

# Management plan for the natural resources of the EEZ of the Dutch Caribbean

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## Executive Summary

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### Preamble

On the 10th of October 2010 the governmental entity known as the Netherlands Antilles is scheduled to cease to exist. Each island will acquire a new status within the kingdom. Following the declaration of an Exclusive Fishery Zone (EFZ) in 1993, an Exclusive Economic Zone (EEZ) has been declared in the Dutch Caribbean on the tenth of June 2010.

The EEZ area concerned, is a large expanse of sea which harbours exceptional biodiversity, and represents an important natural renewable resource potential. The Netherlands Antilles, Aruba and The Netherlands have, therefore, opted to draft a management plan for the EEZ. This initiative began in the year 2005 when the first conference regarding the management of the biodiversity in the EEZ was held. The consensus was that despite a fragmented Dutch Caribbean, the EEZ should always be integrally managed. In 2009 the participants of the second conference confirmed the need for a common management and developed common goals, principles and a framework for the management of the Dutch Caribbean waters. Resulting from this conference a management plan was drafted, circulated to all stakeholders and discussed on the 1<sup>st</sup> of June 2010. Based on the input and feedback received, as well as subsequent correspondence, this final management plan was jointly developed.

The Dutch Ministry of Agriculture, Nature, and Food Quality (LNV) gave financial support to facilitate the process. This management plan initially stems from the framework policy plan "Natuurbeleid van de Nederlandse Antillen" (2000) that recognized the urgent need for a management plan for the Saba Bank, situated inside the EFZ waters, to ensure sustainable fisheries and protection of its rich biodiversity. It also closely follows the intention of the Kingdom with regards to the goals set forth in the Dutch biodiversity policy programme "Beleidsprogramma Biodiversiteit 2008-2011". In this respect, as a party to the Convention on Biodiversity, The Netherlands also has a strong international commitment to help stem the global decline in biodiversity by the year 2010.

This management plan outlines the purposes and manner in which the Caribbean Exclusive Economic Zone and Saba Bank in particular may be used in a sustainable manner, based on a shared vision and common set of goals. It outlines the management objectives, as well as key policies, and strategies with which to achieve sustainable management. It also addresses the administrative structure, resource use, financial support, key information needs, and action points most urgently required to set sustainable management in place.

To set the stage for implementation and properly initiate this process governments of The Netherlands Antilles, Aruba and The Netherlands have, among others resolved to:

- a) take those steps needed to legally designate the Saba bank as a specially protected national marine area,
- b) take all steps necessary to legally designate the Dutch Caribbean EEZ as a Marine Mammal Sanctuary,
- c) install a EEZ Marine Resources Committee to guide the process of further management implementation and
- d) allocate the required core funding.

These important intentions are formalized and set in action by means of the following **Agreement** between parties:

## **Agreement between Curaçao, Aruba, St. Maarten, and the Netherlands**

Hereby, the governments of the Netherlands Antilles, Aruba, and the Netherlands declare their joint intention to safeguard the “Common sustainable management of marine biodiversity (the living and non-living resources), which includes the protection of species, and habitats in the waters and on the seabed of the Dutch Caribbean EEZ and the zone between the borders of the Island marine parks and territorial waters, with a particular focus on special areas such as Saba Bank and particular species”.

This intention is meant to include, but not be limited to, the protection of species and habitats in the water column and on the seabed with a particular focus on special areas of concern, such as the Saba Bank, and particular species of concern, be they of conservation or commercial importance. In so doing the governments of the aforementioned Kingdom partners additionally intend to update and effectuate their compliance with all applying international conventions and adherent protocols.

To this end the governments of the Netherlands Antilles, Aruba, and the Netherlands hereby decide to:

**1) Take all steps necessary to legally designate the Saba Bank as a specially protected national marine area**

**2) Take all steps necessary to legally designate the Dutch Caribbean EEZ as a Marine Mammal Sanctuary by national law**

**3) Install and finance a EEZ committee, for which this document will serve as the terms of reference and which will have as its tasks to:**

- A) Provide for active management of the Dutch Caribbean EEZ by developing common policies.
- B) Promote sufficient stakeholder involvement in the development and implementation of the management plan.
- C) Develop an integrated research and monitoring plan taking into account the different competences of partners and counterparts using local capacity as much as possible, and which will focus on:
  - a. The compilation and assembly of baseline data on the distribution and abundance, habitats, species and communities represented, as well as key ecological driving factors of concern, be they natural or anthropogenic.
  - b. The treaty obligations following from international conventions and their protocols.
  - c. Encourage research contributing to the conservation and sustainable use of biological diversity.
  - d. Stimulate the dissemination of research results and monitoring data in relevant regional and international networks.
- D) Conduct a 3 yearly evaluation of the management and monitoring activities and adapt the management accordingly.
- E) Conduct all preparations towards the establishment of the Dutch Caribbean as a sanctuary for marine mammals.
- F) Conduct all preparations towards IMO nomination and ultimate designation of the Saba Bank as a Particularly Sensitive Sea Area (PSSA).
- G) Support the organization and implementation of sustainable and viable traditional coastal fisheries, recreational fisheries, Saba fisheries and (semi)industrial fishery on pelagic species in territorial waters and the EEZ.
- H) Ensure that the finances acquired through licenses, permits etc (cost recovery) are both allocated and used for the sustainable management of the natural resources.



- l) Support the implementation of adequate law enforcement, including enforcement of fisheries legislation.

**4) Annually allocate the following funds towards achieving basic management objectives for the EEZ biological resources.....**





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## Acknowledgments

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## 1 Introduction

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Currently, the constitutional restructuring of the Kingdom of the Netherlands towards a new status for the various islands of the Netherlands Antilles is in progress. On the 10th of October 2010 the governmental entity known Netherlands Antilles is scheduled to cease to exist. The islands of Curaçao and Sint Maarten are intended to become autonomous territories, as is the case already with Aruba. The islands of Bonaire, Sint Eustatius and Saba together known as the BES ('Bijzondere Eilandelijke Status') islands, will become more closely tied to the Netherlands. They will become part of the Netherlands and have the status of 'special municipality'. Since June 2010 there is an Exclusive Economic Zone (EEZ) in the Dutch Caribbean including the BES islands ('Besluit grenzen exclusieve economische zone van Aruba en de Nederlandse Antillen' published on 10 June 2010).

### June 2010 conference

In his opening speech for the Maritime conference held on June 1, 2010, in Bonaire, the Governor of the Netherlands Antilles, Excellency Mr. Fritz Goedgedrag, welcomed the initiative to manage the EEZ biological resources. He expressed the hope that while the Netherlands Antilles stands to be dismantled after 10-10-10, the same would not be the case with their joint biodiversity in the EEZ. He found it very wise that before the dissolution of the Netherlands Antilles comes into effect, the entities will have taken initiatives for cooperation in the field of common management of biodiversity, management of the Saba Bank, and designation of the Dutch Caribbean EEZ as a marine mammal (whale) sanctuary, based on an active and sustainable policy. He further stressed the supranational character of the matter and that it can only be dealt with through interregional and international cooperation. He concluded succinctly by saying "In this field autonomy seems an inadequate phenomenon".

In his turn, the Minister of Economic and Labour Affairs of the Netherlands Antilles, Honourable Mr. Ing. Elvis Tjin A Sjoe, pointed out that the people of the Netherlands Antilles have always been strongly aware of their dependency of the surrounding sea and its natural resources. He continued by saying that in light of the constitutional reforms under way for the Netherlands Antilles, and to be properly prepared to further develop the local and international fisheries of the islands in a responsible and sustainable manner on behalf of the local fishermen and fisheries of all the islands, it is a necessary and very important condition for the Netherlands Antilles to draft a management plan for the Exclusive Economic Zone (EEZ) of the Caribbean part of the Kingdom so as to manage this huge zone in a proper manner.

The current Caribbean EEZ (Stb. 2010, 277) consists of two sectors, a southern sector associated with the leeward ABC-islands (Aruba, Bonaire and Curaçao) lying off the coast of Venezuela, and a northern sector, associated with the windward islands of Saba, St. Eustatius and St. Maarten (Figure 1 and 2). Respectively these sectors have a surface area of approximately 71.198 en 21.803km<sup>2</sup> (Data VLIZ).

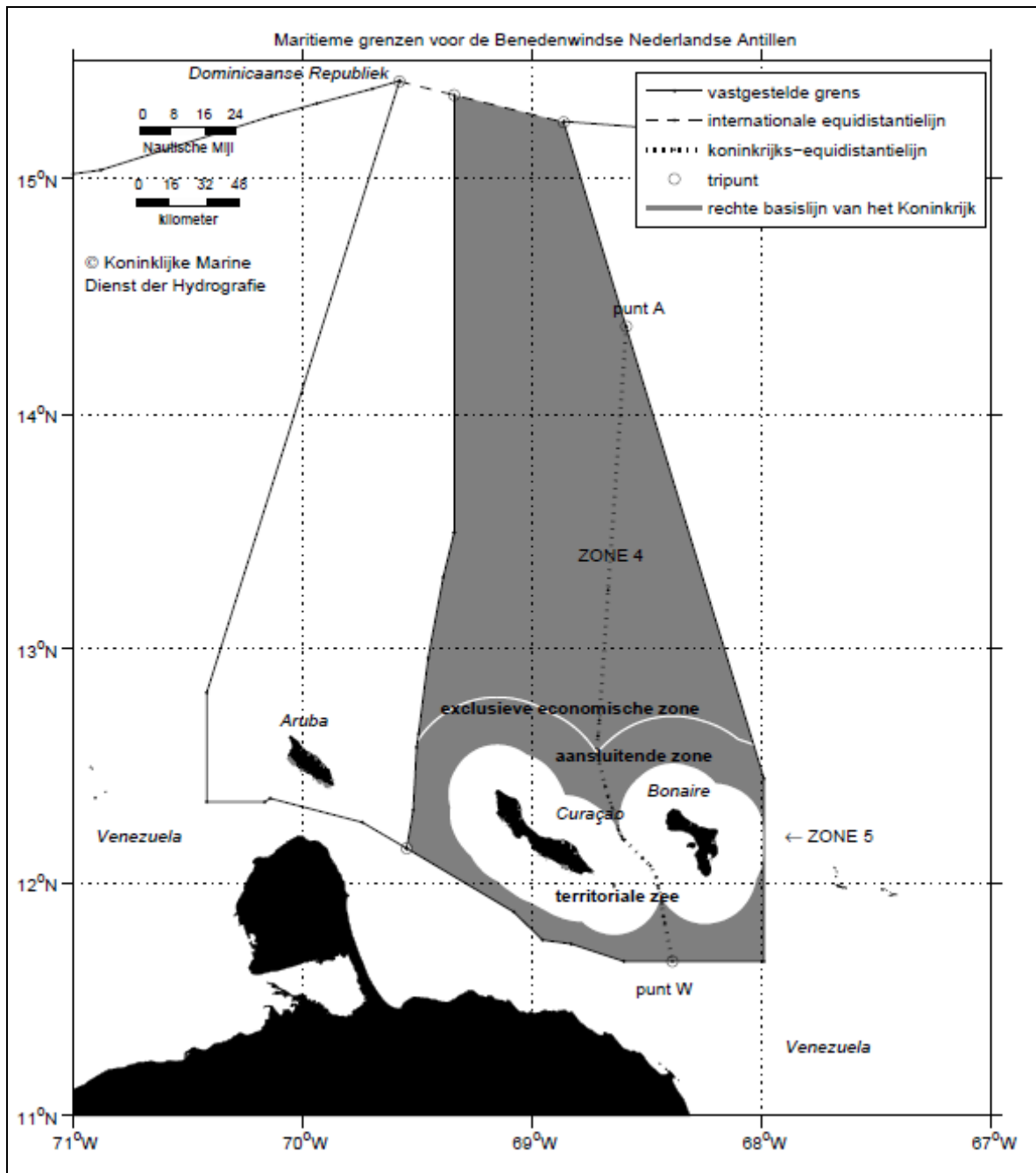


Figure 1. Maritime boundaries ABC islands (Appendix 1 from "Besluit grenzen exclusieve economische zone van Aruba en de Nederlandse Antillen", Stb. 2010, 277).

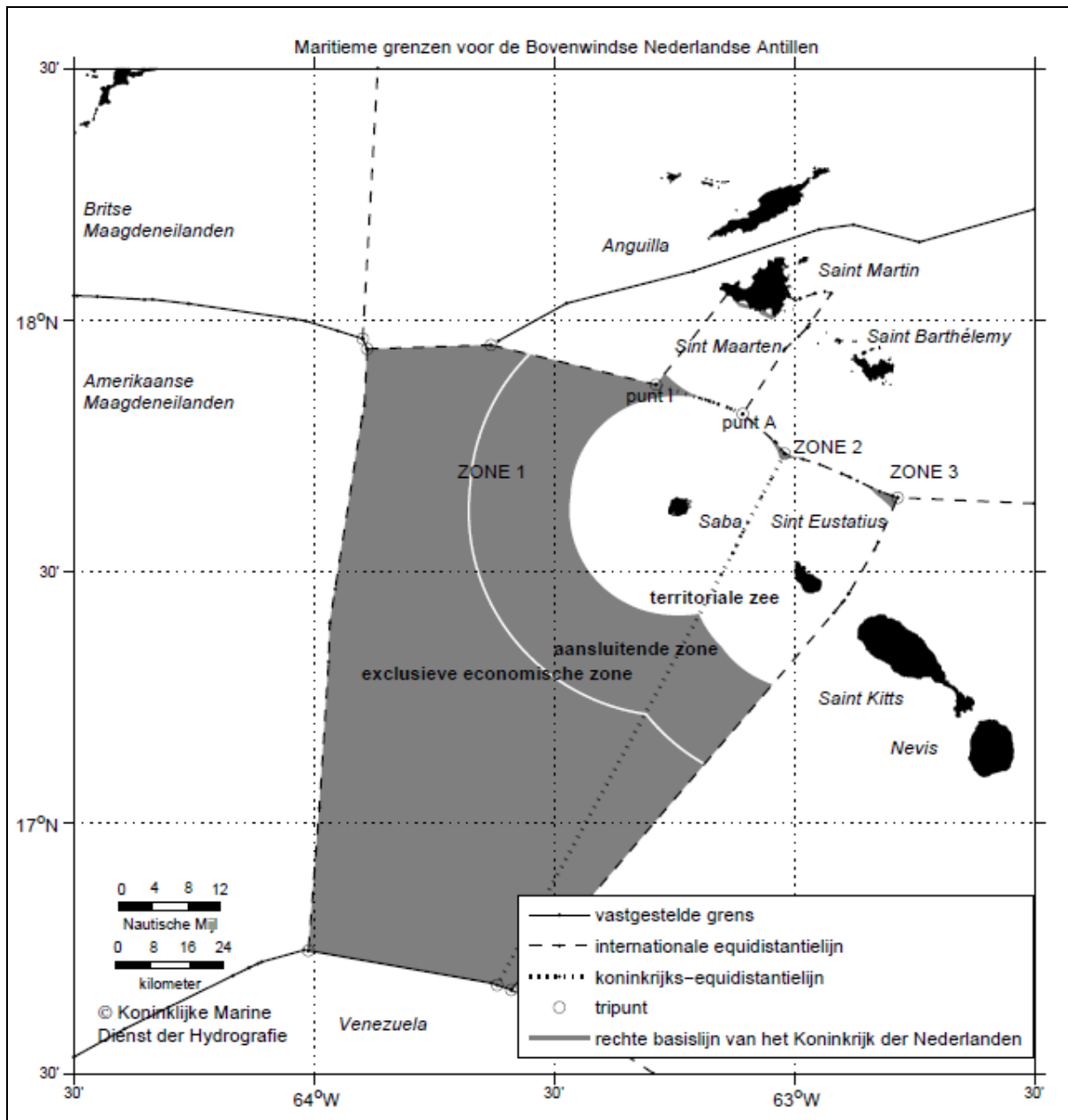


Figure 2. Maritime boundaries Windward Dutch Antilles (Appendix 2 from "Besluit grenzen exclusieve economische zone van Aruba en de Nederlandse Antillen", Stb. 2010, 277).

The Netherlands Antilles, Aruba and The Netherlands have opted to draft a management plan for the Exclusive Economic Zone (EEZ) of the Caribbean part of the Kingdom (Figure 1 and 2). The Dutch Ministry of Agriculture, Nature, and Food Quality (LNV) has given financial support to facilitate this intention. This management plan initially stems from the policy plan "Natuurbeleid van de Nederlandse Antillen" that recognizes the urgent need for a management plan for the Saba Bank, situated in the EEZ waters, to ensure sustainable fisheries and protection of the rich biodiversity. It also closely follows the intention of the Kingdom with regards to the goals set forth in the Dutch "Beleidsprogramma Biodiversiteit 2008-2011". In this respect, as a party to the Convention on Biodiversity, The Netherlands also have a strong international commitment to help stem the decline in biodiversity.

Particularly in the marine arena, the threats to biodiversity are large because the protection regime is still very limited. Furthermore, a large part of the world population depends critically



on the natural resources of the coastal zone. Both of these global generalizations apply to the Netherlands Antilles and Aruba where longterm declines in coastal resources have been taking place but where at the same time the population has also always been strongly aware of its dependency on the surrounding sea and its marine resources. The tripartite initiative to draft a management plan for the Caribbean EEZ is wholeheartedly supported by the Kingdom of the Netherlands as specifically mentioned in the programme 'Biodiversiteit werkt: voor natuur, voor mensen, voor altijd'. Specific attention in this programme is focussed on the need for protection of mangrove areas, coral reefs, delta areas and estuaries, all of which are crucial to the conservation of biodiversity, fish stocks and local economic activities. Adaptation of the existing protection regime of the Antilles with regards to the structural changes at hand forms part of the 10 priorities set forward by the Kingdom within its biodiversity policy.

Under the United Nations Convention of the Law Of the Sea (UNCLOS, 1982), an Exclusive Economic Zone (EEZ) is a maritime zone over which a state possesses special rights for the exploration and use of marine resources (Figure 3). The EEZ starts at the outside boundary of the Territorial Waters, 12 nautical miles out from the coastal baseline, and extends to 200 nautical miles (370.4 km) from the coastal baseline of the Territorial waters. In the case of adjoining states, the location of maritime boundaries of the EEZ also depend on boundary agreements reached with the bordering states (or islands). States also have rights to the seabed of the continental shelf up to 350 nautical miles (650 km) from the coastal baseline, where this extends beyond the EEZ, but this does not form part of their EEZ

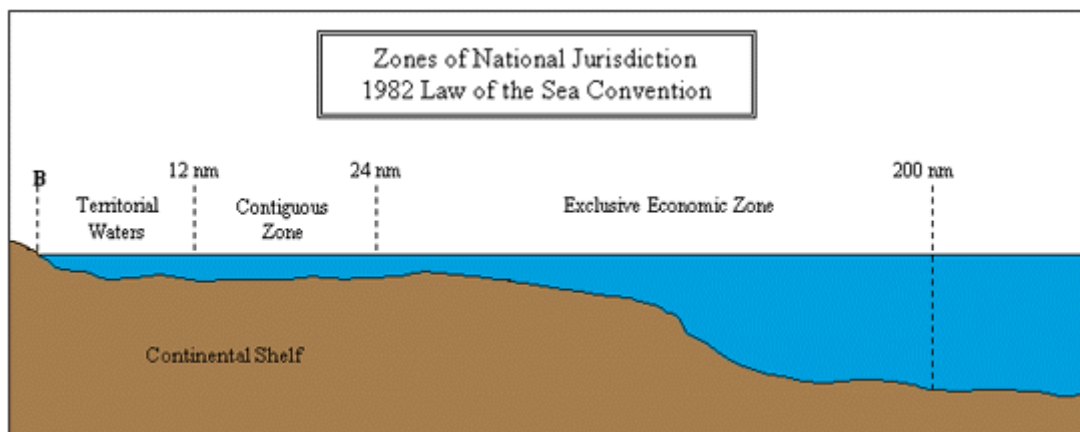


Figure 3. Zones of national jurisdiction under Law of the Sea Convention

The declaration of an EEZ in the Dutch Caribbean (Fig. 1 - 2) is the responsibility of the Kingdom and was effected in June 2010 (Stb. 2010, 277). The management of the EEZ can be transferred by the Kingdom to the separate islands or countries ('Besluit grenzen exclusieve economische zone van Aruba en de Nederlandse Antillen', Stb. 2010, 277). The borders (equidistance lines) between the islands and neighbouring countries are shown in Figures 1 and 2.

The southern EEZ sector, associated with the ABC-islands, is almost completely surrounded by the EEZ of Venezuela except on the northern side where it borders the EEZ of the Dominican Republic. The northern EEZ (Fig. 2) is limited in the east by the EEZ of Saint Kitts and Nevis, in the south by Venezuela, in the west by Puerto Rico and US Virgin Islands, and in the north by Anguilla and France (Saint-Martin). Only with Venezuela a treaty has been signed on the demarcation of the EEZ. Borders with other countries have been determined based on equidistance lines.

### **Two distinct EEZ sectors**

The EEZ waters of the Dutch Caribbean constitute of two distinct zones (Figure 1 and 2). These differ significantly in terms of their biological resources (as discussed in the later chapters). The fact that the two EEZ sectors are widely separated also has large practical consequences in terms of enforcement and management cooperation.

An important feature in the northern sector of the windward Dutch Caribbean is the Saba Bank. The island with by far the largest interests in the Saba Bank is the island of Saba, for which a large part of its territorial sea falls on the Bank. In contrast, only an extremely small part of St. Eustatius' territorial waters lies on the bank while for St. Maarten the Saba Bank lies fully outside its territorial waters. Both Saba and St. Eustatius will become part of one entity (the Netherlands) following the planned constitutional changes. Saba is the island closest to the bank which will have large practical consequences for management choices. International cooperation for this EEZ sector in terms of international joint research and enforcement with parties outside the Kingdom will largely involve the USA and France.

In contrast to the northern sector, the southern EEZ sector does not contain shallow bank areas and is shared by Aruba, Curacao and Bonaire, each of which will have a distinct national status once the constitutional restructuring has been completed. Good forms of cooperation between these entities will be important for optimal management of this sector. The main neighboring state for potential international cooperation in this sector is Venezuela. Several incidences of illegal industrial fishing interception of Venezuelan vessels in Antillean waters have occurred. For the southern sector, the island with the largest share of EEZ surface is Curacao and that with the least is Bonaire. Curacao is the main base for both the Dutch military and coastguard in the Dutch Caribbean, and has traditionally possessed the largest institutional capacity in terms of management, research, disaster readiness, search and rescue and enforcement capability of the Dutch Caribbean.

## 1.1 General Objective

The long-term overall goal and fundamental purpose for the management of the Dutch Caribbean EEZ is to achieve:

Common sustainable management of marine biodiversity (the living and non-living resources), which includes the protection of species, and habitats in the waters and on the seabed of the Dutch Caribbean EEZ and the zone between the borders of the Island marine parks and territorial waters, with a particular focus on special areas such as Saba Bank and particular species<sup>1</sup>.

The Dutch Caribbean EEZ is proposed as a marine area, with common policies and management, where the emphasis is on sustainable management of human activities, species protection, including marine mammals, and habitat protection.

## 1.2 History and scope of this management plan

The Netherlands Antilles, Aruba and The Netherlands have jointly opted to draft a management plan to achieve a coherent common and coordinated management for the offshore maritime areas of the Exclusive Economic Zone (EEZ) of the Caribbean part of the Kingdom. The Netherlands Ministry of Agriculture, Nature, and Food Quality (LNV) has provided support to facilitate this intention by helping to draft this document. This management plan outlines the purposes and manner in which the Caribbean Exclusive Economic Zone may be used in a sustainable manner. It outlines the key management objectives, as well as key policies, and strategies through which sustainable management can be achieved. It also broadly addresses the administrative structure, resource use, financial support, staff needs, and monitoring plans.

While this plan serves as a guiding Terms of Reference to the new EEZ commission, it is beyond the scope of this plan to work out all issues in depth. The task of more narrowly setting priorities and working out the practical details and alternatives for all the various issues that need to be addressed and implemented, will be for the EEZ Marine Resources Committee. The final decisions regarding the various autonomous marine areas (such as the territorial zones (from the seaward border of the marine park out to 12 nm) always remain with the government of the respective kingdom members participating in this initiative.

Sustainable use of a dynamic and as yet imperfectly understood marine system can only be achieved by adaptive management, allowing for best practices and new insights to be implemented when available. Periodic management updates are critical to adaptive management of the EEZ, as are effective interaction and interchange between the scientific knowledge base, management strategy, monitoring studies and management implementation.

The area for which this management plan is intended however includes also part of the territorial waters, see Figure 4.

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<sup>1</sup> Oil and gas resources are excluded from this management plan.

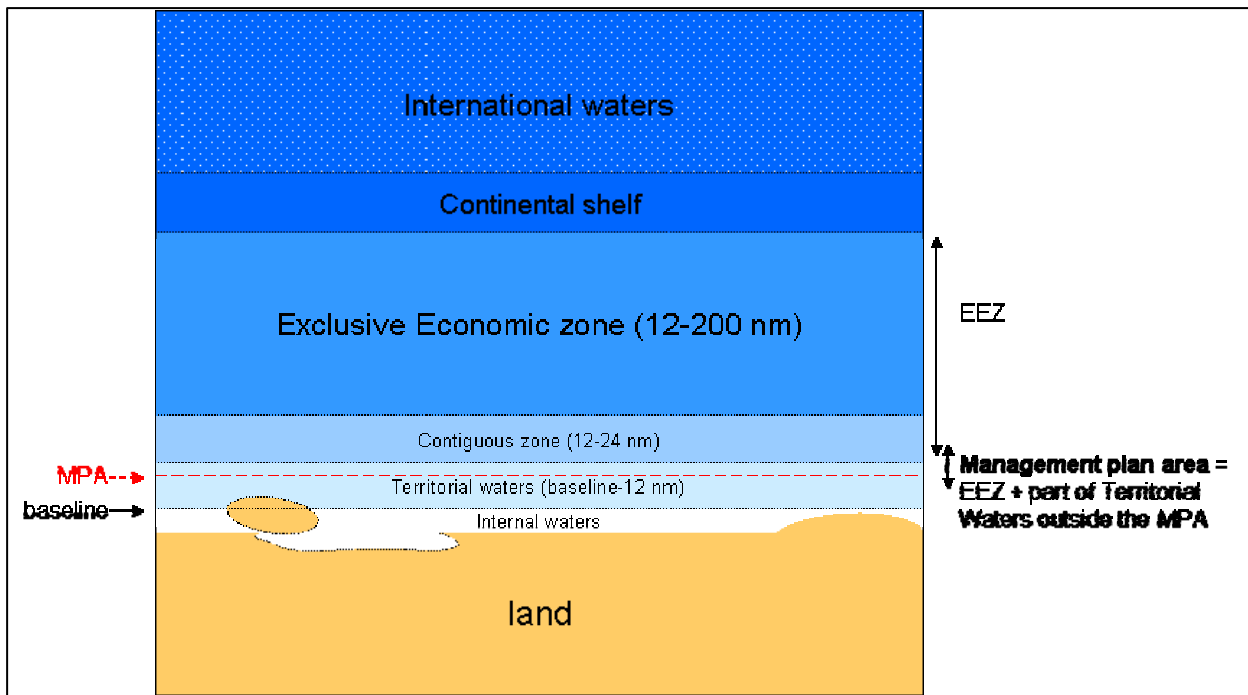


Figure 4. Boundaries of the area that this management plan is focussed on.

### 1.3 Development of the management plan

This document states the significance, mission and goals of the management of the Dutch Caribbean EEZ. A general background on the natural resources of the area as well as human use, and impacts and threats is given in Chapter 2. The actual management actions for the Dutch Caribbean Marine Management Area that are proposed to guarantee progress towards the mission and goals are clarified in Chapter 3. Recommended actions to tackle the identified issues are presented in Chapter 2. Chapter 4 addresses research and monitoring that is necessary to fulfill obligations from international treaties as well as the required data storage facilities. A financial and governance framework are described in Chapter 5.



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## 2 Background information on the Caribbean EEZ

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The Dutch Caribbean is part of the “Large Marine Ecosystem” Caribbean Sea (UNEP). Large Marine Ecosystems (LMEs) are relatively large areas of ocean space of approximately 200,000 km<sup>2</sup> or greater, adjacent to the continents in coastal waters where primary productivity is generally higher than in open ocean areas.

The Dutch Caribbean is a special case, because it consists of two parts, a northern and a southern sector (Figure 1 and 2) that are separated by a distance of 540 to 1000km. There are large differences between these two sectors because of oceanographic and geological differences. Sea currents and hurricanes are crucial to the functioning of the ecosystems on and around the islands, as well as to the benthic and pelagic habitats farther offshore. The frequency of hurricane strikes differs by an order of magnitude between the southern and the northern sectors of the EEZ.

### 2.1 Geographical information

The islands of the Caribbean, also called the West Indies, are made up of the Lesser Antilles and the Greater Antilles, (Figure 5). The islands are a long volcanic island arc, most of which wrap around the eastern end of the Caribbean Sea on the western boundary with the Atlantic Ocean, and some of which lie on the southern fringe of the sea just north of South America. The Lesser Antilles more or less coincide with the outer edge of the Caribbean Plate, and many of the islands were formed as a result of subduction when one or more Atlantic plates slipped under the Caribbean Plate.

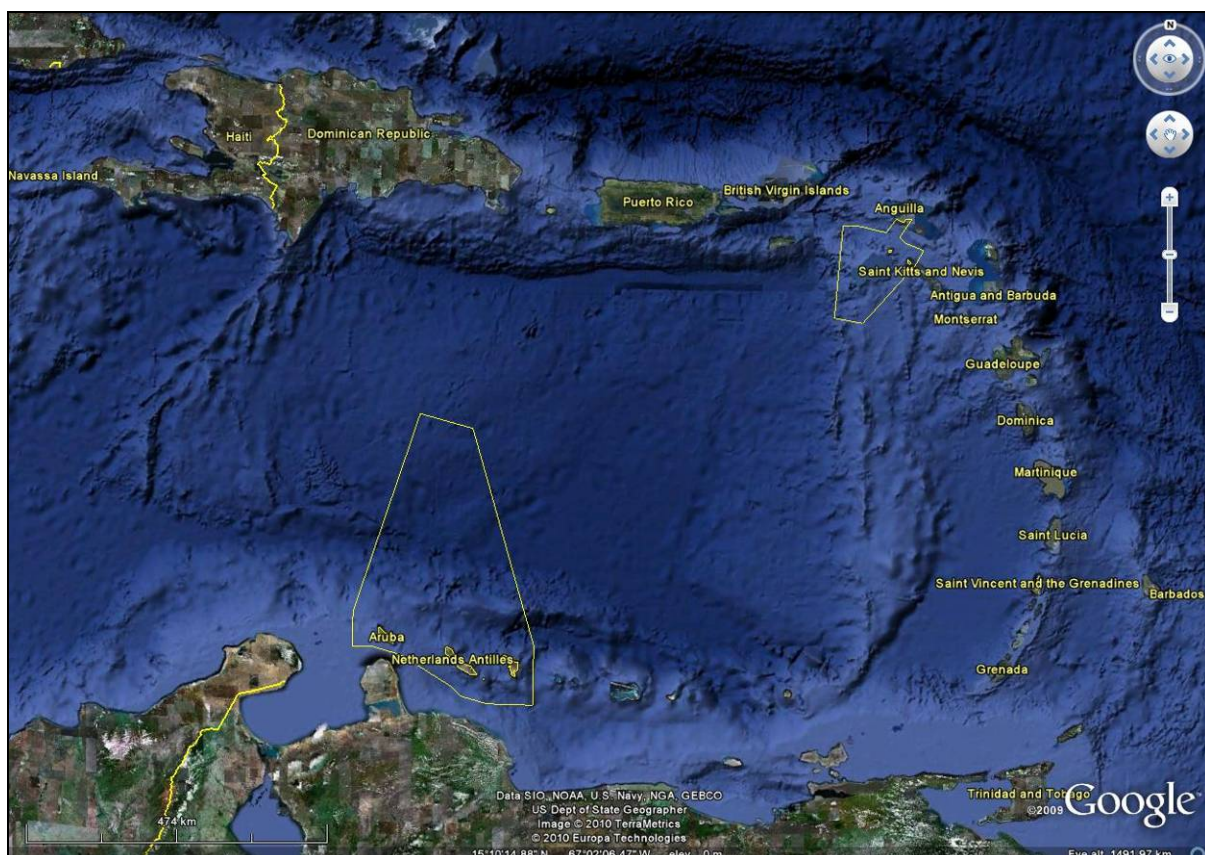


Figure 5. Caribbean region and the West Indies including the EEZ of the Netherlands Antilles.

The two main groups of the Lesser Antilles are the Windward Islands in the north and the Leeward Islands in the east. The Windward Islands are thus named because they were more windward to sailing ships arriving in the New World than the Leeward Islands, given that the prevailing trade winds blow east to west. The trans-Atlantic currents and winds that provided the fastest route across the ocean brought these ships to the rough dividing line between the Windward and Leeward Islands.

A third category which is part of the Lesser Antilles is the Netherland Antilles. The Netherlands Antilles consist of two groups of islands, one in the south just off the coast of Venezuela (the Dutch Leeward Islands or the ABC islands), and one in the northeastern Caribbean consisting of St. Maarten, St. Eustatius and Saba (referred to as the Dutch Windward Islands). The northern part of the island of St. Martin is Saint-Martin (Collectivity of St. Martin) and belongs to France, while the southern part, St. Maarten is part of the Netherlands Antilles.

In the Netherlands Antilles some of the main islands also have small satellite islands such as Klein Bonaire (part of the island territory of Bonaire) and Klein Curaçao (island territory of Curaçao) and some very small islands and rocky outcrops such as, Green Island and Diamond Rock (Saba), Guana Key, Hen & Chickens, Cow & Calff, Molly Beday and Pelican Key (St. Maarten).

### ***2.1.1 The Saba Bank***

In the Dutch Caribbean, coral reefs are typically found in shallow nearshore waters, inside the territorial waters of the island. In this respect the Saba Bank forms a large exception as it is a shallow significantly coralline area that largely lies outside the territorial waters of the nearest islands and hosts extensive coral reefs. The Saba Bank (17°25' N, 63°30' W) is an undersea elevation with a flattened top, a bank, 3 - 5 km Southwest of the island of Saba and 25 km west of St. Eustatius (Figure 6). It rises approximately 1000m above the general depths of the surrounding sea floor and its shape is somewhat rectangular, the long axis trending ENE-WSW. With a length of 60-65 km and a width of 30-40 km, the total surface area is approximately 2200 km<sup>2</sup> (measured to the 200 m isobath). The platform is somewhat tilted with the north-western part of the surface being deeper than the south-eastern part. The largest part of the bank is between 20 and 50 m depth, but a substantial eastern part (app. 225 km<sup>2</sup>) lies between 10 and 20 m depth. On its western rim, depths are around 50 m, while on the eastern and south-eastern edges, where a prominent coral ridge system (55 km long) runs along the platform, minimum depths vary between 7 and 15 m (Van der Land 1974, MacIntyre et al. 1975). The Saba Bank is now considered to be a classic subsurface atoll consisting of a submerged mountain with a margin or ring of actively growing coral reefs. As such it constitutes the largest atoll in the Atlantic Ocean Basin and stands among the one the largest atolls on earth<sup>2</sup>.

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<sup>2</sup> What exactly constitutes an atoll is open to discussion. There are a number of banks that also are sometimes referred to as atolls (Purdy & Winterer 2001). If these are included, the Saba Bank is still approximately the 15th largest of 394 atolls in the world and by far the largest in the Caribbean.



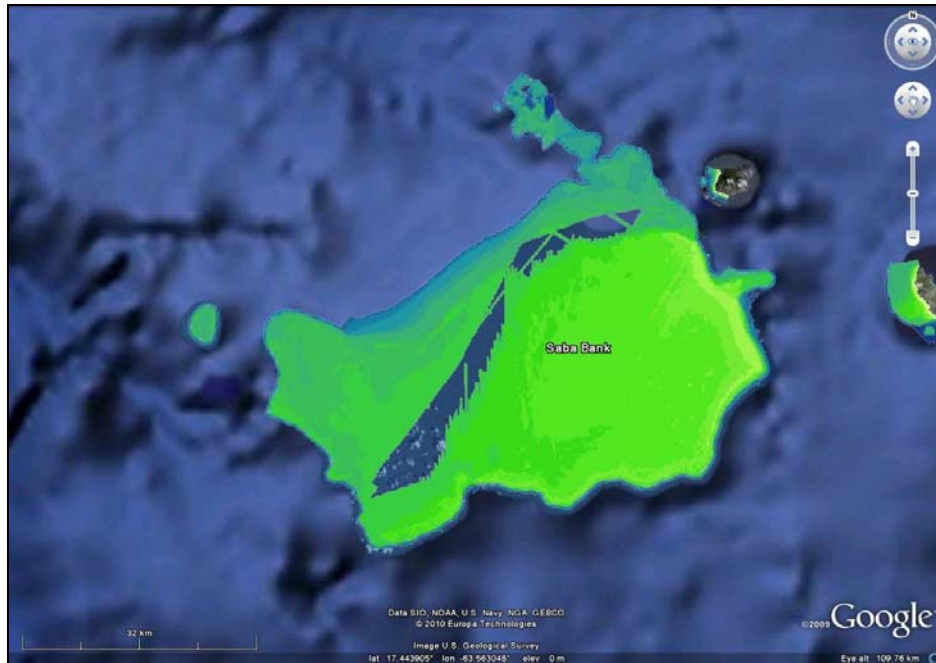


Figure 6. Bathymetry of the Saba Bank and surrounding region (Data Netherlands Hydrographic Service).

## 2.2 Geomorphology

The Caribbean islands have a relatively recent geomorphological history. The Caribbean basin developed approximately 200 million years ago when islands arose from the seafloor as a result of processes on the borders of this basin. The islands of the Caribbean Sea, and adjacent areas are sorted by size and location into the Bahamas, the Lesser Antilles, and the Greater Antilles. The "Greater Antilles" refers to Cuba, Jamaica, Hispaniola (Haiti and the Dominican Republic), and Puerto Rico and their associated satellite islands. The Greater Antilles are made up of continental rock, partly from North America, as distinct from that of the Lesser Antilles, which are mostly young volcanic or coral islands. The Saba Bank is probably of volcanic origin but after the last glacial period the Bank was an island that became submerged since 5,000 years ago and has been covered by carbonate rock and carbonaceous sediments (Van der Land 1977).

## 2.3 Marine habitats, fauna, and other natural resources

Marine habitats of the Caribbean EEZ can be categorized as either benthic or pelagic, though the two can not be considered isolated from each other as they are closely linked through many ecological and physical processes. The main benthic habitats<sup>3</sup> are coral reefs, sand and sediment fields, and sea mounts. Maximum depth in the Dutch Caribbean is around 4000m. The pelagic zone supports planktonic and pelagic sea creatures including fish and migratory species such as various commercially important tuna species, wahoo, dolphin fish, whales, dolphins, and sea turtles.

The Caribbean sea is generally oligotrophic having very low concentrations of nutrients such as phosphate and nitrate which enables the proliferation of coral reefs. Coral reefs are large ecosystems supporting a high diversity of marine life and sustaining many coastal communities in different ways. Coral reefs are often, but not necessarily, found together with sea grass beds and mangrove forests. Since the latter two however occur exclusively in the

<sup>3</sup> Note that these do not include the nearshore (within the marine parks) habitats which also contain seagrass beds and mangrove areas.



coastal zone, they are excluded from this report which only addresses the area of the EEZ outside the marine parks. The Dutch Antilles are best known for their rich and diverse coral reefs, and the reefs and the sea are also important habitat for seabirds, sea turtles and marine mammals.

Apart from the coral reefs close to the islands and in shallow waters, little is known about the potential occurrence of reefs in deeper water, so called mesophotic reefs. At present much scientific attention is being devoted to these reefs among which their possible role in serving as a refugium for shallow water corals (Bongaerts et al. 2010). However, there is little known about these reefs and much still needs to be researched as concluded in a recent issue of the journal *Coral Reefs* which was devoted to these unique reefs (2010, vol. 29, issue 2). Furthermore, it is assumed that the Caribbean must also be home to deep-water or aphotic coral reefs that occur at depths outside of the euphotic zone (Cairns and Chapman 2001). These deep-water reefs may support many species that are hardly known. North of Curaçao and Bonaire there exists a deep trench bordering the Curaçao Ridge, a subsea mountain ridge, which may also harbour aphotic coral reefs and many endemic species (see Figure 5). However, almost nothing is known about areas such as these.

In the north of the Caribbean the Saba Bank has recently received much attention because of its unique situation and coral reef communities teeming with marine life (Hoetjes and Carpenter 2010). The inner part of the Bank consists of a lagoon like floor where a diverse flora and fauna is present (Etnoyer et al. 2010, Littler et al. 2010, McKenna and Etnoyer 2010, Thacker et al. 2010, Toller et al. 2010, Williams et al. 2010).

There are large differences between the southern and northern parts of the Dutch Caribbean. Hurricanes seldom strike in the southern part and consequently coral reefs are well developed. Fresh water influx from the Amazon and Orinoco however occurs seasonally in this area (Cherubin and Richardson 2007). Currents in the Caribbean are not only important for fresh water impacts and transport of sediment, but they also distribute larvae from one area to another. The crucial importance of demographic connections between reefs for enhancing coral reef resilience to perturbations is only recently being recognized (Steneck et al. 2009). This may also mean that the Saba Bank is very important as a source of larvae for reefs of other islands in the region, notably Puerto Rico and the British and US Virgin Islands.

### **2.3.1 Seabirds**

Relatively little is known about the species composition, density and distribution of seabirds in the offshore areas of the Dutch Caribbean EEZ. Most available data for the offshore deepwater EEZ areas as well as the Saba Bank are based upon observations made during the hydrographic expeditions on the HMS Luymes in 1972 (Poppe 1974), and observations made in April and May 1996 during bathymetric charting of the Saba Bank with the HNLMS Tydeman (Postma and Nijkamp 1996).

Seabird densities in the Caribbean are certainly manifold lower than in former times (McGowan et al. 2006). Factors that are especially relevant today are 1) the availability of undisturbed nesting habitat, 2) human competition for fish, 3) discard practices by the fishing industry, 4) oiling mortality due to oil spills, 5) net entanglement, and 6) bioaccumulation of anthropogenic contaminants and toxins through the food chain (McGowan et al. 2006). Direct human predation, which used to be widespread, is now illegal in most countries in the Caribbean and likely to be only a minor threat to seabirds in general (e.g., Debrot et al. 2009). Recent surveys on the breeding seabirds of the Dutch Caribbean islands are available for all six islands (Bradley and Norton 2009). The offshore pelagic habitat may be of particular importance as a wintering area for several pelagic seabirds (Murphy 2000).

Apart from the Saba Bank, the other EEZ areas of the Dutch Caribbean fall principally in the pelagic zone referred to as the Venezuela Basin. While by and large seabird density and

species richness is highest closer to islands, several species show a marked preference for the offshore areas of the Venezuela Basin. These include: Sooty Tern, Redfooted Booby, the Brown Noddy, and the visiting Pomerine Skua, and Leach's Storm Petrel (Poppe 1974). The IUCN status for mentioned species is LC, meaning least concern.

By far most common species of the Venezuela Basin are the Sooty Tern and the Red Footed Booby. Even based on scant data, large differences in seabird density and species composition between the northern and southern halves of the Venezuela Basin are evident. So, for instance while Sooty Terns are sighted equally across the Venezuela Basin, Red Footed Boobies and Brown Noddy are notably more abundant in the southern half of the Venezuela Basin (Poppe 1974). The higher density and species richness of seabirds in the southern half of the Venezuela Basin (north of the ABC islands) may be due to the differential proximity of breeding areas (Aves Islands) or the higher productivity caused by the seasonal upwelling phenomenon of the southern Caribbean (Sturm 1991).

Postma and Nijkamp (1996) found that seabird densities on the Saba Bank averaged two times higher than off the Bank. On the Saba Bank most seabirds appear to be concentrated around the 200 m isobath. The most common species recorded (April-May) were Red-billed Tropicbird, Magnificent Frigatebird, Sooty Tern, and Bridled Tern. Other species were Pomerine Skua, and Wilson's Storm Petrel. In the pelagic areas adjacent to the bank, the Brown Noddy, and Audubon's Shearwater were most common. The IUCN status for mentioned species is LC.

Note that with exception of rare records for the Black Tern, Bulwer's Petrel and the endangered Black-capped Petrel (Prins et al. 2009) all seabirds documented in the offshore EEZ areas so far are quite common (IUCN Red list status LC, least concern), indicating that a dedicated survey by trained seabird observers may well discover more of the less-common birds that have a more critical IUCN status.

### **2.3.2 Marine mammals**

At least 34 species of marine mammals have been documented from the Wider Caribbean Region (WCR): six species of baleen whales, 24 species of toothed whales, one sirenian (the West Indian manatee), and three pinnipeds (the Caribbean monk seal, the hooded seal, and the California sea lion). For many of these species, waters of the region serve as primary habitat for critical activities that include feeding, mating and calving. Of these, at least 16 species have been recently documented for the waters of the Netherlands Antilles, including the West Indian manatee (Debrot et al. 1998, 2006; Bree 1975; Bree and Kristensen 1974; Post and Nijkamp 1996). Although some species have been studied extensively elsewhere, data concerning the biology, life history, distribution and behavior of most cetacean (whale and dolphin) and manatee populations in the Caribbean Sea are scarce. The WCR is the one of only two regions in the world to have experienced the extinction of a marine mammal species in the past 250 years. This concerns the Caribbean monk seal, a species which formerly occurred in the Dutch Caribbean (Debrot 2006).

In the North Atlantic, the humpback whale ranges from tropical waters in the Caribbean to Arctic waters. During the winter, the majority of the population congregates to mate and calve in a number of locations among the reefs and islands of the West Indies. The western North Atlantic population appears to be comprised of relatively discrete feeding stocks. These include the Gulf of Maine, the Gulf of St. Lawrence, Newfoundland-Labrador, Greenland, Iceland, and Norway. Fidelity to feeding areas and migratory destinations from the western North Atlantic have been well documented. The principal breeding areas documented occur on offshore banks and off insular coasts of the Atlantic margins of the West Indies. Humpback whales have been recorded from nearly all the islands in the West Indies, however. Humpback whales in the Caribbean are strongly associated with banks and other shallow waters. There is little information on the summer feeding grounds used by the humpback whales that winter in the Eastern Caribbean. An understanding as to the

apparent lack of recovery in the southern habitat areas is limited by the paucity of information on the relationships between individuals wintering in the Eastern Caribbean waters to those in other feeding and breeding areas. Applying photo-identification techniques could help address these questions.

The French have carried out a one-time intensive survey in the adjoining EEZ of Martinique and Guadeloupe and identified 12 cetacean species, but apart from this survey very little is known about population densities and migratory behaviour of sea mammals in the areas adjacent to the Windward Dutch EEZ sector.

Relatively little is known about the marine mammals in both sectors of the Dutch Caribbean EEZ. While some cetacean surveys have been done for the Leeward Dutch Islands, very little is known for the Windward Dutch Islands and even less is known about the occurrence of cetaceans in the offshore areas. Marine mammal densities in the Caribbean, especially of the large whales that were formerly commercially targeted, are certainly manyfold lower than in former times and are now slowly recovering from former overexploitation. The EEZ areas of the Dutch Caribbean fall principally in the pelagic zone referred to as the Venezuela Basin. Based on limited sightings, Poppe (1974) suggests that the southern part of the Venezuela Basin has higher densities of cetaceans than the northern half. This would correlate with the higher density and species richness of seabirds observed in the southern half of the Venezuela Basin (north of the ABC islands) (Poppe 1974) and might be expected based either on the higher productivity caused by the seasonal upwelling phenomenon of the southern Caribbean (Sturm 1991), or the likelihood that the area appears to form part of a migration zone for the cetaceans of the Caribbean (Debrot et al. 1998). Stranding records further suggest that the southern Caribbean may have a comparatively high density of beaked whales (Debrot et al. 1998).

### **Saba Bank**

As is the case for seabirds, most available data on marine mammals for the Saba Bank is based upon observations made during ten hydrographic expeditions on the HMS Luymes in 1972 (Poppe 1974), and observations made in April and May 1996 during bathymetric charting of the Saba Bank with the HNLMS Tydeman (Postma and Nijkamp 1996). Post and Nijkamp (1996) have documented the following five species for the Saba Bank and vicinity: Bottlenose Dolphin (*Tursiops truncatus*), Clymene Dolphin (*Stenella clymene*), False Killer Whale (*Pseudorca crassidens*), Humpback Whale (*Balaenoptera edeni*), and unidentified Ziphiids, possibly *Mesoplodon* sp, (or *Z. cavirostris* see Bree et al. 1973). Repeat sightings of the Humpback may have regarded the same animal. Nevertheless, Postma and Nijkamp (1996) suggest the possibility that the Saba Bank may be part of the Humpback Whale's former wintering grounds and propose research to evaluate this idea. Humpback whales, migrating north to their mating grounds, are occasionally seen in the channel between Saba and the Bank. More recently, a humpback whale with calf was seen on the Saba Bank in the area known as Moonfish Bank during the 2006 Saba Bank expedition. During dives in February 2002 and in January 2006, humpback whale song was heard (Hoetjes, pers. comm.). So while marine mammals have been sighted already many times on the Saba Bank (Hoetjes and Carpenter 2010), little effort has been made to carry out bias-free surveys from which population densities can be calculated. It is likely that a shallow area as large as the Saba Bank could play an important role for marine mammals in a mostly much deeper region.

### **2.3.3 Sea turtles**

Sea turtles, once abundant in the Caribbean Sea and now a days serving as a flagship<sup>4</sup> species, are severely reduced from historical levels, both in population size and range. In general, sea turtles throughout the world are severely reduced from historical levels. According to the World Conservation Union (IUCN) Red List of Threatened Species persistent

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<sup>4</sup> iconic animals that provide a focus for raising awareness and stimulating action and funding for broader conservation efforts

over-exploitation, especially of adult females on nesting beaches, and the widespread collection of eggs are largely responsible for the “Endangered” or “Critically Endangered” status of all six Caribbean sea turtle species.

Five sea turtle species have been documented for the waters of the Dutch Caribbean. These are, with red list status, the nesting Loggerhead (Endangered), Hawksbill (Critically Endangered), Green Turtle (Endangered), and Leatherback (Critically Endangered) (Sybesma 1992, Barmes et al 1993), Debrot et al. 2005), while Olive Ridley (Vulnerable) does not nest and only occurs sporadically (Sybesma and Hoetjes 1992). Recent work suggests that scattered nesting beaches, such as those typical of the Dutch Caribbean, may play a significant role in the eventual recovery of these species. The Leatherback feeds principally in pelagic deepwater areas of the EEZ, while the other three nesting species can be expected to be more closely linked to nearshore benthic and shallow water habitats.

On Aruba, Curacao, Bonaire, St. Maarten and St. Eustatius park management organizations, NGOs and volunteers are trying to protect turtles and carry out regular surveys, but no governmentally supported structural long term monitoring program is in place.

### **Saba Bank**

The enormous diversity and abundance of marine algae and sponges means that there is ample food for these animals, particularly for Hawksbills. Therefore it is assumed that the area is important as a feeding area for turtles. There have been several confirmed sightings of Hawksbills (Critically Endangered) during a survey in 2007. Leatherbacks (Critically Endangered), and Loggerheads (Endangered) have also been seen on the Bank (Lundvall 2008).

### **2.3.4 Sharks and rays**

Little is known about sharks, rays and other cartilaginous fishes in the Dutch Caribbean EEZ, however, IUCN lists many species in the region as having a decreasing trend. Of the 172 species, 4 are Critically Endangered, 4 Endangered, 23 Vulnerable, and 81 as being Data Deficient. More research on abundance and distribution in the region is needed.

The Western Central Atlantic Fishery Commission (WECAFC) in the 2008 reports (WECAFC/XIII/08/02E):

“There is global concern about the status of Sharks (ISCAAP Group 38 – sharks, rays, chimaeras) and the risks of their over-exploitation. Within the WECAFC region, catches of chondrichthyans escalated spectacularly after 1950, reaching a peak of 37.000t in 1994 (Figure B3.9, *not shown here*). They subsequently declined but rose sharply again after 2001 and in 2006 were approximately 35 000 t and close to the 1994 peak. This is of particular concern because there is very little knowledge of the status of sharks in the region and equally little management of their exploitation. Mexico and Venezuela recorded the highest landings of Group 38 between 2004 and 2006 at above 11.000t per year. USA, Guyana and Cuba reported catches of over 2.000t (Table 2, *not shown here*). The major contributors to the landings in 2006 were: sharks, rays, skates etc nei; requiem sharks nei; and rays, stingrays, mantas etc.; with a number of other species and species groups contributing smaller masses, including blue sharks, hammerhead sharks, shortfin mako, silky shark, smoothhounds nei, blacktip sharks and dogfish sharks nei. The poor species identification of catch records demonstrates the poor quality of much of the data submitted to FAO from the region and clearly demonstrates the need for improved and careful monitoring. The best information available on the status of sharks in the region remains that reported to WECAFC in 2003. That includes a report by Yegres et al. (1996) on the shark fishery in Venezuela, operating beyond the EEZ of that country in both the Caribbean Sea and the Atlantic Ocean in the south western reaches of the WECAFC area, which listed 31 shark species as being caught. The most common, by number, in the industrial fleet included blue shark (36 percent), reef shark (14 percent), and shortfin mako (12 percent), and in the artisanal fleet, Caribbean sharpnose shark (21 percent), scalloped hammerhead (14 percent) and smalleye hammerhead (12 percent). Bonfil (1997) reported that 34 species of shark occur in the Mexican waters of the

Gulf of Mexico, of which 14 are important in fisheries and nine of these he described as being of “prime importance”. Of the nine most important, five were requiem sharks and two hammerhead species.

Based on available documentation, major declines in the abundance of sharks have occurred in the coastal areas of the Dutch Caribbean over the last decades (Debrot and Criens 2005). The WECAF Scientific Advisory Committee recently recommended that countries that have not yet developed and implemented a national plan of action to wisely manage sharks (e.g. Shing 2006) should do so urgently (WECAF 2008).

### **Saba Bank**

Recent observations show that compared to other shallow benthic areas, the Saba Bank still has a remarkable abundance of sharks and large piscivores, which contribute to its outstanding conservation value (Toller et al, 2010). Sharks are often spotted on the Bank, particularly the abundant nurse shark (Debrot, pers. obs), reef shark, blacktip shark and tiger shark (Hoetjes, pers. observ).



*Figure 7. Red Hind, a mid-sized commercially important grouper fished to depletion everywhere else in the Dutch Caribbean but still abundant on the Saba Bank (photo: S. Lundvall).*

## **2.4 Human use and economic significance**

What is the present economic significance of the EEZ? Valuation of the economic value of biological resources present in the EEZ is not uncomplicated. Aside from direct income, for instance through fisheries catches or fishing licence fees, it is useful to think in terms of the ecosystem services the EEZ provides. These can be divided into four broad categories of ecosystem services, namely a) provisioning—such as clean water and fish for consumption, b) regulating—such as control of climate and isolation against disease, c) supporting—such as nutrient cycling and decomposition, and d) cultural—such as spiritual and recreational values (Millenium Ecosystem Assessment 2005). In this respect it is especially worth noting the high economic value the EEZ represents in terms of the shipping activities that take place there, the provision of water quality for coastal tourism, recreation and water desalination for human use, as well as unfathomed potential in terms of biopharmaceutical products.

It must be realized that the most important users of the EEZ are not direct users, such as fishermen, but coastal industries, such as shipping and tourism, and the island communities themselves, which depend critically on the ecosystem services that the EEZ provides in terms of shipping routes, clean water etc. At the same time these industries and coastal

development activities that form one of the the greatest threats to the biological resources and sustained health of the EEZ. Ecosystem services obtained “freely” from nature provide a large portion of “real wealth” to nations and need to be taken into account eventhough in classical economy this has rarely been done (World Bank 1995, Hamilton and Dixon 2003). For instance the use even today of GDP as the main economic index generally overvalues material goods (such as military production), undervalues services, sets key national assets at zero value and even adds the social and environmental costs to the GDP (based on the labor and material costs required to mitigate), instead of subtracting these costs (Henderson 1996). The the possibility of requiring other industries, aside from the purely extractive ones (fisheries), to contribute structurally to the financing of management costs should be seriously considered.

Beginning with the seminal work by Spurgeon (1993) a lot more work has since been done on the economic valuation of coral reefs. Cesar and Van Beukering (2004) used their Coral Reef Ecological Economics Model (CREEM) to calculate the economic value of the coral reefs of Hawaii and arrived at an annual net income of US\$ 360 million per year, representing a net asset value of some 10 billion dollars. A few studies valueing the economic value of biological resources (cost benefit analysises) have also been done in the Netherlands Antilles, particularly for the marine parks of Saba (Fernandes 1995, Fernandes et al. 1999), Statia (Bervoets 2010) and Bonaire (Dixon et al. 1993).

In spite of the clear economic benefits flowing from marine resources, governments often fail to provide structural funding for basic management.

#### ***2.4.1 Commercial Fishery in Territorial Waters***

The traditional coastal fishery is relatively well developed on Curaçao and Bonaire. Small boats (<10m) powered by outboard engines are used to fish with hand lines on reef fish close to shore or to fish for pelagic species with trolling lines in the open water but within the territorial waters. The use of gill nets, spear guns, beach seines and fish traps is less common (FAO 2002), but the recent increase in the use of gillnets on the reef and at the mouths of nursery lagoons has been observed (Debrot, pers. observ.). The traditional coastal fishery is under pressure and the participation in this fishery is in decline (Dilrosun 2007). Maintaining a sustainable and viable coastal fishery was one of the main objectives of the Fishery Policy Plan of the Netherlands Antilles (Buurt, van 2001). However, for Curacao and Bonaire, fisheries catches represent less than 1% of the annual GDP (CBS 2009). The fishing sector is excessively capitalized (van Buurt 2001). It is therefore, not profitable and a large part of the produced revenues are expended on imported fuel and vessel maintenance. Nevertheless it is evidently of value as a small and variable source of employment for the unemployed and retired (van Buurt 2001).

##### **Saba Bank**

The Saba Bank is located partly (app. 25%) in Saba’s territorial waters (i.e. within 12 nautical miles) and partly in the EEZ. The lobster fishery is the most economically significant section of this commercial fishery (app. 10 boats). In addition to the lobster trap fishery, some fishers target deep reef fish (snapper species) using fish traps and hook and line. Bycatch of other species is common in the lobster pots.





*Figure 8. Immature Silk Snapper, Mutton Snapper and Round Snapper caught with traps on the deeper edges of the Saba Bank. (source S. Lundvall)*

The fishery on the Saba Bank has remained relatively stable over the period 2000-2007 with regards to effort, economic value (€ 1 million), total catch and fishing methods (Toller and Lundvall 2008).

In absolute numbers the commercial fishery operating from Saba is small with around 50 people participating. However, in relative terms, the importance of the commercial fishery is considerable as these 50 people consist of almost 10% of the economic active part of Saba's population (Dilrosun 2000).

#### ***2.4.2 Commercial fishery in the Exclusive Economic Zone***

An Antillean commercial fishery on economically attractive species like wahoo, dolphinfish, tuna and swordfish is poorly developed. In 2009 only three local vessels were issued a permit by the Fishery Board to fish in the EEZ. The development of a (semi-) industrial fishery in the EEZ and/or the development of a fish processing industry was the second main objective of the Fishery Policy Plan (van Buurt 2001).

Since 1998, the Venezuelan operator AVATUN has had Netherlands Antillean government permits to fish with 14 vessels for tuna (1000-1500 MT annually) in the EEZ to the north of Curaçao and Bonaire. Furthermore since 1996 vessels of the Spanish operator ALBACORA fly the Antillean flag. These vessels do not fish in the EEZ but target large pelagic species on the high seas (van Buurt, pers. comm.).

#### ***2.4.3 Recreational Fishery***

Recreational fishing charters are offered from most of the Antillean islands. Artisanal fishing often occurs relatively close to shore targeting demersal or reef fish, while most recreational charter fishing occurs in the open water targeting large pelagic species like wahoo, dolphinfish and marlin. Overall, recreation fishing takes place within the boundaries of the territorial waters and probably plays no role in the EEZ. Operators at St Maarten do organize fishing trips to the Saba Bank in the EEZ, however, these recreational fishing trips are infrequent and most St. Maarten recreational fishing occurs closer to the island.

Depending on the owner of the fishing charter, captured fish are returned to the sea ('catch-and-release") or (part of) the catch is landed for consumption. Selling fish landed by recreational fishers is usually not allowed. At present no catch registration system is in place for the recreational fishery and no fee (recreational fishing license) needs to be paid to fish in waters surrounding the Antillean Islands.

#### **2.4.4 Maritime transportation and anchoring**

Maritime transportation within the EEZ and Saba bank consists of tanker- and cargo-transport vessels, cruise ships, and fisheries. The first two types will be described in the section below, the others (cruise ships and fisheries) in other sections.

Shipping movements in the northern EEZ and Saba Bank appear stable (Lundvall 2008). Shipping traffic is most intense in the Northern Zone due to the presence of the Statia Oil Terminal. Statia Oil Terminal is an oil transshipment and storage facility for oil transport between the Middle east and the US. Each month approximately 100 vessels are called in at the terminal (Lundvall 2008), which is equivalent to 3-4 vessels per day.

The heavy ship traffic across the Saba Bank poses a danger to the small artisanal fishing boats, which run the risk of being overrun by the large tankers. According to the fishermen, this risk has caused them to avoid certain traditional fishing grounds, impacting their catches. Furthermore, the large vessels that cross the Bank can not avoid buoys attached to the lobster traps which are consequently lost. Overrunning of fisheries vessels, and the loss of gear (pots and buoys) is a direct impact of the vessel movements on the Bank. Additionally, lost pots result in ghost fishing as long as the trap mesh is intact which affects local fisheries income and the ecology of the Bank. Another threat from heavy shipping traffic is the release of bilge water (which may contain oil residues, contaminants and other compounds), sewage water and ballast water. The discharge of ballast water can be accompanied with the introduction of species which may become invasive, resulting in shifts in species composition and ecosystem functioning.

Some ships do not just pass over, but anchor on the Bank while waiting to dock at Statia Oil Terminals or simply waiting for their next assignment. Instead of using anchor buoys, tankers are actually advised to anchor on the Saba Bank to avoid paying mooring fees to Statia's Ports Authority (Lundvall 2008). Anchoring ships are both tankers and cargo ships with a depth range between 9 and 12 m. Larger tankers avoid the Bank when they are fully loaded because their draught is between 12 and 20 m, which exceeds the water depth in the shallow areas of the Bank.

Most of the boats using Bonaire's waters are tankers visiting the BOPEC oil terminal and local boat traffic. Figures that distort this are the movements of tug boats from the harbour, which have at least twice as many journeys as the tankers (due to return trips). There have been changes in the amount of boat traffic in recent years, particularly the amount of airport/jet fuel boats visiting the fuel pier. In waters of Bonaire, the nature of boat traffic has not changed excessively between 2002 and 2004, other than a marked reduction by almost a quarter of local boat traffic, possibly due to the end of ferry services to Curaçao, and doubling of the amount of boat traffic visiting BOPEC.

The Expansion of the Panama Canal is a project being carried out by the Panama Canal Authority (ACP), that will double the capacity of the Panama Canal by 2014. The canal's capacity will be doubled and allow more traffic and bigger ships. Consequently, maritime traffic in the Caribbean will also increase, as will use of the Dutch Caribbean EEZ, with all the risks that this represents (pers. comm. J. Sierhuis).

An increase in shipping movements is foreseen as Statia's government has identified Port/Harbour Development as one of six areas of priority areas for sustainable island development. In particular, the following are highlighted as investment opportunities: Cargo



#### **2.4.5 Exploitation of natural minerals**

Within the EEZ of the Dutch Caribbean, only Saba Bank is known to be a potential source for oil and gas. Consequently, extensive seismologic research and two drillings have been conducted on the Saba Bank in the past (1977 and 1982). The exploration did however not detect any significant amount of oil or gas and therefore it is not expected that commercial production will be an activity within the EEZ in the foreseeable future. Mineral resources deep under the sea bottom, such as oil and gas, are not considered a part of biodiversity and are not further addressed in this management plan. However, it goes without saying that any plans dealing with extraction of such mineral resources from the sea bottom must take into account the need to protect the environment.

Mineral resources that are on the surface and thus are directly part of the biodiversity include things such as sand, manganese nodules in deep waters, and possibly titanium deposits off Statia and on the Luymes Bank.

Sand is the currently only commercial mineral on Saba Bank that could be of any potential interest for extraction. Sand is present in the central parts of the Saba Bank (Van der Land 1977), but only in a thin layer. Commercial mining is not feasible due to the limited quantity of the sand and the depth of the location. Mining activities would damage the reef, but the coral reef would most probably also obstruct and/or damage the mining equipment.

#### **2.4.6 Bio-prospecting**

Bioprospecting is the exploration of biodiversity for both scientific and commercial purposes. The abundance and diversity of coral reef life have lured researchers and biotechnology companies to explore the oceans in the hope of finding unknown genes, proteins, and other bioactive compounds that could be of interest for medical (e.g. cancer treatment, antibiotics) and non-medical applications (e.g. anti-fouling agents). Despite the enormous costs that still limit sea research and exploitation, some now worry about the potential negative side effects of deep sea bioprospecting (Ruth 2006). Presently, the Saba Bank and other EEZ waters are not being used for this purpose. However, the EEZs rich biodiversity and the ongoing discovery of many new species (e.g. seaweeds and gorgonians on the Saba Bank) might eventually form the basis for further explorations and development of a new economic activity in future. Besides the gains of bioprospecting, to e.g. science and medicine, potential impacts should be considered as well. In the past, small-scale bioprospecting in the Dutch Caribbean has led to development of the multimillion antibiotic product marketed as *Neosporin* (Bonaire), and the discovery of the compound Curacin A (Curacao), a very promising substance active against malignant cell growth (Gerwick et al. 1994). Potential impacts of bioharvesting may include physical disturbance or disruption of ecosystems, potential pollution and contamination, as well as problems of over-harvesting of rare organisms. An example in point is the discovery of Curacin A, which was found to be limited to only highly localised strains of the common bluegreen alga *Lyngbia majuscula*.

Within a country's EEZ, bioprospecting in the seabed can be regulated by a legal regime, resulting e.g. in a clear zonation or limitation of prospecting in order to protect the ecosystem. Articles 15, 16 and 19 of the CDB further recognize the sovereign rights of a country to its natural resources and the authority to determine the access to the genetic resources on mutually agreed terms. To this end, the Netherlands Antilles Ministry of Public Health and Social Development (VOMIL) recently drafted a concept collection permit and Material Transfer Agreement (MTA), This was based on the Access and Benefit Sharing (ABS) proposal as drafted in Bonn under the CBD. In the draft MTA, intellectual property rights to any process, substance or idea derived from the research on these genetic resources will be shared by user and provider, to the extent that the provider will have the right to one third of

royalty fees, which part will be paid to a conservation fund (E.Newton, pers. comm.). Most bioprospecting only involves the collection of small amounts from any given species (eg. recent bioprospecting work in Curacao by Harbor Branch Foundation (USA) (*Geoderma*, a deep reef sponge). However, in any proposed cases of larger scale collecting of organisms, it is advised to require an environmental impact assessment (EIA) before approval of any bioprospecting activities.

#### **2.4.7 Infrastructure: Pipelines and cables**

Infrastructure on the ocean floor consists of pipelines, power transmission cables and cables for data communication (mostly fibre optic cables). Fibre optic cables in the Caribbean are most likely not relevant to the Dutch Caribbean EEZ as can be concluded from Figure 9 and Figure 10. Figure 9 shows the ring of optic fibre cable network that connects the countries surrounding the Caribbean Sea.



Figure 9. The Americas Region Caribbean Optical - Ring System (ARCOS) is an undersea fiber optic cable system that was developed to link the Caribbean region to the USA (<http://www.nearshore.cc/images/redundancyImage.jpg>).

Trans-Caribbean Cable Company (TCCC) is the organization for planning, building, operating, and maintaining the Trans-Caribbean Cable Network (TCCN). It services the ever-growing Internet, data and voice traffic demands of the Caribbean. In Figure 10 the cable network is shown for 2004. It is obvious that the cables are laid outside the EEZ and Sababank. Only the EEZ near the ABC islands holds cables, but those are already on the seafloor. At least two cables are currently being planned from Curaçao.



Figure 10. Trans-Caribbean Cable Network (<http://www.trans-caribbeancable.com/page3.html>)

Relevant activities regarding cables are cable laying and repair. Several international organizations have expressed their concern about the (possible) impact of cables on marine biodiversity.

Possible impact of cables on marine biodiversity includes:

- Disturbance of marine habitats and fauna during cable laying;
- Disturbance during cable repair and maintenance;
- Change of habitat due to the presence of cables;
- Disturbance of animals due to the electrical field surrounding cables;

Pipelines are not of relevance to the Dutch Caribbean EEZ. The only submarine pipeline in the Caribbean is the Trinidad & Tobago Pipeline, which is a cross border pipeline from Trinidad to Guadeloupe, transporting gas.

## 2.4.8 Recreation

### Diving

Outside the marine parks of the islands there is hardly any diving except incidentally on the Saba Bank. On the Saba Bank, tourist activities are very limited. Regular diving trips from Saba and St. Eustatius are not offered. Land-based EEZ diving activities are not likely to increase as near-shore diving offers good diving and as petrol expenses to the Saba Bank are not competitive. Live-aboard diving on the Saba Bank might be a future activity, but no activity is known till now. Recently, a wreck was discovered, attracting marine life and was featured on National Geographic Television in April 2010. This discovery might give an impulse to recreational diving activity (Lundvall 2008).

### Cruise shipping

Cruise shipping in the Caribbean is of significance for almost all islands. Only small cruise ships visit Saba. In Statia no cruise ship facilities exist due to the island's small size and its shallow waters. For Bonaire a significant increase in cruise ship port calls has taken place since early 2000, notwithstanding a slight decrease in port calls from 2007 to 2008.

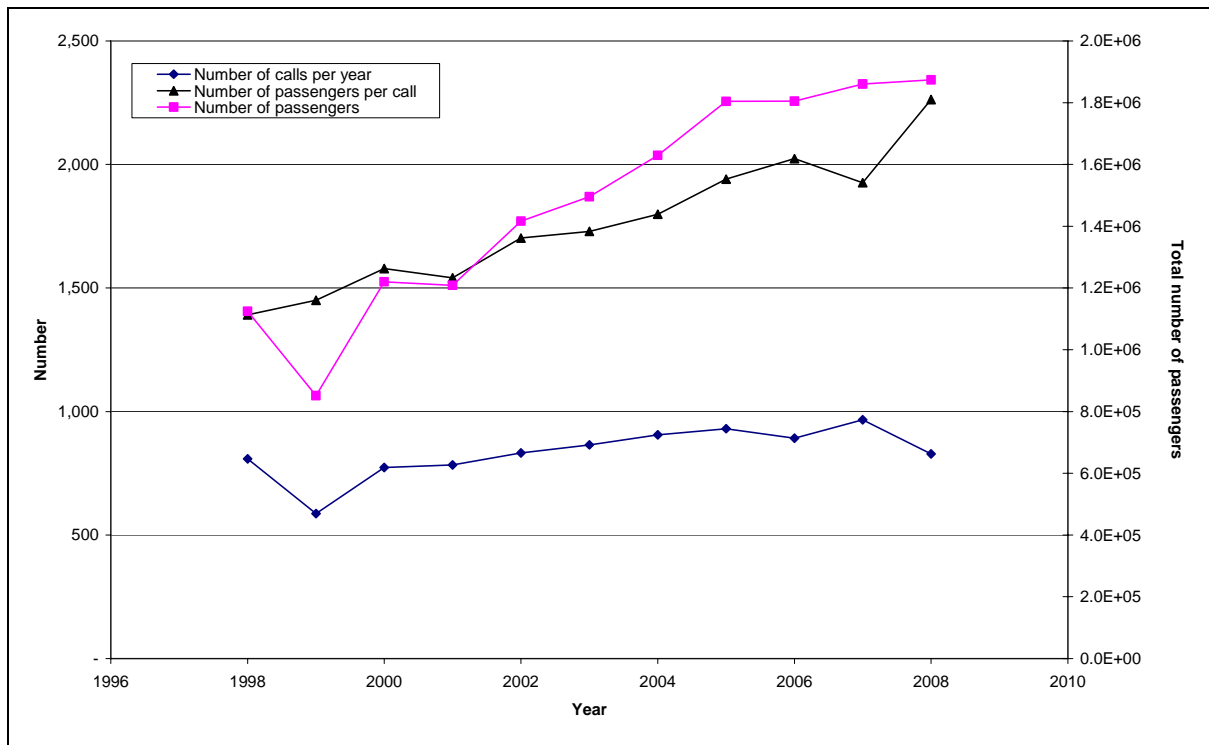


Figure 11. Number of visits of cruise ships, number of passengers per call and total number of cruise passengers from 1998 till 2008 in the Netherlands Antilles (Data from Bank of the Netherlands Antilles).

Cruise ships are also a significant source of pollution in the Caribbean. A typical cruise ship generates an average of 8 mt (2,228 gallons) of oily bilge water and 1 mt of garbage each day. The volume of cruise-ship tourism has roughly quadrupled in the last 20 years (Burke and Maidens 2004). Figure 11 shows summary statistics for the whole Netherlands Antilles. It should be noted that St. Maarten receives approximately two thirds of all cruise ships (app. 75% of all passengers) in the Netherlands Antilles, thus there is potentially much traffic and likely pollution around the Saba Bank.

#### 2.4.9 Aquaculture

Commercial marine aquaculture activities are known only for Bonaire (e.g. shrimp and fish), but only occur on shore or in the coastal zone. No activities are foreseen in the near future within the Caribbean EEZ.

### 2.5 Impacts and threats

Threats to the sustainable use of the natural resources of the marine environment can be divided into those that can be managed and those that currently are beyond our capabilities to manage (at least within the framework of this management plan). For example, limiting the CO<sub>2</sub> emission on the islands will have no direct effect on the acidification of the oceans, whereas limiting the number of lobster pots on the Saba Bank could directly influence the lobster population and impact the sustainability of the lobster fishery on the Bank.

Below we present an overview of current activities and environmental changes that may have affect the natural resources of the Caribbean EEZ.

### **2.5.1 Climate change**

Global climate change with impact on the marine environment follows from the increase of CO<sub>2</sub> concentrations in air and sea, and therewith the acidification of oceans, changes in temperature (and greater dynamics in weather conditions). The precise impacts of these changes are not yet clear at the local level. Since these drivers are global, local measures will not directly result in less impact.

#### **Acidification**

The increase of atmospheric CO<sub>2</sub> accelerates as a result from worldwide human activities. CO<sub>2</sub> is taken up by oceans, leading to lower pH, and this lowers the saturation of carbonate and magnesium minerals. These minerals are needed for the skeletons of many marine organisms, such as corals and shells (Kleypas et al. 2006). Ocean acidification has a world wide origin, and cannot be solved by local management plans. Local species however respond in different ways to acidification. Therefore, at the local level, an important goal for management is to help optimize the natural resilience of the ecosystem (Hoegh-Guldberg et al. 2007; Hoegh-Guldberg et al. 2008). By increasing ecosystem resilience environmental perturbations will less likely lead to ecosystem collapse and ecosystem components will more quickly recover from adverse impacts.

#### **Dynamics in weather conditions: Hurricanes**

Most of the Caribbean lies within the hurricane belt. Hurricanes are natural events from which coral reefs can recover, given time and if the ecosystem is resilient enough. However, even in best case scenario's, recovery of severely damaged reefs may take a decade or more after the fiercest storms.

Hurricanes and tropical storms are the most frequent natural pressures affecting reef ecosystems (Gardner et al. 2005). They constitute a defining factor in the structuring and functioning of marine and coastal ecosystems, and are always an important factor to include when evaluating reef ecosystems. The windward Dutch Caribbean (SSS islands) are subject to more than 10 times as many hurricanes as the leeward islands (ABC islands) (Meteo 2010). Climate change is believed to ultimately result in an increase in the number and magnitude of hurricanes and their impact on reefs is likely to increase. Climate change and resulting desertification also affects the Caribbean sea through input of nutrients (particularly iron) that enter the pelagic system via Sahara dust (Garrison et al 2006, Prospero and Nees 1986). Again, optimizing the natural resilience of the ecosystem, through integrated sustainable management is an important overall management goal.

#### **Temperature**

Increased water temperatures of oceans as a results from global warming, can have huge effects on reef ecosystems (e.g. Crabbe 2008). The most direct evidence of the impact of climate warming on Caribbean marine biodiversity has been widespread "bleaching" of its reef-building corals. Bleaching refers to the loss of a coral's natural color (often hues of green and brown) caused by the expulsion of symbiotic algae (zooxanthellae). This leaves the coral very pale to brilliant white in appearance. Bleaching, which leaves the coral vulnerable without its symbiotic energy source, can be a response to many different stresses, including salinity changes, excessive light, toxins, sedimentation and microbial infection, but increases in sea surface temperature (SST) are the most common cause of bleaching. Bleaching reduces coral resistance to diseases, growth and regeneration capabilities (Meesters and Bak 1993).

#### **Saba Bank**

In 2005 the Caribbean experienced a major coral bleaching event (Donner et al. 2007). There has been no monitoring on the Saba Bank but there has been a notable change in live coral cover on other reefs. One site in an area known as Coral Gardens was visited in 2002 and this area was used in an informational video about the Saba Bank. This site was again visited during the 2007 dive survey and the coral cover was greatly reduced, while algal



cover increased. Based on this comparison, as well as additional data and impressions, it appears likely that the impact of the 2005 bleaching event has been very significant (Lundvall 2008). Further coral mortality may have resulted from increased sensitivity to diseases following bleaching (Croquer and Weil 2009).

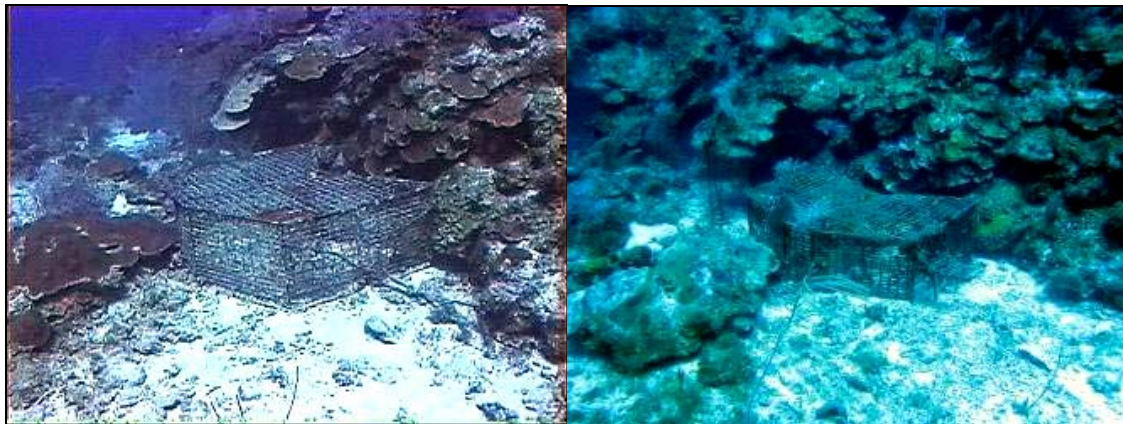


Figure 12. The exact same spot on the Dutch Caribbean EEZ—marked by a lost lobster trap—with luxuriant live coral cover in 2002 on the left, and almost no living coral cover in 2007 on the right (source P. Hoetjes).

As with all global threats that are not directly responsive to local action, the best way to cope with them is to optimize the resilience of the local reefs, ensuring the best chance for survival/recovery after major bleaching events.

### 2.5.2 Invasive species

A species is invasive when it enters an aquatic ecosystem outside of its historic or native range, establishes itself and interferes with local ecological processes. Other related terms are exotic species, alien species, or non-indigenous species. Common sources of aquatic invasive species introduction include ballast water<sup>5</sup>, aquaculture escapes, and accidental and/or intentional introductions. The main consequence on the ecosystem that is affected by invasive species is loss of biodiversity (Millennium Ecosystem Assessment 2005). The impacts of invasive species can be economically devastating (Pimental et al. 2001) and are ecologically complex, operating at ecosystem, habitat, community, species and genetic levels. Little is known or documented on the status of marine invasive species in the Caribbean beyond a few instances (e.g. green mussel). Indeed, a 2003 compilation listed 552 invasive species in the insular Caribbean, only 18 of which were marine (Kairo et al. 2003). However, a more recent survey identified a total of 118 marine invasive species in the Caribbean, that included 39 fish and 31 arthropod species (UNEP 2006).

#### Lionfish

The Indo-Pacific lionfish was introduced to Florida waters in the early 1990s, and is currently spreading rapidly throughout the reefs of Caribbean region (Albins and Hixon 2008). Lionfish are considered a dangerous pest because they are not native to the Caribbean, reproduce quickly, have no natural enemies on the Caribbean reefs (except for large groupers which are practically absent because of overfishing). They have sharp, highly venomous spines that cause excruciating pain when stung, and in exceptional cases can even cause death in humans. Lionfish devour large amounts of small and juvenile fish dramatically reducing recruitment of new reef fish such as snappers, groupers, grunts and parrotfish. Initial examination of crustacean prey suggests that lionfish may also eat the juvenile spiny lobster.

<sup>5</sup> The global transport of organisms via ships' ballast water is an important subject in studies of biodiversity. Royal NIOZ is coordinating the EU-Interreg IVb project 'Ballast water opportunity' (2009-2013) for the North Sea Region. NIOZ is also a recognized test-site of the IMO for the land-based testing of the efficiency of organism removal by ballast water treatment installations designed to be used on board ships.

The reduction in recruitment of coral-reef fishes suggests that lionfish may also compete with native piscivores by monopolizing this important food resource. In addition, lionfish have the potential to reduce the abundance of ecologically important species such as parrotfish and other herbivorous fishes that keep seaweeds and macroalgae from overgrowing corals (Albins and Hixon 2008). Recent anecdotal reports from Belize and the Bahamas now seem to link the presence of lionfish to the absence of lobsters; lobsters reportedly shun structures used by lionfish for shelter. If this is found to be true it would be detrimental to the lobster fishery on the Saba Bank.

Since 2008 lionfish spread among all the northern islands of the Caribbean down to Virgin Islands only 135 km from Saba. In September 2009, lionfish were reported for the first time from Aruba (<http://www.nacri.org/>), but have now been found on Curaçao and Bonaire as well. In July 2010 lionfish have also been spotted on Saba and St. Eustatius.

### 2.5.3 Diseases

Perhaps the most profound and widespread changes in Caribbean coral reefs in the past 30 years have been caused by diseases of corals and other organisms (Williams and Bunkley-Williams 2000). In recent decades, an unprecedented array of new diseases has emerged, severely affecting coral reefs. Most observations of coral reef diseases reported across the globe have come from the Caribbean region. The Global Coral Disease Database includes 23 different diseases and syndromes affecting corals alone in the Caribbean.

Prominent among these reports have been:

- The Caribbean-wide die-off of the long-spined black sea urchin *Diadema antillarum*;
- Widespread losses of major reef-building corals (staghorn and elkhorn) due to white band disease;
- The current widespread occurrence of aspergillosis, a fungal disease that attacks some species of gorgonians (sea fans);
- Numerous outbreaks of white plague.

The reasons for this sudden emergence and rapid spread of reef diseases throughout the Caribbean are not well understood. Possibly bleaching may affect coral resistance to diseases (Meesters and Bak 1993; Croquer and Weil 2009). Diseases have been observed all across the Caribbean, even on the most remote coral reefs, far from the influence of islands.

Infections in corals are increasing in numbers, and the Caribbean is considered a “hot spot” for coral disease (Jordan-Dahlgren et al. 2005). “Black-band”, “white-plague diseases” and “yellowblotch (yellow-band)” syndromes are most frequent infections. These infections are alarming as they can infect different species, spread fast and typically result in the death of the affected corals. Especially *Acropora* species in the Caribbean have been decimated (Hughes 1994). Other stresses such as high nutrients and sedimentation may similarly alter the balance between the coral and its resident microbial flora (Harvell et al. 2007).

More research and integrated environmental monitoring are needed to better understand and help predict this major, widespread threat to coral reefs. Ensuring good water quality may help reduce coral vulnerability to infections. Within the EEZ, the principal area in which coral diseases are a concern is the Saba Bank.

Aside from corals, recent years have also witnessed several localized and even regional outbursts of reef fish mass mortalities (Buurt 1981a,b, Williams and Bunkley-Williams 2000). Most often, several to a range of reef species are affected, including planctivores, herbivores and piscivores, among which commercially valuable species. Again, within the EEZ, the principal area for which coral reef fish mortalities are a concern is the Saba Bank.

#### **2.5.4 Pollution**

Within the EEZ of the Dutch Caribbean, several sources of pollution may be a cause of concern. These include oil discharge and spills, sewage, ballast and bilge discharge, and dumping of garbage and other human waste from ships.

##### **Oil and Chemical Contaminants**

Discharge of bilge and ballast water from ships releases a toxic mix of oil, nutrients, exotic marine species, and other pollutants. Acute impacts on local organisms is not expected due to dilution and currents . Oil damages coral reproductive tissues, harms zooxanthellae, inhibits juvenile recruitment, and reduces resilience of reefs to other stresses. Oil pollution is of particular concern in the waters around St Eustatius and Saba due to the presence of Statia Oil Terminal. There were major oil spills in 2002 (Tanker *Paulina*) and in 2009 (Tanker *Vallombrosa*). Oil spills tend to drift to the north and north west towards Saba and Saba Bank in the predominant currents. Therefore, attention to oil spill response management is needed. Newton (1987) and Debrot et al. (1995), provide monitoring results for oil and tar washed up on beaches, while Nagelkerken and Debrot (1995) have documented the chronic effects of oil pollution on intertidal mollusc community density and composition.

Contamination by TBT (Tributyltin) will be of declining importance in the years to come as production and application of this antifouling agent is being phased out. Globally concentrations of this compound in the marine environment can be expected to eventually decline. At present, TBT contamination can be expected to be least acute in the EEZ and most problematic in the coastal zone, particularly the lagoons and harbour areas. Other deleterious agents may arise, but due to dilution in offshore water no acute effects are expected.

##### **Marine litter**

Marine litter or debris is any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment from any source (<http://www.unep.org/regionalseas/marinelitter/>) (Coe & Rogers 1997). Marine litter can be classified into land- or ocean/waterway-based, depending on how the debris enters the water (UNEP 2008). Land-based sources include dumps/landfills, riverine transport, untreated sewage and storm water discharges, industrial and manufacturing facilities, tourism, and beach-goers. Sea-/ocean-based sources of marine litter include fishing vessels, cruise liners, merchant shipping, military and research vessels, pleasure crafts, oil/gas platforms, and fish farming (<http://marine-litter.gpa.unep.org/facts/facts.htm>).





*Figure 13. Marine litter, fishing lines, collected during one dive in the mouth of Lac Bonaire.*

Entanglement and ingestion of marine litter is directly damaging (often killing) wildlife and the environment in which they live. Marine litter can cause habitat destruction by smothering the seabed, entangling litter on coral reefs and by deposition on seagrass beds (Figure 13). According to Chiappone et al. (2002), fishing gear (hooks and lines) and debris from lobster traps cause damage to the coral reefs in the Florida Keys. Furthermore, alien species may use the transport mechanism of marine debris in the ocean to migrate into new areas and disturb the ecosystem.

The indirect effects of marine litter are potentially much more serious. Plastics are broken down by waves in very small particles, hardly visible to the human eye. These particles end up in animals and start accumulating in the food chain (UNEP 2005 2008, Barnes et al. 2009, Gregory 2009).

Practically no information on marine litter exists for the EEZ of the Dutch Caribbean. However, some insight into the extent of the problem is provided by beach and submerged litter monitoring results in Curacao (Debrot et al. 1999, Nagelkerken et al. 2001). Some data on marine litter composition from beach clean up data by Stenapa is available for Zeelandia Beach, St. Eustatius, and by St. Maarten Pride for St. Maarten, as submitted annually to the International Coastal Clean up organisation. The available information would indicate that litter in the marine environment remains a serious and persistent problem. In the leeward Dutch islands, entanglement of sea turtles in fishing debris has been documented both with fatal and nonfatal consequences while one beaked whale was documented with ingested plastic (Debrot 1998).

While the Dutch Caribbean no longer practice dumping of municipal garbage and waste in the sea, generally, the small islands in the Caribbean have difficulty locating suitable sites for landfills (UNEP 1999), and much domestic litter winds up directly in the marine environment. According to Ivar do Sul and Costa (2007), who conducted a review of existing literature on marine litter from Latin America and the Wider Caribbean Region for the period 1970-2007, plastics were the most common material reported. Some areas in the Caribbean show a significant amount of ocean-based litter related to fishing activities. There is no reason to assume that this observation would differ for the Dutch Caribbean.

Marine litter is one of the most urgent matters on the environmental agenda in the coming years (UNEP 2005, 2008). Pollution from chemicals dissolved in the plastics seriously threaten sea life and accumulate through the food chain (<http://www.unep.org/regionalseas/marinelitter/>).

### **Underwater noise**

Noise can impact marine mammals in different ways ranging from interfering with their detection of biologically important sounds, disturbing their behaviour to impairing hearing abilities and even death. The impacts of acoustic disturbance on cetaceans can be classified in direct and indirect effects. Direct effects are e.g. physical damage to the ear (temporary or permanent threshold shift) or to body tissue (gas bubble lesions in lung, liver) (Jepson et al. 2003), behavioural effects like displacement from an area, perceptual effects such as masking of communication and perception of the environment. Those direct effects will induce or bring about indirect effects including disruption of social behaviour, reduced prey detection possibilities, chronic stress, increased vulnerability to predation, increased risk for entanglement and collision with ships (see e.g. Ketten 2005, Hildebrand 2005, Simmonds et al. 2004, Dolman and Simmonds 2005).

There is a vast amount of literature on the impact of man-made noise on marine mammals as deduced from observed reactions of free ranging cetaceans to boat traffic and shipping noise, to seismic surveys and to the use of low frequency active sonar (see e.g. Richardson et al. 1995, IWC 2005, Simmonds et al. 2004), however, there are hardly any studies on population effects and our knowledge on the impact of noise on marine mammals is still poor. Van Bree and Kristensen (1974), have suggested that one incidence of deaths and stranding of beaked whales in the Dutch Caribbean may be linked to military acoustic activity.

Furthermore, studies have shown that many coral reef fishes use a variety of sounds for important intraspecific communication relating to all aspects of their life on the reef, including territoriality, individual recognition, reproduction (Hawkins and Myrberg 1983, Myrberg and Riggio 1985, Myrberg et al. 1986, Myrberg 1990, Myrberg and Fuiman 2002; Gannon et al 2005) and that even coral settling is mediated by sound (Vermeij et al. 2010). Excess man-made submarine noise may have unforeseen effects on reef fish stock and coral reef health.

National and international actions demonstrate the potential seriousness of impacts from underwater noise. Within the implementation of the EU Marine Strategy Framework Directive an environmental target, which should be reached in 2020 concerns underwater noise. In the US impacts of underwater sound on marine mammals are on the research agenda since 2003. In the Netherlands IMARES is involved in several research studies concerning the effects of acoustic underwater pollution on marine mammals.

### **2.5.5 Overfishing within the EEZ**

Overfishing of fish stocks is a global problem (Pauli et al. 1998). Overfishing is occurring on all islands in the Caribbean (Mora 2008). In the Dutch Caribbean the impacts of overfishing are mainly within the Territorial waters close to the coast and often within the marine park boundaries. Within the EEZ overfishing may be a problem on the Saba Bank, but a large part of this fishing occurs within the Territorial waters of Saba.

### **Pelagic species**

Preventing overfishing of large migratory pelagic species such as wahoo, dolphinfish, tuna and swordfish in the EEZ will have to be accomplished in close co-operation with international organization like ICCAT (International Commission for the Conservation of Atlantic Tuna). In November 2009, the Netherlands Antilles (limited) membership of ICCAT was extended and the monitoring requirements (catch registration) need to be adhered to.

In general, a good overview of the international obligations with regards to monitoring fish populations in the EEZ and the (inter)national judicial framework for sustainable fisheries is provided in a recent report by NILOS (Molenaar et al. 2008). The implementation of a robust catch recording system and investing in the required capacity to analyze and translate the data in relevant regulation, rules and policies is crucial.

WECAF (2008) expresses concerns regarding the status of sharks and the risks of overexploitation. Though these species are not specifically targeted within the Dutch EEZ their status at this moment may indicate that fishing by national or foreign ships is presently unsustainable.

### **Demersal species**

To estimate the risk of overfishing lobster and reef fish stocks on the Saba Bank is difficult due to the lack of robust, long term data sets. This is especially true for the fishery targeting red snappers (several species). Between 2000 and 2007 changes in fishing gears were observed in the snapper fishery. In 2000 hand lines were the most common fishing gear while in 2007 predominantly fish traps were used to target red snappers. The lack of knowledge about population dynamics and stock size in combination with the current harvest of predominantly juvenile fish, which often is indicative of overfishing, should be reason for concern (Toller and Lundvall 2008).

Lobster fishery on the Saba Bank (Figure 14) appears to be reaching carrying capacity. While no change was observed in the average size of caught lobsters from 2000-2007, lobster CPUE (Catch Per Unit Effort) declined by about 30% in the same period: due to the increase in the estimated total number of lobster traps deployed (from 1400 in 2000 to 1800 in 2007), only a small (~6%) reduction in landed lobsters was observed (Toller and Lundvall 2008).

Since the mid 1990's fishing pressure on the Saba Bank grouper and conch stocks, was dramatically reduced by excluding all foreign fishing. Nevertheless, current catches of large groupers and conch remain respectively low or negligible. With several years now of a conch fishing moratorium it seems useful to assess the conch stock status but the larger grouper species in any case have certainly not recovered much (Toller et al 2010). This may be partially ascribed to the groupers' longer population life cycle and/or the likely reduction in ecological carrying capacity of the Bank due to coral cover losses which evidently have taken place in recent decades (Lundvall 2008). In addition, across the board, Caribbean reef fish stocks have been undergoing a recruitment crisis (Paddock et al. 2009). So, even without any changes in actual fishing effort, ecological deterioration may cause initially acceptable fishing effort levels to become excessive and unsustainable.

Studies of potential yields of tropical reef fisheries suggest a range of potential yields of between 1.7-2.3 metric tons per km<sup>2</sup> per year (Neilson et al. 1994). The current yields for the Saba Bank are very low by these standards, as is the case in most reef fisheries throughout the region (Neilson et al. 1994). With signs of current overfishing generally evident, this would suggest that with proper management and assessment, eventually a significant increase in landings could be realized. Hence the economic argument may be seen as an important incentive towards better management of the Saba Bank fish stocks.



*Figure 14. The important Spiny Lobster trap fishery of the Saba Bank may be showing signs of overfishing (photo: W. Toller).*

Currently there is no commercial queen conch fishery on the Saba Bank. Although no historic data exist on the conch population anecdotal evidence suggests that conch stocks were severely overfished by foreign fishing vessels (Meesters et al. 1996). Caribbean wide evidence indicates that queen conch had become severely overfished by the mid nineties (Declaration of San Juan, Puerto Rico 1996), thus it is likely that this was also the case for the Saba Bank.

Legislation is currently in place stating that all fishers on the Saba Bank must report data on their catches, effort, fishing location and fishing gear to the Fisheries Commission. Unfortunately the required infrastructure to collect and analyze this information is not in place. Improvement of capacity (science, policy, compliance) in the near future is important to manage and maintain a sustainable fishery.

#### ***2.5.6 Physical damage by anchoring, groundings, and collisions***

The risks of physical damage by anchoring, groundings, and collisions appear mainly important for the Saba Bank. Anchors can devastate coral reefs and recovery may take decades (Rogers and Garrison 2001).





Figure 15. Remotely operated vehicle exploring an anchor scar on the Saba Bank (source S. Lundvall).

Anchors and even more the chains may cause damage to coral reefs during setting, retrieval, and while at anchor (Figure 15). The chain and anchor of a large cruise ship can weigh 4.5 metric tons (mt). Even in calm seas, reckless anchoring can easily damage up to 200 square meters of ocean bottom. For instance, observations made off Grand Cayman Island, West Indies, found that a single anchoring by a cruise ship anchoring, for one day, may destroy 3150 m<sup>2</sup> of previously intact reef (Smith 1988). Regeneration of coral reefs from such damage may never occur (Rogers and Garrison 2001). Anchoring on the Saba Bank appears to have increased in 2009 (Figure 16).

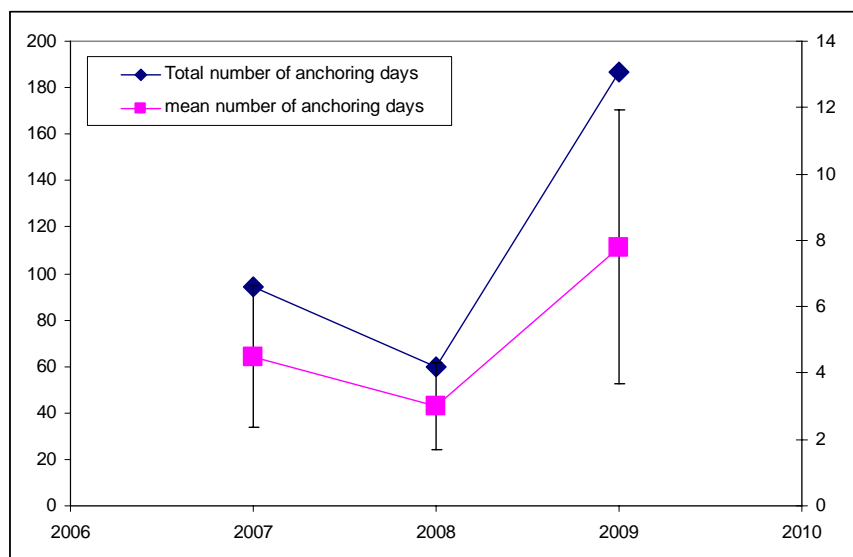


Figure 16. Total number of anchoring days (left axis) and the mean number of days per ship with 95% confidence limits (right axis). In 2007 observations are a minimum as the Bank was not monitored the whole year round. The total number of ships anchoring was 20 and 24, and crossing the Bank was 54 and 29 in respectively 2008 and 2009.

Ship groundings and collisions on the Saba Bank could potentially cause great damage to the Bank coral reefs (Hudson and Diaz 1988, Rogers and Garrison 2001, Dinsdale and Harriott 2004). Eventhough ship groundings or collisions have not yet happenend on the Saba Bank,

and the actual likelihood of a grounding accident would be hard to estimate, the grounding of large tankers is a genuine danger when considering that if engine failure ever occurs, prevailing winds and currents could carry a tanker rapidly from Statia towards the shallow coralline eastern rim of the Bank. The potential impact of a grounding or collision would be even worse if accompanied by an oil spill. This could endanger marine life which may suffer smothering and poisoning, and it may destroy fisheries.

The draught of large oil tankers is deeper than the average depth of the eastern and southeastern rim of the Bank, resulting in more risk at that area. Risk is therefore highest in the eastern and southeastern part of the Bank where the rim of the Bank, which supports the most coral reefs, should be considered very sensitive to anchor damage. Elsewhere, the very diverse algae fields, sponge and gorgonian communities found in other parts of the bank are similarly sensitive to anchor damage. In addition, any structure on the very flat and relatively featureless center parts of the Bank, such as formed by solitary coral colonies, large sponges or even rocky outcrops resulting from former erosion processes, forms scarce and essential habitat for lobsters, which are the basis of the most important fishery of Saba. Anchoring destroys such structure and can consequently be expected to severely impact the lobster abundance on the bank and thus the fishery.

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## 3 EEZ management

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### 3.1 Introduction

This management plan is based on a shared vision and mission, which describes the broad longterm goals and fundamental purpose of the plan. The vision/mission statement as jointly developed by parties is presented in the box below. Based on this vision and mission statement, goals have been defined. These have been further dissected into specific objectives. The specific actions and processes by which to achieve those objectives, as well as an implementation plan and a control mechanism by which to monitor progress and incorporate feedback, together constitute the chosen "strategy" by which to proceed. Critical to the usefulness of any plan is that the objectives are formulated so as to be specific, measurable, achievable, realistic, and time-bound ("SMART"). Again, for any objective any number of different strategies may be designed to yield the desired results.

#### **Vision**

There is a shared vision between the parties which is presented in the general objective (Chapter 1.1) and repeated below.

Common sustainable management of marine biodiversity (the living and non-living resources), which includes the protection of species, and habitats in the waters and on the seabed of the Dutch Caribbean EEZ and the zone between the borders of the Island marine parks and territorial waters, with a particular focus on special areas such as Saba Bank and particular species<sup>6</sup>.

Because the plan pertains to a natural marine system (or systems) which is (are), dynamic, subject to change, and only imperfectly known, management is designed to be adaptive, in the sense that the management strategy will be scheduled for periodic review and adaptation. Adaptive management, which can most simply be seen as a cyclical process of decision, implementation, monitoring, evaluation, and adaptation, depends on effective feedback between four system components. Adaptive management is by nature a science-based and learning process as it relies critically on the use and availability of scientific knowledge and monitoring of results.

#### **Guiding Principles**

In the case of the resources represented in the EEZ, it must be remarked that they are by nature public resources, jointly owned by several jurisdictions within the Kingdom and that the management process needs to be formulated to be transparent, joint, and cooperative. Finally for management to be effective it needs to be legally based and allocated sufficient funding to build and maintain the necessary organizational capacity so that the rules and regulations that will be used can be effectively enforced.

Eventhough in the Dutch Caribbean the EEZ (with exception of the Saba Bank) largely concern deep, oligotrophic and "empty" waters, it is important to recognize critical ecological connectivity to, and dependancies on, the nearshore insular marine environment, not only as feeding grounds, nursery habitats, and roosting sites for birds, but also as

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<sup>6</sup> Oil and gas resources are excluded

important sources of land-based nutrients and or pollution. To a large extent, successful management of the EEZ will, therefore, be highly dependent on the management regime of the nearshore areas. Acknowledging the complex linkages and interconnections within and between component systems in the marine ecosystem, as well as ecological linkages to areas bordering as well as well outside the EEZ, management of the EEZ further aims to be integral and comprehensive, paying due attention not only to natural resource issues but also to social and economic interests (People, Planet, Profit). Insofar as possible the initiative should strive towards, complementarity to the legal and management regimes of adjacent marine areas pertaining to different Kingdom partners, as well as towards international participation and cooperation, particularly as to migratory and transboundary species and issues. The legislative framework for the area must ensure compliance with all relevant international treaties and conventions to ensure that all legal obligations regarding the area are met.

In chapters 1 and 2 the significance and principal values of the EEZ have been briefly described as well as the main threats and issues. In this chapter key management objectives are defined, actions and processes by which to achieve those goals are formulated as well as how to implement, monitor and adapt the chosen strategy.

### 3.2 Integrated and adaptive management

Environmental management has converged into two main methods, namely integration and adaptation. These concepts will be briefly described below.

Management should be “integrated” at various levels. The term “integrated management” refers principally to the integration of social, economic and environmental goals as part of management so as to achieve sustainable development. Sustainable development can be diagrammatically portrayed as the intersectional area between the three general focal areas (Figure 17). This concept is also referred to as “Triple Bottom Line” management and also often as the “People, Planet, Profit” approach to sustainable management.

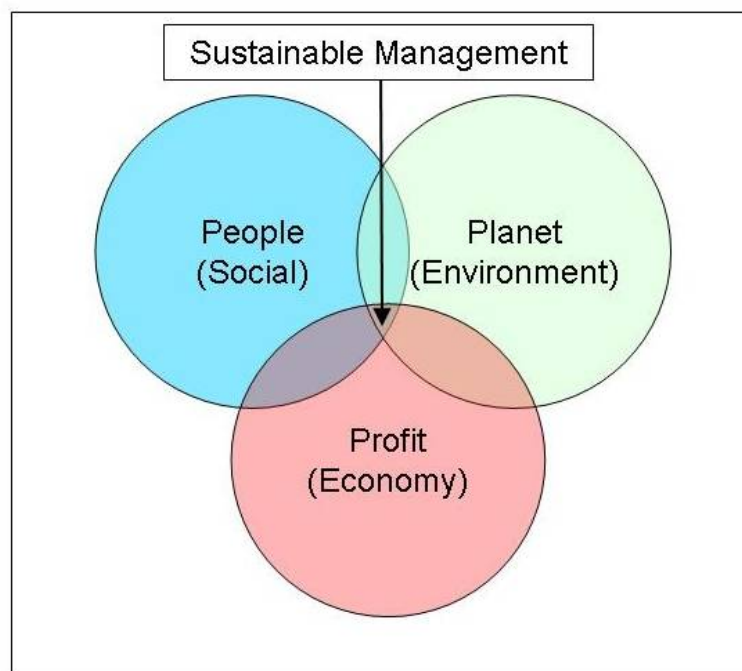


Figure 17. Sustainable environmental management is attained with integration of social and economic goals along with environmental goals.



To integrate management in terms of “PPP”, broad participation of stakeholders from within the three key areas (environment, economics and social) is essential. For the EEZ, this is largely achieved by implementation of the proposed governance structure (Chapter 5.1)

The adaptive management cycle provides for sequential planning, implementation, evaluation and adaptation in management (Figure 18). This approach is based firmly on the IUCN management cycle, which seeks to ensure that there is continuous learning by reassessing and re-evaluating the success of management actions, programs and initiatives. These steps basically come down to:

1. Identifying and describing the significance and condition of the natural values, the threats and issues facing these values and identify critical threats.
2. Developing and prioritizing management objectives and strategies, monitoring and operational plan;
3. Implementing actions and monitoring actions: develop work plan, time line, budget and implement plans.
4. Evaluating the success of management actions by analysing data, evaluating results and adapting the strategic plan.
5. Documenting and sharing of experience and knowledge for continual improvement over time.

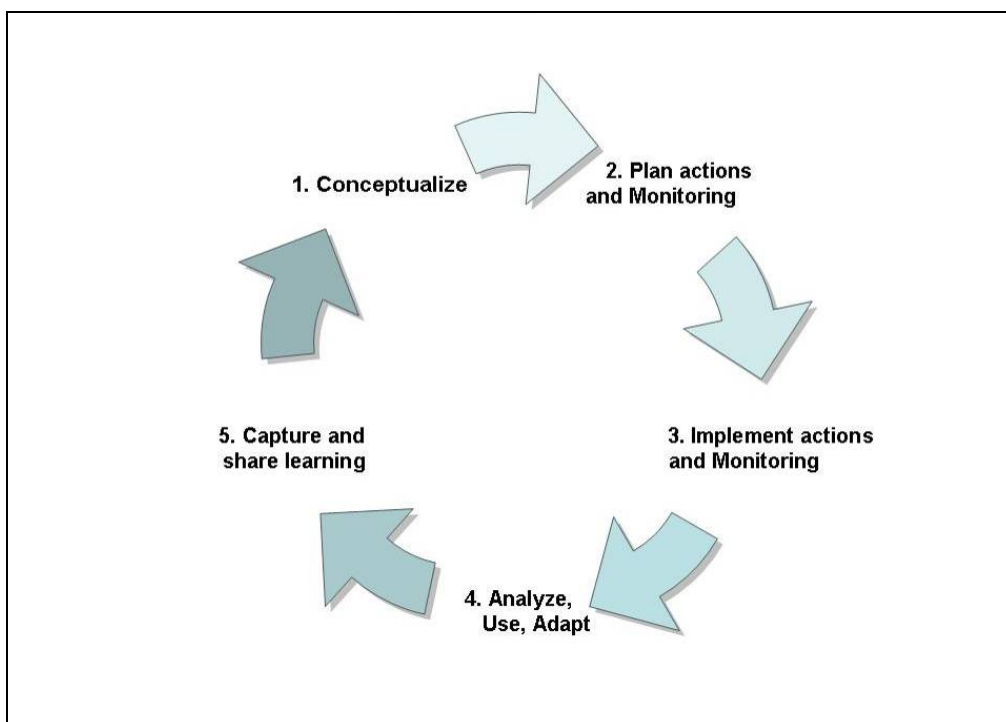


Figure 18. Principle stages in the adaptive management cycle.

A key decision will be to decide on the length of the chosen cycle. Keeping in mind on the one hand the desire to achieve change for the better, but on the other hand the costs associated with the cyclical process and the inertia and lags that are characteristic to change in ecological systems, a 3-5 year management cycle is mostly deemed appropriate. It may be advisable to begin with a shorter cycle in the beginning and opt for a longer cycle later.

Several key elements are needed for the management cycle to function properly. These are diagrammatically portrayed in Figure 19. Key and foremost is the element labelled “strategy”.

This element incorporates such considerations as stakeholder participation, balanced integration, management cycle length and provides the blue print for achieving both short and longterm goals. Most critical here is for general goals to be translated into clear and concise action points.

Based on the decided strategy, "management" is implemented. Both a legal and financial basis are essential to implementation. In the context of the integrated management of a large interconnected marine ecosystem, in which ecosystem functioning is still largely intact, the choice of management methods should focus on holistic, "sweeping" approaches instead of micromanagement" approaches. Because marine ecosystems further typically serve many interests and parties, and requires many diverse specialities, the implementation of marine management in all its diverse aspects, is inevitably characterized as involving many different organizations at various levels (e.g. coast guard, directorate of shipping, fishery departments, research institutes, game wardens, etc).

Adaptive management is of necessity science-based. Therefore, access to the best and latest scientific and policy knowledge in areas ranging from shipping to tourism, ecosystems, biodiversity, species management, enforcement, mapping etc. is essential. The "knowledge" element is typically housed in a network of organizations scientifically equipped to produce new knowledge and insight related to their specific expertise, and harbour this knowledge (in the form of data bases, literature collections, specimen collections and/or experts). Knowledge, data exchange and sharing to make this available to the various management partners and decisionmakers is very important. All of these aspects require financial investment to maintain the systems and experts in organizational structures in which they can function. Sustainable management must be based on sustainable organizations.

Without new knowledge input, management will essentially be blind, and the management cycle will have little purpose. Sometimes new knowledge may enter the management system fortuitously. Nevertheless, specific and directed "monitoring" to measure trends in key biotic, abiotic and user parameters is essential as a means with which to evaluate management effectiveness. Because monitoring is costly, and because there is often a myriad of parameters to potentially monitor, it is especially important to decide what to monitor and how frequently to monitor.

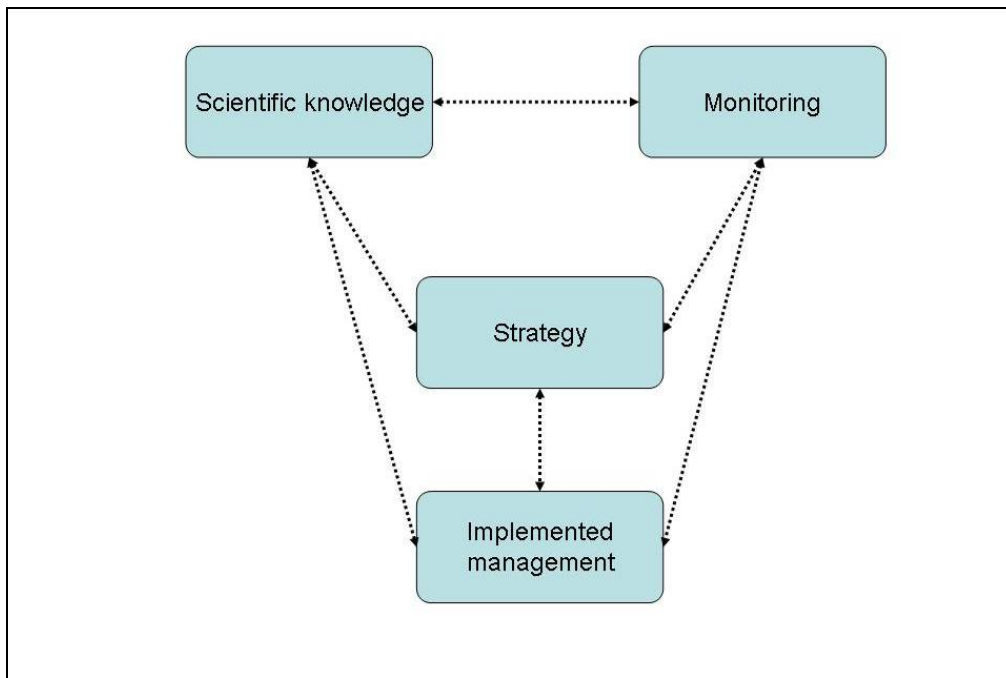


Figure 19. Key elements of adaptive management strategy and their interactions.

### 3.3 Distribution of fishing rights within the EEZ

Many different versions of exclusive fishing rights systems are in place over the world: Access Rights e.g. limited entry right, fishing co-operatives, territorial use right; Harvest Share Right e.g. Individual quota shares or IFQs, collective quota's or territorial right (Huppert 2005). **The three main forms of more exclusive fishing rights – limited entry permits, individual fishing quotas (IFQs), and local community-based or co-operative harvesting – vary widely in content and detail. But, when successful, they all increase the economic efficiency of fisheries.**

Initial distribution of fishing rights must be a transparent and fair process in close co-operation with existing stakeholders, which is difficult to achieve in practice. Allocation of fishing rights is often based upon historic fishing participation. The issue of fishing privileges for large, pelagic species will need to be addressed for foreign vessel in the EEZ, recreational fishers and traditional coastal fishers in the territorial waters.

One key issue that needs to be dealt with is the fact that historically large numbers of Curacao fishermen have always fished in territorial zone of Bonaire. This is a rather unique situation in the Netherlands Antilles. For instance, Aruban fishermen fish largely west and south from Aruba (due to the natural distribution of demersal fish stocks), and traditionally have never ventured much east towards Curacao. Vice a versa, the same is also true for Curacao fishermen. There have never been significant numbers of Curacao fishermen heading significantly west towards Aruba to fish. It is further generally unheard of that Bonairean fishermen significantly head west from Bonaire to fish in or near Curacao waters. It has always been such that Curacao fishermen tended to fish east, upwinds towards and beyond Bonaire, in accordance to where most migratory fish (wahoo and dolphin fish) come from (the east).

After 10-10-10, the territorial waters of Bonaire will formally fall within the Netherlands while the waters of Curacao will constitute the national waters of the country of Curacao. Therefore, the (then) Netherlands island of Bonaire will need to set up a permitting system to regulate

the entrance of fishing boats from Curacao for the purpose of traditional fishing in Bonaire waters. The permitting system should be simple and costs should not be prohibitive.

In the windward EEZ area no similar situation exists to the same extent. In practice for the Saba Bank, virtually only Saban fishing occurs on the Saba Bank. There are at least two important reasons for this. Not only are St. Maarten and St. Eustatius in practical terms quite far for their island fishermen, but both St. Maarten and St. Eustatius possess extensive shallow shelf areas close to the island. As a consequence, most St. Maarten and St. Eustatius fishing takes place close to their own islands. Saba, however, has no effective shelf area due to its steep volcanic form and Saban fishermen have, therefore, by and large always been forced to fish far away from home, on the Bank. Practically no Saban fishermen venture towards either St. Maarten or St. Eustatius during normal fishing activity. Nevertheless, legal instruments should be put in place that can regulate "cross-border" fishing for St. Maarten and the Windward BES islands, in order to accommodate possible future developments such as for instance 'charter-boat' fishing as a potential tourism development.

**Action point(s):**

An unencumbered reciprocal permitting system needs to be designed between The Netherlands and its new Kingdom partners that will not only allow for traditional fishing to continue at sustainable levels, but that will also not form unnecessary hindrances to ecologically sustainable development of local fishing and fishing related industry.

### **3.4 Zones of sovereign jurisdiction**

General principles of International law recognize different types of maritime zones that may be subject to varying degrees of coastal jurisdiction (see also chapter 1 and figures 3 - 4). These principles are codified in the UN Convention on the Law of the Sea (UNCLOS) laying down 5 overlapping maritime areas as follows:

- A boundary of 12 nautical miles (nm) from baselines of a coastal state for a territorial sea;
- A boundary up to 24 nm from baselines for a contiguous zone;
- A boundary of 200 nm from baselines for an Exclusive Economic Zone (EEZ); and
- A continental shelf boundary at 200 nm from the shore baseline, but up to 350 nm in cases where the shelf extends further, or a further boundary 100 nm outward from a 2,500-meter isobath.
- The water column above the continental shelf beyond 200 nm is defined as "the high seas". The high seas include all parts of the sea that are not included in the EEZ, in the territorial sea or in the internal waters of a state.

In the territorial sea (Figure 4) the coastal state has full sovereignty. In other words, the coastal state has the exclusive authority to control the activities of others. Foreign vessels are entitled to the right of innocent passage through the territorial sea. In exercising this right, the vessels must comply with legislation enacted by the coastal state in conformity with international law. The UN Convention on the Law of the Sea expressly permits such legislation for: traffic lanes, safety of navigation, conservation of living resources, prevention of pollution of the marine environment and laws regarding marine and scientific surveys. Upon declaring an Exclusive Economic Zone up to 200 nm outwards from its territorial sea, the coastal state has sovereign rights for the purpose of exploring and exploiting, conserving and managing the living and non-living resources of the seabed and the superjacent waters. It also has jurisdiction with respect to installations, structures, marine scientific research and environmental protection. These rights are concurrent with the right of other states to exercise freedom of navigation and overflight, as well as freedom to lay submarine cables and pipelines in the EEZ. Special protection is to be accorded to highly migratory species of fish and marine mammals.

### 3.5 International treaties, conventions, protocols, and other initiatives.

When countries join a convention or treaty, they are enlisting in an international effort for a common objective. Parties to the treaty agree on a number of commitments. Compliance with the commitments is mostly voluntary and there is no regulatory regime nor punitive sanctions for violations of or defaulting upon treaty commitments. International treaties however are binding in international law in that sense. The whole edifice is based upon an expectation of common and equitably shared transparent accountability. Failure to live up to that expectation could lead to political and diplomatic discomfort in high-profile international fora or the media, and would prevent any Party concerned from getting the most, more generally, out of what would otherwise be a robust and coherent system of checks and balances and mutual support frameworks. Failure to meet the treaty's commitments may also impact upon success in other ways, for example, in efforts to secure international funding. In addition, national jurisdictions should embody international obligations in national law and/or policy with direct effect in their own court systems.

Treaties and conventions applying directly to marine biological resources in the Caribbean region are:

- Cartagena / SPAW protocol
- Convention on Biological Diversity
- CITES Convention
- Convention for Migratory Species
- Inter- American Convention for the Protection and conservation of Sea Turtles (IAC)

#### 3.5.1 CITES Convention (1973)

The Convention on International Trade in Endangered Species (CITES, [www.cites.org](http://www.cites.org)) aims to protect animals and plants threatened in their survival by international trade. Many species are covered, including many Caribbean species or species that may occur in the Caribbean Sea. Protection against trafficking in endangered animal or plant species requires international cooperation. CITES obliges countries that have ratified the treaty to act against trafficking of the endangered species in the three annexes of the Convention (<http://www.cites.org>).

The Kingdom has ratified CITES for the Netherlands Antilles as well as for the Netherlands and Aruba. The three categories of species annexed under the CITES Convention are given in Table 1. A large number of CITES species occur on the BES islands.

The Caribbean, including the Dutch Caribbean islands has been identified as a "Global Biodiversity Hotspot" by Conservation International because of its high degree of biodiversity while being subject to great human impact (Meyers et al. 2000). The Caribbean has an estimated 14,500 species of plants and (vertebrate) animals - of which about half are endemic species occurring only on one island. The islands of the Netherlands Antilles and Aruba also have an extensive and specific biological richness, both on land and in the sea with some 200 extant endemic species and subspecies (Debrot 2006) , 11 CITES Appendix 1 species and nearly 100 CITES Appendix 2 species. In total, there are more than 200 globally threatened species on the islands.

*Table 1. Characterisation of the species in the annexes of the CITES convention*

- I Species that are threatened with extinction; trade or trafficking in these species is only possible in exceptional circumstances.
- II Species that are not necessarily threatened, but to avoid unsustainable use that is incompatible with their survival, trade must be controlled.
- III This appendix concerns species that are threatened in at least one country which has asked other CITES parties for assistance in controlling the trade.

The Annex I and II species of the CITES Convention are included as Appendix 7.3 to this management plan.

### **3.5.2 Convention for Migratory Species (CMS, 1985)**

The Convention on Migratory species ([www.cms.int](http://www.cms.int)) is agreed upon in 2005 and ratified by the Netherlands. A migratory species under the Convention can be an entire population of a species or a geographically distinct part of the species. The term migratory is a partly political, partly biologically defined. In any case, a significant proportion of the population of the species must cross national borders on a cyclical basis or migrate.

There are no specific agreements under the CMS for the Caribbean, but as it is a region where cetaceans, dolphins and turtles are found and as it is part of the flyway of the eastern U.S. migratory range, the islands are dealing with endangered migratory species (Voous 1983, Wells and DeBrot 2008, Brown et al. 2009, Prins et al. 2009). The CMS has two appendices listing species in need of protection. In CMS Appendix I, the migratory species in danger of extinction throughout all or a significant proportion of their range are listed. In Appendix II species with an "unfavorable conservation status" are listed. This is meant as an additional stimulus to international, and sometimes regional protection agreements.

For the Caribbean area, initiatives are undertaken such as collaboration between CMS and the Cartagena Convention for establishing a work plan for marine mammals. But so far, no concrete results have been reached. For the Dutch Caribbean there are 9 Annex I CMS species - four whales and five turtles -. The Annex CITES II listed 14 species that also occur on the CMS Annex II list, nine dolphins and five birds (see appendix 7.3).

### **3.5.3 Cartagena Convention (1983) and SPAW protocol (1990)**

The Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (the Cartagena Convention, 1983, [www.cep.unep.org/cartagena-convention](http://www.cep.unep.org/cartagena-convention)) is a legally binding environmental treaty for the Wider Caribbean Region. The Convention and its Protocols constitute a legal commitment by the participating governments to protect, develop and manage their coastal and marine resources individually or jointly.

The SPAW Protocol (Protocol concerning Specially Protected Areas and Wildlife, 1990, entering into force 2000), is part of the Cartagena Convention and is signed by the Kingdom of the Netherlands to apply to the Netherlands Antilles. The SPAW Protocol has been internationally recognised as the most comprehensive treaty of its kind, and concerns the Marine and Terrestrial environment.

The objective of the Protocol is to protect rare and fragile ecosystems and habitats, thereby protecting the endangered and threatened species residing therein. The Caribbean Regional Co-ordinating Unit pursues this objective by assisting with the establishment and proper management of protected areas, by promoting sustainable management (and use)

of species to prevent their endangerment and by providing assistance to the governments of the region in conserving their coastal ecosystems.

The protocol is in many ways a precursor to the Convention on Biological Diversity (CBD). It is therefore now also described as a regional vehicle for the Convention on Biological Diversity. The protocol calls on parties to take the necessary measures, in accordance with its laws and regulations and the terms of the Protocol, to protect, preserve and manage in a sustainable way, within areas of the Wider Caribbean Region in which it exercises sovereignty, or sovereign rights or jurisdiction: a) areas that require protection to safeguard their special value; and b) threatened or endangered species of flora and fauna.

For proper management of these areas the protocol calls on parties to adopt and implement planning, management and enforcement measures for protected areas including among others:

- Scientific research and monitoring of impact of users, ecological processes, habitats, species and populations, aimed at optimizing the management.
- Develop public awareness
- Active involvement of the local population
- Ensuring qualified managers

In addition, reporting is required to the Treaty organisation on:

- The status of disappearing, new protected areas, buffer zones and protected species
- Changes in the margins or the legal status of protected areas, buffer zones and protected species.

The Netherlands Antilles has always been an active member of the SPAW Protocol. A number of tasks flow from the Protocol related to monitoring and reporting of the status of listed species, habitats and ecosystems.

#### ***3.5.4 Convention on Biological Diversity (CBD, 1992)***

The Convention on Biological Diversity ([www.cbd.int](http://www.cbd.int)) was opened for signature at the Earth Summit in Rio de Janeiro (1992) and entered into force on 29 December 1993. The CBD has 193 parties and 168 signatures. As such it constitutes one of the most important environmental treaties. The CBD has 3 main objectives:

1. The conservation of biological diversity,
2. The sustainable use of the components of biological diversity, and
3. The fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

It is often seen as the key convention regarding sustainable development. The Convention also offers guidance based on the precautionary principle: that where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimize such a threat. The Convention is legally binding; countries that join it are obliged to implement its provisions. Marine and coastal biodiversity have been a priority since the first Conference of Parties (COP 1, 1995). Other include coral bleaching, physical degradation and destruction of coral reefs, mariculture, high seas biodiversity, deep seabed genetic resources beyond the limits of national jurisdiction, and the development of a network of marine protected areas.

Most of the Parties have established National Biodiversity Strategies and Action Plans (NBSAP) to implement the convention.

### **3.5.5 Inter- American Convention for the Protection and Conservation of Sea Turtles (IAC, 1996)**

The Inter-American Convention for the Protection and Conservation of Sea Turtles is the only international treaty dedicated exclusively to sea turtles, setting standards for the conservation of these endangered animals and their habitats. Because individual sea turtles migrate and disperse over vast distances, they are resources shared by the peoples of many nations. The Netherlands has ratified the Convention.

Although the text of the Inter-American Convention does not make specific mention of the Convention on the Conservation of Migratory Species of Wild Animals (CMS), the two instruments complement each other. All species of sea turtles found in the western hemisphere are listed in both Appendix I and Appendix II of the CMS, and the text of CMS includes many concepts fundamental to regional conservation of migratory marine animals, such as sea turtles. In the same way, the Protocol concerning Specially Protected Areas and Wildlife (SPA) to the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (the Cartagena Convention) is totally complementary to the Inter-American Convention. All six species of Caribbean sea turtle are listed in Annex II of the SPAW Protocol. The Cartagena Convention and SPAW Protocol, supported by the UNEP Caribbean Environmental Programme, enjoys full collaboration with the Wider Caribbean Sea Turtle Conservation Network (WIDECAST) and is of great importance to the Caribbean region of the Western Hemisphere.

The measures proposed in the Inter-American Convention, promote regional management plans and agreements, such as the International Agreement for the Conservation of Caribbean Sea Turtles (Tripartite Agreement), a recently completed pact which deals specifically with the Caribbean coasts of Costa Rica, Nicaragua and Panama. The Inter-American Convention places great importance on environmental conservation, as well as the reduction of bycatch by developing more selective fisheries gear and practices, for example through the use of Trawling Efficiency Devices (also called Turtle Excluder Devices - TEDs).

Measures to be taken by the contracting parties include among others:

- a. Prohibition of the intentional capture, retention or killing of, and domestic trade in, sea turtles, their eggs, parts or products;
- b. Compliance with the obligations established under the CITES relating to sea turtles, their eggs, parts or products;
- c. Restriction of human activities that could seriously affect sea turtles, especially during the periods of reproduction, nesting and migration;
- d. Protection, conservation and, if necessary, the restoration of sea turtle habitats and nesting areas, as well as the establishment of necessary restrictions on the use of such zones, including the designation of protected areas, as provided in Annex II;
- e. Promotion of scientific research relating to sea turtles and their habitats;
- f. Promotion of efforts to enhance sea turtle populations;
- g. Promotion of environmental education and dissemination of information in an effort to encourage the participation of government institutions, nongovernmental organizations and the general public in the protection, conservation and recovery of sea turtle populations and their habitats;

## **3.6 Habitat protection**

The Dutch islands in the Caribbean already have or are in the process of installing Marine Protected Areas. Participants decided that the management of the marine parks within the territorial waters will not be included in this management plan. If there is a marine park around an island, however, the outer borders of these parks will be designated as the inner



border of the area that this management plan addresses. The zone from the outer borders of the marine parks out to the 12 nm limit is considered a buffer zone. Until more is known about other areas in the EEZ of the Dutch Caribbean, only the Saba Bank will be considered an area for special protection.

### **3.6.1 Saba Bank: Particularly Sensitive Sea Area (PSSA)**

Under the International Maritime Organization (IMO) an area can be assigned a special status if it satisfies a number of criteria. Participants in this management plan agree that the Saba Bank warrants such a status and that an application should be made to IMO as soon as possible to grant the Saba Bank the status of Particularly Sensitive Sea Area (PSSA).

The application to IMO is being drafted by VOMIL, and will be submitted to IMO in september 2010. Attaining the PSSA status is important as it will provide the legal basis by which to regulate or even fully ban anchoring on the bank by large vessels and regulate shipping. In so doing, the PSSA status can eliminate an important chronic impact of anchor damage to the benthic communities, reduce gear loss to the artisanal Saba lobster fishery, and reduce the risk of potential ship groundings, collisions and oil spills on the bank. In the case the PSSA status cannot be obtained for whatever reason, unilateral regulation of anchoring within the EEZ remains a distinct possibility (Molenaar 2008). Closing the Saba Bank to ships and anchoring will not be a serious hindrance to operation or development of Statia's Oil Terminal (J. Sierhuis). The tankers today are equipped to station themselves and maintain position safely at sea without needing to anchor. In addition they may be able to make more use of permanent moorings. Finally, a significant portion of the anchoring ships apparently are not associated at all with the Statia Oil Terminal. In conclusion, an anchoring prohibition will not limit Statia Oil Terminal (NUSTAR) in any way.

Further research should address the extent of present anchor damage to the Bank, the time required for recovery of those areas and investigate if there are areas on the Bank where anchoring may cause less damage.

### **Saba Bank Management Plan**

All available research points to the fact that the Saba Bank is a unique resource requiring special protection and management (Etnoyer et al. 2010, Littler et al. 2010, McKenna and Enoyer 2010, Meesters et al. 1996, Thacker et al. 2010, Toller et al. 2010, Van der Land 1977, Williams et al. 2010), and existing research on fish stocks indicates that the various fisheries as currently conducted are already having non-sustainable negative impacts (Dilrosun 2000, Toller and Lundvall 2008, Toller et al. 2010).

A number of measures to limit the impact of fisheries can already be implemented. These include measures regarding trap mesh sizes, by-catch practices, seasonal closure of a number of mass spawning sites (e.g. queen triggerfish, red hind). Many of these can already be found in the Saba Bank Special Marine Area Management Plan 2008 (Lundvall 2008). Sustainable management of the fishery is urgently needed, and protective management measures as offered by Lundvall (2008) should be considered.

Nevertheless, too little is presently known about the distribution of habitats and fish stocks to optimally manage the fisheries on the Bank and relevant research is direly needed.

### **Saba Bank action points**

- a) Pursue PSSA status for the Saba Bank
- b) Implement basic protective management measures for the Saba Bank as outlined in the Saba Bank Special Marine Area Management Plan 2008 (Lundvall 2008).
- c) Implement longterm regular fishery catch monitoring program on Saba.
- d) Quantitatively describe and map the various habitats occurring on the Bank (with particular emphasis on identifying potential mass spawning sites for adults and nursery grounds for juveniles) and

- e) Quantitatively assess the various fish stocks in terms of distribution, size and structure.

### **3.6.2 EEZ: Marine mammal sanctuary**

There is anecdotal evidence that the EEZ may be of special importance to marine mammals in the Caribbean. More specifically, the area of the Saba Bank may be part of the eastern Caribbean calving area of the humpback whale, while the deep water parts of the EEZ may be of special importance to beaked whales (Debrot et al. 1998). Possibly, the Bank also acts as an important migratory area for various cetaceans (Debrot et al. 1998), and as habitat to the possibly genetically distinct (G. Leduc, UCLA, La Joya, pers. comm.) non-migratory Venezuelan subpopulation of the Bryde's whale. However, little is known about the marine mammals of the Dutch Caribbean EEZ and additional research is needed.

The Netherlands have ratified the SPAW Protocol for the Netherlands Antilles and have always been an active participant to SPAW. The SPAW protocol requires conservation of all marine mammals and implementation of the Action Plan for the Conservation of Marine Mammals in the Wider Caribbean (MMAP). In the Netherlands Antilles all occurring cetaceans are legally protected from hunting. The protocol calls on parties to actively involve in monitoring and reporting of the status of listed species, habitats, and ecosystems.

#### **Marine Mammals action Points**

- a. Join the eastern Caribbean marine mammal sanctuary initiative of neighboring states by declaring the Dutch Caribbean EEZ as a marine mammal sanctuary. (No extra research is needed to achieve this)
- b. Develop marine mammal research projects to further evaluate and assess the importance of the EEZ as suggested by previous research. In this it may be optimal to tie in to current regional joint projects to identify and quantify marine mammal populations (the French "Agoa" marine mammal sanctuary initiative, the US Stellwagen Bank National Marine Sanctuary (SBNMS) and the "Sanctuario de Mamíferos Marinos de la República Dominicana" (SMMRD). These projects use passive acoustic survey buoys, and photo identification to compare individual specimens, in particular of humpback whales.

### **3.6.3 Deep Sea Initiative**

Very little is known about the biodiversity of the Dutch Caribbean deep sea, mesophotic reefs, aphotic coral reefs, and status and distribution of commercial pelagic fish stocks. There is no knowledge about the occurrence of deep-water coral reefs on submerged sea mounts, so called aphotic coral reefs, but it is very likely that these are present on for example the Curaçao Ridge north of Curaçao and Bonaire. This area is also relatively isolated from other deep sea areas in the Caribbean and may be home to a number of endemic species. Also the functioning of coral reefs in the mesophotic zone (between 60-150 m) and their role for shallow water coral reefs is virtually unexplored.

#### **Deep sea action points**

- a) Assemble, review and assess existing literature on the Dutch Caribbean deep sea and adjacent areas.
- b) Organize a deep sea expedition to collect, describe and document the biodiversity, possibly coupled this with preliminary bioprospecting.

## **3.7 Species protection**

The Dutch Caribbean EEZ serves as a regular habitat, a migratory stopover, wintering, feeding or breeding area for many species that are in some degree of danger according to the IUCN Red List. One species in particular has been overfished in most of its range and listed on CITES Appendix II, namely the Queen Conch. Participants to CITES agree to develop measures to protect all seabirds, sea turtles and migratory sharks, as well as all species rated

as vulnerable, endangered or critically endangered by IUCN (Red List 2010), or listed in Appendix I of CITES. The full listing is shown in Appendix 7.3

#### **CITES action points**

- a) Insofar as not already the case, designate most of the CITES species as fully protected in the Dutch Caribbean EEZ, with maximum penalties for infractions.
- b) Develop a research program to document the use of the EEZ by seabirds.

### **3.8 Sustainable fisheries development**

Fishing is one of the options to generate jobs and income for resident Antilleans. An improved fishery industry could contribute to the improvement of the prosperity of the population in the Caribbean part of the Kingdom. The Antillean fishery includes the traditional coastal fishery within the territorial zone, the recreational fishery in the territorial zone and the EEZ, and the commercial fishery (incl. Saba Bank) in the EEZ. The development of a viable fishery and the sustainable management of the fish stocks (occurring seawards of the Marine Parks and in the Dutch Caribbean EEZ is an important objective for the Netherlands Antilles (Buurt 2001). As the coral reefs of the EEZ (only Saba Bank) are possibly already over-exploited, opportunities to develop new or expand current fisheries there are limited until basic stock assessments, including conch, have been done and, in addition to the permitting system and current gear restrictions as provided for in the National Fisheries Ordinance, additional protective measures are implemented (e.g. protecting vulnerable spawning aggregations).

Recent research elsewhere (e.g. Caley and St. John 1996) as well as on the expansive Saba Bank (Toller et al 2010) indicates the importance of three dimensional reef structure to fish stocks. Three dimensional reef structure is generally quite low on the Saba Bank and may be an important limiting factor to fish density and distribution. Fish density was found to be highest in those habitats which provide the most structure (Toller et al. 2010). This suggests important potential for using artificial habitats to enhance fish stocks of the bank. Artificial reefs are widely used elsewhere as fish attractants and as fishery management tools (Bohnsack and Southerland 1985, Bohnsack 1989), and their deployment on the Bank to enhance fish stocks and fishery production, is worth studying.

With reference to the Saba Bank lobster fishery it can be further be said that elsewhere in the region, where three dimensional habitat structure is often in short supply, artificial habitats have been successfully used to increase lobster production, such as in Cuba, Mexico and the U.S. Virgin Islands (Quinn and Kojis 1995). Deployment of artificial structures for the purpose of increasing lobster catches should also be studied.

Of all fisheries, coral reef fisheries are the most extreme in both multispecies and spatial heterogeneity. As a consequence, traditional stock assessment and management methods are fraught with problems, particularly in terms of incompleteness of data. Thus while complex models may provide more accurate descriptions of the coral reef ecosystem, the large number of potential inaccuracies make it likely that the best models and management methods will be simple (Medley et al. 1993). In this context, marine fishery reserves and no-take zones have been developed as a powerful and simple method used to enhance reef fisheries in tropical regions (Bohnsack 1994, Bohnsack 1996, Bohnsack and Ault 1996; Roberts 1995, Roberts et al. 2001, 2005, Roberts and Hawkins 1997). After stock assessments have been carried out, results should be evaluated to assess if fishery no-take zones may enhance the fish stocks of the Saba Bank.

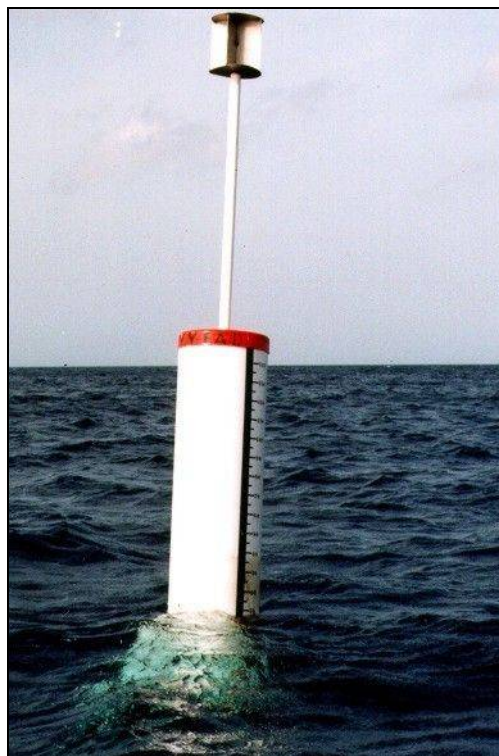
#### **Pelagic transboundary EEZ fish stocks**

Aside from the Saba Bank fishery, at present practically all other fishing in the EEZ takes place by foreign fleets. A study is needed to evaluate how the Dutch Caribbean islands may better benefit from the value that these resources represent. This could be achieved in many ways, ranging from the charging of higher licence fees to foreign fleets, developing local

processing of the catch, or developing a locally owned offshore fleet. The coastal fishing fleet is inadequate for offshore fishing and is also overcapitalized.

Nevertheless, the development of new fisheries must look especially to the larger more pelagic stocks of migratory big game species, such as the wahoo, dolphin fish, and various tuna species (van Buurt 2001), which appear to hold some scope for development (Murray 1997).

In this respect, the use of fish attracting devices (FADs) to concentrate pelagic species for handline fishing purposes has been very successfully developed and implemented in the Netherlands Antilles, upon initiative of Drs. G. van Buurt, of the Agriculture and Fishery Service of Curacao. This is a method that should be promoted (de Sylva 1981. , Bruyere et al. 2005, Buurt 1995 2000, 2002). The deployment of FADs is useful for fisheries development in both the windward and leeward Dutch islands (Fig xx ). Proper construction, and placement, in terms of water depth, bottom topography and currents is critical (G. v Buurt, pers. comm.). When placing permanent moored FAD's, in our region, areas with very strong waves, currents, mooring depths exceeding 500 meters, and anchoring areas with steeply sloping sea bottoms should be avoided. It can thus be seen that the actual locations where permanent FAD's could be moored are in fact quite limited. Even so FAD' s can provide a particularly effective alternative to fishing on the reef, and can also save fishermen much in terms of fuel costs by concentrating fish in a smaller area.



*Fig xx. A newly constructed PVC FAD deployed off Curacao. (photo: G. v Buurt)*

Driftnets are a very destructive technique and should not be considered for use (Richards 1994, Cognetti 1995). One possible exception is their deployment for flyingfishes, a technique successfully applied elsewhere in the southern Caribbean (Oxenford et al. 1992, Mahon et al. 2000). Possibilities to develop a flyingfish fishery may be interesting to explore for the leeward Dutch islands.

Possibilities to develop a fishery on yet unexploited stocks of deepwater squid, which undoubtedly represent a large potential in the southern Caribbean, may be worth exploring (Voss 1956, 1960, 1971a and b, 1973, 1986, Voss et al. 1973).

One technique that, until the turn of the century, was considered the best option for developing a commercial fishery in the EEZ are drift longlines which have since also been applied elsewhere in the region (e.g. Samlalsingh et al. 2005). However, this option may no longer be feasible as the swordfish, an important catch for the drift longliners in the region, falls under ICCAT and it is extremely unlikely for the islands to obtain a quatum (G. v Buurt, pers. comm.). A few large countries have already monopolized the regional swordfish quatum (Weidner et al. 2001). Swordfish longlines deployed in the Caribbean will also typically catch a variety of endangered, likely endangered or overfished species such as sea turtles, sharks and/or yellowfin tuna. Recent ICCAT assessments (2008) indicate that yellowfin tuna is fully-exploited and possibly overexploited. More potential exists for bigeye tuna (*Thunnus obesus*) for which the southern Caribbean population is not yet over-exploited (WECAFC 2008). Often, longlines take a heavy toll of protected species such as seaturtles and seabirds (seaturtles.org 2003, Lewison and Crowder 2007), however, generalizations about the different longlining methods are difficult. The Venezuelan (daytime) tuna longline has practically no turtle by catch (less than 0,1 %) and only some sharks 2-3%. However, catches in this fishery have fallen from initial catches of 100- 120 kg per 100 hooks, to less than 35 kg per 100 hooks, which is no longer profitable (G. v Buurt, pers. comm.). A particularly worrisome and destructive development is the practice of targeting juvenile tunas off West Africa using floating FADs with camaras for fish detection. As a consequence, the large trans Atlantic migratory runs of tunas have suffered (G. v Buurt, pers. comm.). A new Venezuelan longline has been developed with short side-lines specially for dolphin fish. Very little information is available for this new, small-scale fishery that may have high turtle by-catch. Concluding, development of a feasible longline fishery is no longer a realistic option in the Dutch Antilles.

During the June 1, 2010 conference, the fisheries focus group pointed out several priorities for attention (see box below).

#### **Fisheries Focus Group Priorities**

- Implementation of management measures for the Saba Bank
- Any restrictive measures to reduce unsustainable fishery should include facilitating the fishermen for incurred losses (material costs, down time) and compensate with (eg FADs), conch fishery if possible) or provide technical assistance and training for alternatives (e.g. Statia).
- Limit (Saba trap) bycatch discards and utilize the inevitable bycatch (Statia is interested in obtaining these for a favorable price)
- Reinforcement for the BES island fisheries dept. capabilities.
- Exploratory fishing, an assessment of the pelagic fishery stocks and an assessment of the Saba bank conch stock status should receive priority.
- The EEZ plan should recommend exploratory studies of aquaculture development.

Several factors are of crucial importance for the successful management of the pelagic EEZ fisheries in the Caribbean part of the Kingdom:

- Collecting, managing and communication of fish and fisheries information at one central location
- Investing in building extra capacity (science, policy, management)
- Creating a broad social base by intensive co-operation with industry during the development of fisheries management plans and by involving the fishers in the collection of fish and fisheries data
- Co-operation with international organizations

- Preventing overfishing by controlling and restricting access, among others via a permitting system.

#### **Fisheries action points:**

- a) Facilitate the development and implementation of a catch recording system for commercial and recreational fisheries in the territorial waters outside the marine park boundaries and in the waters of the EEZ.
- b) Promote the development of a stock assessment program for species targeted by commercial and recreational fisheries in the territorial waters outside the marine park boundaries and in the waters of the EEZ, including an assessment of conch stocks on the Saba Bank.
- c) Facilitate a thorough review and assess available literature on all (potentially) commercially valuable pelagic fish stocks of the EEZ (migratory tuna's, wahoo, dolphinfishes, swordfish, marlins, scad (*Decapturus*) and flyingfishes, as well as nonconventional species (e.g. deep water cephalopods).
- d) Develop an experimental artificial habitats program for the Saba Bank and a structural FAD program for pelagic EEZ waters.
- e) Propose and test trial fishing methods and conduct exploratory fishing to identify potentially unfished or under-exploited stocks.
- f) Participate actively in international fora to defend Dutch Caribbean fishing interests and rights (e.g. ICCAT).
- g) Commit to co-operate to achieve the eradication of IUU (Illegal, Unreported, Unregulated) fishing in the territorial waters and the EEZ.

### **3.9 Shipping and anchoring**

Shipping brings pollution, causes human safety hazards, and carries risks of collision with other ships and whales, and environmental calamities (oil spills). Anchoring on the Saba Bank leads to direct physical damage, including indirect damage to functioning integrity of the reef. Anchor damage has been dealt with under section 3.6.1 regarding the PSSA status for Saba Bank. For the other items of concern, the following action points can be recommended.

#### **Shipping and anchoring action points:**

- a) Based on the mapping of shipping routes, seasonal current and wind factors, as well as a map of sensitive habitats within or near to the EEZ, an ecological sensitivity model and map to identify risk-prone shipping issues and habitat areas should be developed.
- b) Use this to develop a disaster preparedness plan to deal with the most probable scenarios, all building upon the regionally available capacity and cooperation.
- c) Apply and enforce rules and regulations as based on national and international law.

### **3.10 Pollution control**

#### **Oil and chemical contaminants**

The current oil calamity with the BP drilling platform Deepwater Horizon in the Gulf of Mexico shows that oil spills can occur suddenly and without warning. The responsibility for oil spill readiness and clean up within the 200 mile EEZ and the 12 mile transition zone lies with the Ministry of Transport, Public Works and Water Management. Oil spill and maritime disaster readiness entails having a) an operationally equipped oil spill response organization, b) an oil spill calamities plan, c) adequate material for deployment and d) a plan for periodic training and exercises.

Since the mid 1990s, the Regional Activity Centre - Regional Marine Pollution Emergency Information and Training Center Wider Caribbean (RAC-REMPEITC-Caribe) has an important role in terms of training, coordination and oil spill response for the whole Caribbean region. On initiative of the Netherlands Antilles and Aruba, this center was established on Curacao with funding from various sources, among which the above ministry. RAC-REMPEITC provides services to the nations, States and Territories of the Wider Caribbean Region. It was established on the basis of article 9 of the Oil Spill Protocol of the Cartagena Convention (1983) to "assist countries to develop their national capabilities to implement the Cartagena Convention Oil Spill Protocol, the OPRC 1990 Convention and other IMO Conventions and Protocols relevant to preparedness for and response to oil, hazardous and noxious substances releases, and other marine environmental threats from ships in the Wider Caribbean Region". It operates under a Memorandum of Understanding of UNEP, the International Maritime Organization (IMO) and the Netherlands Antilles. On behalf of the Netherlands, the Netherlands Antilles and Aruba are contracting parties to the Cartagena Convention. Since its inception, experts have been seconded to the Centre, on a short to mid-term basis, by the USA, Netherlands, France and Venezuela. Currently, only France and the USA provide officers to REMPEITC.

The Ministry of Transport, Public Works and Water Management could support the islands by developing contingency plans, training courses, exercises, and advise about the procurement of equipment.

RAC-REMPEITC implements technical co-operation activities on environmental protection on behalf of the Technical Cooperation Division of IMO (Integrated Technical Cooperation Programme, ITCP), facilitates regional and international cooperation between Caribbean nations, relevant industries and UN agencies, organizes trainings and exercises and assists with the development and implementation of national contingency plans. Provided availability of resources, it can also conduct consultancy missions, for examples for the establishment of sensitivity maps or the assessment of spill preparedness. RAC-REMPEITC developed and regularly updates a regional OPRC plan for Caribbean islands, and is currently working of a similar plan for Central American countries. However, given its mandate as a regional body, RAC-REMPEITC does not have the mandate or the authority to develop or enforce national/local regulations.

Furthermore, RAC-REMPEITC is the Regional Coordinating Organization of the GEF/UNDP/IMO GloBallast Partnerships project that aims to assist developing countries in the implementation of a ballast water management regime. Within the framework of this project, a Regional Task Force has been established, and a regional strategy has been created. The later will be presented for endorsement during the upcoming 14th Inter-Governmental Meeting on the Action Plan for the Caribbean Environment Programme. It encourages Countries to create National Task Forces to tackle issues linked with ballast water and to accede to the BWM Convention.

For the Dutch Caribbean, both Aruba and Curacao have draft contingency plans. The larger oil companies on Aruba, Curacao (Ref Isla), St. Eustatius (NUSTAR) and Bonaire (BOPEC) have oil spill response and clean up plans, some response equipment, regular practice and have been so far assisting local governments in case of spills with the loan of resources. However, the equipment currently available is barely sufficient for small scale incidents (Level I, at least in Curacao). The Coast Guard of the Netherlands Antilles and Aruba is planning to buy additional equipment for oil spill response. Neither contingency plans nor sensitivity maps are in place at the insular and national levels within the Dutch Caribbean. Another regional organization, based on membership by various oil companies, and active in clean ups is 'Clean Caribbean and Americas' (CCA) which can help by providing equipment and cooperating with exercises. The Region has not really started to develop contingency plan to respond to chemical pollutions.

## **Contaminants**

Shipping causes discharges (intentional or not) at open sea (Bilge water, ballast water). These discharges contain different pollutants. Although dilution does occur at open sea, dilution should not be considered the only solution to pollution. It is important to reduce the amount of contaminated effluent. Besides the frequent discharges of ballast and bilge water resulting in low (but possibly chronic or cumulative) impact or risk for the environment, spills and collisions can also result in an environmental disaster. The risks of collisions should be reduced to the utmost minimum. RAC-REMPEITC is working on the realization of a GIS to map the maritime traffic and determine the areas of high risk.

There are various approaches and methods that can be applied to deal with marine contamination by ships. These are well described in the IMO treaties, and include insurance requirements, the use of discharge and emission standards, design, construction, manning and equipment standards as well as operational and management standards. (Molenaar 2008). In the Netherlands Antilles, the National Ordinance on Maritime Management (Landsverordening Maritiem Beheer) applies. In order to guarantee sufficient resilience of the marine ecosystems within the Dutch Caribbean EEZ to natural perturbations participants agree to closely follow guidelines as set by MARPOL for ship-based pollution sources.

## **Marine litter**

In these respects litter deserves separate attention. In 2005, UNEP-CAR/RCU and its Regional Activity Centres for the Land Based Sources of Marine Pollution Protocol and Oil Spills Protocols with support from UNEP Regional Seas began the development of a Regional Action Plan on Marine Litter in the Wider Caribbean. The objective was to assist in the environmental protection and sustainable management and development of the WCR through the development of a Regional Action Plan on Marine Litter in the Wider Caribbean Sea (RAPMaLi, 2007). The RAPMaLi was designed to address the complex and interconnected nature of the marine litter problem and outlines several actions at the National and Regional Level within five thematic areas:

- 1) Legislation, policies and enforcement
- 2) Institutional framework and stakeholder engagement
- 3) Monitoring programmes and research
- 4) Education and outreach
- 5) Solid waste management strategies

## **Pollution action points**

- a) Apply and enforce rules and regulations as based on national and international law.
- b) Conduct baseline pollution monitoring studies
- c) Develop facilities to accept, handle and process liquid and solid waste from ships, at minimally one location in the Dutch Caribbean (there is a great shortage of such facilities in the Caribbean).



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## 4 Research, monitoring and data storage

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Access to scientific knowledge, and the synthesis of new insights based on the availability of monitoring data about the system being managed are vital components of the adaptive management process (Figure 18). They also form the crux of the science-based and learning approach that is essential in cases (such as with the EEZ) of imperfect knowledge and continual change. Most treaties require the availability of up-to-date knowledge on the status and use of natural resources.

At present there is no research and monitoring plan for the EEZ, but an inventory is being made of the key research needs for the near future. Several of the most urgent research priorities have been indicated above as they all relate to specific areas of management concern. Topics include orientative literature reviews, baseline field studies on marine mammals and seabirds, mapping of habitats and sensitive areas, as well as fish catch monitoring and basic stock assessments.

### 4.1 Baseline data

There is an urgent need for baseline information on human use and the abundance and distribution of flora and fauna. These data need to be linked to Geographic Information Systems (GIS) and combined with predictive research to allow for evaluation of potential effects of human activities on the marine ecosystem and assist and anticipate management issues.

Data are necessary on the distribution, abundance and dependencies of commercial fish species, coral reefs, seabirds, sea turtles and marine mammals, but just as important are data on human use of the marine environment, water quality and the presence of indicator species. Where these data are available they should be stored and maintained in relational databases and be available to everybody. Furthermore, the use of remote sensing should be fully explored to reduce costs and support monitoring.

Thus, one or more collaborative expeditions combining various disciplines of Dutch and Dutch Caribbean marine tropical expertise would be an efficient way to quickly fill in a number of gaps in baseline knowledge as well as more fundamental knowledge regarding the functioning and occurrence of marine species and ecosystems in the Dutch Caribbean EEZ.

### 4.2 Research

Priority should be given to the Saba Bank. Up to now research has been solely devoted to describing the diversity of this unique atoll, one of the three largest atolls of the world. And while not all of its biodiversity is known presently, nothing is known about the biological and hydrophysical processes that structure this unique ecosystem. For example the role of the Saba Bank as a source of coral and fish larvae for other reefs in the Caribbean region is totally unknown, just as the presence of nursery habitats, spawning aggregations, and migratory routes of transboundary species. The extent and cover of the Saba Bank coral reefs is still largely a guesstimate. Frequent anchoring by large ships may already have destroyed large parts of the bank.

Several ongoing international research and conservation network initiatives exist and may be useful to those in the field, both managers and researchers, to establish fruitful contacts and realize joint projects. More information on two of these is featured in below box. Throughout this management plan action points have been defined that also link to research topics. A separate project is currently commissioned by the The Ministry of Agriculture, Nature and Food Quality (LNV) to identify research priorities for the BES islands and the EEZ.

### **International Coral Reef Initiative (ICRI)**

In 2002 the Netherlands Antilles joined the International Coral Reef Initiative, a platform for knowledge sharing. The Dutch Minister of LNV at that time supported participation of the Kingdom in ICRI and indicated that the Netherlands Antilles should coordinate this for the Kingdom.

With regard to research and monitoring ICRI asks members to:

- Use regional networks to achieve better coordination and cooperation among national research programs.
- Promote linkages between regional and global research and monitoring networks, such as CARICOMP (Caribbean Coastal Marine Productivity), PACICOMP (Pacific Coastal Marine Productivity), and GOOS (Global Ocean Observing System).
- Support research and monitoring programs, projects, or activities identified as essential to managing coral reef ecosystems for the benefit of humankind.
- Promote the development and maintenance of a global coral reef monitoring network.

The Netherlands Antilles have consistently participated in coral reef monitoring efforts and submitted data to the Global Coral Reef Monitoring Network (GCRMN) for the biannual publication of "Status of Coral Reefs of the World".

### **NET-BIOME (NETworking Tropical and Subtropical Biodiversity in the OuterMost Regions and Territories of Europe in support of sustainable development)**

In 2005 the Netherlands Antilles joined the NET-BIOME partnership which is a four year (2007-2011) ERA-Net that addresses the urgent needs of biodiversity research and sustainable development in the Outermost Regions (ORs) and Overseas Countries and Territories (OCTs) of the European Union (EU).

Net-Biome brings together most of the EU Tropical and Subtropical (T&ST) regions and territories, making it the first truly regional ERA-Net with a total of

## **4.3 Monitoring and data storage**

In the past much research has been carried out by institutes and university researchers from the Netherlands. More recently researchers from other countries also have started to carry out research and even monitoring on the Antillean islands. Without any doubt most of the collected data is presently stored in the Netherlands. Within the Netherlands Antilles to date much environmental and biological data are being collected, but no central data coordinating unit has been set up to guarantee the availability of these data to interested parties. Data collection that is financed by public money should generally be made available to everybody.

An overview of abiotic and biotic monitoring in the Netherlands in relation with international obligations is presented in Meesters et al. (2009) and Smit et al. (2010). Abiotic monitoring in the Netherlands is carried out mainly on behalf of the Ministry of Transport, Public Works and Water Management. Data gathering bodies may be external contractors or institutes. Biotic data are mainly collected on behalf of programmes financed by the Ministry of Agriculture, Nature and Food Quality (e.g. [www.kennisonline.wur.nl](http://www.kennisonline.wur.nl)). There is also a joined programme called "Netwerk Ecologisch Monitoring" (NEM) in which the above ministries, the Ministry of Housing, Spatial Planning and the Environment (VROM), Statistics Netherlands (CBS), the provinces, and The Netherlands Environmental Assessment Agency (PBL) have

joined forces. The actual data collection in the NEM is carried out by well organized volunteer groups ([www.netwerkecologischemonitoring.nl/meetnetten](http://www.netwerkecologischemonitoring.nl/meetnetten)). The Netherlands have an advanced network of monitoring, data storage and data sharing. Much effort is being invested in making different data sources available through a common interface developed and maintained by the the National Oceanographic Data Committee of the Netherlands ([www.nodc.nl](http://www.nodc.nl)). This initiative is supported by the main data collecting and storing bodies in the Netherlands such as the Royal Netherlands Institute for Sea Research (NIOZ), the Institute for Marine Resource and Ecosystem Studies (IMARES), TNO, Deltares, the Ministry of Transport, Public Works and Water Management, the Royal Netherlands Navy Command, Hydrographic Office, the Centre for Estuarine and Marine Ecology (NIOO-CEME). NODC ensures that data collections are available to users over the internet and can assist in setting up data storage protocols that will guarantee access to users from all over the world. For the EEZ management plan data collection, storage and dissemination should from the onset be a principal part of the plan. All data that are collected on the islands, whether through regular monitoring or through incidental research projects, should be made available through a common interface. This does not mean that all data will be stored in a central place, however, it would guarantee that data will be available through a common interface. Data storage and maintenance would be the responsibility of the data collecting party. Availability and access to knowledge and information are critical to the adaptive management process. To this end, the generation of new knowledge through research alone is certainly not enough. Without a sound repository for this knowledge, the knowledge will become scattered and lost. However, making knowledge available takes resources, manpower and funds. Within the Netherlands and the Dutch Antilles, several major sources of environmental information, experience and expertise are available.

#### **Research and Monitoring Focus Group Priorities**

- Baseline of economics/activities
- Inventory existing data for the EEZ regions and Saba bank.
- Analyse existing data
- Prioritise research in terms of obligations and the division between pure science and applied science
- Create stakeholder involvement
- Pure and applied research on: lobster, conch, redfish, corals, deep sea corals

#### **Research action points**

- a. Identify baseline data needs flowing forth from international treaty obligations, compile analyses and synthesise these to identify additional information needs.
- b. Commission knowledge institutes indicated to design a joint proposal on how to simply and effectively organise and implement broad stakeholder access to knowledge and data regarding the EEZ.
- c. Commission knowledge institutes, in collaboration with the park management stakeholders, to identify monitoring and research needs and design a monitoring system for the EEZ, based on key biotic (e.g. keystone, target and indicator species) and abiotic indicators of ecosystem health.



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## 5 Governance and financial management

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As indicated previously, the resources present in the EEZ are by nature public and jointly owned by several jurisdictions within the Kingdom. Keeping this in mind, the management process needs to be formulated to be transparent, joint, and cooperative, paying due attention to principal stakeholder interests. In addition, the management of the EEZ further aims to be integral and comprehensive, with a balanced approach, not only towards natural resource issues but also towards social and economic aspects (People, Planet, Production), as well as complementarity to the legal and management regimes of adjacent marine areas pertaining to the different Kingdom partners.

Nevertheless, the governance structure needs to be simple enough to allow for effective decision making without becoming emburdened by excess complexity. The installation of the EEZ Marine Resources Committee (MRC) serves to provide the minimum basis to ensure a balanced and joint decision making. The committee is to be the principle vehicle by which involvement of Kingdom partners can be assured, and by which to allow key stakeholder inputs.

### 5.1 Installation of the EEZ Marine Resources Committee (EEZ-MRC)

The countries of the Kingdom intend to jointly manage the natural resources of the Dutch Caribbean EEZ through common policy and coordinated actions.

Integrate position paper Paul Hoetjes need to synthesized into something that is agreed on by all others.

#### Task 1. Decide on priority topics and budget spending

The MRC will set the priorities to achieve as well as how to optimally spend their budget on research and management. The MRC will need to be flexible with setting priorities because whether or not something can be achieved will depend on availability of funds, and other critical factors that govern opportunity.

Box below shows the rough selection of priorities as based on the June 1, 2010 conference. In this the conference participants were asked to rank and indicate to their opinion which three themes were those of greatest priority in terms of need and urgency. The results indicate that the three themes of highest perceived priority were firstly, the achievement of PSSA Status for the Saba Bank, secondly, research and monitoring and thirdly, fishery development.

Priority	topic	votes
1	PSSA Status Saba Bank	33
2	Research and Monitoring	32
3	Fishery Development	30
4	Enforcement	23
5	Governance and Funding	21
6	Shipping and Anchoring	16
7	EEZ Marine Mammal Sanctuary	13
8	Species Protection	8
9	Pollution Control	4
10	Deep Sea Research	3

### **Task 2. Coordinate and prepare documents for governments**

As the final decisions regarding the various autonomous marine areas (such as the national contiguous zones (from the seaward border of the marine park out to 24 nm) always remain with the government of the respective kingdom members participating in this initiative, a principal task will be to prepare the final documents for the governments to decide on.

### **Task 3. Evaluate and advise on fishing licences for the EEZ**

The committee will advise on the issuing of fishing permits for the EEZ (as is currently the case with the Netherland Antilles Fishery Committee).

#### **Governance Action Points**

- a) letter of intent by Kingdom partners to jointly manage the EZZ (see executive summary)
- b) design and approve terms of reference and mandate for and formally commission the joint EEZ Marine Resource Commission (see executive summary)
- c) institutionalize participation in fora for broader consultation of EEZ MRC with other parties directly or indirectly of influence in the EEZ (eg. shipping industry, armed forces, land-based actors, calamity readiness teams, rescue organizations etc).

## **5.2 Enforcement**

To be effective, management rules and regulations must be implemented in national law, published and be actively enforced. For effective management law enforcement is crucial.

#### **Tasks for Enforcement**

Several important enforcement tasks can be identified as they relate to the management of biodiversity. They concern shipping safety, anchoring, pollution as well as IUU (Illegal Unreported and Unregulated Fishing activity). Other critical areas of open seas enforcement that relate to border patrol, international human trafficking, customs surveillance, counter terrorism operations and transportation of hazardous substances fall outside the scope of biodiversity enforcement.

At the moment, the Coast Guard for the Netherlands Antilles and Aruba carries out all these enforcement tasks in the EEZ of the Dutch Caribbean, with some 240 men and women employed full time. The Coast Guard represents a joint initiative of The Netherlands, The Netherlands Antilles and Aruba and is a true Kingdom organization. It receives its mandate from the Kingdom Council of Ministers and has its legal foundation in a Royal Decree. The NA&A Coast guard has its Headquarters with the 24/7 Rescue and Coordination (RCC) on the Naval Base at Parera on Curacao. In addition it has operational substations on Curacao (both on Parera and on Hato airport), on Aruba and on St. Maarten. To fulfill the maritime law enforcement and safety tasks the Coastguard disposes of 12 Superhips, 3 coastguard cutters, a shore based surveillance radar system around ABC-islands, 2 maritime surveillance planes and a helicopter and has contractual access to the larger West Indian Guard Ship of the Royal Netherlands Navy. For the coming decade the Coast Guard envisions a general increase for all its tasks, and a shift in priority towards a more environmental orientation, especially as it relates to the expected increase in shipping, both commercial and pleasure (tourism), and (the resulting) environmental pollution concerns. The legal framework and tools with which the Coast Guard operates will also change and expand. The Coast Guard anticipates some change in area of operation as well both closer to shore and further out towards open sea and the focus on the BES islands will certainly increase (W. Hansen, NA&A Coast Guard, pers. comm.).



Examples of operational units of Coast Guard NA&A (Photos Coast Guard NA&A)

The tasks of enforcement on the open seas, often takes place far from port and requires the ability to safely patrol under a range of weather conditions, out to several hundreds of kilometres from shore. Furthermore, enforcement also requires the ability to authoritatively interact with large vessels, and deal with aggressive and potentially armed opponents. This involves trained (para)military personnel and large well equipped vessels and aircraft. Examples can be drawn from around the region. Open seas enforcement cannot be done safely, effectively or regularly working from small vessels, and is quite costly to implement.

### 5.2.1 Coast Guard Surveillance 2001-2007

The Coast Guard of the Netherlands Antilles & Aruba delivers yearly reports with statistics regarding observations and violations on Fisheries (illegal fisheries, permitting, prohibited species, prohibited gear), environment (pollution from shore, pollution from ships, unknown source) and the marine environment (spear fishing, damage to marine environment (e.g. anchoring on reef), and collection of protected species. Most observations relate to the islands of Curacao, Aruba and St Maarten.

#### Fisheries

Numbers regarding Fisheries surveillance covering 2001-2009 (Figure 20) indicate a decrease in observed violations. In general, the EFZ of Aruba covers most violations. These violations mostly refer to not having permits to fish.

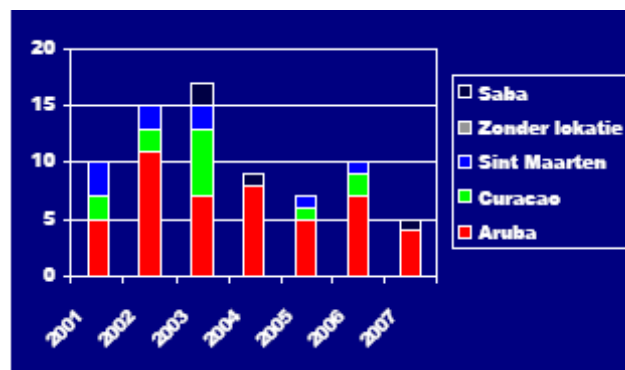


Figure 20. Number of violations regarding fisheries in 2001-2007.

### Environmental pollution:

In general, observed environmental violations have increased (Figure 21). Most observations relate to pollution in harbors and shore-based origin, especially in Curacao and Aruba. The other half of observation mostly relate to oil pollution from ships, and unknown sources.

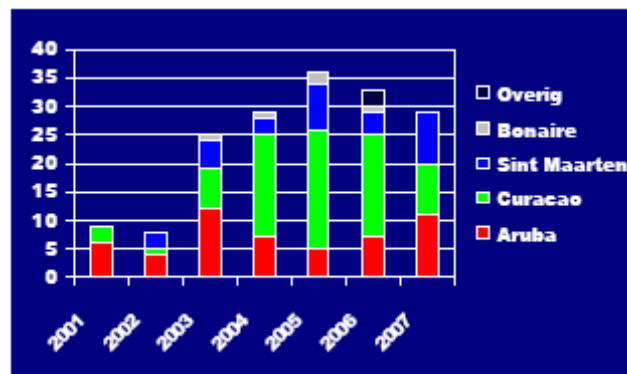


Figure 21. Number of violations regarding environmental pollution in 2001-2007.

### Marine environment surveillance

Observations and notifications relating to violations regarding the marine environment have increased (Figure 22). These violations often relate to spear fishing and in minor numbers to damaging the environment, or collecting protected species. In 2009 relatively few cases of spearfishing were recorded (only 14 cases versus 38 in 2007 and 33 in 2008).

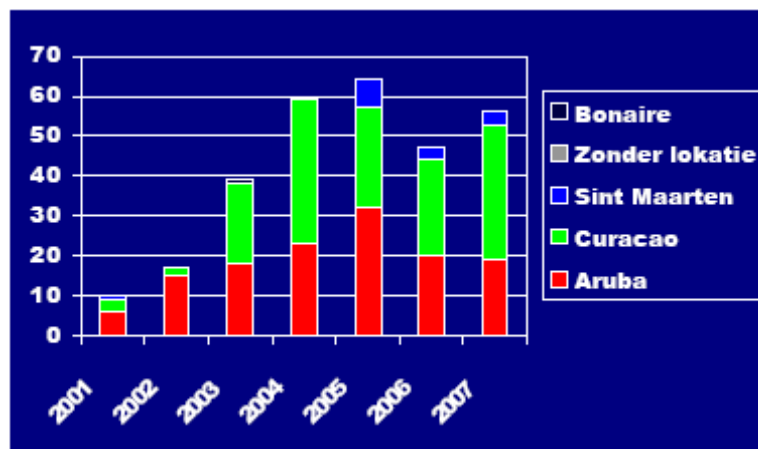


Figure 22. Number of violations regarding the Marine environment in 2001-2007.

Obviously, the only organization equipped for this kind of enforcement is the Coast Guard of the Netherlands Antilles and Aruba. As indicated before, in recent years this organization has actively play a key role in nature enforcement in the offshore areas of the Dutch Caribbean. This includes enforcement regarding illegal fishing practices, oil discharges from ships, and detentions with respect to illegal spearfishing (Sybesma and Debrot 2002). Fishing activity is (almost universally) the key human impact affecting biodiversity in the EEZ. This involves international fishing fleets as well local shore-based island fleets (e.g. Saba lobster and snapper fisheries). Looking toward the planning horizon of 2018, little increase in terms of fishery enforcement is to be expected. Current levels of surveillance are adequate to keep illegal fishing at a minimum and no dramatic increase in local commercial fishing in the EEZ is to be expected for the near future. Enforcement of rules and regulations as it relates to the local fleet can be most effectively monitored and enforced in port where landing of the catch takes place. To be able to operate effectively the Coast Guard needs clear guidelines



and rules and regulations encoded in law. In addition it is important to define and specify the stakeholder (i.e. the participating departments) requirements and wishes. To this end, closer communication and cooperation is deemed essential (W. Hansen, NA&A Coast Guard, pers. comm.).

Effective enforcement for offshore EEZ biodiversity management depends critically upon:

- Surveillance, e.g. remote monitoring and detection of vessel movement at sea (e.g. AIS system on Saba for the Saba Bank)
- Enforcement (inspection, interception, confiscation and arrest) on the open sea (by the Coast Guard)
- Shoreside processing of citations, detention, legal persecution and conviction in the courts of law.
- Shoreside monitoring and enforcement of national fishing regulations (gears, size limits, seasons, species etc) in the harbors.

During the June 1, 2010 conference the Enforcement focus group identified a number of key issues as regards enforcement. These are shown in BOX below.

#### **Enforcement Focus Group Priorities**

- Clear legislation: Identify the relevant international and national legislation in relation to the themes, and the legal bases in that legislation for enforcement (for example jurisdiction, limits to powers)
- Synchronise legislation: synchronise where possible, the way legislation of the different countries is formulated and the level of jurisdiction.
- Synchronise instrumentation: synchronise where possible, the legal instruments and competencies of enforcing authorities of the different countries, and the possibilities of using those instruments by the competent authorities.
- Design scenarios for proper enforcement
- Optimize use of available instruments: competent authorities of the different countries should work together to make optimal use of the available capacity en capability.
- Early involvement of enforcement in the decision making process: The feasibility of effective and efficient enforcement should be a standard criterium in the policy making process.
- Regular evaluation and when needed adaptation of the above points: The effectiveness and efficient use of (available) enforcement capabilities is strengthened when its use is adaptive.

#### **Enforcement action points**

- a. Study and improve offshore remote monitoring capabilities. The IAS at Saba port will soon be placed more favourably but shore radar for the SSS islands are also part of the current Saba 10-year strategic plan.
- b. Set up closer cooperation with the Coast Guard, Customs and other maritime enforcement agencies to effectuate offshore enforcement, by combining strengths and complementing shortcomings.
- c. Provide and equip trained personnel for fisheries enforcement in port and shoreside processing of open sea enforcement cases as produces by the Coast Guard.
- d. Set up enforcement (and research, see section 3.4.2.) cooperation with neighboring France, particularly as it relates to their marine mammal sanctuary.

### **5.3 Financial framework**

Of utmost importance is that each of the countries Aruba, Curaçao, St. Maarten and the Netherlands annually provides sources and sufficient funding for the management,

conservation and exploitation of the natural resources of the joint EEZ. A number of potential sources can be employed.

It must be realized that the most important users of the EEZ are not direct users, such as fishermen, but coastal industries, such as shipping and tourism, and the island communities themselves, which depend critically on the ecosystem services that the EEZ provides in terms of shipping routes, clean water etc. At the same time these industries and coastal development activities that form one of the the greatest threats to the biological resources and sustained health of the EEZ. Ecosystem services obtained "freely" from nature provide a large portion of "real wealth" to nations and need to be taken into account eventhough in classical economy this has rarely been done (World Bank 1995, Hamilton and Dixon 2003). For instance the use even today of GDP as the main economic index generally overvalues material goods (such as military production), undervalues services, sets key national assets at zero value and even adds the social and environmental costs to the GDP (based on the labor and material costs required to mitigate), instead of subtracting these costs (Henderson 1996). The the possibility of requiring other industries, aside from the purely extractive ones (fisheries), to contribute structurally to the financing of management costs should be seriously considered

### **User fees**

More and more, world-wide the "the user pays" principle is being applied to finance management and regulation, but also to all kinds of environmental use. The philosophy behind this is that while users derive value from the use of public resources, they are expected to pay part of that value "back" to the government or authorized management agency with which to help finance management of those same resources. The use of "user fees" stimulates active involvement of users and provides a legal framework for registration and contact between users and management. The costs for management and development of the fisheries industry could be (partially) financed by the different parts of the fishing industry. Examples of finances generated through industry are the fees obtained levied for fishing permits, licenses and catch certificates from local fishermen (coastal and commercial on the Saba Bank) and foreign operators like AVATUN that fish in the EEZ, or fishing vessels from ALBACORE which fish outside the EEZ but fly the Antillean flag. The "user pays" principle has already been successfully applied to finance the management of marine resources in the Netherlands Antilles, particularly with the use of dive tags by the coastal marine parks of Bonaire (Dixon et al. 1993), Saba (Fernandes et al. 1999) and St Eustatius (Bervoets 2010). Up to now these fee systems have especially targeted the tourist diving visitors but surveys conducted in Curacao have shown that the concept can be quite acceptable to other user groups such as recreational boaters and fishermen as well (Debrot and Nagelkerken 2000).

Nevertheless, the potential finances that the use of fishing liscenses, permits and catch certificates for direct use of the EEZ can generate is probably quite limited, due to the low number of users of the offshore zone. The main source of income from users of the biological resources of the EEZ is from permitting of the large foreign fishery operators. Based on the current permit levels (NAF 36,000.—per vessel per year) and number of vessels (presently 0 but otherwise about 3) annual permit fees generated via this means amount to about NAF 108,000.-- (S. Mambi, pers. comm.). However, at present all levied funds disappear into general government spending and are not earmarked or made available for management. Earmarked funds have been critical to the successful use of user fees for marine park management, and this is also recommended here. A fishery management and development fund would need to be set up, for use by the EEZ Marine Resource Committee towards fishery management research and development. Part of these funds should then be earmarked for ICCAT participation and representation by the EEZ Committee.

The introduction of a system of registration and licenses whereby user fees are collected for the various additional kinds of fishery that already exist or may be introduced in the EEZ can not only generate some funds but should also be seen as a key means of legally

communicating with the user public, monitoring various aspects of that public and its use of the resources. While the number of licenses, fees and conditions etc for EEZ fishing can best be determined by the Fishery Commission, the execution of the task should ideally be coordinated by the marine parks on each island, as they already do so for the dive tags for the current marine parks.

Based on an advanced registry and permitting system as it exists in the Netherlands, below box shows a breakdown of items to consider when introducing such system.

### **Examples of licensed fisheries**

#### Recreational Fishing License (based on license Marine Parks)

- yearly fee for tourist and local residents (US\$25= 50 ANT guilders)
- collect fee at fishing charters, head office, activity centers
- local residents, register contact details for recfish surveys
- fishing charters: introduce logbook for captains (day, location, catch (species, size, kept, released)
- fishing charters: co-operate with fishing charters for research (tagging studies)
- Restrictions Rec Fish Lic:
  - o Hook and line fishing only
  - o Limited bag limit (provide list of bag limits per species)
  - o Selling of fish not allowed, own consumption only

#### Line Fishery License (Saba Bank)

- deep-line and trolling line
- yearly fee per boat
- register contact details for surveys
- introduce logbook (day, location, gear, species, kg)
- regulate fishery through season, area, # license, minimum size

#### Fish Trap Fishery (Saba Bank)

- Regulate fishery through season, # pots, minimum size, mesh size, area
- Fee per trap, each trap needs tag
- introduce logbook (day, location, gear, species, kg)
- register contact details for surveys

#### Lobster Trap Fishery (Saba Bank)

- Regulate fishery through season, # pots, minimum size, mesh size, area
- Fee per trap, each trap needs tag
- introduce logbook (day, location, gear, species, kg)
- register contact details for surveys

#### Developing or Experimental Fishing License

- flying fish, conch, pelagic, FADs
- regulate fishery through restricted entry
- conduct solid baseline study and catch registration

### **b) Core funding**

The key problem to improved environmental management in Caribbean Small Island Developing States (SIDS) has long been recognized as being the lack of institutional capacity (ECLAC 1998). In turn, the key to institutional capacity is dependable core funding, which is a minimum upon which to build and from which to expand. Without core funding there can even be no structural effort to write grant proposals to obtain external funds. So while different projects may be funded externally, some core funding is essential and will have to

be provided by the Kingdom governments (the Netherlands, Aruba, Curacao St. Maarten). In this, the financial costs of management will have to be shared fairly between Kingdom partners, commensurate with financial ability as well as realized and potential benefits.

**Dutch Government Funding:** As of 10-10-10 the islands of Bonaire Saba and St. Eustatius along with the surrounding EEZ, will become public entities within the Netherlands. This implies considerable new responsibility with regards to the various treaties which apply, as well as a dramatic expansion of important tropical and deep sea habitat types, hundreds of endemic (Debrot 2006) and endangered (this report) species, and a veritable biodiversity “hotspot” (Meyers et al. 2000) for which the Netherlands will then carry the final responsibility. The Netherlands is internationally recognized as a leader in natural resource management and sustainable development, and via various ministries devotes much resources to such ends in the continental part of the Kingdom. Key commitments from which nature management spending in the continental Netherlands flows forth (e.g. the EU Natura 2000 as based on the Habitat Directive and the Birds Directive, and the Dutch Nature Protection Act of 1998) will not apply to the BES islands, and it can therefore not be expected that the Netherlands will spend in the Dutch Caribbean at the same level of its own spending in the Netherlands and the Dutch North Sea EEZ. Nevertheless, based on Dutch commitment to the CBD, structural funding for basic biodiversity management and research should be justified.

**Island Government Funding:** The economies of most of the Dutch Caribbean islands depend greatly on tourism, which in the last decades, almost invariably has been developed as a principal or even almost sole (Saba, Bonaire) pillar for the economy. Based on this high economic importance of coastal marine biological resources in general, as well as their dependence on and integral ties to the offshore EEZ, management of the EEZ should be allotted significant core funding by the island governments annually. Up to now, structural government funding for nature on all islands of the Dutch Caribbean has been significantly less than one thousandth of the annual budget (e.g. Anonymous 1994), which is exorbitantly low considering the locally widely acknowledged importance of environment to the key tourist industry. By comparison, even a poor country like Bhutan spends some 3 ‰ (per mil) on nature conservation. Hence, based on balanced government spending, the national and island governments of the Dutch Caribbean islands should also allocate adequate funds for EEZ biodiversity management purposes.

### **c) Additional external funding**

Various sources of external funding exist by which to realise important goals. These sources include various EU development funds, research funds, international foundations. Most project funding does not cover “running costs” and have elaborate application, deadline and reporting requirements. A head start towards an overview of potential sources is provided by Ecovision (1999). Teaming with institutions that have experience with this form of funding carries great advantages.

### **Funding action points**

- a. Kingdom partners must decide on a minimum program, and how much core will be made available by each party.
- b. Allocated funds for use in a simple way keeping red tape within normal proportions and keen on developing longterm joint institutional capacity by means of joint projects and structural funding.
- c. Implement a fee system for fisheries and other users.
- d. Implement a fee/royalties system for biological exploration and natural products development.
- e. Review external possibilities for project funding for nature.
- f. Based on a core funding base, develop joint project proposals with which to tap into ulterior funding sources.

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## 6 Overview of Action Points

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### As relating to the Agreement

#### Governance action Points

- a) letter of intent by Kingdom partners to jointly manage the EEZ (see executive summary)
- b) design and approve terms of reference and mandate for and formally commission the joint EEZ Marine Resource Commission (see executive summary)
- c) institutionalize participation in fora for broader consultation of EEZ MRC with other parties directly or indirectly of influence in the EEZ (eg. shipping industry, armed forces, land-based actors, calamity readiness teams, rescue organizations etc).

#### Funding action points

- a) Kingdom partners must decide on a minimum program, and how much core will be made available by each party.
- b) Allocated funds for use in a simple way keeping red tape within normal proportions and keen on developing longterm joint institutional capacity by means of joint projects and structural funding.
- c) Implement a fee system for fisheries and other users.
- d) Implement a fee/royalties system for biological exploration and natural products development.
- e) Review external possibilities for project funding for nature.
- f) Based on a core funding base, develop joint project proposals with which to tap into ulterior funding sources.

### As relating to the implementation of the Agreement

#### Saba Bank action points

- a) Pursue PSSA status for the Saba Bank
- b) Implement basic protective management measures for the Saba Bank as outlined in the Saba Bank Special Marine Area Management Plan 2008 (Lundvall 2008).
- c) Implement longterm regular fishery catch monitoring program on Saba.
- d) Quantitatively describe and map the various habitats occurring on the Bank (with particular emphasis on identifying potential mass spawning sites for adults and nursery grounds for juveniles) and
- e) Quantitatively asses the various fish stocks interms of distribution, size and structure.

#### Marine Mammals action Points

- a) Join the eastern Caribbean marine mammal sanctuary initiative of neighboring states by declaring the Dutch Caribbean EEZ as a marine mammal sanctuary. (No extra research is needed to achieve this)
- b) Develop marine mammal research projects to further evaluate and asses the importance of the EEZ as suggested by previous research. In this it may be optimal to tie in to current regional joint projects to identify and quantify marine mammal populations (the French "Agoa" marine mammal sanctuary initiative, the US Stellwagen Bank National Marine Sanctuary (SBNMS) and the "Sanctuario de Mamíferos Marinos de la República Dominicana" (SMMRD). These projects use passive acoustic survey buoys, and photo identification to compare individual specimens, in particular of humpback whales.

### **Deep sea action points**

- a) Assemble, review and assess existing literature on the Dutch Caribbean deep sea and adjacent areas.
- b) Organize a deep sea expedition to collect, describe and document the biodiversity, possibly coupled this with preliminary bioprospecting.

### **CITES (species protection) action points**

- a) Insofar as not already the case, designate most of the CITES species as fully protected in the Dutch Caribbean EEZ, with maximum penalties for infractions.
- b) Develop a research program to document the use of the EEZ by seabirds.

### **Fisheries action points:**

- a) Facilitate the development and implementation of a catch recording system for commercial and recreational fisheries in the territorial waters outside the marine park boundaries and in the waters of the EEZ.
- b) Promote the development of a stock assessment program for species targeted by commercial and recreational fisheries in the territorial waters outside the marine park boundaries and in the waters of the EEZ, including an assessment of conch stocks on the Saba Bank.
- c) Facilitate a thorough review and assess available literature on all (potentially) commercially valuable pelagic fish stocks of the EEZ (migratory tuna's, wahoo, dolphinfishes, swordfish, marlins, scad (*Decapturus*) and flyingfishes, as well as nonconventional species (e.g. deep water cephalopods).
- d) Develop an experimental artificial habitats program for the Saba Bank and a structural FAD program for pelagic EEZ waters.
- e) Propose and test trial fishing methods and conduct exploratory fishing to identify potentially unfished or under-exploited stocks.
- f) Participate actively in international fora to defend Dutch Caribbean fishing interests and rights (e.g. ICCAT).
- g) Commit to co-operate to achieve the eradication of IUU (Illegal, Unreported, Unregulated) fishing in the territorial waters and the EEZ.

### **Shipping and anchoring action points:**

- a) Based on the mapping of shipping routes, seasonal current and wind factors, as well as a map of sensitive habitats within or near to the EEZ, an ecological sensitivity model and map to identify risk-prone shipping issues and habitat areas should be developed.
- b) Use this to develop a disaster preparedness plan to deal with the most probable scenarios, all building upon the regionally available capacity and cooperation.
- c) Apply and enforce rules and regulations as based on national and international law.

### **Pollution action points**

- a) Apply and enforce rules and regulations as based on national and international law.
- b) Conduct baseline pollution monitoring studies
- c) Develop facilities to accept, handle and process liquid and solid waste from ships, at minimally one location in the Dutch Caribbean (there is a great shortage of such facilities in the Caribbean).

### **Research action points**

- a) Identify baseline data needs flowing forth from international treaty obligations, compile analyses and synthesise these to identify additional information needs.

- b) Commission knowledge institutes indicated to design a joint proposal on how to simply and effectively organise and implement broad stakeholder access to knowledge and data regarding the EEZ.
- c) Commission knowledge institutes, in collaboration with the park management stakeholders, to identify monitoring and research needs and design a monitoring system for the EEZ, based on key biotic (e.g. keystone, target and indicator species) and abiotic indicators of ecosystem health.

#### **Enforcement action points**

- a) Identify the relevant international and national legislation in relation to the themes, and the legal bases in that legislation for enforcement
- b) Synchronise legislation: synchronise where possible, the way legislation of the different countries is formulated and the level of jurisdiction. E.g in cooperation with neighbouring France, particularly as it relates to their marine mammal sanctuary.
- c) Synchronise instrumentation: synchronise where possible, the legal instruments and competencies of enforcing authorities of the different countries, and the possibilities of using those instruments by the competent authorities.
- d) Study and improve offshore remote monitoring capabilities. The IAS at Saba port will soon be placed more favourably but shore radar for the SSS islands are also part of the current strategic plan.
- e) Set up closer cooperation with the Coast Guard, Customs and other maritime enforcement agencies to effectuate offshore enforcement, by combining strengths and complementing shortcomings.
- f) Provide and equip trained personnel for fisheries enforcement in port and shoreside processing of open sea enforcement cases as produces by the Coast Guard.

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## 7 Appendices and other background material

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### 7.1 Abbreviations

AGRRRA	Atlantic and Gulf Rapid Reef Assessment (Caribbean wide study of coral reef health)
AIS	Automatic Identification System
Cartagena Convention	The Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
DCNA	Dutch Caribbean Nature Alliance
EEZ	Exclusive Economic Zone
ICRAN	International Coral Reef Action Network
IUCN	World Conservation Union (formerly International Union for the Conservation of Nature and Natural Resources)
MARPOL	International Convention for the Prevention of Pollution from Ships
MINA	Central Government Department of Nature and the Environment
MP	Marine Park
MPA	Marine Protected Area
PA	Protected Area
SCF	Saba Conservation Foundation
SBMO	Saba Bank Management Organization
SBSMA	Saba Bank Special Marine Area
SPAW	Specially Protected Areas and Wildlife – Annex of the Cartagena Convention
UNEP	United Nations Environment Programme
WCPA	World Commission on Protected Areas
WWF	World Wide Fund for Nature



## 7.2 Use of the Saba Bank

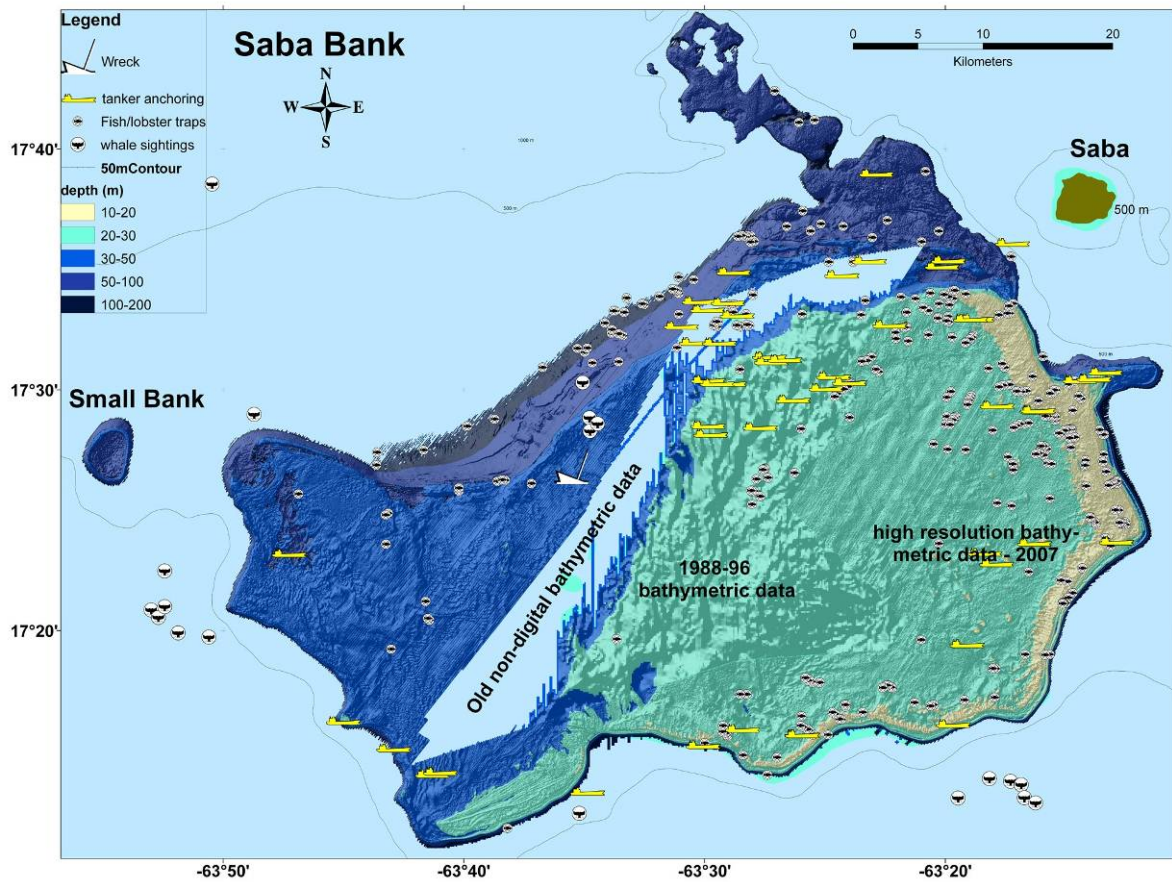


Figure 23. locations of observations of anchoring, fish and lobster traps and whale sightings (graph supplied by P. Hoetjes).

### 7.3 CITES/CMS species list

Only marine species are included. CITES Appendix I species and CMS appendix number.

Scientific name	English	Papiamentu	CMS
<b>Cetaceans (whales, dolphins)</b>			
<i>Physeter catodon</i>	Great Sperm Whale	Kachalote	I/II
<i>Balaenoptera acutorostrata</i>	Minke Whale	Bayena	
<i>Balaenoptera edeni</i>	Bryde's Whale	Topo	II
<i>Balaenoptera physalis</i>	Fin Whale	Bayena	I/II
<i>Megaptera novaeangliae</i>	Humpback Whale	Bayena	I
<b>Sea turtles</b>			
<i>Chelonia mydas</i>	Green Turtle	Tortuga blanku	I/II
<i>Eretmochelys imbricata</i>	Hawksbill Turtle	Karèt	I/II
<i>Caretta caretta</i>	Loggerhead Turtle	Kawama	I/II
<i>Lepidochelys olivacea</i>	Olive Ridley	Tortuga bastiá	I/II
<i>Dermodochelys coriacea</i>	Leatherback Turtle	Drikil	I/II

CITES Appendix II species and CMS appendix number.

Scientific name	English	Papiamentu	CMS
<b>Cetaceans (Whales, dolphins)</b>			
<i>Tursiops truncatus</i>	Bottlenose Dolphin	Toniu	II
<i>Lagenodelphis hosei</i>	Fraser's Dolphin		II
<i>Delphinus delphis</i>	Common Dolphin	Toniu	II
<i>Stenella attenuata</i>	Pantropical Spotted Dolphin	Toniu	
<i>Stenella frontalis</i>	Atlantic Spotted Dolphin		
<i>Stenella longirostris</i>	Spinner Dolphin		II
<i>Stenella coeruleoalba</i>	Striped Dolphin		II
<i>Stenella clymene</i>	Clymene Dolphin		II
<i>Grampus griseus</i>	Risso's Dolphin		II
<i>Ziphius cavirostris</i>	Cuvier's Whale		
<i>Mesoplodon europaeus</i>	Gervais's Beaked Whale		
<i>Pseudorca crassidens</i>	False Killer Whale		
<i>Orcinus orca</i>	Orca - Killer Whale		II
<i>Kogia breviceps</i>	Pygmy Sperm Whale		
<i>Kogia simus</i>	Dwarf Sperm Whale		
<i>Peponocephala electra</i>	Melon-headed Whale		
<i>Globicephala macrorhynchus</i>	Shortfin Pilot Whale	Kabe'i keshi	
<b>Gastropods (snails)</b>			
<i>Strombus gigas</i>	Queen Conch	Karkó	
<b>Black corals</b>			
<i>Antipathes americana</i>			
<i>Antipathes atlantica</i>			
<i>Antipathes dichotoma</i>	Black Coral	Koral pretu	
<i>Antipathes pennacea</i>			
<i>Antipathes tanacetum</i>			
<i>Antipathes hirta</i>			
<i>Antipathes furcata</i>			
<i>Antipathes caribbeana</i>			
<i>Stichopathes lutkeni</i>			
<i>Stichopathes gracilis</i>			
<b>Stony corals</b>			
<i>Acropora cervicornis</i>	Staghorn Coral	Koral Kachu di Biná	
<i>Acropora palmata</i>	Elkhorn Coral	Koral Kachu grandi	
<i>Acropora prolifera</i>	Fused Staghorn Coral		
<i>Agaricia agaricites</i>	Leaf Coral		
<i>Agaricia humilis</i>			
<i>Agaricia tenuifolia</i>	Ribbon Coral		
<i>Agaricia fragilis</i>	Fragile Saucer Coral		
<i>Agaricia lamarcki</i>	Leaf Coral		
<i>Agaricia grahamae</i>	Leaf Coral		
<i>Agaricia undulata</i>	Scroll Coral		
<i>Montastrea annularis (s.l.)</i>	Mountainous Star Coral		
<i>Montastrea cavernosa</i>	Cavernous Star Coral		
<i>Dichocoenia stokesii</i>	Elliptical Star Coral		
<i>Colpophyllia natans</i>	Floating Brain Coral		
<i>Diploria labyrinthiformis</i>	Brain Coral		
<i>Diploria strigosa</i>	Brain Coral		
<i>Diploria clivosa</i>	Brain Coral		

<i>Porites asteroides</i>	Mustard Hill Coral		
<i>Porites porites</i>	Club Finger Coral		
<i>Porites branneri</i>			
<i>Porites furcata</i>			
<i>Madracis mirabilis</i>	Yellow Pencil Coral		
<i>Madracis decactis</i>	Green Cactus Coral		
<i>Madracis carmabi</i>			
<i>Madracis senaria</i>			
<i>Siderastrea sidereal</i>			
<i>Siderastrea radians</i>			
<i>Scolymia cubensis</i>	Solitary Disk Coral		
<i>Scolymia lacera</i>			
<i>Mycetophyllia aliciae</i>			
<i>Mycetophyllia daniana</i>			
<i>Mycetophyllia ferox</i>			
<i>Mycetophyllia lamarckiana</i>			
<i>Mycetophyllia reesi</i>			
<i>Mussa angulosa</i>	Large Flower Coral		
<i>Stephanocoenia michelinii</i>	Blushing Star Coral		
<i>Leptoseris cucculata</i>			
<i>Eusmilia fastigiata</i>	Flower Coral		
<i>Favia fragum</i>	Golfball Coral		
<i>Meandrina meandrites</i>			
<i>Dendrogyra cylindrus</i>	Pillar Coral		
<i>Millepora alcicornis</i>	Fire Coral		
<i>Millepora complanata</i>			
<i>Millepora squarrosa</i>			
<i>Stylaster roseus</i>	Lace Coral		

## 7.4 IUCN Red List species found in the Dutch Caribbean EEZ.

Scientific name	Popular name	Red List Status
<i>Acropora cervicornis</i>	STAGHORN CORAL	Critically Endangered
<i>Acropora palmata</i>	ELKHORN CORAL	Critically Endangered
<i>Agaricia lamarcki</i>	LAMARCK'S SHEET CORAL	Vulnerable
<i>Carcharhinus longimanus</i>	OCEANIC WHITETIP SHARK	Vulnerable
<i>Dendrogyra cylindrus</i>	PILLAR CORAL	Vulnerable
<i>Dichocoenia stokesii</i>	ELLIPTICAL STAR CORAL	Vulnerable
<i>Millepora striata</i>	FIRE CORAL	Endangered
<i>Montastraea annularis</i>	BOULDER STAR CORAL	Endangered
<i>Montastraea faveolata</i>		Endangered
<i>Montastraea franksi</i>		Vulnerable
<i>Mycetophyllia ferox</i>	ROUGH CACTUS CORAL	Vulnerable
<i>Oculina varicosa</i>	LARGE IVORY CORAL	Vulnerable
<i>Megaptera novaeangliae</i>	HUMPBACK WHALE	Vulnerable
<i>Physeter macrocephalus</i>	SPERM WHALE	Vulnerable
<i>Trichechus manatus</i>	WEST INDIAN MANATEE	Vulnerable
<i>Lutjanus analis</i>	MUTTON SNAPPER	Vulnerable
<i>Lutjanus cyanopterus</i>	CUBERA SNAPPER	Vulnerable
<i>Mycteroperca interstitialis</i>	YELLOWMOUTH GROUPER	Vulnerable
<i>Mycteroperca venenosa</i>	YELLOWFIN GROUPER	Near Threatened
<i>Epinephelus flavolimbatus</i>	YELLOWFINNED GROUPER	Vulnerable
<i>Epinephelus itajara</i>	GOLIATH GROUPER	Critically Endangered
<i>Epinephelus morio</i>	RED GROUPER	Near Threatened
<i>Epinephelus niveatus</i>	SNOWY GROUPER	Vulnerable
<i>Epinephelus striatus</i>	NASSAU GROUPER	Endangered
<i>Balistes vetula</i>	QUEEN TRIGGERFISH/MOONFISH	Vulnerable
<i>Scarus quacamaia</i>	RAINBOW PARROTFISH	Vulnerable
<i>Lachnolaimus maximus</i>	HOGFISH	Vulnerable
<i>Pristis pectinata</i>	WIDE SAWFISH	Critically Endangered
<i>Carcharhinus perezi</i>	CARIBBEAN REEF SHARK	Near Threatened
<i>Carcharhinus leucas</i>	BULL SHARK	Lower Risk, Near Threatened
<i>Elsurus oxyrinchus</i>	SHORTFIN MAKO	Vulnerable
<i>Galeocerdo cuvier</i>	TIGER SHARK	Lower Risk, Near Threatened
<i>Sphyrna lewini</i>	SCALLOPED HAMMERHEAD	Endangered
<i>Sphyrna mokarran</i>	SQUAT-HEADED HAMMERHEAD SHARK	Endangered
<i>Caretta caretta</i>	LOGGERHEAD TURTLE	Endangered
<i>Chelonia mydas</i>	GREEN TURTLE	Endangered
<i>Eretmochelys imbricata</i>	HAWKSBILL TURTLE	Critically endangered
<i>Dermochelys coriacea</i>	LEATHERBACK TURTLE	Critically endangered
<i>Lepidochelys olivacea</i>	OLIVE RIDLEY TURTLE	Vulnerable
<i>Pterodroma hasitata</i>	BLACK-CAPPED PETREL	Endangered

## 7.5 Common and scientific species names

### Fish

Blacktip shark	<i>Carcharhinus limbatus</i>
Blue shark	<i>Prionace glauca</i>
Dolphin fish	<i>Coryphaena hippurus</i>
Marlin	( <i>Makaira spp.</i> )
Nurse shark	<i>Ginglymostoma cirratum</i>
Reef shark	<i>Carcharhinus springeri</i>
Scalloped hammerhead	<i>Sphyrna lewini</i>
Sharpnose shark	<i>Rhizoprionodon porosus</i>
Shortfin mako	<i>Isurus oxyrinchus</i>
Smalleye hammerhead	<i>S. Tudes</i>
Tiger shark	<i>Galeocerdo cuvier</i>
Wahoo	<i>Acanthocybium solandri</i>

### Birds

Audubon's Shearwater	<i>Puffinus lherminieri</i>
Black Tern	<i>Chlidonias niger</i>
Black-capped Petrel	<i>Pterodroma hasitata</i>
Bridled Tern	<i>S. aneaethus</i>
Brown Noddy	<i>Anous stolidus</i>
Bulwer's Petrel	<i>Bulweria bulwerii</i>
Leach's Storm Petrel	<i>Oceanodroma leucorhoa</i>
Magnificent Frigatebird	<i>Fregata magnificens</i>
Pomerine Skua	<i>Stercorarius pomarinus</i>
Red-billed Tropicbird	<i>Phaethon aethereus</i>
Redfooted Booby	<i>Sula sula</i>
Sooty Tern	<i>Sterna fuscata</i>
Wilson's Storm Petrel	<i>Oceanites oceanicus</i>

### Mammals

Bottlenose Dolphin	<i>Tursiops truncates</i>
Caribbean monk seal,	<i>Monachus tropicalis</i>
Clymene Dolphin	<i>Stenella clymene</i>
False Killer Whale	<i>Pseudorca crassidens</i>
Humpback Whale	<i>Balaenoptera edeni</i>

### Turtles

Green Turtle	<i>Chelonia mydas</i>
Hawksbill	<i>Eretmochelys imbricata</i>
Leatherback	<i>Dermochelys coriacea</i>
Loggerhead	<i>Caretta caretta</i>
Olive Ridley	<i>Eretmochelys olivaceae</i>

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## 8 Justification

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Rapport C100/10

Project Number: ~number~

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## 9 References

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- Albins, M.A., M.A. Hixon, 2008. Invasive Indo-Pacific lionfish *Pterois volitans* reduce recruitment of Atlantic coral-reef fishes. *Mar. Ecol. Prog. Ser.* 367: 233-238.
- Anonymous, 1994. Te weinig geld gaat naar natuurbeheer. *Beurs en Nieuwsberichten*, (Dagblad Curacao), 16 april, 1994.
- Barnes, T., K.L. Eckert and J. Sybesma, 1993. Sea turtle recovery action plan for Aruba. CEP Techn. Rept. #25. UNEP Caribbean Environmental Programme, Kingston, Jamaica. 58 pp.
- Barnes, D.K.A., F. Galgani, R.C. Thompson & M. Barlaz, 2009. Accumulation and fragmentation of plastic debris in global environments. *Phil. Trans. R. Soc. B* 364: 1985-1998.
- Bervoets, T., 2010. Report on the Economic Valuation of St. Eustatius' Coral Reef Resources. Stenapa, Report. 40 pp.
- Bohnsack, J.A., 1989. Are high densities of fishes at artificial reefs the result of habitat limitation or behavioral preference? *Bull. Mar. Sci.* 44: 631-645.
- Bohnsack, J.A., 1994. How marine fishery reserves can improve reef fisheries. *Proc. 43rd Gulf and Carib. Fish. Inst.* (1990): 217-241.
- Bohnsack, J.A., 1996. Marine reserves, zoning, and the future of fishery management. *Fisheries* 21: 14-16.
- Bohnsack, J.A. and J.S. Ault., 1996. Management strategies to conserve marine biodiversity. *Oceanography* 9: 73-82.
- Bohnsack, J.A. and D.L. Sutherland, 1985. Artificial reef research: a review with recommendations for future priorities. *Bull. Mar. Sci.* 37: 11-39.
- Bongaerts, P., T. Ridgway, E.M. Sampayo and O. Hoegh-Guldberg, 2010. Assessing the 'deep reef refugia' hypothesis: focus on Caribbean reefs. *Coral Reefs* 29: 309-327.
- Bree, P.J.H. van, 1975. Preliminary list of the cetaceans of the southern Caribbean. *Stud. Fauna Curaçao Caribb. Isl.* 48: 79-87.
- Bree, P.J.H., van. and I. Kristensen, 1974. On the intriguing stranding of four Cuvier's beaked whales, *Ziphius cavirostris* G. Cuvier, 1823, on the lesser Antillean island of Bonaire. *Bijdr. Dier.* 44: 235-238.
- Bree, P.J.H., F. van Creutzberg and I. Kristensen, 1973. On strandings of Cuvier's whale, *Ziphius Cavirostris* G. Cuvier, 1823, on the lesser Antillean islands of St. Maarten and Curaçao. *Lutra* 15: 6-8.
- Brown, A.N. Collier, A. DeBrot, A. Del Nevo and J. Wells, 2009. Important bird areas. Americas: Dutch Caribbean. In: Devenish, C. (ed.). *Important Bird Areas in the Americas*. Cambridge, UK: BirdLife International (in press).
- Burke, L, J. Maidens, 2004. Reefs at risk in the Caribbean. Report World Resources Institute, Washington DC. 80 pp.
- Buurt, G, van, 1981a. A report on observed recent mortalities in the Netherlands Antilles as they relate to the regional problem. *Proc. Ad hoc GCFI Symp "Unusual mass fish mortalities in the Caribbean and Gulf of Mexico:* 9-14.
- Buurt, G. van, 1981b. The 1980 fish kills in Curacao, Bonaire and Aruba and their relation to the regional problem. *Kristof VI-2:* 1-8.
- Buurt, G. van, 1995. The Construction and Deployment of Deepwater Fish Aggregating Devices in Curaçao. FAO regional Office for Latin America and the Caribbean, RLAC/95/14-PES-25, Santiago de Chile, Chile.
- Buurt, G. van, 2000. Implementation of an ongoing FAD programme in Curaçao (Netherlands Antilles) during the period 1993–2000. In: *Pêche thonière et dispositifs de concentration de poissons*. Le Gall, J.Y. Cayré, Taquet, P.M. (eds), Ed. IFREMER 28: 230–249.
- Buurt, G. van, 2001. Visserijbeleidsplan eilandgebied Curaçao. Dienst Landbouw, Veeteelt en Visserij, 42 pp.
- Buurt, G. van, 2002. Island of Curaçao FAD programme. FAO Fisheries Report N0683, Supplement SLAC/FIIT/R683 Suppl, ISSN 0429-9337: 21–26.

- Bradley P.E. and R.L. Norton (eds.), 2009. Breeding seabirds of the Caribbean. Univ. Press, Florida.
- Bruyere, F., A. Guillou and A. Lagin, 2005. Fishing Activities Developed Around Fish Aggregating Devices in Martinique Results Obtained from January to June 1994. Proc. 47th Gulf and Carib. Fish. Inst.: 678-704.
- Cairns, S.D., R.E. Chapman, 2001. Biogeographic affinities of the North Atlantic deep-water Scleractinia. . In: J.H.M. Willison, J. Hall, S.E. Gasset al (Eds). Proc. 1st Int. Symp. Deep-Sea Corals. Ecology Action Centre and Nova Scotia Museum, Halifax, Canada: 30-57.
- Caley, M.J. and J. St. John, 1996. Refuge availability structures assemblages of tropical reef fishes. J. Anim. Ecol. 65: 414-428.
- CBS (Centraal Bureau voor de Statistiek, Nederlandse Antillen), 2009. Statistical Yearbook of the Netherlands Antilles 2009.**
- Cesar, H.S.J. and P. Van Beukering, 2004. "Economic Valuation of the Coral Reefs of Hawaii." Pac. Sci. 58: 231-242.
- Cherubin, L.M., P.L. Richardson, 2007. Caribbean current variability and the influence of the Amazon and Orinoco freshwater plumes. Deep-Sea Res. Part I-Ocean. Res Pap., 54: 1451-1473.
- Chiappone, M., White, A., Swanson, D., Miller, S.L., 2002. Occurrence and biological impacts of fishing gear and other marine debris in the Florida Keys. Marine Pollution Bulletin 44, 597-604.**
- Coe, J. M. and Rogers, D. B. eds (1997) Marine Debris. Sources, Impacts and Solutions. Springer, New York**
- Cognetti, G., 1995. Pelagic fishing and protection of cetaceans: two contrasting rights? Mar. Poll. Bull. 3: 290.
- Crabbe, M.J.C., 2008. Climate change, global warming and coral reefs: Modelling the effects of temperature. Comp. Biol. Chem. 32: 311-314.
- Croquer, A. and E. Weil, 2009. Changes in Caribbean coral disease prevalence after the 2005 bleaching event. Dis. Aquat. Org. 87: 33-43.
- Debrot, A.O., 2006. Preliminary checklist of extant endemic taxa of Aruba, Bonaire and Curaçao, Leeward Antilles. Carmabi Report, Carmabi, Curaçao. 28 pp.
- Debrot, A.O., 2000. A review of records of the extinct West Indian monk seal, *Monachus tropicalis* (Carnivora: Phocidae), for the Netherlands Antilles. Mar. Mamm. Sci. 16: 834-837.
- Debrot, A.O., 1998. New cetacean records for Curaçao, Netherlands Antilles. Carib. J. Sci. 34: 168-170.
- Debrot, A. O., C. Boogerd and D. van den Broeck. 2009. Chapter 24. The Netherlands Antilles III: Curaçao and Bonaire. Pp. 207-215. In: P. E. Bradley and R. L. Norton (eds.) Breeding seabirds of the Caribbean. Univ. Press, Florida.**
- Debrot, A.O., G. van Buurt, A. Caballero and A.A. Antczak, 2006. A historical review of records of the West Indian manatee and the American crocodile in the Dutch Antilles. Car. J. Sci. 42: 272-280.
- Debrot, A.O., J.E. Bradshaw and A.B. Tiel, 1995. Tar contamination on beaches in Curaçao. Mar. Poll. Bull. 30: 689-693.
- Debrot, A. O., S.R. Criens, 2005. Reef fish stock collapse documented in Curaçao, Netherlands Antilles, based on a preliminary comparison of recreational spear fishing catches half a century apart. 32nd AMLC (Abstract)
- Debrot, A.O., N. Esteban, R. Le Scao, A. Caballero, and P.C. Hoetjes, 2005. New sea turtle nesting records for the Netherlands Antilles provide impetus to conservation action. Car. J. Sci. 41: 334-339.**
- Debrot, A.O., J.A. de Meyer and P.J.E. Dezentjé, 1998. An overview of the cetacean fauna of the Leeward Dutch Antilles. Car. J. Sci. 34: 204-210.
- Debrot, A.O. and I. Nagelkerken, 2000. User perceptions on resource state and management options in Curaçao. Rev. Biol. Trop. 48 Supl. I: 95-106.
- Debrot, A.O., A.B. Tiel and J.E. Bradshaw, 1999. A study of beach debris contamination in Curaçao, Netherlands Antilles. Mar. Poll. Bull. 38: 795-801.
- Dilrosun, F., 2000. Monitoring the Saba Bank fishery. Department of Public Health and Environmental Hygiene, Environmental Division. Curaçao, Netherlands Antilles, 56 pp.



- Dilrosun, F., 2007. Eindevaluatie Visserijbeleid, 2001. Dienst Landbouw, Veeteelt en Visserij.
- Dinsdale, E.A. and V.J. Harriott, 2004. Assessing Anchor Damage on Coral Reefs: A Case Study in Selection of Environmental Indicators. *Environ. Manage.* 33: 126-139.
- Dixon, J., L.F. Scura and T. van't Hof, 1993. Meeting ecological and economic goals: marine parks in the Caribbean. *Ambio* 22: 117-125.
- Dolman S and Simmonds M. 2005. Un updated note on the vulnerability of cetaceans to Acoustic disturbance. Paper presented to IWC Scientific Committee SC/52/E22
- Donner, S.D., T.R. Knutson and M. Oppenheimer, 2007. Model-based assessment of the role of human-induced climate change in the 2005 Caribbean coral bleaching event. *Proc. Nat. Acad. Sci. USA* 104: 5483-5488.
- do Sul, J. A. I. and M. F. Costa, 2007. Marine debris review for Latin America and the Wider Caribbean Region: From the 1970s until now, and where do we go from here? *Mar. Pollut. Bull.* 54: 1087-1104.
- ECLAC (Economic Commission for Latin America and the Caribbean), 1998. National implementation of the SIDS/POA. A Caribbean perspective. ECLAC, Trinidad.
- EcoVision N.V, 1999. Handboek fondsen natuur voor de Nederlandse Antillen Opgesteld in opdracht van het Departement van Volksgezondheid en Milieuhygiëne Sectie Milieu en Natuur Curaçao, Maart 1999
- Etnoyer, P.J., H.H. Wirshing, J.A. Sanchez, 2010. Rapid assessment of Alcyonacean diversity and habitat on Saba Bank, Netherlands Antilles. *Plos One* 5: e10668, 9 pp.
- FAO. 2002. Western Central Atlantic Fishery Commission. Fishery Report No. 683, Suppl. Rome, 295 pp.
- Fernandes, L., 1995. Integrating economic, environmental and social issues in an evaluation of the Saba Marine Park, Netherlands Antilles, Caribbean Sea, March 1995. Saba Conservation Foundation, The Bottom, Saba, Netherlands Antilles. 62 pp.
- Fernandes, L., M.A. Ridgley, T. van't Hof, 1999. Multiple criteria analysis integrates economic, ecological and social objectives for coral reef managers. *Coral Reefs* 18: 393-402.
- Gannon, D.P., N.B. Barros, D.P. Nowacek, A.J. Read, D.M. Waples and S. Wells. 2005. Prey detection by bottlenose dolphins, *Tursiops truncatus*: an experimental test of the passive listening hypothesis. *Anim Behav.* 96: 709-720.
- Gardner, T.A., I.M. Cote, J.A. Gill, A. Grant, A.R. Watkinson, 2005. Hurricanes and Caribbean coral reefs: impacts, recovery patterns, and role in long-term decline. *Ecology*, 86: 174-184.
- Garrison V.H., W.T. Foreman, S. Genualdi, D.W. Griffin, C.A. Kellogg, M.S. Majewski, A. Mohammed, A. Ramsubhag, E.A. Shinn, S.L. Simonich and G.W. Smith, 2006. Saharan dust – a carrier of persistent organic pollutants, metals and microbes to the Caribbean? *Rev. Biol. Trop.* 54: 9-21.
- GEBCO: The GEBCO\_08 Grid, version 20091120, <http://www.gebco.net>
- Gerwick, W.H., P.J. Proteau, D.G. Nagle, E. Hamel, A. Blokhin, D.L. Slate, 1994. Structure of curacin A, a novel antimitotic, antiproliferative, and brine shrimp toxic natural product from the marine cyanobacterium *Lyngbya majuscula*. *J. Org. Chem.* 59: 1243-1245.
- Gregory, M.R., 2009. Environmental implications of plastic debris in marine settings-entanglement, ingestion, smothering, hangers-on, hitch-hiking and alien invasions. *Phil. Trans. R. Soc. B* 364:2013-2025
- Hamilton, K. and J.A. Dixon, 2003. Measuring the wealth of nations. *Environ. Monit. Assess.* 86: 75-89.
- Harvell, D., E. Jordan-Dahlgren, S. Merkel, E. Rosenberg, L. Raymundo, G. Smith, E. Weil, B. Willis, 2007. Coral disease, environmental drivers, and the balance between coral and microbial associates. *Oceanography* 20: 172-195.
- Hawkins, A.D. and A.A. Myrberg, Jr., 1983. Hearing and sound communication under water. In: B. Lewis (ed.) *Bioacoustics, a comparative approach*. Academic Press, London. 347-405.
- Hildebrand, J. A. 2005. "Impacts of Anthropogenic Sound" in J.E. Reynolds et al. (eds), *Marine Mammal Research: Conservation beyond Crisis*. The Johns Hopkins University Press, Baltimore, Maryland. Pages 101-124.

- Henderson, H., 1996. What's next in the great debate about measuring wealth and progress? Challenge 39.
- Hoegh-Guldberg, O., P.J. Mumby, A.J. Hooten, R.S. Steneck, P. Greenfield, E. Gomez, C.D. Harvell, P.F. Sale, A.J. Edwards, K. Caldeira, N. Knowlton, C.M. Eakin, R. Iglesias-Prieto, N. Muthiga, R.H. Bradbury, A. Dubi, M.E. Hatzioiols, 2007. Coral reefs under rapid climate change and ocean acidification. *Science*, 318: 1737-1742.
- Hoegh-Guldberg, O., P.J. Mumby, A.J. Hooten, R.S. Steneck, P. Greenfield, E. Gomez, D.R. Harvell, P.F. Sale, A.J. Edwards, K. Caldeira, N. Knowlton, C.M. Eakin, R. Iglesias-Prieto, N. Muthiga, R.H. Bradbury, A. Dubi, M.E. Hatzioiols, 2008. Coral adaptation in the face of climate change - Response. *Science*, 320: 315-316.
- Hoetjes, P.C., K.E. Carpenter, 2010. Saving Saba Bank: Policy Implications of Biodiversity Studies. *Plos One* 5, e10769, 6 pp.
- Hudson, J.H., & Diaz, R. (1988). Damage survey and restoration of M/V Wellwood grounding site, Molasses Reef, Key Largo National Marine Sanctuary, Florida. *Proceedings of the Sixth International Coral Reef Symposium*, 231-236.
- Hughes T.P., 1994. Catastrophes, phase shifts, and large-scale degradation of a Caribbean coral reef. *Science* 265: 1547-1551
- Huppert, D.D., 2005 An overview of fishing rights. *Reviews in Fish Biology and Fisheries* 15: 201-215.
- Jepson P.D., M. Arbelo, R. Deaville, I.A.P. Patterson, P. Castro, J.R. Baker, E. Degollada, H.M. Ross, P. Herraiez, A.M. Pocknell, F. Rodriguez, F.E. Howie, A. Espinosa, R.J. Reid, J.R. Jaber, V. Martin, A.A. Cunningham, A. Fernandez, 2003. Gas-bubble lesions in stranded cetaceans. *Nature* 425: 575-576
- Ivar do Sul, J. A. and M. F. Costa. 2007. Marine debris review for Latin America and the Wider Caribbean Region: From the 1970s until now, and where do we go from here? *Mar. Poll. Bull.* 54: 1087-1104.
- Jordan-Dahlgren, E., M.A. Maldonado, R.E. Rodriguez-Martinez, 2005. Diseases and partial mortality in *Montastraea annularis* species complex in reefs with differing environmental conditions (NW Caribbean and Gulf of Mexico). *Dis. Aquat. Org.* 63: 3-12.
- Kairo, M.T., Bibi, A., Cheesman, O., Haysom, K. and Murphy, S. 2003. Invasive Species Threats to the Caribbean Region: a report to The Nature Conservancy, Report to the Nature Conservancy. CABI Bioscience, Egham, Surrey, UK.
- 2005 Ketten, D. R., Beaked Whale Necropsy Findings for Strandings in the Bahamas, Puerto Rico, and Madeira, 1999-2002. WHOI Technical Report WHOI-2005-09. pp. 1-38
- Kleypas, J.A., R.A. Feely, V.J. Fabry, C. Langdon, C.L. Sabine, L.L. Robbins, 2006. Impacts of ocean acidification on coral reefs and other marine calcifiers: a guide for future research, report of a workshop held 18-20 April 2005, St. Petersburg, FL. In: t.N.O.a.A.a.t.U.S.G.S. National Science Foundation (Ed). sponsored by NSF, NOAA, and the U.S. Geological Survey, 88 p.
- Lewis, R.L. and L.B. Crowder, 2007. Putting longline bycatch of sea turtles into perspective. *Cons. Biol.* 21: 79-86.
- Littler, M.M., D.S. Littler, B.L. Brooks, 2010. Marine macroalgal diversity assessment of Saba Bank, Netherlands Antilles. *PloS one* 5, e10677, 11 pp.
- Lundvall, S., 2008. Saba Bank Special Marine Area Management Plan 2008: 94 pp.
- Mahon, R., S. Khokiattiwong and H.A. Oxenford, 2000. Selectivity of experimental gillnets for fourwing flyingfish, *Hirundichthys affinis*, off Barbados. *Environ. Biol. Fishes* 59: 459-463.
- Macintyre, I. G., D. J. J. Kinsman, and R. C. German (1975) Geological reconnaissance survey of Saba Bank, Caribbean Sea. *Caribbean Journal of Science* 15(1-2):11-20.
- McGowan, A.,A.C. Broderick, S. Gore, G. Hilton, N.K. Woodfield and B.J. Godley, 2006. Breeding seabirds in the British Virgin Islands. *End. Species. Res.* 3: 15-20.
- McKenna, S.A. and P. Etnoyer, 2010. Rapid assessment of stony coral richness and condition on Saba Bank, Netherlands Antilles. *Plos One* 5, e10749, 9 pp.
- Medley, P.A., G. Gaudian and S. Wells, 1993. Coral reef fisheries stock assessment. *Rev. Fish Biol. & Fisheries* 3: 242-285.

- Meesters, E.H., R.P.M. Bak, 1993. Effects of coral bleaching on tissue regeneration potential and colony survival. *Mar. Ecol. Prog. Ser.* 96: 189-198.
- Meesters, H.W.G., A.G. Brinkman, W.E. van Duin, H.J. Lindeboom, S. van Breukelen, 2009. Salt-water biodiversity indicator system. Part I: Policy frameworks and indicators. Wageningen, Statutory Research Tasks Unit for Nature and the Environment. WOt-rapport 92, 134 pp.
- Meesters E.H., H. Nijkamp, L. Bijvoet, 1996. Towards sustainable management of the Saba Bank. A report for the Department of Public Health and Environment (VOMIL), Curacao, Netherlands Antilles. AIDEnvironment, Amsterdam, The Netherlands. 58 pp.
- Meteo (Meteorological Service of the Netherlands Antilles and Aruba). 2010. Hurricanes and tropical storms in the Netherlands Antilles and Aruba. 38 pp.
- Millennium Ecosystem Assessment (MEA). 2005. Ecosystems and Human Well-Being: Synthesis. Island Press, Washington. 155pp.
- Molenaar, E., A. Soons, J. Zeeberg, 2008. Bescherming en beheer mariene biodiversiteit in de Nederlandse Antillen en Aruba. Een analyse van het internationaalrechtelijk en nationaalrechtelijk kader. Rapport opgesteld ten behoeve van het Ministerie van Landbouw, Natuur en Voedselkwaliteit, Utrecht, 87 pp.
- Mora, C., 2008. A clear human footprint in the coral reefs of the Caribbean. *Proc. R. Soc. B* 275: 767-773.
- Murphy, W.L., 2000. Observations of pelagic seabirds wintering at sea in the southeastern Caribbean. In: F. E. Hayes and S. A. Temple (eds.). *Stud. In Trinidad and Tobago Ornithology Honouring Richard French*. Dept. Life Sci., Univ. West Indies, St. Augustine, Occ. Pap. 11: 104-110.
- Murray, P.A., 1997. An approach to the assessment of the finfish fisheries of the Caribbean community. *Naga, ICLARM Quarterly*: 42-45.
- Meyers, N., Mittermeier, R.A., C.G. Mittermeier, G.A.B. da Fonseca and J. Kent, 2000. Biodiversity hotspots for conservation priorities. *Nature* 403: 853-858.
- Myrberg, A.A. Jr., 1990. The effects of man-made noise on the behavior of marine animals. *Envir. Intern.* 575-586.
- Myrberg, A.A. Jr. and L.A. Fuiman, 2002. The sensory world of coral reef fishes. In: *Coral reef fishes*, Elsevier Science: 123-148.
- Myrberg, A.A. Jr., M. Mohler and J.D. Catala, 1986. Sound production by males of a coral reef fish (*Pomacentrus partitus*): its significance to females. *Anim. Behav.* 43: 913-923.
- Myrberg, A.A. Jr., and R.J. Riggio, 1985. Acoustically mediated individual recognition by a coral reef fish (*Pomacentrus partitus*). *Anim. Behav.* 33: 411-416.
- Nagelkerken, I. and A.O. Debrot, 1995. Mollusc communities of tropical rubble shores of Curaçao: long-term (7+ years) impacts of oil pollution. *Mar. Poll. Bull.* 30: 592-598.
- Nagelkerken, I., M. Wiltjer, A.O. Debrot and L.P.J.J. Pors, 2001. Baseline study of submerged marine debris at beaches in Curaçao, West Indies. *Mar. Poll. Bull.* 42: 786-789.
- Neilson, J.D., Aiken, K.A., Mahon, R., 1994. Potential yield estimates for reef and slope fisheries: Review of approaches and their limitations with special reference to the Caribbean. *Proc. Gulf Carib. Fish. Inst.* 46: 360-376.
- Newton, E., 1987. Tar on beaches, Bonaire, Netherlands Antilles. *Car. J. Sci.* 23: 139-143.
- Oxenford, H, R. Mahon and W. Hunte, 1992. Relative abundance and distribution of adult flyingfish in the Eastern Caribbean. *Proc. 42th Gulf Carib. Fish. Inst.*: 251-260.
- Pauly, D., V. Christensen., J. Dalsgaard, R. Froese. & F. Torres jr., 1998. Fishing down marine food webs. *Science*, 279: 860-863.
- Paddack M.J. et al., 2009. Recent region-wide declines in Caribbean reef fish abundance. *Curr Biol.* 19: 590-595.
- Pimentel, D., S. McNair, J. Janecka, J. Wightman, C. Simmonds, C. O'Connell, E. Wong, L. Russel, J. Zern, T. Aquino, T. Tsomondo, 2001. Economic and environmental threats of alien plant, animal, and microbe invasions. *Agriculture, Ecosystems & Environment* 84: 1-20.
- Poppe, D.M.C. 1974. Zeevogel waarnemingen in het oostelijk deel van de Caraïbische Zee. CICAR 1972. Carmabi Foundation, report. 82 pp.

- Postma, T.A.C. and H. Nijkamp. 1996. Seabirds, marine mammals and human activities on the Saba Bank. Field observations made during the Tydeman expedition, April-May 1996. AIDEnvironment, report 25 pp.
- Prins, T.G., J.H. Reuter, A.O. Debrot, J. Wattel and V. Nijman, 2009. Checklist of the birds of Aruba, Curacao, and Bonaire, South Caribbean. *Ardea* 97: 137-262.
- Prospero, J.M. and R.T. Nees, 1986. Impact of the North African drought and El Niño on mineral dust in the Barbados trade winds. *Nature* 320: 735-738.
- Purdy, E.G. and E.L. Winterer, 2001. Origin of atoll lagoons. *Bull. Geol. Soc. Am.*, 113: 837-854.
- Quinn, N.J. and B.L. Kojis, 1995. Use of artificial shelters to increase lobster production in the U. S. Virgin Islands, with notes on the use of shelters in Mexican waters. *Caribb. J. Sci.* 31: 311-316.
- Rac-REMPEITC-Carib 2009. Regional Caribbean Island Oil Pollution Response and Cooperation Plan:**
- CARIBBEAN ISLAND OPRC PLAN 2009. RAC/REMPEITC-Carib, Seru Mahuma z/n, Aviation & Meteorology Building, Curacao, Netherlands Antilles, 80 pp.**
- Richards, A.H., 1994. Problems of drift-net fisheries in the South Pacific. *Mar. Poll. Bull.* 29: 106-111.
- Roberts, C. M., 1995. Rapid build-up of fish biomass in a Caribbean marine reserve. *Cons. Biol.* 9: 815-826.
- Roberts, C.M. and J.P. Hawkins, 1997. How small can a marine reserve be and still be effective? *Coral Reefs* 16: 50.
- Roberts, C.M., J.P. Hawkins and F.R. Gell, 2005. The role of marine reserves in achieving sustainable fisheries. *Phil. Trans. R. Soc. B*, 360: 123-132.
- Roberts, C.M., J.A. Bohnsack, F. Gell, J.P. Hawkins and R. Goodridge, 2001. Effects of marine reserves on adjacent fisheries. *Science* 294: 1920-1923.
- Rogers, C.S. and V.H. Garrison, 2001. Ten years after the crime: Lasting effects of damage from a cruise ship anchor on a coral reef in St. John, US Virgin Islands. *Bull. Mar. Sci.* 69: 793-803.
- Ruth, L. (2006) 'Gambling in the deep sea', *European Molecular Biology Organization Reports*, 7, pp. 17-21.**
- Samlalsingh, S., H. Oxenford and J. Rennie. 2005. A successful small-scale longline fishery in Grenada. *Proc. 46th Gulf and Carib. Fish. Inst.*: 3-21.
- Seaturtles.org, 2003. Longline fishing is killing sea turtles. Info leaflet, Sea Turtle Restoration Project, Fort Knolls, CA. 2 pp.
- Shing, C.C.A., 2006. Shark Fisheries of Trinidad and Tobago: A National Plan of Action. Proc. 57th Gulf Carib. Fish. Inst.: 205-213.**
- Simmonds M, Dolman S, Weilgart L (2004) Oceans of noise. A WDCS Science Report.
- Smith, S. H. (1988) Cruise ships: a serious threat to coral reefs and associated organisms. *Ocean and Shoreline Management* 11: 231-248.**
- Spurgeon, J.P.G., 1993. The economic valuation of coral reefs. *Mar. Poll. Bull.* 24: 529-536.
- Steneck, R.S., C.B. Paris, S.N. Arnold, M.C. Ablan-Lagman, A.C. Alcalá, M.J. Butler, L.J. McCook, G.R. Russ, P.F. Sale, 2009. Thinking and managing outside the box: coalescing connectivity networks to build region-wide resilience in coral reef ecosystems. *Coral Reefs*, 28, 367-378.
- Sturm, M. G. de L., 1991. The living resources of the Caribbean Sea and adjacent areas. *Car. Mar. Stud.* (1&2): 18-44.
- Sybesma, J., 1992. WIDECASST Sea Turtle Recovery Action Plan for the Netherlands Antilles (K. L. Eckert, editor) CEP Techn. Rept. No. 11. UNEP Caribbean Environmental Programme, Kingston, Jamaica. 63 pp.
- Sybesma, J. and A.O. Debrot, 2002. Speervisverbod en strafmeting; hoe komt de rechter tot zijn strafmaat? *SPES Victoriae* 3: 5-10.
- Sybesma, J., and P. Hoetjes, 1992. First record of the Olive Ridley and of nesting by the Loggerhead Turtle in Curacao. *Carib. J. Sci.* 28:103-104.
- Sylva, D.P. de, 1981. Potential for increasing artisanal fisheries production from floating artificial habitats in the Caribbean. *Proc. 34th Gulf Caribb. Fish. Inst.*, 1981: 156-167.

- Thacker, R.W., M.C. Diaz, N.J. de Voogd, R.W.M. van Soest, C.J. Freeman, A.S. Mobley, J. LaPietra, K. Cope and S. McKenna, 2010. Preliminary assessment of sponge biodiversity on Saba Bank, Netherlands Antilles Plos One 5, e9622, 5 pp.
- Toller, W., A.O. Debrot, M.J.A. Vermeij, P.C. Hoetjes, 2010. Reef fishes of Saba Bank, Netherlands Antilles: assemblage structure across a gradient of habitat types. Plos One 5, e9207, 13 pp.
- Toller W. and S. Lundvall, 2008. Assessment of the commercial fishery of the Saba Bank. Saba Conservation Foundation, 47pp.
- UNCLOS, 1982. United Nations Convention on the Law Of the Sea.
- UNEP, 2005. Marine Litter an analytical overview. Nairobi, Kenya. 58 pp.
- UNEP, 2008. Marine Litter in the Wider Caribbean. Kingston, Jamaica. 90 pp.
- UNEP. 2006. National and regional capacities and experiences on marine invasive species, including ballast waters, management programmes in the Wider Caribbean Region - a compilation of current information. V. Lopez and U. Krauss. CAB International, CLARC, Trinidad & Tobago. 105 pp.
- Van der Land, J., 1977. The Saba Bank - A Large Atoll In The Northeastern Caribbean. FAO Fisheries Report no. 200: 469-481.
- Vermeij, M.J.A., K.L. Marhaver, C.M. Huijbers, I. Nagelkerken, S. D. Simpson, 2010. Coral larvae move toward reef sounds. Plos One 5, e10660, 4 pp.
- Voous, K.H., 1983. Birds of the Netherlands Antilles . Zutphen: De Walburg Pers.
- Voss, G.L., 1956. A review of the cephalopods of the Gulf of Mexico. Bull. Mar. Sci. 6: 85-178.
- Voss, G.L., 1960. Potentialities for an octopus and squid fishery in the West Indies. Proc. Gulf and Carib. Fish. Inst., 1959: 129-135.
- Voss, G.L., 1971a. The cephalopod resources of the Caribbean Sea and adjacent regions. pp. 307-323. In: Symposium on Investigations and Resources of the Caribbean Sea and Adjacent Regions, Papers on Fishery Resources, FAO, Rome, 347 pp.
- Voss, G.L., 1971b. Study of squid fisheries and giant squid of the North Atlantic. National Geographic Society Research Reports, 1965 Projects: 241-244.
- Voss, G.L., 1973. Cephalopod resources of the world. FAO Fisheries Circular, 149: 1-75.
- Voss, G.L., L. Opresko and R. Thomas, 1973. The potentially commercial species of octopus and squid of Florida, the Gulf of Mexico and the Caribbean Sea. Sea Grant Field Guide Series 2: 1-33.
- Voss, G.L., 1986. A new look at squid and octopus potential of the Caribbean. Pages 34-40 in F. Williams, ed. Proc. 37th Annual Gulf & Carib. Fish. Inst., Miami, FL, 248 pp.
- WECAF (Western Central Atlantic Fishery Commission) 2008. Status of the stocks of the Western Central Atlantic FAO Statistical Area 31. Proc. Thirteenth Session WECAFC Lesser Antilles Fisheries Committee, Tenth Session Cartagena de Indias, Colombia, 21–24 October 2008: 15 pp.
- Weidner, D.M., G.E. Laya and J.A. Serano, 2001. World swordfish fisheries: an analysis of swordfish fisheries, market trends and trade patterns, past-present-future, Vol. IV. Latin America, Part B. Caribbean, Section 4. Montserrat to Puerto Rico. Chapter 17. The Netherlands Antilles and Aruba. Pp. 1053-1145. NOAA Tech. Memo. NMFS-F/SPO-53. NMFS: Silver Spring, Maryland.
- Wells, J. and A.O. Debrot, 2008. Bonaire. Pp. 95-102. In: D. C. Wege and V. Anadon-Irizarry. Important bird areas in the Caribbean: key sites for conservation. Cambridge, UK: BirdLife International (BirdLife Conservation Series 15)
- Williams, E.H. and L. Bunkley-Williams, 2000. Marine major ecological disturbances of the Caribbean. The Infectious Diseases Review 2000: 110-127.
- Williams, J.T., K.E. Carpenter, J.L. Van Tassel, P. Hoetje, W. Toller, P. Etnoyer and M. Smith, 2010. Biodiversity assessment of the fishes of Saba Bank Atoll, Netherlands Antilles. Plos One 5, e10676, 37 pp
- World Bank, 1995. Monitoring Environmental Progress: A Report on Work in Progress, Washington, DC.