protocol), and all 6 species of Caribbean-occurring sea turtles are included in Annex II. A new convention may provide additional protection. The Inter-American Convention for the Protection and Conservation of Sea Turtles would prohibit the intentional capture, killing or sale of all sea turtles. It would also promote the conservation and restoration of sea turtle habitat and nesting beaches, and the reduction of, to the greatest practicable extent, accidental harm to sea turtles in the course of fishing activities.

Birds

Research during the past decade has substantially increased the number of bird species recorded for Antigua and Barbuda from 106 (Faaborg and Arendt, 1985) to 182 (Gricks *et al.*, 1997). Approximately two-thirds of these are migratory. Of the other third, some 20 of the species that occur in the country are restricted to the Caribbean basin (primarily West Indian, but some also occurring on adjoining mainland). The country has 1, possibly 2, single-island endemic sub-species: the Broad-winged Hawk and a Barbudan endemic sub-species or race of the Adelaide's Warbler.

Several species are known from the fossil record: 3 of these are extinct; 12 are extirpated from Barbuda and 8 are extirpated from Antigua (Pregill *et al.*, 1994).

Several two-to-three-year periods of severe drought over the past two decades are assumed to have impacted bird populations; as did the hurricanes of 1995. Drastic reductions in the populations of many of the small song bird species were noted, especially for the 3 hummingbird species. Unregulated and excessive misuse of pesticides also may be affecting bird populations, especially species that frequent farms and residential areas. For example, older people report that there have been reductions in the numbers of Ground Dove and Zeneida Dove, even though hunting of these two species has declined over the last decade to the point that it is only a minor recreational activity.

Conservation Implications

The major threat to local birds is loss of habitat, in particular mangroves and other wetlands. Even mangroves with nesting herons and chicks have been bulldozed. Species that are particularly at risk in Antigua due to deterioration of wetland habitat include: Black-crowned Night Heron, West Indian Whistling Duck, White-cheeked Pintail, Ruddy Duck, Masked Duck, Clapper Rail, Caribbean Coot, and the Magnificent Frigatebird. Despite the conservation importance of mangroves and associated wetlands, and despite the alarming rate at which they are being destroyed and degraded, we do not have accurate, quantitative data on the amount that has been lost in recent years or the amount remaining. Bacon (1991) provides the best information, but it lacks adequate detail at the site level and is in need of updating.

The mangroves of Antigua have been severely impacted even during this decade. Jolly Harbour development resulted in the loss of a 56 ha salt pond and associated mangroves. Emerald Cove has lost virtually all of the mangroves that once lined its 1.4 miles of coastline; an additional 0.5 mile of mangrove-lined coastline in Coconut Hall was cleared; and the Carlisle Bay development has significantly reduced the mangroves in that area. Sand mining has produced dramatic impacts at Darkwood. Less than half of its once renowned beach remains, and relatively few birds are now supported by the wetland that once teemed with wildlife. The destruction of any particular site is unfortunate, and should only be allowed if justified by a careful cost-benefit analysis. However, it is the cumulative impacts of the loss of these sites that is the most serious cause for concern and the reason for requiring a different approach to site-specific evaluation (Horwith and Lindsay, 1997a; Bacon, 1993).

Neither economists nor ecologists pretend that they can reasonably quantify all of the direct and indirect benefits that result from healthy functioning wetlands—but most responsible people in both disciplines acknowledge that these values exist and that there may be a steep price to pay if such ecosystems are destroyed. In areas where mangroves can exist (not all coastline provides the

appropriate requirements), they are considered to be the critical component essential to the well-being of nearshore fisheries, seagrass beds and coral reefs. A workshop was convened recently because of concerns that these highly valuable resources are increasingly at risk. The leading mangrove specialists of the Western Hemisphere identified the mangroves of the Lesser Antilles, from among all of those in Latin America and the Caribbean, as being the most impacted by development and the ones at the greatest conservation risk (WWF, 1996).

Antigua may be at a crossroads, where planning strategies and permitting procedures must examine not only the specifics of proposed development activities, but also the larger national context in which they occur. The Environmental Awareness Group and Island Resources Foundation have begun to gather data that can be used to provide a national perspective on mangroves and associated wetlands. They plan to resurvey all sites to refine and update Bacon (1991) and establish an ongoing monitoring programme.

Redonda, and many of the small islands off the Antiguan mainland, especially those in the North Sound, provide valuable nesting habitat for Brown Pelican, Black-crowned Night Heron and several seabird species: Laughing Gull, Roseate Tern, Least Tern, Bridled Tern, Sooty Tern, Brown Noddy, and Red-billed Tropic Bird. The importance of protecting the offshore islands—as habitat for the Racer snake and because of their vegetation—is discussed elsewhere in this report.

Guiana Island supports a population of between 80-100 West Indian Whistling Ducks. The Society of Caribbean Ornithology has established a West Indian Whistling Duck Working Group to collect better regional data on the duck and develop an action plan to safeguard its survival. Island Resources Foundation is collaborating with this group to secure funding for the work in Antigua-Barbuda, and fieldwork is anticipated during the spring of 1998. The proposed studies should include observations on the Guiana Island population (Horwith and Lindsay, 1997b).

Guiana Island also is the only location within the country where the Tropical Mockingbird occurs. This is believed to be the most northern one for the species, which ranges from Central and South America, north through the Caribbean to Guadeloupe, and then a jump to the small population on Guiana Island. It is unknown why the species has not expanded onto the Antigua mainland (we know of only one sighting of the bird on the mainland, from Crabs Peninsula); certainly it is not the lack of insects and fruit that comprise its diet. A possible explanation for the island restriction is that while the presumably small colonizing population (perhaps consisting of a single pregnant female) was able to maintain itself on Guiana Island, some aspect of the habitat in this margin of the bird's natural range has worked against its successful expansion. The estimated 25-50 individuals seem to be concentrated on the western half of the island (none were

seen or heard during our fieldwork in the eastern part; Horwith and Lindsay, 1997b).

This information is summarized in Table 3, which identifies bird species of special conservation concern for the country. This list includes 41 species, or more than 20% of the avian fauna, and reflects our bias towards including species that occur in threatened habitat.

Table 3. Antigua-Barbuda-Redonda Bird Species of Special Conservation Concern
(Rare; Vulnerable or Endangered; and/or Endemic).

Audubon's Shearwater (<i>Puffinus lherminieri</i>)	Widespread breeder in Eastern Caribbean, but Redonda is only nesting site in the country
Red-billed Tropic bird (<i>Phaethon aethereus</i>)	Uncommon, Vulnerable due to threats to nesting habitat in North Sound
Masked Booby (<i>Sula dactylatra</i>)	Redonda is 1 of only 12 known nesting sites in the Caribbean
Brown Booby (<i>Sula leucogaster</i>)	Redonda is one of the few nesting sites in the Caribbean
Red-footed booby (<i>Sula sula</i>)	Redonda is 1 of 3 nesting sites in the Lesser Antilles
Brown Pelican (<i>Pelecanus occidentalis</i>)	Uncommon, Vulnerable due to threats to nesting habitat in North Sound
Magnificent Frigatebird (<i>Fregata magnificens</i>)	Common, Vulnerable due to dependence on Codrington Lagoon mangrove stand for nesting
Black-crowned Night Heron (<i>Nycticorax nycticorax</i>)	Rare throughout Lesser Antilles; Vulnerable due to threats to nesting habitat
West Indian Whistling Duck (<i>Dendrocygna arborea</i>)	West Indian endemic. Rare, Endangered in Lesser Antilles due to habitat loss and hunting
White-cheeked Pintail (<i>Anas bahamensis</i>)	Uncommon, Vulnerable in Lesser Antilles due to habitat loss and hunting
Ruddy Duck (<i>Oxyura jamaicensis</i>)	Rare, Vulnerable in Lesser Antilles due to habitat loss
Masked Duck (<i>Nomonyx dominica</i>)	Rare, Vulnerable in Lesser Antilles due to habitat loss
Osprey (<i>Pandion haliaetus</i>)	Rare winter visitor
Broad-winged Hawk (<i>Buteo platypterus insulicola</i>)	Antigua endemic sub-species
Peregrine Falcon (<i>Falco peregrinus</i>)	Rare, Endangered in Antigua and globally
Clapper Rail (<i>Rallus longirostris</i>)	Rare, Vulnerable to habitat loss

Table 3 (continued).
Antigua-Barbuda-Redonda Bird Species of Special Conservation Concern.

Caribbean Coot (<i>Fulica caribaea</i>)	West Indies and north-western Venezuela
Laughing Gull (<i>Larus atricilla</i>)	Uncommon, Vulnerable due to threats to nesting habitat in North Sound
Roseate Tern (<i>Sterna dougallii</i>)	Uncommon, Vulnerable due to threats to nesting habitat in North Sound
Least Tern (<i>Sterna antillarum</i>)	Rare, Vulnerable due to threats to nesting habitat in North Sound
Bridled Tern (<i>Sterna anaethetus</i>)	Rare, Vulnerable due to threats to nesting habitat in North Sound
Sooty Tern (<i>Sterna fuscata</i>)	Uncommon, Vulnerable due to threats to nesting habitat in North Sound
Brown Noddy (<i>Anous stolidus</i>)	Uncommon, Vulnerable due to threats to nesting habitat in North Sound
Red-necked pigeon (<i>Columba squamosa</i>)	West Indies endemic
White-crowned pigeon (<i>Columba leucocephala</i>)	West Indies (and Florida Keys)
Zenaida Dove (<i>Zenaida aurita</i>)	West Indies (and Yucatan Peninsula)
Bridled Quail-Dove (<i>Geotrygon mystacea</i>)	Lesser Antilles & Puerto Rico
Ruddy Quail-Dove (<i>Geotrygon montana</i>)	West Indies (and Central and South America)
Mangrove cuckoo (<i>Coccyzus minor</i>)	Lesser Antillean sub-species?
Antillean Nighthawk (<i>Chordeiles gundlachi</i>)	West Indies; Uncommon in Barbuda
Purple-throated Carib (<i>Eulampis jugularis</i>)	Lesser Antillean endemic
Green-throated Carib (<i>Sericotes holosericeus</i>)	Lesser Antilles, Virgin Islands & Puerto Rico
Antillean Crested Hummingbird (<i>Orthorhyncus cristatus</i>)	Lesser Antilles, Virgin Islands & Puerto Rico
Lesser Antillean Flycatcher (<i>Myiarchus oberi</i>)	Lesser Antillean endemic (Barbuda, not Antigua)
Caribbean Martin (<i>Progne dominicensis</i>)	West Indies (Rare in Antigua); winters in South America
Tropical Mocking Bird (<i>Mimus gilvus</i>)	Rare, only on Guiana Island; Vulnerable

Table 3 (continued).
Antigua-Barbuda-Redonda Bird Species of Special Conservation Concern.

Scaly-breasted Thrasher (<i>Margarops fuscus</i>)	Lesser Antillean endemic
Brown Trembler (<i>Cinlocertia ruficauda</i>)	Lesser Antillean endemic. Extirpated from Antigua and Barbuda, where it is known from fossil records and occasional sightings of vagrants from neighboring islands
Adelaide's Warbler (<i>Dendroica adelaidae</i>)	Lesser Antilles (and Puerto Rico); Barbuda endemic sub-species or race
Blue-headed Euphonia (<i>Euphonia musica</i>)	Lesser Antillean endemic sub-species
Lesser Antillean Bullfinch (<i>Loxigilla noctis</i>)	Lesser Antillean endemic

Note: This list follows the order and nomenclature adopted by the American Ornithologists' Union Checklist of North American Birds (1983, 6th edition), which includes the Caribbean.

Mammals: Terrestrial

Bats are the only native terrestrial mammals in the country (Table 4), and as is the case throughout the Lesser Antilles, they constitute the largest mammalian group. Morton (1994) has done the most recent and comprehensive research on the bats of Antigua and Barbuda, finding the same 7 species on both islands. His addition of the Funnel-eared or Long-legged Bat (*Natalus stramineus*) to the Barbuda record builds on the West Indian accounts of Breuil and Masson (1991), Jones (1989), and Koopman (1989). Fossil remains exist for 3 bat species extirpated from Antigua and Barbuda but extant in the Greater Antilles: *Pteronotus parnelii*, *Marmoops blainvillei*, and *Phyllonycteris* cf. *P. major* (Pregill et al., 1988). Morton's report includes information on important roosting sites and recommendations for bat conservation.

Other native mammals are known only from the subfossil record, although some may have become extinct within historical times. An extinct "rice rat(s)" or Oryzomyine rodent is known from middens and non-archaic sites in Antigua, and non-archaic sites in Barbuda. The West Indian Manatee (*Trichechus manatus*) is known from local folklore as the "sea cow", and also from middens. An incomplete set of bones, attributed to this species, was discovered in the weathered silt of a mangrove system in the early 1990s. These are now housed at the Museum of Antigua-Barbuda in St. John's.

The Barbudan "muskrat" is known from non-archaic sites on Barbuda, and it has been suggested that the species became extinct sometime before or after AD 1500 (McPhee and Flemming, 1997).

Table 4. Bats of Antigua-Barbuda-Redonda.

Common Fruit Bat (<i>Artibeus jamaicensis</i>)	
Pig-faced or Rat Bat (<i>Brachyphylla cavernarum</i>)	Antillean endemic, primarily Lesser Antilles, but also Puerto Rico and the Virgin Islands). Common, Vulnerable; only one roost—Bat's Cave—has been found.
Long-tongued fruit Bat (<i>Monophyllus plethodon</i>)	Lesser Antillean endemic; Endangered, possibly extirpated on Antigua.
Fishing Bat (<i>Noctilio leporinus</i>)	Uncommon, Vulnerable; very few roost sites.
Funnel-eared or Long-legged Bat (<i>Natalus stramineus</i>)	
Brazilian free-tailed Bat (<i>Tadarida brasiliensis</i>)	
Velvety house Bat (<i>Molossus molossus</i>)	

Mammalian introductions include:

Agouti (*Dasyprocta agouti*): believed to be an Amerindian introduction, but extirpated within historical times.

European fallow deer (*Dama dama dama*): a sub-species of *Dama dama* introduced for game, and extant on Barbuda (population size unknown) and Guiana Island (estimated population of 250; Horwith and Lindsay, 1997b).

Indian mongoose (*Herpestes javanicus*): introduced in the late 1800s to control rats which infected Antiguan sugarcane plantations. It is widespread on the island but does not occur on Barbuda.

Domestic Rabbits (*Oryctolagus cuniculus*): introduced to Long, Rabbit and perhaps other offshore islands, as game stock (Museum of Antigua-Barbuda, 1997), but extirpated.

Rats (*Rattus rattus* and *R. norvegicus*) and Mouse (*Mus muscalus*) have been inadvertently introduced since the 1600s, or earlier.

Mammals: Marine

These include 26 cetacean species that have been recorded for the Caribbean, 7 of which are known from Antiguan or Barbudan waters (Gricks, 1994).

Conservation Implications

While there are no country-specific conservation issues regarding cetaceans, many species are endangered throughout their range by hunting and/or over-fishing of their prey. Perhaps the greatest threat, however, is chemical pollution of the world's oceans. Bio-accumulation of PCBs and other toxins in the animals' fat reserves are suspected to contribute to breeding difficulties and illnesses associated with pollution-suppressed immune systems.

FAUNA – INVERTEBRATES

“The only solid piece of scientific truth about which I feel totally confident is that we are profoundly ignorant about nature”

Lewis Thomas, *The Medusa and the Snail*, 1979

The treatment of invertebrates in this report is extremely weak, which is especially unfortunate given the document's focus on biodiversity and the fact that worldwide invertebrates comprise far more taxa than the better-studied vertebrate animals. For most of us, however, our knowledge of the “lower” forms of life is inadequate to even provide a perspective for evaluating the data and data gaps.

For example, there is some data on West Indian amphipods because of the work of a Dutch scientist who started collecting in the region in the 1930s and continued for nearly half a century. Many of the thousands of samples collected from Aruba to Florida during these Hummelinck expeditions have been sorted, but fewer have been thoroughly classified. So far five families have been identified. Is this a lot or a little? To rephrase the question more scientifically, issues such as the following need to be considered:

- How many families of amphipods are there globally, *i.e.*, how well represented are they in the Caribbean from a global perspective?
- Do the families contain many genera, and do the genera contain many species? Although biodiversity can be measured from the ecosystem level to the genetic level, the most intuitive measurement of biodiversity emphasizes numbers of species.
- Are any of the families, genera or species endemic to Antigua-Barbuda, or to the Caribbean?
- What is an amphipod; and how does it fit into the tree of life?

In a sense, the last question is the starting point. From our study of bird species, we know that Antigua-Barbuda has approximately 175 species of birds, and we have an intuitive sense of what this means in terms of avian biodiversity. While most of us might not know that there are an estimated 9,600 species of birds that are known to science, our guess would probably be within an order of magnitude in either direction; *i.e.*, between 1,000 and 100,000. We have a sense of what it means for the country to have about 175 species of birds. To be able to do the same sort of thing with amphipods would require that we know something not only about their diversity, but also about their taxonomic relationship to other organisms.

The section on invertebrates that follows obviously is not comprehensive. Interested readers are referred to Brusca and Brusca's (1990) text *Invertebrates*, which provides a taxonomic system that is used in Table 5. Note that Brusca and Brusca (1990) differentiate 29 phyla or equivalent taxa comprising the Metazoa; but that we used Maddison and Maddison's (1996) figure of 22 phyla in the discussion above. The reasons for these differences among biologists are as informative to our understanding of biology as the information they present, but clearly it is beyond the scope of this document to elaborate on this theme.

Table 5. Invertebrates: global and country estimates.

Taxa	G.S.E.¹	Country Estimate³ (and notes)
Porifera (sponges)	9,000	56 (Humann, 1993)
Cnidaria (includes corals, hydroids, jellyfish and anemones)	9,000	148 corals plus another 62 Cnidarians in various other taxa (Humann, 1993)
Ctenophora (comb-jellies or sea walnuts)	100	9 (Humann, 1993)
Platyhelminthes (flatworms)	20,000	5 (Humann, 1993)
Nemertea [= Rhynchozoela] (ribbon worms)	900	1 (Humann, 1993)
Pseudocoelomates (Rotifera, Gastrotricha, Kinorhyncha, Nematoda, Nematomorpha, Acanthocephala and Entoprocta), Pripula, Gnathostomulida and Loricifera	16,000 (12,000 of which are nematodes)	
Annelida (segmented worms: earthworms, fireworms, feather duster worms, calcareous tube worms, spaghetti worms)	10,000	23 (Humann, 1993)

Table 5 (continued). Invertebrates: global and country estimates.

Taxa	G.S.E. ¹	Country Estimate ³ (and notes)
Coelomate Worms (4 phyla: Sipuncula, Echiura, Pogonophora, Vestimentifera)	600	
Arthropoda (4 subphyla, 1 of which—Trilobitomorpha—is extinct)		
Cheliceriformes	>65,000	
Arachnida (subclass containing 10 orders, including spiders (35,000 spp), scorpions (1,200 spp), mites and ticks (30,000))	65,000	Kohls (1969) lists 17 species of ticks in the L.A: 5 in Antigua, 3 in Barbuda
Uniramia		
Myriapoda	13,120	
Chilopoda (centipedes) and Diplopoda (millipedes)	2,500 10,000	
Insecta (class containing 32 orders, only some of which are included below)	>850,000	
Odonata (Dragonflies and Damselflies)	5,500	86 species of dragonflies and 44 species of damselflies are recorded for Florida (Dunkle, 1989)
Isoptera (Termites)	2,000	94 species recorded for the Caribbean (Collins, unpublished)
Orthoptera (grasshoppers, crickets and locusts)	20,000	
Hemiptera	35,000	
Homoptera	33,000	
Coleoptera (beetles)	300,000 -350,000 ²	>1,200 species recorded in the USVI, which has been relatively well-studied (Ivie, reported by Chadwick, 1998)
Hymenoptera (ants, bees, wasps)	125,000	
Diptera (flies, mosquitoes)	150,000	

Table 5 (continued). Invertebrates: global and country estimates.

Taxa	G.S.E. ¹	Country Estimate ³ (and notes)
Lepidoptera (Butterflies and Moths)	120-180,000	292 species of butterflies in the West Indies (Stiling, 1986), over half endemic (following Miller and Miller's (1989) inclusion of the southern tip of Florida and the Keys as Antillean); 69 in the Lesser Antilles: 9 of which occur in the Leeward Islands but not the Windward Islands and 19 that occur in the Windwards but not the Leewards (Riley, 1975). Antigua, which has been investigated by several researchers, has 25 species, 11 of which are not known for Barbuda. An endemic species or subspecies, <i>Battus polydamas antiquus</i> [= <i>Papilio polydamas antiquus</i>] is a 26th species, unless it has been extirpated (Schwartz and Henderson, 1990). Although it does not appear that a country list exists of the moths, Barnes' (1996) identification guide lists just over 500 species for the Lesser Antilles.
Crustacea (includes crayfish, lobster, crab, shrimp, barnacles)	30,000	64 marine (Humann, 1993)
Mollusca (includes chitons; clams, oysters, mussels; snails, slugs, whelks; tooth shell; squid, octopus)	50,000	100 marine (Humann, 1993)
Lophophorates: 3 phyla—Phoronida, Ectoprocta [=Bryozoa] and Brachiopoda	5,000	13 (Humann, 1993)
Echinodermata (includes starfish, brittle stars, sea urchins, sea cucumbers and feather stars)	6,000	14 starfish, 9 brittle stars, 11 sea urchins, 7 sea cucumbers, 4 feather stars (Humann, 1993)
Invertebrate Chordates and kin: 3 phyla—Chaetognatha, Hemichordata and some of the Chordata	3,200	23 (Humann, 1993)

Notes:

- ¹ Global Species Estimates (G.S.E.) are from Brusca and Brusca (1990). This tome on invertebrate biology is the source of much of the information presented in Table 5.
- ² Chadwick (1998).
- ³ Almost no country-specific accounts exist for Antigua-Barbuda. The estimates referenced as Humann (1993) probably are vast underestimates, in part because the emphasis of his guide presumably is on the most conspicuous species, but also because these taxa remain inadequately researched.

One of the invertebrate groups that has received substantial attention in the Caribbean is the Coleoptera. The notes that follow, paraphrased from discussions with Dr. Michael Ivie, an entomologist who has worked extensively in the Virgin Islands, offer an interesting and valuable perspective:

Beetles (Order Coleoptera) are the single largest group of organisms on earth. For the West Indies, it is even more dominant than elsewhere because so many other groups are relatively underrepresented or already extinct. Beetles occupy the largest number of trophic levels, have the largest size range, and the greatest ecological diversity of any group of West Indian organisms. Yet, we know very little about them. Further, our knowledge is very uneven geographically, with the best data existing for the Virgin Islands and Guadeloupe.

Based on data from the better-studied islands [Table 6], we know that the area and elevation of an island seem to be the best predictors of its species diversity. Thus, St. Kitts, which is larger and higher than St. Thomas, should have more beetle species, yet it has less than 10% of the number known for St. Thomas. Redonda, with 1 known species, would be expected to have more species than Guana, BVI, which has 250 known species.

In the Virgin Islands, we have found that 50% or more of the species on each island are endemic to that island, or at least to that island bank (i.e., the island or islands of today that would have been exposed above sea level as one island during the Pleistocene period). The Northern Leewards area probably contains well over 1,000 undescribed, undiscovered species of beetles alone.

Ivie goes on to argue that a critical step in trying to identify biodiversity conservation priorities requires that we have a relatively good inventory of at least some groups; and that the best candidates are the vascular plants and at least one of the insect orders.

Table 6. Data from beetle studies in the West Indies.
(M. Ivie, University of Montana, unpublished data).

Island Group	Area (km²)	Max. Elev. (m)	Known spp Beetles	Estimate of Completeness
Puerto Rico	8897	1333	ca. 1300	< 30%
Virgin Islands	500	527	ca. 1450	ca. 70%
N. Leeward Is.	1045	1307	< 250	ca. 10%
Guadeloupe	1434	898	ca. 1400	ca. 70%
Sombrero	5	12	0	
Anguilla	91	65	7	
St. Martin	91	424	23	
St. Barths	18	281	54	
Barbuda	161	62	9	
Antigua	280	403	87	
Saba	13	864	4	
Statia	21	599	7	
St. Kitts	166	1307	37	
Nevis	93	979	10	
Redonda	5	295	1	
Montserrat	101	909	74	
St. Croix	230	353	>450	
St. Thomas	77	470	>400	
St. John	52	387	>400	
Guana (BVI)	3	245	>250	

Conservation Implications

Fortunately, the major conservation concerns for the land and marine invertebrates in Antigua-Barbuda-Redonda are known, even if many of the species are not. On the terrestrial side, the greatest threat is loss of habitat, which is why it is particularly important to ensure that representatives of each of the 54 vegetation communities are protected. Less is known about the country's marine invertebrates, but it is clear that their conservation will benefit from protection of biologically rich wetlands and reefs, and efforts to preserve the quality of the water.

The country can support international agreements to reduce agents contributing to global warming and chemical contamination of the world's oceans (see Table 7). More direct actions include reducing land-based sources of pollution and sedimentation runoff.

Table 7(a). Environmental treaties signed by Antigua-Barbuda.

Date Entered Into Force	Date of Signature	Title of Environmental Treaty
16-NOV-94	07-FEB-83	United Nations Convention on the Law of the Sea.
11-OCT-86	11-SEP-86	Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region
	18-JAN-90	Protocol Concerning Specially Protected Areas and Wildlife to the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region
21-MAR-94	04-JUN-92	Framework Convention on Climate Change
29-DEC-93	05-JUN-92	Convention on Biodiversity
03-DEC-81	03-DEC-81	Charter of the Organization of American States
30-JAN-70	18-OCT-69	Agreement establishing the Caribbean Development Bank
22-SEP-83	22-SEP-83	Agreement of the International Bank for Reconstruction and Development
15-JUL-82	15-JUL-82	Constitution of the United Nations Educational, Scientific and Cultural Organization
25-FEB-82	25-FEB-82	Agreement of the International Monetary Fund
11-OCT-83	11-OCT-83	Treaty for the Prohibition of Nuclear Weapons in Latin America
	08-DEC-84	Third ACP EEC Convention
	15-DEC-89	Fourth ACP EEC Convention
21-JUN-85	08-SEP-82	Constitution of the United Nations Industrial Development Organization
26-DEC-96	04-APR-95	International Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, particularly in Africa.

Table 7(b). Environmental treaties *not signed* by Antigua-Barbuda.

Date Entered Into Force	Title of Environmental Treaty
21-JUL-82	International Convention for the Regulation of Whaling
29-APR-88	International Convention for the Prevention of Pollution from Ships as modified by the Protocol of 1978
	International Convention for the Prevention of Pollution from Ships (MARPOL)
01-NOV-81	Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water
05-FEB-89	Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter
21-JUL-82	Protocol to the International Convention for the Regulation of Whaling
01-FEB-84	Convention concerning the Protection of the World Cultural and Natural Heritage
05-FEB-89	Amendments to Annexes to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter concerning Incineration at Sea
11-OCT-86	Protocol concerning Co-operation in Combating Oil Spills in the Wider Caribbean Region
03-MAR-93	Convention for the Protection of the Ozone Layer
03-MAR-93	Protocol on Substances that deplete the Ozone Layer
01-JUL-92	International Convention for the Prevention of Pollution from Ships, 1973 (MARPOL) Annex III (Optional): Hazardous substances carried in packaged form
	International Convention for the Prevention of Pollution from Ships (MARPOL) Annex IV (Optional): Sewage
04-JUL-93	Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal
24-MAY-93	Amendment to the Montreal Protocol on Substances that deplete the Ozone Layer
14-JUN-94	Amendment to the Montreal Protocol on Substances that deplete the Ozone Layer
29-JAN-88	Convention on the International Regulations for Preventing Collisions at Sea
09-MAY-87	Protocol relating to the International Convention for the Safety of Life at Sea (SOLAS Prot.)
09-MAY-87	International Convention for the Safety of Life at Sea (SOLAS)
25-JAN-89	Convention and Statute on the Regime of Navigable Waterways of International Concern
25-OCT-88	Convention on the Prohibition of Military or any other Hostile Use of Environmental Modification Techniques
02-MAY-89	Convention on the Recognition and Enforcement of Foreign Arbitral Awards
13-DEC-88	Convention on Registration of Objects Launched into Outer Space
01-NOV-81	Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or Other Gases, and of Bacteriological Methods of Warfare

Table 7(b) [continued]. Environmental treaties not signed by Antigua-Barbuda.

Date Entered Into Force	Title of Environmental Treaty
03-SEP-93	Convention on the Physical Protection of Nuclear Material
01-NOV-81	Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies
17-JUN-85	Treaty on the Non Proliferation of Nuclear Weapons
16-NOV-88	Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects launched into Outer Space
16-NOV-88	Treaty on the Prohibition of the Emplacement of Nuclear Weapons and other Weapons of Mass Destruction on the Sea Bed and the Ocean Floor and in the Subsoil thereof
01-NOV-81	Convention on International Liability for Damage caused by Space Objects
16-FEB-82	Constitution of the International Labour Organisation
10-DEC-81	Convention on International Civil Aviation Annex 16 Aircraft Noise
16-NOV-88	Convention of the World Meteorological Organization
11-NOV-81	Charter of the United Nations
13-JAN-86	Convention on the International Maritime Organization
12-MAR-84	Constitution of the World Health Organization
07-NOV-83	Constitution of the Food and Agriculture Organization of the United Nations
01-NOV-81	General Agreement on Tariffs and Trade
05-FEB-89	Amendments to the Annexes to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter
31-DEC-88	International Convention for the Prevention of Pollution from Ships (MARPOL) Annex V (Optional) = Garbage
06-APR-87	Protocol Additional to the Geneva Conventions of 12 August 1949 and relating to the Protection of Victims of International Armed Conflicts (Protocol I)
06-APR-87	Protocol Additional to the Geneva Conventions relating to the Protection of Victims of Non International Armed Conflicts (Protocol II)

Source: Information from the World Conservation Union (IUCN) database of 60 environmental treaties, updated as of 1 March 1997, and mounted on the World Wide Web server of the Center for International Earth Science Information Network (CIESIN) <<http://sedac.ciesin.org/pidb>>.

Even though we do not have quantitative data on the deterioration of the country's marine environment, the trend is clear and disturbing. In 1996, Island Resources Foundation examined a total of 110 sites in 7 areas of the North Sound and found:

- *Most hard corals in shallow areas are dead.* Over 95% of the hard corals surveyed in waters of approximately 9.1 meters or shallower are dead. This problem is spread over a wide geographic area (all seven areas) and occurs in both *linear* (including bank barrier and fringing reefs) and *patch* reefs (relatively isolated, with characteristic ring of bare sand from fish and sea urchins that inhabit the reef and graze the vegetation close to it).
- *Deeper reefs tend to be healthier.* Studies confirm this relationship, one recognized by the fishermen and divers. Bunce's October 1995 post-Hurricane Luis study of several reefs at depths of 9.1-13.7 meters labeled them in "good" health (Bunce, 1996). Other studies of reefs in Antigua and elsewhere in the Caribbean often note the better condition of corals at depths of 18.2 meters and more.
- *Changes in the resource base.* There has been significant deterioration of hard and soft corals with replacement (or overgrowth) of macroalgae and sea-grass. Much of the reef area recorded in 1988 (Weiss and Multer, 1988) now appears as sand/coral/sea grass. [Some former sand areas now have a lot of sea grass; but since the converse also is true, it is not clear whether there have been changes in the relative abundance of these two resource categories.]

While it is possible to show that some of the areas previously recorded as coral have deteriorated, the 1988 map does not distinguish live coral from dead coral, and therefore it is not possible to quantify the decrease in the percent of live corals over this time period. However, the few studies that do exist present an alarming picture. Multer collected some live coral coverage data from a few transects in the Great Bird Island area in the 1980s. Island Resources resurveyed the approximate areas (but investigators could not know if they were looking at the exact same spots) and found 75% and more dead coral with isolated live coral heads, where he had recorded less than 25% dead corals.

Multer also surveyed reefs in other parts of Antigua (Nonsuch Bay, Goat Head, and Bishops Reef). He first surveyed these sites in 1983, and then resurveyed them in early 1996. In all three areas, he observed that three-quarters of the corals alive in 1983 were dead 13 years later (Nonsuch Bay declined from 35% live corals to 7%; Goat Head and Bishops Reef went from 20% to 5%; and 15% to 2%, respectively). Soft corals showed a comparable decrease.

Goreau and Goreau (1996) conducted a rapid ecological assessment of coral reefs off the coasts of Antigua and Barbuda. They also reported that most sites were dominated by dead coral rubble and had live coral cover of only between 5% and 20%. These figures were approximately the same as those reached by Bunce (1993; 1996) and the Fisheries Division, who based their findings on detailed transect surveys.

Equally important in this analysis is the near-universal response of fishermen and dive operators, who report the same pattern of deterioration over the past 20 years or more.

Several factors, possibly interacting synergistically, have been proposed to account for the deterioration of coral reefs in the Caribbean. Although their relative impacts on Antigua's reefs are not known, the following stresses are assumed to be involved:

Natural stresses:

- Predation by other organisms and cannibalism by other corals;
- Crowding and substrate take-over by algae;
- Bleaching;
- Black line disease, white line disease, and related pathogens;
- Physical breakage and high turbidity;
- Long term climate (temperature) changes.

Human-induced stresses:

- Over-fishing;
- Nutrient-enriched runoff and biocides (pesticides, herbicides, and fungicides)
- Hydrocarbons and trace elements from terrestrial waste streams and marine products;
- Anchor, boat grounding and swimmer damage and coral removal [site-specific, and observed as a factor around Great Bird Island];
- Suspended sediment discharge following rainy periods from unstabilized slopes, spoil banks, construction sites, roads, ravines, etc. (worldwide, this is considered the greatest single factor).

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About the Eastern Caribbean Biodiversity Programme —

ISLAND RESOURCES FOUNDATION is a donor-supported, development assistance organisation that was established in the Caribbean in the early 1970s to protect and enhance the environments of small island states and territories, especially those in tropical areas. The Foundation's traditional preoccupation with small island systems has always been coupled with a strong focus on conservation and protection issues. More than 25 years ago—long before it was called *biodiversity conservation*—the Foundation's commitment to species protection helped to launch a sea turtle research and conservation programme that resulted in the tagging of over twelve hundred green sea turtles in the eastern Caribbean.

By the early 1990s, biodiversity conservation had emerged as a newer, more holistic programme emphasis for the Foundation, representing a logical extension of our more than two decades of commitment to Caribbean environmental protection. Biodiversity concerns played an ever-increasing role in the Foundation's nine-year (1986-1995) Institutional Strengthening Programme for Conservation NGOs in the eastern Caribbean. By 1990 the Foundation and several of its NGO partners began to support initiatives specifically designed to build local institutional capacity for maintaining the biological diversity of Caribbean islands.

In 1993, ISLAND RESOURCES FOUNDATION established Biodiversity Conservation as a primary programme sector for its work in the eastern Caribbean. This effort, which receives major support from the MORIAH FUND, was carried out initially in partnership with the U.S.-based NATURE CONSERVANCY and with conservation NGOs and government agencies in Antigua-Barbuda, Dominica, Montserrat, and St. Kitts-Nevis. Dr. Bruce Horwith served as the first director of the Programme.

The overall goal of the Biodiversity Programme is to facilitate and strengthen a process of improved national decision-making about biodiversity, including the protection and preservation of threatened natural resources. It is shaped by four important elements:

- Support for technical studies and research.
- Expansion of the biodiversity information base by encouraging more effective data assembly and interpretation.
- Building institutional and individual capabilities, cooperation, and active support on behalf of biodiversity conservation and protection of endangered species.
- Linking public and private sector interests in support of biodiversity conservation programmes.

For more information on the Biodiversity Conservation Programme, to request a list of activities and publications, to join the CARIBBEAN BIODIVERSITY ELECTRONIC MAIL LIST, or to request assistance from programme staff, please contact:

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