Geographic Priorities of Marine Conservation: The Nature Conservancy's Ecoregional Platform for the Wider Caribbean

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ABSTRACT

This paper reviews the application of The Nature Conservancy's ecoregion-based planning process to marine conservation for the tropical northwestern Atlantic. Priority-setting exercises have been undertaken by both international conservation and donor organizations to understand where investment of programs and funding can yield the greatest results in terms of biodiversity protection. The ecoregion-based plan is the "blueprint for conservation" for large landscapes; the process of planning and implementation builds on the terrestrial experience and expertise of The Nature Conservancy and can be applied to conservation of marine and coastal biological diversity as well. Over the past two years, scientists and conservationists have developed a shallow-water marine regional classification system and the assessment tools necessary to carry out a priority-setting exercise for the marine systems of the tropical northwestern Atlantic. We wish to present the process of priority setting for one region, the Central Caribbean to illustrate the utility of this planning process for long-term marine conservation investments. The methods are based on information and ranking criteria developed in the Biodiversity Support Program's marine geographic priority setting exercise for Latin America and the wider Caribbean.

KEY WORDS: Marine conservation, biodiversity, northwestern Atlantic

INTRODUCTION

Overview of priority setting exercises

However vast the oceans appear, there is growing evidence that our coastal oceans are degraded by human activity and harvesting practices. There has been global press coverage of the impacts of over-harvesting on important fisheries, whaling, oil spills and ocean dumping. These issues of use (or abuse) of the ocean as a global resource has been the primary focus of many marine conservation organizations. The Nature Conservancy has a tradition of using scientific information for site-based action; and has recently adopted ecoregion-based planning as the logical synthesis of information learned about species, natural communities and large ecological system conservation. The ability to take a regional approach to priority-setting and assessment of the status of marine resources presents a valuable tool for protecting our ocean margins by linking local threats to regional policies and management issues.

The Biodiversity Support Program (BSP) was initiated following recognition of the global loss of biodiversity - and the dependence of billions of people in the developing world on plant and animal resources. The BSP was created in 1988 as a consortium of the U.S. World Wildlife Fund, The Nature Conservancy, and World Resources Institute with support from the U.S. Agency for International Development (USAID). This program started by supporting innovative, on-the-ground projects in conservation. BSP aims to work as a catalyst to focus increased attention on biodiversity conservation as part of USAID programs, local governments and non-government agencies. USAID hosted the first meeting to explore the criteria for setting geographic priorities for biodiversity conservation in December of 1988. The criteria for setting these priorities included *biological importance, threats, utility and institutional feasibility*. The principles underlying this geographic priority-setting approach are outlined as:

i} every nation's biodiversity is critical to its economic future and sustainable development,
ii) biological diversity includes not only the diversity of species but also diversity of communities and natural systems often represented as biogeographic units, and
iii) biological importance alone is not sufficient for determining conservation priorities, thus integration of information on threats, regional capacity, and feasibility is essential for any measure of success.

The Biodiveristy Support Program aims to establish geographic priorities for marine conservation in the western hemisphere, exclusive of Canada and the U.S., on two levels: first on the level of the larger biogeographic provinces, and second on the scale of smaller regions and coastal systems. Figure 1 illustrates the location and extent of the coastal biogeographic provinces for Latin America and the Caribbean. Note that the boundary of the provinces is not the natural bathymetric faunal boundary of 1000 meters but rather the Economic Exclusive Zone boundaries for the adjacent countries. The second level of priority setting is the focus of this paper: establishing priority coastal systems within the biogeographic regions or "bioregions". The marine priority-setting exercise relied on identification of areas of exceptional or unique biodiversity or high threats by a Geographic Information Systems (GIS) analysis of spatial data. The project is designed to identify a hierarchical process for classifying and characterizing marine systems for unique or vulnerable biodiversity features. Priority setting can be defined as establishing the key geographic locations where conservation investments would likely be successful and see real benefits realized. In an ideal world, we would wish to have sufficient information to identify geographic units of biodiversity that ultimately can be the focus for site-based conservation.

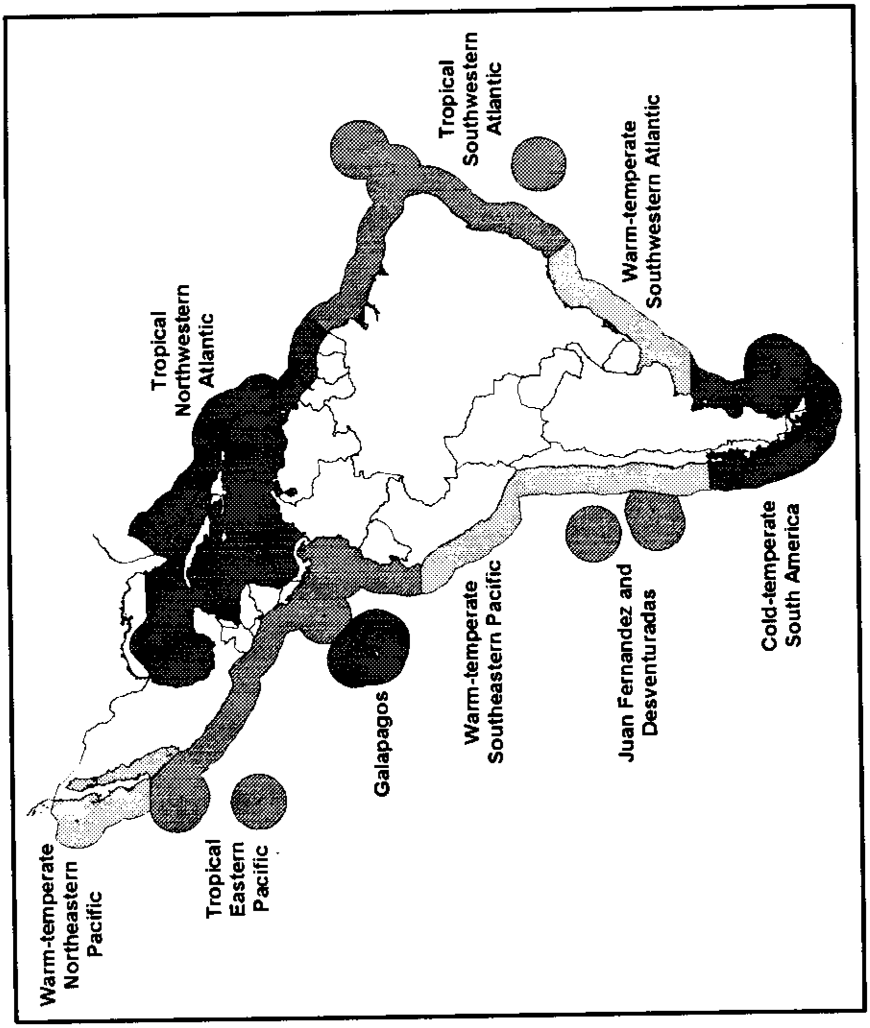

Figure 1. Coastal Biogeographic Provinces of Latin America and the wider Caribbean. The coastal provinces are primarily delineated by sea surface temperature and macro-scale oceanographic circulation. The offshore extent of the provinces is mapped to the Economic Exclusive Zone for each country.

Tropical Northwestern Atlantic Coastal Biogeographic Province

The Tropical Northwestern Atlantic is the largest coastal marine biogeographic province in the Western Hemisphere and extends from the tropical waters of the Gulf of Mexico and the Florida Keys, to the French Guianan-Brazil border. The province encompasses a complex tropical area of shallow seas, banks, atolls, continental coastlines and islands. This province is remarkable in a number of features of all the provinces in Latin American and the Caribbean: the largest province overall at 5.7 million square kilometers, the largest area of shallow coastal shelf both by percent area of the province as well as total area, the largest number of islands and largest island area within a province and, most diverse and largest inclusion of enclosed seas, bays and gulfs. The large-scale features are generally well understood. The entire province is influenced by the development of tropical storms and hurricanes usually started as tropical waves west of the Cape Verde Islands. The occurrence of these disturbances can vary throughout the region and influences the ecology of shallow-water coastal systems. Throughout the province, seasons are punctuated by rainfall patterns varying from approximately June through November. There are latitudinal and longitudinal gradients in climate throughout the province, the eastern half of the province tends to be drier, the western half tending to have higher rainfall.

Figure 2 presents the six bioregions of the Tropical Northwestern Atlantic. These regions can be delineated by the subtle changes in physical factors mentioned earlier (such as storm frequency, rainfall and geography) that result in differences in fauna and ecological systems. Table 1 lists the geographic indicators for each region; special focus should be given to the Central Caribbean bioregion. The Central Caribbean covers 46% of the entire province with the greatest length of coastline, largest area of mangrove coverage and greatest linear extent of mangrove coastline. In the coarsest level of priority setting, the Central Caribbean bioregion ranks highest in both biological value and conservation status, a reflection not only of the size of the region, but the complexity of the insular and continental components of this region (Figure 3). This is a huge area; where would one start in developing a region-wide conservation initiative? Simply put, what needs to happen within this region to insure region-wide conservation success and long-term (e.g., 100 year) survival of species, natural communities and larger coastal venues?

The goal of this paper is to outline the priority setting process in three steps:

i) the process of mapping and classification of coastal systems within the Central Caribbean region,
ii) the evaluation of biological value and conservation targets within systems,
iii) the ranking of priority coastal systems for more in-depth site conservation planning.

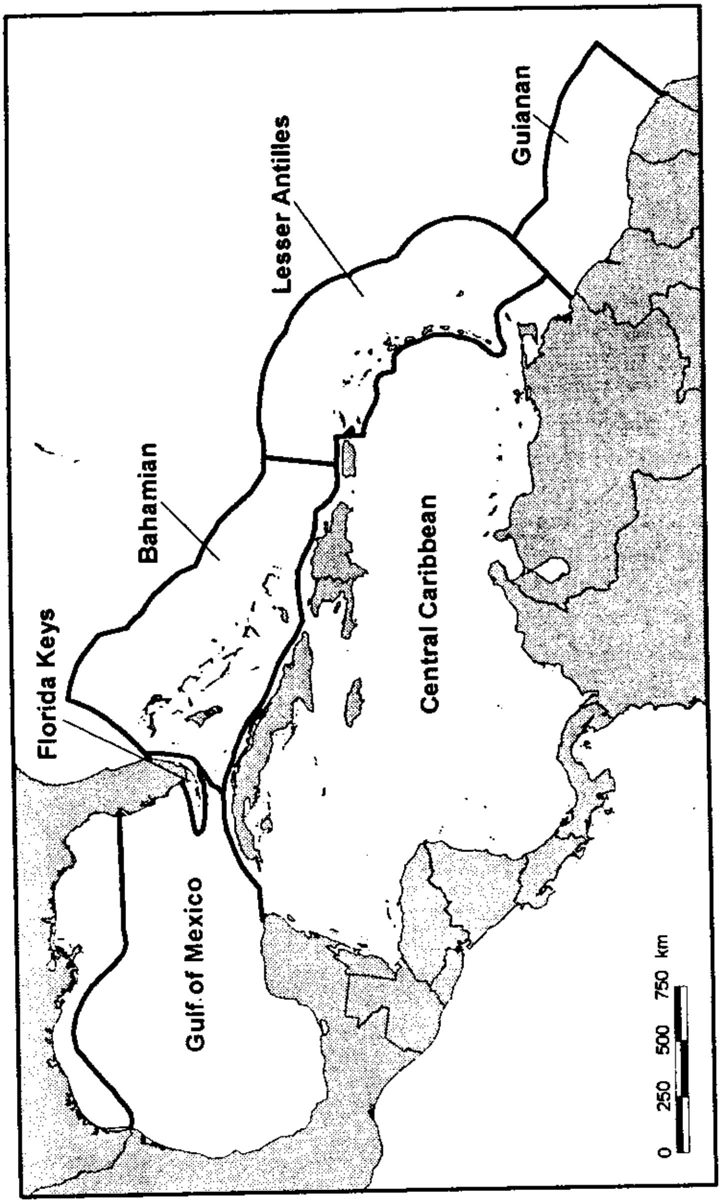

Figure 2. Ecoregions of the Tropical Northwestern Atlantic: the Gulf of Mexico, Florida Keys, Bahamian archipelago, Lesser Antilles, Guianan and Central Caribbean. Bathymetry is not shown.

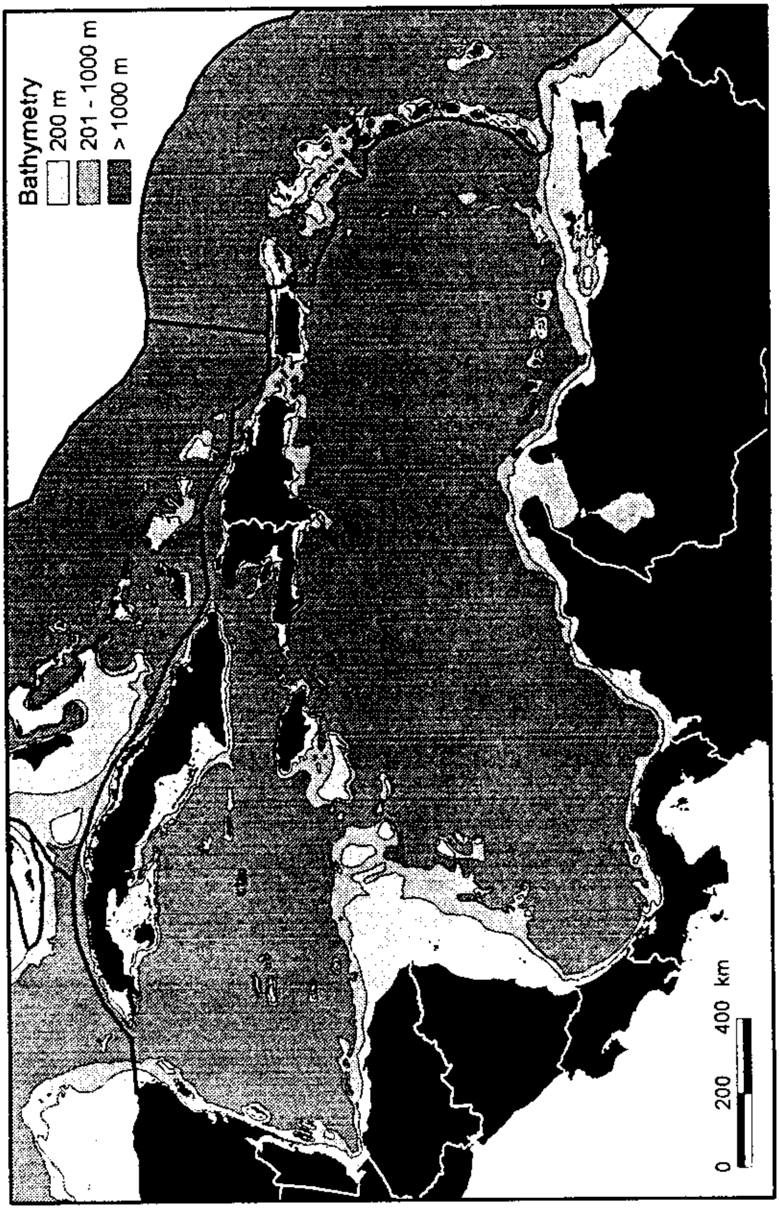

Figure 3. Bathymetry of the Central Caribbean Ecoregion. This illustrates the variability in continental shelf width throughout the region.

Table 1. Geographic indicators of the ecoregions within the tropical northwestern Atlantic biogeographic region

Bioregion	Area of Bioregion (km^2 and % of Province)	Coastline length (km and % of Province)	Area of Mangroves (km^2 and % of Province)	Length of Mangrove Coastline (km and % of Province)	Bathymetry (meters)	Area of Bathymetry (km^2 and % of Bioregion)
Guianan	384,566 (7)	1,824 (4)	7,067.9 (11)	989 (4)	0 - 200	147,820 (35)
					200 - 1,000	28,936 (5)
					> 1,000	207,609 (54)
Lesser Antilles	689,664 12%	2,508 (6)	314.1 (0)	369 (2)	0 - 200	29,429 (4)
					200 - 1,000	52,664 (5)
					>1,000	607,671 (86)
Bahamian	823,497 (14)	7,225 (16)	6,299.9 (9)	3,045 (14)	0 - 200	123,274 (15)
					200 - 1,000	102,236 (12)
					>1,000	597,988 (73)
Central Caribbean	2,648,472 (14)	26,969 (59)	38,913.7 (59)	14,940 (68)	0 - 200	419,554 (16)
					200 - 1,000	294,588 (11)
					>1,000	1,934,329 (73)
Florida Keys	23,508 (0)	1,238 (3)	1,661.3 (3)	711 (3)	0 - 200	18,375 (78)
					200 - 1,000	5,133 (22)
Gulf of Mexico	1,193,856 (21)	5,616 (12)	12,170.0 (18)	1,786 (8)	0 - 200	342,178 (29)
					200 - 1,000	119,137 (10)
					>1,000	732,541 (61)

METHODS

Mapping Coastal Systems

The Central Caribbean Ecological region will serve as the case study to illustrate the classification and mapping of coastal systems. Coastal systems can be described as sections of the coastline and coastal shelf in which similar ecological processes occur in the transfer of organisms and energy between a matrix of natural communities. This hierarchical approach of classification is based on the best available information, often remotely sensed or collected, on important physical factors that control the distribution of organisms. Coastal systems are identified and mapped based on a classification that characterized geology, coastal shelf morphology and rainfall. Local oceanographers and marine scientists delineated these systems based on knowledge of the area and occurrence of particular fauna and natural communities.

This often is not a purely objective exercise; more frequently information is collected along political rather than ecological boundaries. After the classification and mapping of coastal biogeographic regions and coastal systems, two additional types of information needed to be mapped: 1) information about ocean currents and circulation patterns so that we can understand how the pieces of the larger region are connected, and 2) information about the distribution of natural communities and specific features of these smaller coastal system to group them.

Biological value, conservation targets and threats

In marine and terrestrial systems, the diversity of communities and species may be closely linked to overall productivity. People have often evaluated productivity of oceans by the abundance of fishes or other commercially exploitable species. The classification of coastal systems of the Central Caribbean can be used to group together areas dominated by specific natural communities such as coral reefs or seagrass beds. In fact, six different types of coastal systems can be described: reef, mangrove, seagrass, rocky platform, upwelling areas, and beaches. Within each type, there can be more specific identification such as atolls, windward fringing or bank reef systems. Figure 4 illustrates the reef-dominated coastal systems of the Central Caribbean. "Mixed systems" are a unique combination of reefs, mangrove and seagrasses, often in a larger shallow shelf areas, such as Gulf of Batabano off southwestern Cuba. The mapping of reef-dominated coastal systems illustrates both the relationship of reef systems in a upstream-downstream relationship to ocean surface currents, and placement as bank, atoll, island, fringing or mixed reef systems. Each of these systems has a unique assemblage of species and unique ecological processes, but which and how many need to be conserved to protect regional coral reef diversity?

Although we can identify unique types of coastal system at the scale appropriate for many coastal ecological processes, what can be the measure of success? There needs to be criteria that can be monitored for guiding specific management actions. The decline of many species can be documented locally or even regionally, but there is only isolated evidence of marine extinctions, particularly among fishes and invertebrates. Conspicuous species such as marine mammals and sea turtles migrate and utilize large areas of the ocean. These species do not lend themselves to exclusive site-based conservation. Though the protection of turtle nesting beaches is important, the challenge now is to protect these species throughout their life cycle with a network of conservation action focused at the coastal system level.

A list of conservation targets has been generated for the region (Table 2), but our information on species such as large groupers or black coral is meager and incomplete. Our approach must be to conserve a network of healthy natural systems that include these targets. We are using the entire coastal system as a *surrogate conservation target*; we know important species are there, and we know we need to preserve the system for them to survive.

Ranking Coastal Systems

If the goal is to capture both the ecological function and processes associated with the the coastal system as well as the species diversity, how many coastal systems need to be targeted for conservation? How can the coastal systems be ranked? First, we need combine information on biological value with that of conservation status. Table 3 outlines some of the stresses and sources of stress to coastal systems in the Central Caribbean. It would be important to identify sites with the highest conservation need. The threats were evaluated qualitatively by local experts for coastal systems as either high, medium or low. This "scorecard" approach provides a rapid evaluation that can be reviewed, and revised when/if new information becomes available. For example, Figure 5 presents the mangrove coastal systems; these areas can be further characterized as continental forest systems, dry island forest systems and mixed coastal systems. Of the systems mapped in Figure 5, the Orinoco Delta coastal system is carried forward as a priority site in Figure 6 based on its size, upstream location in the circulatory patterns of the region, and the high value given for threats or potential threats to the system.

Designing the portfolio of priority systems with surrogate conservation targets can represent a very subjective exercise at best. In the selection of coastal systems, three steps were employed:

1. Selection of the best representatives of each type of coastal system: In the Central Caribbean, coastal systems include reef-dominated, mangrove-dominated, seagrass-dominated, mixed systems, upwelling areas and rocky platform coasts.

2. Selection of the widest geographic distribution of coastal systems: The circulation patterns in Central Caribbean is from the east to the west through the Caribbean basin, then north through the straits of Yucatan to the Gulf of Mexico. Colombia and Venezuela represented upstream systems, Belize and Cuba were then downstream.
3. Selection of sites based on conservation status and feasibility: A discussion of the current state of resources, amount of coastal development and habitat loss, and feasibility for working in these areas served to finalize the selection of priority coastal systems.

RESULTS AND CONCLUSIONS

Figure 6 presents the results of the ranking process for coastal systems. There are 24 "priority" systems out of a total of 51 coastal systems. That has narrowed the territory down considerably, but still covers a huge area. The key point here has to be that a regional effort based on specific plans for each site is essential to the long-term maintenance of regional marine resources. The goals of marine conservation go beyond preservation of individual species. We want to continue to receive the benefits or services from the healthy coast ecological system such as fisheries production, protection from coastal erosion, and high recreation and tourism value from areas such as coral reefs and beaches. Our goal at the specific coastal system is to define the balance between use of marine resources and protection from degradation and destruction. The strategies for marine conservation are no mystery, and there are several key "beliefs":

i) *Marine parks and protected areas are essential*. Areas in the coastal oceans need to be established as "no-take" zones, and current scientific information suggests as much as 20% of coastal areas should be in protection.
ii) *Linking coastal marine protection to upland terrestrial conservation is even more essential*. Land-based conservation projects are connected to coastal marine projects by natural hydrological cycles, water quality of run-off, and river discharge. The natural links between land and sea, with all the variability of storms, climates or biological cycles play a critical role in coastal ecology and productivity. Success will be difficult without addressing these linkages.
iii) *Understanding and being able to change how people use marine resources is absolutely imperative to long-term conservation success*. We have a need to develop the means to evaluate patterns of resource use, and to transfer information to a wide spectrum of audiences on the best practices for coastal development, sustainable harvesting and preserving the quality of life associated with living at the ocean s edge.

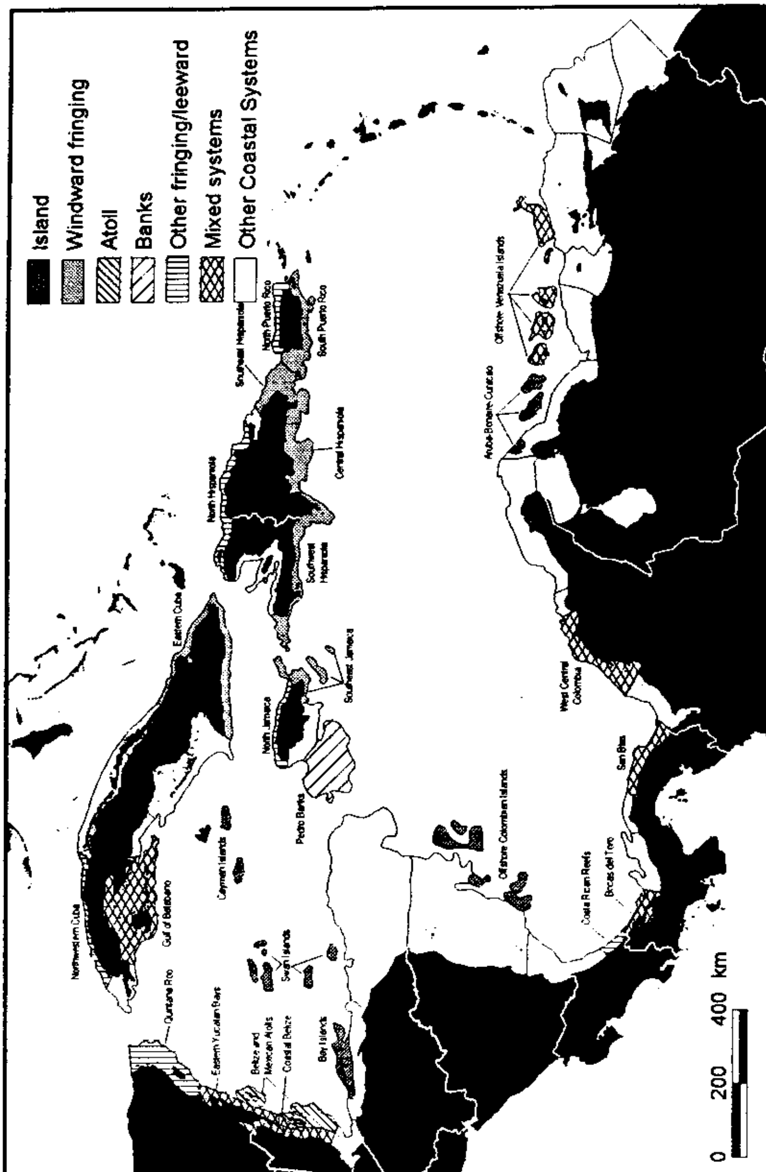

Figure 4. Reef-Dominated coastal systems of the Central Caribbean Ecoregion: coastal systems were delineated and identified as one of six types of reef-domianted systems. Bathymetry shown is 1,000 m contour.

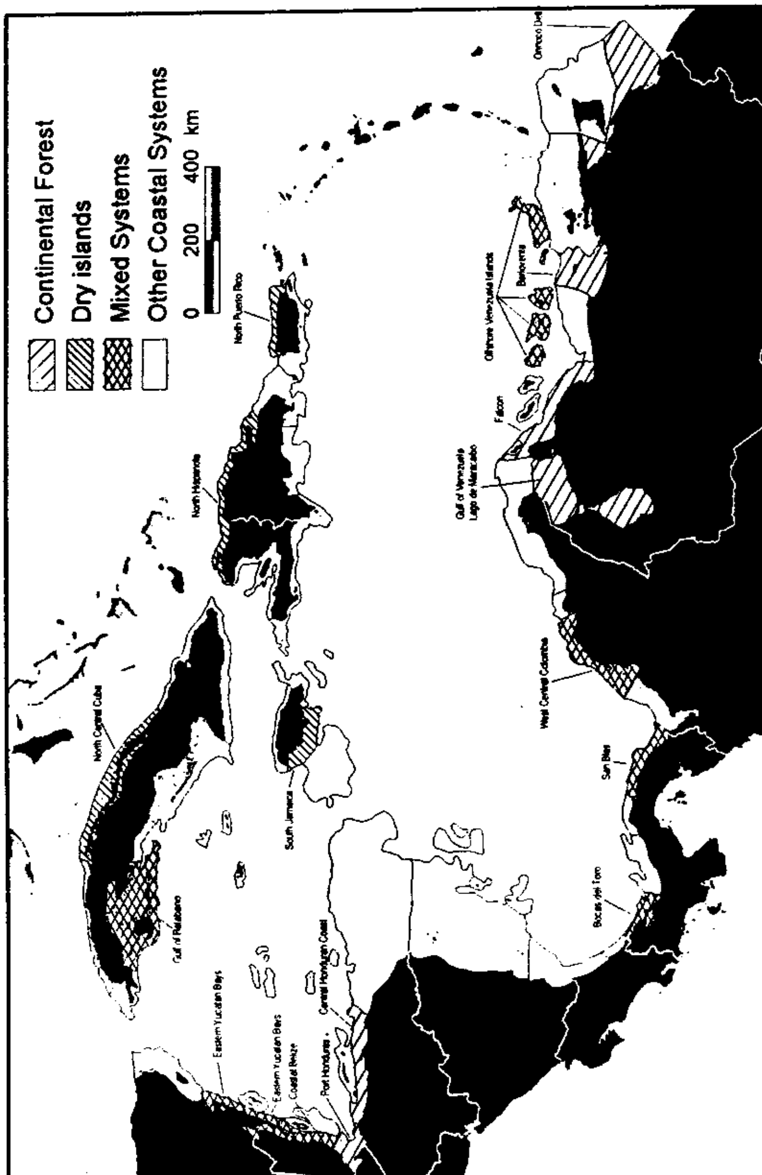

Figure 5. Mangrove-dominated coastal systems of the Central Caribbean Ecoregion: coastal systems were delineated and identified as one of three types of mangrove-dominated systems. Bathymetry shown is 1,000 m contour.

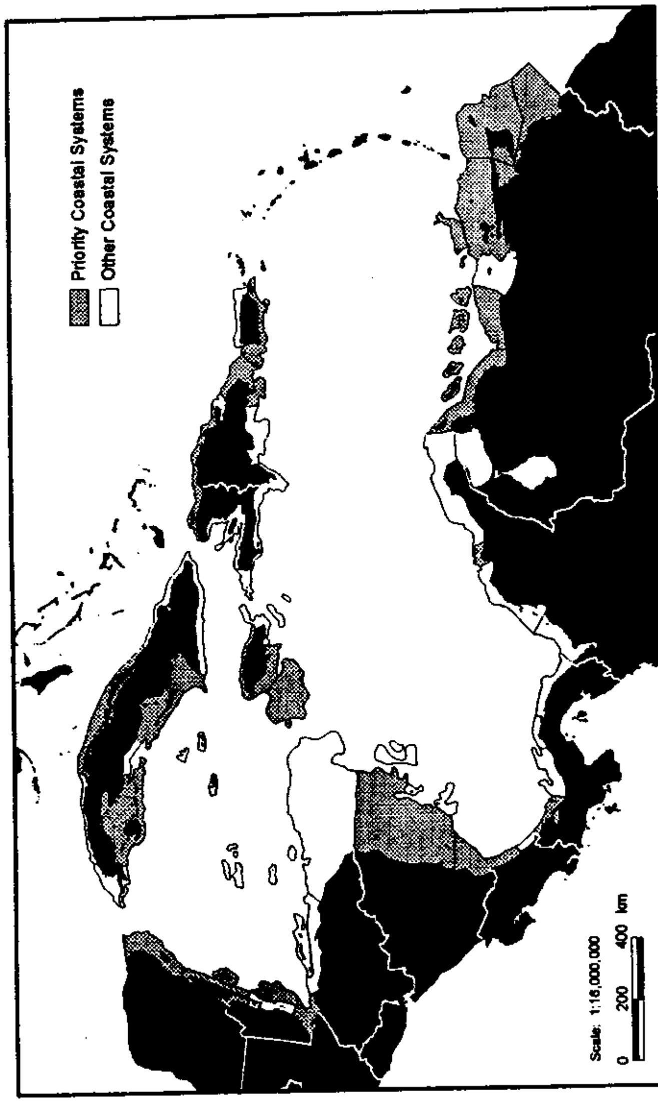

Figure 6. Priority Coastal systems for the Central Caribbean Ecoregion: This represents priority coastal systems of all types: reef, mangrove, seagrass, upwelling, rocky platform and beaches. Ranking was based on criteria for biological value and conservation status, Feasibility and local capacity for system-wide conservation intiatives would further filter site selection.

Table 2. Surrogate CONSERVATION Targets

Natural Community Targets	
Coral Reefs	expressed as these major community types: atoll bank reef barrier reef channel reef fringing leeward reef fringing windward island group reef northern hardbottom reef
Gulf Soft-bottom Communities	Feature soft sediment substrates inhabited by a host of invertebrate species including arthropods and molluscs.
Seagrass Beds	Found in unconsolidated substrates less than 10 meters deep. They are important nursery and feeding areas for a large number of species, and are expressed as: broad platform seagrass beds coastal with river influence seagrass bed insular seagrass bed
Species Targets	
Corals	black coral Antipathidae
Fishes	Nassau grouper *Epinephelus striatus* jewfish *Epihephelus itajara* other groupers *Epinephelus* spp, *Mycteroperca* spp mutton snapper *Lutjanus analis* gray snapper *Lutjanus griseus* lane snapper *Lutjanus synagris* southern red snapper *Lutjanus purpureus* blenny *Starksia ocellata*

Table 2 (continued)	Species Targets
Mollusks and Crustaceans	queen conch *Strombus gigas* helmet shells *Cassis* spp West Indian top snail *Cittarium pica* crown conch *Melongena melongena* mangrove oyster *Crassostrea rhizophorae* Atlantic pearl oyster *Pinctada radiata* cowries *Cyprea* conus *Conus* spiny lobster *Panulirus argus* shrimps *Penaeus* spp blue crabs *Callinectes* spp stone crab *Mennipe mercenaria*
Seabirds and Flamingoes	black-capped petrel *Pterodroma (hasitata) caribbaea* Cory's shearwater *Calonectris diomedea* sooty shearwater *Puffinus griseus* Audubon's shearwater *Puffinus iherminei* Wilson's storm petrel *Oceanites oceanicus* Leach's storm petrel *Oceanodroma leucorhea* band-rumped storm petrel *Oceanodroma castro* white-tailed tropicbird *Phaeton lepturus* red-billed tropicbird *Phaeton aethereus* masked booby *Sula dactylatra* brown booby *Sula leucogaster* red-footed booby *Sula sula* northern gannet *Sula bassanus* roseate tern *Sterna dougali* brown pelican *Pelecanus occidentalis* frigatebird *Fregata magnificens* greater flamingo *Phoenicopterus ruber*

Table 3. Threats to coastal systems of the tropical norwest Atlantic

Coastal System	Stress	Source
seagrass	1. overharvesting of all major herbivores 2. nutrification 3. near-shore sedimentation	1 .commercial fishing 2. sewage, agriculture 3. mangrove deforestation
mangrove complex	1.water quality (freshwater starvation) 2. deforestation 3. direct reduction of coastal fish	1. hydrologic alteration 2. old growth logging 3. commercial/local fishing
reefs	1. overfishing 2. nutrification 3. sedimentation 4. mechanical	1.commercial, local, sport 2. sewage, shoreline development, agriculture 3. upland deforestation, agriculture 4. diving, navigation
mixed	1. overfishing 2. nutrification 3. sedimentation 4. deforestation of mangrove keys 5. mechanical	1.commercial, local, sport 2. sewage, shoreline development 3. upland deforestation, agriculture 4. charcoaling, development 5. divers, navigation

The priority-setting exercise is a process that can be improved and expanded, though this initial iteration has produced some important changes in how The Nature Conservancy will approach marine conservation in the future. First, this exercise must dramatically altered the scale and scope of site-based projects. For example, Parque Nacional del Este, Dominican Republic has been the site of USAID and conservation work for the past five years. In many respects, The

Nature Conservancy's work in PNDE has been very successful: we have strong local partners, a comprehensive rapid ecological assessment completed, and much national attention focused on the park financing. However, the park represents only 220 square kilometers of coastal shelf out of 11,300 square kilometers or about 2% of the area. Can the park survive in the long term without addressing resource use from a broader area? Marine conservation at a site such as the Southeastern Hispaniola coastal system will require a long-term commitment of a partnership of agencies, individuals and organizations to:

i) assist in the development of local conservation institutions,
ii) render on-the-ground protection assistance,
iii) economic incentives and sustainable financing for conservation and regulation of land-based sources of pollution, and
iv) generate the conservation information for management through research and monitoring. All of these activities need to focus on changing how people use the marine resources and how people live adjacent to shorelines.

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