CARIBBEAN MARINE BIODIVERSITY: THE KNOWN AND THE UNKNOWN: DOMINICAN REPUBLIC[1]

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Abstract
The island of Hispaniola is the second largest in the Caribbean (78,000 km^2). It is politically divided into two countries: Haiti to the west and the Dominican Republic to the east (Map 1), it has a land area of 48,484 km^2, and its coastline has 1,389 km, 27% (376.7 km) of which are mangroves, and 11% (166 km) coral reefs and associated sea grasses. The major areas were these ecosystems are located are MPA's, occupying about 22% of the coastline. The main coastal features found along the coasts are emerged reef terraces and cliffs, especially on the southeastern portion of the island. The continental shelf has a mean width of 7.5 km, and covers an area of 8,130 km^2. There are two submerged offshore banks: La Navidad and La Plata, 70 and 150 km^2 respectively, located north of Cabo Samaná, in the Atlantic Ocean (North Coast). The circulatory pattern in the coastal waters is influenced by the Northern Equatorial Current, which flows westward towards the eastern shore, and then divides into northern and southern branches at the Mona Passage (Metcalf et al., 1977). Coastal counter currents are associated with diurnal tides. The spring tidal range is 90 cm. on the northern coast, and 20 cm. on the southern coast. The first marine reports were done in the XVI and XVII centuries by Europeans, studies by local scientists started in 1958. The marine biodiversity reports known for the country sums a total of 1392 species for the major taxa. The collections are located at the Centro de Investigaciones de Biología Marina, Universidad Autónoma de Santo Domingo and Museo Nacional de Historia Natural. Threats are identified along the coastal zone by increase urban, tourist and agricultural development associated with watershed intervention, river translocations and reservoir constructions for power and irrigation purposes. There is a need to update the marine biodiversity inventories and maintenance of the existing collections

Introduction

The island of Hispaniola is the second largest in the Caribbean (78,000 km^2). It is located at 17º 40' and 19º 56' N latitude and 68º 20' and 70.01º W longitude, in the north central boundary of the Caribbean Sea. It is separated from Cuba to the north-northwest by the Windward Passage (4,000 m ave. depth), from Jamaica to the west-southwest by the Jamaica Passage, (3,000 m ave. depth), and from Puerto Rico to the east by the shallow Mona Passage (350-400 m ave depth). Hispaniola is politically divided into two countries: Haiti to the west and the Dominican Republic to the east (Map 1). The Dominican Republic has a land area of 48,484 km^2, and its coastline has 1,389 km, 27% (376.7 km) of which are mangroves, and 11% (166 km) coral reefs and associated seagrasses. The main coastal features found along the coasts are emerged reef terraces and cliffs, especially on the southeastern portion of the island. The continental shelf has a mean width of 7.5 km, and covers an area of 8,130 km^2. There are two submerged offshore banks: La Navidad and La Plata, 70 and 150 km^2 respectively, located north of Cabo Samaná, in the Atlantic Ocean (North Coast). These banks are important winter breeding and mating territories for humpback whales. Many wrecks from colonial times (1500's) can also be found here.

The circulatory pattern in the coastal waters is influenced by the Northern Equatorial Current, which flows westward towards the eastern shore, and then divides into northern and southern branches at the Mona Passage (Metcalf et al., 1977). The northern branch of this current flows westward to Bahamas, Haiti, Cuba and Jamaica (Antilles Current). The southern branch meets with the Caribbean Sea, and joins with the northernmost pulse of the Orinoco River at the Mona Passage and Saona Island, creating rich environs suitable for shallow coastal ecosystems development, as well as pelagic nursery grounds ("hotspots"). The current keeps flowing westward through the Central Caribbean Current. Coastal counter currents are associated with diurnal tides. The spring tidal range is 90 cm. on the northern coast, and 20 cm. on the southern coast. The climate of Hispaniola is mainly tropical marine dry, with an average annual temperature ranging from 18 -27º C, although cooler temperatures occur at the higher elevations (down to –3º C during winter months). There are considerable variations in the climate and the rainfall, which tends to decrease from east to west. Precipitation is greatest during the warm summers (May - November), and less during the cold winters (December - April). The mean annual rainfall is 1395 mm. Predominant winds are the northeasterly trade winds during the winter and the east-southeast winds during the rest of the year (Chiappone, 2001b).

Marine and Coastal Ecosystems of the Dominican Republic

Parque Nacional Montecristi, located on the northern coast and near Haiti one can find the Montecristi Barrier Reef (MPA), it includes reef tracks with the associated ecosystems (sea grasses, mangroves and swamps). At the western end of this barrier the coast changes due to the presence of the largest drainage of

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the island, from the Yaque del Norte River. Here one finds a mangrove-estuarine setting (3900 ha). To the north, in territorial waters some 90 nautical miles from Puerto Plata, are the *Silver and Navidad Banks* (MPA), where during winters months one can find the largest concentration of humpback whales, *Megaptera novangleae*, gathering around the coral reefs that form a barrier on the northernmost section of these banks, facing the oncoming northeasterly winds from the Atlantic Ocean. On the northern coast and to the east of the Montecristi barrier reef, rocky shores and small bays surrounded by mangrove swamps, are typical features until one reaches Puerto Plata. From there and towards the east, sandy beaches, mostly of terrigenous origin, separated by mountains and cliffs are common. In some areas away from the sediments near shore, coral formations appear. There is the large Bahía Escocesa , where recent fisheries studies have found deep-water squids and where sperm whales gather seasonally near Cabo Cabrón at the Samaná Peninsula. On the southern side of this peninsula, there are large watershed basin drains and another large mangrove track (2200 ha), and an MPA is found. Following this easterly route along the coastline of the Dominican Republic, the coastal features become terrigenous-lime-sand with the Redonda and Limón coastal lagoons, both also MPAs, and the marshes associated with them. Reaching Macao a large reef track appears, the Bávaro - Macao reef with 35 km. in length. Here one finds the largest tourism development in the island, with some 45,000 beds. The ecosystems are in constant stress and perpetually degrading due to the pressure they are receiving from the 1.3 - 2 million annual visitors to this area. The features of this reef track are similar to those found at the Silver Banks and other sites in the north coast.

Rounding the eastern tip of the island, Cabo Engaño, the Punta Cana - Juanillo reef appears. The Bávaro - Macao reef and this reef are located near the Mona Passage and bathed by two oceans, the Atlantic Ocean and the Caribbean Sea, creating unique conditions since there are representations of two biogeography provinces in one locality. The Punta Cana - Juanillo reef faces the southeast (Caribbean Sea). The reef on its southernmost areas becomes more distinct from its northern portion (Atlantic Ocean).

Parque Nacional del Este (MPA) is found on the southern coast starting at Boca de Yuna, and including the Catuano Passage and the Saona Island. Here one finds fringing and patch reefs associated with large spans of seagrasses and fringing mangroves. Features associated with the typical marine habitat setting turns this area into an ideal breeding ground for many species, specially conch (*Strombus* spp*.),* lobster (*Panulirus* spp), other invertebrates, and a myriad of fish species, amongst them groupers (Serranidae), snappers (Lutjanidae), grunts (Pomadasyidae), swordfish (Xiphiidae), marlin (Istiophoridae), and other pelagics. Following the coastline towards the west, Pleistocene-Recent reef terraces and rocky shores predominate the landscape, interrupted by river discharges where most of the urban and industrial development of the island occurs, including Santo Domingo, the capital city of the Dominican Republic. From there towards the west, the climate is dry and the coast changes into terrigenous sand-rubble and a narrow continental shelf. In this stretch there are four important coastal features, Bahía de las Calderas, Bahía de Ocoa, Puerto Viejo and Bahía de Neyba, all of them fauna shelters in the northern Caribbean.

The most important marine biodiversity refuges are located in the MPA´s: Parque Nacional Montecristi (north), Parque Nacional del Este (east), Parque Nacional Submarino La Caleta (center), and Parque Nacional Jaragua (west). The types of coastal ecosystems found in these protected areas encompass mangroves occupying large areas at Montecristi and Parque del Este, seagrass beds, finding large extensions at Montecristi, Parque del Este and Jaragua, and coral reefs which differ among the MPA´s described. Following is a summary description of these:

At the northern coast of the Dominican Republic, Parque Nacional Montecristi has the largest reef formation in the country, with a length of 64.2 km. on the nearshore of the Montecristi Shoals (1,181 km^2). The reef system can be considered as a barrier reef in accretion. High relief features and large living coral colonies with sizes exceeding 10 m in diameter are common. The deep reef has different characteristics depending on location and position relative to currents, waves, wind direction, and tidal channels. The lagoon varies from 20m to 2 km. wide and in some places can be up to 20 m deep. Here large extensions of seagrasses and coral patches can be found. One also finds skeletal remains of Acroporids, poorly lithified forming the reef crest, and although today a few young *Acropora palmata* are found, *Millepora* spp. are dominant. This change in dominance patterns could be attributed to the Acroporid disease, and *Millepora* substituting the previously dominant *Acropora palmata* and *Porites* spp. structures. In most of the reef area, the crest is narrow and crossed by tidal channels. Here, the waves from oceanic swells hardly reach, and this may be due to the effect of the precedent shoal that reduces their force. The energy here is represented mainly by wind-generated waves with short periods (choppy seas), conditioning a low energy environment. On its oceanic side the crest abruptly drops to 6 - 10 m in less than 30 m, allowing a clear view of its basal structure which is composed by large skeletons of *A. palmata, A. cervicornis, Porites* spp, and *Montastraea* spp. Some of these skeletons have broken loose and lie at the base of the crest serving as

suitable substrates for future colonization, as well as refuge for other reef inhabitants. In exposed areas, there is evidence of a Lower Palmata zone consisting mostly of dead large colonies of *Acropora palmata*. Seaward one finds low relief spur and groove formations, where large colonies of the dominant *Montastraea* complex are found. There are variations to this zonation pattern. When tidal channels divide the reef crest, one usually finds a portion of the breaker zone that faces away from the predominant forces (wind and waves), which creates a very calm and protected portion on the reef. In this setting, the reef crest can usually drop abruptly to a sandy channel, with seagrasses present, sometimes down to 30 m deep. As this portion is allowed to receive certain ocean energy, the coral growth can be found forming patches 10 to 5,000 m^2 in size.

Parque Nacional del Este (PNE) is the most studied marine site in the Dominican Republic (Vega 1994 ; Vega et al. 1994 ; Vega et al. 1997, Chiappone, M. 2000 and Geraldes 2003a). Six categories of hard bottom substrate have been identified for this area : low relief spur and groove formations, reef flats, transitional reef communities, patch reefs, low relief rocky shoals, and rocky coasts. The basal substrate for these formations is consolidated carbonate reef as well as sediments and rubble. The reefs of Parque Nacional del Este are basically low relief systems, found either as fringing, small deep (20-30 m deep) patches, or banks. Most of them are on the leeward side, protected by a land mass of Pleistocene and Recent reef terraces. Southeasterly trade winds are dominant. The reef on the leeward side can be divided into two distinct areas: along the southern coast of Saona Island (influenced by oceanic currents) and along the western side of the Catuano Passage (more protected). The bottoms of the Saona reefs are consolidated hard bottoms and octocorals and sponges dominate the benthic communities. Hard corals are abundant only at specific places where they concentrate forming small and dispersed coral patches. Here the waves and currents are strong and in part are responsible for sculpturing these reefs. The reefs west of Catuano are basically of sandy bottoms with patch reefs. Large amounts of sediments and biogenic sands are transported from the Catuano Passage and deposited along this coastline towards the west, with large seagrass meadows covering most of the very nearshore areas. Corals grow mostly in patches from 12 to 30 m deep. Further to the west, away from the influences of the Catuano Passage, coral patches increase in frequency and grow as deep-water fringing reefs, these being the most common reef structures of the southern coast of the Dominican Republic.

Parque Nacional Submarino La Caleta is located in the center of the southern coast and to the leeward side of the Caucedo Peninsula, with rocky shores surrounding this area. Nearshore there is a sandy bottom with patchy corals, continuing towards patchy seagrasses. At 10 m spurs and grooves appear. At greater depths (18 m) there is an abrupt drop to 25 - 40 m, where there are low and medium relief spur and groove formations. Here, there are hard bottom reef-flat carbonate platforms, reef walls, and sunken structures deployed there to serve as artificial reefs and fish aggregation devices. The main benthic organisms recorded for this area are 32 species of corals, 20 species of octocorals 50 species of sponges, and 45 species of algae. The benthic coverage is as follows: algae 41%, sponges 13%, octocorals 13%, and corals 28% (Geraldes 1994a ; Geraldes and Vega 1995a). due to the prevailing high-energy conditions of the seas. This type of reef structure is commonly found along the south coast (Caribbean Sea), in places where the marine platform widens and depth is less than 40 m. In places where shallows and sandy beaches appear, fringing reefs with breakers are found (e.i. Boca Chica, Juan Dolio, Guayacanes and Najayo). From Rio Nizao to the west, terrigenous deposits from large rivers prevents reef formations all the way to Puerto Viejo (Bahia de Ocoa), where reefs again appears.

Parque Nacional Jaragua is located at the southwestern end of the Dominican Republic. No rivers or surface runoff is found in these Pleistocene carbonate reef terraces. On its windward side strong seas and high-energy pebble and pocket beaches with fringing reefs are found. On its leeward coast, protected by high cliffs, sheltered, long and white sandy beaches are common, with consolidated hard carbonate offshore, where coral cover and density is high. There is not a well-developed fringing or bank reef in most of the zone, except near Cabo Rojo (Weil 1997). In the southern tip Beata Island is found, and further out is Alto Velo Island. Moving towards the southwest, at the edge of the continental shelf there is an elevation of the seafloor called Los Frailes Shoals. Other descriptive studies of this area are included in Borrell (1981) and Vega (1981). On its windward side of Beata island at its northeastern end, coral reefs are located offshore forming bank reefs (Weil 1997). On the leeward side there are seagrass beds, followed by a hard carbonate bottom with sparse coral, sponge, and octocoral growth, and with a high cover of algae. There is a interesting formation Los Frailes Shoals, located 12 miles southwest of Cabo Rojo, is a seafloor rise, receives clean oceanic waters that allow the establishment of a diverse community. There are boulders and submerged walls 10 m high covered by Tubastrea aurea. Large Montastraea, Diploria and Colpophyllia colonies, as well as sponges, are also present on the other side (Weil 1997). From Cabo Falso to Bahía de Las Aguilas and starting at the Beata Canal a platform that reaches a depth of 18 m can be found. It is covered with algae, hydrozoans, gorgonians and sponges and sparse coral colonies

along its bottom. In the deeper areas diverse communities associated appear with large boulders, where octocorals, zoanthids and sponges dominate. In this area sponge diversity and abundance are also significant, but corals are sparse. At Bahía de Las Aguilas the reef has a higher coral diversity and coverage, and rare species such as *Mycethophyllia reesi* are uncharacteristically abundant (Weil 1997). The other different reef structure found at Jaragua is the reef at Cabo Rojo. Here the continental shelf forms a submarine canyon. The reef begins at 18 m on a wide platform covered by seagrasses. The reef then drops to 45 m to a sandy bottom. There is a high cover by plate-like species which can be found in association with blue-green algae abundant between 13 and 18 m. Octocorals are scarce and scattered along the slopes. Sponges are abundant and diverse. *Millepora* species are common in the shallow areas, where *Acropora cervicornis* patches are also common. *Montastraea franksi* and *Agaricia lamarcki* are the dominant coral species in the deep area of the reef (Weil 1997).

Figures and tables summarize the coastal and marine ecosystems in the 1,575 km. long coastline of the Dominican Republic. In these regions ecosystems supply environmental services and nourish tropical biodiversity.

Marine Research in the Dominican Republic

Since 1958 several authors have produced information regarding the marine environment of the Dominican Republic and its related biological diversity. Most of these studies, as well as the reference collection gathered, has been deposited in the Museo de Referencia Costero Marina of the Centro de Investigaciones de Biología Marina of the Universidad Autónoma de Santo Domingo (CIBIMA-UASD), and in the Museo Nacional de Historia Natural. Several NGO´s have also done marine research and accumulated didactic and scientific materials. The latest biodiversity status in a publication was completed by CIBIMA as "Estudio Preliminar sobre la Biodiversidad Costera y Marina de la República Dominicana," which was published in 1992 (CIBIMA, 1992) It reported 224 species. In 2003, Geraldes and a group of local scientists at CIBIMA updated the previous report to 1,391 marine and coastal species for the Dominican Republic (Table 2) (Geraldes et al., 2003b).

Dominican contributors to coastal marine research include: C. González-Nuñez from 1954 until 1974 (González-Núñez, 1974); I. Bonnelly de Calventi from 1962 until 1999 (Bonnelly de Calventi, 1974), and more recently F.X. Geraldes from 1973 until present (Geraldes, 1976, 1978, ,1980, 1994a, 1994b, 1994c, 1996a, 1996b, 1996c, 2001, 2003; Geraldes and Vega, 1995a, 1995b; Geraldes et al., 1997, 2003; Cintrón et al., 1994). Other authors have dedicated efforts doing research in fisheries, E. Pugibet (Chiappone 2001a, 2001b: Geraldes 1996a, 1996c; Geraldes and Vega 1995a; Geraldes et al., 1997, 2003; Vega, 1994; Vega et al., 1994, 1997), and N. Terrero; algae, G. Rosado; plankton, H. Ramírez; freshwater fishes, C. Rodríguez, mollusks, C. Díaz and J. Gómez; crustaceans, M. García and C. Mateo; and sponges, L. Rathe (Rathe, 1981). Most of these investigations were published at CIBIMA or at the Museo Nacional de Historia Natural. More recent investigators (1995 to present) include M. Vega (Vega 1994; Vega et al., 1994, 1997; Chiappone 2001a, 2001b; Geraldes, 1994a, 1996b, 1996c; Geraldes and Vega, 1995a, 1995b; Geraldes et al., 1997), R. Torres (Chiappone 2001a, 2001b; Geraldes, 1996a, 1996c; Geraldes and Vega, 1995a; Geraldes et al., 1997, 2003; Vega, 1994; Vega et al., 1994, 1997) and Y. Leon, which have produced publications on marine environs and biodiversity as well. Since the inauguration of the Acuario Nacional in 1990, and through its efforts, much research and new studies have also been produced. Following is a summary table with the major biodiversity reports for the Dominican Republic:

Country Inititatives for Marine Life: Laws and Regulations, MPA´s and Others

In the year 2000 a new Environmental Law (64-00) was passed. This law created the institutional and legal framework for sustainable development and conservation of nature in the country. In charge of implementing this law is the Secretaría de Estado de Medio Ambiente y Recursos Naturales, with 4 executive branches (Subsecretarías) which are: Areas Protegidas y Biodiversidad, Recursos Costeros Marinos, Recursos Forestales and Gestión Ambiental. They deal with the administration of the environment and of natural resources. The Dominican Republic has signed and ratified international treaties, such as MARPOL, CITES, the Convention of Biological Diversity, Climate Change, the SPAW Protocol, the Cartagena Convention, and the Basilea Convention, and has enhanced compliance with local environmental, fishery and development regulations.

Concepts of integrated coastal management are just beginning to be applied in the country. The Global Environmental Fund (GEF) of the World Bank has funded projects to assist the Dominicans in evaluating their coastal resources, as well as other projects to help design the national environmental policies. Shoreline development is controlled by law, and restricts all constructions on the beach dunes or 60 m away from the high tide mark. Turbidity barriers, or some other method of sediment control, are required and being used at coastal construction sites. MPA´s are found in the northern coast with Parque Nacional Montecristi (1,309 km^2), and Cabo Cabrón in the Samaná Peninsula (552 km^2). In Samaná Bay one finds Parque Nacional los Haitíses and its associated Yuna river mangroves (285 km^2). The Silver Banks

Marine Mammals Sanctuary (25,240 km^2) encompasses the territorial waters from Samaná Bay including the Silver and Navidad Banks, and portions of the Mouchoirs Banks. Parque Nacional del Este (430 km^2) is on the east, and in the center of the southern coast is Parque Nacional Submarino La Caleta (10 km^2) and the Boca Chica reef (5 km^2). At the southwestern end and near Haiti is Parque Nacional Jaragua (1,374 km^2). The total coastal area protected as MPAs in the Dominican Republic is 30,015 km^2, with 4,775 km^2 occurring nearer to the mainland while the rest is the Marine Sanctuary. Other coastal ecosystems in the northwestern portion are the swamps and marshes as well as coastal lagoons Redonda and Limón, which are also part of the MPAs of the Dominican Republic.

Nonwithstanding this ample legal frame and areas set aside for conservation, there is a lack of short and middle term policies and plans for biodiversity conservation and research in the country. There is also a need for trained personnel at medium (technicians) and low (inspectors and such) levels in governmental offices with administrative duties for the marine and coastal zone. In the private sector, environmental education, sustainable managerial practices, promotion and propaganda are needed for the promotion of a change in attitude with regards to marine and coastal conservation and sustainable uses.

Threats to Marine Biodiversity

There is degradation taking place in most marine and coastal areas (except those included in the protected areas) of the Dominican Republic. Deforestation, irrigation projects, and overfishing, among others, have produced increased siltation, and nutrient availability in the marine and coastal systems. There has also been a noticeable increase in human use of the coastal resources generated by population expansion, with subsequent increases of waste disposal (solid and untreated sewers) in coastal waters. The following table summarizes the percentage of ecosystems exploited by different socioeconomic activities (anthropogenic), with the subsequence level of impact from those actions:

Anthropogenic activities have destroyed or modified natural settings and have impacted areas by reducing or changing the biodiversity composition. The use of the coastal zones has been escalating and is associated with the expansion of the human population. Today, Dominican Republic has 9 million inhabitants and some 3.5 millions tourists visit a year. The territory has 48,484 km^2, reaching a density of 1,090 persons per km^2; of these, 65% reside or have activities near the 1,389 km. of coast, thus the actual calculated and homogeny theorical density on this territory is of 198 persons per km. of coastline. In reality, this is higher in the urban and tourist centers near the littoral zones.

The Unknow: Taxonomy, Unexplored Regions, and Others

The need for more research and explorations regarding the marine and coastal ecosystems of the Dominican Republic is obvious. From 1954 until 2004 local scientists have studied specific areas mainly in the southern and eastern coasts, dedicating efforts on ecological processes and fisheries. In this last field, major efforts have been achieved in prospecting fisheries explorations (Colom et al., 1994) but very few attempts have been accomplished in actual biodiversity collections targeted to specific habitats or ecosystems. Regarding ecological assessments, the field efforts have been more directed towards identifying, characterizing and determining the status of the ecosystems. Other works have been dedicated to determining ambient conditions. Since research has concentrated primarily in the MPAs, there are regions along the coastline (maybe even 60% of it, or 950 km.) that remain relatively unstudied. Little effort has been dedicated to biodiversity inventories in habitats other than coral reefs, and in taxa besides those of corals, octocorals, fishes, sponges and more evident benthic forms. Knowledgeable and trained personnel in crustaceans, mollusks, echinoderms, and less known groups such as plankton, worms, mud dwelling creatures (swamps and marshes) and small sized creatures are needed to complete the local understanding and diversity richness of the marine and coastal ecosystems of the Dominican Republic. Finally, the level of our museums is poor to bad. There is no political or financial support for them, and collections have been lost by lack of maintenance, and the data (records) in them have partially been lost.

Literature Cited

Bonnelly de Calventi, I. 1974. Corales Pétreos de la República Dominicana. Estudios Biología Pesquera. Colección Ciencia y Tecnología, UASD 1: 1-3.

Borrell, P. 1981. La Isla Beata. In : Investigaciones en las Islas Beata y Alto Velo. Museo del Hombre Dominicano y Marina de Guerra. Editora Amigo del Hogar, República Dominicana. Pp. 111-123.

Chiappone, M. (ed.). 2001a. Coral Reef Conservation in Marine Protected Areas. A Case Study of Parque Nacional del Este, Dominican Republic. The Nature Conservancy. 119 pp.

Chiappone, M. (ed.). 2001b. Water Quality Conservation in Marine Protected Areas. A Case Study of Parque Nacional del Este, Dominican Republic. The Nature Conservancy. 149 pp.

CIBIMA, 1992. Estudio Preliminar sobre la Biodiversidad Costera y Marina de la República Dominicana. Ed. Alfa y Omega 459 pp.

Cintrón G., J. R. García and F. Geraldes. 1994. Manual de Métodos para la Caracterización y

Monitoreo de Arrecifes de Coral. Washington D.C. World Wildlife Fund. 67 pp.
Colom, R, Z. Reyes and Y. Gil. 1994. Censo de la pesca costera de la República Dominicana. Pags. 3, 1-34. En :Secretaría de Estado de Agricultura. Subsecretaría de Recursos Naturales. Proyecto de Promoción de la pesca artesanal del litoral Sur. Reportes del PROPESCAR-SUR. Contribuciones al conocimiento de las pesquerías en la República Dominicana/PROPESCAR-SUR. 264 pp.
Geraldes, F.X. 1976. Ecología y Taxonomía de los Arrecifes de Coral Dominicanos 1 : Costa Sur. Tésis de grado para Licenciado en Biología, Departamento de Biología, Facultad de Ciencias, Universidad Autónoma de Santo Domingo. 124 pp.
Geraldes, F. X. 1978. Los Arrecifes de Coral de la Costa Sur Dominicana. In: Conservación y Ecodesarrollo. Editora Alga & Omega. 125 pp.
Geraldes, F.X. 1980. Arrecifes Fósiles de la Costa Sur de la República Dominicana. IX Conf. Geol. Carib. 2 : 6 pp.
Geraldes, F. X. (ed.). 1994a. Inventario y elaboración del plan de manejo del Parque Nacional Submarino La Caleta. Primer informe parcial. Fundación Dominicana Pro-Investigación y Conservación de los Recursos Marinos, Inc. (MAMMA). Documento de proyecto. PRONATURA/FMAN/PNUD. 150 pp.
Geraldes, F. X. 1994b. Iniciativa para la conservación de los arrecifes coralinos del Caribe. Informe Final del proyecto CIBIMA/WWF. 150 pp.
Geraldes, F. X. 1994c. Estudio de los ecosistemas costeros marinos del sector 9 (Boca Chica-San Pedro de Macorís). Informe ONAPLAN/UNEP, 135 pp.
Geraldes, F. X. 1996a. Los Ecosistemas Costeros Marinos del Litoral de la Provincia de Montecristi. Informe Segundo Semestre, Proyecto CIBIMA-UASD/GEF-PNUD/ONAPLAN. Centro de Investigaciones de Biología Marina, Universidad Autónoma de Santo Domingo.
Geraldes, F. X. 1996b. Bitácora del Crucero Montecristi 96. Proyecto CIBIMA-UASD/GEF-PNUD/ONAPLAN. Centro de Investigaciones de Biología Marina, Universidad Autónoma de Santo Domingo.
Geraldes, F. X. 1996c. Reporte sobre los sistemas arrecifales del litoral de la provincia de Montecristi. Crucero Montecristi 96. Reporte Proyecto CIBIMA-UASD/GEF-PNUD/ONAPLAN. Centro de Investigaciones de Biología Marina, Universidad Autónoma de Santo Domingo.
Geraldes, F.X. 2001. Análisis Económico de los Aspectos Ambientales Costeros Marinos en Las Islas Caribeñas: Caso De La República Dominicana. IV Diálogo Interamericano sobre Administración de Aguas, Foz do Iguaçu, Brasil, 28 pp.
Geraldes F.X. 2003. The Coral Reefs of Dominican Republic, in Latin American Coral Reefs. J. Cortés editor. Elsevier Publisher.
Geraldes, F. X. and M. Vega. 1995a. Evaluación Ecológica, Pesquera y Socioeconómica. Plan de Manejo del Parque Nacional Submarino La Caleta. Informe Final Proyecto FMAN/PNUD/PRONATURA. Fundación Dominicana Pro-Investigación y Conservación de los Recursos Marinos (MAMMA). 152 pp
Geraldes F. X. and M. Vega, 1995b. Reporte sobre Evaluaciones Ecológicas en los Ambientes Arrecifales y Zona Costero-Marina de Las Terrenas, El Portillo, Puerto Escondido, y Cabo Cabrón, Península de Samaná, República Dominicana, 24-25 de septiembre del 1995. Fundación Dominicana Pro-Investigación y Conservación de los Recursos Marinos, Inc. 54 pp.
Geraldes F. X., M. Vega, V. Alvarez, E. Pugibet, L. Almánzar T, Vargas, H. Ramírez, C. Mateo, Y. Rodríguez, R. Torres, A. L. Franco, V. Rivas, and R. Castellanos. 1997. Reconocimiento e inventario de las principales comunidades del litoral de Montecristi. Crucero MC96. Informe de 2do. Semestre. Proyecto *GEF-PNUD/ONAPLAN.* CIBIMA-UASD. 350 pp.
Geraldes, F.X., E. Pugibet, H. Ramírez, G. Rosado, C. Mateo, V. Rivas, and E. Domínguez, 2003. Evaluación Comparactiva de las Condiciones Ambienales Costero Marinas de Bahía de las Calderas, Provincia de Peravia. Centro de Investigaciones de Biología Marina, Facultad de Ciencias, Universidad Autónoma de Santo Domingo Contribuciones del CIBIMA No. 2-2003. 18 pp.
González-Núñez, C. 1974. Operación Madre Perla (1960). Bol. Soc. Dom. Geo. 4: 13-31.
Metcalf, William G., Marvel C. Stalcup, and Donald K. Atwood. 1977. Mona passage drift bottle study. Bull. Mar. Sci. 27(3): 586-591.
Rathe, L. 1981. Estudio Sistemático de las Esponjas (Porifera) del Litoral de la República Dominicana. Tésis de Grado para Licenciado en Biología, Departamento de Biología, Universidad Autónoma de Santo Domingo.
Vega, Bernardo. 1981. Aspectos Históricos delas Islas Beata y Alto Velo. In : Investigaciones en las Islas Beata y Alto Velo. Museo del Hombre Dominicano y Marina de Guerra. Editora Amigo del Hogar. Santo Domingo, República Dominicana. Pp.13-16.
Vega, M. 1994. Evaluación ecológica rápida del área marina del Parque Nacional del Este, República Dominicana. Informe Final. Acuario Nacional. 100 pp.
Vega, M., Gabriel A. Delgado, and Kathleen M. Sullivan. 1994. Rapid Ecological Assessment. Parque Nacional del Este, Dominican Republic. 151 pp.
Vega M., M. Chiappone, G. Delgado, R. Wright, K. Sullivan 1997. Evaluacion Ecologica Integral del Parque Nacional del Este, República Dominicana 2: Recursos Marinos. The Nature Conservancy Media Publishing Ltd, Bahamas. 93 pp.
Weil, Ernesto. 1997. Coral, Octocoral and Sponge Diversity on Reefs of the Jaragua National Park, Dominican Republic. Report to Grupo Jaragua. GEF-PNUD/ONAPLAN. 9 pp.

Region	Length km	% of total
North Coast	526	
Lowlands and swamps	96	33.0
Sandy beaches	284	
Cliffs and rocky shores	146	
East Coast	374	
Lowlands and swamps	13	24.0
Sandy beaches	57	
Cliffs and rocky shores	304	
South Coast	675	
Lowlands and swamps	14	43.0
Sandy beaches	472	
Cliffs and rocky shores	189	

Table 1: Physical characteristics of the coastline for the Dominican Republic

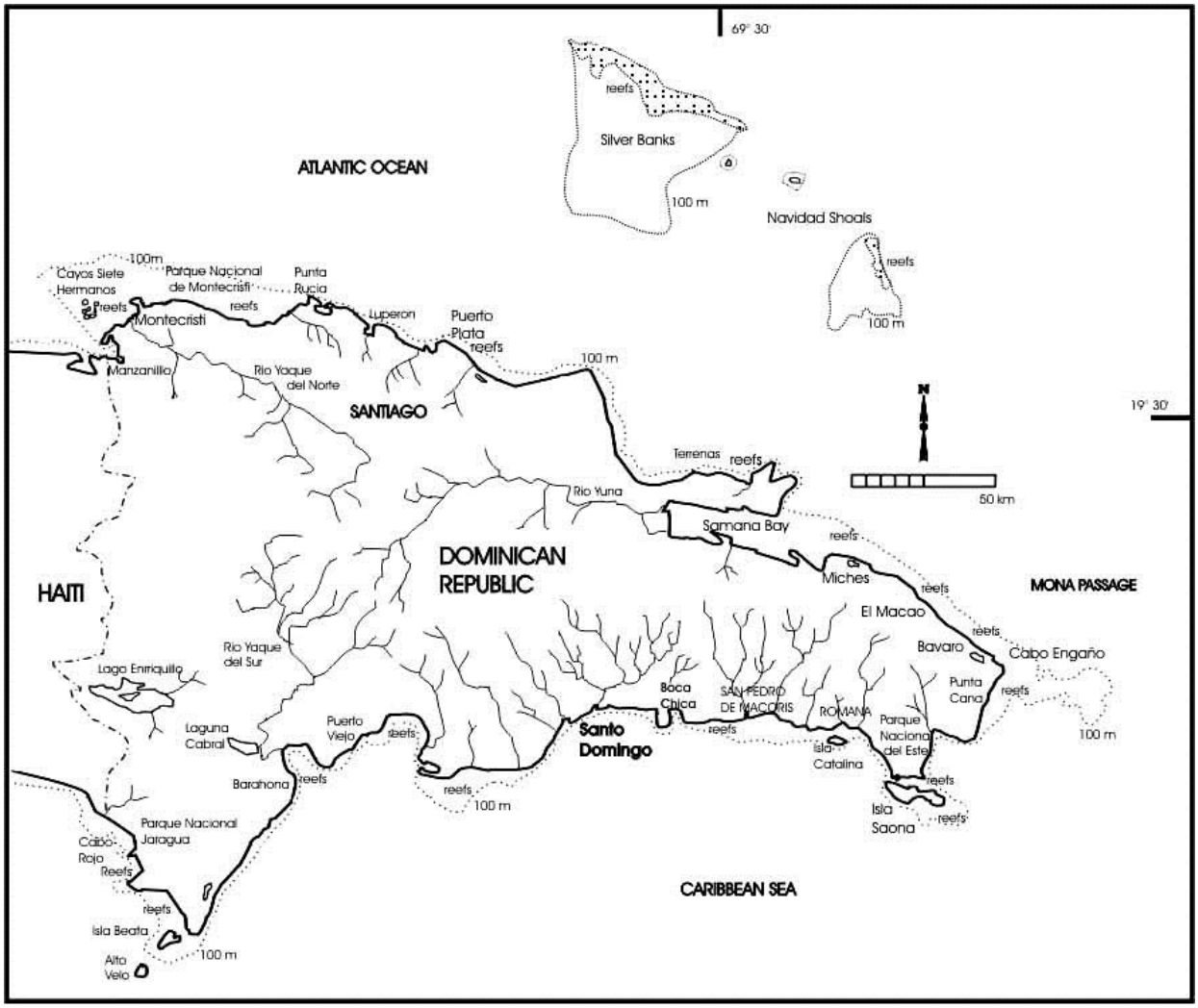
Taxa	Total
Algae	262
Seagrass	4
Porifera	39
Celenterata-hidrozoa	3
Celenterata-madreporaria	64
Gorgonidae	25
Hidroideae	19
Anelidae	(*)
Chitonidae	10
Molusca gasteropoda	188
Molusca bivalvia	103
Cephalopoda	2
Crustacea Decapoda	144
Crustacea Anomura	25
Equinodermata	67
Tunicata	8
Pices	403
Reptilia	4
Mamifera	16
Mangroves/ Flora	6
Total	**1392**

(*) No existing reports

Table 2: Summary results of preliminary revision of marine and coastal biodiversity for the Dominican Republic. July 2004.

Ecosystems	Country Area (ha.)	Estimated area of exploitation by fisheries in %	Estimated area of exploitation by tourism in %	Estimated area of exploitation by urban and industries in %	Estimated area of exploitation by rural agro- development in %
Mangroves	9,840	75	5	10	10
Sea grass bed	18,600	70	20	5.0	20
Coral reefs	13,300	90	30	10	20
Beaches	24,420	70	35	10	30
Other coastal ecosystems	5,000,000	80	10	8	20
Total	5,066,160	77%	20%	8.6%	20%

Table 3: Areas and uses of marine and coastal ecosystems by human activities (taken from Geraldes, 2001)



Map. 1. Dominican Republic coastal features and MPA´s locations. 2004

Fig 1. Map of the Dominican Republic, showing the coastal and marine ecosystems as well as the coastal development areas. July, 2004