Priorities for Coastal and Marine Conservation in South America

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Map 12: Colombia's Coastal and Marine Priority Areas for Conservation

CHAPTER 4

Coastal and Marine Conservation Priorities in Colombia

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4.1 Introduction

With 988,000 square kilometers of territorial waters and approximately 3,000 kilometers of coastline, Colombia is close to being 50% maritime, and is the only South American country having coasts on both the Tropical Pacific Ocean and the Caribbean Sea. Because Colombia possesses oceanic islands located far offshore, wide sections of both the Tropical Eastern Pacific and the Southern-central Caribbean are included within the boundaries of its Economic Exclusive Zone. In contrast to most coastal countries however, Colombia´s population percentage inhabiting the coastal zones is relatively low at less than 15% (12.5% in the Caribbean, 2.0% in the Pacific).

There are remarkable differences between the two coasts in terms of climatic, geological, oceanographic, ecological, and biological features (see Botero and Alvarez León 2000, Marrugo et al. 2000, Díaz & Acero 2003). Coastal morphology, climate, and physical oceanographic processes vary greatly along spatial gradients as well as seasonally within both the Caribbean and the Pacific realms. In short, the great majority of tropical marine habitats are well represented in Colombia. Since most of these result from different and contrasting physical conditions and ecological processes, each habitat harbors its own particular biota. The total diversity of marine organisms in such a variety of environments is likely to be very high. Their study and effective conservation are huge challenges and a great responsibility for the country.

One of the first steps taken by Colombia towards the conservation of marine ecosystems and natural resources was the creation of the National Institute of Natural Renewable Resources (INDERENA) in 1968. However, it was only in 1994 that a more formal environmental policy was adopted in Colombia, when the National Environmental System (SINA) and the Ministry of the Environment were created. The SINA includes a National Parks Administration Unit and five scientific institutes devoted to environmental and biodiversity studies. Almost simultaneously, the mandates and decisions of the Convention of Biological Diversity (CBD) were adopted and incorporated into the national legislation (Law 165 of 1994) and the National Biodiversity Policy that was launched in 1997 (MMA-IAvH, 1997).

The National System of Protected Areas is currently represented by 11 coastal-marine areas (7 in the Caribbean and 4 in the Pacific). These coastal-marine protected areas are supposed to ensure the conservation of representative samples of the most important ecosystems, including vital ecological processes and biodiversity. However, until the projects reported here, no comprehensive, wide-reaching regional studies such as gap analyses or ecorregional conservation assessments had been performed in Colombian marine-coastal areas.

An agreement between the Ministry of Environment, research institutions and several NGOs was signed in 2005 in order to facilitate Colombia´s fulfillment of the compromises established in CBD COP-7. This agreement provides a unique opportunity to develop an effective agenda for the consolidation of the National System of Protected Areas, calling for the development of Marine Ecoregional Assessments to identify priority sites for biodiversity conservation in both the Caribbean and the Pacific coastal zones. Such priority sites will be the basis for an assessment of gaps in Colombia's protected areas.

4.2 Priority Areas for Conservation of Coastal and Marine Biodiversity in Colombia

The priority areas for coastal and marine conservation in the Caribbean were identified using The Nature Conservancy's (TNC) methodology (Groves et al. 2002) and a decision system support tool (DSS

MARXAN – see Appendix A). The ecoregional planning process was developed together with national experts, independent consultants, NGOs, research institutions, universities and governmental agencies. Through 3 national workshops, targets representative of marine and coastal biodiversity were defined, as were their key ecological attributes. The conservation goals and biodiversity threats were established and the priority conservation sites evaluated. The priority areas have been endorsed by a number of recognized national experts as well as by the Minister of Environmental, Home and Land Development and by The Special Unit of the National Natural Systems Parks—entities who were involved in the process since the beginning.

Experts selected 37 targets classified as either ecological subtidal systems, ecological intertidal systems, or relevant ecological communities (ecosystem level). During the second workshop the conservation goals for each system were defined as 30%, 60%, and 100%, respectively. The minimum viable biodiversity conservation goal was settled at 30%. The information was digitalized using the most up-to-date data available for the country. The threats were classified according with their grade of impact by assigning a value to express the threats as a cost per planning unit (PU). Areas with high cost were excluded from the analysis. Exclusion areas correspond to sites non-viable to conservation; they include infrastructure and productive extraction sites like cities, airports, ports, and shrimp aquaculture and salt extraction areas. Marine protected areas (MPAs) along the continental Caribbean were also included.

The hexagonal planning units measured 260 ha each (refer to Appendix B for planning units). The parameters to run MARXAN were: BLM= 0.1, 1 million of iterations and 300 runs. The portfolio of priority areas obtained through MARXAN was analyzed with the experts during the last workshop. The last portfolio presents 100 new priority conservation sites equivalent to 12.2% of the Caribbean continental platform. The total area represented by the portfolio and the existing Caribbean MPAs is 22.4% (without the insular area of San Andres, Providencia and Santa Catalina). The areas selected in the portfolio meet 97% of all the conservation target goals described in Table 6. The only targets for which goals were not met are those located in sites adjacent to exclusion areas. In those cases, MARXAN cannot select the complete unit inside the portfolio. Another explanation could be the high cost of the PU that includes the target; in this case the penalization for selecting any of these units is too high.

The priority areas for the Colombian Pacific are being developed in conjunction with those for Costa Rica and Panama through the Tropical Eastern Pacific Ecoregional Plan. This project encompasses three marine ecoregions: Panama Bight, Nicoya, and Cocos Island, and is being led by TNC with the cooperation of Conservation International (CI) and several research institutions, NGOs, and governmental agencies of Costa Rica, Panama and Colombia. As with the Caribbean assessment, the methodology employed follows the steps and procedures recommended by Groves et al. (2002) using MARXAN as a decision support system. This process involved experts from Colombia, Panama and Costa Rica in national workshops in each of the countries.

The planning units to be used for the MARXAN runs will be hexagons, each with an area of 65 ha. Once the preliminary sites are identified, one last series of national workshops will provide the venue for final decisions regarding the final arrangement of priority sites for conservation.

4.3 Conservation Targets

Over a 2-day workshop, 24 experts representing 15 institutions selected 37 ecosystem-level conservation targets to represent the coastal and marine biodiversity of the Colombian Caribbean. Those targets were classified by ecological systems (intertidal and subtidal) and relevant biological communities (Table 6).

Table 6: Conservation Targets and Goals, per Subregion, for Colombia's Caribbean Coastal and Marine Environment; A) Ecosystem Targets and B) Species Level Targets

A) ECOSYSTEM LEVEL CONSERVATION TARGETS	% GOALS						
	Guajira	Palomino	Tayrona	Magdalena	Archipelagos Coralinos	Morrosquillo	Darien
Intertidal Ecological Systems							
High Energy Beaches	30	30	30	30			30
Low Energy Beaches	30		30	30		30	30
Coastal Tidal River						100	30
Rocky Beaches	100						100
Hard Rock Cliffs	100		30	100	30		100
Soft Rock Cliffs	30	100		30	30	100	30
Mixohaline Mangroves	100	100		60	100	100	60
Marine Water Mangroves					100	100	60
Saline Shores	60	100		100	60		
Estuaries				100		100	60
Coastal Lagoons	60	60	100	100	100	100	100
Arracachal *(Monntrichardia arborescens)*						100	60
Corchal *(Pterocarpus officinalis)*						100	
Helechales *(Fern Association)*							100
Panganales *(Palm Tree Association)*							100
Subtidal Ecological Systems							
Coral Reefs	100		100	100	100		100
Calcareous Algal Hard Bottoms			100		60		60
Seagrass Beds	60	60	100	100	60	100	100
Fleshy Algal Bottoms				60	60		60
Submarine Diapir				60	60	60	
Deep Water Coral Reefs		60	100		60		
Upwelling Areas	10		10				
Not Carbonated Mobile Bottoms of Thick Grain – Subtidal	30	30	30	60	60	60	30
Not Carbonated Mobile Bottoms of Fine Grain – Subtidal	60	60	60	60	30	60	30
Carbonated Mobile Bottoms of Thick Grain – Subtidal	30	30	30	30	30	60	30
Carbonated Mobile Bottoms of Fine Grain – Subtidal	30				30		
Relevant Biological Communities							
Fish Spawning and Nurse Areas	60	60		100			60
Lobster Spawning and Nurse Areas	30	100			100	100	100
Conch *(Strombus gigas)* Spawning and Nurse Areas					60		
Pearl Oysters Banks *(Pinctada and Pteria)*	100						
Marine Turtles Nesting Areas	60	100	60	100	100	100	60
Marine Turtles Feeding Areas	60	60		100	100		100
Relevant Biological Communities							
Crocodile (Crocodylus acutus) Congregation Areas	100	100		60		100	100
Marine Mammals Congregation, Alimentation and Reproduction Areas *(Whales, Manatees, Otters)*	100	100	60	100	60	60	100
Marine Birds Congregation Areas	100	100	60	100	100	100	60
Shorebirds Congregation Areas	60	60	100	100		100	100

Table 6: Conservation Targets and Goals, per Subregion, for Colombia's Caribbean Coastal and Marine Environment; A) Ecosystem Targets and B) Species Level Targets

B) SPECIES LEVEL CONSERVATION TARGETS (Endangered Species Classified on IUCN's Red List)

GROUP	Scientific Name	Common Name	IUCN Category
Reptiles (Crocodiles and Turtles)	Crocodylus acutus	Cayman	Critically Endangered
	Caretta caretta	Loggerhead Turtle	Critically Endangered
	Eretmochelys imbricata	Hawksbill Turtle	Critically Endangered
	Dermochelys coriacea	Leatherback Turtle	Critically Endangered
	Chelonia mydas	Green Sea Turtle	Endangered
	Lepidochelys olivacea	Olive Ridley Sea Turtle	Endangered
Marine and Shore Birds	Phoenicopterus ruber	Flamingo	Vulnerable
	Chauna chavaria	Black-necked Screamer	Vulnerable
	Lepidopyga lilliae	Sapphire-bellied Hummingbird	Critically Endangered
	Vireo caribaeus	St. Andrew Vireo	Critically Endangered
	Molothrus armenti*	Bronze-brown Cowbird	Vulnerable
Mollusks	Strombus gigas	Conch	Vulnerable
	Cittarium picca	West Indian Top shell	Vulnerable
Aquatic Mammals	Trichechus manatus	Manatee	Vulnerable
	Lontra longicaudis	Sea Otter	Data Deficient

The ecological systems classifications were made taking into account the European Natural Information Systems (EUNIS) methodology, adapted to tropical marine environmental conditions. Targets at the species level were not included in the ecoregional planning due to gaps in information about their distribution. However, some sites known to be critically important, such as known feeding and reproduction areas, to species classified in any threatened category, were included as conservation targets. An example of such a target is "Aggregation of Aquatic Mammals" that was based on information about the distribution of such species as: *Trichechus manatus, Lontra longicaudis, Balaenoptera edeni, Tursiops truncatus, Stenella frontalis* and *Globicephala macrorhynchus.* Other species like the mollusk *Strombus gigas*; marine turtles *Dermochelys imbricada*, *Caretta caretta*, *Cheledonia mydas* and *Dermochelys coriacea;* and reptile *Crocodylus acutus,* appear on the national Red List for threatened species (Table 6.B).

The available information for digitalizing targets is concentrated in the Marine Environmental Information System of Colombia (SIAM) coordinated by INVEMAR. Other sources of information were provided by the experts working on the planning process. This information dealt mainly with sites for feeding and reproduction of relevant biological communities where primary information gaps were identified. The scale used for this exercise was 1:250,000; however, much of the information was in a higher resolution. Targets were digitalized in ArcGIS 9.2. as lines, points and polygons, depending on the target.

Conservation targets for the Pacific coast were first selected by 31 coastal and marine experts representing 11 institutions during an August 2006 workshop in the city of Cali. Species-level conservation targets were added by 22 experts representing 10 institutions who attended workshops held in Costa Rica and Panama during November of 2006.

Then, 27 ecosystem-level conservation targets (Table 7) were selected on the basis of a hierarchical, multi-scale classification of marine habitats adapted for American tropical seas from the European Natural Information Systems (EUNIS) classification (Davies et al. 2004) and the Interim Marine and Coastal Regionalisation for Australia (Environment Australia 1998). These conservation targets were then discussed and defined in a second series of national experts workshops held in all three countries.

A total of 33 species-level targets (Table 7) were selected from a preliminary list of 163 taxa, including endemic species within the Tropical Eastern Pacific;

Table 7: Conservation Targets and Goals (by Subregion) for Colombia's Pacific Ocean Coastal and Marine Environment

CONSERVATION TARGETS	% CONSERVATION GOALS								
	Tumaco	Sanquianga	Gorgona	Naya	Buenaventura	Baudo	Choo	Malpelo	Pacifico Oceanico
Ecosystem Level									
Coarse Sand Beaches	80		100				40		
Fine Sand Beaches	40	30		20	30	30	30		
Intertidal Mud Banks	50	40		50	50	50	60		
Rocky Beaches			80			80	20		
Hard Rock Cliffs			80				20		
Soft Rock Cliffs	100				90				
Mangroves	60	40	100	50	70	80	100		
Coral Communities			100				100	100	
Upwelling Areas							30		
Estuaries	40	40		80	50	100	100		
Non Carbonate Sublittoral Sand Bottoms	20	50	50	30	20	20	30		
Carbonated Sublittoral Sand Bottoms		100	70				100		
Non Carbonated Sublittoral Muddy Bottoms	10	10	30	10	40	10	20		
Carbonated Sublittoral Muddy Bottoms		100	30				100		
Bathyal Soft Bottoms								30	10
Bathyal Hard Bottoms								40	60
Abyssal Soft Bottoms									5
Abyssal Hard Bottoms									100
Sea Mounts *(guyots)*									100
Nearshore Islets									100
Infralitoral Hard Bottoms			100				20	80	
Circalitoral Hard Bottoms			100			100		80	
Species level									
Piangua *(Anadara spp.)* Banks	50	40		50	60		100		
Hawksbill Turtle *(Eretmochelys imbricata)* Nesting Places	80	80	100		100	100	100		
Leatherback Turtle *(Dermochelys coriacea)* Nesting Places	100				100	90	80		
Green Turtle (Chelonia mydas) Nesting Places	100	80	100		90	90	100		
Olive Ridley Turtle *(Lepidoochelys olivacea)* Nesting Places	90	90	100		100	100	100		
Marine and Shorebirds Birds Congregation Areas *(feeding, resting)*	100	100	100	100	70	100	100	100	
Marine and Shorebirds Nesting Sites	100	80	100	90	100		90	100	
Cetaceans Concentration Areas			100		100			100	
Groupers and Snappers Concentration Areas						100	100		
Hammerhead Sharks Concentration Areas			100					100	
Whale Shark Concentration Areas			100					100	
Occurrences of Bullshark *(Odontaspis ferox)*								100	
Nesting Sites of the Boobie *(Sula granti)*								100	
Occurrences of Sporophila insulata	100	100							
Occurrences of the Nudibranch *(Peltodoris lancei)*								*100*	

species with main distribution in other biogeographic regions but occurring in few or scattered localities in the Eastern Tropical Pacific; endangered species at global, regional or national scales; and emblematic taxa. Due to the lack of accurate information and data gaps, some targets, such as "Aggregation Areas of Cetaceans" and "Marine-coastal Bird Important Feeding Areas" encompass several taxa.

Distribution and occurrences (site records) of each target in the planning region were mapped either as polygons, lines, or points using ArcGIS 9.2., based on published papers, unpublished documents, satellite imagery, and consultations with experts. In order to overcome the lack of information on the distribution of most benthic targets, a digital topographic model of the sea bottom in the planning region was generated from bathymetric information available from different sources. It was used to generate a bottom depth-steepness classification model which allowed the discrimination of soft-dominated and hard-dominated benthic substrate areas (areas with 20º steepness or more were assumed to be hard-bottom dominated, and this criterion coincided with the information available from several locations along the continental shelf and slope of Costa Rica and Colombia).

4.4 Conservation Goals

The goals established in the projects described here represent the first attempt to determine the minimum area that the country must designate for conservation in order to fulfill the commitments specified by the CBD.

The methodology used to determine goals was developed by TNC and adapted for the planning process described here for Colombia's Caribbean and Pacific coasts. The methodology assigns a relative qualification to each target based on 4 criteria: (1) if the target is an ecosystem or a community, (2) the abundance, (3) the target current condition, and (4) the target vulnerability. In order to obtain the final goals of each target, the total values corresponding to each 1 of the 4 evaluated criteria were added. The total value is in between 4 and 12. During the second workshop, the experts, using the total value assigned to each target, determined 3 ranks to define 3 goal values: 30%, 60%, and 100%. The minimum goal (30%) was established by the *Secretariat of the Convention on Biological Diversity* recommendations and the opinions of other authors who mention 30% as the minimum percentage of ecosystem and habitat conservation necessary to guarantee future viability. The goal for the target "upwelling area" was set at 10%, and was based on expert consensus.

Conservation goals were first selected for Colombia at a workshop in the city of Santa Marta, Colombia, in October 2006, by 25 experts representing 13 institutions. However, due to difficulties in the time schedule and suggestions made by some experts, the methodology was somewhat simplified for the Pacific coasts of Costa Rica and Panama, and the goal setting for these countries took place at workshops in Heredia and Panama City, respectively, in March 2007, that were attended by 38 experts from 22 institutions.

Conservation goals for the Colombian Pacific were set for each target taking into account the minimum effort needed to assure its successful permanence within each sub region or strata. The goal is expressed as percentage of the distribution area/number of occurrences of the conservation target in the corresponding sub region. Conservation goals by subregion of the Colombian Pacific are shown in Table 7.

4.5 Key Threats to Coastal and Marine Biodiversity in Colombia

The Colombian population settled in the Caribbean coast is concentrated in three primary coastal port cities: Cartagena, Barranquilla and Santa Marta, where the economic activities also converge. The major activities impacting the marine waters of the Caribbean Sea are navigation, tourism, fishing, and gas exploitation, which collectively represent approximately 17% of the internal product. Fishing and tourism represent the most important income-generating activities for coastal communities. The Caribbean region has undergone significant conversion due to deforestation, grazing of livestock, agriculture, mineral exploration, and tourism.

A threat assessment was conducted in order to identify the key human activities and natural hazards impacting coastal and marine biodiversity. Experts identified industrial fishing (shrimp trawling), maritime transportation, pollution (microorganisms, suspended solids), heavy metals, and oil and gas activities as the key threats to Colombia's Caribbean coastal and marine biodiversity conservation. Information about these types of hazards is available to the country and was included in GIS. Population density, tourism and productive extraction (shrimp culture and salt exploration) were also included as threats in areas

where biodiversity conservation was non-viable. Finally, rising sea levels as a result of climate change were included as a natural hazard to marine and coastal ecosystems. Spatial information about how 100 years of rising sea levels would affect Colombia is available in INVEMAR (2003). In general, the information related to threats was included in the GIS by building a buffer around the threats center source. Threats were classified according to magnitude and a relative value was assigned to calculate the cost implicated by choosing planning units with any degree of threat.

In contrast to the Caribbean coast, the Pacific coast of Colombia is still poorly developed and, with the exception of two major urban areas (Buenaventura and Tumaco), has a very low population density. However, shrimp aquaculture in mangrove areas, trawl and long-line fishing on the continental shelf, and deforestation, agriculture, and mining along the western slopes of the Western Cordillera are causing some impacts. Strong evidence points to the overexploitation of marine living resources as the explanation for the severe reduction observed in the fisheries of shrimps, sharks, tuna and other pelagic fishes in the course of the last two decades (cf. INPA 2000). By-catch of turtles by near-shore long-line fishing has also been identified as a major threat. Key threats to marine biodiversity in the Tropical Eastern Pacific to be considered for producing a total costs layer were selected from a large series of human activities with potential impact on coastal-marine resources and ecological processes identified from the Unified Classification of Direct Threats recently published by UICN-CMP (2006). The selected threats obtained the highest summed scores of probability, coverage area, severity, and persistence assigned by the experts.

Figure 10: Key Threats for Colombia's Caribbean Coastal and Marine Environment

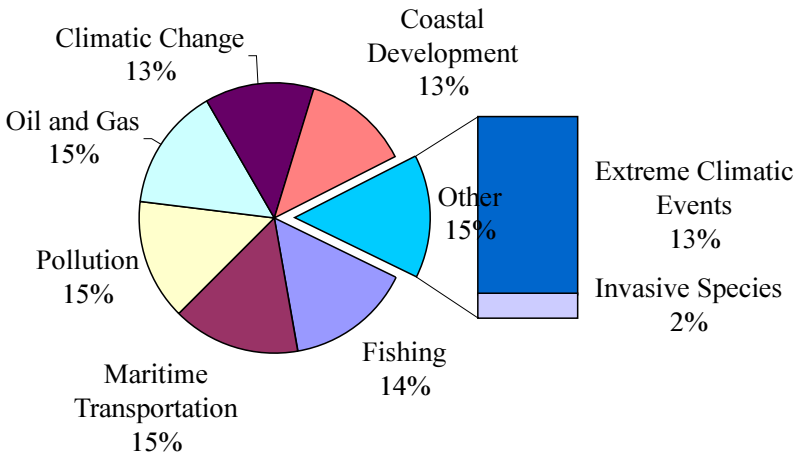
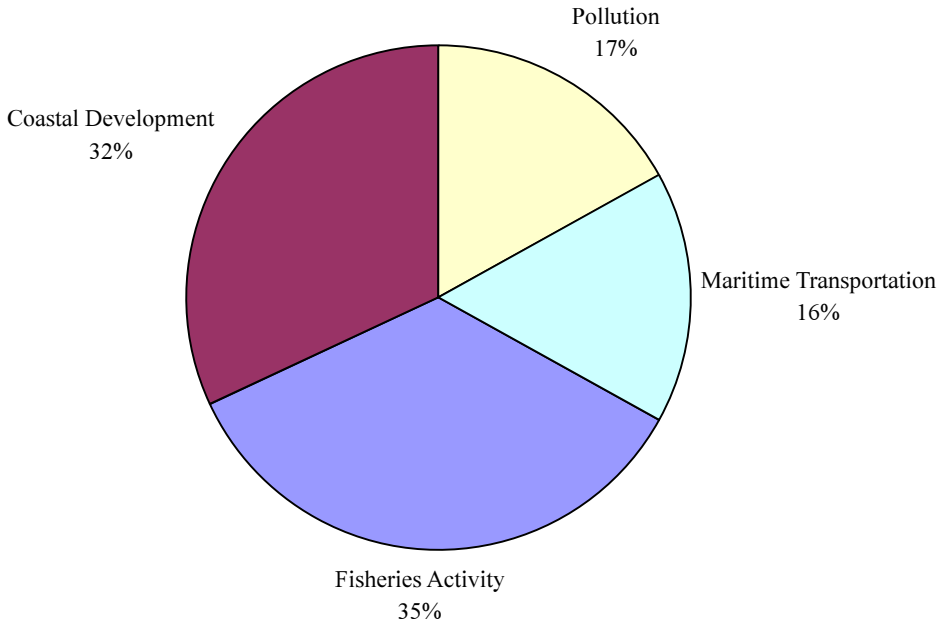


Figure 11 - Key Threats to Colombia's Pacific Ocean Coastal and Marine Environment



4.6 Information Needs and Monitoring

Although the country has had a national coral reef monitoring system (SIMAC) since 1998, it must be extended to include the condition and degree of change of additional conservation targets and other studies sites which are completely unknown. The characterization and monitoring of ecosystems and species (endangered or introduced), as well as prospection studies, are needed for the improvement of conservation and management of coastal and marine biodiversity in the country.

Some information gaps identified are related to the distribution of fine filter species (species in any endangered category) from which their distribution and abundance is unknown. Monitoring of the key ecological attributes of the targets will allow accurate evaluations of the current condition and vulnerability of conservation targets and would gauge the effectiveness of existing protected areas. The connectivity analysis between ecosystems and habitats is vital for the design of a marine protected areas network. In addition, the creation of a monitoring system that includes socioeconomic and management indicators is necessary to quantify the management effectiveness of protected areas.

As previously mentioned, SIMAC (a coral reef monitoring system), together with the national environmental quality network (RedCAM) and the fisheries information system (SIPEIN), provides information on measuring the benefits of increasing biodiversity protection. Colombia has designed a marine and coastal biodiversity research plan to pursue between 2001 and 2010. In this action plan are three strategies: (1) increasing and divulging scientific knowledge through the support and execution of marine and coastal biodiversity research, (2) promoting and coordinating the efforts to capacitate investigators in the characterization of marine and coastal biodiversity, and (3) developing and implementing a national system for monitoring marine and coastal biodiversity.

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