Ecoregional Assessment of the Mesoamerican Reef

Marine Conservation Plan

January, 2008

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ECOREGIONAL ASSESSMENT OF THE
MESOAMERICAN REEF

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January 2008

Mesoamerican Reef Ecoregional Assessment, The Nature Conservancy – TNC

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FOREWORD

The Mesoamerican Reef (MAR) ecoregion covers a broad geographic area with vast biodiversity resources and amazing spatial and social diversity, which make this an important region of the world. The main threat to conservation and particularly that of large geographical areas is the definition of priorities for the implementation of actions. In the year 2002 the first Ecoregional Plan was published for the Mesoamerican Caribbean Reef by World Wildlife Fund (WWF), which from the viewpoint of the Conservation by Design methodology is the basis for the conservation of large geographic spaces. An ecoregional assessment provides the definition of conservation priorities, the identification of the most important threats and, based on these, establishes strategies to fulfill the conservation goals.

In order to construct over the established knowledge base, The Nature Conservancy (TNC) coordinated with WWF and other organizations involved in the first MAR ecoregional plan, to develop an ***Ecoregional Assessment****, that would compiled the information from the original plan and update it with recent data. For example, new information from World Resources Institute's Reefs at Risk in the Caribbean, the Inter-American Development Bank's Environmental Management Project in the Bay Islands, Honduras, and from Wildlife Conservation Society, mainly for Belize was incorporated. With this information and through a series of highly participatory workshops involving more than 75 persons from more than 27 organizations in the region, the discussions lead to the development of a valid and interesting portfolio.*

The process, which was lead by Dr. Alejandro Arrivillaga, identified from 30 potential conservation targets, those with geographic distribution data which can act as an umbrella to nest other conservation targets. The selected targets were eleven, including coral reefs, mangroves, reef fish spawning aggregations, estuaries and coastal lagoons, sandy beaches, seagrass beds, and whale shark feeding areas. The assessment included updating the information from the first MAR ecoregional plan, validation of results with local stakeholders, and mapping the impact from human activities.

The analyses and discussions allowed for the identification, qualification and prioritization of threats, finding global climate change as the most important one, affecting many ecosystems on which the productivity of the region depends upon. Likewise, unsustainable tourism and fisheries, which affects resource management, massive tourism, environment and socioeconomic aspects in the region, appeared as main threats at local and ecoregional levels. On the other hand, pollution and sedimentation derived from watershed mismanagement, together with coastal development and infrastructure with inadequate conditions were identified as important threats.

Through a MARXAN analysis this assessment identified the areas within the ecoregion in which conservation can be achieved in a more efficient manner. The participants at assessment workshops set the ambitious conservation goals resulting in the selection of a sophisticated portfolio of priority sites covering a high percentage of conservation targets. This document illustrates the results of the optimization organized in 31 sites, which should be the areas in which we should invest to ensure conservation in the MAR. It is interesting to notice that the results of this assessment show a series of conservation gaps that should be fulfilled; however, it is likely noticeable that a good part of the portfolio matches partial or totally existing marine protected areas. The strategies section analyzed these results and established the need for the declaration of new protected areas and the adoption of systems of protected areas in the MAR.

The strategies developed focus on minimizing or abating threats and guaranteeing the improvement of viability of the conservation targets. Strategies also promote sustainable use and conservation of biodiversity in the ecoregion to promote the achievement of aspirations and economic and social development, as well as the conservation in the region.

We are pleased in communicating that various organizations have already started using these results to establish their priorities, which itself constitutes a highlighted achievement. Nevertheless, the purpose of this effort and investments from TNC, partner organizations,

and governments, is that these results be used to orient and strengthen the conservation work in the MAR. It is a pleasure for us to deliver this report to foster the strategies related with TNC's work in this important region of the world and thus, contribute to its conservation. The implementation of this information to fulfill these goals is our common responsibility.

Best regards,

Nestor Windevoxhel
MAR Program Director
The Nature Conservancy

ABSTRACT

An ecoregional assessment seeks to identify priority conservation sites that meet specific conservation goals for the selected targets. The assessment also conducts an analysis of the threats to the biodiversity based on the same conservation targets and develops strategies to mitigate threats and implement of the portfolio of priority conservation sites. A key component of an ecoregional exercise is to keep in mind that it is a regional effort, where participants are asked to think and plan beyond their work areas and countries of origin, and to identify, in a participatory manner, conservation priorities at an ecoregional scale.

This assessment of the Mesoamerican Reef was the second iteration of a planning exercise for this ecoregion. The first ecoregional plan was developed by WWF in 2002. The current process took advantage of the information gathered the previous planning exercise, incorporated new information, and facilitated the participation of local scientist, government officials, and key stakeholders. Moreover, the development of the portfolio of sites was based on a decision making tool (MARXAN) to help identify priority sites that meet the conservation goals.

This ecoregional assessment is based on the conservation by design process developed by TNC, and started with the definition of the planning area and its stratification. Next priority conservation targets that had information available on its geographic distribution were identified.

Conservation targets included ecosystems or habitat types (reefs, mangroves, seagrasses, manatee habitat, estuaries and coastal lagoons, sandy beaches, and whale shark feeding areas) and species occurrences (seaturtle and crocodile nesting sites, and reef fish spawning aggregation sites).

The threats analysis focused on the threats to the conservation targets, including the sources of stress, the severity and the reach of the threats such as habitat reduction, community structure and composition changes, reductions on population size, and physical-chemical alterations. The threats analysis identified as main threats global climate change, inadequate aquatic tourism practices, urban development and tourism infrastructure development, sewage discharge, and solid waste accumulation. Also, sedimentation and agrochemical discharges, overfishing and the use of inadequate fishing practices (use of spear gun, trawling, and scuba fishing). Lastly, the threat of navigation and the development of transportation infrastructure were identified. Using this threats analysis objectives and strategies were developed and then prioritized. Out of a total of 56 strategies, twenty were identified as priority, including facilitating civil society participation

in the Marine Protected Areas administration process, promote the declaration of new MPAs in Mexico and Honduras, promote changes in MPA legislation and the harmonization of policies for the management of fisheries, mangroves and land use plans.

RESUMEN

Una evaluación ecorregional persigue identificar los sitios prioritarios para la conservación que permiten alcanzar metas para elementos seleccionados. La evaluación ecorregional también desarrolla un análisis de amenazas a la biodiversidad basado en los mismos elementos de conservación y elabora estrategias para mitigar las amenazas e implementar la red de sitios de conservación prioritarios. Un elemento clave en este ejercicio ecorregional fue mantener presente que se trata de un esfuerzo regional, en donde se pidió a los participantes que pensaran y planificaran más allá de sus áreas de trabajo y países de origen, e identificaran, de manera participativa, las prioridades a escala ecorregional.

La presente evaluación del arrecife mesoamericano constituye la segunda iteración de un ejercicio de planificación para esta ecorregión. El primer plan ecorregional fue desarrollado por WWF en 2002. El presente proceso tomó ventaja de la información recopilada en el ejercicio de planificación previo, incorporó nueva información y facilitó la participación de científicos locales, oficiales de gobierno y actores clave. Más aun, el desarrollo del portafolio de sitios prioritarios se basó en la utilización de una herramienta de toma de decisión (MARXAN) para apoyar la identificación de sitios prioritarios que alcancen las metas de conservación.

La evaluación ecorregional se basó en el proceso de conservación por diseño desarrollado por TNC y se inició con la definición del área de planificación y su estratificación. Seguidamente se identificaron aquellos elementos de conservación prioritarios que cuentan con información sobre su distribución geográfica. Los elementos de conservación incluyeron ecosistemas o tipos de hábitat (arrecifes, manglares, pastos marinos, hábitat de manatí, estuarios y lagunas costeras, playas arenosas y áreas de alimentación de tiburón ballena) y la ocurrencia de especies (sitios de anidación de tortugas marinas y cocodrilos y sitios de agregación de desove de peces arrecifales).

El análisis de amenazas se enfocó en las amenazas a los elementos de conservación e incluyó la descripción de las fuentes de estrés, la severidad y alcance de las amenazas, tales como reducción del hábitat, cambios en la composición y estructura de las comunidades naturales, reducciones en el tamaño de las poblaciones y alteraciones físico-químicas. El análisis de amenazas identificó como principales amenazas el cambio climático global, prácticas inadecuadas de turismo acuático, desarrollo urbano y desarrollo de infraestructura turística, descarga de aguas servidas y acumulación de desechos sólidos.

También la sedimentación y descargas de agroquímicos, sobrepesca y el uso de prácticas inadecuadas de pesca (uso de arpón, pesca de arrastre y con scuba). Finalmente, fueron identificadas las amenazas de la navegación y el desarrollo de infraestructura de transporte.

Utilizando los resultados del análisis de amenazas se desarrollaron objetivos y estrategias, los cuales fueron luego priorizados. Del total de 56 estrategias desarrolladas, veinte fueron identificadas como prioritarias, incluyendo facilitar la participación de la sociedad civil en la administración de áreas marinas protegidas, promover la declaratoria de nuevas áreas marinas protegidas (AMP) en México y Honduras, promover cambios en la

legislación y la armonización de políticas para el manejo de pesquerías, manglares y planes de utilización de la tierra.

INTRODUCTION

Ecoregional assessments pursue several objectives that generally include the identification of key ecological processes and priority conservation targets useful for the development of a network of priority conservation areas (also known as a conservation site portfolio).

In addition, ecoregional assessments seek to identify main threats to biodiversity and to the services natural resources provide. These assessments also make it possible to estimate the viability of the conservation targets and identify strategies for addressing the threats and implementing a network of priority conservation sites.

Finally, ecoregional assessments conclude with the implementation of strategies, through the political support of the authorities of the countries involved and nongovernmental organizations (NGOs) involved in conservation of nature.

The Nature Conservancy's Mesoamerican Reef Program (MAR), in collaboration with other national and international partner organizations, has undertaken the task of conducting an ecoregional assessment of the MAR region. This initiative began in the first half of 2005 in view of the need for a solid and scientifically-based plan of conservation priorities for this marine region of global importance. This plan is expected to optimize the efficiency of limited resources for conservation of biodiversity in the MAR region, and to address the threats and opportunities presented by economic development.

Ecoregional assessments are dynamic processes that should be periodically revised in order to update information about new threats, distribution of conservation targets or new protected areas and geographic and scientific information generated since the last assessment. This ecoregional assessment of the Mesoamerican Reef constitutes the second iteration of the ecoregional plan of the Mesoamerican Caribbean, which was lead by the World Wildlife Fund (WWF) based on the 2000 Cancun workshop, followed by an expert review (Kramer and Kramer, 2002). The current effort will take the previous WWF product a further step, updating and incorporating new information, incorporating the participation of scientists, experts, government agencies, and key stakeholders, and utilizing a decision-making tool to assist with site prioritization.

One of the most important criteria to bear in mind is that this is a regional effort, requiring an approach that goes beyond the work areas and national boundaries of the participants for a participatory identification of conservation priorities at the ecoregional scale. The ecoregional assessment workshops promoted the participation of the main stakeholders, including national and local governments, civil society organizations (NGOs), and natural resource users such as fishers, providers of tourism services, and merchants. Finally, only information of a regional character is utilized; the detailed information that has been generated at a local or national level, which could be implemented at the stratus level, has been excluded in this effort.

This document presents the results of discussions and agreements reached during the three ecoregional assessment workshops of the Mesoamerican Reef (MAR) and the two meetings of the strategies committee. The workshops were organized by the MAR program and were held in Antigua, Guatemala (May 30 to June 1, 2006); San Pedro Sula, Honduras (September 5-7, 2006); and Belize City, Belize (October 24-26, 2006). The objectives of the ecoregional assessment are the following:

- Develop a network of priority conservation sites
- Identify main conservation threats in the ecoregion
- Formulate strategies to address threats and implement the network of priority conservation sites

In order to achieve these objectives, several agreements and intermediate steps are required:

- Define the geographic boundaries and stratification of the planning area inside the ecoregion
- Compile, validate and improve the geo-referenced baseline information available, made up of existing information on the MAR region (maps and databases)
- Define criteria for identifying the conservation targets, including ecosystems, natural communities, species and important sites
- Define conservation goals and ranking for each conservation target
- Define the targets that make up the layer of environmental costs, including human activities and infrastructure
- Analyze issues related to strategy design approach by refining the threat analysis, with an emphasis on priority conservation targets and focusing on the different strata of the planning unit.

Characteristics of the Mesoamerican Reef Ecoregion:

The Mesoamerican Reef (MAR) is a globally important and highly productive system, that requires great efforts to ensure it is adequately conserved. The 1997 Tulum Declaration was signed by the Heads of State of Belize, Guatemala, Honduras and Mexico, leading to a campaign for sustainable management of the region consistent with the economic well-being of the communities whose livelihood depends on the natural resources.

The region covered by the Mesoamerican Reef encompasses 1000 km of coastline, from the northeast end of the Yucatán peninsula, Mexico, to the Bay Islands, in Honduras. It includes the coast of the Mexican state of Quintana Roo, the coast of Belize and Guatemala and the north coast of Honduras up to Cabo Camarón and Swan Islands. This region of high biodiversity includes barrier, fringing and patch reefs and a highly associated system of mangroves, coastal lagoons, seagrass beds, beaches, rivers and coastal wetlands. Almost two million people live in the ecoregion and almost one million depend directly on the integrity and resilience of the reef in order to maintain their lifestyles, and the national economies of the four countries. Members of different indigenous groups inhabit the region, including Garifunas, Kekchi, Maya, Mopán and Creole.

The ecoregion presents more than 66 species of stony corals and more than 500 species of fish, forming one of the most diverse coral reef systems in the Western Hemisphere. The shallow reefs are distinguished by the presence of Elkhorn coral, and massive corals dominate the deepest reefs. Four atolls are prominent in its geography, including Banco Chinchorro in Mexico, and Turneffe Island, Lighthouse Reef and Glovers Reef, in Belize. The bays and coastal lagoons as well as the lagoon reef include extensive seagrass meadows, while mangroves border multiple rivers, lagoons and islands. Seagrass beds and mangroves serve as important nursery areas for species of commercial importance such as queen conch (*Strombus gigas*), spiny lobster (*Panulirus argus*), grouper (Serranidae) and snapper (Lutjanidae), and for other species of recreational importance such as snook (*Centropomus sp.*) tarpon (*Megalops atlanticus*) and bonefish (*Albula vulpes*). World Heritage Sites have been declared in the ecoregion, including the biosphere reserves of Sian Ka'an and Banco Chinchorro, and the barrier reef of Belize (Kramer and Kramer, 2002). A more detailed description of the coral reefs of the Mesoamerican reef region is found in Arrivillaga and García (2004).

METHODS

1. Method for development of the portfolio priority conservation sites

The initial phase consisted of an exhaustive search of ecoregional information of value for conservation. This also included setting up the necessary data-sharing agreements with the organizations generating the information. The base information was taken from the Ecoregional Plan of the Mesoamerican Caribbean published by WWF (http://www.wwfca.org/wwfpdfs/Mesoamerican.pdf), complemented with more recent data such as the reef distribution maps of the Millennium Reef Mapping Program (http://imars.usf.edu/corals/), which includes a word-wide classification of the coral reef structures utilizing high resolution remote sensing images. Another preliminary step was the integration of an advisory group to review the products of the ecoregional assessment.

The assessment process was based on the conservation-by-design concepts and methodology developed by The Nature Conservancy. During the assessment workshops, work group and plenary sessions were held to reach agreements and identify information gaps and new information available. Geographic information was also included on localization of both terrestrial and marine sources, and values were assigned to threat intensity and scope.

Finally, the planning area within the Mesoamerican Reef ecoregion was defined and the area of influence, which includes the watersheds and surrounding sea. Thus, in the current assessment exercise the ecoregion defined by WWF in 2002 was divided in two parts: the planning area and the area of influence. The planning area is a sub-area of the ecoregion where conservation efforts focus. The planning area was subdivided in strata, which were defined as sub-regions of the planning area, whose characteristics make them more similar to one another than to other sub-regions.

The processes for the selection of priority conservation sites make use of the MARXAN program (Marine Reserve Design Using Spatially Explicit Annealing) as a support tool. Developed by the Great Barrier Reef Marine Park Authority of Australia (2000), MARXAN is an optimization tool for conservation planning that supports decision making in the design of marine reserve systems. The basic idea is that the team in charge of the design has a large number of potential sites, or planning units, from which to select a new system of reserves. The goal is thus to develop a system of reserves integrated through a selection of these planning units satisfying a number of ecological, social and economic criteria. These criteria typically require that certain species or specific conservation characteristics must be included in a system of reserves; that all the habitat types defined are sufficiently protected by the reserve system; and that the reserve system does not impact unnecessarily on human activities in the region.

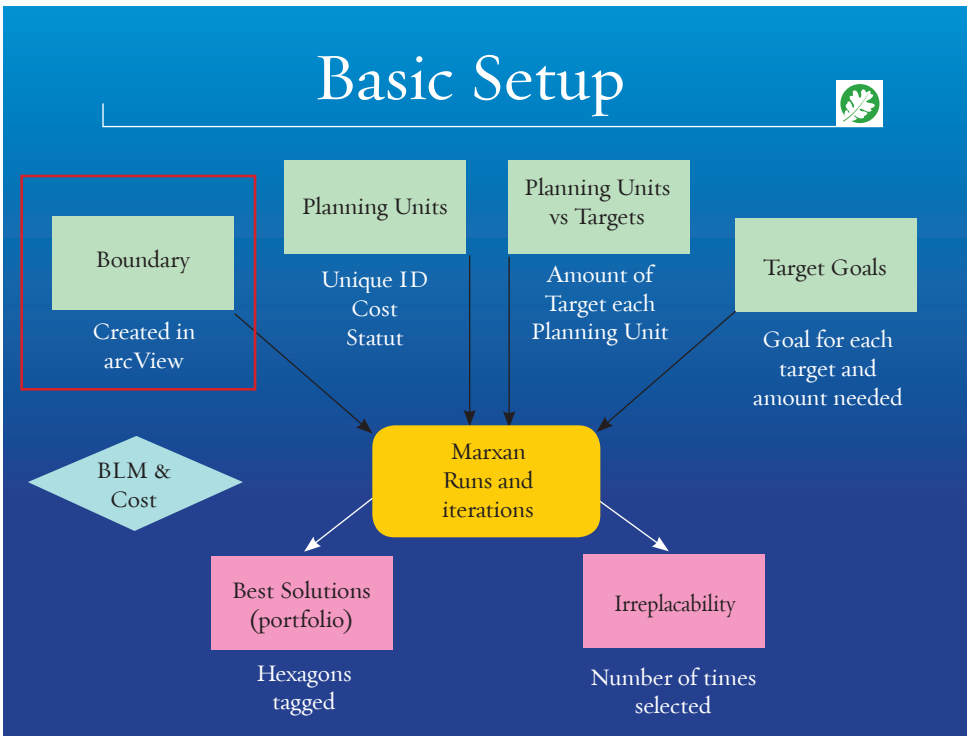
MARXAN finds efficient and reasonable solutions to the problem of selecting a system of spatially cohesive sites that achieves a range of conservation goals. Based on information about the distribution of species, habitat types and ecosystems, and with planning units arbitrarily defined, MARXAN minimizes "cost" (see further down) while obtaining the conservation goals defined by the users.

The MARXAN tool makes it possible to use numerous variables and can present the results in different ways. However, it should be understood that the results should be utilized as a tool to help decision-makers design a network of priority conservation sites, acceptable from ecological, social, economic and political points of view. An essential component of the analysis is the planning

area's division into planning units. The size of the planning units must be in harmony with the scale of the data employed. In the case of the MAR ecoregional assessment, the size of the planning units (or hexagons) was 500 hectares, for a total of 11,566 units.

One of the important variables to specify in the MARXAN analysis is the boundary length modifier. This variable determines the degree of "compactedness" of the priority sites. In other words, a high level of clumping would result in the selection of a lower number of larger sized areas, giving a reduced edge effect. A lower level of clumping would result in a larger number of individual areas selected that would not necessarily be inter-connected. In the current case a boundary length modifier of 0.25 was used, which is a value normally employed in the design of networks of marine protected areas. MARXAN selects the planning units based on the data entered, but each different run begins with a different randomly selected hexagon. In this ecoregional assessment a total of 200 individual runs were made, with a million iterations in each run. The number of times the program selects a hexagon during the 200 runs is indicative of the importance of that planning unit. In the final results, the MARXAN analysis presents two options. The first result is the optimal portfolio (best) and the second result is indicative of the irreplaceability ("solution"). The optimum portfolio shows a one or zero value, depending on whether or not a hexagon was selected. Irreplaceability provides for each hexagon the number of times it was selected in the 200 runs. This last option allows the planner more freedom in interpreting the results.

The bases of a MARXAN analysis are the conservation targets. Conservation targets can be species, habitat types, or ecosystems. The main criterion is that available data representing the conservation target be uniform for the entire planning area. The limitation on this is that non-georeferenced data or data restricted to a geographic area cannot be used in the MARXAN analysis, which restricts the quantity and type of information that can be used in the analysis. Finally, conservation goals are assigned to each conservation target in percent, representing the quantity that ideally needs to be protected.



MARXAN also involves the use of a cost layer. This is an important component in the process of selecting priority areas and aims to locate the presence of human activities in the planning area and the extent of their influence. The cost layer represents a geographic analysis of the conservation threats and serves the purpose of locating areas that, because they are farther away from human activities, can have increased viability. The basis for building the cost layer was the analysis of threats to resource conservation in the ecoregion, and the ecological services they provide, developed by the World Resources Institute project, "Reefs at Risk in the Caribbean". (http://marine.wri.org/reefsatriskcaribbean-pub-3944.html).

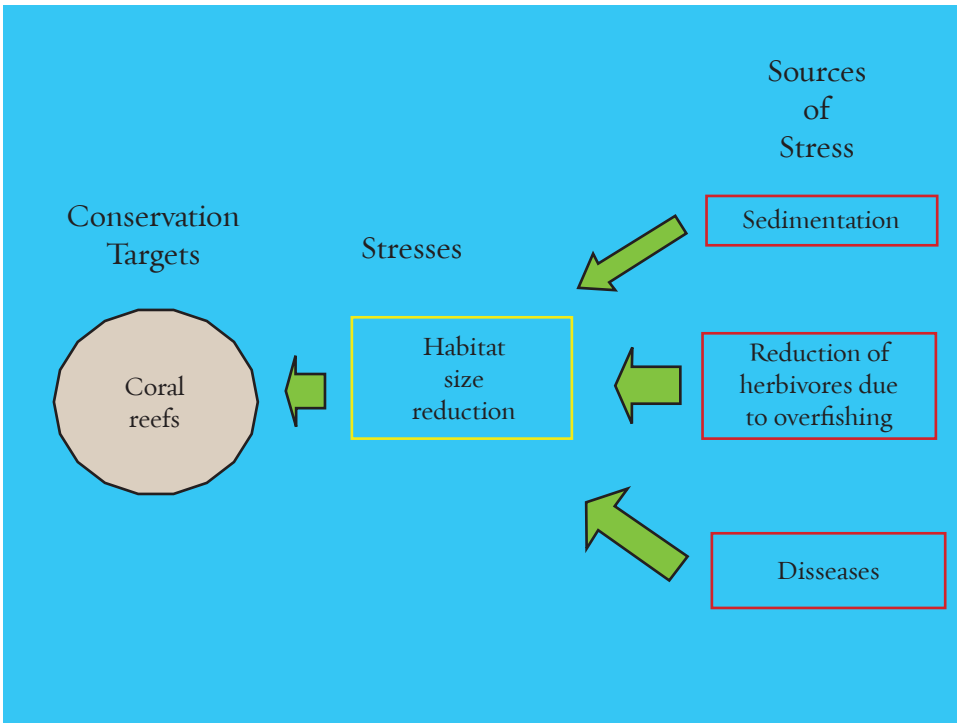
2. Method used for the identification and analysis of the main threats to conservation targets

A threat analysis aims to identify the stresses and the sources of stress on conservation targets. Stress is defined as the damage or degradation of biological factors of a conservation target causing a reduction of its viability. On the other hand, the sources of stress, also known as threats, are the incompatible uses of natural resources that give rise to the stresses.

Some of the potential stresses include reduction in the size of the area, reduction of populations of aquatic fauna, alteration in the composition and structure of the communities, alteration of the hydrological regimen, or physical-chemical alterations in the environment. Likewise, some of the sources of potential stressors include incompatible agricultural practices, over fishing, invasive or exotic species, discharge of wastewater, alteration of the hydrological regimen, or unsustainable tourism. A stress can also have many sources and the analysis of stresses and sources is critical in order to establish priorities.

There are two steps in the analysis of stresses. The first is to identify the main stresses on the conservation targets, meaning potential damage in the next ten years. Then the stresses are "scored" in terms of the **severity** and **scope** of the damage.

Severity is the level of the damage that can be expected for the conservation target within the next 10 years under current circumstances. The



severity of a stress can be scored according to the following scale:

- Very High: It is probable that the stress will destroy or eliminate the conservation target in a portion of its distribution within the site.
- High: It is probable that the stress will seriously deteriorate the conservation target in a portion of its distribution within the site.
- Medium: It is probable that the stress will moderately deteriorate the conservation target in a portion of its distribution within the site.
- Low: It is probable that the stress will slightly deteriorate the conservation target in a portion of its distribution within the site.

Scope is the geographic extent of the stress on the conservation target that can be expected for the next ten years under the current circumstances. The scope of a stress is rated according to the following scale:

- Very High: It is probable that the stress is very widely distributed and affects all of the occurrences of this conservation target in the site (more than 75%).
- High: It is probable that the stress has a wide scope and affects many of the occurrences of the conservation target (50-75%).
- Medium: It is probable that the stress has a local scope and affects some of the occurrences of the conservation target in the site (25-50%).
- Low: It is probable that the stress has a very limited local scope and affects few of the occurrences of the conservation target (less than 25%).

Analysis of the sources of stress in turn requires two steps. First the proximal sources of stress are pinpointed. It is possible that each source may require a different strategy. Second, sources of stress are "scored" based on the degree of ***contribution*** to the stress and their level of ***irreversibility***.

Contribution measures the degree of contribution of the source of stress that can be expected for the next ten years. The contribution of a source of stress is scored according to the following scale:

- Very High: the source is a very large contributor to the particular stress (main or one of the main ones)
- High: the source is a large contributor to the particular stress
- Medium: the source is a moderate contributor to the particular stress
- Low: the source is a small contributor to the particular stress

Irreversibility is the degree of irreversibility of the stress caused by the source of stress. Irreversibility is scored according to the following scale:

- Very High: the source produces a stress that cannot be reversed (for example, a wetland turned into an urban development)
- High: the source produces a stress that can be reversed, but is not socially or economically viable (for example, a wetland turned into an agricultural area)
- Medium: the source produces a stress that can be reversed with a reasonable commitment of resources (for example, construct tunnels underneath roads that run through the wetland)
- Low: the source produces a stress that can be reversed easily at a relatively low cost (for example, boardwalks crossing a wetland)

To score the threats, the conservation targets were used as the basic criteria. For each conservation target the threats and the sources of stress were identified and graded. The conservation targets are grouped as follows:

- Reefs
- Seagrasses
- Beach system, with nesting sites of turtles, birds, and crocodiles as nested conservation targets
- Mangroves
- Estuaries and coastal lagoons, with manatee habitat and fish growing sites as nested conservation targets

- Whale shark and spawning aggregation sites of reef fishes

Two or three stresses were identified for each group of conservation target and the stresses were then ranked according to severity and scope. Next, two or three sources were identified for each stress, and finally, the sources were ranked according to contribution and irreversibility.

3. Method for prioritizing strategies

The final step in the ecoregional assessment process was the ranking of the proposed strategies. This process was similarly carried out in a participatory manner, with a reduced group of national representatives from the four countries.

In total there were eight criteria for ranking strategies: contribution to the strategic objective, level of threat reduction, duration of the result of implementing the strategy, degree of influence, presence of a lead institution or person, ease of implementation, capacity to motivate the key public, and the costs of implementing the strategy.

Contribution to this strategic objective *is the degree to which the strategy, if implemented successfully, contributes to reaching this strategic objective. The levels of scoring are:*

- Very high: The strategy in itself makes it possible to achieve one or more strategic objectives.
- High: The strategy contributes substantially to achieving one or more objectives, but is not enough on its own.
- Medium: The strategy makes an important contribution towards the achievement of one or more objectives.
- Low: The strategy makes a small contribution toward reaching one or more objectives.

Level of threat abatement. In this part of the process, threats that would be abated by implementing the strategy are selected, if the strategy will lower the score of the threat by one or two ranks, for all the conservation targets that are affected by that threat.

Duration of results is scored according to the degree to which the proposed strategy, if implemented successfully, can achieve a lasting result. The scoring levels are:

- Very high: lasting result, more than 10 years
- High: relatively long results, from five to 10 years
- Medium: results of moderate duration, from three to five years
- Low: results of short duration, one year

Level of influence of the strategy is scored as the degree of influence on the achievement of other strategies, and is based on the following scale:

- Very high: The strategy is key to carrying out other strategies (provides a frame of work)
- High: large influence
- Medium: moderate influence
- Low: no influence

Presence of a lead institution or person: *whether there are subjects capable of implementing a given strategy, according to the following scale:*

- Very high: one or several people with enough time, proven talent, relevant experience and institutional support are present and committed to leading the strategy's implementation
- High: one or several people with enough time, promising talent, some relevant experience and moderate institutional support are present and committed to leading the strategy's implementation
- Medium: one or several people with enough time and promising talent are available to lead the strategy, but lack experience and institutional support
- Low: There are no people available to lead this strategy.

Ease of implementation of the strategy, scored as follows:

- Very high: implementation is very viable since the strategy has already been applied several times

- High: implementation is relatively viable, although there is some uncertainty about the results; the strategy has been applied previously
- Medium: implementation is complex since there is a great deal of uncertainty; has not been applied often
- Low: implementation is very complex; has never been applied at other sites

Ability to motivate relevant stakeholders to implement the strategy:

- Very high: key stakeholders and their motivations are very well known and the strategy is sure to appeal to their interests.
- High: key stakeholders are known and it is very probable that the strategy will appeal to their interests.
- Medium: key stakeholders are not well known, but the strategy could appeal to their interests / key stakeholders are well known, but it is not very probable that the strategy will appeal to their interests.
- Low: key stakeholders are not known and it is uncertain whether the strategy will appeal to their interests.

Implementation costs of the strategy, scored as follows:

- Very high: more than $1 million
- High: from $100,000 to $1 million dollars
- Medium: from $10,000-$100,000
- Low: less than $10,000

The strategy's scores are finally grouped under three indicators: benefits, feasibility and cost:

- Benefits, including the scores on contribution, duration and influence
- Feasibility, including the scores on presence of lead person or institution, ease of implementation, and ability to motivate the key public.

RESULTS

1. Limits of the planning unit:

The first results in the ecoregional assessment process were the delimitation and stratification of the planning area. The ecoregion defined by WWF (Kramer and Kramer, 2002) was used as the base. The ecoregional boundaries were discussed extensively in participatory form and a clear and consensual definition was reached on the boundaries and stratification of the planning area. The agreed geographical area is shown on the map of the area (Overview Map).

Concerning the boundary of the planning area to the northwest in Mexico, it was agreed that the assessment area should start at the borders of the Yum Balam Natural Protected Area (Area de Proteccion de Flora y Fauna de Yum Balam), without including the Ría Lagartos Biosphere Reserve, which has a different hydrological behavior. The oceanic part in the northeast of the Yucatán peninsula was also maintained due to its importance as habitat for whale shark. Cabo Camarón, Honduras was established as the southeast limit of the planning area, taking into account that the Río Plátano lagoon systems are more associated with pond systems of the Moskitia area, and in the terrestrial environments the coastal plains begin at the level of the mouth of Río Aguán.

The marine boundaries of the planning area extended to the of 200 m depth contour (border limit of the continental shelf). However, in the south, in Honduras, the marine limit was extended 11 nautical miles (20 km) around the Bay Islands, to include occurrences of conservation targets such as dolphins, marlin and other non-commercial pelagic fish. The terrestrial limit of the planning unit was agreed as to be the coastline, but extending inland to include mangrove forests, coastal lagoons and estuaries.

Finally, in defining the area of influence, both terrestrial and marine, the MAR limits defined by WWF (Kramer and Kramer 2002) were maintained. Since recent studies indicate a strong influence of the Cayman current, this needed to be taken into account in the systems north and south of Quintana Roo and Belize. Also, the importance of the marine area of influence was noted in the dispersion of larvae and as a migration route for some species, such as turtles, whale shark and marine mammals. However, it was recognized that more information was needed on patterns of oceanic circulation in order to define the marine area of influence in greater detail.

The terrestrial area of influence was defined as to include the watersheds and micro-watersheds that drain in the Mesoamerican reef. This terrestrial area of influence covers a total area of 209,219 km^2 and includes extensive territory with important economic activities such as agriculture, industry and commerce. These human activities have a significant impact with profound effects on the Mesoamerican Reef.

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2. Stratification of the planning unit

The advantages of stratifying the planning area include identifying sub-areas more similar among themselves while simultaneously making it possible individualized conservation goals per stratum. Using the WWF stratification as base (Kramer and Kramer 2002), island systems outside the continental shelf such as Cozumel and the Bay Islands in Honduras were separated from the rest of the area. Likewise, the atolls of Banco Chinchorro, Glover's Reef, Lighthouse Reef and Turneffe Island remained in a different stratum, separated from the portion of the ecoregion located on the continental shelf.

On the continent the **first stratum** extended from the northwestern limit of the planning area to the village of Xcalac, Quintana Roo, Mexico. This stratum is characterized by karst terrain hydrography without surface rivers and having an important underground drainage about which very little is known (Jorge Herrera, pers. comm.). In this stratum the coral reefs show certain variability. For example, from Akumal northward the fore-reef is less developed and there are three ridges that begin to develop south of Akumal (Ernesto Arias, pers. comm.) From Akumal southward to the Sian Ka'an Biosphere Reserve (excluding Uayamil), the coast is characterized by the influence of coastal lagoons, mangroves and seagrasses.

The **second stratum** covers the continental littoral from Xcalac and the mouth of Bahía de Chetumal in the north, to the edge of the Gulf of Honduras. This stratum includes the main part of the Belize barrier reef. The boundary of the Gulf of Honduras is identified as the city of Punta Gorda, Belize. The **third stratum** covers the area of the Gulf of Honduras, extending from Punta Gorda in Belize to Punta Sal in Honduras, and covers the entire Caribbean littoral of Guatemala. The boundary in Punta Sal is recognized by the patterns of marine currents that occur there (Gustavo Cabrera, pers. comm.).

The **fourth stratum** includes the north coast of Honduras from the limit of the Gulf of Honduras to Cabo Camarón. Cabo Camarón is where the continental shelf begins to extend outwards to form the Bancos Mosquito, which is also the beginning of the zone dominated by the extensive coastal lagoons of Rió Plátano. The **fifth stratum** includes the island of Cozumel and Arrowsmith Bank, facing the coast of Quintana Roo, Mexico. The **sixth strata** covers the atolls, Banco Chinchorro, Mexico, and Turneffe Islands, Glover's Reef and Lighthouse Reef, in Belize.

The archipelago of Cayos Cochinos and island of Utila were included with the other two Bay Islands, Roatán and Guanaja, even though the first two are located on the continental shelf. The justification for the Bay Islands stratum are the different reef characteristics, the dominance of certain types of corals, the structure and composition of species, and the quantity of sediments carried there. In addition, differences in structure of island and coastal mangroves. This constitutes the **seventh stratum**. The final seven strata agreed appear on the map of the study area (Study Area Map).

An extra stratum was created that includes the Moskitia continental shelf, and extends from Cabo Camarón to Cayos Miskitos in Nicaragua. This stratum includes the oceanic portion to Islas del Cisne, Honduras, and the entire platform of the Moskitia. This stratum is characterized by an extensive continental shelf, markedly different from the rest of the MAR ecoregion. In addition, inspection of the patterns of oceanic circulation demonstrates that when the southwest Caribbean current runs into the Moskitia platform, it veers off toward the northeast, effectively separating the two ecoregions. This zone is characterized by its importance in industrial fishery for conch and lobster. This last stratum forms part of the ecoregional plan of Central America and therefore it was not contemplated in the Mesoamerican reef ecoregional assessment.

3. Conservation targets:

The next task in this current ecoregional assessment exercise was identifying the priority conservation targets. Once again, this was based on the conservation targets pre-identified by TNC's MAR program, through a compilation of ecoregional information of conservation value, based initially on the WWF plan (Kramer and Kramer 2002).

The criteria for inclusion of targets were those that are considered main habitat, such as coral reefs, mangroves, seagrass beds, and estuaries; important ecological features such as spawning aggregations and sea turtles nesting sites; and charismatic species of ecological and economic importance such as the whale shark and manatee.

Maps of conservation target distribution were reviewed to identify gaps and new geographic distribution information was added; the objective was to validate the information and determine whether any more recent or more reliable map exists. The information available was also checked to see if it was suitable for inclusion in the ecoregional assessment and use with the decision-making tool. The conservation targets were grouped in gross filter targets that include habitat and ecosystems, and in fine filter targets that include species and ecological phenomenon of discrete distribution. A review of the information resulted in the following list of conservation targets:

Targets with sufficient adequate information to be included in the ecoregional assessment:

- Coral reefs
- mangroves
- reef fish spawning aggregations sites
- estuaries and coastal lagoons
- manatee habitat
- sandy beaches
- crocodile nesting sites
- migratory birds nesting sites
- sea turtle nesting sites
- seagrass beds
- whale shark

Conservation targets with limited or less reliable information:

- Queen conch fishing sites
- lobster fishing sites
- seabirds
- finfish fishing sites
- distribution of marine mammals
- growing sites of commercial fishes and invertebrates
- sea turtle foraging sites
- flood forest

4. Description of the conservation targets:

Coral reefs

Covering approximately 133,000 ha, coral reefs are one of the most important conservation targets in the ecoregion. Reefs create a complex structural system with four types of main reef

Coral reefs © *Nancy Sefton*

habitat- atolls, barrier, fringing, lagoon and oceanic island- each with its corresponding reef zones- fore, patch and crest. The MAR ecoregion includes one the largest reef systems in the world, and extends close to 700 km from the northeast end of the Yucatán peninsula, in Mexico, all along Belize, and up to the Bay Islands, Honduras. This system is part of the Caribbean reefs with more than 70 species of corals and around 500 species of fish.

Mangroves:
The mangroves of the MAR ecoregion are a valuable resource, and are represented by four genera: *Rhizophora* spp., *Avicenia* spp., *Laguncularia* spp., and *Conocarpus* sp. Mangrove forests create a rich habitat due to the large quantity of aquatic species associated with their root system and bottom areas. The MAR ecoregion includes the four structural types of mangroves of the Caribbean (Lugo and Snedaker 1974). Fringe mangroves are distributed all along the coast, while the hammock and dwarf mangroves are strongly associated with the low lands in the northern portion of the ecoregion, and principally the north of Belize and Quintana Roo, Mexico. Riverine mangroves are associated with the coastal lagoons and river mouths, and the island mangroves are associated small cays and dry areas on the coasts, sometimes near the dwarf mangroves. The ecoregion has around 300,000 ha of mangroves, distributed in a large number of patches. The distribution of dwarf and hammock mangroves is quite fragmented, while the fringe and riverine mangroves are more structured, massive and are present in large patches. The mangroves associated with the karst systems in the northern portion of the ecoregion are less developed in comparison to similar structural types in the southern portion of the region between the south of the Belize, Guatemala and Honduras.

Mangroves *© Alejandro Arrivillaga*

Reef fish spawning aggregations (SPAGs)
One of the most important features for the sustainability of fisheries in the MAR are the reproductive aggregations of reef fish. Aggregations occur 10 days around the full moon all year long, but are more frequent between December and July. At least 22 species of reef fishes aggregate for reproductive purposes, some with high value for local economies such as groupers and snappers. Other species such as pampano and jurel aggregate in the same sites, but their aggregation peaks occur at different times or depths. The aggregations occur in groups that range from 5,000 to 15,000 individuals in any given moment. The MAR ecoregion includes 76 verified aggregations distributed between Mexico, Belize and Honduras.

Reef fish spawning aggregations *© Fundación Cayos Cochinos*

Estuaries and coastal lagoons
Estuaries and coastal lagoons are critically important as nursery areas for fishes and invertebrates that use these types of coastal habitat during different phases of their lifecycle. The hydrological balance between fresh and seawater in the estuaries and coastal lagoons, and the role that coastal vegetation plays are vital features of these ecotone systems. Estuaries and coastal lagoons are sites of high productivity that export nutrients to other surrounding marine environments. In addition, they trap sediments and nutrients, protecting adjacent reefs and seagrass beds. In the MAR ecoregion there are some 500,000 ha of estuaries and coastal lagoons.

Estuaries and coastal lagoons *© Alejandro Arrivillaga*

Sandy beaches:
There are large numbers of white sandy beaches in the MAR ecoregion that serve as nesting sites for both sea turtles and local and migratory birds. The sandy beaches and dune systems are very rich in vegetation specifically adapted to these ecosystems and functioning as control for the stability and erosion of the coastline. Beach and dune systems in the MAR ecoregion serve as nesting habitat for four species of sea turtles: Green (*Chelonia mydas*), Leatherback (*Dermochelys coriacea*), Hawksbill (*Eretmochelys imbricata*), and Loggerhead (*Caretta caretta*). The list of birds that nest on the beaches includes the Red-Footed Booby (*Sula sula*), in one of the largest nesting colonies of the Caribbean with over 50,000 individuals. The beaches are also resting sites for numerous migratory birds of the Western Hemisphere. Finally, the beaches also serve as nesting site for the American Crocodile (*Crocodylus acutus*), an emblematic crocodile species that tolerates saline environments and nests in some areas of the islands and atolls.

Sandy beaches *© Alejandro Arrivillaga*

Seagrasses:
The MAR ecoregion has an impressive quantity of seagrasses, dominated by turtle grass (*Thalasia testudinum*, but with other species as shoal grass *Halodule* sp., manatee grass *Syringodium* sp., and widgeon grass *Rupia maritima*. This complex and productive ecosystem is an important growing habitat for fishes and invertebrates, especially queen conch (*Strombus gigas*), one of the most important species for local economies. Seagrasses are also important habitat for numerous species of manta rays and serve as sea turtle feeding and mating habitat. The MAR ecoregion contains a total of 300,000 hectares of seagrass meadows.

Seagrasses *© Alejandro Arrivillaga*

Whale shark:
The whale shark is one of the charismatic species in the MAR ecoregion. This is due to its peaceful character and the ease with which it can be observed while graciously ignores the observers around it. Whale sharks are an extraordinary tourism product, reporting several millions of dollars in the MAR region. The presence of whale shark in the MAR ecoregion is associated with their feeding in some of the most productive areas. These areas include the gyre off the coast of Utila island, Honduras, where 35 sharks have been observed; the spawning aggregation site in Gladden Spit, Belize, where 25 individuals have been identified; and lastly the up-welling zone in Holbox, Mexico, having the largest population of whale shark documented in the world, with 500 individuals recorded to date. The whale shark acts as an umbrella covering a number of sharks, tuna, manta ray, dolphins, and sea turtles that also use the productive up-welling habitat.

Whale shark *© Alejandro Arrivillaga*

5. Assignment of conservation goals

The next step was to set conservation goals for the selected targets. Guiding elements include identifying goals in an adaptive process, using the goals as working hypothesis that should be adjusted later on. The rule of conserving a least two occurrences of common targets and 10 of rarer targets in order to ensure representation and replication was used. Also, the rule of 30%, which is derived from island biodiversity, was used. The criteria of historical ranges, rarity and endemism, ecological importance, vulnerability and limited distribution were also considered.

Conservation goals often result from the mix of scientific knowledge and political feasibility, and it is often difficult to know where science ends and political pragmatism begins. The agreed criteria for setting conservation goals included vulnerability, rarity, limited distribution, the pattern of spatial configuration (linear, point, patch), the proportion that remains compared to the historical range of distribution, degree of endemism, and the relative ecological importance (keystone species). The value assigned to the conservation goal translates into the percent of the target that should remain in the portfolio of priority sites.

Conservation goals in percentages initially assigned for the different targets:

Target	Regional Range (%)
Spawning aggregation sites	80 – 100
Sea turtle nesting sites	30 – 80
Manatee habitat	50 - 80
Manatee corridors	
Estuaries	50 – 90
Coastal lagoons	50 – 100
Mangroves	30 – 100
Mangroves associated with reefs	50 – 100
Reefs	20 – 100
Sandy beaches	0 – 70
Sandy beaches of coral origin	80
Seagrasses	50 – 100
Nesting sites of migratory and sea birds	50 – 100
Pink conch	30 – 100
Spiny lobster	30 – 100
Birds	30 – 60
Fishing sites (high biological productivity) fishery management	0 – 60
Finfish sites	0 – 60
Marine mammals (specify by species)	20 – 100
Whale shark	50 – 100
Crocodile nesting sites	30 – 70
Sea turtle foraging sites	50 – 100
Endemic terrestrial species*	100
Low-lying flood forest	0 – 75

* *yellow-neck parrot* in Roatán, pink boa in the Cochino Cays, coral snake in Roatán, Roatan guatuza, coral endemic to Roatan, Utila garrobo, two species of lizards endemic to Utila, endemic geckos on the Bay Islands, Utila *chachalaca* and others. Around 15 endemic reptile species have been reported on the Bay Islands (Jenny Myton, pers. comm).

The review of the conservation goals was a complex process in which participants were encouraged to establish goals allowing decision-making tools to find the sites of greatest priority within the ecoregion. The goals presented below were obtained as a result. While these reflect participants' spirit of conservation, a clear selection of priority sites was still not yet possible. The decision was therefore made to set prioritization goals that have lower values, which are presented in the following chart.

Review of the conservation goals and assignment of prioritization goals in percentage:

Conservation Target	Conservation Goals				Prioritization Goals			
	Strata				Strata			
	1 & 5	2 & 6	4 & 7	3	1 & 5	2 & 6	4 & 7	3
Reef fish spawning aggregations	100	80	100	0	80	80	80	80
Sea turtle nesting beaches	80	60	80	75	50	50	60	50
Manatee habitat	100	75	80	80	70	75	80	60
Estuaries and coastal lagoons	-	60	80	80	30	50	60	50
Mangroves	80	60	100	80	55	55	65	55
Coral reefs	90	50	90	80	65	50	60	50
Sandy beaches	70	30	30	75	60	30	30	30
Sea grasses	80	0	100	75	70	50	70	60
Nesting sites of migratory and sea birds	100	80	80	-	60	50	40	40
Feeding zone of the whale shark	100	100	80	-	80	80	80	-
Crocodile nesting sites	-	70	50	-	-	70	-	-

6. Cost layer development using threats with geographic distribution information:

Concerning threats to natural resource conservation, those for which geographical information is available include human activities such as agriculture, aquaculture, discharge of sediments, urban areas, ports, airports and roads were selected. This information was used to produce the cost layer used by the decision-making tool.

The threat analysis had three phases. The first phase was to evaluate the adaptation of the results of the World Resources Institute's "Reefs at Risk in the Caribbean". As main threats to coral reefs, this document identifies coastal development, sources of pollution and sediments drained from watersheds. The threat maps of Reefs at Risk in the Caribbean were analyzed for the different strata in terms of their usefulness as threat indicators. In the second phase, threats with geographic information were analyzed and assigned relative values of intensity and area of extent of their influence. The relative values of intensity have ranges of -10 for factors that abate threats (i.e., wetlands), up to + 10 for threats of greater intensity. The extent of the influence corresponds to the value in kilometers where the threat impact is perceived. Separate analyses were made for coastal and marine targets. Coastal targets are those located directly on the coastline, such as mangroves, coastal lagoons, turtle's nesting sites and sandy beaches, which can have direct contact with the threat. Marine targets, including coral reefs, seagrass beds, reef fish spawning aggregation sites and estuaries, are those separated from the threat by an aquatic space. Results from the WRI project *Land Use Change and Watershed-based Impacts to the Mesoamerican Reef* were used. This project classified the region's watersheds in five groups based on their sediment discharge. Watersheds with greater discharge correspond

to Class 5, while watersheds with less discharge are Class 1. This data was used to represent the impact of deforestation, drainage and discharge of sediments, and upper watershed pollution on conservation targets.

Other threats identified that do not have geographic distribution data were not considered in preparing the cost layer. These threats include the density of hotel rooms, ship traffic, overfishing and fishing of herbivorous species, fishing with gill nets, trawling, mining, accidental spills or discharge of bilge water and global climate change.

With the conservation targets and goals defined, and utilizing the cost layer, the MARXAN program was run, obtaining maps of priority sites and generating the irreplaceability map. The priority sites results cover 1,043,000 ha, of which 53% (almost 550,000 ha) are located within the current system of protected areas.

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Average results were as follows:

Threat	Relative Intensity	Extent of the Influence (km)
Threats to Coastal Targets		
Agriculture	5	1
Aquaculture	8	1
Urban Areas	10	10
Roads	6	4
Ports	7	1
Airports	3	2
Forests	-2	1
Shrubs	-2	1
Wetlands	-6	2
Threat to Marine Elements		
Agriculture	7	1
Aquaculture	8	1
Urban areas	10	10
Roads	4	4
Ports	10	1
Airports	1	2
Impact of Threats in Watersheds Above		
Sediment discharge points		
Class 1	2	5
Class 2	4	10
Class 3	6	15
Class 4	8	25
Class 5	10	40

7. Network of priority sites

Based on the results of the MARXAN analysis, maps of portfolio of priority sites and irreplaceability were obtained. These results were evaluated by local experts; previously unidentified sites of importance were added, and sites were eliminated that, due to potential threats, should not form part of the network of priority sites. The final results are presented on a map. In general terms, the priority sites include the list of sites cited in the table described on the next page.

Finally, coverage of the main conservation targets was assessed in each priority site in terms of their extension in hectares and the percent of each conservation target covered by each priority site. The final network of priority sites established includes close to 99,100 ha of coral reefs (75% of coral reefs in the ecoregion), 192,100 ha of mangroves (65% of all mangroves in the ecoregion), 282,700 hectares of coastal lagoons and estuaries (58% of the total) and 212,500 hectares of seagrass beds (71% of the seagrass beds in the ecoregion).

List of Ecoregional Assessment Priority Sites:

1	Yum Balam – whale shark – Chacmochuc: northeast corner of the Yucatán peninsula (Yum Balam and Isla Holbox), Mexico, including the whale shark feeding zones and Laguna Chacmochuk, north of Cancun.
2	Punta Cancún – Puerto Morelos: the coast of Quintana Roo between Punta Cancún, Punta Nizuc and around Puerto Morelos, Mexico.
3	NE Cozumel: the northeast end of Cozumel Island, Mexico.
4	Cozumel reefs: the south end of Cozumel Island, Mexico.
5	Caletas Akumal – Tulum: the bights in Akumal and Tulum.
6	Sian Ka'an: Sian Ka'an Biosphere Reserve, Mexico.
7	Uaymil: in the Sian Ka'an Biosphere Reserve, Mexico.
8	Mahahual: the corridor of Mahahual - Bacalar Chico (Belize).
9	Bahía de Chetumal: the north end of Bahía de Chetumal, Mexico.
10	Banco Chinchorro: the eastern region of the reefal ring of Banco Chinchorro Biosphere Reserve, Mexico.
11	Xcalac: the area of Arrecifes de Xcalac National Park (Mexico).
12	Corozal Bay: the zone south of the mouth of the Belize River, across from the town of Corozal (Belize).
13	Consejo Shores: terrestrial zone adjoining Corozal Bay Wildlife Reserve, Belize.
14	Central Belize: the region north and across from Belize City.
15	Turneffe: the central region of Turneffe Atoll, Belize.
16	Glovers: the atoll in Glover's Reef Marine Reserve, Belize.
17	North of South Water: area north of the South Water Caye Marine Reserve, Belize.
18	Lighthouse Reef: the atoll of Lighthouse Reef, Belize.
19	South Water – Gladden: the triangular area that includes Gladden Spit – Silk Cayes, Laughing Bird and southern portion of South Water Caye Marine Reserve, Belize.
20	Placencia: the coastal lagoon of Placencia, in Stann Creek, Belize.
21	Port Honduras: the region of Port Honduras Marine Reserve and Paynes Creek Forest Reserve, in Toledo, Belize.
22	Ranguana – Sapodilla: The corridor between Ranguana Caye and Sapodilla Cayes Marine Reserve, Belize.
23	Golfete: El Golfete area, in Río Dulce National Park, Guatemala.
24	Amatique – Manabique: Amatique Bay region between the mouth of the Sarstun River (Belize – Guatemala) and Punta de Manabique Wildlife Refuge, Guatemala.
25	Tela – Cuero y Salado: the region of Bahía de Tela and Punta Izopo, up to the area of the Cuero and Salado Rivers, Atlantic coast of Honduras.
26	Utila: the island of Utila and the Salmedina Bank, Honduras.
27	Cayos Cochinos: the region south of Cayos Cochinos Marine National Monument, Honduras.
28	West Roatán: the south coast of the west end of Roatán Island, Honduras.
29	East Roatán and Barbareta: the east end of Roatán and Barbareta Island, Honduras.
30	Guanaja: Guanaja Island, Honduras.
31	Trujillo – Aguán: Trujillo Bay and the mouth of Río Aguán, Honduras.

8. Analysis of threats to the conservation targets:

The table below shows the results of the threat analysis for the conservation targets.

Summary of threats to the conservation targets

Threats	Coral Reefs	Seagrass beds	Beaches and coastal dunes	Mangrove forests	Estuaries and coastal lagoons	SPAGs	Whale shark	Overall value of threat
Global climate change (temperature and sea level rise and elevation f CO_2)	Very high	Medium	Low	High	Medium	-	-	High
Unsuitable aquatic tourism activities	Very high	Low	-	-	Medium	Low	High	High
Wastewater discharge	High	High	-	Low	High	Medium	Low	High
Tourism infrastructure development	Medium	High	High	High	-	-	-	High
Sedimentation	High	High	-	Low	High	-	-	High
Coastal urban development	-	-	High	High	High	-	-	High
Overfishing and unsuitable fishing practices (spear fishing, trawling, Scuba)	High	Medium	-	-	Medium	High	-	High
Agro-chemical and pesticide use	High	High	Low	Low	Medium	-	-	High
Navigation (anchor damage, oil spills, boat scars)	High	Low	Medium	Low	Medium	-	Medium	Medium
Highway and transportation infrastructure development	High	Medium	Medium	Medium	Low	-	-	Medium
Accumulation of solid wastes	-	-	High	-	-	-	Medium	Medium
Invasive species	High	-	Low	-	-	-	-	Medium
Extensive animal husbandry	-	-	-	High	-	-	-	Medium
Shrimp aquaculture	-	Medium	Medium	Medium	Medium	-	-	Medium
Natural disasters	-	Medium	Medium	-	-	-	-	Medium
Mining	-	-	Low	-	Medium	-	-	Low
Overall status of threats to conservation targets	Very High	High	High	High	High	Medium	Medium	Very High

9. Identification and development of threat abatement strategies:

Once the main threats to the conservation targets were identified, threats were grouped by similarity and according to the strategies that can tackle them. The final threat groups were as follows:

- global climate change
- unsuitable aquatic tourism practices
- development of tourism infrastructure, coastal urban development, wastewater discharge and accumulation of solid wastes
- sedimentation and discharge of agro-chemicals and pesticides
- overfishing and unsuitable fishing practices (spear fishing, trawling, Scuba)
- navigation
- development of transportation infrastructure (docks, ports, canals, dredging, fill, dykes, oil pipelines)

Ten-year objectives, lines of action and actions were developed for each strategy. The results of identification of strategies for each threat are presented in Annex 2. Strategy development was complemented at the third ecoregional assessment workshop that took place in Belize City, October 24-26, 2006.

10. Strategic objectives:

The ecoregional assessment resulted in a total of 17 strategic objectives. The complete list of strategic objectives and their success indicators are presented in Annex 3.

These 17 strategic objectives can be grouped in five thematic areas: (1) climate change impacts, research and monitoring; (2) tourism; (3) environmental pollution, watersheds, land use planning, ports and navigation; (4) fishing communities; and (5) conservation of resources and marine protected areas.

With respect to climate change, research and monitoring, strategic objectives include promoting that governments and civil society constitute a solid front that exerts influence in international fora on global climate change, and that research is conducted to find out impacts that a rise in water temperature and sea level will have on the entire region. This information should then serve to propose concrete management actions for adaptation and for the protection of refugia sites. Finally, an objective was proposed for regional research and monitoring programs to be permanent in duration, to have long-term financing and that the information they generate be used in decision-making.

There were two strategic objectives for tourism. The first is to establish, harmonize and adopt best tourism practices in the region, in order to maintain and improve ecosystem integrity and viability. The second was for tourism to generate greater economic income for natural resource protection and for the communities where community tourism is viable, including scientific and cultural tourism.

In relation to pollution, watersheds, land use planning, ports and navigation, four strategic objectives were developed. The first is to reduce discharge of sediments, nutrients and agro-chemicals and solid waste in the most polluted watersheds, including the Motagua, Chamelecon, Aguan and Río Dulce-Izabal. The second is to reduce wastewater discharge in the region's main cities and coastal settlement with the greatest impact on ecosystems, as well as a comprehensive management of solid waste generated in coastal cities and watersheds. The third and fourth strategic objectives are aimed at having in place marine and land zoning plans with instruments for assessing cumulative environmental impacts, and that ports, navigation and marinas have updated tools, contingency plans, harmonized environmental regulations, and infrastructure and technology for waste treatment. Finally, mechanisms for payment of environmental services should be provided for ports.

Although several sustainable fishing strategies are grouped together, this strategic objective has special relevance. The goal for fishing

communities is an improved level of organization and economic and environmental sustainability in fishing activities by 2017 in the region's main fishing communities.

Finally, there are seven objectives related to resource sustainable use and marine protected areas. The first is for all marine protected areas to be managed effectively and that conservation of their biodiversity is assured and sustainable. In this case, the aim is for marine protected areas to have an effective legal framework, guaranteed financing, and that threats are controlled. The second objective is for one half of MAR economic resources for conservation to be generated within the region, from direct use and payment for environmental services, and the funds are invested efficiently, equitably and transparently. The other objectives are to develop formal management mechanisms for priority conservation sites outside marine protected areas, including resilient reefs, fish spawning and nursery areas, seagrass beds and mangroves; the declaration of at least four new marine protected areas in the region; coordination of conservation efforts through formal bodies, alliances and application of regional agreements; strengthen application of law through the revision of legislation on environmental crimes; and establish a policy for regional cooperation in surveillance and compliance.

11. Priority strategies:

Several strategies were developed in order to reach these objectives. Below is a summary of strategies selected because of their overall high- and very high-ranked value. Details on all of the strategies formulated can be found in the annex 2.

a) Strategies aimed at marine protected areas:

A group of four high-value strategies involve actions in protected areas that can contribute to the conservation of targets selected in this ecoregional assessment. The first strategy promotes civil society empowerment in the administration of marine protected areas and recognition of traditional use rights, through the establishment of formal administration bodies with broad participation of communities and resource users. The second strategy promotes declaration of new marine protected areas (federal, state, municipal or private) through the development of technical studies, resource users and authorities' participation, lobbying, development of management plans, fundraising, and implementation of management. This strategy focuses particularly on new marine protected areas proposed in Honduras and Mexico. The third strategy promotes the sharing of experiences and good practices among the region's marine protected areas, including management plans, monitoring, tourism and sustainable fishing. Finally, the fourth strategy promotes changes needed in legislation and policies on marine protected areas for their strengthening and harmonization. This strategy aims particularly at fishing legislation, mangrove use and zoning in marine protected areas, which is often uncoordinated.

b) Strategies to foster the sustainability of fisheries:

Two high-value strategies were developed in this category. One is aimed at redefining and implementing no take zones in marine protected areas in order to ensure the recruitment of commercial species. The second strategy promotes and strengthens fishermen organizations at the local, national and regional level, in order to improve economic competitiveness, environmental awareness, legal compliance and political incidence.

c) Strategies for resilience to climate change:

Four strategies with high hierarchical value in the climate change topic promote actions to address this global-level threat. These are: 1) assess the impact of an increase in seawater temperature on reef health and to protect reefs identified as resilient; 2) promote activities to mitigate the effect of a rise in sea level, such as mangrove restoration and protection and broadcast the social effects on coastal communities and on

nursery areas conservation; 3) revise the current network of conservation areas based on new information, much of it not yet available, including reef resilience in sandflats, finfish fishing sites, and spawning and nursery areas for mollusks and crustaceans; and 4) promote and strengthen environmental education programs at all levels regarding the importance of the MAR system and its conservation. Environmental education themes should include global climate change, solid waste and pollution due to wastewater, and promotion of sustainable natural resource use.

d) Strategies to foster land use planning:

With respect to fostering land use planning, three main strategies were developed. These include 1) establish, consolidate and verify the implementation of legal instruments for land use planning in the coastal zone and marine waters. Legal instruments should include assessment of carrying capacity, revision of construction codes, volume of water demand, and maximum permissible construction density, with all of these actions striving for full participation of authorities, civil society and private business. The second strategy is to promote and implement best practices in land management, agro-chemical use, and highway infrastructure development, through economic incentives, training and best practices and environmental certification. The last strategy's goal is reviewing, updating and enforcing regulations on urban wastewater and solid waste management in the entire region, as a mechanism to reduce the impacts of pollution on reefs.

e) Strategies that support the need for research and monitoring:

The final group of high-impact strategies relates to the importance of fostering research and monitoring of marine resources, and includes three strategies. The first is to strengthen the current system of research, monitoring and assessment of the Mesoamerican Reef, through the establishment of the MAR Regional Center and development of the regional agenda to integrate different methodologies and programs. The Regional Center is a research and monitoring structure proposed by the Central American Commission on Environment and Development (CCAD), through the Tulum+8 initiative. The second strategy is to obtain, review and update biophysical information, including data on bathymetry, currents, tides and physical oceanography, related particularly to the threat of commercial and recreational navigation. This strategy implies updating inventories of infrastructure to establish navigation routes and signals, and formulating emergency contingency plans. Finally, the last strategy is to prepare and implement carrying capacity assessments of tourist destinations in the region, to avoid exceeding ecological limits. Use of the precautionary principle is proposed in conducting evaluations of carrying capacity.

CONCLUSIONS

In summary, the ecoregional assessment process reached the proposed goals, as well as enabled the integration of a group of local and regional experts committed to conservation of the Mesoamerican Reef. In addition, it was possible to develop a network of priority conservation areas (portfolio of priority sites) and cost layer utilized by the decision-making tool. Finally strategies were developed and prioritized according to their importance and scope.

Participation during the assessment process was highly satisfactory, with representatives of the four countries of the Mesoamerican Reef and regional experts, with 73 people from 41 different organizations.

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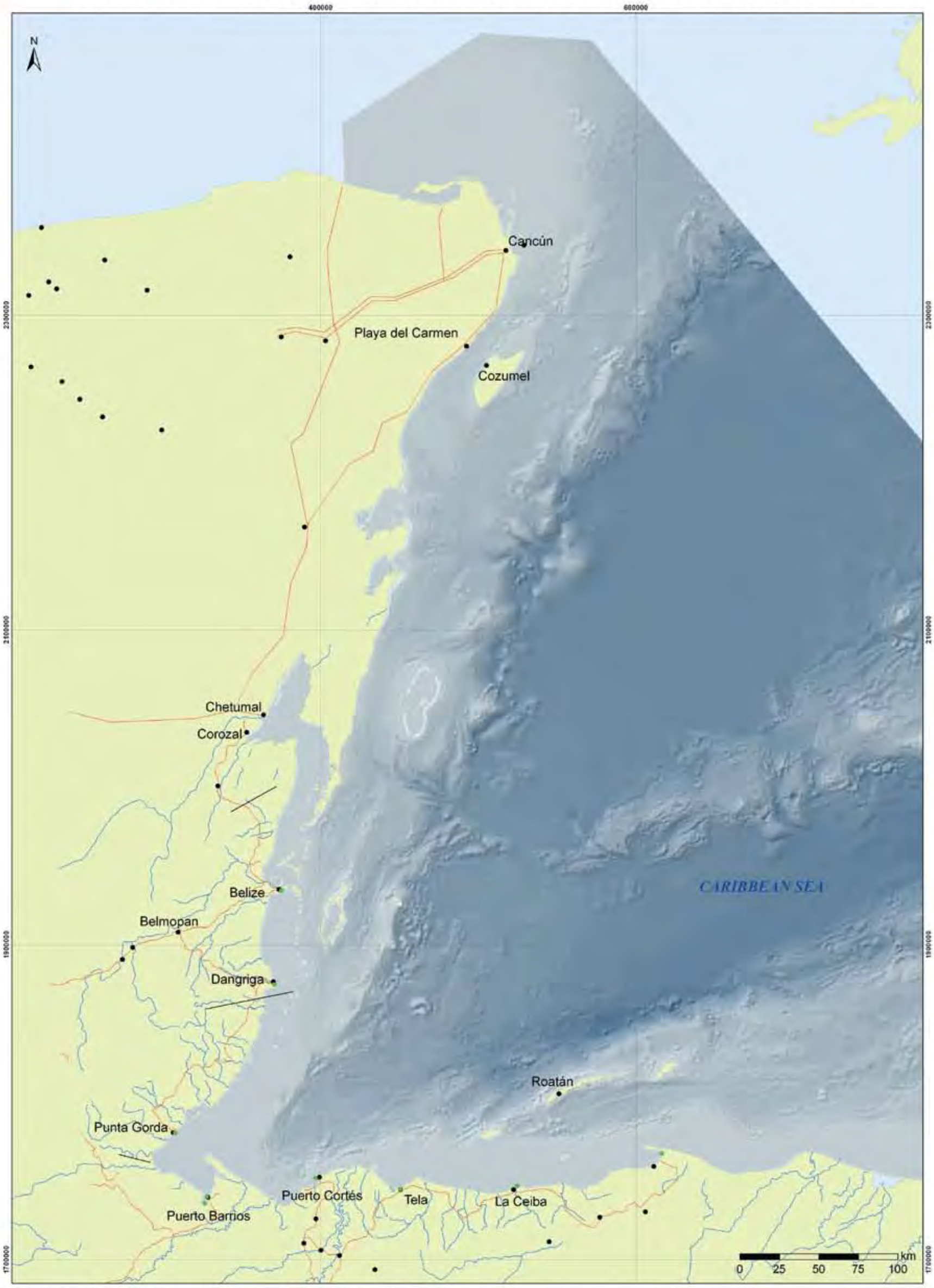
ANNEXES

Annex 1
Maps

MESOAMERICAN REEF: OVERVIEW MAP
ARRECIFE MESOAMERICANO: MAPA DE UBICACIÓN



MESOAMERICAN REEF ECOREGIONAL ASSESSMENT
EVALUACION ECORREGIONAL
ARRECIFE MESOAMERICANO

Study area / Area de estudio: 5,778,172 ha

Projection / Proyección: UTM Zone 16 WGS84
Prepared by: / Preparado por: A. Arrivillaga, 2008

- Inland / Tierra firme
- Highways / Carreteras
- Rivers / Rios
- Cities / Ciudades
- Ports / Puertos

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STUDY EXTENT & STRATIFICATION
AREA DE ESTUDIO Y ESTRATIFICACIÓN

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Stratification / Estratification

1 2 3 4 5 6 7

Study area / Area de estudio
Inland / Tierra firme
Highways / Carreteras
Rivers / Ríos
Cities / Ciudades
Ports / Puertos

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CORAL REEFS
ARRECIFES DE CORAL

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ARRECIFE MESOAMERICANO

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- Coral reefs / Arrecifes de coral
- Inland / Tierra firme
- Study area / Area de estudio
- Highways / Carreteras
- Rivers / Ríos
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MANGROVES
MANGLARES

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Projection / Proyección: UTM Zone 16 WGS84
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- Mangroves / Manglares
- Inland / Tierra firme
- Study area / Area de estudio
- Highways / Carreteras
- Rivers / Ríos
- Cities / Ciudades
- Ports / Puertos

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SEAGRASS BEDS
PASTOS MARINOS

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ARRECIFE MESOAMERICANO

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Projection / Proyección: UTM Zone 16 WGS84
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- Seagrass beds / Pastos marinos
- Inland / Tierra firme
- Study area / Area de estudio
- Highways / Carreteras
- Rivers / Ríos
- Cities / Ciudades
- Ports / Puertos

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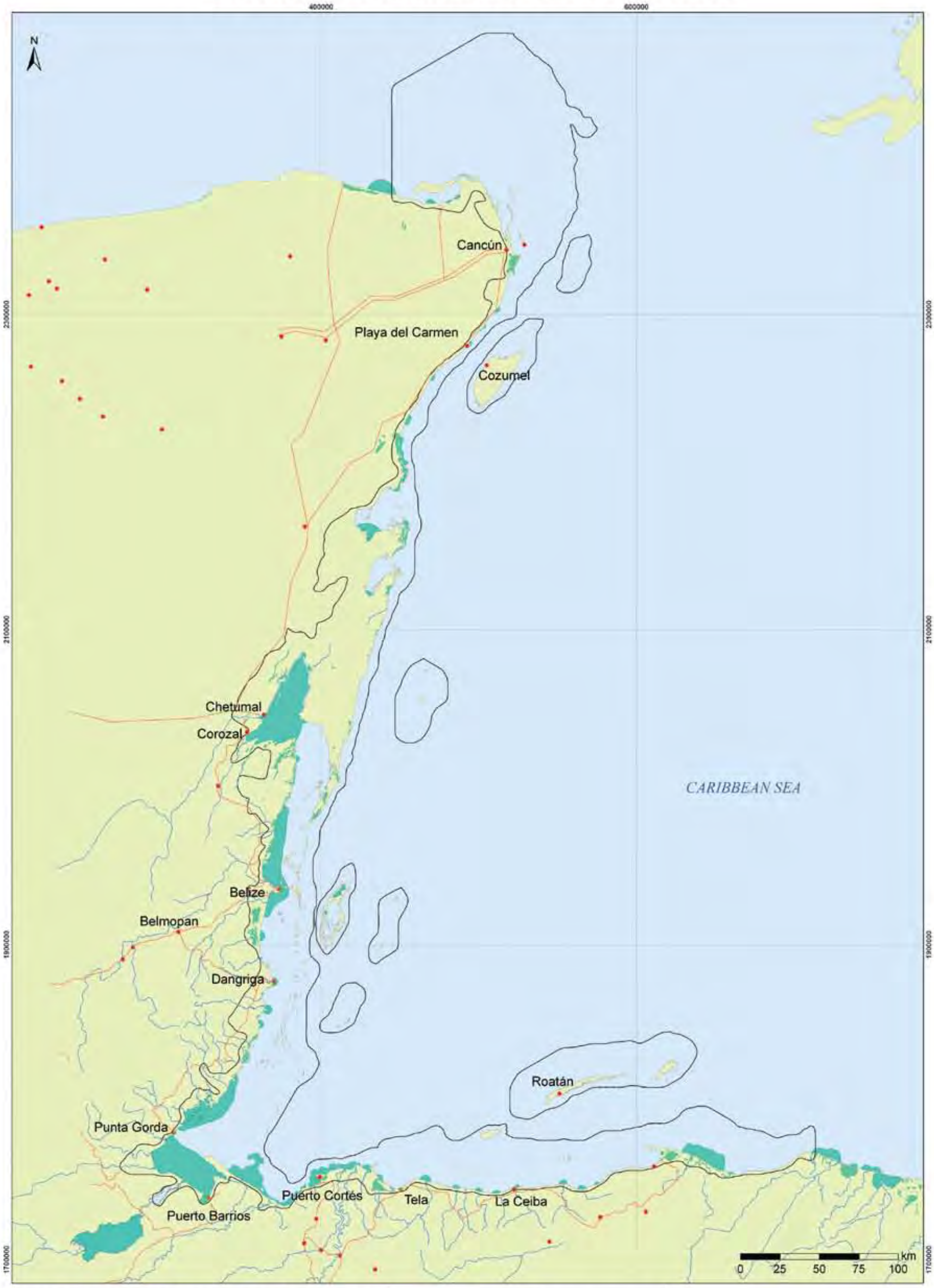
ESTUARIES & COASTAL LAGOONS
ESTUARIOS Y LAGUNAS COSTERAS



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EVALUACION ECORREGIONAL
ARRECIFE MESOAMERICANO

Study area / Area de estudio 5,778,172 ha

Projection / Proyección: UTM Zone 16 WGS84
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- Estuaries & Coastal Lagoons / Estuarios y Lagunas Costeras
- Inland / Tierra firme
- Study area / Area de estudio
- Highways / Carreteras
- Rivers / Ríos
- Cities / Ciudades
- Ports / Puertos

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SANDY BEACHES
PLAYAS ARENOSAS

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EVALUACION ECORREGIONAL
ARRECIFE MESOAMERICANO

Study area / Area de estudio: 5,778,172 ha

Projection / Proyección: UTM Zone 16 WGS84
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- Sandy beaches / Playas arenosas
- Inland / Tierra firme
- Study area / Area de estudio
- Highways / Carreteras
- Rivers / Ríos
- Cities / Ciudades
- Ports / Puertos

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SEATURTLE NESTING SITES
SITIOS DE ANIDAMIENTO DE TORTUGAS MARINAS

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EVALUACION ECORREGIONAL
ARRECIFE MESOAMERICANO

Study area / Area de estudio: 5,778,172 ha

Projection / Proyección: UTM Zone 16 WGS84
Prepared by: / Preparado por: A. Arrivillaga, 2008

- Seaturtle nesting sites / Sitios de anidamiento de tortugas marinas
- Inland / Tierra firme
- Study area / Area de estudio
- Highways / Carreteras
- Rivers / Ríos
- Cities / Ciudades
- Ports / Puertos

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MANATEE HABITAT
HÁBITAT DEL MANATÍ

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EVALUACION ECORREGIONAL
ARRECIFE MESOAMERICANO

Study area / Area de estudio: 5,778,172 ha

Projection / Proyección: UTM Zone 16 WGS84
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- Manatee habitat / Habitat del manatí
- Inland / Tierra firme
- Study area / Area de estudio
- Highways / Carreteras
- Rivers / Ríos
- Cities / Ciudades
- Ports / Puertos

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REEF FISH SPAWNING AGGREGATION SITES
SITIOS DE AGREGACIÓN DE DESOVE DE PECES ARRECIFALES

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EVALUACION ECORREGIONAL
ARRECIFE MESOAMERICANO

Study area / Area de estudio: 5,778,172 ha

Projection / Proyección: UTM Zone 16 WGS84
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- Reef fish spawning aggregation sites / Sitios de agregación de desove de peces arrecifales
- Inland / Tierra firme
- Study area / Area de estudio
- Highways / Carreteras
- Rivers / Ríos
- Cities / Ciudades
- Ports / Puertos

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CROCODILE NESTING SITES
SITIOS DE ANIDAMIENTO DE COCODRILOS

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Projection / Proyección: UTM Zone 16 WGS84
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- Crocodile nesting sites / Sitios de anidamiento de cocodrilos
- Inland / Tierra firme
- Study area / Area de estudio
- Highways / Carreteras
- Rivers / Ríos
- Cities / Ciudades
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SEABIRD NESTING SITES
SITIOS DE ANIDAMIENTO DE AVES MARINAS

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ARRECIFE MESOAMERICANO

Study area / Area de estudio: 5,778,172 ha

Projection / Proyección: UTM Zone 16 WGS84
Prepared by: / Preparado por: A. Arrivillaga, 2008

- Seabird nesting sites / Sitios de anidamiento de aves marinas
- Inland / Tierra firme
- Study area / Area de estudio
- Highways / Carreteras
- Rivers / Ríos
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WHALE SHARK FEEDING AREAS
ÁREAS DE ALIMENTACIÓN DE TIBURÓN BALLENA

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ARRECIFE MESOAMERICANO

Study area / Area de estudio: 5,778,172 ha

Projection / Proyección: UTM Zone 16 WGS84
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- Whale shark feeding areas / Areas de alimentación de tiburón ballena
- Inland / Tierra firme
- Study area / Area de estudio
- Highways / Carreteras
- Rivers / Ríos
- Cities / Ciudades
- Ports / Puertos

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MARXAN ANALYSIS: COST SURFACE
ANÁLISIS MARXAN: SUPERFICIE DE COSTO

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EVALUACION ECORREGIONAL
ARRECIFE MESOAMERICANO

Study area / Area de estudio: 5,778,172 ha

Projection / Proyección: UTM Zone 16 WGS84
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Threat / Amenaza
High / Alta — Low / Baja
Study area / Area de estudio
Inland / Tierra firme
Highways / Carreteras
Rivers / Ríos
Cities / Ciudades
Ports / Puertos

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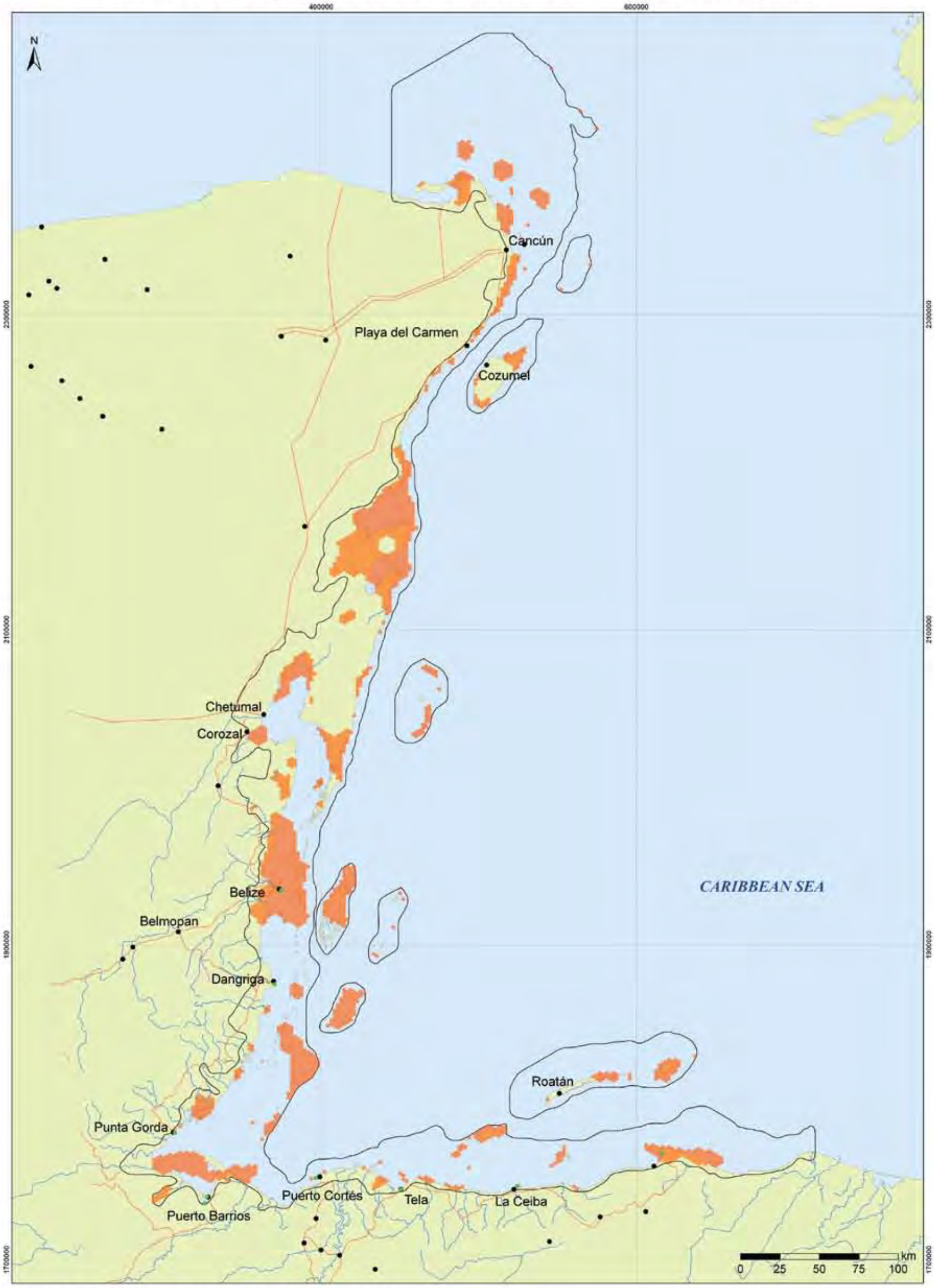
MARXAN ANALYSIS RESULTS: PORTFOLIO
RESULTADOS ANÁLISIS MARXAN: PORTAFOLIO



MESOAMERICAN REEF ECOREGIONAL ASSESSMENT
EVALUACION ECORREGIONAL
ARRECIFE MESOAMERICANO

BLM = 0.25
COST = Averaged suface / COSTO = Superficie promedio
GOALS = Ideal for priorization / META = Ideal para priorización
Study area / Area de estudio: 5,778,172 ha

Projection / Proyección: UTM Zone 16 WGS84
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- Portfolio / Portafolio
- Inland / Tierra firme
- Study area / Area de estudio
- Highways / Carreteras
- Rivers / Ríos
- Cities / Ciudades
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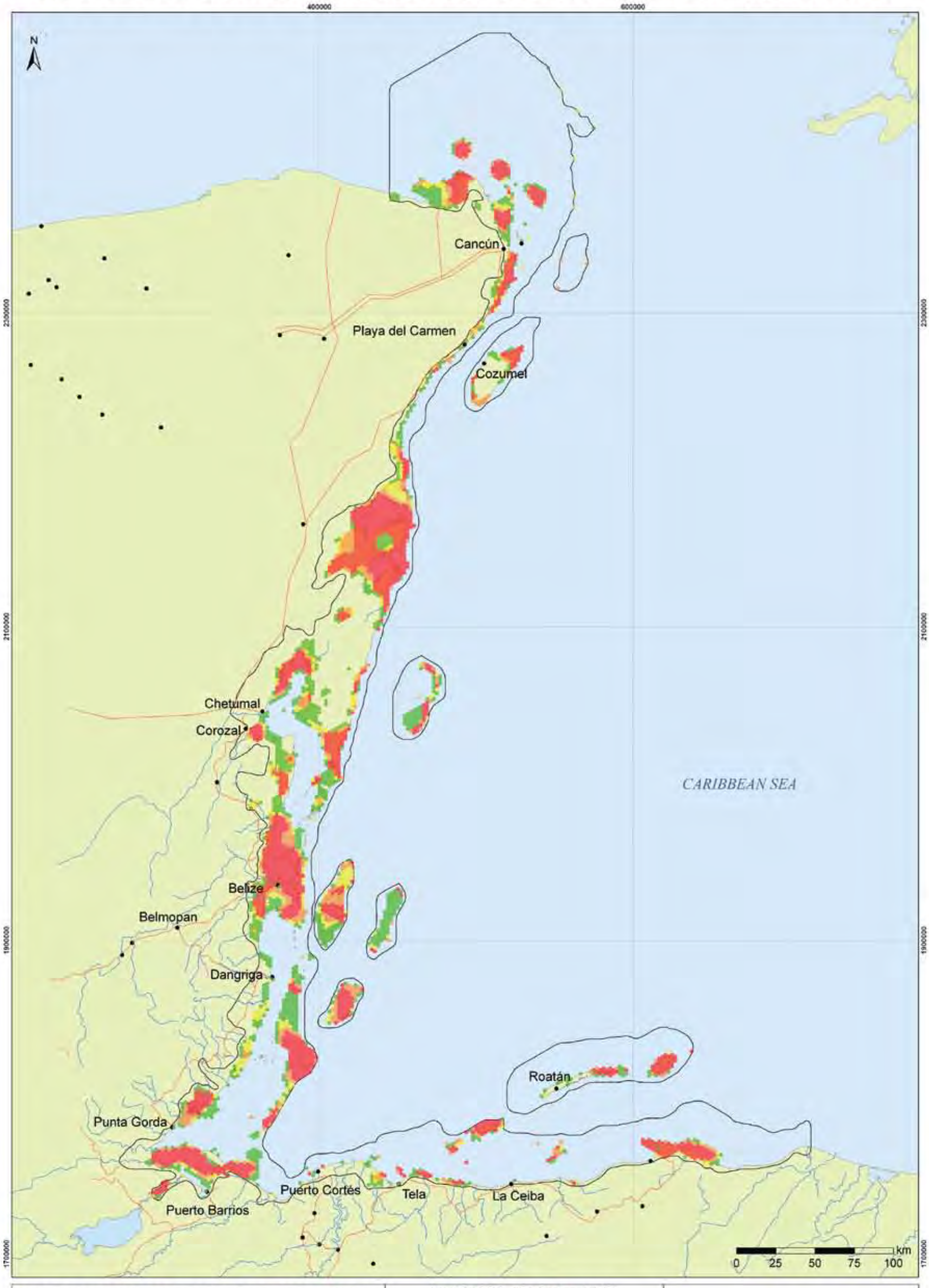
MARXAN ANALYSIS RESULTS: IRREPLACEABILITY
RESULTADOS ANÁLISIS MARXAN: IRREEMPLAZABILIDAD



MESOAMERICAN REEF ECOREGIONAL ASSESSMENT
EVALUACION ECORREGIONAL
ARRECIFE MESOAMERICANO

Study area / Area de estudio: 5,778,172 ha

Projection / Proyección: UTM Zone 16 WGS84
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Irreplaceability / Irreemplazabilidad
21 - 40 41 - 60 61 - 80 81 - 100
Inland / Tierra firme
Study area / Area de estudio
Highways / Carreteras
Rivers / Ríos
Cities / Ciudades
Ports / Puertos

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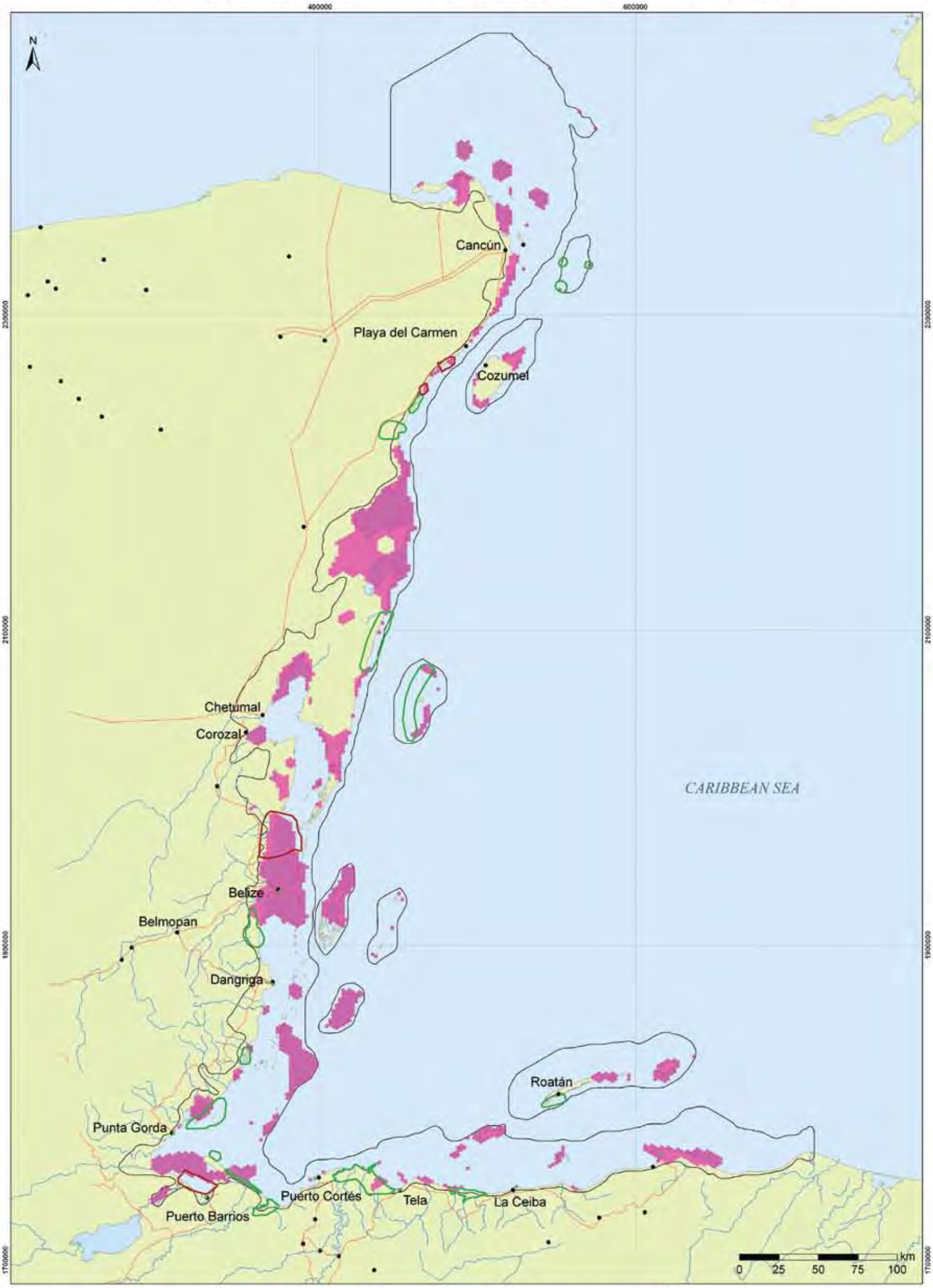
MARXAN ANALYSIS RESULTS: REVISION
RESULTADOS ANÁLISIS MARXAN: REVISIÓN



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EVALUACION ECORREGIONAL
ARRECIFE MESOAMERICANO

Study area / Area de estudio: 5,778,172 ha

Projection / Proyección: UTM Zone 16 WGS84
Prepared by: / Preparado por: A. Arrivillaga, 2008

Areas to include / Areas a incluir
Areas to exclude / Areas a excluir
Portfolio / Portafolio
Inland / Tierra firme
Study area / Area de estudio
Highways / Carreteras
Rivers / Ríos
Cities / Ciudades
Ports / Puertos

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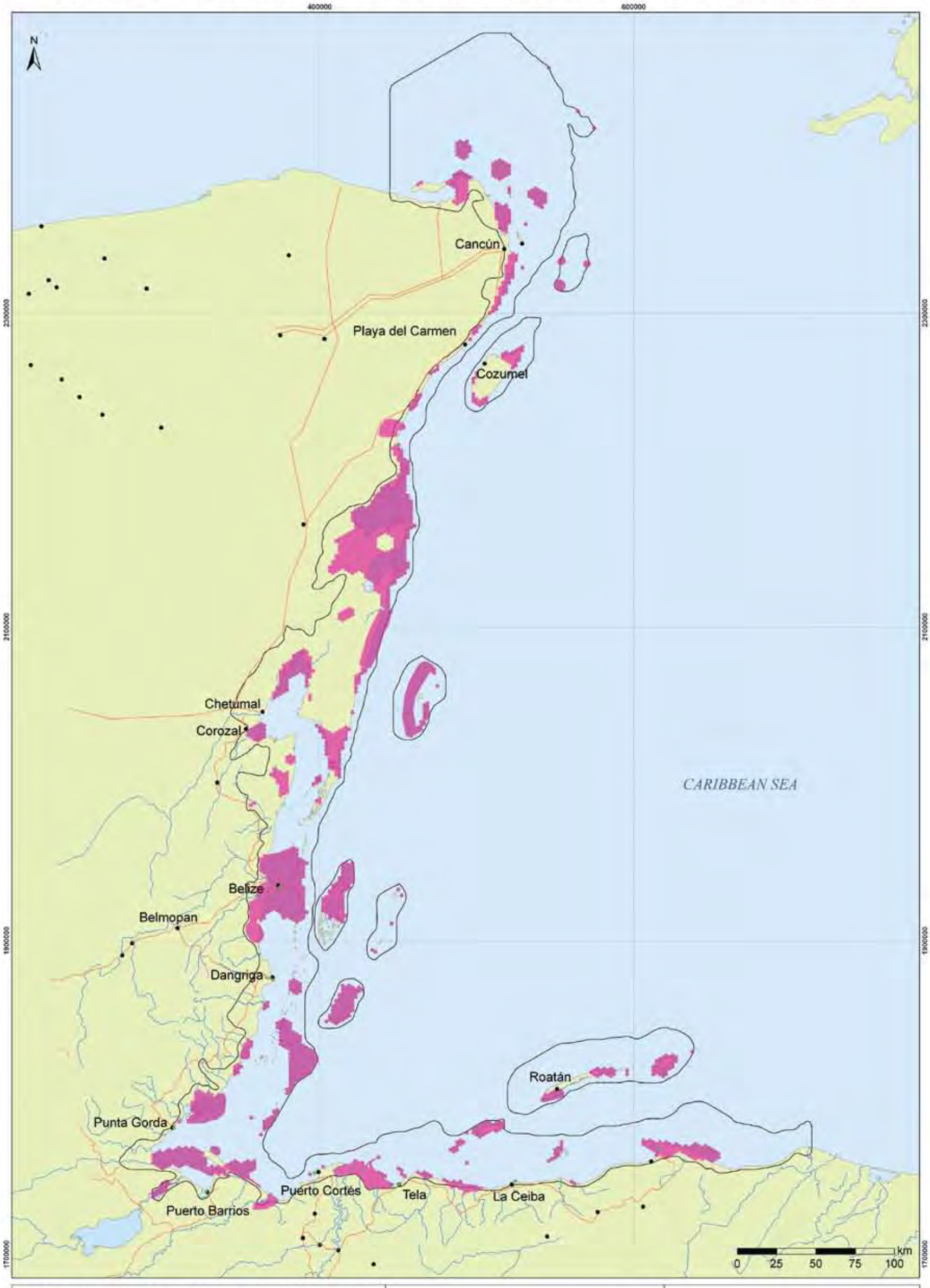
MARXAN ANALYSIS RESULTS: FINAL PORTFOLIO
RESULTADOS ANÁLISIS MARXAN: PORTAFOLIO FINAL



MESOAMERICAN REEF ECOREGIONAL ASSESSMENT
EVALUACION ECORREGIONAL
ARRECIFE MESOAMERICANO

Study area / Area de estudio: 5,778,172 ha

Projection / Proyección: UTM Zone 16 WGS84
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- Final portfolio / Portafolio final
- Inland / Tierra firme
- Study area / Area de estudio
- Highways / Carreteras
- Rivers / Ríos
- Cities / Ciudades
- Ports / Puertos

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PRIORITY CONSERVATION SITES
SITIOS PRIORITARIOS DE CONSERVACIÓN

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EVALUACION ECORREGIONAL
ARRECIFE MESOAMERICANO

Study area / Area de estudio: 5,778,172 ha

Projection / Proyección: UTM Zone 16 WGS84
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- Priority sites / Sitios prioritarios
- Study area / Area de estudio
- Inland / Tierra firme
- Highways / Carreteras
- Rivers / Rios
- Cities / Ciudades
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Annex 2

Development of Strategies for the Main Threats to Conservation Targets in the Mesoamerican Reef

Threat: global climate change

a) Strategies focused on mitigation of global climate change and its effects

Vision: The ecoregion recognizes the risks and vulnerability of the biodiversity and ecological integrity of the MBRS and recommends compliance with the Kyoto protocol, National Plans of Adaptation to GCC and the commitments and programs of the Intergovernmental Panel on Climate Change (IPCC) and other policies and ongoing actions to mitigate and reduce greenhouse gas emissions, so that the countries of the region contribute to full compliance with the commitments acquired, demanding that the rest of the international community do so as well.

Strategic 10-year objective	Line of action (strategies)	Actions
Promote awareness and compliance with international commitments aimed at mitigating GCC and encourage all types of activities to reduce emissions	The conservation community and group of organizations uniting around MBRS conservation promote awareness and environmental education about the effects of GCC on the ecosystems of the ecoregion.	The work group of the ecoregional plan declares on behalf of regional governments' compliance with agreements and protocols.
		Promotion of sustainable products, services and practices on the coast and inside the countries
		MBRS governments implement solid environmental education programs that incorporate this theme in national study plans at all levels
		Promotion of a summit of countries in the ecoregion so that the agencies responsible in each country share experiences and information and integrate efforts for collaboration
		Promote agreements between conservation organizations to harmonize GCC mitigation efforts
	Promote among visitors to the region the urgent need for mitigating GCC in order to contribute to the conservation of the MBRS and its attractions	Develop informational material about GCC and its effects on the ecoregion for intensive dissemination in cruise ships, hotels, tourist attractions, etc.
Foster conditions so that MBRS ecosystems are conserved and kept viable in the context of GCC and its impacts	Promote a research program to find out GCC impact on the ecoregion's ecology and focal conservation targets	Generate research to forecast GCC impacts on the region's coastal zone and aquatic ecosystems
		Determine the ecosystems' vulnerability and resilience to GCC
		Establish a long-term regional system for monitoring indicators of vulnerability and resilience to GCC
		Implement a system of fund raising for GCC research using a percentage of fees imposed on visitors and service providers, as well as the governments
		Conduct studies on ocean-atmosphere carbon exchange in the MBRS region
		Integrate a regional center of excellence focused on research on GCC in the MBRS with the participation of an interdisciplinary group from the four countries

b) Strategies aimed at the adaptation of ecological processes, ecosystems and species to the effects of GCC

Threat: rise in sea level (direct effects on mangroves, beaches and turtle nesting sites, growing areas and coastal lagoons)

Vision: Through special management practices and measures, encourage processes enabling ecosystems and focal conservation targets to adapt to the rise in sea level (calculated at 4 mm a year, equal to 40 cm in 100 years), aimed at conserving the greater part of the biodiversity in the ecoregion

Strategic 10-year objective	Line of action (strategies)	Actions
Find out the impacts that a rise in sea level will have on the entire region in order to propose management measures for adaptation	Study the balance between average rise in sea level and sediment accumulation (accretion) and coastal subsidence	Set up a network of accretion and subsidence measures in mangrove zones and beaches throughout the region
		Set up a network of tide graphs throughout the region, complementing those already existing (Red Mexicana de Nivel del Mar - REDMMAR)
	LIDAR surveys available to generate simulation models for rise in sea level using modeling in a Geographic Information System	Propose to governments funding and preparation of sub-meter digital elevation models of MBRS coasts, islands and cays due to their economic importance
	Project the potential impacts of rise in sea level on infrastructure and human activities in order to determine social, economic and environmental impacts	Create human resource and infrastructure capacities in countries of the MBRS region in order to develop these projections and other studies on GCC
Based on the findings of research on impacts, design and promote management activities for ecosystems' adaptation to rise in sea level	Promote projects to restore mangrove areas degraded by both natural elements and human activities	
	Detect stands of mature mangroves and actively protect them	

Threat: Unsuitable aquatic tourism activities

Vision: The ecological integrity of the Mesoamerican Reef, MAR, is maintained, and enjoyed by informed users who have adopted best use practice.

Strategic 10-year objective	Line of action (strategies)	Actions	Comments
Maintain and improve the integrity and viability of the MAR aquatic environment (coral diversity and abundance of fishes, measured using scientific protocols)	Develop and implement guidelines to ensure MAR's sustainability as a tourist destination	Investigate existing guidelines	Involve tourism service providers in the creation of these materials
		Develop and implement relevant guidelines	Develop in the same way that the standards of the ICRAN project (International Coral Reef Action Network) were developed
		Prepare informational documents (flyers, brochures, posters, videos) for distribution to users	Present the videos to all passengers of cruise ships
		Produce and distribute regional standards and informational material for tourism service providers and employees of cruise ships	
	Develop regular training events and certification processes for all tourism operators and guides	Training courses general and specific for each site)	
		Certification of tourism operators and guides	Carry out regional training sessions on use of the new materials
		Implement standardized monitoring protocols to evaluate the effectiveness of the guides	
		Conduct user counts to evaluate efficiency and implementation of the guidelines	
		All aquatic tourism providers educate their customers utilizing video or verbal communication	Include the 5 minute video-briefing in the general "Welcome to the Cruise Ship" video
		Tour operators deliver the region-wide video/ verbal briefing to ALL customers.	Use the standard video prior to all in-water activities

Strategic 10-year objective	Line of action (strategies)	Actions	Comments
Create and implement regulations to ensure the integrity of the aquatic environment and the safety of the users	Create regional regulations and promote their subsequent implementation	Involve providers in the creation of these regulations	Use the leverage of international conservation-oriented NGOs to encourage the creation of these regulations
			Carried out in the same manner as the ICRAN standards development
		Train providers in the use of these regulations	Carry out region-wide training sessions on the use and existence of these regulations
	Implement and apply laws and regulations in the MAR region	Monitor in-water activities	Foster the involvement of local enforcement agencies and NGOs
		Collect data on user patterns	Carry out user surveys to evaluate the efficiency and implementation of the guidelines
		Institute a line of standard consequences/ fines to users/providers violating the standards	Consequences for similar neglect of regulations are standardized within the region
		Limit the number of users in certain areas at one time (create and follow carrying capacity criteria)	Establish this "carrying capacity" criteria by involving all actors within the specific regions
Regional laws and regulations have been established and are observed by all ship operators	Create and promote these regulations in a regional forum	Involve providers in the creation of these regulations	Use the leverage of international conservation-oriented NGOs to foster the creation of these regulations. Carried out in the same way as the ICRAN standard development
		Train providers on the use of these regulations	Carry out region-wide training sessions on the use and existence of these regulations
		Reinforce application of the regulations in the MAR region	Standardized penalties

Strategic 10-year objective	Line of action (strategies)	Actions	Comments
		All providers follow a set of standard rules and regulations.	
		Eliminate ALL fish feeding practices	
	Certify all ship captains to ensure navigation follows safe practices in the MAR region	All visitors with no experience in captaining a boat must be accompanied at all times by a certified captain	Create/develop a region-wide certifying agency
		All visitors wanting to captain a chartered boat must undergo a training session focused on the local environment (local navigation charts, etc.)	

Threat: Development of tourism infrastructure, urban coastal development, wastewater discharge, accumulation of solid wastes

Vision: Urban and tourism development is in alignment with a plan that considers the health of the ecosystems and which is socially and economically beneficial and sustainable.

10-YEAR OBJECTIVE OR LESS	Line of Action	Action
Wastewater discharge- ensure that 90% of water is treated	1) Revision, updating and application of laws and regulations on wastewater throughout the region. (Actors in Mexico: National Water Commission, CNA and CAPA)	1A) revised norms (Mexico: karst)
		1B) Review existing water treatment technologies
		1C) Inventory discharge levels and sources as well as existing systems
		1D) Raise awareness of decision makers and responsible entities
		1E) Analyze economic and social impact on tourism and inhabitants' health from having high levels of contamination and resultant beach closings, loss of tourism, etc.
	2) Strengthen authorities in the theme of wastewaters	2A) Identify funding mechanisms for the installation of adequate wastewater treatment systems
		2B) Provide advising for authorities to prepare proposals and access funds for installing adequate wastewater treatment systems

10-YEAR OBJECTIVE OR LESS	Line of Action	Action
		2C) Create strategic alliances among governments, NGOs and international agencies in order to implement wastewater management programs
	3) Promote non-concentrating technologies (artificial wetlands, improved septic tanks, etc.) for wastewater management. Re-use of gray water, dry compost bathrooms associated with backyard garden projects	3A) Create a discussion forum on the issue of wastewater to raise awareness, information about new technologies, find out about funding sources, etc.
		3B) Review non-concentrating and innovative technologies
Accumulation of solid wastes- Ensure comprehensive solid waste management in the region	1) Revision, updating and application of laws and regulations related to solid waste in the entire region. Official Mexican Norm (NOM) on landfills in Mexico should be adjusted to the conditions of Quintana Roo.	1A) Revise and complement existing regulations
	2) Strengthen authorities and service providers in the theme of solid waste	2A) Identification of management and training gaps
		2B) Establish parallel strategies for solid waste management
	3) Work with the communities and do environmental education	3A) Promote waste recycling and industrialization programs. Fabricate compost associated with backyard garden projects in rural zones. Promote biodegradable disposable products.
		3B) Certification of industry producing solid wastes
	4) Ensure that the countries sign MARPOL 5 and ensure that facilities exist so ships can treat or unload their waste	4A) Ensure suitable management of used oils and batteries produced by maritime transport
Coastal urban development- have ecological zoning plans and institutions that ensure they are followed	1) Establish and consolidate instruments for land use planning in the coastal zone. Regularize the concession of federal maritime zone in Mexico	1A) Mexico: establish penal sanctions for public officials who violate ecological land zoning plans (POETs), as well as for private persons responsible for the projects

10-YEAR OBJECTIVE OR LESS	Line of Action	Action
	2) Create the legal foundations if none exist	
	3) Make sure these are being complied with if they do exist	3A) Co-participation of society in monitoring processes
		3B) Strengthening of the institutions responsible for implementing the POETs. Include inspection and surveillance.
	4) Disseminate information and mount campaigns informing the public about the POETs	4A) Design an Internet portal for accessing information about POETs
		4B) Design a campaign to publicize the POETs
Tourism—tourism development internalizes the costs of mitigating their own impacts	1) Revision, updating and application of regulations regarding location, construction and operation of tourism infrastructure (hotels, docks, roads, airports) in the entire region	1) Revise norms and laws currently in effect in the four countries and promote mechanisms for inter-institutional coordination to get them applied
	2) Make a review of models of tourism development and propose suitable models compatible with management of the ecosystems	2A) Establish carrying capacities and/or acceptable carrying limits for the different tourism sites
		2B) Promote negotiations to drive fair tourism (suitable dispersion of profits)
		2C) Promote agreements between businesspeople and government for the development of strategies for absorbing environmental impacts
	3) Encourage diversification of tourism activities	
	4) Develop a strategy for cooperation and dissemination of best practices in tourism development with the tourism industry	4) Negotiate with governments for implementation of specific regulations concerning cruise ships (that includes management of solid and liquid wastes)
	5) Identify mechanisms so that the tourism industry pays the environmental costs of the development	

Threat: Sedimentation and discharge of agro-chemicals and pesticides

Vision: Maintain low levels of sedimentation, agro-chemicals and pesticides so they do not affect the ecological integrity, functionality and permanence of the ecosystems and coastal and marine species

Strategic 10-year objective	Line of action (strategies)	Actions
For the year 2017, reduce discharge of **sediments** by 25% in the priority watersheds (Motagua watershed in Honduras, watersheds in south Belize, Río Dulce and Río Sarstun in Guatemala)	Maintenance of riverine vegetation (riparian)	Promote changes in laws to regulate and protect riparian vegetation
		Restoration of riparian vegetation
	Best practices of adequate soil management	Promote soil management practices in priority areas
		Train and provide inputs in best practices in priority areas
		Construction of terraces, gabions, reforestation
	Generate the information necessary for monitoring and supporting watershed management	Modeling of sedimentation in different scenarios
		Determine historical sedimentation
		Success indicators of the actions (materials carried by water currents and sedimentation rate)
		Generate and validate maps on soil use capacity
For the year 2017, reduce the concentration of **agrochemicals and pesticides** by 25% in the priority watersheds (Motagua watershed in Honduras, watersheds in the south of Belize, Río Dulce and Sarstun in Guatemala, and underground watersheds in Mexico	Good practices in management of pesticides and agrochemicals by farmers in the watersheds above	Promote practices in management of pesticides and agrochemicals in priority areas
		Train and provide inputs in best practices in priority areas
		Promote changes in the law to regulate and prohibit the use of pesticides and agrochemicals. Foster and support organic farming.
		Compliance with the Stockholm Convention on POPs with respect to agrochemicals and pesticides
		Encourage and raise awareness of agroindustry regarding certification of their products
	Need for generating information necessary for monitoring and supporting watershed management	Modeling and validation of nutrients carried (developed by WWF and ICRAN MAR)
		Evaluation of the concentration of pesticides and agrochemicals in bodies of water and fishes in order to establish a baseline
		Monitoring of success indicators for the actions (concentration in water currents and fishes)

Threat: overfishing and unsuitable fishing practices (harpoon, trawling, Scuba)

Vision: Artisanal fishing: transform small-scale fishing so that it can become sustainable, economically efficient and organized. Organization will be accompanied by economic efficiency.

Strategic 10-year objective	Line of action (Strategies)	Actions
Fishers share regional vision: transform small-scale fishing so that it can become sustainable, economically efficient and organized	Prepare and carry out a training program focused on fishers that includes the three following components: organization, sustainability and economic efficiency	Implement a general educational campaign prior to formal training in order to inform and obtain the fishermen's feedback. This activity will be aimed at 50% of the fishermen's organizations already established.
	With those same fishermen, define economic alternatives to improve domestic economies during times of low catch or closed seasons; for example, course on repairing outboard motors	Use the opportunity of the educational campaign to compile the fishermen's initiatives
		Search for funding to implement the initiatives
Artisanal fishing is sustainable	Compliance with the law, protection of spawning areas, and closed areas	100% increase in investments for application of the law in the next 10 years
		10 to 20% increase in the areas with fishing restrictions within the protected areas
		Create a community volunteer patrolling program
		Integrates 70% of the spawning aggregation (SPAGS) and fish growing sites within the marine protected area system of the Mesoamerican Reef
	50% of fishers in the Mesoamerican program are applying self-regulatory systems as codes of conduct, best management practices or certification programs. This objective cannot be achieved if fishermen are not organized.	Conduct case studies for validation and monitoring of application of these codes or practices in at least three communities per country
		Create environmental awards for fishermen or associations that carry out best practices or codes in an exemplary manner. The awards should be given annually with the help of the press.
	Alternative for fishing communities	
Artisanal fishing is economically efficient	Assign value-added in terms of quality, presentation and storage	
	Reduction in the cost of inputs, group purchasing	

Strategic 10-year objective	Line of action (Strategies)	Actions
Artisanal fishing is organized	Strengthen already existing organizations and promote the creation of new ones	In 10 years, 80% of the fishermen are organized. This action should be implemented locally.
		10% increase in the number of fishermen joining these associations
	Codes of conduct	By the end of 2010, create a handbook on best fishing practices integrating current fishing law

Threat: Navigation

Vision: Environmentally responsible and committed navigation

Strategic 10-year objective	Line of action (strategies)	Actions
60% of navigation in the region has updated navigational tools	Updating of hydrographic information	Hydrographic surveys
		Updating of nautical charts
		Dissemination of information through port authorities
		Possess technology for signage of sites with environmental importance
All of the main ports in the region have contingency plans for prevention and attention to emergencies and they are applied	Updating or preparation of contingency plans	Implement plans
		Lobbying with port authorities and other key actors to guarantee that plans are implemented
		Carry out simulations in addressing emergencies
		Zoning of navigation areas, considering hydrography and ecological factors
The four countries in the ecoregion have harmonized environmental regulations for navigation and the regulations are observed.	Harmonization of the environmental regulations related to navigation	Review of legislation and proposal on modifications and creation of new laws where necessary
		Standardization of norms
		Establish a monitoring and evaluation system for compliance with norms
		Carry out campaigns on the importance of the marine environments in port authorities and private navigation businesses

Strategic 10-year objective	Line of action (strategies)	Actions
The number of incidents of anchorage and running aground on reefs has been reduced 80% from the current situation	Improve signage of areas that are particularly sensitive to navigation	Installation of signal buoys in critical areas
		Modification of related laws so that sanctions are in proportion to the impacts caused
		Promote the application of best practices in navigation using the existing guides at the local, national and regional level
		Training of ship operators in the importance of reducing impacts on the reef and in other themes, such as social organization. Consider establishing an accreditation system to promote good management.

Threat: Development of transportation infrastructure (docks, ports, canals, dredging, fill, dykes, oil pipelines)

Vision: Transportation infrastructure development responding to coastal planning in line with environmental standards.

10-year or less objective	Line of action	Action
Ports with infrastructure and technology for treatment of liquid and solid wastes	Compliance with existing environmental legislation as well as international conventions signed, i.e., MARPOL	Develop the infrastructure necessary for waste disposal and treatment (bilge and ballast water) in the ports
Creation and implementation of coastal zoning plans	Economic resources obtained for creation and/ or monitoring of the zoning plans	Formulation of the plans in Honduras and Guatemala
		Lobbying in the four countries in order to achieve the plans' implementation
		Development of mechanisms of payment for environmental services for environmental costs of infrastructure development and operation
Compliance with country commitments in the application of national and international laws and treaties on coastal development	Review of the current situation regarding commitments and compliance	Dissemination of the countries' commitments in the area of coastal zoning

Opportunity Analysis

Characteristics intrinsic to conservation targets	Mangroves	Estuaries, and growing zones	Seagrass beds	Reefs	Beaches	SPAGs	Manatees whale shark turtles	Birds, crocodiles
Resilience within natural time frames if they are not destroyed	Medium	Medium	High	Low	High	Low	Low	Medium
Low population density (from Tulum southward)	High	High	Medium	High	Low	High	High	Medium
Existence of a legal framework (Mexico, Belize, Guatemala-weakness in liquid waste management, Honduras) **Application of the law**	MX Low GT Medium BZ High HN High	MX Low GT Low BZ Low HN Low	MX Low GT Low BZ Medium HN Low	MX High GT Low BZ Medium HN Low	MX Low GT Medium BZ Medium HN Low	MX Low GT NA BZ High HN None	MX High GT High BZ Medium HN Medium	MX High GT High BZ High HN None
Existence of land use plans (Mexico-adequate, none in Belize-, Guatemala-, Honduras). **No weakening of land use plans**	MX Medium GT None	MX Medium GT None	MX Medium GT None	MX High GT None	MX High GT None	MX na GT NA	MX na GT BZ HN|	MX na GT BZ HN
Existence of global niche for a responsible, low-density tourism market	Medium	Low	Low	High	High	Medium	High	High
Existence of international markets for certified products/services in terms of their low environmental impact	N.A.	Medium	N.A.	N.A.	N.A.	High	Low	Low
Existence of remote-sensing technologies to identify the threats themselves and monitor them	High	Low	High	Low	High	N.A.	N.A.	N.A.
Existence of best practices for: tourism (T), lobster fisheries (F), agriculture (A)	T High F NA A NA	T High F Low A Low	T Medium F NA A NA	T High F Low A Medium	T Medium F NA A NA	T High F High A NA	T High F NA A NA	T High F NA A NA
Existence of incipient socially/ environmentally responsible corporate culture (concrete experiences in the region: Dole, Chiquita, Crop Life. Fyffes)	Low	Medium	Low	High	Medium	NA	Low	Low

Opportunities to create a favorable environment:

- Existence of political conditions for the project through the Central American Integration System, of which Mexico is an observer
- Pre-existence of assemblages of natural protected areas in the countries
- Multinational interest in conservation of the ecosystem with a comprehensive vision
- Existence of a large quantity of NGOs, donors, experiences and some alliances; Increase work in NGO networks in order to carry out positive work on behalf of the ecosystems
- Formation of genuine alliances in each one of the four countries
- Existence of national and regional funding mechanisms
- Need for innovative and long-term strategies for feeding them
- Existence of protocols, treaties and conventions for environmental conservation
- Application and strengthening of those instruments (participation of the NGOs)
- Existence of a tourism industry that requires the persistence of natural assets (diving, sport fishing, observation of species and charismatic phenomenon, adventure tourism, etc.)
- Fishing sector's growing awareness of the importance of maintaining the fisheries and convergence with the environmental sector
- Existence and empowerment of fishermen's organizations and coastal communities enabling them to play an important role in the process (Mexico-more or less, Belize-, Guatemala-, Honduras)
- An important stock of information exists in the region.
- There is a social awareness of the value to the economy represented by natural resources and the services they provide society. It is necessary to reinforce this awareness in order to keep large economic interests from destroying them with the complacency of the governments. This can be done by utilizing the mass media. In addition, studies are needed in order to quantify the value of the services and utilize this information to politically influence.
- Existence of international markets/incentives for certified products/services in terms of their low environmental impact

Annex 3

Strategic objectives and their success indicators:

OBJECTIVE	INDICATORS
1. By 2011, the governments and civil society have built a solid bloc that exercises significant influence at international forums on global climate change, in alliance with the Small Island Development Countries (SIDs)	Number of countries in the region that have ratified international conventions on global climate change; percent compliance with agreements on global climate change in each country of the region
2. By 2011, knowledge of the impacts that rising sea level and water temperature will have on the region, and concrete management measures have been proposed for adaptation and protection of refuge sites	Number of tide graphs and accretion and subsidence measures set up and functioning; existence of fine-scale topographical maps for the coast of the region
3. By 2009, regional research and monitoring programs are permanent, have long-term funding and the information generated is used in decision-making	Number of themes and sites that are being permanently monitored; MBRS Regional Center established and functioning; number of decisions made based on scientific and traditional knowledge; percent of recommendations established in the reports that are incorporated in government work programs; number of regional investigations carried out and applied; number of monitoring programs implemented regionally
4. By 2010, best tourism practices have been harmonized and adopted in the region in order to maintain and improve ecosystem integrity and viability (2009: 50% tour operators are certified; 2012: 100%).	Percent compliance with best practices in aquatic tourism; percent of tour operators of aquatic tourism certified
5. By 2017, reduce discharge of sediments, nutrients and agrochemicals and solid wastes by 35% in the watersheds that contaminate most (Motagua watershed, Chamelecon, Aguan and Río Dulce-Izabal)	Number of hectares of riparian vegetation restored; number of hectares or linear meters under suitable land conservation and agrochemical use practices; percent of riparian vegetation maintained; volume of nutrients, sediments and agrochemicals discharged per year by the main watersheds
6. By 2017, wastewater discharge in the main cities and coastal settlements of the region that most impact on ecosystems has been substantially reduced in accordance with the capacity of the system (90% in Mexico, 30% in the rest of the region), and 50% of the solid wastes from coastal cities and 30% from watersheds are comprehensively managed in the region	Percent increase of the budget coming from ports, derived from environmental services payments; percent volume of wastewater in each one of the main coastal cities; percent volume of solid wastes treated in the coastal cities; volume of solid wastes accumulated on the beaches

OBJECTIVE	INDICATORS
7. By 2017, all coastal and marine zones have territorial and marine ecological zoning plans and instruments for cumulative environmental impact assessments, and these are 80% implemented and complied with	Percent compliance with zoning plans; percent of territory with zoning plans; number of mitigation measures that involve more than one country for projects that have transboundary effects; number of projects that have transboundary effects that are analyzed in a coordinated manner by the countries affected, in relation to the number of projects existing
8. By 2017, the ports, 60% of navigation and 80% of marinas have updated tools, contingency plans, harmonized environmental regulations, infrastructure and technology for waste treatment and mechanisms for payment of environmental services	Percent increase of the budget coming from ports, derived from payment for environmental services; percent of marinas complying with the regulations established; percent of ports and marinas that comply with dredging regulations; number of incidents of anchorage and running aground on reefs and other critical habitats
9. By 2010, tourism generates greater economic income for natural resource protection and for at least 40% of the communities where community tourism is viable, including scientific and cultural tourism	Quantity of money and percent of funds generated by tourism that is directed toward nature conservation and promotion of community tourism; existence of an institution in each country in charge of channeling tourism-generated taxes toward nature conservation and promotion of community tourism; number of communities, families and SMEs that benefit from tourism in the region
10. By 2017, fishing in the main fishing communities of the region has improved the level of organization and economic and environmental sustainability	Number of violations to fishing regulations; number of local, national and regional organizations; number and percent of fishermen that have adopted activities other than fishing; number and percent of fishermen that have adopted best practices, percent of families participating in fishing per community; percent of the fishermen organized; abundance and sizes of fishery populations; increase in economic income per family derived from fishing activities
11. By 2012, all of the marine protected areas are being managed effectively and their conservation is ensured and sustainable (have effective legal framework, guaranteed funding and threats are controlled)	Number of denunciations of regional impact made, processed and sanctioned; number of business plans prepared, implemented and evaluated; effectiveness of improved management
12. By 2017, 50% of MAR funds allocated for conservation are generated within the region from direct use and payment for environmental services, and are invested efficiently, equitably and transparently	Percent of MAR funds allocated to conservation that come from national, international and local funds; percent of national budgets dedicated to conservation of MAR; percent of the estimated portfolio conservation cost that is being financed; proportion of PES generated in comparison to the value of the environmental services
13. By 2012, formal conservation mechanisms have been developed in the priority sites of the portfolio outside the marine protected areas, including resilient reefs, spawning and growing sites, seagrass beds and mangroves	Number of resilient reefs that have management regulations; number of areas declared closed or off limits to fishing

OBJECTIVE	INDICATORS
14. By 2012, at least four new marine protected areas have been declared in the region	Number of new marine protected areas declared
15. By 2008, conservation efforts are made in a coordinated and integrated manner through formal bodies, alliances and the application of regional agreements	Ministers Council formed and operating; Consultative/ Advisory Committee formed and functioning; number of activities executed together by different sectors; number of agreements implemented between institutions and the private sector; number of exchange programs at the regional level
16. By 2017 there is greater commitment to conservation of the Mesoamerican Reef on the part of decision makers, local communities, private sector and other key actors in the region.	Number of newspaper articles and radio/television programs referring to the environment of the Mesoamerican Reef; number of workshops carried out by the trained trainers; number of candidates for the award/recognition; number of sponsors involved in funding of the awards/recognition; percent reduction in the cost of patrolling activities in relation to the incentives
17. By 2010, application of justice has been strengthened through the revision of legislation on environmental crimes and establishment of policy for regional cooperation in issues of surveillance and compliance with legislation.	Number of warnings/patrolling hours; number of captured vs. number processed; number of convictions

Annex 4

Prioritized strategic actions:

Strategies of overall very high hierarchical value:

Strategic Actions	Benefits *	Feasibility **	Cost ***	Objectives It Helps to Achieve	Selected for Taking Action
Promote civil society empowerment in the administration of marine protected areas and recognition of traditional use rights, through the establishment of formal administration bodies with extensive participation of communities and resource users	Very High	Medium	Medium	11	Yes
Promote the declaration of new federal, state, municaipal and private marine protected areas, based on technical studies made, convergence with users and authorities, lobbying, management plans, fund raising, and the implementation of management, with particular focus on the areas proposed in Honduras and Mexico[1]	Very High	Medium	Medium	11, 14	Yes
Promote the necessary changes in legislation and policies regarding marine protected areas for their strengthening and harmonization (legislation on fishing, use of mangrove and zoning in the marine protected areas)[2]	Very High	Medium	Medium	11	Yes

Strategies with high hierarchical value:

Strategic actions	Benefits *	Feasibility **	Cost ***	Objectives It Helps Achieve	Selected for Taking Action
Develop and implement assessments of carrying capacity in the tourism destinations of the region and in the mean time utilize the precautionary principle	Very High	Medium	Very High	4, 11, 13, 17	Yes
Design and set up liquid and solid waste treatment systems suited to current and anticipated volume and the type of waste to be treated, including appropriate management of dangerous materials and disposal of dredged sediments[3]	Very High	Medium	Very High	6, 8	No
Establish, consolidate and verify the implementation of legal instruments for land use planning in the coastal zone and marine waters, which include measurement of carrying capacity, building codes, water volume, construction density, etc., with full participation of authorities, civil society and private business	Very High	Medium	Very High	5, 6, 7, 8, 9, 11, 13, 17	Yes
Assess the impact of the rise in seawater temperature on reef health and protect the reefs identified as resilient	Very High	Medium	High	2, 11, 13, 14, 16	Yes
Strengthen the system of research, monitoring and evaluation of the Mesoamerican Reef through the establishment of the MBRS Regional Center[4] and the development of a regional agenda that integrates the different methodologies and programs	Very High	High	Very High	1, 2, 3, 5, 6, 7, 8, 10, 11, 13, 14, 16	Yes
Obtain, review and update biophysical information (bathymetry, currents, tides, physical oceanography), legal information and infrastructure inventories in order to establish routes and signage helpful for navigation and contingency plans	Very High	Medium	Very High	3, 8, 17	Yes
Promote activities mitigating the effects of the rise in sea level, such as restoration and protection of mangroves, planting of *Acropora* coral, dissemination of the social effects, etc.	Very High	Medium	High	2	Yes
Promote and implement best practices in soil management and use of agrochemicals in agricultural areas and highway infrastructure development through economic incentives, training and environmental certification[5]	Very High	Medium	High	5	Yes

Strategic actions	Benefits *	Feasibility **	Cost ***	Objectives It Helps Achieve	Selected for Taking Action
Promote sharing of experiences and good practices among the marine protected areas of the region, including management plans, monitoring, tourism and sustainable fishing	Medium	Very High	Medium	9, 10, 11	Yes
Promote and strengthen fishermen's organizations at the local, national and regional level, in order to improve their economic competitiveness, environmental awareness, legal compliance and political advocacy	High	High	High	10, 13, 16, 17	Yes
Promote and strengthen environmental education programs at every level (government and civil society[6]) about the importance of the MBRS and its conservation (priority issues: global climate change, solid waste, wastewater, sustainable natural resource use, etc.)	Very High	Medium	Very High	1, 4, 5, 12, 16	Yes
Redefine and implement no-fishing zones in the marine protected areas in order to ensure recruitment of commercial species	Very High	Medium	High	11	Yes
Review design of the network of conservation areas with new information (reef resilience, sand flats, finfish, mollusks and crustaceans, etc.)	Very High	Medium	High	3, 11, 13, 14	Yes
Review, update and apply regulations related to urban wastewater and solid waste management in the entire region	Very High	Medium	High	6	Yes

Strategies of medium hierarchical value:

Strategic Actions	Benefits *	Feasibility **	Cost ***	Objectives It Helps Achieve	Selected for Taking Action
Train and certify ship operators in observance of regulations and navigation rules	Medium	Medium	Low	4, 8	Yes
Create and/or strengthen national funds based on already established taxes on tourism in order to fund conservation of nature and development of community tourism destinations, especially through micro, small and medium businesses (MSMBs)	Medium	Medium	Medium	9, 12, 16	Yes
Develop and implement public use plans in the marine protected areas as integral part of the management plans, in order to minimize the impact of tourism and ensure its contribution to the financial sustainability of the marine protected areas and neighboring communities	Medium	High	High	7, 9, 11, 12	Yes
Develop a monitoring program on discharge of sediments, nutrients and agrochemicals in the priority watersheds of the region[7]	Medium	Medium	Medium	5	Yes
Develop and strengthen local, national and regional mechanisms for conservation funding: public and private funds, payment of fees, concessions, payment for environmental services, and taxes[8]	Medium	Medium	Medium	3, 9, 11, 12	Yes
Establish and operationalize a multi-sector consultative / advisory council as an integral part of the Action Plan of the Mesoamerican Reef, with the participation of representatives of government, the fishing and tourism private sector, academia, and local and international NGOs, and organize local communities (do the necessary advocacy)	Medium	Medium	Low	1, 15, 16	Yes
Formation and consolidation of national alliances between the governments and NGOs of the Mesoamerican Reef[9]	Medium	Medium	Low	1, 15, 16	Yes
Generate information about the economic value of the goods and services produced by the Mesoamerican Reef[10]	Medium	High	Medium	9, 10, 11, 12, 16	Yes

Strategic Actions	Benefits *	Feasibility **	Cost ***	Objectives It Helps Achieve	Selected for Taking Action
Increase surveillance, improve and harmonize regulations (closed seasons on lobster, conch, shrimp, sea bass) conserve spawning and growing areas and foster good practices and responsibility on the part of fishermen and consumers, with an emphasis on the marine protected areas	High	Medium	Very High	10, 13, 16, 17	Yes
Improve the management, processing and marketing of fishery products in order to give greater value-added and quality and obtain greater economic benefits for the fishermen of the region[11]	Medium	Medium	Medium	10	Yes
Modify legislation in order to increase penalties for environmental crimes	High	Low	Medium	6, 17	Yes
Promote the support of regional and national alliances, such as the association of marine protected areas administrators of the Caribbean CAMPAM), the Tri-national Alliance of the Gulf of Honduras (TRIGoH), BEMANCOR and RHEDES, in strengthening application of environmental legislation	Low	High	Low	17	Yes
Promote wastewater treatment and solid waste management in the coastal cities through strengthening of municipal authorities, promoting discussion forums, access to sources of funding and involving private initiative[12]	Very High	Low	Very High	6	Yes
Promote the urgent need to mitigate global climate change and its impact on tourism among visitors, so that they influence and act locally and in their countries of origin, through informational material in cruise ships, hotels, tourist attractions, etc.	Medium	Medium	Medium	4, 5, 6, 9, 10, 16	Yes
Promote decision makers' support for changes in policies and regulations that favor socioeconomic and environmental sustainability of fishing through documentation of successful cases, organized demand by society and political linkage, among others	Medium	Medium	Medium	10, 13, 14, 17	Yes
Promote and strengthen authorities responsible for implementation of terrestrial and marine zoning	Medium	Medium	Medium	7, 11, 16, 17	Yes

Strategies with low hierarchical value:

Strategic actions	Benefits *	Feasibility **	Cost ***	Objectives It Helps Achieve	Selected for Taking Action
Create and implement an information and public awareness program about regulations on navigation, port security, and incidents of running aground and anchoring in critical areas, so that the population participates in surveillance and supports compliance	Medium	Low	High	8, 11, 16, 17	Yes
Develop, train, disseminate and implement best practices in low-impact and massive aquatic tourism, in alliance with the tourism industry (assess those already existing for the region, train and certify tour operators and guides, disseminate to tourists)	Medium	Medium	High	4, 8, 9	Yes
Disseminate the results of research and monitoring to decision makers in the region and to the general public	Low	Medium	Medium	3, 16	Yes
Establish and operationalize the Ministerial Council for the region, in support of the presidents' proposal in the Tulum +8 Declaration	Low	Medium	Low	1, 15, 16	Yes
Assess the impact of the rise in sea level by studying its balance with accretion and subsidence- on the coasts develop fine-scale topographical surveys (sub-meter), model scenarios and quantify their socioeconomic and environmental impact[13]	Low	Medium	High	2, 3	Yes
Regionally assess large-magnitude projects with potential transboundary impacts, identify joint mitigation measures and assess the cumulative impact of local projects[14]	Medium	Medium	High	1, 7, 8, 17	Yes
Strengthen the institutions responsible for application of environmental legislation	Medium	Medium	Very High	17	No
Implement actions and management plans for priority areas outside of the marine protected areas system, including connectivity corridors, alliance building, technical studies, convergence and approval of plans, implementation and monitoring, etc.[15]	Medium	Medium	Very High	10, 13, 17	Yes

Strategic actions	Benefits *	Feasibility **	Cost ***	Objectives It Helps Achieve	Selected for Taking Action
Implement management practices in maritime transportation, infrastructure and public use for the protection of resilient coral reefs	Medium	Low	High	8, 13	Yes
Promote alternative economic activities such as tourism, trade, manufacturing, carpentry, mechanics and repair of ships, and aquaculture in the coastal communities in order to reduce pressure on fishery resources	Medium	Medium	High	10	Yes
Promote maintenance and restoration of riparian vegetation through economic incentives and technical assistance[16]	Medium	Medium	High	5	Yes
Promote the creation of official and community no-fishing areas and other instruments such as concessions, quotas and sizes, that protect spawning and growing areas and important sites for commercial species agreed together with fishermen	Medium	Medium	High	10, 13, 14, 17	Yes
Promote government allocation of the necessary budget for conservation in the region based on the real cost to conservation[17]	Low	Medium	Low	11, 12, 13	Yes

Strategies without overall hierarchical value:

Strategic Actions	Benefits *	Feasibility **	Cost ***	Objectives It Helps Achieve	Selected for Taking Action
Ensure the incorporation of information compiled in the Mesoamerican Environmental Information System-Regional Monitoring and Visualization System (SIAM-SERVIR) and in information-sharing mechanisms (Clearing House) established by the Commission on Biological Diversity (CBD) in the governments of the region	-	High	Low	1, 3, 15	Yes
Find out the structure and dynamics of the underground watersheds in the Yucatán peninsula in order to guide application of prior actions in that region[18]	-	High	Medium	6	Yes
Develop an incentive and stimulus program for the promotion of environmental protection and sustainable development (award /recognition for conservation; recognition for sustainable production)	-	Medium	Low	4, 5, 10, 16	No
Have regional systems and agreements for the prosecution of environmental crimes throughout the region, including exchanges and coordinated patrols	-	Low	Low	17	No
Foster massive tourism as a space for the promotion and sale of community-based natural and cultural tourist destinations, such as visitation alternatives	-	Low	Low	9, 16	Yes
Strengthen the development of organizations and associations of local tourism service providers, micro, small and medium-sized community businesses, through training, financing, legal protection, certification, incentives for the promotion of products, trade association advocacy and sharing of experiences	-	Medium	High	9	Yes
Identify the most viable mechanisms for implementing payment for environmental services in port and navigation activities[19]	-	Medium	Low	8, 11, 12, 16	No
Promote the development and implementation of business plans for all of the marine protected areas in the region, identifying sources of income and mechanisms for their development[20]	-	Medium	Medium	12	Yes
Promote influencing by the MBRS Commission on governments of the region to ratify and comply with commitments in international agreements on GCC (declaration, lobbying, sharing of experiences, coordinated actions of civil society, etc.)	-	Medium	Medium	1	No

Notes:

* Benefits: includes contribution, duration and influence

** Feasibility: includes presence of a lead person or institution, ease of implementation, and the ability to motivate the key public

***Costs = very high: more than $1 million; high: $100,000-$1,000,000; medium: from $10,000-$100,000; low: less than $10,000

1. Honduras: Sandy Bay – West End, Turtle Harbor, Barbareta – Santa Elena, Michaels Rock, Laguna de Guaimoreto and Cuyamel; Mexico: Cozumel Norte, Banco Arrowsmith, Xamanhá, Mahahual, extension of Yum Balam

2. Zoning of coastal lands within the protected areas is not coordinated with the administrator of the protected natural areas. The zoning plans cannot impact on the protected area. The feasibility of the strategy in Belize is high, even though the impact on threats to conservation targets is limited to the geographical space of the protected areas.

3. This is a strategy that should be implemented through the port companies and other groups in the private sector. Work should focus on encouraging these sectors to invest in this strategy. The governments should enforce compliance with national and regional laws and norms regulating these activities.

4. The MBRS Regional Center will focus on research and monitoring and will be made up of an interdisciplinary group from the four countries of the region, aimed at issues such as vulnerability and resilience, forecasting of effects from global climate change, valuation of environmental goods and services, traditional knowledge, etcetera. Integration of the different methodologies and programs should also be sought in order to optimize efforts.

5. Does not include the Yucatán peninsula or solid wastes. Shrimp cultivation is not covered since it is a medium-level threat. It is necessary to work with large companies and small farmers. The challenge is to substantially increase the coverage of our actions.

6. This strategy has not advanced well in the large diversity of prior experiences in the region.

7. This strategy is essential in order to verify impacts. Its direct contribution is minimal, but annual monitoring should be implemented in the main watersheds, at the level of the river mouths.

8. Not in itself a strategy that abates any threat, but is necessary in order to support multiple strategies.

9. In Belize there is a National Protected Areas System Commission. In the cases in which the NISPs include local NGOs, this can be a frame of work.

10. Strategy that supports several other strategies, but in itself does not abate any threat. It is an important strategy for any negotiation with decision makers.

11. There are several antecedents in this theme and processes initiated that should be complemented. The effort should channel funds from other sources in order to improve the management, processing and marketing of these products.

12. Very complicated strategy, but with a great deal of impact.

13. Currently investigation exists only in Mexico, so it is not sufficient for the entire region.

14. For example, projects such as the Panama Puebla Plan and Mundo Maya

15. A very broad strategy that should be deployed in stages, initiating with site identification.

16. Strategy that provides many benefits in retention of sediments, mitigation of landslides, etc. Should be selected for action. Riparian vegetation is essential for good management, but contributes little to the objective.

17. Strategy does not abate any threat, but supports many other strategies.

18. Strategy itself does not reduce threat level, but is a vital contribution toward future management of the peninsula in order to achieve strategies of wastewater treatment and regulations.

19. This is a strategy that should be tackled mainly at the local level with the government and port authorities.

20. Strategy that applies only to protected areas. It is considered a very important strategy, despite the low score because it is not connected with the threat.

Annex 5

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