



BONAIRE NATIONAL MARINE PARK MANAGEMENT PLAN 2006



Cover image source: ftp://eol.jsc.nasa.gov/scanned_highres_STS075_STS075-706-41.JPG
Image courtesy of Earth Sciences and Image Analysis Laboratory, NASA Johnson Space Center. (<http://eol.jsc.nasa.gov>)
photo number: STS075-706-41.JPG

Kalli De Meyer



DUTCH CARIBBEAN NATURE ALLIANCE

kdm@telbonet.an
+ 599-717-5010

Duncan MacRae



22 Rosemundy, St Agnes, Cornwall, UK,
solutions@cozm.co.uk,
+44 (0)1872 552 219

Contents

Introduction	10
 Part 1. Bonaire National Marine Park: background information	
Location	12
History and culture.....	14
Population	16
Politics and Economics	17
<i>Politics.....</i>	<i>17</i>
<i>Economics.....</i>	<i>17</i>
Geology and geomorphology	20
Climate	21
Terrestrial Habitats, flora and fauna	25
Marine Habitats, Flora and Fauna	27
<i>Open Water.....</i>	<i>29</i>
<i>Sea Bed.....</i>	<i>32</i>
<i>Intertidal</i>	<i>39</i>
Special interest habitats and species.....	47
Human use of the marine environment	50
<i>Tourism and recreation</i>	<i>50</i>
<i>Fishing</i>	<i>50</i>
<i>Shipping</i>	<i>50</i>
References	51
 PART 2. The Management environment	
Introduction	52
Bonaire National Marine Park.....	53
<i>Statement of significance</i>	<i>54</i>
<i>Values of the Bonaire National Marine Park</i>	<i>55</i>
Mission and goals	60
<i>Goals.....</i>	<i>60</i>
Legal protection	61
<i>Current Legislation</i>	<i>61</i>
<i>Marine Environment Ordinance (A.B 1991 nr.8).....</i>	<i>62</i>
<i>Relevant International treaties and conventions to BNMP</i>	<i>63</i>
<i>Central Government regulations</i>	<i>63</i>
<i>Permits.....</i>	<i>63</i>
<i>Rules and guidelines.....</i>	<i>64</i>

Governance: institutional arrangements	66
<i>STINAPA Bonaire.....</i>	<i>66</i>
<i>Organisation and meetings</i>	<i>67</i>
Physical Resources	68
Human Resources.....	69
<i>Summary.....</i>	<i>69</i>
<i>Staff Members 2006</i>	<i>70</i>
Stakeholders	71
<i>Local</i>	<i>71</i>
<i>International</i>	<i>71</i>
Stakeholder input into the BNMP management plan.....	72
Uses	77
Zoning	80
Analysis of issues	82
<i>Historical issues</i>	<i>82</i>
<i>Management issues</i>	<i>82</i>
<i>Current 'external' issues.....</i>	<i>83</i>
Summary of issues	89

Part 3. Management Plan

Introduction	90
Marine Park management activities	91
<i>Year core activity Plan 2006.....</i>	<i>93</i>
<i>Work schedule overview 2006.....</i>	<i>95</i>
Key Issues and actions.....	99
Recommendations	104
<i>Zoning Plan.....</i>	<i>104</i>
<i>Management Plans for Lac and Klein Bonaire.....</i>	<i>105</i>
<i>Conservation Value.....</i>	<i>105</i>
<i>Monitoring and Review.....</i>	<i>105</i>
Appendices.....	106

Part 4. Additions and Developments.....	107
--	------------

Figures

Figure 1: Bonaire in relation to the other Dutch Caribbean Islands	12
Figure 2: Key towns and features of Bonaire.....	13
Figure 3: Population statistics for residents and visitors to Bonaire.....	16
Figure 4: Population pyramids for the permanent population of Bonaire.....	16
Figure 5: % contribution of different sectors of Bonaire's economy to the GDP	17
Figure 6: Changes in the nature of passenger transport on Bonaire.....	18
Figure 7: Average temperature/rainfall chart for Flamingo Airport 1971-2000.....	21
Figure 8: Wind rose showing the average wind speed and direction on Bonaire	22
Figure 9 Sea surface currents influencing Bonaire.	23
Figure 10: 3 Dimensional Representation of Bonaire's surrounding Bathymetry.....	24
Figure 11: Schematic diagram of a typical tropical coastal seascape.....	28
Figure 12: Seagrass succession diagram	32
Figure 13: The vertical distribution of macrofauna in mangrove forests.....	42
Figure 14: A colour composite aerial Photograph of Lac,	43
Figure 15: Ramsar sites of Bonaire.....	55
Figure 16: % of tourists taking part in recreational activities	74
Figure 17: Most memorable part of participant's trip to Bonaire	74
Figure 18: Visitors use of Marine Park outreach.....	75
Figure 19: Challenges facing BNMP	75
Figure 20: International visitors by country/region 1992-2002	78
Figure 21: Marine Park Tag sales 1992-2004	78
Figure 22: The number of different types of boats using Bonaire's waters.....	79
Figure 23: The nature of Boat Traffic in 2002 (left).....	79
Figure 24: The nature of boat traffic in 2004 (right)	79
Figure 25: Map of Bonaire showing the main dive sites and Marine Reserves	81
Figure 26: Results of the Management Success Project threat Analysis	83

Tables

Table 1: Recommendations for review of the management document.....	11
Table 2: Historical zonation of Bonaire's Reefs.....	36
Table 3: Typical Mangrove zonation in Bonaire.....	41
Table 4: Ramsar sites on Bonaire	47
Table 5: Key Red list and CITES species on Bonaire.....	49
Table 6: BNMP's fees schedule	53
Table 7: General values of Coral Reefs, Mangroves and Seagrasses	57
Table 8: Key endangered species of Bonaire.	58
Table 9: Permits issued by BNMP	63
Table 10: The STINAPA Board	66
Table 11: Institutional arrangements.....	67
Table 12: Meeting arrangements.....	67
Table 13: Bonaire National Marine Park physical resources.....	68
Table 14: Summary of the staff of BNMP	69
Table 15: Staff members of BNMP	70
Table 16: Local stakeholders	71
Table 17: International stakeholders	71
Table 18: The main uses of BNMP.....	77
Table 19: Issue priority levels from BNMP strategic planning	84
Table 20: Issue identification from stakeholder consultation.....	84
Table 21: A hierarchical list of the issues identified by the threat analysis.....	85
Table 22: A summary of the most critical issues facing BNMP	85
Table 23: Recommended zones for BNMP.....	104

Images

Image 1: Rincon, the original settlement on Bonaire	14
Image 2: Aloe plants growing in WSNP.	18
Image 3: Commercial fishing boats, Sorobon.	18
Image 4: Tug boats used to guide BOPEC's shipping.	19
Image 5: Cruise Boat visitors disembarking	19
Image 6: The characteristic limestone cliffs (raised reefs) on Bonaire.....	20
Image 7: An active solution notch	20
Image 8: Bonaire's South West Coast looking north towards the Salt Pier.....	22
Image 9: The East Coast of Bonaire.....	22
Image 10: The high tide line marked by detritus.....	23
Image 11: Fringing reefs of Bonaire at '1000 Steps'	24
Image 12: Drought resistant vegetation near Lac on the East Coast	25
Image 13: Vegetation in WSNP in the North of Bonaire.....	25
Image 14: The Lora; endangered by collection for the pet trade	26
Image 15: The Green Iguana.....	26
Image 16: Stove-Pipe sponge (<i>Aplysina archeri</i>) on one of Bonaire's reefs	27
Image 17: Intertidal coral beach near Cai	27
Image 18: Seagrass community in Lac	27
Image 19: Dorado / <i>Coryphaena hippurus</i>	29
Image 20: Aerial Photograph of Lac 1996	33
Image 21 and Image 22 : Conch shell piles at Cai	34
Image 23: Aerial view of The Town Pier and Kralendijk,	35
Image 24: Algae dominated upper reef slope at Cliff dive site	37
Image 25: 'Healthy' Reef at 1000 steps dive site in 2006.....	37
Image 26: Playa Chikitu looking North.....	39
Image 27: Playa Chikitu - view to the South	39
Image 28: Threats to dunes and beaches	40
Image 29: A stand of Red Mangrove (<i>Rhizophora Mangle</i>) near Cai, within Lac	41
Image 30 and Image 31: Mangrove die-off around Awa di Lodo	44
Image 32: The mangroves of Lac afford protection to many recreational users	45
Image 33: Interesting formations on the rocky shores of Bonaire	46
Image 34: Rock pools formed on the rocky shores	46
Image 35: Salinas in WSNP with Mt. Brandaris in the background	48
Image 36: Salinas such as Slagbaai, are an important breeding grounds for Flamingos. .	48
Image 37 and Image 38 : Bacterial mats at Lac	48
Image 39: Dive boat.....	50
Image 40: Artisanal fishing boats near Atlantis on the leeward coast.....	50
Image 41: Signage at Lac with general guidelines and rules	64
Image 42: The brochures currently in use by BNMP.	64
Image 43: BNMP Manager Ramon De Leon with tags and brochures	64
Image 44: BNMP full uniform and badge detail.	67

Boxes

Box 1: Definitions of key terms used in section 2	52
Box 2: Significance and values explanation	54
Box 3: Statement of Significance.....	54

Acknowledgements

This plan could not have been completed without the cooperation and enthusiastic support of a number of individuals and organizations. This includes the stakeholders of Bonaire National Marine Park who attended the meetings in January 2006 or contributed directly to the management plan;

VOLUNTEERS	Melody Hamilton, Tom Thurman, Patti DeLong, Mike DeLong, Susan Porter, Phyllis Blackburn, Brian McCarley, Daniel DeAnda Jr, Caren Eckrich, Dee Scarr, Linda D Ridley, Chile Ridley.
CAI FISHING GROUP	Calos Soliana, Freek Ford, Gevy Soliana, Netty Soliana, Gibi Soliana, Robby Soliana, Robby Martis, Leo Maktines, Raymond Bernabela, Eddy Bernabels, Ortis Martilda, Jossy
GOVERNMENT DEPARTMENTS AND OTHERS	Peter Montanas, Frank Van Slobbe, Bert Mijland, George DeSalvo, Carlos Ponnieu
STINAPA STAFF AND BOARD	Diana Sint Jago, Corine Gerharts, Jack Chalk, Ronella Croes, Jeannette Nolen, Fernando Simal, Kerenza Rennou, Sixto Trenidad, July-Ann Frans, George Saragoza, Edwin Dommacase, George Thode, Karel Rosaria
TOURISM SECTOR AND INDUSTRY	Jake Richter, Anja Romeijunders, Mabel Nava, Mark Vlietstra, Richard Duijn, Theo Knevel, Bob Bartikoski, Alvin Clemencia, Andy Uhr, Bruce Bowker, Captain Don Stewart, Janet Thibault, Leonie van Hunsel, Peter Montanas, Streefkerk Harm JC, William A. Nicolaas, Jan Kloos, Junny Janga
WATERSPORTS OPERATORS	Benji Schaub, Martyn Eichorn, Monique Reighert, Malin Kaijser, Christien Souiltheiss, Harry vid. Ouweelen, Justine Gonggrijp, Catherine Gilmore, Stephan Zaat, Roan Jaspars, Hans Voerman, Elly Albers, Frank Verbinnen, Jan Blonk, Peter Blonk, Larry Beillie, Mennojde Bree, Rick Aguiuar, Max Margarita, Augusto Montbrun, Zwanet Kooij
TOURISTS	All of the tourists who took the time to complete the questionnaire

We would specifically like to thank:

Expert Reviewers

- Floyd Homer, Chair of the World Commission on Protected Areas (Caribbean Region)
- John E. Clarke, World Commission on Protected Areas member.

Contributors

- Susan Porter for contributing valuable local knowledge of species to the species lists of Lac.
- Daniel DeAnda of SeaHatch for his detailed description of the aquaculture operation.
- Maria Uyarra of the University of East Anglia (UK) for carrying out the tourist survey.
- Daniel Yuchnovicz of www.chesapeakebaydiving.com for his photographic contribution.

Acronyms and abbreviations

AGRRA	Atlantic and Gulf Rapid Reef Assessment (Caribbean wide study of coral reef health)
BNMP	Bonaire National Marine Park
Cartagena	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
MPA	Marine Protected Area
PA	Protected Area
Ramsar	Convention on Wetlands of International Importance especially as Waterfowl Habitat
SPAW	Specially Protected Areas and Wildlife – Annex of the Cartagena Convention
STINAPA	Stichting Nationale Parken Nederlandse Antillean
TCB	Tourism Corporation Bonaire
UNEP	United Nations Environment Programme
WCPA	World Commission on Protected Areas
WSNP	Washington Slagbaai National Park
WWF	World Wide Fund for Nature

How to use the Bonaire National Marine Park Management Plan

This management plan is intended to act as a reference document and to provide structure for the management of Bonaire National Marine Park. The target audiences include those responsible for managing BNMP in the field as well as stakeholders, external supporters, potential donors and other interested parties.

The Bonaire National Marine Park Management plan has been designed to be a dynamic document, accessible to all interested parties via hard copy, electronic copy and websites. The master copy, owned by the Marine Park Manager should be kept up to date with additional material to allow adaptive management as situations and issues change. Changes to the plan should be listed in a simple format and agreed by the STINAPA director and/or Board. The Plan has 4 parts:

Part 1. Bonaire: Background Information

The physical, social and political environment that BNMP works within greatly influences the operations of the protected area. Those using the management plan may not be aware of the stage upon which BNMP operates and can refer to this section for background information. Technical terms are explained in the text and names of plants and animals are given as the common name in English, followed by local and scientific names.

Part 1 provides valuable background and contextual information. It can be used as a stand alone introduction to the island/marine park and has been written with a range of audiences in mind.

Part 2. Management environment

This is the first part of the working document which states the significance, mission and goals of BNMP. Resources available to BNMP are described, including the legal instruments, institutional arrangements, human and physical resources. The main issues facing BNMP are detailed and described before being summarised.

Part 2 will be of interest to those wishing to develop a more in depth understanding of the operational management of the marine park and the issues facing the park.

Part 3. Management Plan.

In part 3 the actions that BNMP need to take to work towards the mission and goals are clarified. Day to day activities of the marine park staff are outlined, and actions are recommended to tackle the management issues and external issues identified in Part 2 that BNMP faces.

Part 3 is of concern to those with an interest in the current activities of BNMP and the rational behind actions being taken.

Part 4. Additions and Developments

The final part of the plan is intended to act as a place marker for updates, where management actions have lead to outcomes that can be described or there has been a change in the tools available to the marine park. This section needs to be kept up to date so that staff can work from the proposed actions and work schedule, and so any interested party can pick up the whole plan and have a thorough understanding of BNMP from the context through to the most recent management actions.

Part 4 is to be used by the management body to keep the management plan up to date; its contents are unlikely to be available until the plan has been formally updated.

Summary

The Bonaire National Marine Park was first established in 1979. It surrounds the island of Bonaire and includes the satellite island and the waters around Klein Bonaire. Bonaire lies in the Southern Caribbean approximately 100km (60 miles) north of Venezuela and 12' north of the equator. Bonaire is unusual in that it is a true oceanic island, separated from the South American mainland by a deep water trench. Bonaire is part of the Kingdom of the Netherlands and is regarded by the European Union as an Overseas Territory. The marine park falls entirely within the territorial waters and jurisdiction of the Island of Bonaire and is protected by the Marine Environment Ordinance (A.B 1991 Nr.8). The marine park was declared a National Park by the Central Government of the Netherlands Antilles in November 1999. For issues related to World Heritage, Ramsar wetlands, threatened and endangered species, migratory species and marine pollution the Central Government Department of Nature and the Environment (MINA) also has jurisdiction.

The marine park includes 2,700 hectares of coral reef, seagrass and mangrove ecosystems and provides habitat for a diverse range of marine species including over 50 species of stony coral and more than 350 species of reef fish. Sea turtles nest on the shores of Klein Bonaire and forage in Lac, a semi enclosed seagrass and mangrove bay located on the islands windward shore. Bottlenose and Spinner dolphin as well as various species of whale can be found seasonally in the seas around Bonaire. Bonaire is regularly visited by migratory birds.

Bonaire has a well deserved international reputation for excellence in the field of SCUBA diving and is routinely listed in the top five destinations for the Caribbean.

The Bonaire National Marine Park consists of the waters around Bonaire from the high water mark to the 200' (60m) depth contour, the island of Klein Bonaire and its surrounding waters and the mangrove, seagrass and coral reefs of Lac. The park is managed by a local non governmental, not for profit foundation, STINAPA Bonaire which has a co-management structure with stakeholders, conservationists and local interest groups represented on the Board. The day to day management is carried out under the supervision of a Director but the Marine Park manager, Chief Ranger and Rangers employed by STINAPA Bonaire.

The marine park is managed predominately for biodiversity conservation, the promotion of sustainable use and for the protection of cultural and historical sites within the park with the aim of providing protection for the island's unique marine resources whilst allowing appropriate recreational and commercial use to be made of the park.

This is the first management plan for the Bonaire National Marine Park. Rapid changes in management over the past six years have highlighted the need for a strategic document to guide management decision making and to better define the mission, goals and objective of the park. It is also a prerequisite for Bonaire's World Heritage Site nomination and essential if the park is going to begin monitoring its own effectiveness.

This document has been prepared in close consultation with STINAPA Bonaire, their management and staff and a considerable number of stakeholders and stakeholder group representatives.

The plan specifies management goals and strategies for the Bonaire National Marine Park related to the park's mission, which is to conserve and manage the natural, cultural and historical resources within the park, allowing their sustainable use for the benefit of current and future generations. It also identifies the major existing and potential threats and issues facing the park from ecological, social and cultural perspectives and includes substantial input from stakeholders. It is designed to be an adaptive management tool.

Introduction

In 1979 the Bonaire Marine Park was first set up with grant funding from the World Wildlife Fund, in the Netherlands, assistance from the Island Government and other funding sources. The responsibility for management was given to STINAPA Bonaire, an existing non governmental conservation organisation which was already managing the islands land park, the Washington Slagbaai National park which had been created a decade earlier. The marine park had its headquarters at Karpata and was managed by Eric Newton with the assistance of a consultant Tom van't Hof. Over the next four years the Marine Park was actively managed, legislation was passed protecting the park, a system of dive moorings was established along the length of the leeward shore and a range of outreach materials were developed in addition to the very first Guide to the Bonaire Marine Park written by Tom van't Hof (1982). However, failure to identify a sustainable source of funding for the park caused serious financial difficulties. Eventually, with funding for operational management, the Park became a 'paper park' — established on paper but without any active day to day management. For the coming six years the spirit of the Park was kept alive through the hard work of the dive industry and a few dedicated individuals.

By 1990 there was a real fear that the expanding dive industry and increasing tourist visitation were creating a serious threat to the health of Bonaire's coral reefs. After serious concerns had been raised about the lack of formal management of the Marine Park, after a trebling in diver activity, and with increasing pressure on the island's coastal resources, Dutch Government funding (Meerjaaren Plan Fondsen – MJP funds) was sought to re-establish, or 'revitalize', the Marine Park. This was successful and in April 1991 the marine park was revitalized and a new manager, Kalli De Meyer, was hired to work alongside Tom van't Hof in order to re-establish the Bonaire Marine Park. The Dutch Government funding, which amounted to Naf 225,000 per annum for a maximum period of three years, was administered by DEPOS (Departement Ontwikkeling Samenwerking) on Curaçao and had a number of significant strings attached. It obligated the Island Government of Bonaire to:

- Ensure that the Marine Park became self financing within the term of the grant
- Set up an appropriate management structure for the Marine Park

Both of these requirements were fulfilled. The Marine Park was re-established and the Island Government passed amendments to the Marine Environment Ordinance allowing an annual admission fee of US\$ 10 per diver to be levied in order to offset operational expenses. In January 1992 admission fees were introduced and in the course of the first year over US\$ 170,000 was raised, enough to cover salaries and operating costs. The Island Government gave management of the Marine Park to STINAPA Bonaire (Stichting Nationale Parken Nederlandse Antillean), a local NGO which was already had management of the island's land park and created a 'Begleidingscommissie' made up of representatives of the tourism sector, conservation interests as well as local island interests to guide Park management.

Since the early 1990's the Marine Park has gone from strength to strength. By the end of that decade it was considered a model marine park and was being copied as far a field as Bunaken, Indonesia. It was selected as a UNEP/ICRAN demonstration site for the Caribbean and ranked alongside the Great Barrier Reef and Florida Keys National Marine Sanctuary for the value of its conservation work. In November 1999 the Marine Park was formally declared a National Park by the Central Government of the Netherlands Antilles and the name was changed to Bonaire National Marine Park (BNMP).

Despite its undisputed success, Bonaire National Marine Park (BNMP) has never had a formal management plan. Rapid institutional developments and changes in leadership over the past six years have highlighted the need for such a document in order to better define the goals and objectives of the Park and to clarify management objectives and strategies which will allow the Park's success to be measured and its management effectiveness to be assessed. It will also assist both staff and Board by providing a solid framework for reference, decision making and planning. The management plan will also ensure continuity of management effort and allow stakeholders and other interest groups to understand and participate in the planning process. According to IUCN management plans are an essential step towards ensuring the proper management of protected

areas. This management plan is also a prerequisite document in support of Bonaire's marine transboundary World Heritage Site nomination.

The first project proposal for a management plan was submitted and approved in January 2004. The strategic planning component was conducted throughout the fall of 2004 and the first data collection and gathering of background information began in September 2005. Stakeholder input into the management plan was conducted throughout the month of January 2006 with formal meetings held over a 3 week period.

ADAPTIVE MANAGEMENT AND TIMEFRAME

For this management plan to serve the needs of STINAPA Bonaire, park management and staff it is vital that it be periodically reviewed and updated. Stakeholders are also keen to see a review process adopted and this emerged as a repeated theme during the course of stakeholder meetings held in January 2006.

It is recommended that Part 1 of this plan is updated every 3-5 years, and parts 2 and 3 of this plan are reviewed together on an annual basis. Necessary updates should then be added in section 4. Stakeholder input to the running of BNMP needs to be an ongoing process. It is recommended that formal stakeholder input regarding the functioning of the management plan is carried out every 3-5 years, in conjunction with the revision of Part one.

The recommendations below for reviewing and revising the Management Plan should be seen as guidelines. After the management planning and review process has been consolidated, revisions may become less frequent and/or more specific.

Section	Time period	People involved
1,2,3,4	Every 3-5 years as required	STINAPA Staff, Board and Stakeholders
2	Once a year additions put into section 4	STINAPA Staff and Board
3	Once a year additions put into section 4	STINAPA Staff and Board
4	Additions made continually	STINAPA Staff

Table 1: Recommendations for review of the management document

Part 1. Bonaire National Marine Park: background information

Location

Bonaire is situated in the southern Caribbean (12°10'N, 68°15'W) approximately 100 km north of Venezuela. It is one of the five islands that form the Netherlands Antilles: Bonaire, Curaçao, and the Windward Islands of St. Maarten, Saba, and St. Eustatius (Statia) (See Figure 1).



Figure 1: Bonaire in relation to the other Dutch Caribbean Islands

Bonaire is a crescent shaped island, oriented NW-SE, approximately 40 km (27 miles) long by 11 km (5 miles) at its widest point, with a land area of 28,100 ha. The small undeveloped satellite island of Klein Bonaire ("small" Bonaire) is located some 750 m off the western shore of Bonaire and has a land area of approximately 600ha (see Figure 2).

The islands terrestrial park, Washington Slagbaai National Park[†] protects approximately 17% of the total land area of Bonaire and was established in May 1969. It is managed, like the Marine Park, by the local conservation foundation, STINAPA Bonaire. Other significant features include the salt lakes or Saliñas along leeward shore

Klein Bonaire, along with Pekelmeer, Saliña Slagbaai, Gotomeer and Lac, are the only Ramsar sites in the Netherlands Antilles. As Ramsar sites they are internationally recognised as wetlands of significance by the RAMSAR Convention on Wetlands (1971) (see Figure 3 and Appendix 1 for further details).

The Bonaire National Marine Park surrounds the islands of Bonaire and Klein Bonaire extending from the high water mark to the 60m (200') depth contour and including both the sea bottom and associated waters and extending up to 200m from the coast. The geomorphology, bathymetry and location of Bonaire combine to produce a unique marine environment shared only by its sister islands of Curacao, Las Aves and Los Roques. The park encompasses 2,700 hectares of fringing coral

[†]Washington Slagbaai National Park is not currently a 'National Park' – this designation can only be given by Central government and WSNP does not currently meet the criteria

reef, seagrass and mangrove ecosystems. The park therefore contains representative habitats of whole ecosystems from the shore to intertidal environments and from coral reefs to deep water environments. The satellite island of Klein Bonaire is also under the management of the marine park along with Lac (both Ramsar sites), the largest semi-enclosed seagrass and mangrove bay in the Netherlands Antilles.

The centrally located main town is called Kralendijk (or '*Playa*' in the local language). It has become the focus of the islands tourism industry with the majority of hotels, dive and watersports centres and restaurants located in these areas. The first settlement and older town of Rincon lies to the North and it has become the focus of the island's historical and cultural activities and has seen a significant revival in the last ten years (see Figure 2).



Figure 2: Key towns and features of Bonaire

Image courtesy of Earth Sciences and Image Analysis Laboratory, NASA Johnson Space Center. (<http://eol.jsc.nasa.gov>) photo number: STS075-706-41.JPG

History and culture

The Caiquetio Indians of the Venezuelan Central Orinoco Region (a branch of the Arawak Indians) first populated the islands off the Venezuelan coast; Los Roques, Las Aves, Bonaire and Curaçao some time around 500 AD. Eventually, the Caiquetio Indians established a society on Bonaire that could make ceramics and manage forms of agriculture. The population of Bonaire during the 'Ceramic Age' probably never exceeded 800 to 1,200 people, living in wooden huts built in the vicinity of their land. The main crops were manioc and maize. Agaves may also have been farmed to make nails, needles and string.

The Spanish were the first Europeans to arrive on Bonaire in 1499. Finding little of commercial value and seeing no future for large-scale agriculture, the Spanish decided not to colonise the island. Instead, they enslaved the Indians and moved them off to work in the plantations on the Island of Hispaniola, effectively leaving the island unpopulated. The island remained an isolated outpost until 1526.

In 1526, cattle were brought to the island by the governor - Juan de Ampues. Some of the Caiquetios returned to act as labourers and eventually the island became a centre for raising live stock such as sheep, goats, pigs, horses and donkeys. The animals were being raised for their skins so they required little tending and roamed freely. The results were large herds of grazing animals that far outnumbered the human population.

The only permanent settlement was the village of Rincon (see Image 1), located inland where it was thought to be safe from pirates.



Image 1: Rincon, the original settlement on Bonaire

(Source: <http://www.atlantisbonaire.com/images/bonaire/rincon.jpg>).

In 1633, the Dutch took possession of Curaçao, Bonaire and Aruba. The largest island, Curaçao, became a centre of the slave trade. Bonaire became a plantation island belonging to the Dutch West Indies Company. The first African slaves to arrive on Bonaire were forced to work, cutting wood for dyes, cultivating maize and harvesting salt. The ownership of Bonaire then changed hands a number of times until 1816, when the island was returned to the Dutch as a result of the Treaty of Paris. A small fort, Fort Oranje, was built to protect the island. By 1837, Bonaire was a thriving centre of

government controlled, slave laboured salt production. Slave huts and the salt pans, which were constructed by hand, still exist and are an important relic.

The abolition of slavery in 1863 signalled an end to the era of exploitation of those first Bonaireans. It was almost a hundred years later that the salt industry was revitalized. Today it is a division of Cargill Incorporated, one of the largest businesses in the world.

Tourists started to visit the island when the island government constructed the first pier in the harbour in 1940[†], just before the airport was built in 1943. After the Second World War, the deserted Nazi internment camps were converted into the Hotel Zeebad, and the wooden shacks were replaced by charming stone bungalows. This became what is now the Divi Flamingo Hotel. A second hotel, the Bonaire Beach Hotel, was opened up in 1962 on the Playa Lechi. Other hotels began to spring up and cater to the early visitors who enjoyed the tranquillity of Bonaire.

Dive tourism did not start up on Bonaire until 1963 with the arrival of 'Capt Don Stewart'. Having grown from small beginnings - in 1980 there were just 4 dive operations catering to some 5,000 divers annually – it has become the mainstay of the island economy. Gross revenues from dive tourism in 1994 (the date of the most recent economic study), with 25,000 visiting divers, were estimated at US\$ 34 million. Currently there are 21 registered dive operators on Bonaire (Anon, 2002b) catering to around 28,000 (BNMP 2006) visiting divers annually. Accompanying Bonaire's diving tourists are an unspecified number of snorkellers, windsurfers and other water-sports enthusiasts so that the island now also has two windsurf centres and one kite school, kayak rental, parasailing, boating, sailing and fishing activities on offer to visiting tourists.

The name Bonaire is thought to have originally come from the Caiquetio word 'Bonay', a name that meant low country. The early Spanish and Dutch modified its spelling to Bojnaj and also Bonaire. The Bonairean culture has its origins in the ethnic roots of the 10,000 plus residents. The culture is based on strong family ties and a general respect for nature. The local people have a valuable understanding of their environment which was at first inhospitable to the settlers and slaves. African traditions of song and dance developed within the slave communities. These songs and dances evolved into festivals and have survived to become an important part of life and culture on Bonaire. Many of the festivals are regional, even on a relatively small island different traditions exist (Anon, 2002a).

†

Town pier (North pier) built 1940 reinforced in 1961 and renovated 1986,
Customs Pier (Middle pier) built 1978,
Cargo pier (South pier) built 1973 renovated in 1986.

Population

Between 10,000 and 13,000 people are considered permanent residents of Bonaire (CBS, 2005). The population density of the permanent residents on Bonaire is 35 people per km², which is considerably lower than the other islands. Figure 3 illustrates how the resident and visitor populations have changed since 1992. The fact that visitors increase the population over the year by 5 or 6 times has a considerable impact on the islands infrastructure, although visitors generally do not stay on island for periods of time more than 2 weeks.

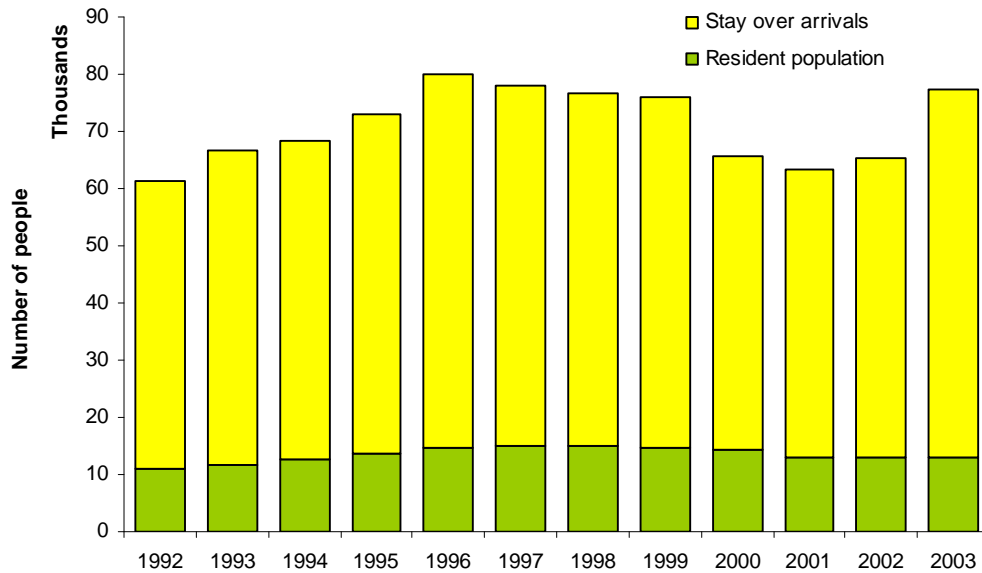


Figure 3: Population statistics for residents and visitors to Bonaire (CBS, 2005)

There has been a significant shift in the structure of the resident population from 1995 to 2004 as illustrated in Figure 4. The most striking difference is the out-migration of 20-35 year olds as well as the over all reduction in population by a factor of around 10%. It is believed this is due to the economically active population leaving Bonaire to find work.

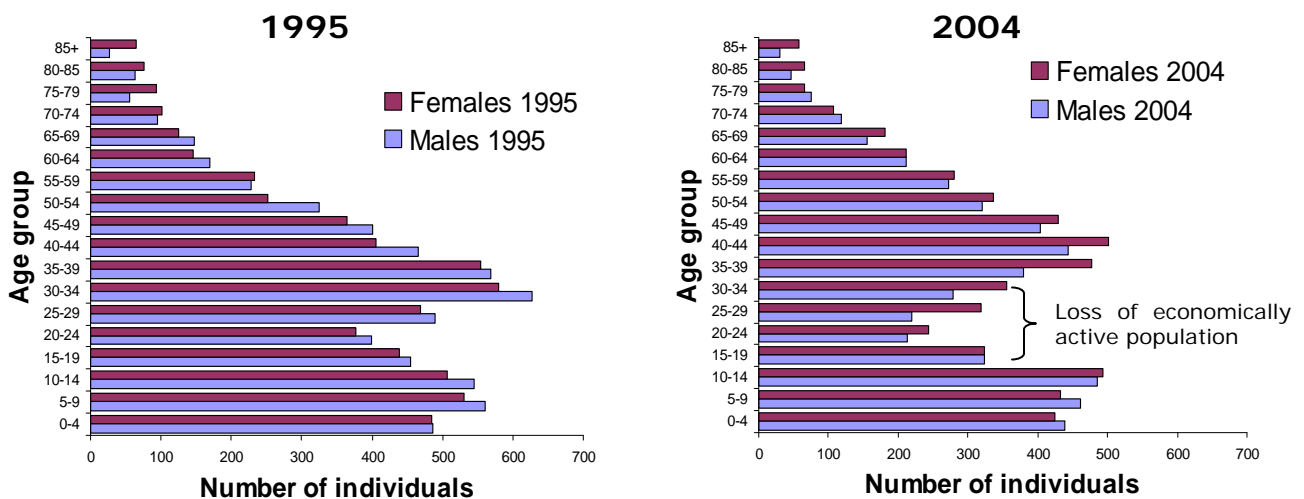


Figure 4: Population pyramids for the permanent population of Bonaire for 1995 and 2004 (numbers taken from (CBS, 2005))

The predominant religion on Bonaire is Christianity and a number of churches exist on the Island. More recently an Islamic mosque has also been built. The official language of Bonaire is Dutch, but most Bonairean’s speak English and Spanish in addition to their local language, Papiamentu.

Politics and Economics

Politics

The Netherlands Antilles as a constitutional unity is described as "country" and is classed as an 'overseas country' by the European Union. Bonaire, along with Aruba, Curacao, Saba, St Eustatius and St. Maarten, forms part of the Kingdom of the Netherlands which has been administered for the past 50 years by a central government located on Curaçao.

Queen Beatrix of the Netherlands is represented in the Central Government of the Netherlands Antilles by a Governor, who is based in Curaçao. She is also represented on Bonaire by a Lieutenant Governor. There are three commissioners for the Executive Council (Bestuurscollege) who lead administrative units that perform the main government functions. There is a separate Island council (Eilandsrat), similar to a parliament. The Island has considerable political autonomy in relation to most issues, including natural resource management (Scura & van't Hof, 1993).

Economics

ECONOMIC DEVELOPMENT

Bonaire's Gross Domestic Product (at market prices) for 2003 was 293.8 million Nafls, an increase of 3.4% on the previous year. The relative contributions to the GDP from different sectors of the economy can be seen in Figure 5. The sector described by DEZA (Economic Department of Bonaire) that includes hotels, restaurants and cafés, saw an increase of production of 13% from 2002 to 2003. One of the other economic pillars is the construction sector which boomed from late 2003 onwards. Houses and hotels continue to be built as well as extensions and renovation projects (further economic analyses to 2003 can be found in Appendix 2).

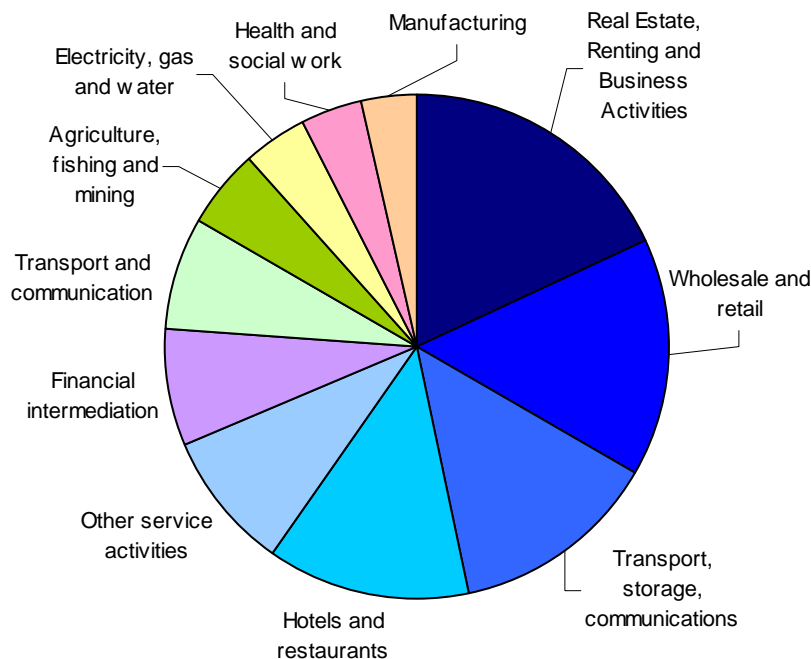


Figure 5: % contribution of different sectors of Bonaire's economy to the GDP in 2003 (CBS, 2005).

Since the early 1990's the Government's plans for economic development have been focussed on reducing the economies deficit, and encouraging economic growth. Schemes have been set up in the past to encourage the diversification of the tourism sector e.g. by attracting wealthy individuals to retire in Bonaire (through personal and development tax incentives) (Scura & van't Hof, 1993).

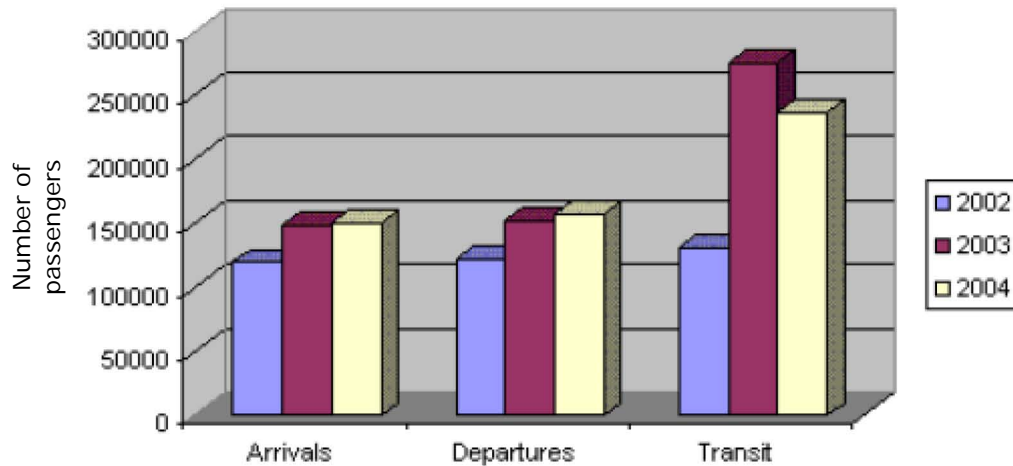


Figure 6: Changes in the nature of passenger transport on Bonaire, 2002-2004 (CBS, 2005)

More recently, focus has changed to bringing more travel related income to the island by changing the nature of flights to and from Bonaire. Bonaire's Flamingo Airport was recently extended to accommodate stop over flights with refuelling facilities for flights between Europe (Schipol), Ecuador and Peru in South America and there has been an associated increase in passenger transport, as shown in Figure 6.

AGRICULTURE AND FISHERIES

The climate and geography of the island do not offer a good environment for most types of commercial agriculture. Out of the islands total area of 28,100 ha only 2,800 ha (10%) is suitable for rain-fed agriculture and another 400 ha is suitable for irrigated agriculture. Similarly, only 195 ha are suitable for grazing (Scura & van't Hof, 1993). Rice production and export used to be an important part of agriculture on Bonaire. Aloe (Image 2) production and export continues to provide some income for farmers. There are a number of fisherfolk on the island who practice artisanal fishing and a small number who fish commercially (Image 3).



Image 2: Aloe plants growing in WSNP.

Image 3: Commercial fishing boats, Sorobon (Photographs by K. De Meyer).

A small number of staff are employed by the only aquaculture venture on Bonaire, 'Seahatch Bonaire', which was purchased from Fundacion Marcultura in 1999 to serve as a back up facility and or quarantine facility for shrimp brood stock. It houses two different species of shrimp that have been domesticated for over 15 years in a closed production cycle. Breeding shrimp are provided from Bonaire for different maturation facilities either in Aruba or in Venezuela. The breeding population is isolated in case of a viral outbreak in Venezuela. The facility also has the capacity to

produce between 60 - 80 million post larvae shrimp in a 21 day cycle. Each production cycle is usually followed by a 10 day dry out or disinfection period. No antibiotics are used at any of 'Seahatches' facilities and in Bonaire all of the effluent water passes to the salt flats belonging to the Cargill Salt Production Company. The effluent load reaching the salt flats is very small and it usually evaporates before it reaches Cargill's canal system, indeed, Cargill believes any slight increase in biological load would help with the process of salt crystallization.

MANUFACTURING

Manufacturing and the extraction of natural resources (other than salt) do not offer workable sources of income Bonaire's population. This is because the physical resources of the island that can be used, sold or extracted are very limited. The communications, infrastructure and working population of Bonaire do not suit the needs of a competitive manufacturing industry.

Cargill Salt Bonaire N.V. solar plant produces 400,000 tons of industrial grade salt per year. The main outlets for this salt are water treatment and the chemical industry for which the salt is being exported. A very small portion of the salt exported is processed to make table salt, another 1% is sold locally to the fishermen and the bakery and a tiny amount is used for cosmetics. Bonaire offers a unique salt quality with big crystals of salt produced nowhere else in the world as the island offers a unique combination of natural factors specific for the salt industry: flat land, deep water, wind and plentiful sunshine, ideal for the natural process of evaporation. Pekelmeer was physically modified in 1969 due to its inclusion in the solar salt works.

SHIPPING

In the mid-1970s the Bonaire Petroleum Corporation (BOPEC) set up an oil transfer depot with a deep-water port with facilities for transferring oil from ocean-going to coastal tankers (Image 4). The terminal continues to be used primarily as a storage and trans-shipment facility for Crude oil and derivatives.



Image 4: Tug boats used to guide BOPEC's shipping (Photograph by K. De Meyer).

Image 5: Cruise Boat visitors disembarking (Photograph by D.R. MacRae)

TOURISM

The wealth of natural resources on Bonaire, such as coral reefs and a number of other marine and terrestrial environments has lead the economy of Bonaire to be dependant on services relating to tourism. There are a variety of tourism associated activities which contribute to two thirds of the islands income, namely real estate, retail, transport, hotels and restaurants. Tourists are stop over tourists – arriving by aeroplane, yacht visitors or cruise ship passengers (Image 5).

Geology and geomorphology

Bonaire lies on a conservative plate boundary, where the South American and Caribbean Tectonic Plates meet and slide past one another. Along with its sister island of Curacao and the oceanic islands off Venezuela's north coast, it has been travelling eastward at a slow but steady rate having originated in the Pacific in the vicinity of the current day Galapagos Islands.

The geology of Bonaire is complex, with the core of the island consisting of strongly folded and faulted rocks of volcanic origin, silica rich sediments and turbidites (debris deposited from an underwater landslide) formed during the Cretaceous era some 120 million years before present (Beets, 1972a; Beets, 1972b)). Overlying this are later fossil reef and reef-generated calcareous (calcium rich) deposits. It is these limestone formations which make up the coastline in the form of coral-rubble beaches (coral shingle and calcareous sand) or iron shore, except in the north where low limestone cliffs are found (see Image 6) (Zonneveld, Buissonje & Herweijer, 1972) Klein Bonaire consists entirely of limestone formations (Buissonje, 1974) which are the remains of emergent reefs. Substantial changes in sea level have left up to four stranded terraces above the present mean sea level on Bonaire, and one below. These terraces can generally be distinguished by "solution notches" (undercutting caused by chemical erosion, physical erosion and in some cases biological erosion (see Image 7) in the elevated seaward facing limestone cliffs.



Image 6: The characteristic limestone cliffs (raised reefs) on the Leeward Shore of Bonaire (left)

Image 7: An active solution notch (Right) (Photographs by K. De Meyer)

Both Bonaire and Klein Bonaire are relatively flat. Little of the southern land area of Bonaire and Klein Bonaire is more than 2 m above sea level, with higher elevations found only in the north and reaching a maximum of 238 m (Brandaris, Washington Park). Roughly two thirds of the island of Bonaire and all of Klein Bonaire are made up of emergent reefs with associated former shorelines and wave eroded benches or solution notches which is a feature unique to these oceanic islands.

The water retention of the soil is poor so most rainfall quickly runs off into permanently or temporarily flooded "saliñas" (hypersaline lakes separated from the sea by a coral rubble barrier), or directly into the sea (Roos, 1971). Any water falling on exposed limestone swiftly percolates through the rock into the ground water and eventually discharges into the sea.

Climate

The climate of Bonaire is arid tropical characterised by low rainfall, high evaporation rates, year round high temperatures with little seasonal variation and almost constant easterly trade winds. Average monthly air temperatures range from 26.6°C (February) to 28.4°C (October), and average rainfall is just 490.5 mm/year (see Figure 7). Rainfall is unequally distributed geographically, with approximately four times as much rain falling in the northern portion of the island as in the south. The rainy season begins at the end of October and lasts until around the beginning of January; a second, shorter rainy season occurs in June/July. Commonly, no rainfall is recorded during the dry months.

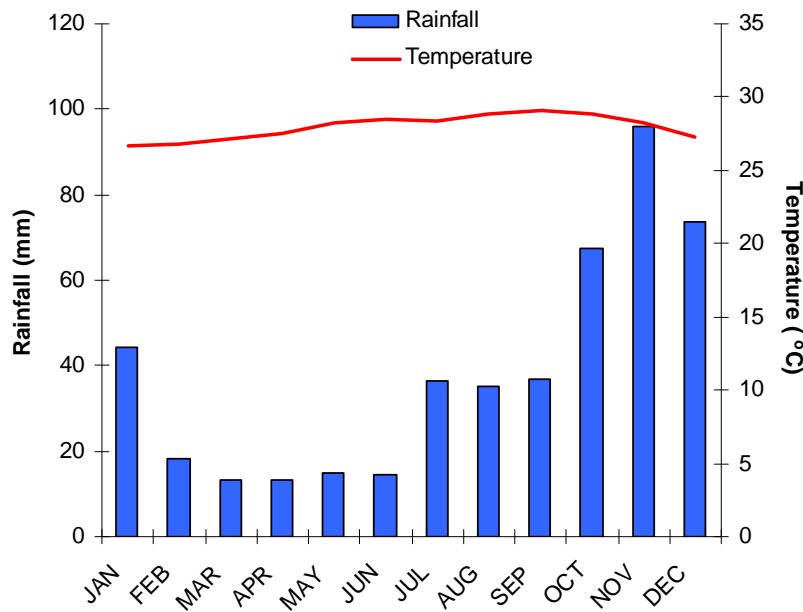


Figure 7: Average temperature/rainfall chart for Flamingo Airport 1971-2000. (Anon, 2000)

Because rainfall is seasonal and the bedrock is largely porous limestone the island has few reliable sources of fresh groundwater and no standing or running fresh water outside of the rainy season. Traditional water management practices such as inland dams have largely fallen into disrepair further reducing fresh water retention. Brackish wind driven wells which tap into subterranean water basins are scattered around the island but none provide fresh water and most are showing signs of nutrient enrichment and or salt water intrusion. Therefore drinking water is supplied through the desalination of seawater by a combined power and desalination plant operated by WEB.

Year round (over 97% of the time), Bonaire experiences constant easterly trade winds (from 70°-110°) with an average velocity of 6.7 metres per second. Wind speeds are generally highest in June and July and lowest in November at the start of the rainy season. The wind rose below (Figure 8) shows monthly average wind speeds and direction from 1977 – 2001. 55% of the wind comes from the East, half of which reaches speeds of 7-8. The rest of the winds come from the North East-East, 30% of which are between 6 and 7 metres per second. The wind is a significant natural resource on the island and many windsurfers and kite surfers travel to Bonaire for the reliable trade winds.

Technically Bonaire lies outside the hurricane belt, the last recorded hurricane strike occurred in 1877 but recent hurricanes that have had an impact on Bonaire include Hurricane Lenny (Nov. 99) which produced 10m waves on the leeward shore and Hurricane Ivan (Sep 2004) (de Leon, 2005) which passed 75 nautical miles north of Bonaire and battered Bonaire's windward shore causing considerable damage.

Tropical storms and hurricanes passing north of Bonaire can also cause the wind to swing around (locally known as a "wind reversal"), which creates high seas and intense wave action along Bonaire's exposed leeward shore for up to a week. Wind reversals have caused extensive, generally

localized damage to the reefs and the coastal zone of the leeward shore. Damaging wind reversals have been recorded in 1976, 1981, 1985, 1990, and 1996 (De Meyer, 1998b).

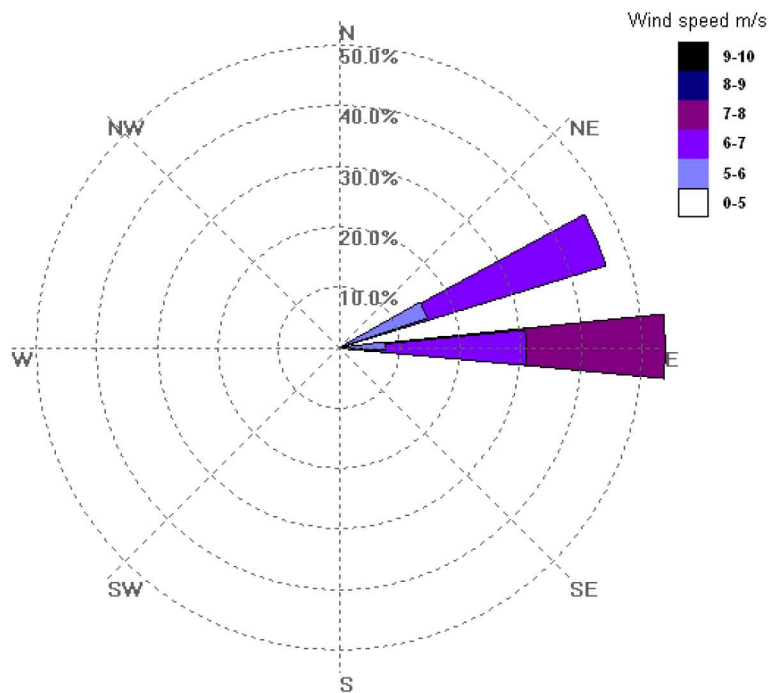


Figure 8: Wind rose showing the average wind speed and direction on Bonaire from 1977-2001. (Anon, 2000)

Due to the strong prevailing trade winds the protected western (leeward, Image 8) and exposed eastern (windward, Image 9) shorelines are strikingly different. The windward shore is a very high wave energy environment characterized by rough water conditions and constant waves breaking against limestone cliffs or onto the iron-shore coast. Wind and water conditions on the leeward shore rarely exceed Beaufort Force 4, with only moderate swells affecting the northern and southern extremes of the island.



Image 8: Bonaire’s South West Coast looking north towards the Salt Pier. (Left)

Image 9: The East Coast of Bonaire. (Right) (Photographs by D.R. MacRae)

Oceanography

Bonaire is located close to where Atlantic water flushes into the Caribbean Basin through the leeward island chain. Bonaire lies down stream of surface water flow from the direction of St Vincent and the Grenadines and wind driven currents from Las Roques and Las Aves (see Figure 9). When the surface currents strike Bonaire on the windward shore, near Spelonk, they are deflected to the north and south. There are pronounced eddies at the south of the island, around Willemstoren, at the north of the island around Malmok and Boca Bartol and just north of BOPEC. Currents are unpredictable but slight, rarely exceeding 0.5 m s^{-1} . The predominant current movement is toward the north along the leeward shore, but this pattern is complicated by local eddies and upwelling. Water conditions are stable, with a constant 34-36 ppt salinity and mean annual water temperatures ranging from 26°C to 28°C (De Meyer, 1998a). The speed and direction of deep water currents are thought to affect the nutrient content and temperature of surface waters.

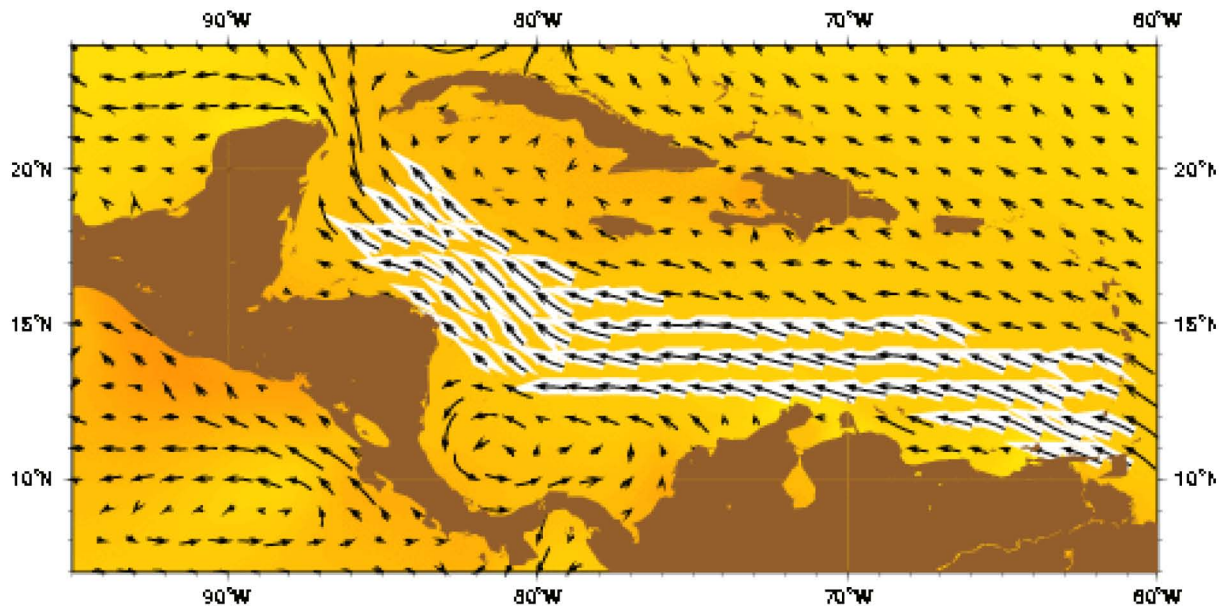


Figure 9 Sea surface currents influencing Bonaire; The Caribbean current that passes Bonaire is represented by the white arrows, flowing from the equatorial Atlantic into the Gulf of Mexico.

Source: <http://oceancurrents.rsmas.miami.edu/caribbean/caribbean.html>



Image 10: The high tide line marked by detritus (Photograph D.R. MacRae)

Tides are diurnal and the maximum annual tidal range is approximately 1 m, with an average range of 0.30 m during a lunar cycle (Bak, 1977). High tides deposit detritus on the windward shore (Image 10), which marks the spring tide line. Lac is anomalous as it has a pronounced semidiurnal tidal pattern with two high and two low waters daily. Spring tides cause extended periods (three to

four weeks) of very low water to the mangrove areas at the back of causing extensive areas of mangroves at Awa di Lodo and feeder channels around Boci Coco to dry up, bringing salinities in the remaining areas of standing water to over 100 ppt.

One of the most striking features of Bonaire is its bathymetry. By virtue of its location on the edge of a plate boundary, Bonaire is separated from the South American mainland by a deep water trench. There is a very rapid drop off from the shore line and fringing reefs (Image 11), water depths of 500m can already be found between the main island of Bonaire and satellite island of Klein Bonaire which lies only 750m off shore.



Image 11: Fringing reefs of Bonaire at ‘1000 Steps’ (Photograph by K. De Meyer)

Both islands are the visible tip of a seamount that rises abruptly from a depth of 3000 metres (see Figure 10 and Appendix 3). This means that oceanic species such as migrating whales and dolphin as well as pelagic fish (Wahoo, Tuna, Dorado) are found very close inshore.

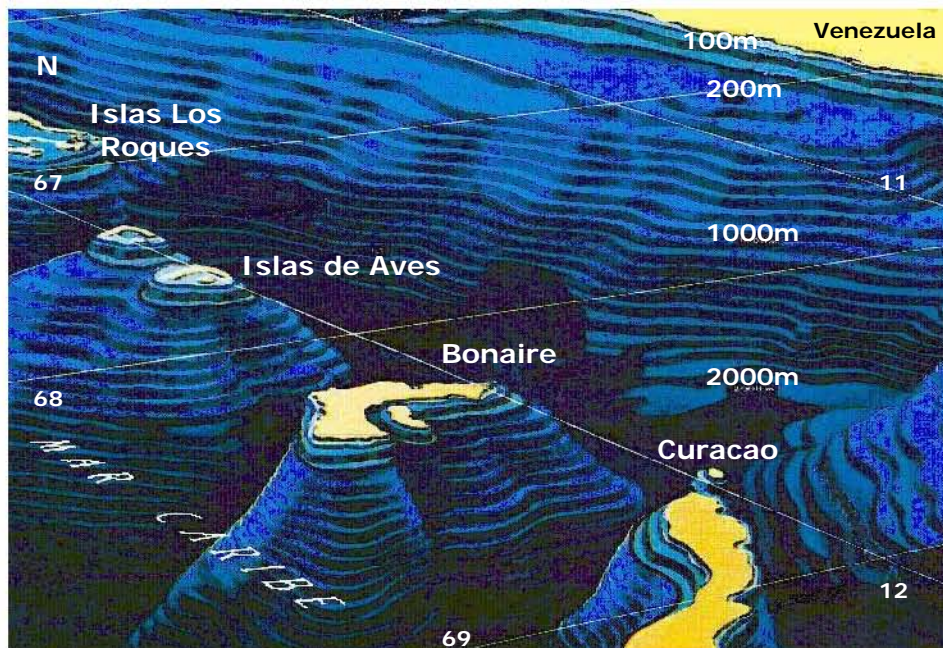


Figure 10: 3 Dimensional Representation of Bonaire's surrounding Bathymetry (depth).
(taken from the Venezuelan World Heritage Site presentation)

Terrestrial Habitats, flora and fauna

A wide range of habitats are represented on Bonaire and Klein Bonaire and within the surrounding waters. These range from the xerotropic (drought resistant) forest covering the northern part of the Island, through sand dunes, salt pans, mangroves, seagrass beds to a number of different coral reef communities. The following descriptions focus on the marine and terrestrial habitats and species which are associated directly or indirectly with the Bonaire National Marine Park (species lists can be found in Appendix 4).

The northern part of the island is hilly consisting of fine grained volcanic rock and limestone. The southern part is flat and consists of fossil coral reef deposits enclosing some lagoonal areas which are either open (Lac) or enclosed (Pekelmeer).



Image 12: Drought resistant vegetation near Lac on the East Coast (Photograph by D.R. MacRae)



Image 13: Vegetation in WSNP in the North of Bonaire (Photograph by K. De Meyer)

The vegetation on Bonaire is xerotropic (drought resistant - see Images 12 and 13), adapted to the semi arid climate. Native plants characteristically show leaf thickening, leaf angle changes through the day to avoid direct sunlight (negative phototropism), thorniness and/or presence of water storage tissues. The flora consists of some 340 species. Inland characteristic plants include Cacti (*Cactaceae*), Acacia (Obada/ *Acacia*), Mesquite (Kuida, *Prosopis*), Caper plants (Stoki/ Oliba, *Capparis*), Brasia (*Haematoxylon*), Lantana (*Lantana*) and Croton (Weli Sali/ *Codiaeum*). On the coastal flats Saltworts (*Batis*) and Sea-purslane (Banana di Rif/ *Sesuvium*) can be found and in lagoonal areas. Red Mangrove (Mangel Tan/ *Rhizophora*), White Mangrove (*Laguncularia racemosa*), Black Mangrove (Mangel blancu/ *Avicennia germinans*) and Buttonwood (*Conocarpus erectus*) are abundant around Lac and some of the salinas. Within Lac itself Turtle grass (Yerba di kania/ *Thalassia*) and Manatee Grass (*Syringodium filiforme*) are abundant (a detailed vegetation map can be seen in Appendix 4 along with terrestrial species paper and lists for Klein Bonaire).

The most abundant groups of terrestrial fauna are lizards, including the charismatic Green Iguana (*Iguana iguana*). 7 species live on the islands of which two are endemic – the Bonairian Anole (Kaku/ *Anolis Bonairensis*) and the Whiptail lizard (Lagadishi/ *Cnemidophorus murinus ruthveni*). Land snails (Kokol/ Kalakuna) are also abundant in places especially those belonging to the genera *Cerion* and *Tudora*. 8 bat species can be found on Bonaire, and the rest of the mammals (mostly goats and donkeys) and the only amphibian species (frogs) have been introduced by man. Some species of tree frog continue to find their way over to Bonaire on boats from Venezuela. The most abundant insects are *Drosophila* and *Tenebrinoid* beetles followed by a variety of ants and some other *Diptera sp.* Other terrestrial arthropods are scorpions and spiders none of which are considered dangerous to humans.



Image 14: The Lora; endangered by collection for the pet trade (source: K. De Meyer)



Image 15: The Green Iguana (source: K. De Meyer)

There are more than 170 species of birds recorded from Bonaire. Most common is the Bananaquit (Chibichibi/ *Coereba flaveola*) followed by the Southern Mockingbird (Chuchubi/ *Mimus gilvus*) and the Yellow Warbler (Para di misa/ *Dendroica petechia*). There is a local subspecies of Amazon Parrot (Lora/ *Amazona barbadensis rothschildi* – Image 14) and Bonaire is the only known breeding area for the southern population of the Caribbean Flamingo (Chogogo/ *Phoenicopterus ruber*) hence Bonaire is often referred to as the "flamingo island". The salt flats on Bonaire are used as breeding grounds by Cayenne Terns (*Sterna sandvicensis eurygnatha*).

Marine Habitats, Flora and Fauna

The marine habitats represented within the Marine Park can be categorized as follows:

- **Open water:** supporting planktonic and pelagic sea creatures including fish and migratory species such as dolphin and turtles
- **Sea bed (benthos):** supporting coral reefs, sea grass beds and including surface dwelling animals and plants and infauna (burrowing creatures like molluscs and crustacean), invertebrates, reef and bottom living fish (Images 16,17)
- **Intertidal:** formed at the interchange between land and sea including mangroves, rocky shores, sandy beach and dune areas (Image 18)

There is, of course, regular exchange between each of these habitats for feeding and reproduction and continuous movement of water and animals between the deep waters surrounding Bonaire, the coral reefs, seagrass and mangrove areas. Because most of Bonaire only has fringing reefs, the corals and other organisms on those reefs are exposed to any terrestrial influences directly. This includes freshwater runoff, sediments, nutrients and any form of pollution, which all stress and eventually kill marine organisms

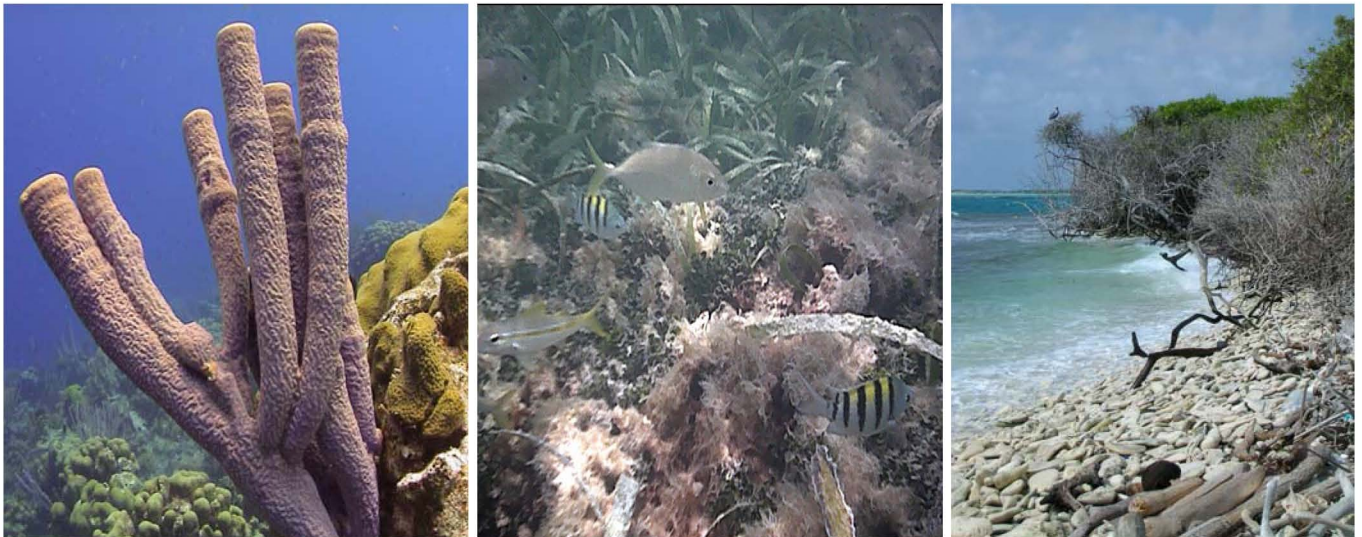


Image 16: Stove-Pipe sponge (*Aplysina archeri*) on one of Bonaire's reefs (By D. Yuchnovicz)

Image 17: Seagrass community in Lac (Renken, 2003)

Image 18: Intertidal coral beach near Cai (photograph by K. De Meyer)

There are few places on Bonaire where the typical sequence of tropical coastal environments can be found i.e a gradual change in habitat from mangrove forest, through seagrass beds to coral reefs and then open ocean. This 'typical' formation can be found at Lac and Lagoon and is represented in Figure 11. However, most of Bonaire's coastline is surrounded by fringing coral reef that slopes into deeper water. These different habitats have species zonation within them and they also play a wider role in the well-being of the coast. The forested areas of Lac have 4 distinct 'zones' where the plants are different. These change as conditions become more saline towards the sea:

**Land and fresh water influence
MANGROVES**

- Trap fine land sediments
- Consume and accumulate organic matter and nutrients
- Buffer changes in salinity
- Stabilise sediments
- Reduce wave action
- Export particles of organic matter

**Lagoonal system
SEAGRASS BEDS**

- Stabilise and bind sediments
- Accumulate, consume and export organic matter and nutrients
- Poor at withstanding wave action

**Open sea interface
FRINGING CORAL REEFS**

- Accrete Calcium Carbonate,
- Accumulate organic matter and sediment
- Recycle nutrients and organic matter
- Consume suspended organic matter
- Produce sediment e.g. parrotfish droppings
- Slow or divert water currents
- Protect from storm damage by reducing wave energy

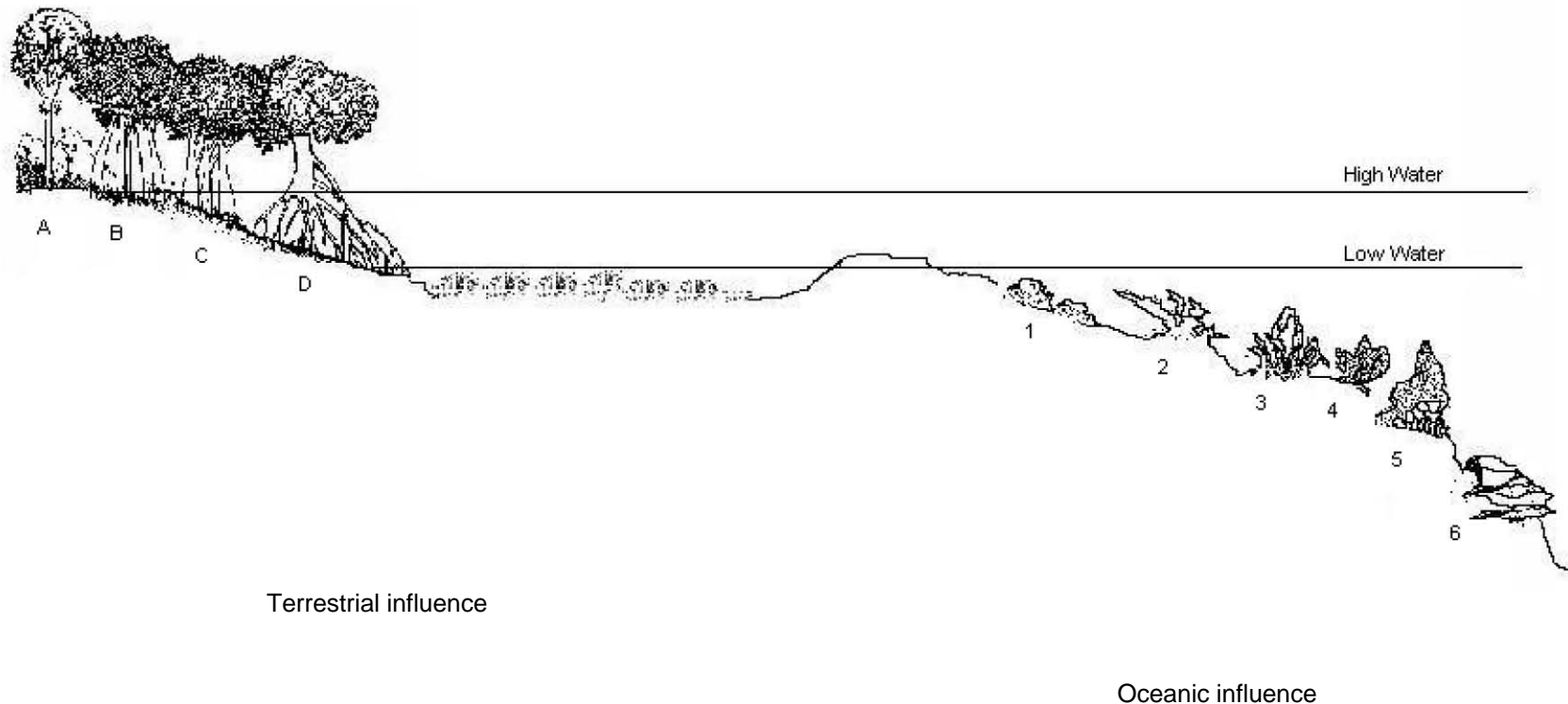


Figure 11: Schematic diagram of a typical tropical coastal seascape.

The majority of the coast of Bonaire does not have seagrass or mangrove – only fringing reefs. The large arrows at the bottom symbolise gradients created by the buffering of the influences of the land and the ocean on the seascape. The letters relate to mangrove zonation in the text, the numbers show model coral reef zonation (van't Hof, 1982)

Open Water

INTRODUCTION

The open water area within the marine park is confined to the waters from the shoreline out to the 60m (200') depth contour, which is no more than 200m from the shore line. The water is warm with constant salinity and is low in naturally occurring nutrients. The marine flora and fauna in the open waters around Bonaire are not very well known.

The water is full of phytoplankton (microscopic plants) which form the basis of the complex food web which supports not only the island's prolific coral reefs and associated animals but also zooplankton (microscopic animals) which are often the juvenile stages of species found in other habitats. There are no known studies of the plankton communities around Bonaire.

The open water supports pelagic fish populations, most of which are highly migratory such as Tuna (*Thunnus sp.*), Dolphin (Dorado / *Coryphaena hippurus*- Image 19) and Wahoo (*Acanthocybium solandri*) as well as Marlin (*Makaira SP.*) and swordfish (*Xiphias gladius*). In general these fish are found passing within the territorial waters of Bonaire but on occasion they can be found within the marine park itself.



Image 19: Dorado / *Coryphaena hippurus* (source: http://www.xcalak.info/images/florafauna/dorado_1.jpg)

Whale sharks, which are the largest fish in the world reaching lengths of over 12m, are occasional visitors. They are filter feeders and feast on plankton, small fish and squid. Their appearance on Bonaire is frequently associated with high densities of blue larval blue swimming crab which are blown into inshore waters. Whale sharks are listed by IUCN as vulnerable species. Sharks are infrequently seen at various points around the island indicating that they are present but cryptic. Most reports are of Reef Sharks (*Carcharhinus perezii*) and Blacktip Sharks (*Carcharhinus limbatus*) and come from South West Corner on Klein Bonaire and Lac. There are also periodic sightings of rays including manta rays, stingrays and spotted eagle rays. Most sightings come from the windward shore.

All four Caribbean species of turtle are frequently found in Bonaire's water: loggerheads, hawksbills, green turtles and leatherbacks, including rare sightings of Olive Ridley. A number of Cetaceans and are regular visitors both to the reefs and the waters around Bonaire, including; Baleen Whale Species (*Balaenoptera sp.*), Pilot Whales (*Globicephala macrorhynchus*), Dwarf Sperm Whales (*Kogia simus*), Humpback Whales (*Megaptera novaeangliae*), Gervais's Beaked Whales (*Mesoplodon europaeus*), Killer Whales (*Orcinus orca*), Melon-Headed Whales (*Peponocephala electra*), Sperm Whales (*Physeter macrocephalus*), Pantropical Spotted Dolphins (*Stenella attenuate*), Striped Dolphin (*Stenella coeruleoalba*), Spinner Dolphins (*Stenella longirostris*), Bottlenose Dolphins (*Tursiops truncates*), Cuvier's Beaked Whales (*Ziphius cavirostris*). Further details of the distribution of these species are given in Appendix 5 (Debrot, De Meyer & Dezentje, 1998).

There are a number of birds that live almost exclusively in the open ocean environment, using Bonaire as a breeding ground or migratory stop over. These include Gulls such as Laughing Gulls (*Larus atricilla*) and Ring Billed Gulls (*Larus delawarensis*), terns, cormorants and boobies.

There is currently no knowledge of the deep water dwelling organisms of Bonaire. Although a recent expedition to the deep water environments within one kilometre of the shoreline of Bonaire and Klein Bonaire, discovered many species of demersal fish and benthic (bottom dwelling) invertebrate, some of which may be new to science. A recent research voyage which used a deep water submersible to explore the waters between Bonaire and Klein Bonaire discovered, amongst other things, the presence of the rare Six Gilled Shark (*Hexanchus griseus*).

LOCATION

Although not strictly part of the marine park, the waters around Bonaire from the shore line to the 12 mile zone do constitute the territorial waters of the island of Bonaire. There is currently no organisation charged with the management of the territorial waters and new legislation is being drafted to regulate fishing activity within this zone. For this reason a description and some information on the deep water environments around Bonaire have been included.

Pelagic zone

With the exception of the seabed, everything in blue water beyond the 60m depth contour which marks the seaward extent of the Bonaire National Marine Park can be considered the pelagic zone. The pelagic environment is commonly thought of as being made up of number of different ecological zones; most importantly, the epipelagic, mesopelagic and the bathypelagic.

- Epipelagic: The epipelagic zone stretches from the surface down to 200 meters. This is where most plants and animals (flora and fauna) live due to the abundance of light and nutrients. Pelagic fish species found in this part of the sea around Bonaire include small bait fish such as Herring (*Clupea harengus*) – a major food source for marine mammals, and larger, predatory fish such as the tuna, Wahoo (*Acanthocybium solandri*), Dolphin (Dorado - *Coryphanaena hippurus*) and Rainbow Runner (*Elagatis bipinnulata*) all of which are commercially important species.
- Mesopelagic: The water from 200-1,000 meters is classified as the mesopelagic zone, a twilight zone where some light filters through but does not reach a level of brightness necessary for photosynthesis to occur. The channel between Bonaire and Klein Bonaire reaches depths beyond 200m and so it supports a mesopelagic zone and the associated animals.
- Bathypelagic: The bathypelagic zone extends from 1,000-4,000 meters depth and is completely dark. The waters around Bonaire plunge to depths exceeding 2000m, especially in the deep oceanic trench that separates Bonaire from Venezuela. Deep water animals rely on nutrients that rain down from productive surface waters. These nutrients arrive at the sea floor in a variety of forms dominated by decaying phytoplankton and zooplankton.

Sea bottom

Soft-bottom habitats dominate much of the sea floor beyond the epipelagic (light) zone. The sediments are usually comprised of a mixture of biologically fixed silica and calcium carbonate, as well as clays, silts, and sand sediments. Large varieties of mobile and stationary animals live on and within these sediments. Around Bonaire, these are likely to include mobile echinoderms such as brittlestars and sea cucumbers, crustaceans such as crabs, amphipods, and shrimps, molluscs such as snails and octopods, and a variety of worms such as polychaetes and nematodes. There are also many sessile (fixed) polychaetes, clams, sponges, and other invertebrates. These mobile and sessile animals typically range in size from megafauna (>1 cm), to the smallest microbes. Microbes such as bacteria play an important role in breaking down organic material.

Sea mounts

Whilst, strictly speaking both Bonaire and Klein Bonaire are the tops of submerged sea mounts there is evidence that there are other true seamounts exist within Bonaire's territorial waters. Sea mounts act as magnets for fish life and fishermen are routinely drawn to them. Seamounts to the east of Bonaire, seaward of the salt pans, are said to be frequented by sharks.

CONDITION

There is little known about the deep water environments around Bonaire which are beyond the reach of SCUBA divers. However pelagic and deeper water habitats need to be considered in protected area management as they influence the ecology of other marine environments and are sure to be home to many as yet undiscovered life forms. The little available evidence indicates that water quality is generally good within open water environments. There have not been reports of 'die offs' of marine animals or birds which could be attributed to poor water quality or pollution and Bonaire does not suffer from ciguatera.

Considerable quantities of water bourn trash are deposited on Bonaire's windward shore annually. Whilst some is undoubtedly dumped overboard by passing ships, much of this material appears to originate in Venezuela, where sea dumping still occurs. Occasional oil slicks also wash up on the windward shore, usually as a result of the dumping of dirty bilge water at sea by passing tankers. Little can be done to address these issues.

Overfishing of Bonaire's territorial waters does seem to be a potential problem. Local fishermen report that their catch diminishes significantly after long liners and trawlers have been seen around the island. These fishing activities within Bonaire's territorial waters are illegal and usually involved Venezuelan fishing vessels. In this context it is also important to note that in addition to pelagic fish, globally endangered sea turtles, sea birds and dolphin are threatened by these illegal fishing activities. Central Government has issued six permits to long lining vessels, which would be able to legally fish around Bonaire, but so far have not done so.

VALUE

Bonaire is a true oceanic island and its location adjacent to the South American mainland and at the inflow to the Caribbean Basin make the open water environment around Bonaire unique. Research voyages in the Florida Keys which have explored deep water environments have recorded considerable numbers of new invertebrate and fish species. There is every reason to believe that the same would be true of the deep water benthic environment around Bonaire and Klein Bonaire.

Healthy and abundant migratory pelagic fish stocks of Tuna, Dolphin and Wahoo are critical to support Bonaire's small scale local fishing industry. Globally endangered cetaceans and sea turtles regularly migrate through Bonaire's waters.

Sea Bed

The two most important ecosystems found on the seabed within the marine park are sea grass beds and coral reefs. Both are highly productive, fragile and valuable marine resources

SEAGRASS BEDS

Introduction

Seagrasses are flowering plants that live underwater. Like land plants, seagrasses produce oxygen. The depth at which seagrasses are found is limited by water clarity which determines the amount of light reaching the plant. Seagrass beds form in shallow coastal lagoon areas. Lac bay has extensive sea grass beds. The main species of seagrass found around Bonaire are Turtle grass (*Thalassia testudinum*) and Manatee grass (*Syringodium filiforme*).

Seagrass ecosystems are considered to be amongst the most productive in the world; an average growth rate of seagrass leaves is about 5mm per day, with entire stands of seagrass being turned over every 16 weeks with 3-4 crops annually (Edwards, 2000). In addition to this, the leaves of seagrasses provide a huge surface area for settlement of epiphytes (plants that live on the surface of another organism such as calcareous green algae, crustose coralline red algae, cyanobacteria, diatoms and epifauna (animals that live on the surface of another organism such as sponges, hydroids, bryozoans, foraminiferans). For a square metre of seabed, a dense seagrass stand may have 20m² of leaf area for other organisms to settle on. The productivity of the epiphytes can be twice that of the seagrasses themselves.

The seagrass stands in Lac are dominated by Turtle grass (*Thalassia testudinum*) together with Manatee grass (*Syringodium filiforme*) and banks of calcareous alga (*Halimeda* sp). Through a succession of growth (see Figure 12), seagrasses can turn vast areas of unconsolidated sediments into highly productive plant dominated, structured habitat with a diversity of microhabitats, such as that found within Lac on Bonaire.

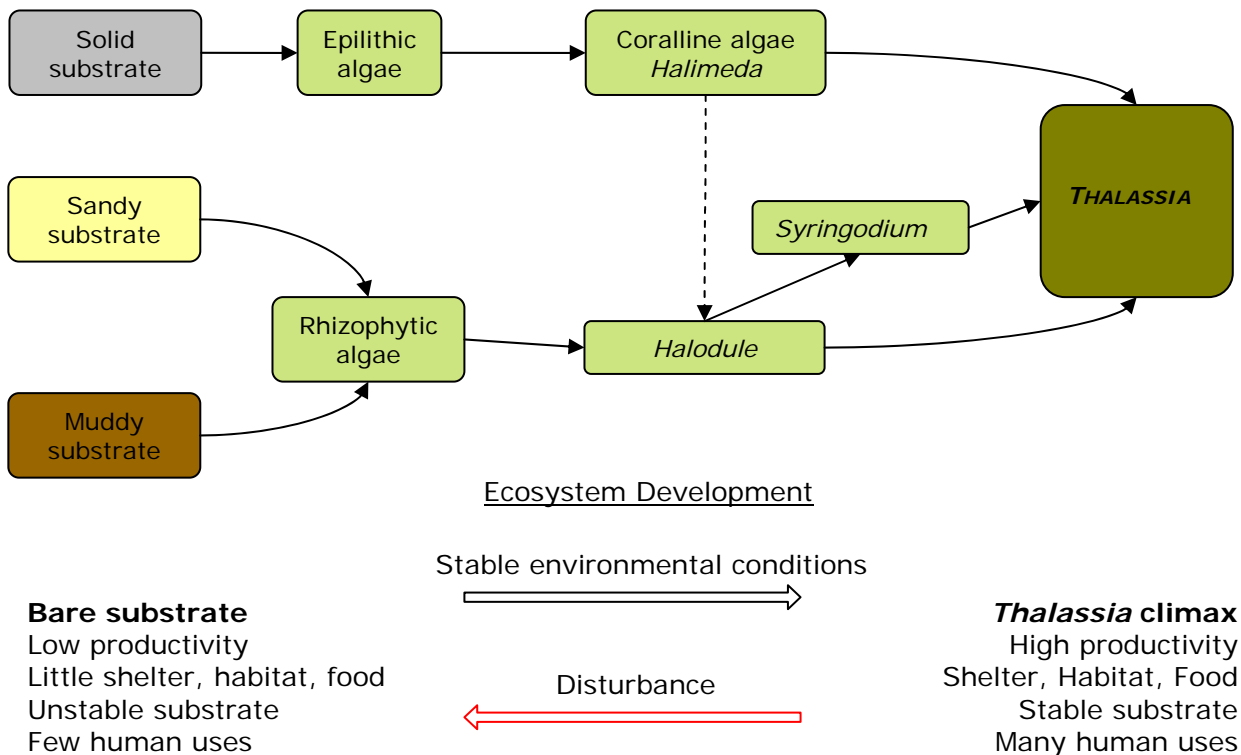


Figure 12: Seagrass succession diagram (Edwards, 2000)

Location

There are two main areas of seagrass on Bonaire both on the windward shore. Sparse sea grass beds and fringing mangroves can be found at Lagoen, adjacent to the island's landfill and the most significant seagrass fields are found at Lac (Image . Lac is the largest inland bay in the Netherlands Antilles, with a flooded area of approximately 7.5 km², and is internationally protected as a RAMSAR site (see Appendix 1). The maximum water depth within the bay is 4.5 m; tidal range is limited to approximately 0.3 m (van Moorsel & Meijer, 1993) and shows distinct double high and double low tides. The bay is protected from the open ocean by exposed fringing coral reefs that protect the bay from wave action. Waves break over the reef, flood the bay, driving a clockwise circulation pattern with water flowing out though a deep water channel at the northernmost tip of the bay adjacent to Cai (see Figure 18), creating a rip current.

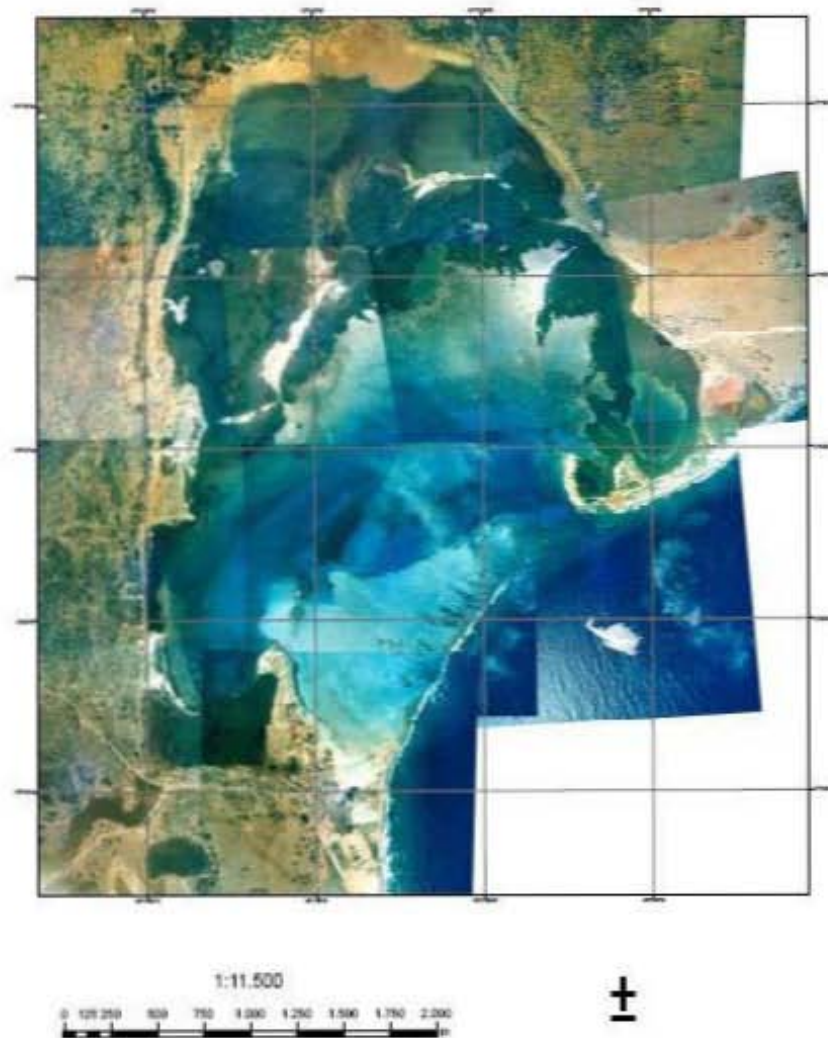


Image 20: Aerial Photograph of Lac 1996

Appendix 6 contains full resolution maps of Lac from 1961 and 1996

(Source: Erstellt 2006 - Wibke Erdmann - Universität Duisburg-Essen - Campus Essen - Institut für Geographie)

Condition

In the shallow waters around Lac, some of the seagrass has been damaged and is being continually eroded by trampling. When swimmers, snorkellers, windsurfers and other users stray into seagrass areas, any contact with the seagrass disturbs the habitat. In severe cases, the seagrass is removed or damaged beyond regrowth. This leads to blowouts in the seagrass beds, where mobile sediment makes it difficult for seagrass to re-colonise. Any further coastal developments around Lac will put pressure on the seagrass.

The Conch population in Lac Bay on the brink of collapse. Historically, the Conch of Lac have been fished extensively (Images 21 and 22), resulting in small individuals being removed before they

have had a chance to breed. This has meant those animals removed have not been replaced by juveniles



Image 21 and Image 22 : Conch shell piles at Cai (Photographs by D.R. MacRae)

Value

The seagrass beds of Lac provide a biological filter system for the waters within the bay. This gives the water its striking azure blue colour which is an essential feature to attract Tourists to the area, which in turn supports local businesses. The seagrasses also prevent terrestrial sediments from reaching the reef where they would smother and kill coral reef organisms.

The seagrass beds of Lac and the Saliñas are within the Ramsar sites, and are internationally significant examples of wetland ecosystems. The Seagrass beds also provide a nursery and habitat for numerous commercially and recreationally valued marine animals such as Conch and juvenile fish. Internationally endangered species such as turtles also depend on the well being of the seagrass for their survival.

CORAL REEFS

Introduction

Bonaire supports some of the most well developed coral reefs in the Caribbean, with high coral cover and diverse populations of fish (Roberts & Hawkins, 1994). Both Bonaire and Klein Bonaire are surrounded by continuous, fringing coral reefs exhibiting around 60 different species of corals. Reefs stretch from the shoreline seaward to depths in excess of 70 m, covering an area of some 2,700 ha (see Image 23). An AGRRA study carried out in 1999 Bonaire had an average of 47% hard coral cover, compared to 14% in the Bahamas and 20% in Belize (See Appendix 7).

Reef formation begins at the shoreline with a gradually shelving submarine terrace extending seaward for between 10 and 250 m. Beyond this, at depths of 10-12 m, the terrace drops off and the reef slope commences. The drop-off zone exhibits maximum diversity of benthos and maximum coral cover (Bak, 1977) The reef slope drops down steeply at a 20-50° angle to depths of 25-55 m where it flattens out onto a shelf. A second drop-off occurs beyond this (Duyf, 1985) to depths of >500m. There is some zonation within the coral community with shallow water dominated by a mix of stony and soft corals, mid-depth reefs (15-25 metres) being dominated by *Montastrea sp.* and deeper waters being dominated by *Agaricia sp.*

In addition to supporting a wealth of marine organisms, the coral reefs of Bonaire also support the Islands economy which is dependant on tourism. The reefs are the basis of the fishing activity that takes place on the island and the structure of the reef protects coastal developments from waves and storm surges.



Image 23: Aerial view of The Town Pier and Kralendijk, showing the form of the fringing reef. (Anon, 2005)

Location

Both Bonaire and Klein Bonaire are surrounded by continuous, fringing coral reefs from the shoreline seaward to depths in excess of 70 m. Reef features of particular interest include:

- Vertical reef slopes can be found at a few known sites on the East coast and on Klein. Carls Hill Annex on Klein Bonaire has a vertical wall stretching from 10m to 20m depth, recent explorations using mixes of gas for diving have discovered more walls at greater depths. Cliff, Small Wall, Rappel and La Danias dive sites also have walls of interest to underwater explorers.
- A double reef stretches from Punt Vierkant in the South of the Island to Salt city dive site. At these sites, a 'second' reef can be found after a sand channel at the bottom of the initial reef slope. The Hilma Hooker wreck is located in the channel between the two reefs.

- A conspicuous geological feature of parts of the reef slope, especially around Karpata on the north western shore, are coral spurs and sediment channels which form as a result of the inherent instability of corals at the top of the reef slope causing the reef to collapse locally. Spur-and-groove coral formations occur in shallow water in high wave energy environments. Spur and groove can only be found at only two sites on Bonaire on the north-western shore (Boca Bartol and Playa Benge).
- Bonaire’s reefs were mapped in 1983, and detailed maps were produced of the shallow coral communities to a depth of 10-12 m along the leeward shore and Klein Bonaire (Duyl, 1985). Along the windward shore, coral development is virtually absent in water shallower than 12 m, where there is an abundance of crustose coralline algae and dense stands of *Sargassum platycarpum* that may extend to 40 m water depth.

Condition

Van't Hof (1982) recognized six distinct coral zones from the shoreline to 50 m. These are: a shore zone (0-1 m), characterized by Knobby Brain Coral (*Diploria clivosa*); an Elkhorn zone (1-4 m), dominated by Elkhorn Coral (*Acropora palmate*), Fire Coral (*Millepora*) sp., and crustose coralline algae; a Staghorn zone (4-7 m), characterized by Staghorn Coral (*Acropora cervicornis*) interspersed with Yellow Pencil Coral (*Madracis mirabilis*), Boulder Brain Coral (*Colpophyllia natans*), and Boulder Star Coral (*Montastraea annularis*) and bounded by Gorgonians; a dropoff zone (7-12 m), characterized by Gorgonians, Boulder Star Coral (*Montastrea annularis*), Yellow Pencil Coral (*Madracis mirabilis*), and Smooth Flower Coral (*Eusmilia fastigiata*); an upper reef slope (12-25 m), characterized by massive Boulder Star Coral (*Montastrea annularis*) and Lettuce Coral (*Agaricia* sp.); and finally a lower reef slope (25 m+), dominated by Lettuce Coral (*Agaricia* sp.) and some flattened forms of Boulder Star Coral (*Montastraea annularis*), Great Star Coral (*Montastraea cavernosa*), and Blushing Star Coral (*Stephanocoenia michelinii*) but with few other abundant corals. These are summarise in Table 5 .These descriptions are historical and the current status of Bonaire’s reefs is very different.

1	Shore zone	0-1m, characterised by Encrusting Knobby Brain coral adapted to the strong water movement of the surf
2	Elkhorn zone	1-4m, dominated by Elkhorn Coral, Fire Coral and Coralline Algae. In a number of places the Elkhorn coral occurs infrequently
3	Staghorn zone	4-7m, dominated by Staghorn Coral, with Fire Coral, Yellow Pencil Coral and gorgonians on the seaward edge
4	Drop-off zone	7-12m, gorgonians just above the drop off and mountainous star coral at the drop-off. Large patches of Pencil Coral in this zone.
5	Upper reef slope	12-25m, Mainly Large, towering Mountainous Star Coral colonies with Leaf Coral, Giant Brain Coral and Smooth Starlet Coral covering significant areas
6	Lower reef slope	>25m Sheet and scroll corals, some mountainous star coral in flattened growth form. 2 species of black coral are also found on the lower reef slope.

Table 2: Historical zonation of Bonaire's Reefs

The reefs as they were described in 1982 no longer exist. The impact of Hurricane Lenny in November 1999 along with nutrients, sediments and other pollution from the land as well as disease and bleaching, have reduced the reef flat and upper reef slopes in places to algae dominated coral rubble, with a few recovering small colonies of hardy coral (see Image 24 compared to Image 25). Extensive stands of Staghorn and Elkhorn Coral are rare. The reef slopes from 12m to 25m continue to show an abundance and diversity of stony coral and other sessile (fixed) organisms in most places. The deeper, lower reef slopes continue to be dominated by Encrusting Fan-Leaf Alga (*Lobophora variegata*), with some Lettuce, Plate and Star Corals in between.



Image 24: Algae dominated upper reef slope at Cliff dive site

(Photograph by D.R. MacRae)



Image 25: 'Healthy' Reef at 1000 steps dive site in 2006.

(Photograph by D. Yuchnovicz)

Bonaire's reefs support some of the most abundant and best studied parrotfish populations in the Caribbean. It is the abundance of parrotfish which is believed to have saved Bonaire's reefs from algal overgrowth after the diadema die off in the early 1980s. Bonaire has had the highest fish

counts in the Caribbean (other than the Florida Keys). A total of 362 fish species have been reported in Bonaire National Marine Park, where volunteers have reported 270 species on Bari Reef alone, the highest species richness of all sites in the 'REEF'[†] database, locally and Caribbean-wide (note that Bari Reef is the most surveyed site in the database). The composition of the fish assemblage on Bonaire reefs is similar to that found throughout the southern Caribbean. The five most frequent species sighted were Blue Tang (*Acanthurus coeruleus*), Bicolor Damsel (*Stegastes partitus*), Stoplight Parrotfish (*Sparisoma viride*), Brown Chromis (*Chromis multilineata*), and Bluehead Wrasse (*Thalassoma bifasciatum*) (Pattengill-Semmens, 1998).

Along with countless species of invertebrate, many different species of algae also inhabit the waters around Bonaire from the aptly named Sea pearl (*Ventricaria ventricosa*) and Mermaids Tea Cup (*Udotea Cyathiformis*) to the reef building crustose coralline algae's.

Bonaire's coral reefs face a number of pressures, some natural and some man-made, though global warming is clearly the most significant. In addition to storm damage, significant natural impacts on Bonaire's reefs during the 1970s and 1980s include an outbreak of white band disease (1980-1982), which caused the death of 90% of the standing stock of Staghorn Coral (*Acropora cervicornis*) and Elkhorn Coral (*Acropora palmata*). This was followed by the mass mortality of *Diadema antillarum* (Black spiny urchin) one of the most important grazers on Caribbean reefs. Both events were thought to have been caused by a water-borne pathogen and both impacted on the entire Caribbean Basin. Bonaire's reefs have also suffered from a number of ongoing disease outbreaks including yellow band disease (affecting primarily the Boulder star coral (*Montastrea* sp)), rapid wasting disease and black band disease.

There have been repeated Caribbean wide coral bleaching events since 1989 some of which have caused wide spread mortality of corals. Particularly severe episodes were recorded in 1990, 1992, 1993, 1995, with the most significant global mass bleaching event ever recorded in 1998. In 2005 a particularly intense coral bleaching event which effected most parts of the Caribbean, had little impact on Curacao and Bonaire where only minor bleaching was observed.

Roberts (1994) observed that Bonaire's reefs supported substantially greater numbers of fish species per survey count than other sites in the Caribbean such as Saba or Belize. In the same study, Bonaire's reefs were seen to support a very high biomass of groupers and snappers. However more recent personal observations by Roberts indicate a significant drop in predator numbers and biomass. Predator counts from 1975 (Bak, 1975) also indicate Bonaire grouper, snapper and grunt populations may be at the point of collapse.

Value

The coral reefs attract around 28,000 tourists a year, most of whom take part in diving and snorkelling activity. Bonaire's economy depends on this tourism which provides income for business as diverse as coral reef education visits, restaurants and realty. The reefs are also valuable as a habitat for many animals and plants which commercial, artisanal and sport fisheries depend on. The building blocks of the reef, hard corals, give protection to shore side developments by reducing wave energy. Hard corals and calcareous algae along with other organisms with shells produce coral sand which has been used for building and a range of other applications.

The coral reefs of Bonaire provide a habitat for countless creatures other than fish and coral. Countless species of crustaceans, worms, anemones, jellyfish, molluscs, echinoderms (cucumbers and star fish) bryozoans, sponges and tunicates live on the reefs.

[†] The REEF/TNC Fish Survey Project is a volunteer fish monitoring program developed by the Reef Environmental Education Foundation (REEF) with support from The Nature Conservancy (TNC), see <http://www.reef.org/data/surveyproject.htm> for further details.

Intertidal

DUNES AND BEACHES

Introduction

Sand dunes form when sand is carried by the wind from the beach towards the land. Dunes are highly dynamic terrestrial features, and especially when they are not anchored by vegetation, they may undergo rapid changes over short time periods. They can move inland as a result of onshore winds and are eroded by wave action and high water associated with severe storms. The vegetation cover represents the difference between a mobile pile of sand and a stabilized dune (Anon., 1998)

Generally, native dune grasses, trailing vines and small perennials are the most hardy species and are found on the seaward face of the dunes. Shrubs and trees are more abundant in the back-dune zone. Dunes can be found around Sorobon and the beaches on the windward shore, and around Klein Bonaire. Some of the plant species found on the sand dunes of Bonaire can be found in Appendix 4

Beaches are formed by waves, currents and tidal action, with waves generally being the predominant force. Within the surf zone, deep water waves begin to interact with the seabed. This results in changes in the direction and height of the incoming waves, which tend to align themselves in a direction parallel to the shoreline. Depending on the actual direction from which these waves approach, sand or other material may be transported along the shore or in an onshore/offshore direction, or a combination of both.



Image 26: Playa Chikitu looking North

Image 27: Playa Chikitu - view to the South (Photographs by K. De Meyer)

Location

Bonaire's beaches are active and mobile and their features depend on the maritime conditions at any point in time. In 1999 Hurricane Lenny for example shifted the major turtle nesting beach on Klein Bonaire, No Name, approximately 500m eastwards and reduced Pink Beach to coral rubble. The most extensive beaches are found on the windward coast of Bonaire in sheltered areas such as Boca Cocolishi and Playa Chikitu in the Washington Slaagbai National Park, and at Sorobon on the south side of Lac, on the leeward coast such as Pink Beach and Donkey Beach and No Name beach on Klein Bonaire. There are numerous small pockets of sand in coves and inlets along the leeward shore and the length of the north shore including in the Washington Park (Playa Lechi, Chachachi, Nucove, Slagbaai, Funchi etc)

Condition

With the exception of Boca Cocolishi and Playa Chikitu (Images 26 and 27) which are protected within the Washington Park, all of Bonaire's coastal dunes along the length of the windward shore have been extensively mined for sand with the attendant destruction of flora and threat to wildlife

such as nesting turtles (see Image 28). Ironically sand mining may have improved the environment for ground nesting birds such as the endangered Least Tern (*Sterna antillarum*), but has removed all dune vegetation which makes sand re-accumulation a painfully slow process.

The dunes and beaches at Sorobon are in mixed condition. The Government sanctioned sand mining to the south of the Sorobon Beach Resort has resulted in a 500m+ area of dune being entirely removed along with historical middens and Indian artefacts. This area is now more or less permanently under water. The result has been severe beach erosion in front of the adjacent resort exacerbated by partial removal of dune vegetation.

The rest of that shoreline still appears to be in moderately good condition with removal of beach vegetation and localised trampling in front of the windsurf centres causing localised pockets of beach erosion. Pink Beach has not existed as a sandy beach since November 1999 when it was washed away by Hurricane Lenny. The sand now lies in shallow water in front of the beach and can be expected to re-accumulate over time. The remaining beaches appear stable and in relatively good condition although high levels of visitation at No Name and Donkey Beach have resulted in beach pollution particularly from BBQs.

Value

The value of Bonaire's beaches and dunes lies not only in the money which can be made from selling the sand for construction and to create artificial beaches but also in tourism dollars. Tourists demand various physical attributes of the tropical destinations they visit and sandy beaches are definitely one of the features in high demand. Additionally beaches support fragile but important flora which binds the sand, prevents erosion and speeds further sand accumulation. Beaches are important nesting sites for 3 species of turtles; Green turtles (*Chelonia mydas*) Hawksbill turtles (*Eretmochelys imbricata*) and Loggerhead turtles (*Caretta caretta*) with occasional Leatherback nests on the windward shore. No Name beach on the north eastern shore of Klein Bonaire is Bonaire's most important turtle nesting site and is frequently checked for turtle nesting activity by staff and volunteers from the Sea Turtle Conservation Bonaire foundation.



Image 28: Threats to dunes and beaches

(Photograph by Ramon de Leon)

A staff member of Sea Turtle Conservation Bonaire stands by and watches as bulldozers remove sand for building as well as turtle nests and eggs from one of Bonaire's Beaches.

MANGROVES

INTRODUCTION

Mangrove forests world-wide are under severe pressure and disappearing in an alarming rate. It is estimated that about 60% of the total mangrove area in the world have disappeared. This is mainly contributed to large scale land clearance for coastal development. Mangroves are trees growing in inter tidal areas. Around Bonaire, four species of mangroves can be found; Red mangrove (*Rhizophora mangle* – Image 29), Black mangrove (*Avicennia germinans*), White Mangrove (*Laguncularia racemosa*) and Buttonwood (*Conocarpus erectus*). Lac has the most significant stand of mangroves with about 2.5km² of a total of 7.5km² supporting mangrove species.



Image 29: A stand of Red Mangrove (*Rhizophora Mangle*) near Cai, within Lac.

(Photograph by D.R. MacRae)

Mangrove forests grow in a pattern from the native terrestrial plants through to the highly adapted Red Mangroves with their specialised prop roots. Table 2 summarises the characteristics of the different vegetation zones.

A	Terrestrial vegetation	Vegetation that grows on land and is intolerant of salty soil or water, such as cacti and other the other xerotrophic species described above.
B	White mangrove zone	The white mangrove, <i>Laguncularia racemosa</i> , usually occupies the highest elevations farther upland than either the red or black mangroves. Unlike its red or black counterparts, the white mangrove has no visible aerial root systems. The easiest way to identify the white mangrove is by the leaves. They are elliptical, light yellow green and have two distinguishing glands at the base of the leaf blade where the stem starts (See Appendix 8).
C	Black mangrove zone	The black mangrove, <i>Avicennia germinans</i> , usually occupies slightly higher elevations upland from the red mangrove. The black mangrove can be identified by numerous finger-like projections, called pneumatophores, which protrude from the soil around the tree's trunk.
D	Red mangrove zone	The red mangrove, <i>Rhizophora mangle</i> , is probably the most well-known. It typically grows along the water's edge, especially in Lac and around the Saliñas. The red mangrove is easily identified by its tangled, reddish roots called 'prop roots'. The roots are usually exposed at low tide but covered at high tide, such exposed roots can be seen in the Awa di Lodo areas of Lac (see Figure 13)

Table 3: Typical Mangrove zonation in Bonaire

The mangrove forests on Bonaire, and especially those around Lac, provide a habitat for a number of different plants and animals dispersed from the muddy sediments through the trees into the canopy (see Figure 13). These include many invertebrates, reptiles, fish and birds



Figure 13: Representation of the vertical distribution of macrofauna in mangrove forests

Significant invertebrates in the bay include a juvenile population of Queen Conch (*Strombus gigas*), Milk Conch (*Strombus costatus*), Cushion Stars (*Oreaster reticulata*), Sea Cucumber (*Holothuria mexicana*), Sea Urchins (*Tripneustes venricosus*, *Lytechinus variegates*, *Meoma ventricosa*) and the Upside Down Jellyfish (*Cassiopeia frondosa*). The Atlantic Triton (*Charonia variegata*), formerly found in the bay, appears to be no longer present in Lac.

At least 100 different fish species use the mangroves of Bonaire as a habitat (see Appendix 4). The species most likely to be seen include; Striped Parrotfish (*Scarus croicensis*), Bluehead (*Thalassoma bifasciatum*), Gray Snapper (*Lutjanus griseus*), Schoolmaster (*Lutjanus apodus*) Silversides, Herrings and Anchovies (families *Atherinidae*, *Clupeidae*, *Engraulidae*) (Porter, 2006). Other interesting species that also use the mangroves and seagrass areas include Spotted Eagle Rays (*Aetobatus narinari*), various species of Moray Eels and young sharks.

On Bonaire, the water-dominated habitats: coastlines, inland saltwater lakes (saliñas), and mangrove marshes harbour many species of egrets, herons, and other species of marsh and shorebirds. Some of which nest in the mangroves and others that roost in the mangroves during migration.

Wherever water accumulates many species of waders and shorebirds, such as both color morphs, normal and white, of Reddish Egret (*Egretta rufescens*), Tricolored Herons (*Egretta tricolor*), Green Heron (*Butorides virescens*), Great Egrets (*Ardea alba*), Snowy Egrets, (*Egretta thula*) and Great Blue Heron (*Ardea herodias*) can be found. Also many of the smaller shorebirds, both Greater and Lesser Yellowleg species, dowitchers, sandpipers, plovers, including the rare Collared Plover (*Charadrius collaris*) from South America, are here in winter or on migration.

In the mangrove marshes along the eastern coast, one can find many of the previously mentioned water dwelling birds and roosting Magnificent Frigate birds (*Fregata magnificens*), Brown Pelicans (*Pelecanus occidentalis*). Also, this is the most likely site for both species of night herons, Black-crowned (*Nycticorax nycticorax*) and Yellow-crowned Night Heron (*Nyctanassa violacea*) and Little Blue Heron (*Egretta caerulea*) (Ligon, 2002).

LOCATION

There are two areas of seagrass and mangrove on Bonaire both on the windward shore. Sparse sea grass beds and fringing mangroves can be found at Lagun, adjacent to the island's landfill and the most significant seagrass and mangrove stands are found at Lac. A sheltered shallow inland bay, Lac, is located on the south-eastern shore of Bonaire. It is the largest inland bay in the Netherlands

Antilles, with a flooded area of approximately 7.5 km², and is internationally protected as a RAMSAR site (see Appendix 1). The maximum water depth within the bay is 4.5 m; tidal range is limited to approximately 0.3 m (van Moorsel & Meijer, 1993) and shows distinct double high and double low tides. The bay is protected from the open ocean by exposed fringing coral reefs that protect the bay from wave action. Waves break over the reef, flood the bay, driving a clockwise circulation pattern with water flowing out though a deep water channel at the northernmost tip of the bay adjacent to Cai (see Figure 18), creating a rip current

Within the mangroves there are a number of permanently dry, islands- Isla Fogon, Isla Pedro, Isla di Yuwana, Isla di Chico, Isla di Rancho, as well as several important areas of open water and feeder channels. Approximately 50% of the mangrove is made up of Red Mangrove (*Rhizophora mangle*) with its distinctive prop root system and the other 50% is made up of Black Mangrove (*Avicennia germinans*) with occasional White Mangrove (*Laguncularia racemosa*) and Buttonwood (*Conocarpus erectus*) on drier ground. Further, detailed descriptions of the mangrove species can be found in Appendix 8.

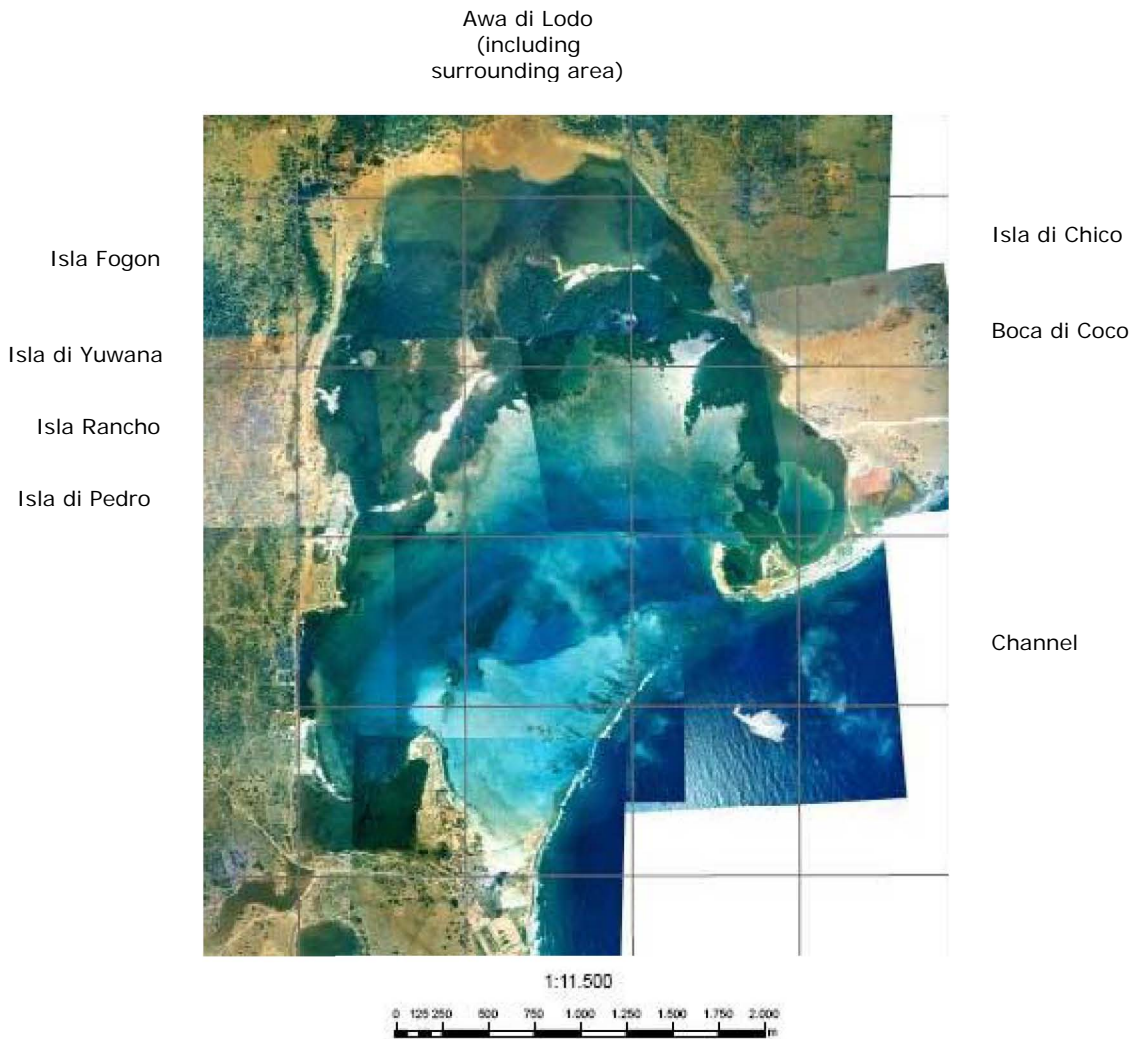


Figure 14: A colour composite aerial Photograph of Lac, including features mentioned in the text

CONDITION

Lac supports Bonaire’s only significant mangrove and seagrass ecosystems. The open water area of the bay is blanketed by seagrass beds. Along the landward edge of the bay is an actively growing fringe of red mangroves which is steadily encroaching on the bay (see Figures 18/19). The mangrove system in Lac is unique within the Caribbean because being entirely seawater driven with no fluvial (river or estuary) input into the system and only limited seasonal inflow of fresh water from rainfall and runoff. There is also an extensive underwater sandy area in the bay (Awa di Mewchi) which is biologically important as it provides a critical habitat for the settlement of larval conch, as well as abundant annelids (worms) and other infauna (animals living in the sediment) which form the basis of the food chain within the bay.

Also atypical is the water circulation pattern within the mangroves. The mangrove area consists of two separate but adjacent basins, each with their own water circulation regime. Water circulation to the back of the mangroves is driven not by water flowing in and out of the feeder channels, as might be expected, but by sheet flow. When the water height in the bay reaches a critical level, fresh seawater flows over and around the sand cays and through the mangroves to the very back of the mangroves. The feeder channels are therefore most important in draining water out of the mangroves.

An important feature of the feeder channels are the 'sills' or shallow bars which are ubiquitous. During low water episodes these sills prevent hypersaline water from draining back out into Lac. They are therefore a critical feature, the most important of the sills can be found at Boca di Coco at the start of the channel which feeds the Awa di Lodo (see Figure 18).

Because of its unusual hydrological regime, the mangroves do not show the classical pattern of succession typical of tropical mangrove systems. Instead the landward and seaward fringes are dominated by Red Mangrove (*Rhizophora mangle* – see Figure 19) and Black Mangrove (*Avicennia germinans*) thrives within the mangroves and around the drier ground associated with the cays. Red mangroves are actively encroaching on the bay, encircling areas of deeper water as they march into the bay. The Red Mangrove stands have an average height of 8 m and an average diameter at breast height (dbh) of 17 cm. Within the Black Mangrove zone, average tree height is 5 m and average dbh is 8.1 cm.

One of the dominant features of the mangrove system is a significant die-back of Red Mangrove at its north western extreme (Awa di Lodo), thought to be due to hypersaline conditions created by the landward damming of freshwater and choking of feeder channels on the seaward side resulting in water temperatures of 40°C and salinities of up to 100 ppt (van Moorsel & Meijer, 1993). This area is being recolonized by Black Mangrove, but the process is slow due to adverse environmental conditions typified by seasonal lack of water exchange lasting up to three weeks when salinity and temperatures soar.



Image 30 and Image 31: Mangrove die-off around Awa di Lodo (Renken, 2003)

VALUE

Lac is a Ramsar site and is therefore internationally recognised as a uniquely valuable wetland. Many of its mangroves are completely inaccessible and therefore pristine. Within the bay water quality is generally excellent, with the mangroves and seagrass acting as biological filters. The Bay is an important sanctuary, breeding and foraging ground for many wetland birds, marine invertebrates and fish. Lac is also home for two globally endangered species: Green Turtles (*Chelonia mydas*) and Queen Conch (*Strombus gigas*).

The Mangroves of Lac act as a filter for water being washed off the land by preventing harmful sediments smothering the coral reef. By establishing themselves successfully, the mangrove trees

become a thriving habitat for many other plants and animals as well as an important nursery for many species of fish. Fish using the mangroves as a nursery include Schoolmasters (*Lutjanus apodus*), Gray Snapper (*Lutjanus griseus*), Great Barracuda (*Sphyraena barracuda*) and the Four-eye butterfly (*Chaetodon capistratus*) (Lott, 2001).

The well being of Lac is essential for a range of human uses. The Bay attracts beach users, snorkellers and kayakers that financially support local tourist orientated businesses. The consistent onshore trade winds make the bay an internationally outstanding location for windsurfing, where beginners and intermediates can practice in safety (Image32). The small fishery based at Cai relies on the maintenance of stocks and the well being of the mangroves. Traditionally the mangroves and the islands within have been used for charcoal and lime production.



Image 32: The mangroves of Lac afford protection to many recreational users
(Photograph by D.R. MacRae)

ROCKY SHORES

INTRODUCTION

Rocky shores form the transition between terrestrial and marine environments, and are thus exposed to very different physical conditions. In the course of a day, rocky shores are covered with seawater at high tide and exposed directly to the air at low tide. On Bonaire, rocky shores are found in close vicinity to the fringing coral reefs. With high tides and storm surges, the rocky shores become covered, at low tides, rock pools form (Image 33). The rocky shores on Bonaire are mostly limestone – old coral reefs that have become exposed by changes in sea level.



Image 33: Interesting formations on the rocky shores of Bonaire (Photograph by K. de Meyer)



Image 34: Rock pools formed on the rocky shores (Photograph by D.R. MacRae)

LOCATION

The main rocky shore environments on Bonaire are found on in the south of the island on both the leeward and windward shores

CONDITION

Around Bonaire the rocky shores are intact. Some interesting formations exist (Image 34), the significance of which is unknown. On the windward shore in the south, the rocky shores have gathered piles of wood and rubbish which have been deposited by waves. The source of the rubbish is likely to be the coastline of Venezuela and neighbouring countries to the east, since the main currents effecting Bonaire run in an east to west direction.

The limestone around Bonaire is being continually eroded by chemical, biological and physical erosion. These processes take many years to operate, and result in the formation of craggy cliffs and plateaus as well as complex drainage channels.

VALUE

The rocky shores provide essential protection from the sea by acting as a barrier from the pounding waves. Little is known about the many different plants and animals inhabit the rock pools.

Special interest habitats and species

RAMSAR SITES

Bonaire has 5 internationally recognised RAMSAR Sites: Lac, Klein Bonaire, Slagbaai, Gotomeer and Pekelmeer. These sites are a hub of biological activity and they demand special attention and integrated management since they include terrestrial, intertidal and marine habitats. Further details of these sites can be found in Appendix 1.

Site	Description
Lac	Lac is located at about 7 km southeast of Kralendijk. The site is an important feeding area for waterbirds, including <i>Fregata sp.</i> , and members of the <i>Pelecanidae</i> , <i>Ardeidae</i> , <i>Laridae</i> and waders. Mangroves also support breeding waterbirds, including <i>Egretta tricolor</i> , <i>E. caerulea</i> , <i>E. thula</i> and <i>Butorides striatus</i> .
Klein Bonaire	Klein Bonaire is located about 2 km west of the mainland town of Kralendijk. The coral reefs support an extremely rich marine fauna and the beaches have nesting turtles. The vegetation on Klein Bonaire (all of which is within the marine park) is of particular interest because it is no longer grazed by animals. There are a few building foundations on the island which have some historical value
Slagbaai	Slagbaai is located about 20 km northwest of the town of Kralendijk. The lagoon is a resting area for <i>Phalacrocorax olivaceus</i> (max. 50), and a staging area for a variety of shorebird species that breed in the Nearctic. Brine shrimps (<i>Artemia salina</i>) and brine flies (<i>Ephydriidae</i>) are abundant in the hypersaline areas, and provide a valuable food source for birds, including <i>Ardeidae</i> , <i>Phoenicopterus ruber ruber</i> (300) and <i>Recurvirostridae</i> .
Goto lake	Goto is located about 17 km northwest of Kralendijk. The area supports many breeding and staging bird species. Breeding birds include <i>Anas bahamensis</i> , <i>Haematopus palliatus</i> , <i>Himantopus himantopus</i> , <i>Charadrius wilsonia</i> , <i>C. alexandrinus</i> , <i>Larus atricilla</i> and <i>Sterna albifrons</i> . The site is also important for staging shorebirds which nest in North America, including <i>Pluvialis squatarola</i> , <i>Charadrius semipalmatus</i> , <i>Numenius phaeopus</i> , <i>Arenaria interpres</i> , <i>Limnodromus griseus</i> , <i>Calidris canutus</i> , <i>C. alba</i> , <i>C. pusilla</i> , <i>C. mauri</i> , <i>C. minutilla</i> , <i>C. melanotos</i> and <i>Micropalama himantopus</i> . The brine shrimp <i>Artemia salina</i> and brine fly (<i>Ephydriidae</i>) are abundant in the hypersaline areas, and provide a valuable food source for birds, including <i>Phoenicopterus ruber ruber</i> (100-500).
Pekelmeer	Pekelmeer is located about 10 km south of Kralendijk. The site supports one of the most important nesting colonies of <i>Phoenicopterus ruber ruber</i> in the Caribbean (averaging 1,000 pairs). Other breeding birds include <i>Himantopus himantopus</i> , <i>Charadrius alexandrinus</i> and <i>Sterna sp.</i> The lagoon is also an important feeding area for <i>Pelecanidae</i> , <i>Ardeidae</i> and migratory shorebirds which breed in North America.

Table 4: Ramsar sites on Bonaire

HABITATS OF INTEREST

Other environments on Bonaire which have considerable environmental value and are associated with or occur within the Marine Park:

- Saliñas (hypersaline lakes). Saliñas are an important permanent wetland feature on Bonaire. They are found along the leeward shore and are very numerous: Saliña Bartol, Saliña Funchi, Saliña Wayaka, Saliña Slagbaai, Saliña Tam, Gotomeer and Saliña Vlijt on the outskirts of the main town of Kralendijk. Whilst they are hypersaline they are far from abiotic (devoid of life) having significant fish populations, and are a stop over habitat for many migratory birds, hence the Ramsar designation. The Saliñas are also critical drainage features that prevent sediment in run-off from the land adversely affecting coral reefs



Image 35: Salinas in WSNP with Mt. Brandaris in the background (Photographs by K. de Meyer)

Image 36: Salinas such as Slagbaai, are an important breeding grounds for Flamingos.

- Karstic (Limestone) Caves located in the marine and terrestrial fossilised coral reefs in the North and South of the island. These are unique ecosystems that contain species endemic fish and crustaceans (Debrot 2003).
- The ‘coral’ reef on the East coast of the island is in some places dominated by algal assemblages which may also have an important ecological role
- Bacterial mats in intertidal areas around the island, particularly within the mangroves of Lac. These bacterial mats that cover parts of the ground near the mangroves of Lac and low lying intertidal areas may have an important ecological role. Further investigations are required. Similar blue/green algae found on Curaçao has been found to contain important chemicals that can be used in various medications.



Image 37 and Image 38 : The value of Bacterial mats, such as these at Lac is unknown (Photographs by D.R. MacRae)

SPECIES OF INTEREST

Endangered species

Bonaire is a home, breeding site or migratory stop-over for 6 IUCN Red list species, 11 CITES Appendix I species (see Table 5) and 94 Appendix II species, including many fish, crustaceans and all of the corals that can be found in the surrounding waters. For further details on the IUCN and CITES classifications, please refer to Appendix 9. Further information on each species can be found at <http://www.redlist.org> or <http://www.cites.org/>

SPECIES	COMMON NAME	STATUS
<i>Chelonia mydas</i>	GREEN TURTLE	IUCN Red list, CITES Appendix I
<i>Dermochelys coriacea</i>	LEATHERBACK	IUCN Red list, CITES Appendix I
<i>Eretmochelys imbricata</i>	HAWKSBILL TURTLE	IUCN Red list, CITES Appendix I
<i>Caretta caretta</i>	LOGGERHEAD TURTLE	CITES Appendix I
<i>Lepidochelys olivacea</i>	OLIVE RIDLEY	CITES Appendix I
<i>Physeter catodon</i>	GREAT SPERM WHALE	CITES Appendix I
<i>Balaenoptera edeni</i>	BRYDE'S WHALE	CITES Appendix I
<i>Balaenoptera physalis</i>	FIN WHALE	CITES Appendix I
<i>Megaptera novaeangliae</i>	HUMPBACK WHALE	CITES Appendix I
<i>Amazona barbadensis</i>	YELLOW-SHOULDERED AMAZON	IUCN Red list, CITES Appendix I
<i>Falco peregrinus</i>	PEREGRINE FALCON	CITES Appendix I
<i>Leptonycteris curasoae</i>	SOUTHERN LONG-NOSED BAT	IUCN Red list
<i>Guaiacum officinale</i>	LIGNUM-VITAE	IUCN Red list

Table 5: Key Red list and CITES species on Bonaire

Human use of the marine environment

The most important human use of the marine park is for recreational activities on and around the reef. There is some recreational fishing and boating. Commercial fishing activity in the park is very limited as most of it is focused off shore. The marine park is also used by some commercial shipping traffic.

Tourism and recreation

Around 28,000 tourists a year make use of the marine environment on Bonaire. The majority of visitors and locals alike take part in diving and snorkelling activities (Image 39). Diving and related activities are the mainstay of Bonaire's economy. It is frequently rated as the number one dive destination for shore diving in the world by the diving press. Sales of dive tags to divers and other water users sustainably finances STINAPA Bonaire. Many visitors to the island, including cruise boat passengers take part in snorkelling along the coral reefs or around the mangroves.

Many other water activities take place on Bonaire including Power boating (including Banana Boat rides and parasailing), jet skiing, kayaking, glass bottom boating, waterskiing, kitesurfing, windsurfing and yachting. The latter wind sports benefit from the constant trade winds from the East. Lac is an internationally recognised windsurfing destination and kitesurfing is rapidly establishing itself as a popular sport on the west coast.



Image 39: Divers are a significant user group of the marine environment

Image 40: Artisanal fishing boats near Atlantis on the leeward coast (Photographs by D.R. MacRae)

Fishing

A small number of sport fishing operators run businesses on the island. Charter boats take visitors fishing for larger pelagic fish in deeper waters than the current marine park boundary. Some local fishermen at Lac use the bay as fishing grounds and others use Sorobon pier and the beaches on the West coast (Image 40) to moor their boats which they use to fish in pelagic environments. Commercial fishing mainly takes place beyond the boundaries of the marine park, though some of the fish caught in Lac are sold on.

Shipping

There are three active harbour areas: in the main town which is used by freight carrying ships, in front of CARGILL the salt company which is used to ship salt to destination and in front of BOPEC the oil transshipment facility. Around 6 cruise ships visit the Island every month, using the piers in the town centre. A total of around 80 cruise ships per year visit and the passengers disembark for tours of the island and the marine park.

References

- Anon. (2000). Climatological figures for Flamingo Airport Bonaire 1971-2000. <http://www.weather.an/>.
- Anon. (2002a). Culture of Bonaire, vol. 2005. <http://www.infobonaire.com/history.html>.
- Anon. (2002b). Dive operators on Bonaire, vol. 2005. <http://www.infobonaire.com/diveoperators.html>.
- Anon. (2005). Aerial view of the Town Pier and Kralendijk, vol. 2005. http://www.shorediving.com/Earth/ABC/BonaireN/Town_Pier/.
- Anon. (1998). Manual for Sand Dune Management in the Wider Caribbean, pp. 66. Caribbean Environment Programme, United Nations Environment Programme.
- Bak, R. P. M. (1977). Coral Reefs and their zonation in the Netherlands Antilles. *Studies in Geology* **4**, 3-16.
- Bak, R. P. M., 45:181-190. (1975). Ecological aspects of the distribution of reef corals in the Netherlands Antilles. *Bijd. Dierk* **45**, 181-190.
- Beets, D. J. (1972a). Lithology and Stratigraphy of the Cretaceous and Danian Succession of Curacao, vol. 7. *Natuurwetenschappelijke Studiekring voor Suriname en de Nederlandse Antillen*, pp. 153, Utrecht, The Netherlands.
- Beets, D. J. (1972b). Outline of the Cretaceous and Early Tertiary history of Curacao, Bonaire and Aruba. In *Guide to the field excursions on Curacao, Bonaire and Aruba, Netherlands Antilles*. *Natuurwetenschappelijke Studiekring voor Suriname en de Nederlandse Antillen*, Utrecht, The Netherlands.
- BNMP. (2001). Dive tag sales 1991 - 2001.
- Buissonje, P. H. d. (1974). Neogene and Quaternary Geology of Aruba, Curacao and Bonaire., vol. 78. *Natuurwetenschappelijke Studiekring voor Suriname en de Nederlandse Antillen*, Utrecht, The Netherlands.
- CBS. (2005). National Economic Statistics, vol. 2005. Central Bureau of Statistics Netherlands Antilles: <http://www.central-bureau-of-statistics.an/>.
- Cesar, H., S.J. (2000). Collected Essays on the Economics of Coral Reefs. CORDIO, Kalmar, Sweden.
- de Leon, R. (2005). Hurricane dates.
- De Meyer, K. (1998a). Coastal Region and small Island papers 3: Bonaire, Netherlands Antilles. In *Environment and development in coastal regions and small Islands*.
- De Meyer, K. (1998b). Environment and development in coastal regions and in small islands. Bonaire, Netherlands Antilles, vol. 2005. <http://www.unesco.org/csi/pub/papers/demayer.htm>.
- Debrot, A. O., De Meyer, J. A. & Dezentje, P. J. E. (1998). Additional Records and a Review of the RCetacean Fauna of the Leeward Dutch Antilles. *Caribbean Journal of Science* **34**, 204-210.
- Duyl, F. C. v. (1985). *Atlas of the Living Reefs of Curacao and Bonaire (Netherlands Antilles)*. Foundation for Scientific Research, Utrecht, Netherlands.
- Edwards, A. J. (2000). MSc notes on the ecology of seagrasses.
- Ligon, J. (2002). Birding on Bonaire, vol. 2006. <http://www.infobonaire.com/birdwatching.html#article>.
- Lott, C. E. (2001). Lac Bay: Then and Now. Environics N.V.
- Pattengill-Semmens, C. V. (1998). The reef fish assemblage of Bonaire Marine Park: an analysis of REEF Fish Survey Project data. In *52nd Gulf Carrib. Fish. Inst. Proc.*
- Porter, S. (2006). Fish species of Lac.
- Renken, H. (2003). Lac Bay Management Plan. Bonaire National Marine Park.
- Roberts, C. M. & Hawkins, J. P. (1994). Report on the status of Bonaire's Coral Reefs, pp. 31. Eastern Caribbean Centre, University of the Virgin Islands, St Thomas, US Virgin Islands.
- Roos, P. J. (1971). The shallow water stoney corals of the Netherlands Antilles. In *Studies of Fauna: Curacao and other Caribbean Islands*, vol. 37. *Natuurwetenschappelijke Studiekring voor Suriname en de Nederlandse Antillen*, pp. 1-108.
- Scura, L. F. & van't Hof, T. (1993). The ecology and Economic of Bonaire Marine Park, pp. 48. The World Bank, Environment Department.
- van Moorsel, G. W. N. M. & Meijer, A. J. M. (1993). Base-line Ecological study van het Lac op Bonaire, pp. 120. Bureau waardenburg BV, Holland.
- van't Hof, T. (1982). *Guide to the Bonaire Marine Park*. Orphan Publishing Company, Curacao, Netherlands Antilles.
- Zonneveld, J. I. S., Buissonje, P. H. d. & Herweijer, J. P. (1972). Geomorphology and denudation processes. In *Guide to the Field Excursions on Curaçao, Bonaire and Aruba, Netherlands Antilles*. *Natuurwetenschappelijke Studiekring voor Suriname en de Nederlandse Antillen*, pp. 59-69, Utrecht, The Netherlands.

PART 2. The Management environment

Introduction

Understanding the goals and objectives of a protected area as well as the range of direct and indirect threats are essential elements of any management plan.

The Bonaire National Marine Park chose to adopt an adaptive management framework for its management planning. The adaptive management framework provides a logical approach to management planning which is highly prioritized and threat orientated.

The key elements of the adaptive management framework are:

1. Identifying and describing the significance and condition of the natural values within the marine park
2. Identifying and describing the threats and issues facing the natural values
3. Assessing which threats pose the greatest risk to the natural values
4. Developing and prioritizing management objectives
5. Developing and implementing management actions to address threats
6. Measuring the success of those management actions

Information on the significance of the ecosystems, habitats and species found within the Bonaire National Marine Park as well as their general condition has been presented in Part 1. This is summarized and highlighted in the statement of significance and values (below). Part 2 goes on to identify the threats and issues facing the marine park. Together with the Park's goals and objectives this information is used to build a framework for management.

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, programmes and initiatives.

The Dutch Caribbean Nature Alliance, of which STINAPA Bonaire is a member, is in the process of developing a uniform tool to measure management success of the terrestrial and marine parks on each of the six islands of the Dutch Caribbean. This newly developed Bonaire National Marine Park management plan is an important component of the management success project. Setting clear goals and objectives for the marine park makes it possible to begin evaluating management effectiveness and management success and assisting park managers to become ever more effective in their management planning and implementation.

Natural values: The intrinsic natural values of the marine park include:

- Rich diversity of marine life and habitats (biodiversity)
- Ecological processes such as reproduction and foraging
- Unique marine life including species with limited distribution and endemic species
- Internationally and/or locally threatened and vulnerable marine life
- Geomorphological significant features

Threat: A threat is a biological, chemical or physical process or entity which has the potential to harm the natural values of the park. A threat can be an entity such as a marine organism which becomes a pest, or a process such as an increase in sedimentation which damages habitat.

Impact: An impact is the effect that a threat has on the natural assets of the park. For example increased sedimentation may impact on a seagrass bed by causing reduced visibility so that the sea grass is no longer able to photosynthesise (grow) optimally causing a reduction in the amount of seagrass.

Box 1: Definitions of key terms used in section 2

Bonaire National Marine Park

The Bonaire National Marine Park surrounds the islands of Bonaire and Klein Bonaire extending from the high water mark to the 60 metre depth contour and covering an estimated 2700 hectares. It was first established in 1979, but due to financial difficulties was not actively managed from 1984 until 1991 when it was revitalized utilizing Dutch Government grant funding (MJP fonsen). Comprehensive legislation exists and is enforced. The Bonaire National Marine Park headquarters are located at Barcadera, some 5km north of the main town on Kralendijk.

The major use of BNMP is for recreational diving and snorkelling with some subsistence fishing by local people and other watersports. Until January 2006 visitors to the marine park paid a flat rate entry fee of \$10. This was changed to a graded fees system (outlined in Table 6) where yearly fee payers receive a tag and a right to enter into Washington Slagbaai National Park. Those that choose to pay daily receive a coupon which does not include entry into Washington Park

Divers	\$25 a year or \$10 a day
Other users	\$10 per year or \$2 per day

Table 6: BNMP's fees schedule

The Park manager is responsible for the day to day management of the Marine Park, whilst STINAPA Bonaire (Stichting Nationale Parken Nederlandse Antillean), is responsible for policy decision making, finances and personnel.

Statement of significance and values

A **statement of significance** explains the protected area's importance. The statement of significance expands upon the identification of values by adding unique qualifiers and placing the marine park within a regional, national and international context.

Key features or exceptional values are the features or values that must be protected and preserved to maintain the significance of the marine park. They may not be limited to those within the protected area boundary, and have all been recognised during the stakeholder consultations of January 2006.

Box 2: Significance and values explanation

The purpose of this section is to explain why the Bonaire National Marine Park is important, describing the values associated with the park, explaining why it was designated and what its benefits to society are.

Frequently the initial reasons for creating a protected area are subjective or poorly understood and badly communicated. Unless protected area values are understood, there is a risk that management actions, either deliberately or inadvertently, will adversely affect not only the natural resources but also the social and economic situation, especially that of local people. It is therefore critical that the significance and value of the marine park are clearly understood and are reflected in the park's goals and objectives. This will ensure that everyone is 'on the same page' when it comes to how the marine park is to be managed and will avoid use being made of the park which is incompatible with its future conservation. As more emphasis is placed on including a range of stakeholders in the planning process, it is important to have a mechanism through which the values they hold for the area can be identified and described.

Statement of significance

The marine environment of Bonaire is unique in the Caribbean being one of only four true oceanic islands separated from the South American mainland by a deep water trench. The Marine Park on Bonaire which was established in 1979 and has been under active management since 1991, has been recognised as a National Park by the Central Government of the Netherlands Antilles and as a Demonstration site by UNEP (United Nations Environment Programme) and ICRAN (International Coral Reef Action Network). It includes 2,700 hectares of globally threatened coral reef, seagrass and mangrove ecosystems all of which are considered to be in excellent condition. Bonaire's reefs are considered the healthiest in the Caribbean according to data from the Atlantic and Gulf Rapid Reef Assessment protocol. Bonaire's marine environments include all five of the RAMSAR sites within the Netherlands Antilles and are home to 111 globally endangered species including 6 on the IUCN Red list, 11 species on CITES Appendix I and 94 on CITES Appendix II.

Box 3: Statement of Significance.

Values of the Bonaire National Marine Park

INTERNATIONAL AND NATIONAL SIGNIFICANCE

The Bonaire National Marine Park is of major international and national significance.

Internationally Bonaire is recognised for its five globally important wetland sites which have been included under the RAMSAR Convention namely: Saliña Slagbaai, Goto, the island of Klein Bonaire, Lac and Pekelmeer

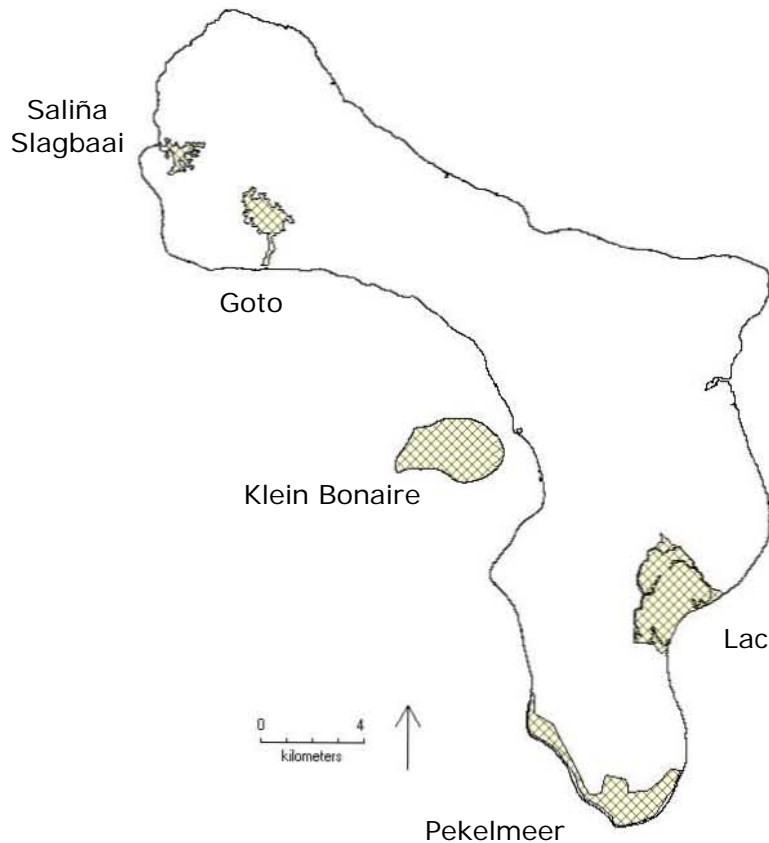


Figure 15: Ramsar sites of Bonaire

Saliña Slagbaai and Goto are most important for migratory wetland birds and provide important foraging grounds for the Caribbean Flamingo (*Phoenicopterus ruber*). The undeveloped satellite island of Klein Bonaire which lies approximately 750m to the west of Bonaire preserves vestiges of the island's original vegetation and is an important stop over point for migrating wetland birds. Lac, which contains thriving seagrass beds and actively growing mangroves, is the largest semi enclosed bay in the Netherlands Antilles and an important nursery site for conch and many species of reef fish as well as being a critical foraging ground for globally endangered juvenile green turtles. The salt pans adjacent to the Pekelmeer RAMSAR site are home to the largest and most important breeding grounds for the Southern Flamingo.

The Bonaire National Marine Park has been declared a UNEP/ICRAN Demonstration site by the United Nations Environment Programme and the International Coral Reef Action Network for its innovative work on sustainable financing and successful private sector participation by hoteliers and dive operators and is in the process of preparing a nomination to become the world's first marine transboundary World Heritage Site. The United Nations Environment Programme have also included Bonaire's coral reefs its list of coral reefs of international significance. Details of 'Demonstration site' and the 'World Heritage Site' recognitions are presented in Appendix 29.

The Bonaire National Marine Park includes examples of all three globally threatened coastal ecosystems: coral reefs, seagrass beds and mangroves. The reefs around Bonaire are unusually in

that they are fringing reefs, starting more or less at the shore line and extending seaward into deep water within 200m of the shore. According to recent AGRRA surveys, Bonaire's reefs are also considered amongst the healthiest in the Caribbean.

BIODIVERSITY

Within the Bonaire National Marine Park there are about 470 species of fish (<http://www.reefbase.org/>) 57 recorded species of hard and soft coral and along with an uncounted number of other marine invertebrates. Virtually every species of hard and soft coral recorded in the Caribbean can be found on the reefs of Bonaire. The diversity of fish life is unrivalled outside of the Florida Keys. Within Lac around 225 species of fish have been recorded. Klein Bonaire is home to some of the last remaining natural vegetation including Acacia, Prosopis, Capparis, Haematoxylon, Lantana and Croton species and is used as a stop over point by countless species of migratory wetland birds.

Despite repeated bleaching episodes throughout the 1990s and two recent serious storm events in 1999 (Hurricane Lenny) and 2004 (Hurricane Ivan) Bonaire's reefs remain amongst the best developed and most biodiverse in the Caribbean today.

In addition to diverse and healthy reefs, Bonaire has very well developed and extensive populations of parrotfish. Studies by PhD students indicate that the parrotfish populations spawn at different times along the length of Bonaire's leeward shore indicated that each may form a discrete biological unit. This behaviour is thought to be linked to micro current patterns and is designed to aid larval retention on the reef. Overfishing of this keystone species could therefore be catastrophic as they may not easily recolonize vacated reef areas. It is the high numbers of grazing parrotfish which are believed to have saved Bonaire's reefs when another major grazing invertebrate, the Black Spiney Urchin, suffered a population crash in the early 1980s due to disease.

Bonaire's windward shore is an important safe haven for the Caribbean lobster which is subject to only low levels of harvesting due to the prevailing adverse weather and sea conditions and the nature of the shoreline (razor sharp fossil reefs called 'ironshore').

ECOLOGICAL PROCESSES

One of the most important features of Bonaire's reefs are their location. Bonaire is located upstream of the reefs of Colombia and San Andres, Central America and the Gulf Coast. For species with long larval stages and migratory species Bonaire may prove to be a significant source of marine life. Studies of parrotfish genetics, for example, indicate that there may be a strong link between populations living on the northernmost shore, in the Washington Park, and parts of Curacao.

Sediment traps

Bonaire's salinas are a critical component of the island's ecosystems and play a vital role in trapping and containing storm water and associated sediments.

Foraging grounds

Lac is not only the largest semi enclosed seagrass and mangrove bay in the Dutch Caribbean but also a vitally important foraging ground for juvenile green turtles which can be found in the bay in their hundreds cropping on manatee and turtle grass.

Nesting grounds

The sandy beaches on the north eastern shore of Klein Bonaire have also proved to be important turtle nesting grounds for Hawksbill, Loggerhead and Green turtles whose range state extends from Puerto Rico in the north to the island off Nicaragua in the west. 61 nests were recorded on 2004.

Spawning grounds

Grouper spawning grounds have been identified at various sites around the island including seaward of Goto, Red Slave and at Spelonk where local fisherman have long known that grouper congregate seasonally to 'wash their eggs' (laba webu). More recently Ocean Trigger breeding grounds have been discovered on Bonaire's windward shore at Spelonk.

Breeding grounds

It is also important to note that the most significant breeding population in the Caribbean of the Flamingo can be found within the salt company property on the south end of Bonaire adjacent to the Pekelmeer RAMSAR site. Whilst flamingos forage at various sites around the island they have only established breeding colonies adjacent to the Pekelmeer and more recently in Goto, on the south shore of the Washington Park. It is believed that this nesting site is critical to their survival.

Nursery grounds

In addition to its importance as a nesting and foraging ground, Lac has an important roles as a nursery ground for many species of marine fish and for the globally threatened Queen conch. The extensive sandy areas in Lac, for example at Awa di Meuchi, are where larval conch settle and spend their first year of life before emerging to forage amongst the sea grass beds.

UNIQUE HABITATS AND MARINE LIFE

The mangrove stands surrounding Lac can be considered a unique habitat since they do not show the zonation pattern common to mangrove systems around the world but are made up of approximately 50% red mangrove around the actively growing seaward edge and 50% black mangrove in the drier interior. Unlike other mangrove systems which are fed by fresh water inflow from rivers, the mangroves of Lac are fed by the sheet flow of water from the bay itself. This has created a unique environment which is a critical habitat and nursery ground for many marine invertebrate and avian species. Bacterial mats found around Lac and some of the Saliña's have an unknown value, but are likely to have a key role in the food chain.

THREATENED AND ENDANGERED ECOSYSTEMS, HABITATS AND SPECIES

CORAL REEFS, MANGROVES AND SEAGRASSES

Coral reefs, mangroves and seagrass beds are all considered globally endangered ecosystems. The latest figures indicate that 70% of the world's coral reefs could be lost in our lifetime whilst estimates suggest 60% of mangroves have been destroyed globally through mostly due to dredging, aquaculture and land conversion. Despite recent impacts such as bleaching events and storm damage, Bonaire's coral reefs are considered amongst the most diverse and healthiest in the Caribbean. A recent AGRRA survey of the wider Caribbean using multiple indices to provide a measure of coral reef 'health' found Bonaire's reefs to be in the top five regionally. Healthy coral reefs, seagrasses and mangroves provide the increasing numbers of people living on Bonaire with a wide range of products and services. The following table outlines some of the more general values[†] associated with these key ecosystems on Bonaire.

Coral reefs	Seagrasses	Mangroves
<ul style="list-style-type: none"> ▪ Habitat for many animals and plants ▪ Tourism ▪ Recreation – diving and other watersports ▪ Fisheries ▪ Shoreline protection through reduction of wave energy ▪ Production of coral sand 	<ul style="list-style-type: none"> ▪ Provide habitat and food for many animals and species ▪ Tourism ▪ Provide shelter for juveniles of many commercial fish species ▪ Consolidate sediments and reduce wave energy ▪ Traditional uses e.g. weaving, roof thatch, compost, 	<ul style="list-style-type: none"> ▪ Habitat for many plants and animals ▪ Tourism ▪ Fishery ▪ Nursery for fish ▪ Recreational value for windsurfers and other watersports ▪ Traditional uses: charcoal and lime production

Table 7: General values of Coral Reefs, Mangroves and Seagrasses

ENDANGERED SPECIES

The islands of Klein Bonaire and Bonaire provide a safe refuge for 111 internationally recognised endangered species including 6 which are included on the IUCN Red list, 11 species on CITES Appendix I and 94 on CITES Appendix II. All corals are listed in CITES Appendix II and any trade in them or removal of them is prohibited by law, this includes any fossilised corals/coral rock.

[†] Not all values are related to the direct use of the resources. For example, the well-being of the environment of Bonaire has a value for; 1. future generations that will want to use the resource and may find new uses such as medicines, and 2. the present generation who value the knowledge of the continued existence of a healthy marine resource (Cesar, 2000).

SPECIES	COMMON NAME	STATUS	
		IUCN Red list	CITIES
<i>Chelonia mydas</i>	GREEN TURTLE	Endangered	Appendix I
<i>Dermochelys coriacea</i>	LEATHERBACK	Critically endangered	Appendix I
<i>Eretmochelys imbricata</i>	HAWKSBILL TURTLE	Critically endangered	Appendix I
<i>Caretta caretta</i>	LOGGERHEAD TURTLE	-	Appendix I
<i>Lepidochelys olivacea</i>	OLIVE RIDLEY	-	Appendix I
<i>Physeter catodon</i>	GREAT SPERM WHALE	-	Appendix I
<i>Balaenoptera edeni</i>	BRYDE'S WHALE	-	Appendix I
<i>Balaenoptera physalis</i>	FIN WHALE	-	Appendix I
<i>Megaptera novaeangliae</i>	HUMPBACK WHALE	-	Appendix I
<i>Amazona barbadensis</i>	YELLOW-SHOULDERED AMAZON	Vulnerable	Appendix I
<i>Falco peregrinus</i>	PEREGRINE FALCON	-	Appendix I
<i>Leptonycteris curasoae</i>	SOUTHERN LONG-NOSED BAT	Vulnerable	-
<i>Guaiacum officinale</i>	LIGNUM-VITAE	Endangered	-

Table 8: Key endangered species of Bonaire.

The regionally threatened Black Spiny Urchin, (*Diadema antillarum*), which was almost wiped out by a pathogen which swept through the Caribbean in 1985 is slowly making a come back on Bonaire's windward and leeward shores. It was first found colonizing the salt company intake channels. It is a keystone species and a major reef herbivore. The diadema die off has had a significant impact on many Caribbean coral reefs where its absence had frequently trigger a phase shift from coral dominated reefs to algal monocultures.

Regionally threatened acroporids, staghorn and elkhorn corals, are also slowly recolonizing the near shore environment at selected locations around the island. Like the Black Spiny Urchin, acroporids suffered a mass die off in the early 1980s throughout the Caribbean basin.

SUMMARY OF THE VALUES OF BONAIRE NATIONAL MARINE PARK

The following page summarises the key values associated with Bonaire National Marine Park as identified in the stakeholder meetings in January 2006. Values were identified in relation to specific places, uses, history, and the institution itself. For more specific values of Bonaire National Marine Park identified from stakeholder input refer to the meeting minutes in Appendix 10.

Historical/cultural sites

- The Windjammer Wreck from the 1800's located between Karpata and BOPEC.
- Hilma Hooker Wreck
- Historical buildings at Slagbaai
- Quarantine Buildings on Klein Bonaire
- Red and White slave hut groups
- Conch Piles at Cai

Industry

- Tourism forms the basis of Bonaire's economy
- Cruise ship stop over
- BOPEC oil terminal
- Cargill salt production
- Small aquaculture venture
- Shipping

Recreation

- >50 dive moorings around the island and a range of shore dives.
- Swimming snorkelling
- Windsurfing
- Kitesurfing
- Kayaking
- Sailing

Fisheries

- Artisanal (small, traditional) fishery
- Commercial fisheries
- Fishing in Lac
- Pelagic fisheries

A summary of the key values associated with Bonaire National Marine Park

(As identified during the January 2006 stakeholder input consultations)

Image courtesy of Earth Sciences and Image Analysis Laboratory, NASA Johnson Space Centre. (<http://eol.jsc.nasa.gov>) photo number: STS075-706-41.JPG



Others

- High biological diversity
- Healthy marine ecosystems
- Variety of marine ecosystems
- Sustainable tourism
- Highly accessible
- Traditional place names
- Research and education
- Freedom to use a healthy environment

Klein Bonaire

- Nesting and feeding ground for turtles
- Diverse coral reefs
- Dive and other watersports.
- Recreation
- Historical sites
- Valuable vegetation community

Lac

- Recreation
- Traditional artisanal fishery
- Historical conch piles at Cai
- Healthy, diverse mangrove stand
- Flourishing seagrass beds
- Traditional uses include navigation, and charcoal production
- Freshwater wells
- The salinas/channels hydrological role

Saliñas/Salt flats

- Habitat for many species.
- Breeding grounds for Flamingos
- Migratory stop over for bird species
- Resource for Cargill salt works which is seen as a sustainable operation
- Saliñas act as a sediment trap and filtration system for terrestrial run off

BNMP Institution

- Essential for the conservation of the marine environment on Bonaire.
- Very important in an outreach and education role.
- Partners for the government
- BNMP has an obligation as an internationally recognised and effective protected area

Mission and goals

The mission statement of the Bonaire National Marine Park is:

TO CONSERVE AND MANAGE THE NATURAL, CULTURAL AND HISTORICAL RESOURCES, ALLOWING THEIR SUSTAINABLE USE FOR THE BENEFIT OF CURRENT AND FUTURE GENERATIONS.

The four strategic goals of the Bonaire National Marine Park focus on biodiversity conservation, management, promotion of sustainable use within the park and protection of cultural and historical sites within the park. They have been chosen to provide for the protection and conservation of the island's unique marine resources whilst allowing appropriate recreational and commercial use to be made of the park.

Goals[†]

1. MAINTAIN AND/OR RESTORE THE ECOSYSTEMS, BIOLOGICAL DIVERSITY, AND ECOLOGICAL PROCESSES.

By protecting habitats, BNMP safeguards the vital life-support processes of the sea including:

- photosynthesis,
- maintenance of food chains,
- movement of nutrients,
- degradation of pollutants
- conservation of biological diversity
- productivity

This provides an essential foundation for sustainable, nature-based tourism, Bonaire depends on

2. MANAGE THE MARINE PARK AS A REGIONALLY AND GLOBALLY SIGNIFICANT AND SUCCESSFUL MULTI-USE MARINE PROTECTED AREA.

Bonaire National Marine Park challenges in setting realistic objectives that take into account all of the present and future uses. By trying to achieve a balance between use and protection, BNMP can build on its reputation as a regional and global flagship for the success of protected areas.

3. ALLOW USE OF THE MARINE PARK BY PROMOTING NON DESTRUCTIVE ACTIVITIES AND WORKING WITH STAKEHOLDERS TO ESTABLISH GUIDELINES AND REGULATIONS TO MINIMIZE IMPACTS ON THE ENVIRONMENT.

By addressing unsustainable and destructive activities, BNMP can go some way to ensure the existence of the resource it is protecting for current and future generations.

By involving stakeholders five key benefits arise, each of which will help in the pursuit of BNMP's objectives:

- Increased sense of **'ownership'**.
- Greater **support** for the protection of the area.
- Greater public **involvement** in decision-making
- Formation of links between planning for conservation and planning for **development**.
- Provision of a **mechanism for communication**

4. PROTECT AND/OR RESTORE THE CULTURAL AND HISTORICAL RESOURCES IDENTIFIED AS SIGNIFICANT

To be of greatest benefit BNMP must address the full spectrum of human values. This will ensure that BNMP does not attach too much importance to the scientific and technical aspects of managing the natural environment, at the expense of the human, cultural, and spiritual aspects.

[†] These goals are not written in any particular order or priority. Further information about rationales behind MPA's go to : www.iucn.org/themes/wcpa/pubs/guidelines.htm, and look at the Guidelines for Marine Protected Areas

Legal protection

The Marine Park continues to be protected by the Verordening Marien Milieu - Marine Environment Ordinance (A.B. 1991 Nr.8) and associated island resolutions containing general provisions (EBHAMS). The park manager, chief ranger and two rangers have special police powers, and cannot only write out a summons but can also issue summary fines to deal with offences under the Marine Environment Ordinance. Park personnel have attended training courses in law enforcement with a view to obtaining special police powers (Buitengewoon agent van politie). The course included information on how they should conduct themselves and what powers they have to enforce the legislation. The Island Government has an inventory of all those persons with special police powers and the ordinances which they may use to ensure an integrated approach to law enforcement.

Most of the problems that involve law enforcement are associated with development of the coastal zone, modification of the shoreline, illegal sand mining, creation of beaches and illegal placement of moorings, piers and the like. Activities associated with the coastal zone are difficult to control as the Marine Environment Ordinance only covers the marine environment, not the adjacent coastal areas. The ordinance also has no "preventative" component, in other words illegal activities cannot be prevented, only prosecuted after the fact and prosecution is often difficult.

Bonaire has a small but persistent spear fishing problem and occasional problems with recreational divers who are unable or unwilling to control their buoyancy under water or who remove items (such as soft corals and shells) from the reef. BNMP is working with SSV, police and airport authorities to avoid export of collected corals and other CITES listed organisms. Signboards have already been made and placed at strategic locations informing visitors about CITES regulations. There have also been problems with shipping - dumping of dirty ballast or other substances, leaking of oil, groundings. The legislative tools, management agreements and policy plans available to BNMP are as follows:

Current Legislation

- Bouw- en woningverordening (A.B. 1961, no. 17)
Building and housing ordinance. (regulates building and housing practices)
- Verordening marien milieu (A.B. 1991, no. 8)
Marine environment ordinance. (regulates use of Marine Park, fisheries and Lac)
- Havenreglement (A.B. 1975, nr. 33)
Harbour ordinance (regulates shipping and use of the harbour)
-
- Waterveiligheidsverordening Bonaire (A.B. 1974, no. 5)
Water safety ordinance (regulates speed and behaviour on the water)
- Eilandsverordening Afvalstoffen Bonaire (Ao. 1994, no. 5)
Regulation of waste (solid waste and litter)
- Eilandsverordening ruimtelijke ontwikkelingsplanning Bonaire (Ao. 1994, no. 22).
Development plan. (aims to promote responsible spatial development and sustainable environmental management.)
- Hinderverordening Bonaire (Ao. 1995, no. 4)
Nuisance ordinance. (Regulations on prevention and minimizing danger, damage and nuisance for people and environment)

Pending Legislation

- Concept eilandsverordening afvalwater
Regulation on waste water (draft).
- Concept eilandsverordening natuurbeheer
Nature management ordinance (draft).

Management agreement

- Management agreement between the Island Government of Bonaire and STINAPA Bonaire giving STINAPA management of the Marine Park (5th July 1991)
- Management agreement between the Island Government of Bonaire and STINAPA Bonaire giving STINAPA management of the Washington plantation (9th Oct 1990)

Former and Pending Policy Plans

- Meerjarenplan Milieu en Natuur 2001 – 2005 (Ned. Antillen)
Multi year Environmental and Nature Plan (Central Government)
- Natuurbeleidsplan Bonaire 1999-2004 (29th June 1999)
Nature Policy Plan Bonaire
- Milieubeleidsplan Bonaire. 2004 – 2009 (draft)
- Environmental Policy Plan Bonaire 2004 – 2008 (draft)

The relevant policy plans can be found in Appendix 11.

Marine Environment Ordinance (A.B 1991 nr.8)

The Marine Environment Ordinance was passed in 1991 but was revised (2001) to include provision for the protection of the island of Klein Bonaire as part of the Marine Park. It provides a general framework to protect the marine park and control activities within the park, to regulate fisheries and there is a special section concerned with the protection of Lac. The full translation of the Marine Environment Ordinance is presented in Appendix 12

The ordinance contains a number of EBHAMS (island resolution containing general provision). EBHAMS are used to leave the possibility open to further regulate activities which become problematic, to extend and increase user fees and to protect additional species and or areas. They are relatively easy to write and approval can be quite fast as they only need the approval of the Executive Council.

Existing EBHAMS (these can be found in Appendix 13) include:

- Gazetting of Marine Environment Ordinance (EBHAM 28th Jun 1991 Nr.9)
- Permitting anchoring in the bay of Kralendijk (EBHAM 28th Jun 1991 Nr.10)
- Regulation of permitting for dive operators (EBHAM 13th Dec 1991 Nr.21)
- Regulation of diver admission fees (EBHAM 13th Dec 1991 Nr.22)
- Regulation of legal fees for permits (EBHAM 22nd Dec 1993 Nr.18)
- Regulation of fees for private moorings (EBHAM 20th Mar 1996 Nr.3)
- Prohibition of anchoring in the Marine Park (EBHAM 18th Aug 1999 Nr.11)
- Regulation of payment for use of yacht moorings (EBHAM 18th Aug 1999 Nr.12)
- Protection of Klein Bonaire under Marine Environment Ordinance (EBHAM 25th April 2001 Nr.13)

Relevant International treaties and conventions to BNMP

- Convention on Biological Diversity (CBD)
- Ramsar Convention on Wetlands (Ramsar)
- Convention on International Trade in Endangered Species (CITES)
- Convention on Migratory Species (Bonn convention)
- World Heritage Convention
- International Convention for the Prevention of Marine Pollution from Ships (MARPOL)
- Inter American Convention for the Protection and Conservation of Sea Turtles
- UNEP Regional Seas Conventions: Caribbean
 - Cartagena Convention
 - Land based sources of marine pollution (LBSMP) protocol
 - Oil Spill protocol
 - Specially protected areas and wildlife (SPA) protocol

Central Government regulations

Central government

- Landsverordening grondslagen natuurbeheer en bescherming (P.B. 1998, no. 49)
Framework ordinance addressing nature management and protection
- Landsverordening grondslagen ruimtelijke ontwikkelingsplanning (P.B. 1976, no. 195)
Framework ordinance addressing spatial planning
- Concept Landsverordening grondslagen milieubeheer
Draft framework ordinance for environmental management

Concept Landsverordening Visserei
Draft fisheries ordinance

The following tables outline planning provisions, permits that are issued for BNMP, which rules and guidelines are issued by BNMP, board member details, other organisational provisions and meeting details.

Permits

Permits issued by BNMP	Advisory body	Issued by
Public Moorings	CMM [†]	Government
Private Moorings	CMM	Government
Specialised Moorings	CMM	Government
Piers	CMM	
Research	CMM	
Collection	CMM	
Watersports	CMM	Government
Tour operators	CMM	Government
Guides	CMM	Government
Camping	BNMP	
Building	CMM	
Natural resource extraction	Government	

Table 9: Permits issued by BNMP

To apply for a permit relating to any of the activities mentioned above, the following procedure must be followed:

1. Apply to the BC (Executive council).
2. All things relating to marine park – BC ask advice of CMM before granting initial permits.
3. For construction or business on or near the MPA, other specific permits need to be sought from the relevant department

[†] CMM = Commissie Marien Milieu (Marine environment commission)

This process is currently causing problems for BNMP. The first permits issued by DROB are sometimes seen as permission to build because people don't understand correct procedure. People often go ahead and build or start businesses without the correct permits, and without the CMM being consulted. Often the work done is irreversible and many irresponsible individuals and groups pretend to misunderstand the procedure and pay the worst-case 5000 Nafl fine. This highlights the need for an integrated approach to coastal management on the island. This can only be achieved if the marine park is a made consultee for terrestrial developments, and any advice the marine park offers is taken as definitive.

Rules and guidelines

The rules and guidelines published by BNMP can be enforced by the Marine Environment Ordinance. A number of rules and guidelines were published up until 2006, when revisions were made. The rules and guidelines can be found on information boards, (see Appendix 14) and in the relevant brochures;



Image 41: (Top) Signage at Lac with general guidelines and rules

Image 42: (Above Left) The brochures currently in use by BNMP.

Image 43: (Above right) BNMP Manager Ramon De Leon with tags and brochures

Name	Content
Bonaire National Marine Park	Information on the formation of coral reefs and Bonaire's fringing reefs. An introduction to STINAPA, WSNP, Environmental education, General rules, guidelines, (below), contact details and a map of Bonaire's dive sites
Lac Brochure	Lac description, Mangrove details, History of Lac, Details on Green Turtles Outlines of windsurfing, kayaking, snorkelling, scuba diving, fishing guidelines for Lac. Zonation map of Lac and a code of conduct
Nature fee Brochure	Nature fee – who pays what, Justifications of the Nature Fee, where to get the tags from, outline of the work that STINAPA carries out, brief descriptions of WSNP and BNMP and the education/outreach work that is carried out.

PARK INFORMATION & REGULATIONS

The following guidelines and recommendations are presented in the BNMP brochure and at places around the island on posters:

General Marine Park Guidelines

- Please pay the Nature Fee before using the Bonaire
- A dive orientation from your dive operator is mandatory before you can dive in the Bonaire National Marine Park.
- Anchoring is forbidden in the Bonaire National Marine Park. Please use the mooring buoys provided.
- Spear fishing is prohibited. If you have a spear gun, please leave it in safe keeping at the Customs office.
- It is forbidden to remove anything alive or dead from the Bonaire National Marine Park.
- Make sure you do not damage the reefs in any way. Especially don't touch the corals and avoid silting up the bottom.
- For more information on regulations check the brochures our website or contact us.

Recommendations to Divers

- Practise good buoyancy control. If you can't remember how to get neutrally buoyant, ask your dive guide or instructor to help you out.
- Secure all consoles in such a way that they cannot trail along or get caught.
- Do not wear gloves or kneepads when diving within the Bonaire National Marine Park.
- Do not handle, torment or feed marine species.
- Do not manipulate or move marine species from their natural habitat.
- Take only pictures and leave only bubbles.
- Diving East Coast recommended with local guide.

Governance: institutional arrangements

When the Marine Park was revitalised in 1991 its management was given by the Island Government to STINAPA, Bonaire - a local not for profit, non governmental organisation which was already managing the islands terrestrial park (Washington Slagbaai Park) as well as Karpata and the cave system at Barcadera. Management was assigned to STINAPA under a management contract whereby a Begeleidingscommissie (consisting of representatives of STINAPA, tourist industry and persons nominated by the Government) was formed. The intention was to give the Marine Park into the hands of a local, non-governmental conservation organisation whilst allowing for input from the user community.

When it became clear that this two tier approach to management did not work well in reality the Island Government stepped in and, with the board's consent, appointed new members to the board to represent the broadest array of interests. The nine man board of STINAPA officially appointed representatives from the local agricultural co-operative, fishing community, tourism industry, hoteliers, dive operators as well as four of the original board members.

The Park manager is responsible for the day to day management of the Marine Park, whilst STINAPA Bonaire is responsible for policy decision making, finances and personnel.

STINAPA Bonaire

The STINAPA board has 11 positions, 9 of which are currently filled.

Members Name	Position	Interest	Contact details
Evo Cicilia	Chair	Government (DEZA)	717-8960 540-2925 evocici@bonairelive.com
Ronella Croes	Vice Chair	TCB	717-8322 786-8322 gm@tourismbonaire.com
Jeannette Nolen Heitkonig	Secretary	Local representative	717-5280 786-8196 raljea@flamingotv.net
Herbert Piar	Treasurer	Local representative	717-8157 786-5572 isyas@flamingogotv.net
Corinne Gerharts	Member	BONHATA	717-8778 786-8110 corine@bonairetours.com
Diana Sint Jago	Member	BONHATA	717-5134 717-8534 diana@bonhata.org
Bruce Bowker	Member	CURO	717-8819 bruce@caribinn.com
Papy Cicilia	Member	Gov.	717-8868 560-7440 papy@telbonnet.an
Jack Chalk	Member	Local representative	717-8290 560-7253 jack@habitatdiveresorts.com

Table 10: The STINAPA Board

Organisation and meetings

The following governance and administrative documents and framework exist for the marine park. Copies of the house rules and evaluation forms can be seen in Appendix 15. Staff uniforms can be seen in the human resources section of this part on the management plan.

		Comments
Byelaws	✓	
Daily board	✓	
Staff work book	✓	House rules
Job descriptions for staff	x	
Uniforms for staff	✓	
Staff id badges		Planned for 2005
Staff evaluations	✓	After 2 month probation, then every 6 months
Annual report	✓	Date of last report: 12/04
Annual audit	✓	Date of last audit: 2004

Table 11: Institutional arrangements



Image 44 : BNMP full uniform and badge detail.

The following meeting schedule is followed within the marine park

	Frequency	Are the meetings minuted?	Are the minutes circulated?	To whom?
Board member meetings	Monthly	✓	x	
Board member and manager/director meetings	Monthly	✓	✓	MTM members and board of directors
Manager/director and staff meetings	Monthly	✓	✓	All STINAPA staff

Table 12: Meeting arrangements

Physical Resources

Marine Park headquarters is located at Barcadera, some 5km north of the main town on Kralendijk. BNMP has a range of physical resources at its disposal; these are outlined in the table below.

Resource		Detail
Buildings	Office(s)	4 offices, administrative section, 2 store rooms, kitchen/diner, , parking for several cars. Shade for boats/cars. (Offices are from the government)
	Meeting room	With 4m moorings board, extensive library, table and chairs for 10 people and a/c
	Workshop	Workshop, with high pressure washer, dive kit, mooring equipment, lift bags, tools and maintenance parts. storage container
	Boat shed	To fit 2 boats
Transport	4*4 Truck	1*double cab 4*4, 2005, Toyota 2.7 turbo diesel. 1 double cab 4wd 2000, Toyota diesel
	2WD Pick up	1* double cab 2wd, 2005, Isuzu 2.7 diesel 1 double cab 2wd 2000, Toyota diesel
	Hard Hull, out board engine	24' hard boat with a 115 hp outboard Yamaha engine 15' Boston Whaler with a 15hp outboard Yamaha engine
	Rigid Inflatable, out board engine	19' Delta RIB powered by an 85hp outboard Yamaha engine 14' Zodiac with 90hp outboard Yamaha engine
Communication	Fax machine	1 fax machine in admin area – 2005, Brother
	Telephone (Land line)	5 phone points
	Cell phones	All staff members, 2005, 50 nafl a month allowance,
	Radios	Porta-phones in all cars and main office
	VHF radio	In 2 boats and one hand set.
	Base station	Located in main office
	Moorings	>140 moorings, Open moorings on the West coast: 26 drill moorings, 23 Block moorings, 28 barrels. 40+ blocks for public moorings between Harbour village marina and Karels beach bar pier. For a diagram of the construction of the mooring, see Appendix 16.
Other Equipment	BBQ pits	2 on Klein Bonaire needing updating
	Litter Bins	5 bins on Klein Bonaire that are looked after by BNMP
	Signboards	2 AT Karpata reserve, 5 at Cai, 2 at Sorobon, 2 to the south (with STCB). 2 at the commercial kayak entry/exit point at Lac. 2 at the roundabout, 1 in the south near Cargill salt works.
	Marker stones	59 dive sites with yellow marker stones with dive site names written in black
	Desk top Computer	5 desk top computers, 2004.
	Lap top Computer	5 laptops, 4 from 2005, 1 from 2004
	Camera	5 Nikonos cameras with a variety of lenses and strobes. 2 digital cameras – 3.3 megapixels for patrolling
	Video camera	Sony VX1000 video camera with underwater housing
	Projector	2 slide projectors, 1 Dell multimedia projector
	Internet	Broadband internet connection
	BC	16 Scubapro jackets
	Regulator(s)	16 regs Scubapro
	Tank	15 tanks
	Weights (sets)	16 sets
	Wetsuits	16
	Mask Fins Snorkel	30 full snorkel sets
	Drying oven	1 drying oven
	Microscopes	Binocular microscope
	Fridge	1 fridge
	Balance	2 balances
	CTD probe	YSI Conductivity, Temperature, Depth probe
	pH meter	One pH meter
	Water quality test kit	1
GPS	Shared with Washington Park	
Drill mooring equip.	Pneumatic Helix drill equipment	
First Aid kit	1 kit	
Oxygen kit	1	

Table 13: Bonaire National Marine Park physical resources

Human Resources

At the beginning of 2006 Bonaire National Marine Park itself employed 7 skilled staff members, with a further 6 working for STINAPA Bonaire on BNMP and WSNP business. A summary of the staff members, their position and skills can be seen below, with photographs and e-mail contact on the following pages.

Summary

		Director	Manager	Chief ranger	Ranger 1	Ranger 2	Ranger 3	Ranger 4	Ranger 5	Ranger 6	Accountant	Receptionist	Communications Officer	Education officer	Cleaner	
STAFF DETAILS	Initials	EB	RdL	DD	ST	GZ	GIC	KR	DR	DK	KR	JAF	KVD	CM	?	
	Shared position?	Yes	No	No	No	No	No	No	No	No	Yes	Yes	Yes	Yes	Yes	
	Full Time or Part Time?	FT	FT	FT	FT	FT	FT	FT	FT	FT	FT	FT	FT	FT	PT	
	Years of service	2	<1	>10	5	>10	1	<1	<1	<1	<1	6	6	<1	2	>10
	Academic qualification	BA	MSc	-	-	-	-	-	-	-	-	-	-	HBO	-	-
	Evaluation															
Additional qualifications	Dive qualification	R	I	DM	A	OW	A	A	DM	DM	-	-	DM	OW	-	
	Special police powers		✓	✓	✓			✓		✓	✓					
	VHF radio operator	✓	✓		✓			✓	✓			✓				
	Vehicle/boat maintenance		✓	✓	✓	✓										
	First aid	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	
	Conflict resolution	✓	✓													
	Captains licence															
	IT Training	✓	✓				✓				✓	✓	✓	✓		
	Media and communication	✓			✓								✓			
	Species specific training			✓	✓	✓			✓							
Monitoring		✓							✓							

Table 14: Summary of the staff of BNMP

Key

FT = Full Time, PT = Part Time, R = Rescue Diver, I = Instructor, DM = Dive Master, A = Advanced Diver

* The Director and office staff (shaded grey) share work time between Washington Slagbaai National Park and BNMP

Staff Members 2006



Elsmarie Beukenboom
 Director
 director@stinapa.org



Ramon de Leon
 Manager BNMP
 marinepark@stinapa.org



Kerenza Rannou
 Accountant
 accounting@stinapa.org



Edwin Domacassé
 Chief Ranger BNMP



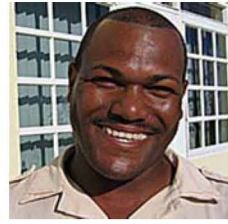
July-Ann Frans
 Administrative Assistant
 julyann@stinapa.org



Sixto Trenidad
 Ranger BNMP



Crisanta Martha
 Environmental Education
 Coordinator
 nme@stinapa.org



Karel Rosaria
 Assistant Ranger BNMP



Karen Van Dijk
 Communication officer
 communications@stinapa.org



Duvan Rios
 Assistant Ranger BNMP



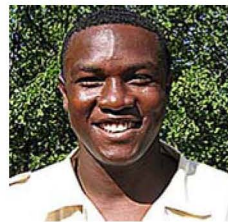
George Saragosa
 All Around Assistant



Denice Keller
 Assistant Ranger BNMP



Sally Thodé
 Interior maintenance person



Gregory La Croes
 Assistant Ranger BNMP

Table 15: Staff members of BNMP

Stakeholders

Local

Stakeholder	Role
Building and zoning department. DROB	Partner in decision making
Legal department	Law making, advice
Environment department	Partners in CMM, advice,
Prosecutors office	Law enforcement and advice
Harbour office	Law enforcement, advice, partners in CMM
Coast Guard	Law enforcement
Agriculture department LVV	Partners in CMM, advise in fisheries related issues,
Police	Law enforcement
SSV	Law enforcement
TCB	To promote the BNMP and distribute information
Fisherfolk – Cai	To give advice in fisheries related issues and use of the protected area issues
Town fisherfolk	To give advice in fisheries related issues and use of the protected area issues
Dive operators	Tags sales, information distribution, users statistics, training, law enforcement
Other watersports	Tags sales, information distribution, users statistics, training, law enforcement
Volunteer groups	Coral reef monitoring, fish population monitoring, help with the tags system, gathering statistic data,
Other NGO's	STCB – To carry research in sea turtle ecology, conservation, outreach and education

Table 16: Local stakeholders

International

Partner	Role
DCNA	To safeguard biodiversity and promote sustainable management of the protected area in the Dutch Caribbean. Tasks include fund rising, promotion, providing support to parks, and creating an information centre.
AGRRA	To provide training and advice in coral reef monitoring
TNC	To provide training and advice in coral bleaching and other reef related problem. To provide help in fund specific projects

Table 17: International stakeholders

Stakeholder input into the BNMP management plan

The following pages summarise the main threads of input from the Stakeholder meetings held in January 2006. Each of the comments or observations mentioned below came up in more than one, and often most of the consultations. These have been taken into account in the text of this document. The presentation given and minutes from the stakeholder meetings can be seen in Appendix 10. Further details from the stakeholder meetings have formed the basis of this part of the management plan and have been woven into the text.

Mission

The mission statement should include a reference to present and future generations
Cultural and historical resources need to be recognised by a group, or have some protocol of recognition

BNMP's number one priority needs to be environmental/ecological issues

Goals of the Marine Park

Goals 1 and 2 should include and/or at the beginning

Goal 3 caused much discussion, and some re-wording was suggested

Goal 4: use of 'Allow' and 'non destructive' could be change to 'promote' and 'low impact'

Values of Bonaire National Marine Park

The significance of the marine resource for Bonaire is invaluable

BNMP as an institution is essential for the well being of the marine resources of Bonaire

Without BNMP economic decline would occur on Bonaire

BNMP is very well respected by industry, locals and visitors as a management body and consultee.

The wrecks, old buildings, Conch shell mounds, Boka di Koko, Puitu, Saliña at Cai, Boka di Pos, Isla Yuwana, Boka Fagon all hold significant cultural value.

The World Heritage Site bid should be mentioned in the management plan

Uses of BNMP

Use of Kayaks needs to be continually regulated

Concern over the future use of jet skis

Reduction in the number of shore dive sites

Research should continue to play an important role for BNMP

The carrying capacity of Bonaire and maximum watersport operator numbers should be established.

Zonation

More zones and a zoning plan are needed

Kite Surfing zone needs to be established

Fish Protected Areas need to be established

Lac needs a zoning plan for kayaking, conch no fishing zone

The nature policy plan should define the MPA to include the Exclusive Economic Zone, 12 nautical miles from the shoreline.

Buffer zones landward of the marine park should be created to protect nesting turtles and establish some influence over coastal development

Confusion of the location of the reserves and the upper limit of the current MPA. Uncertainties of where the High Water Mark is, and if this includes the salinas.

The whole of Klein Bonaire is under the control of BNMP and needs a structured zoning plan

Issues facing BNMP

Political constraints and communication with government/government support are a major issue facing the success of the marine park.

Unsustainable development in all sectors identified as the main physical threat facing the marine park.

Nutrient enrichment seen as a major issue

Considerable concern over the planned development at Lac – Sorobon, and its likely negative effects on the environment

Future issues are likely to be related declining coral cover and public relations

Kite surfing considered a danger to many users

Further discussion

An effective communication and outreach plan is needed

Confusion over the new fees system, who it applies to and concern over the cost of lost tags after the price increase

There is a need to establish the economic benefits of BNMP

BNMP should have greater enforcement powers, especially for people who break rules repeatedly

Requests for a BNMP hotline, where staff members can be contacted.

Klein Bonaire and Lac need their own management plans nested into the BNMP management plan.

Recommendations for the management plan to be reviewed through a structured process and stakeholder consultation every few years.

BNMP staff and offices should be more visible and user friendly

TOURIST CONSULTATION

Tourists were consulted with through a questionnaire, where entry into a free prize draw was offered as an incentive. 200 tourists were questioned by a researcher[†] in the airport during February 2006. Copies of the questionnaires and responses can be seen in Appendix 17. Tourists were asked questions relating to the activities they took part in whilst visiting Bonaire, the most memorable part of their visit, which facets of the marine park they had used and which issues facing the marine park they considered to be most significant.

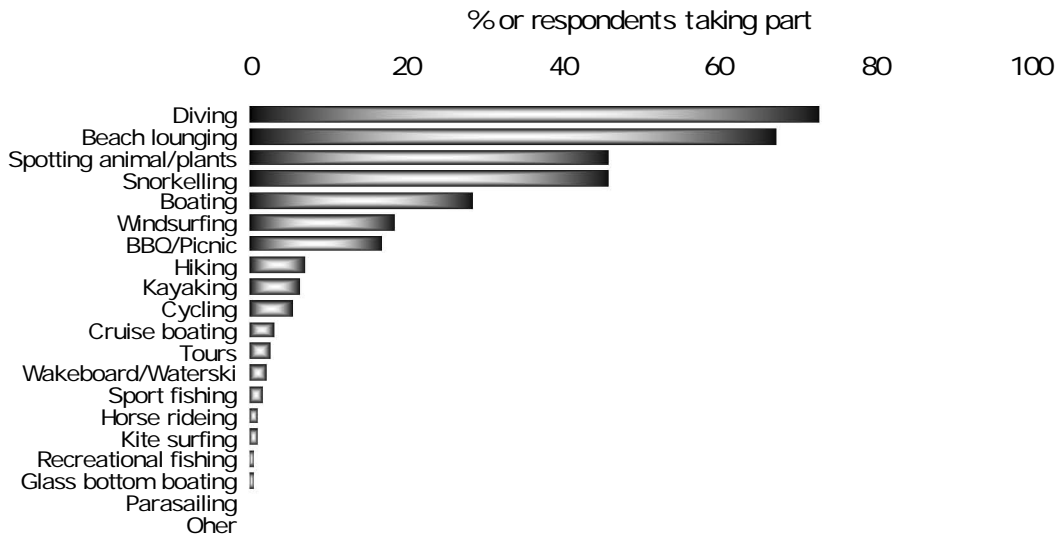


Figure 16: % of tourists taking part in recreational activities

As Figures 34 and 35 show, most visitors to Bonaire had taken part in diving, beach recreation, snorkelling or wildlife spotting. This made the marine environment and related recreational activities the most memorable part of most peoples stay on Bonaire.

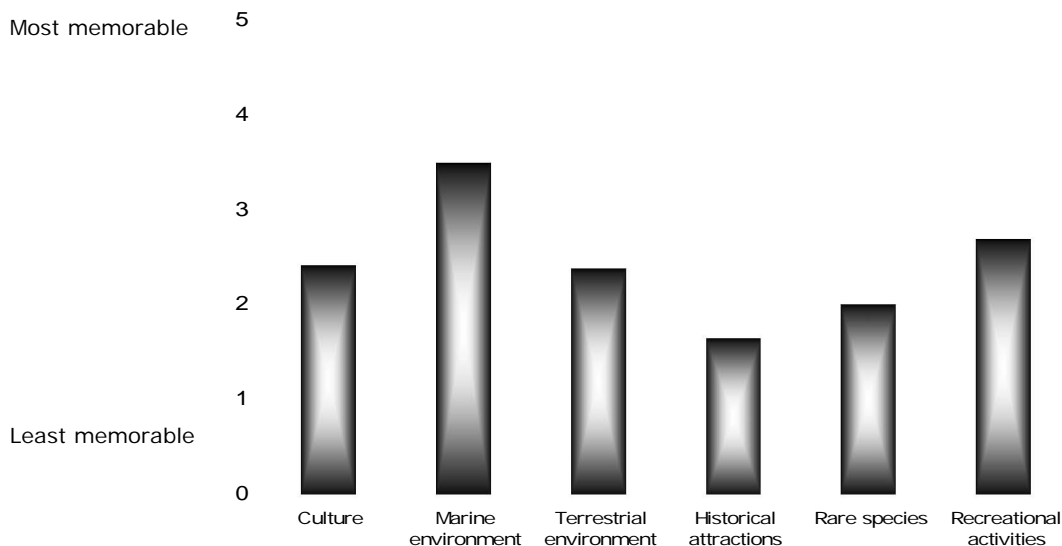


Figure 17: Most memorable part of participant's trip to Bonaire

When the tourists were presented with a list of challenges facing the Marine Park, the one that was ranked as the highest importance was pollution, followed by litter and development. To gain an understanding of what the tourists thought about the Marine Park, they were asked if they had

[†] Maria Uyarra, a researcher from the University of East Anglia (UK) carried out the questionnaires (m.uyarra@uea.ac.uk)

made use of any of the facilities provided by the Marine Park. Most tourists (about 70% of those questioned) had used maps of some description. A few people had used leaflets, but less than 10% had visited or made contact with the Marine Park headquarters or staff members. A similar number had made use of any presentations.

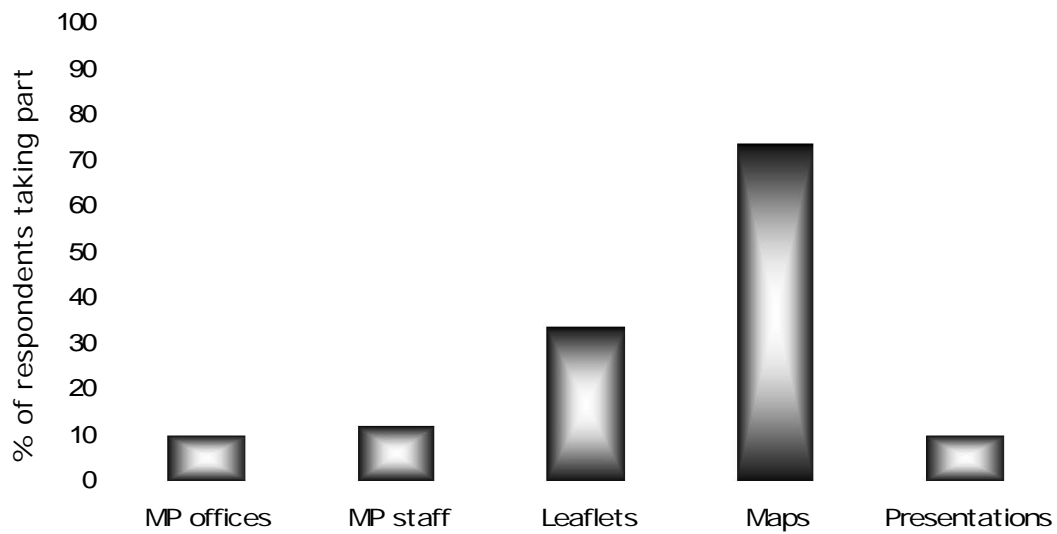


Figure 18: Visitors use of Marine Park outreach.

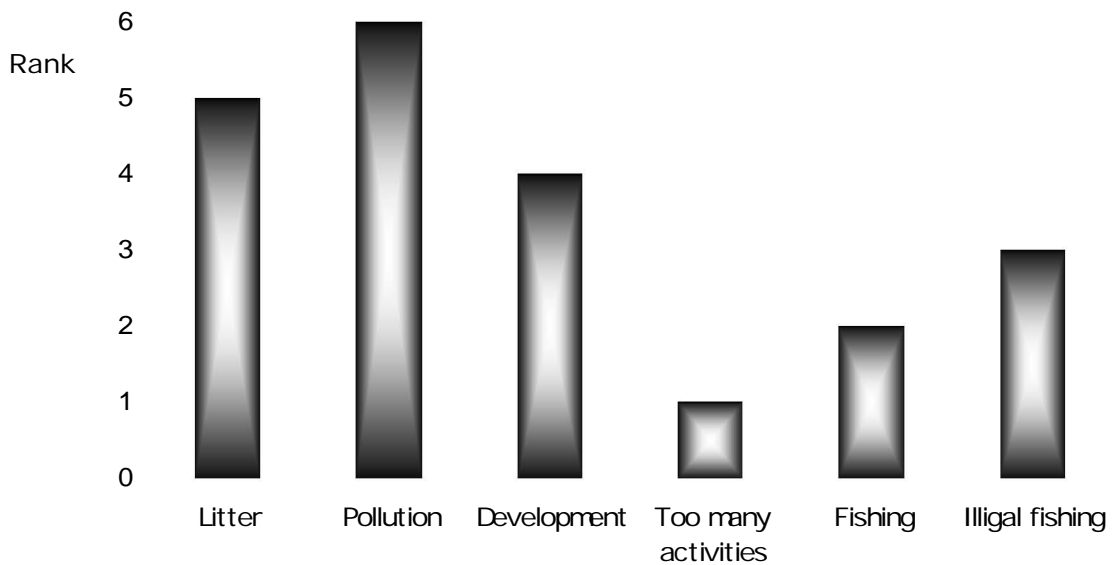


Figure 19: Challenges facing BNMP

From the results it seems that visitors are not aware of the activities of the Marine Park, although they are aware of some of the issues facing the marine environment.

These findings underline the importance of the marine environment for Bonaire’s tourist industry. With such a high percentage of visitors either coming to Bonaire to experience the marine environment or making use of it whilst visiting, its health and well-being is essential for the islands economy.

CONSULTATION WITH LOCAL PEOPLE

Interviews were carried out in October 2005 to investigate the knowledge, attitude and opinions the local residents of Bonaire have about STINAPA/Bonaire National Marine Park. 200 people were interviewed in during the International Bonaire Sailing Regatta.

The main points highlighted by the survey were as follows:

- 77% of those interviewed knew that BNMP exists
- 28% knew where the marine park is.
- 75% of people interviewed thought that it is a good thing to have rules for BNMP,
- 76% that they care for the marine environment.
- 76% of people agree that BNMP contributes significantly to tourism and conservation.

This study shows that local people support the work of BNMP and value the institution. This support is essential for the running of the Marine Park, without it, many aspects of the work carried out by BNMP would fail. Many of the persons interviewed felt that BNMP should give out more information and raise awareness about the work of STINAPA. This is a very important issue for the future actions of the marine park. The responses and work carried out by STINAPA can be seen in Appendix 17.

Uses

BNMP as a multiple use area encourages a range of uses, which generally complement one another. The following table briefly outlines the main uses.

USE	DETAIL
Animal/Plant spotting	Visitors and locals alike take part in activities like walking and snorkelling to observe the native wildlife of Bonaire
Aquaculture	There is one aquaculture venture on the Island that raises two species of shrimp in an enclosed system – refer to the notes in Part 1 for further details.
Artisanal fishing	Some fishermen at Lac use the bay as fishing grounds and others use Sorobon pier to moor their boats which they use to fish in pelagic environments.
Beach lounging	No Name Beach on Klein Bonaire, Pink Beach, Donkey Beach, and Sorobon/ Cai at Lac are the main beaches used for beach lounging and recreation.
Boating	Power boats are used for pleasure and to offer tours of the island as well as trips to Bonaire
Camping	Some camping takes place on the beaches of Bonaire. A permit is required for at No Name Beach on Klein and fires are not permitted.
Collection	The collection of artefacts from the Marine Park has been prohibited
Commercial fishing	Commercial fishing mainly takes place beyond the boundaries of the marine park, though some of the fish caught in Lac are sold on.
Cruise boats	Between 3-6 cruise boats visit the Island every month, a total of around 80 boats per year (see Figure 30) and the passengers disembark for yours of the island and the marine park.
Diving	Diving and related activities are the mainstay of Bonaire's economy. It is frequently rated as the number one dive destination for shore diving in the world by the Diving press. Sales of dive tags to divers and other water users sustainably finances STINAPA Bonaire.
Education	A number of small independent education base businesses run on the island, who make use of the marine parks resources alongside schools and other establishments
Jet skiing	The rental of jet ski's has been prohibited, though a few people on the island continue to use private craft
Kayaking	Kayaking has established itself as an upcoming pastime on Bonaire. Many hotels rent out sea kayaks to visitors and a kayaking business has been set up near Cai to take visitors on tours of the mangroves
Kite surfing	Kite surfing has established itself as a new watersport on the island with approximately 600 people taking instructed courses in 2005. It has been prohibited from Lac and has found a new home in the area of the Atlantis dive site on the south west coast of the island. Further details of Kitesurfing can be seen in Appendix 18.
Natural resource extraction	The Cargill salt works use the flat topography of the south of the island to their advantage to evaporate water from the large salt pans, leaving salt behind which can be exported.
Snorkelling	Many visitors to the island, including cruise boat passengers take part in snorkelling along the coral reefs or around the mangroves.
Sport fishing	A small number of sport fishing operators run businesses on the island, fishing for larger pelagic fish in deeper waters than the current marine park boundary
Glass bottom boating	One boat with an underwater viewing platform operates from a pier near Kralendijk, usually taking passengers on trips around Klein Bonaire
Tours	Boating companies take visitors on tours of Klein Bonaire
Waterskiing	Some waterskiing takes place in the bay of Kralendijk
Windsurfing	Windsurfing is a popular pastime on Bonaire relying on the consistent windy conditions on the East Coast. The majority of windsurfing takes place in Lac with two windsurfing businesses based in Sorobon. Some windsurfers illegally take to the salt lakes of the Pekelmeer Ramsar site in the South.
Yachting	Many people use the bay of Kralendijk to moor their yachts. The reliable winds make sailing a significant pass time on the island.

Table 18: The main uses of BNMP.

Local people and visitors' alike use the marine park, most visitors being from the United States and the Netherlands as can be seen in Figure 31

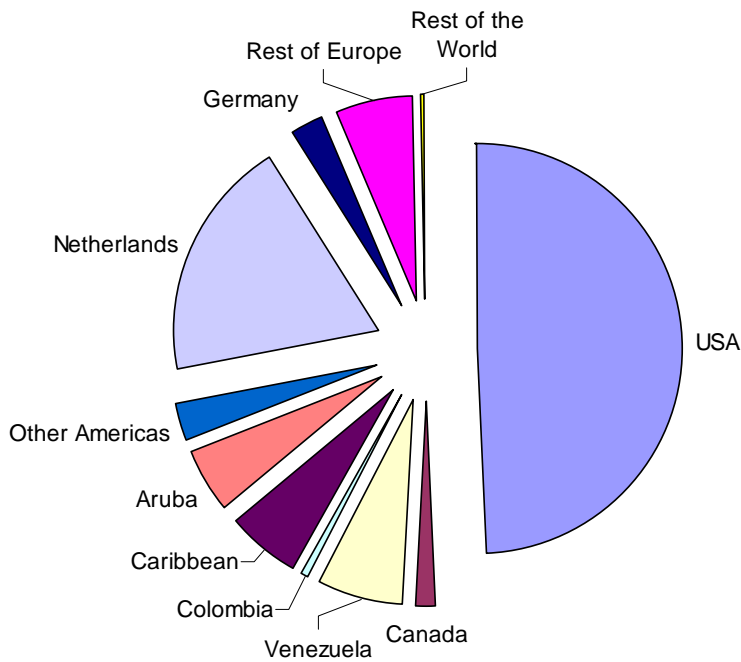


Figure 20: International visitors by country/region 1992-2002
(source: Bonaire Tourism Authority, see Appendix 19)

The amount of people buying marine park tags to use the Marine Park on a yearly basis remains at about 27,000 to 28,000 people, as can be seen in Figure 32. It is important to note, when looking at these figures that an estimate of between 20-30% of tags are re-used at some point, by local people and people coming back to the island. It is therefore not a possibility to use these figures to give an accurate indication of user numbers.

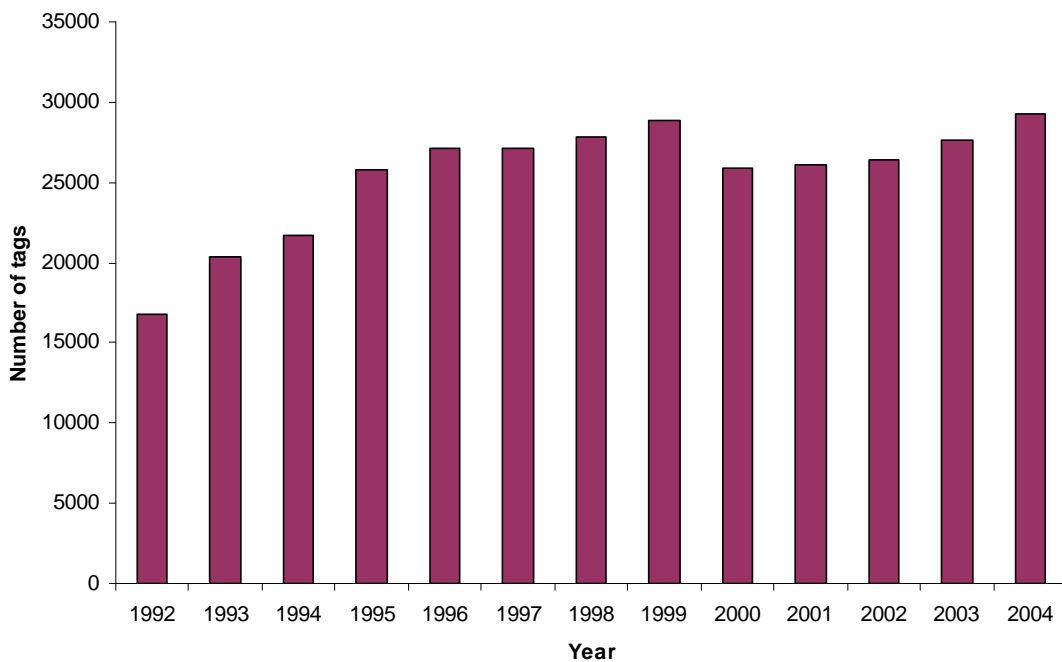


Figure 21: Marine Park Tag sales 1992-2004
(Source: BNMP records, data is presented in Appendix 20)

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, see Figure 33.

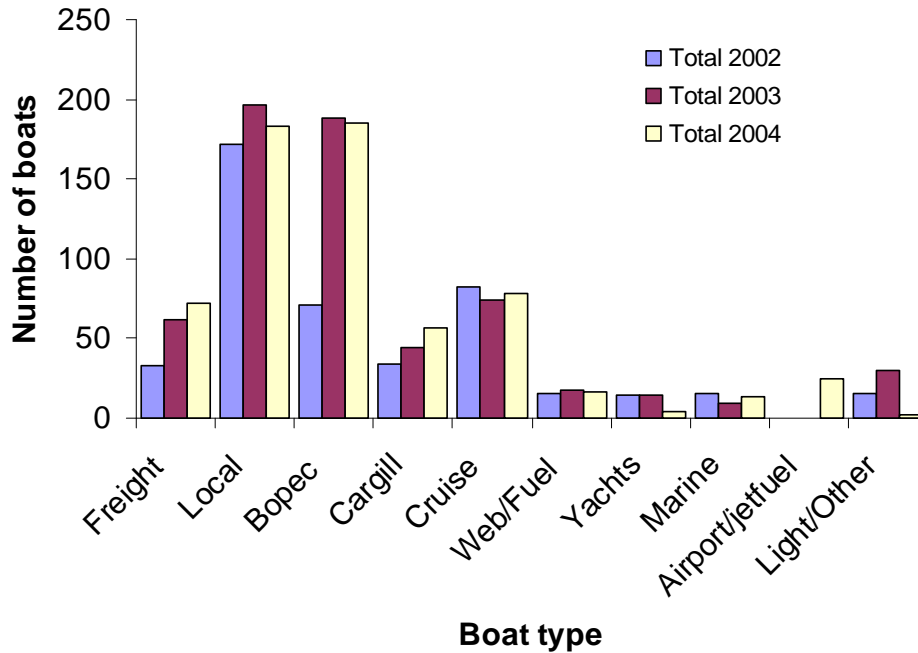


Figure 22: The number of different types of boats using Bonaire's waters.

(Source: DEZA publication 2004, see Appendix 2)

The nature of boat traffic has not changed excessively, 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 (See Figures 34 and 35)

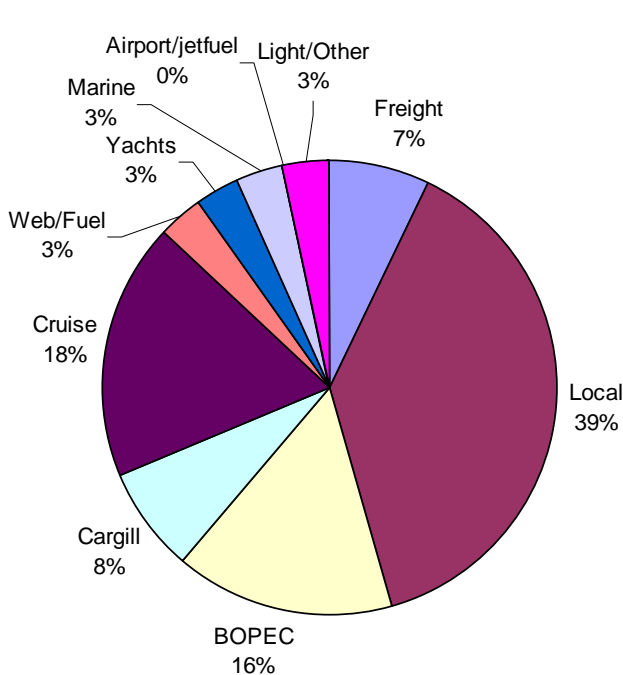


Figure 23: The nature of Boat Traffic in 2002 (left)

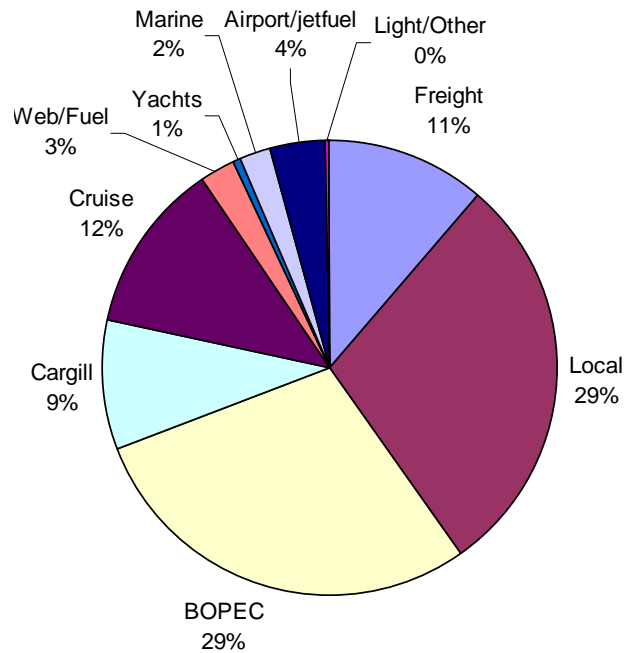


Figure 24: The nature of boat traffic in 2004 (right)

Zoning

When the marine park was first established in 1979 it was decided to take a holistic approach and to protect the waters around the entire island of Bonaire and Klein Bonaire. The rationale for this decision was that the islands themselves are small and that this would afford the most reliable and enforceable protection for the island's reefs, seagrass and mangrove systems as it would be practically impossible for activities such as dredging or destructive fishing practices to go on outside of the park which might impact the island's marine resources.

The boundaries for the marine park were chosen so as to be easily identifiable and to include within the park boundaries the most important user groups. Hence the high water mark was chosen as the landward boundary and the 60m depth contour was chosen as the maximum safe diving depth for SCUBA diving at that time. With regard to the shoreline it is clear that anything which is wet during the course of the normal tidal cycle (excluding storm events and extreme meteorological conditions) falls within the marine park. There is generally speaking a debris line at the high water mark. Also within the mangroves the high water mark is clearly visible on the mangrove prop roots.

With regard to the seaward extent of the marine park, whilst the legal limit of protection is set at 60m the park has generally be regarded to extend in principal beyond this and to give certain amount of protection to the seabed. This has allowed the park to prohibit anchoring in deep water off the island of Klein Bonaire and in mid channel between Bonaire and Klein Bonaire by cruise boats.

When the park was first established little regard was given to the situation of Bonaire's salinas and in fact separate protection was sought for a number of them (Saliña Slagbaai, Gotomeer) via the RAMSAR convention. It has since become clear that there is subterranean water flow between the salina's and the sea and that they are at least partially tidal which would lend weight to the argument that they too should be considered part of the Marine Park. Furthermore when salinas have been opened to the sea in the past e.g Saliña Wayaka in the Washington Park the consequences for the adjacent coral reefs have been devastating.

The Flamingo Paradise (man made lagoonal area adjacent to Plaza Resort) was similarly under dispute but in this case it is clear that the water in the lagoon system is continuous with the adjacent sea and the lagoons can be considered an extension of the Marine Park.

Most recently the Island Government of Bonaire chose to extend the landward boundary of the Marine Park by including with the Park boundaries the island of Klein Bonaire. This is the first known example of a Marine Park extending shorewards to include an entire uninhabited island.

Bonaire has two legally designated marine reserves located at;

- Playa Frans north to Slagbaai
- Karpata north to the entrance of the Gotomeer (Lake Goto)

These areas were set aside when the park was first established in 1979. Their goal was to provide the marine park with control areas or reference sites which would allow the park to gauge the impact of watersports activities on the health of Bonaire's reefs. Whilst the park was not under active management (from approximately 1983 – 1990) the reserves were not respected and their were regular publicized dive trips to the northern most reserve and routine fishing activity in both reserves therefore their value as reference sites was compromised. From 1991 onwards access to the reserves was again restricted.

Within the marine reserves diving, snorkelling and other watersports are strictly prohibited. No anchoring is allowed but fishing vessels passing through the reserves are allowed to fish but may not set fish traps (Marine Environment Ordinance Article 5).

The boundaries of the marine reserves have never been strictly defined. Traditionally the Marine Park has allowed divers and snorkellers to enter the water on the edge of the reserve area providing they also exit the water outside of the reserve area. Essentially therefore a buffer area has existed on the northern and southern edges of both reserves estimated to extend no more than 300m into the reserve. The location of the park and reserves can be seen in Figure 36.



Figure 25: Map of Bonaire showing the main dive sites (numbered 1-63) and Marine Reserves

Analysis of issues

Before defining the specific management objectives for BNMP, the key issues facing the operation and values of the protected area need to be identified. Bonaire National Marine Park is challenged with constraints on management and the existence of historical, current and future issues. Such issues can be human-induced or natural, and may originate from within the protected area or from beyond its boundaries. Often they will manifest themselves in the form of social or economic demands upon the protected area.

Historical issues

Historically the marine park was established to control the perceived threat of diving and the dive industry to the health and wellbeing of the island's reefs. Even when the marine park was revitalized in 1991, the main threat to the reefs was considered to come from SCUBA diving and related activities. Consequently for several years the park focused on addressing issues such as misuse of moorings and anchoring by the dive industry and diver impact on the reefs by visiting divers.

A keystone work produced in 1994 by Drs Callum Roberts and Julie Hawkins paved the way to a broader and more balanced approach to management which took into account the impact of yachting, fishing and coastal development. After 1994 marine park management made a concerted effort to inform users of the less obvious but more pervasive problems of nutrient enrichment and sedimentation as threats to Bonaire's reefs and to address issues such as the lack of a waste treatment facility, landscaping practices and building and construction practices in the coastal zone.

A Pew Fellows meeting held on Bonaire in 2003 brought world renowned researchers and scientists back to the island, some of whom had worked on Bonaire's reefs decades previously. It also brought to light data on Bonaire's reef fish populations from 1974 which indicated that Bonaire's reef fish populations are severely over fished, particularly the groupers, snappers and grunts and prompted the park to immediately consider the establishment of Fish Protected Areas to protect remnant carnivore populations.

Management issues

- **Lack of legal jurisdiction, lack of integrated coastal zone management.**
 - This produces a significant barrier to conservation because of the considerable links between the terrestrial and marine environments of Bonaire
- **Relationship of BNMP and STINAPA with government**
 - A lack of communication between STINAPA and the government means the politicians running the island do not understand the fragility and economic value of Bonaire's marine environments
- **Outreach**
 - Lack of presence is seen as a major constrain to the success of BNMP, many stakeholders would like to see some presence in Kralendijk and at the airport, as well as increased communications with rangers.
 - Dive orientations are essential to the well being of the marine park as more and more divers visit the island and need to be standardised to prevent damage to Bonaire's reefs

Current 'external' issues

BNMP has been through two processes for identifying the key issues facing the protected area. Firstly, a Strategic Planning Process with Coral Resource Management (2004 for a full copy see Appendix 21), secondly, a threat identification process for the Dutch Caribbean Nature Alliance Management Success Project (2005, for full details see Appendix 22).

ISSUES IDENTIFIED BY THE DCNA MANAGEMENT SUCCESS PROJECT

The DCNA Management Success Project used the WWF method of ranking issues facing the Marine Park. The manager of the marine park was presented a list of issues facing the marine park and asked to give them a number relating to the extent, impact and permanence of the threat presented by that particular issue. Numbers were allocated from 1-4, 1 being low impact, permanence or threat and 4 representing a high impact, permanence or threat. These figures were analysed and resulted in a figure for the degree of threat to BNMP that each issue represented, as presented in Figure 37. Further details of the methodology can be found in Appendix 22.

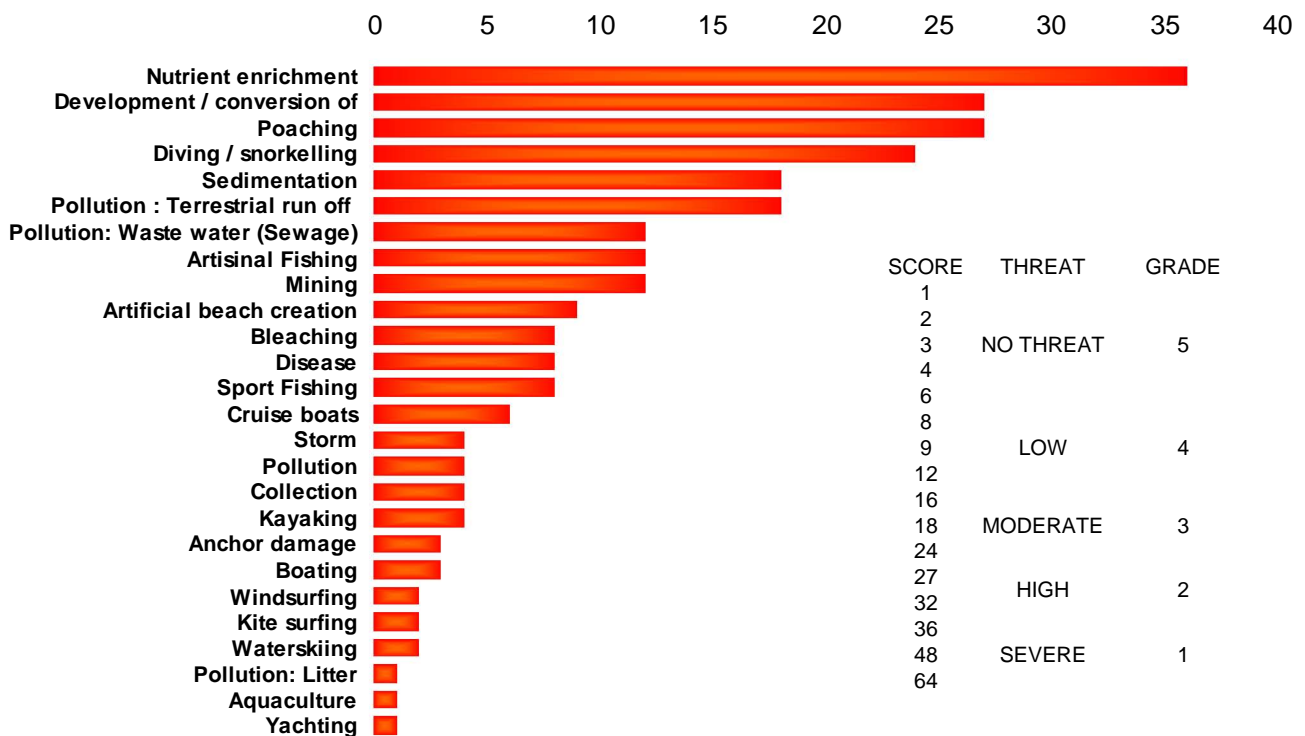


Figure 26: Results of the Management Success Project threat Analysis

The same exercise was carried out by Washington Slagbaai National Park where invasive species and farming were identified as the main threats facing the terrestrial natural environment. One of the key problems with agriculture on the island is the grazing of livestock, in particular goats which are considered an invasive species. Herds of goats can decimate vegetation which leads to excess runoff and erosion. In turn the eroded soils and sediments are washed into the marine environment, causing sedimentation and nutrient enrichment. This is an important factor for integrating efforts to tackle run-off pollution in the marine park.

ISSUES IDENTIFIED BY THE BNMP STRATEGIC PLANNING PROCESS

Issues facing BNMP were identified and management interventions were identified. The process was carried out by BNMP management and Kalli De Meyer, Executive Director of Coral Resource Management. Each of the issues identified was given a level of priority from 1-5, 1 being highest priority.

Grade	Status
5	Required
4	Necessary
3	Important
2	Essential
1	Critical

Table 19: Issue priority levels from BNMP strategic planning

The resulting strategic planning document can be seen in Appendix 21.

ISSUES IDENTIFIED BY BNMP STAKEHOLDER CONSULTATION

For simplicity the main issues raised during the stakeholder consultations of January 2006 have been counted by the number of stakeholder groups that raised each issue and considered it important. To fit with the scoring method from the management success project and the strategic plan, the issues have then been ranked, with 1 being the most frequently raised issue. Issues not included in the table were not brought up in the stakeholder meetings. Full analyses can be seen in Appendix 22.

	Stakeholder input rank score
Pollution : Terrestrial run off	0
Artificial beach creation	0
Development / conversion of land use	1
Sedimentation	0
Bleaching	0
Disease	0
Mining	0
Sport Fishing	0
Collection	0
Nutrient enrichment	5
Storm	0
Yachting	0
Boating	2
Diving / snorkelling	4
Poaching	4
Pollution: Litter	0
Pollution: Waste water (Sewage)	5
Waterskiing	4
Artisinal Fishing	4
Cruise boats	5
Kayaking	4
Kite surfing	4
Pollution	4
Windsurfing	4
Anchor damage	5

Table 20: Issue identification from stakeholder consultation

ANALYSIS

The following table presents a hierarchical list of the issues identified by the three methods outlined above.

	Stakeholder input	Strategic plan	Management success	Total
Pollution : Terrestrial run off	0	0	3	3
Artificial beach creation	0	0	4	4
Development / conversion of land use	1	1	2	4
Sedimentation	0	1	3	4
Bleaching	0	1	4	5
Disease	0	1	4	5
Mining	0	1	4	5
Sport Fishing	0	1	4	5
Collection	0	1	5	6
Nutrient enrichment	5	1	1	7
Storm	0	1	5	6
Yachting	0	1	5	6
Boating	2	0	5	7
Diving / snorkelling	4	0	3	7
Poaching	4	1	2	7
Pollution: Litter	0	2	5	7
Pollution: Waste water (Sewage)	5	0	4	9
Waterskiing	4	0	5	9
Artisinal Fishing	4	2	4	10
Cruise boats	5	0	5	10
Kayaking	4	1	5	10
Kite surfing	4	1	5	10
Pollution	4	1	5	10
Windsurfing	4	1	5	10
Anchor damage	5	1	5	11

Table 21: A hierarchical list of the issues identified by the three threat analysis identified

These results appear skewed since not all of the issues identified were brought up in each of the issue identification processes (so a score of 0 makes the issue more important than identified). To correct this, those issues that did not come up in all of the issue identification processes have been excluded. Table 21 summarises the most significant external issues facing BNMP as identified by stakeholder consultation, the management success project and strategic planning, the most significant issues are placed at the top of the list.

	Stakeholder input	Strategic plan	Management success	Total
Development / conversion of land use	1	1	2	4
Nutrient enrichment	5	1	1	7
Poaching	4	1	2	7
Artisanal Fishing	4	2	4	10
Kayaking	4	1	5	10
Kite surfing	4	1	5	10
Pollution	4	1	5	10
Windsurfing	4	1	5	10
Anchor damage	5	1	5	11

Table 22: A summary of the most critical issues facing BNMP as identified by the 3 described threat analysis processes

DETAILS OF THE CURRENT 'EXTERNAL' ISSUES IDENTIFIED AS SIGNIFICANT

ISSUE	Description
Development / conversion of land use	Building developments for tourism are often carried out near to the waters edge. This presents particular problems for pollutants entering the marine park through bad practice. When it is windy or it rains, cement, bags and other site rubbish can be blown or washed into the sea if preventative steps are not taken. These can then cause considerable damage to coral reef organisms, seagrasses and mangroves. Other changes in land use such as agricultural development, new car parks, beach creation etc can increase the amount of pollutants entering the sea through increased run-off and other changes in hydrology. Habitats can also be removed or affected by a change in land use or land use patterns e.g. turtle nesting beaches. Current projects causing concern include the proposed hotel development of 500+ rooms around Lac. The grazing of livestock (goats and donkeys) , which are considered invasive species' in Washington Slagbaai National Park, also reduces the cover of vegetation which increases run off and pollution from terrestrial sediment.
Nutrient enrichment	Nutrients are chemicals that are used by plants and animals for growth and energy. The main nutrients used on coral reefs are nitrogen and phosphorus compounds. Sewage from the human population is the main source of nutrient pollution on Bonaire's coral reefs. Corals usually thrive in nutrient poor environments and coral reef ecosystems are designed to quickly recycle any excess nutrients in the system. When there are elevated levels of nutrients around coral reefs algal growth and eutrophication kill coral (eutrophication occurs in an aquatic ecosystem where high nutrient concentrations stimulate blooms of algae, especially in areas where there is limited water circulation). Chemicals and microbes associated with nutrient pollution also harm corals. Any damage to the corals on a reef will affect the whole reef and the human use of the reef e.g. a decline in diving tourism because damaged reefs are less attractive to visitors.
Poaching	Poaching of conch, fish, and turtle species from a number of locations takes place. The removal of the animals is illegal (sometimes internationally prohibited) and causes a depletion in the stocks. Such a reduction in numbers directly endangers the populations and reduces reproduction rates. This makes the fishing greatly unsustainable, and is likely to endanger the health of the reef in general.
Artisanal Fishing	There are some issues with local fishermen taking undersized fish.
Kayaking	Kayaking around the mangroves of Lac has become a popular activity. It puts pressure on the seagrass environments through trampling, grounding and paddles scraping the seagrass and associated organisms.
Kite surfing	Recreational activities are a threat to BNMP through the disturbance of the natural environment. The arrival of Kitesurfing on Bonaire has raised a number of conflicts between user groups, mainly relating to safety and the crowding of waters. Kitesurfing has been prohibited in Lac but has found a new area on the South West of Bonaire (see Figure 32)
Pollution	Sewage makes its way onto Bonaire's coral reefs through inadequate waste water treatment and use. Sewage is a cocktail of substances, a number of which are dangerous to coral reef ecosystems and those who use them. Sewage is a source of major damage to Bonaire's coral reefs and a cause of human illness. Terrestrial run-off from Bonaire onto the fringing reef is a source of nutrients, sediments and other pollutants such as hydrocarbons (oil based chemicals), pesticides and herbicides, heavy (poisonous) metals. Ballast waters that are ejected from ships (especially those visiting the oil storage facility in the North of Bonaire) can contain a range of pollutants and exotic species which can become invasive, displacing native organisms. Jet fuel expelled from aircraft using the runway at Flamingo airport may also be having an impact on the reefs around Donkey beach.
Windsurfing	Windsurfing mainly takes place in Lac, where swimmers, snorkellers and fishermen also make use of the marine park. Conflicts centre around safety issues and the trampling of seagrass on the fringes of the bay where windsurfers launch and turn
Anchor damage	Anchoring is prohibited in the Marine Park (other than boats smaller than 12' in length using a stone anchor) since it damages the reef. However, the stone anchors used by local boat users can damage the reef and some anchoring still takes place illegally. This causes issues with tourists who having been through a dive orientation (where environmental awareness is taught), go into the marine park and see local people damaging the reefs.

Other issues considered important

Diving / snorkelling	Recreational SCUBA diving and snorkelling are often considered a non-extractive use of coral reefs causing relatively little environmental damage. Recently it has become clear that this is not the case. With the continued growth in the popularity of the sports in Bonaire, divers and snorkellers can have a considerable effect on the reef. This comes from the direct contact of people and their equipment with reef organisms and also from the more serious indirect impacts resulting from diver associated anchor damage, sewage discharges, sedimentation and other forms of pollution from the tourist developments. Suggestions have been made to provide an artificial reef for divers to take pressure away from key dive sites. In 2006 a private project installed 14 REEFBALL's at Sand Dollar condominiums dive site (Bari Reef).
Sedimentation	Sediment or suspended matter is insoluble particles of soil and other solid inorganic and organic materials that become suspended in water. Sedimentation is a natural process resulting from erosion of land and transport of soil to the sea (terrigenous sediments), or from resuspension of sediment previously deposited (such as carbonate from coral reefs). The main sources of sediment inputs to the coral reefs of Bonaire are considered to be runoff and sewage. Agricultural activities, deforestation, urbanisation and poor land management are key human activities that can increase runoff and consequently sedimentation on coral reefs.
Artificial beach creation	Tourists visiting Bonaire often prefer to have a beach to sit and relax on near the waters edge. The geology of the leeward shore provides very little space for beaches near to the main human settlements. Artificial beaches have been created in some places and can cause sedimentation of the reef as the sand dumped on the site of the beach is washed into the sea.
Cruise boats	Around 80 cruise boats visit BNMP per year, bringing thousands of visitors. They can be a source of pollution, where sewage and ballast are emptied into the marine environment. Ballast discharge in the BNMP is forbidden; all ships coming to Bonaire need to sign a ballast water declaration that states they have changed ballast water at least 12 miles from the island. Visiting boats have also been known to have oil leaks, and cruise ships have dumped broken glass onto the reefs near to the piers.
Mining	Beaches are protected by law against sand extraction, though sand extraction is allowed in certain areas. During the 1990's sand was extracted from a number of illegal sites along the length of the windward shore. During this process a number of cultural and historical resources were damaged along with turtle nests and breeding grounds for bird species; particularly where sand dunes were disturbed. Sand continues to be extracted illegally.
Bleaching Disease Storm	Bleaching is when corals lose their colour and eventually die. Corals also suffer from disease. Although bleaching and disease can be brought on by pollution and other 'human' factors they are difficult to manage since they can also be caused by 'natural' phenomenon making them difficult to manage. Likewise, the destruction that storms can cause cannot be managed, though storms present a very real threat to BNMP.
Collection	Some species found in BNMP are collected by people for pets, or by tourists as souvenirs. This includes many of the species on the CITIES species list, such as hard corals which are collected to be ornaments, and the Lora. Fish are also collected from the reef and put into aquariums.
Pollution: Litter	Litter can smother and kill wildlife though being consumed and becoming stuck on body parts. Plastic bags are often mistaken for jellyfish by feeding turtles.
Aquaculture	There is a small aquaculture venture growing shrimp on the east of Bonaire, near to Lac. It is considered to be only a very small threat to BNMP since it takes only water from the Marine Park (algae, which is food for the shrimp is grown in tanks). Waste from the building is expelled into the salt pans of Cargill in very small amounts, where it evaporates, becomes food for Brine Shrimp which Flamingo's feed on and even helps the process of salt crystallisation.

FUTURE OF ISSUES FACING BNMP

Since planning is about the future, the factors which can affect the future of BNMP must be identified and evaluated. Whilst such predictions are at best uncertain, the identification of future trends in ecological change, visitor use, conflicts, economics and related pressures should be attempted. An understanding of the socioeconomic environment is of particular importance. Predictions are not just about future issues – they also help to identify opportunities for planning, beneficial change, remediation or restoration. The following expectations of change come directly from the extensive stakeholder input of January 2006

FUTURE ECOLOGICAL CHANGE

- Decrease in coral cover (assuming development continues unchecked)
- Mangrove and seagrass damage (assuming development continues unchecked)
- Fish stocks are expected to decrease, however, if the fish protected areas are established, an increase in fish biomass is expected in 2-3 years.

FUTURE VISITOR USE

- Change in flight numbers
- Carrying capacity limits may be exceeded in some areas of use.
- The number of divers is expected to increase
- The number of Kitesurfers visiting the island is expected to increase (see Appendix 18) and begin to make a significant contribution to the islands economy.
- Increase in tourism is expected and the economic department in 2004/currently advise that more rooms are build to accommodate the expected increase
- Influx of visitors from Aruba and Curacao may occur – placing further stresses on BNMP's resources.
- Dive operations plan to start centres on the East coast

FUTURE CONFLICTS

- Coastal development and environmental protection are expected to continually be mismatched, unless steps are taken in outreach and enforcement.
- Less conflict between fisherfolk and other users is expected through the establishment of zones and improved communication
- The development of hotels at Lac is likely to come up against stiff opposition
- The closure of any more shore diving sites with preference given to private coastal developments and other users.
- As the water around Bonaire becomes busier with users, safety issues will become of greater concern. The role of BNMP, the police, the harbour master and other agencies needs to be clearly defined in relation to who carries out safety outreach/rescues etc.

FUTURE ECONOMIC ISSUES

- Although more tourists are expected to visit Bonaire over the coming years, some loss in tourism revenue may be caused through a decline in the ecological integrity of the marine environment.
- Some concerns have been raised over the future political and economic status of the island if Bonaire becomes part of Holland. Particular concerns were raised over an influx of workers and the likely associated unsustainable development.
- Loss of tourism revenue
- Continued increases in energy prices

OTHER FUTURE ISSUES

- The success of the planned waste water treatment plan is a major concern.
- Some concern over the future role of BNMP as an institution and the possibility of a loss of respect if BNMP's role is continually sidelined in favour of 'economic' development and construction.

Summary of issues

The main issues facing BNMP have been identified through stakeholder input, management opinion in the Management Success Project and by the Strategic Planning Process 2005. These are:

Management issues

- **Lack of legal jurisdiction, lack of integrated coastal zone management.**
- **Relationship of BNMP and STNAPA with government**
- **Outreach**

External issues

1. **Development / conversion of land use**
2. **Nutrient enrichment**
3. **Poaching**
4. **Artisanal Fishing**
5. **Kayaking**
6. **Kite surfing**
7. **Pollution**
8. **Windsurfing**
9. **Anchor damage**

Over the coming years, pressures on BNMP are likely to increase so it is essential that an effective management strategy for these issues is established. By dealing choosing an effective course of action to deal with one of these issues, value will be added by outcomes that will have a knock on effect and go some way to tackle other issues that have been identified. An example of this would be to tackle poor building practices and in the process reduce problems of sedimentation and some nutrient loading

Alternatively, BNMP can identify essential projects which deal with multiple issues, a good example of this would be to devise a comprehensive zoning plan to tackle kiting, kayaking, fishing, windsurfing and anchor damage issues.

The recognition of the key issues facing BNMP is essential to the production of an effective work plan and strategy, which is presented in the next section.

Part 3. Management Plan

Introduction

The management actions of Bonaire National Marine Park can be divided into three groups.

1. Actions relating to the core functioning of the marine park. These are the day to day activities without which the marine park could not exist. These activities are briefly described and included in the work plan and outlined.
2. Actions which respond to the issues identified for the management of the marine park.
3. Actions which respond to the external issues or threats and conflicts facing the marine park.

This section of the management plan will address each of these in turn before making further recommendations which have been identified as part of the management planning process. For completeness, at this point it is worth re-stating the mission and the goals of the Marine Park which will be satisfied to some extent by the actions outlined in this part of the management plan.

MISSION

TO CONSERVE AND MANAGE THE NATURAL, CULTURAL AND HISTORICAL RESOURCES, ALLOWING THEIR SUSTAINABLE USE FOR THE BENEFIT OF CURRENT AND FUTURE GENERATIONS.

GOALS

1. MAINTAIN AND/OR RESTORE THE ECOSYSTEMS, BIOLOGICAL DIVERSITY, AND ECOLOGICAL PROCESSES
2. MANAGE THE MARINE PARK AS A REGIONALLY AND GLOBALLY SIGNIFICANT AND SUCCESSFUL MULTI-USE MARINE PROTECTED AREA.
3. ALLOW USE OF THE MARINE PARK BY PROMOTING NON DESTRUCTIVE ACTIVITIES AND WORKING WITH STAKEHOLDERS TO ESTABLISH GUIDELINES AND REGULATIONS TO MINIMIZE IMPACTS ON THE ENVIRONMENT.
4. PROTECT AND/OR RESTORE THE CULTURAL AND HISTORICAL RESOURCES IDENTIFIED AS SIGNIFICANT

Marine Park management activities

The following list describes the current functioning of BNMP in terms of the day to day activities it carries out. In places, projections are made to illustrate how the component might develop in an ideal world. Much of the information was ascertained through a consultation with the STINAPA board, Management and Staff.

Staffing

Current staffing levels are considered insufficient; ideally BNMP would like to function with:

- Manager
- ***Assistant manager***
- Chief ranger
- ***Project manager***
- 7-8 rangers – ***fully qualified and trained***

Those in bold and italic represent the staff that are lacking. BNMP shares the following office staff of STINAPA with Washington Slagbaai National Park

- Director STINAPA
- Accountant
- Communications officer
- Receptionist
- Multi task operative
- Cleaner

Two consultants are being used by BNMP:

- D. MacRae, Director, Coastal Zone Management UK
- Kalli De Meyer, Executive Director, Coral Resource Management

Around 20 Volunteers can be depended on to help with monitoring and some outreach, clean up dives, and maintenance.

Equipment

With an increase in staffing levels, a matched increase in equipment would be required, though there is a lack of funding for both.

Facilities

The facilities that would ideally be improved or included in BNMP are:

- Improved workshop for maintenance
- Lockers and staff area improved
- 'Downtown' location for STINAPA offices in the long term, small gift shop or visitor centre with information would be ideal in the short term.

Training

Planned training includes 2 rangers to qualified to Advanced Open Water, 3 rangers to rescue diver. There are also some planned ranger exchanges with St. Eustatius. Ideally the rangers would be able to take part in the following skills development courses, although at present they are not available

- IT for rangers
- Communication skills (including underwater)
- Boat handling skills
- General water skills
- Tourist guide course especially communication
- Further ranger exchanges

Financial budget

See Appendix 23

Interpretation and education

Currently 3 education courses are running:

- Junior rangers – with Jong Bonaire
- Aspiring ranger – with Centro di Bario Nord Saliña (younger students)
- Tortuganan di Boneiru – snorkel programme for school kids

Monitoring and research*

2 monitoring programmes are currently running within BNMP:

- Carrying capacity monitoring for the use of the buoys
- Coral reef fish survey and coral transects (AGRRA)
- Nutrient monitoring organised by MINA involving samples of algae taken from key sites and analysed for their constituents.

Future research needs may include:

- Reef restoration programmes research e.g. with the Reefball pilot project
- Sedimentation study in critical areas where the government has ideas for development.

Maintenance

Rangers carry out maintenance, mostly on cars, boats, gear buildings and moorings. An improved maintenance area would be beneficial to the work done.

Surveillance

Patrols are carried out daily by boat and on land. The objectives are to control activities in sensitive zones and to gathering information.

Enforcement

Possible crimes are detected during patrols or through contact from an external source. Poachers are stopped and everything involved with the crime is confiscated, then a legal case is started, occasionally the attorney is contacted.

Evaluation of success

The success of BNMP is monitored every 6 months as part of the Dutch Caribbean Nature Alliance Management Success Project. The results are presented in a report and posted to the DCNA website. The most recent report can be seen in Appendix 24.

Year core activity Plan 2006

Activity	Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Human Resource													
1.1 Hiring new personnel													
1.2 Training personnel													
1.3 Fund raising workshops													
1.4 Staff meetings													
1.5 Daily human resource management													
1.6 Volunteer program													
1.7 Non Governmental Organizations (NGO)													
1.8 Reporting													
Equipment													
2.1 Office equipment													
2.2 Car													
2.3 Monitoring equipment and monitoring program													
2.4 Maintenance													
Infrastructure													
3.1 Research center and lodges													
Law enforcement													
4.1 Special police power-course													
4.2 Nature ordinance													
4.3 Enforcement													
4.4 Communication and cooperation with authorities													
4.5 Commissie Marine Milieu (CMM)													
4.6 Communication and cooperation with stakeholders													
Nature													
5.1 Monitoring													
5.2 Waste water treatment facility													
5.4 Fish Protected Areas (FPA)													
5.5 Coastal development guidelines													
5.6 Lac management plan													
5.7 BNMP management plan													
5.8 Coastal clean-up													
5.9 World Heritage Nomination (WHN)													
5.10 Research													
5.11 Communication and cooperation with stakeholders													

Activity	Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Education													
6.1 Turtuganan di Boneiru													
6.2 Junior Ranger Program													
6.3 Other Nature and Environmental Education (NME) -activities													
Public relations and information													
7.1 Update website information													
7.2 STINAPA-newsletter													
7.3 E-mail drops													
7.4 Press releases													
7.5 Communication and cooperation with stakeholders													
7.6 Requests for info													
7.7 Seminars and workshops													
Finance													
8.1 Tag sale													
8.2 Fundraising													
8.3 Grant request													
8.4 Budget													
8.5 Moorings													

Work schedule overview 2006

The headings and actions are not placed in order of priority.

	HEADINGS	ACTIONS	TIME FRAME	FINANCES (NAFL)
1 HUMAN RESOURCE	1.1 Hiring new personnel	1 x ranger	By May	1 x 36,700 =
		Project Manager	By May	57,000.- (incl. 2,000.- recruitment costs)
	1.2 Training personnel	Ranger Course	Ongoing	3,000.- GP
		Special police powers course		
		Managers trainings, upgrading workshops and/or other educational activities	Ongoing	
	1.3 Fund raising workshops			
	1.4 Staff meetings	BNMP-staff meeting	Weekly	none
		STINAPA full staff meeting	Monthly	none
	1.5 Daily human resource management	Management team meeting	Weekly	none
	1.6 Volunteer program	Meeting with Chief Ranger	Ongoing	none
		Meeting with Director and Managers individually	Ongoing	none
		Scheduling	Ongoing	none
		Keep personnel files up to date including vacation days	Ongoing	none
		Supervise personnel	Ongoing	none
	1.7 Non Governmental Organizations (NGO)	Evaluation of personnel	Yearly	
		Input on revision of evaluation system	By March	
		Contribute to STINAPA Integrated Plan and Budget for 2007 (includes set up of BNMP-budget, Budget notes, Investment plan and Work Plan)	By August	
		Work Plan 2007	By October	
Organization and coordination of volunteer projects, (annual) meetings and provide feed back.		Ongoing	3,000.-	
Organize Monitoring teams. Coral, fish, sedimentation.				
1.8 Reporting	Meet with national and international NGOs	Regularly		
	Contribute to the STINAPA Year Report 2005	Yearly		

	HEADINGS	ACTIONS	TIME FRAME	FINANCES (NAFL)	
2. EQUIPMENT	2.1 Office equipment	High Definition screen, Slides scanner	By January	5.000	
	2.2 Car	2 x double cabin pick-up trucks in the first half of the year and 1 extra the second half	2 x by March 1 x by September		
	2.3 Monitoring equipment and monitoring program	Multiparameter sensor + field material for AGRRA monitoring + Sediment traps + lab material. Organization of AGRRA workshop on Bonaire in 2006 (May/June?)		15,000.-	
	2.4 Maintenance	Vehicles (4)		Ongoing (weekly + garage schedule)	13,000.-
		Moorings		Ongoing	In budget
		Boats		By August	In budget
		Properly maintain all other tools and working material		Ongoing	
		Repair lookup room		By June	?????
3	Infrastructure 3.1 Research center and lodges	Set up a plan for realization of a STINAPA research center and accompanying lodges	By December		
4. LAW AND LAW ENFORCEMENT	4.1 Special police power-course	(also see 1.2)			
	4.2 Nature ordinance				
	4.3 Enforcement	Patrolling		Ongoing	
		Supervise construction activities in the BNMP		Upon occasion	
	4.4 Communication and cooperation with authorities	Supervise research in the BNMP		Ongoing	
		District Attorney, Police, SSV, Customs, Coast Guard, Polis Ambiental, DROB		Ongoing	
	4.5 Commissie Marine Milieu (CMM)	Advice CMM on matters concerning the marine environment		Monthly	
4.6 Communication and cooperation with stakeholders	Involve, inform and cooperate with stakeholders and others in matters of law and law enforcement, during set up and implementation of management plans, research, monitoring, etc.		Ongoing		

	HEADINGS	ACTIONS	TIME FRAME	FINANCES (NAFL)
5. NATURE	5.1 Monitoring	Run reef monitoring program according to the schedule.	Ongoing	3.000
		Implement monitoring program for coral diseases, sedimentation, Diadema and dive site use.	By June	GP
	5.2 Waste water treatment facility	In cooperation with other parties continue working towards realization of the facility. Seek funding to add tertiary treatment stage to the facility	t.b.d.	none
	5.4 Fish Protected Areas (FPA)	Gathering information. Together with LVV, set a Catch landing monitoring program.	By September	none
		Set FPA's	By June	
	5.5 Coastal development guidelines	Proposal to BC + EBHAM made	By May	none
		Implementation	By October	none
		Monitoring FPAs and control areas	Ongoing	none
		Finalize guidelines	By April	GP
		Present to DROB and BC	By May	
	5.6 Lac management plan	Distribute and implement guidelines	By July	GP
		Implementation of Lac and Klein Bonaire management plan	Together with BNMP Management Plan	See 5.7
	5.7 BNMP management plan	Develop BNMP-management plan (including executive summary)	By April.	80,000.-
		Present to DROB and BC	By April	none
	5.8 Coastal clean-up	Implementation of BNMP management plan.	From July onwards	5,000.-
5.9 World Heritage Nomination (WHN)	In cooperation with STCB, Tene Boneiru Limpi and Volunteers, organize Earth Day 2006.	By April	none	
	In cooperation with STCB, Tene Boneiru Limpi and Volunteers, organize International Clean up Day	By September	none	
	WHN-preparation	Ongoing	Funding	
5.10 Research	Since Bonaire decides to change the nomination type, this has to go out of the plan.		Funding	
5.11 Communication and cooperation with stakeholders	Set up research programs	Ongoing	GP	
	Supervise and assist visiting researchers and/or students	Rising to the occasion		
	See point 4.6	Ongoing		
	Attend CURO meetings. Help to set up the Association of Snorkel Charters	Monthly		

	HEADINGS	ACTIONS	TIME FRAME	FINANCES (NAFL)
6. EDUCATION	6.1 Turtuganan di Boneiru	Lessons (5 weeks courses)	Ongoing	
		Snorkel and SCUBA club	Ongoing	
	6.2 Junior Ranger Program			
	6.3 Other Nature and Environmental Education (NME) -activities	In cooperation with Jong Bonaire and Sentro di Barrio Nord Saliña	On going	1000.-
In cooperation with the STINAPA-NME coordinator and STINAPA-volunteers		Ongoing		
7. PUBLIC RELATIONS AND INFORMATION	7.1 Update website information		Ongoing	
	7.2 STINAPA-newsletter	In cooperation with Washington Slagbaai National Park, the rest of STINAPA and volunteers set up an online news pamphlet and distribute hard copies twice a year.	Twice a year	12,000.-
	7.3 E-mail drops	Send bits of information, press releases, etc. to Marine Park tag buyers	2 to 4 times a year	
	7.4 Press releases		Ongoing	
	7.5 Communication and cooperation with stakeholders	See point 4.6	Ongoing	
	7.6 Requests for info	Handle requests (phone, e-mail, fax, etc..)	Ongoing	
	7.7 Seminars and workshops	Initiate and attend workshops and seminars	Ongoing. See 2.3	
8. FINANCE	8.1 Tag sale	Distribute tags to dive shops	Ongoing	none
	8.2 Fundraising	Raise additional funding whenever budget is insufficient	On going. In 2005, BNMP create a "Fish of the Bonaire National Marine Park" t-shirt collection. Create more material to sell in WSNP and other outlets.	
		8.3 Grant request	Work out the NOAA application for the monitoring program	Ongoing
	8.4 Budget	Set up BNMP-Budget for 2006 (including an investment plan)	By September	
		Revise BNMP-Budget 2005	By August	
	8.5 Moorings	Guard the BNMP-budget		Ongoing
Supervision of collection of commercial and private mooring fees			Yearly	
Supervision of execution Harbour Village contract to manage public moorings				

Key Issues and actions

The key issues facing BNMP have been identified following stakeholder input, strategic planning and one further threat analysis carried out for The DCNA Management Success Project. The following actions are considered critical for BNMP to deal with. These need to be the focus of Marine Park management activities to ensure the future success of the marine park, and to pursue the mission and goals of the marine park.

Management

NEED FOR AN INTEGRATED APPROACH TO COASTAL ZONE MANAGEMENT.

Bonaire is surrounded by fringing coral reefs which means that everything which happens on the land directly and immediately impacts on the island's fragile coral reefs. Whilst the Marine Park has been able to deal effectively with impacts and issues originating within the marine environment at the present time the Marine Park's jurisdiction ends at the high water mark and it is unable to deal effectively with land based impacts. Therefore whilst Bonaire's marine environment is well regulated and managed the coastal zone is not.

For the Marine Park to effectively protect the island's marine assets an integrated, holistic approach to the sustainable development of the island is essential. **This can only be achieved if the marine park is a made consultee for terrestrial developments, and any advice the marine park offers is taken as definitive.** To achieve this recognition BNMP needs to successfully lobby the government and legal authorities. This needs to be done on two levels.

Actions

- **Petition the Island Government to address the lack of integrated coastal zone management on Bonaire.**
- **Educate the Island Government and other stakeholders about the value of Bonaire's marine resources, their fragility and the impacts of land based development and pollution on Bonaire's fragile fringing reefs.**

NEED FOR COMPREHESIVE ONGOING OUTREACH TO ALL STAKEHOLDER GROUPS

Outreach is an essential part of informing the public, visitors, stakeholders and other interested parties about the affairs and successes of the Marine Park. Successful outreach programs strengthen the position of protected areas on a number of fronts and lighten the workload of the Marine Park in the long run.

Actions

- **identify stakeholder groups**
- **identify the relevant information to distribute**
- **identify the method of communication**
- **carry out communications**

Use a simple structured communication strategy as suggested on the next page.

Further notes:

Stakeholders should be consulted more often and in a structured fashion to increase the feedback that the marine park receives. For example, suggestions have been made for a bi-monthly meeting at a set location with all stakeholders who wish to take part to identify key issues which BNMP can also use as a marketing and update platform.

Fees outreach.

- Boost awareness amongst stakeholders about the new fees system
- Carry out more checks of tags, especially of other water sports at Lac.

Awareness programmes

- Target the government, fishermen, and windsurfers/kiteboarders first.
- Share ideas about the marine park with presentations from both parties, updates on legal issues, guidelines and rules etc.
- New outreach locations should be established at the Harbour and ports, Airport, on Cruise Boats. Other outreach location suggestions include: laundrettes, supermarkets, shops, bars, restaurants, stall for cruise ships.

Dive orientations

- Orientations should be standardised though a video, and
- Those giving orientations should have an update on marine park affairs twice yearly.
- An incentives or awards programme for those professionals and visitors taking part should also be established, for example, badges or formal recognition as a Marine Park Warden for dive professionals

Passive/informal outreach

- Established at the airport, especially information about the user fee, rules and regulations
- Rangers of the marine park should also play a more public role through formal and informal presentations and guided tours for visitors and locals alike.
- Build on the current DIVA GIS system produced by the WWF to establish georeferenced maps for the BNMP website to help with outreach.

International partners.

- Build relationships with international partners, including universities with student/staff that may want to carry out research in BNMP and conservation organisations. Contact the partners and offer them outreach materials or subscription to a newsletter.

Outreach strategy for Bonaire National Marine Park

GROUP	DETAIL	OBJECTIVES	WEBSITE	LIST SERVERS	ANNUAL REPORT	NEWSLETTER	E-NEWS	BROCHURE, LEAFLETS	SIGNAGE	PRESENTATIONS	MEETINGS	PRESS /TV/RADIO	MANAGEMENT PLAN
Government	Governor, commissioners,	Promote: nature as good business and its value to the island economy	◆		◆	◆	◆	◆		◆	◆	◆	◆
Government departments	DROB, DEZA, LVV, JAZ	Developing practical solutions to conservation and management issues	◆		◆	◆	◆	◆		◆	◆		◆
Tourism	Tourism Boards, FCCA, associations, trade shows, fam trips, airlines, travel agents, resorts	Establish BNMP as a premier dive and watersports destination in the Caribbean and the role of conservation	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆
Local Watersports	Dive operators, wind/kite surfers, kayakers, sailors, power boaters, fisherfolk etc	Emphasis the need for practical hands on conservation effort on the part of the industry to protect the reefs and their role	◆		◆	◆	◆	◆	◆	◆	◆	◆	
Tourists	Visiting tourists,	Importance of marine conservation and visitor role in conservation management	◆			◆	◆	◆	◆	◆		◆	
Volunteers	Local and international volunteers	Muster continued interest through involvement and active feedback	◆	◆	◆	◆	◆	◆		◆	◆	◆	◆
Research Institutions	International, regional	Stimulate relevant management orientated research into issues of interest to BNMP	◆	◆			◆			◆			◆
Private sector	Companies, individuals, business associations	Value of the marine park (to their business) and fund raising	◆		◆	◆	◆	◆		◆	◆	◆	
Islanders	Islanders, especially special interest groups such as fishermen	Stimulate interest in BNMP, educate about conservation management and build support for management decisions				◆	◆	◆	◆	◆	◆	◆	
Funders	Current/future funders, AMFO, foundations, individuals	Build donor confidence in BNMP and donor cultivation	◆	◆	◆		◆			◆	◆		◆
International conservation	Regional institutions, international NGOs, conferences	Promote conservation management activities and build relationships with other similar initiatives	◆	◆			◆			◆	◆		
Local Education	Schools and school children	Educate about the marine environment and need for conservation	◆			◆	◆	◆	◆	◆		◆	

External issues

PROMOTE SUSTAINABLE DEVELOPMENT / CONVERSION OF LAND USE

Unsustainable development on Bonaire is the most serious threat to the islands resources. Thoughtless landscaping and building near the waters edge, and even inland, causes sedimentation and nutrient enrichment of the reefs. This destroys the basis of the marine ecosystem and featureless algae covered reefs take the place of thriving, colourful coral ecosystems. Recommendations have been made by the governments' economic department to keep building more hotels to cope with the demand for rooms. The following steps should be taken to make sure any more development has as little impact as possible:

Actions

- **Organise the construction guidelines:** The guidelines should be brought up to date and reviewed. The associated outreach materials, posters, stickers, press releases should also be reviewed.
- **Establish an Incentive programme:** Formulate an incentive programme for the guidelines using recognition e.g. green Flamingo programme. Decide on how companies/individuals qualify and what the benefits to them will be
- **Market the guidelines:** Publish advertisements in the press, involve stakeholders at every stage, in particular the construction industry
- **Publish the construction guidelines:** launch the construction guidelines at an event designed to bring in support – presentation, invite important people and a 'star' representative.
- **Monitor success:** monitor the success of the programme through stakeholder meetings to get feedback and also observe changes in construction practice.
- **Maintain the profile of the programme**
- **Launch associated programmes;** for landscaping and smaller scale builds.

REDUCE NUTRIENT ENRICHMENT

Nutrient enrichment from poorly treated waste water treatment units causes algal growth on Bonaire's coral reefs. Nutrients also come in a cocktail of other substances. As the number of people visiting Bonaire increases even more sewage waste will be produced.

Actions

- **Raise awareness** through press releases and Radio about the impact of nutrients on reefs – explain the process in simple terms and its effect on the economics of BNMP
- **Pursue the planned waste water treatment plant:** Keep involved at the highest level with the planned plant, by liaising weekly with DROB and the government, ensure that the plant will be effective by cross-consulting the plans with external reviewers.
- **Grey water use:** Raise awareness of the uses of grey water by publishing fliers and press releases/radio programmes to tie in with the construction guidelines from above.
- **Treatment effectiveness:** Encourage people through outreach to check the effectiveness of their wastewater treatment method, and update;
- **Lobby the government** for contributions to treatment upgrade programmes for people not serviced by the new planned plant.

REDUCE POACHING

The poaching of turtles and conch from Lac and other areas of the marine park continues to be an issue. Turtles are an endangered species and their capture is illegal on Bonaire. Conch stocks are close to collapse as very young individuals are removed from their habitats at Lac and other locations.

Actions

- **Increase outreach:** Involve the local fishermen in the turtle tracking programme and surveys. Commission a conch survey led by the fishermen. Reinforce the idea of protecting stocks to make them sustainable. Facilitate meetings between STCB and the fisherfolk. Produce press releases, and radio programme releases. Encourage members of the public to report illegal catches.
- **Increase patrols:** Increase patrolling particularly at weekends in the mornings when poaching is most often spotted.
- **Set catch limits:** Set a minimum landing size for conch to prevent juveniles being taken.
- **Set enforcement methods:** Issue permits to fish for conch of a set size, and if people are caught with undersized conch, the permits are revoked (this will also hopefully muster a sense of ownership and self-policing).

MANAGE ARTISANAL FISHING FOR LONG TERM SUSTAINABILITY

Reef fisheries on Bonaire have been in significant decline for a number of years. Target species include grunts, groupers and other large predators. Large herbivores such as Parrot fish are not targeted on Bonaire. These target species are non-migratory and they have very slow reproductive rates. As the fish grow their ability to produce eggs increases exponentially (at an ever increasing rate). These facts along with the amount of fishing effort going into the artisanal fisheries mean that the stocks have no time or space to recover.

Actions

- **Stakeholder presentations.** Use information gathered to date to prepare multiple format presentations. Use not only Power point and visual graphics but also models and simulations of the decline of fisheries, and the benefits of FPA's. Use the report prepared by Steneck et.al. (2005) as a source for scientific references especially pages 75/76.
- **Stakeholder consultations/involvement.** Get feedback from fishermen and watersports operators about the role of FPA's. Involve stakeholders in monitoring programmes from the beginning. Organise fish catch monitoring, have a subsidy for returned undersized fish which are measured and put back.
- **Set up fish protected areas.** Identify areas with stakeholders, especially fishermen and watersports operators, where no take zones can be established. Combine no take zones with other zones such as kite surfing, no anchoring, coral seeding, research area etc.
- **Include a wide geographical area in the decision making.** Include the whole island (not just the West coast) in the FPA planning process, including Lac and Klein. Consider other zones that can be located in FPA's e.g. kayaking, turtle protection zones for feeding and nesting.

Recommendations

The following list of recommendations addresses other issues that have arisen during stakeholder consultation and prior to the development of this management plan. The main issues and action plans have been identified in the previous section. The following suggestions need to be addressed if human, physical and financial resources allow and at the next management plan review.

Zoning Plan

The only legally recognised zones on Bonaire are the Marine Protected Area as a whole, from the High Water Mark to the 200 ft depth contour, and the Reserves at Karpata and Playa Funchi. Through the stakeholder input in January 2006 and considerable effort towards establishing fish protected areas, the need for a clear zoning plan was ascertained. Zoning plans have become into common use in planning of natural areas. Through a properly designated zoning scheme, potential conflicts between users can be minimised and in the same time provide optimum protection of endangered natural areas or species. Motivations listed for zonation of natural areas are:

- When marked conflicts between activities exists, for example between tourism and traditional fisheries.
- If there are current or potential conflicts between the conservation objectives of the area and other possible activities.
- If there are unique habitats or cultural features present
- If there is a need to provide specialised or quality services for a group(s) of park users.

A holistic zoning plan should be written to consolidate the function and positioning of the current zones and to address current conflicts of use. Thought must be given to a hierarchical system of 'zones' with specified uses and rules, through a spectrum of control from strict no-use areas through to single use areas and multiple use zones. In the light of these criteria and identifications made, a number of possible zones have been suggested for Kitesurfing, Power boats, Fish protected areas, various zones in Klein Bonaire and Lac as well as an extension of the marine park to 12 nautical miles.

Zone	Rationale
Kitesurfing	Kitesurfing is a very fast growing sport, with those taking part willing to travel and spend considerable amounts of money to pursue it. The windy conditions on Bonaire are ideal for the sport. Kitesurfing has been banned from Lac for safety reasons. The only Kitesurfing business on Bonaire now uses a location in the South of the Island. Since TCB (Tourism Corporation Bonaire) recognised Kitesurfing as a new industry on Bonaire it requires a fixed area where it can be practiced safely and in a regulated fashion. The kite surfing operator on the island has put forward a positioning document that can be seen on Appendix 18.
Power craft zone	Concern over wash from power boats and individuals travelling too fast near the shore have raised safety issues. A power boat zone and regulations over who can rent the boats, types of craft and engine size restrictions are recommended
Fish Protected areas	Extensive work has already been carried out into the establishment of Fish Protected Areas around Bonaire, where fishing is prohibited. This approach to protecting fish stocks has been proven to increase stocks as the FPA acts as a seeding area for surrounding waters.
MPA extension	An extension of the marine park to include deeper waters to the extent of the Territorial Waters of Bonaire at 12 nautical miles.
Buffer zone	Terrestrial buffer zone a specified distance landward of the marine park, to offer some protection to turtle nesting and some option for consultation over coastal development

Table 23: Recommended zones for BNMP

Zone	Rationale
Klein Bonaire	Klein Bonaire is used extensively by visitors to the islands and locals as a place of recreation. The coral reefs around Klein Bonaire attract divers and snorkellers and fishermen alike. The island is also a hotspot for turtle nesting and feeding (for further information , see Sea Turtle Conservation Bonaire Annual Report, Appendix 25). The government (DROB) have already been working on a zoning plan for Klein Bonaire (Appendix 26), which would be most effective if worked into a management plan for Klein Bonaire, within the structure BNMP management plan.
Lac	Lac is used extensively by visitors to the islands and locals as a place of recreation. The seagrasses and mangroves in Lac attract kayakers and snorkellers, swimmers, windsurfers and fishermen alike. Lac is also a nursery for reef fish and a feeding ground for turtles. Considerable thought has already gone into the Lac Management plan and zoning options for the bay have been put forward (see Appendix 27). These would also be most effective if worked into a management plan for the whole of Lac, within the structure BNMP management plan.

Table 22 Continued

Where possible, the grouping of zones should be arranged. For example, is a kite surfing zone is to be established, perhaps the area could be a no-diving zone in places, fish protected area, no anchoring zone etc, especially as the south of the island is considered to be a seeding zone for coral juveniles from Les Aves and Los Roques. At every stage stakeholder input, especially the fishermen and water sports operators, must be sought.

Management Plans for Lac and Klein Bonaire

Management plans are required for Lac and Klein Bonaire. Lac has very distinctive management issues in terms of use (fisheries, watersports) and conservation (mangroves, seagrass and coral reefs). The current Lac management plan does not address the pertinent issues effectively although it does go some way to recommending a new zoning strategy. Klein Bonaire also has its own issues as it is used by many visitors and tour operators, it is a hotspot for turtle activity and the land mass is under the control of the marine park.

Conservation Value

The conservation values of the marine park need to be established and stated in detail. This includes detailed species lists and a database with photographs which should be available through the website and detailed descriptions of the Ramsar sites of Bonaire as well as values of other important environments such as the Karst systems and the algae dominated reef on the windward shore. Such information should be made available through a GIS platform. The development of such a project should include stakeholder input at every stage with the possibility of establishing a committee with the government, NGO's local people and others to decide on which resources are significant, especially in relation to historical and cultural resources. The values list presented in this management plan would be a good starting point for further investigations.

Monitoring and Review

A robust and strategic programme for monitoring the marine park activities, the progress of actions and the health of the natural resources needs to be established. CARICOMP data is no longer collected; AGGRA should continue to be collected. REEFCHECK is carried out by volunteers twice a year. Historical monitoring and research should be summarised and made readily available, especially in the fields of fisheries and nutrient/sedimentation pollution. An up to date list of published scientific literature can be seen in Appendix 28. It would also be very useful for STINAPA to enrol a volunteer to catalogue it's own extensive library and literature into bibliographic database software such as 'ENDNOTE'.

Appendices

- 1** Ramsar Site Details
- 2** Economic Analyses
- 3** Bathymetric Chart of the ABC Islands
- 4** Species Lists
- 5** Cetacean Study
- 6** Lac Aerial Photographs and Maps
- 7** Bonaire AGGRA study
- 8** Mangrove species of Bonaire
- 9** Red List and CITES classifications
- 10** Stakeholder meeting minutes and presentation
- 11** Policy Plans
- 12** Marine Environment Ordinance
- 13** EBHAM's (Extra Legislation)
- 14** Brochures and signage used by BNMP
- 15** Staff evaluation Forms and House Rules
- 16** Mooring construction diagram
- 17** Questionnaire responses and related documents
- 18** Kiteboarding Bonaire Positioning Document
- 19** Bonaire Tourism Statistics
- 20** BNMP Tag sales Records
- 21** Strategic Planning Documents
- 22** Pressures Analysis
- 23** BNMP Financial Budget
- 24** DCNA Management Success Report 04-05
- 25** Turtle Club Bonaire 2005 Year Report
- 26** Klein Bonaire Zoning Plan
- 27** Lac Management Plan
- 28** Endnote and WORD references for BNMP
- 29** Demonstration and WHS status details

Part 4. Additions and Developments