

Biodiversity Monitoring on the BES-islands:



...Past, Present and Future

**Ministry of Economic Affairs, Agriculture and Innovation
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Abstract

With the transition of the islands of Bonaire, St. Eustatius and Saba (BES) from the former Netherlands Antilles to special municipalities of the Netherlands on the 10th of October 2010, the Netherlands gained a significant amount of biodiversity. The Ministry of Economic Affairs, Agriculture and Innovation (EL&I) has gained an important new area of responsibility in terms of nature policy and management. Ecological monitoring can assist in directing management action and conservation of natural areas. It is essential that biodiversity on the BES-islands is monitored, particularly as it is threatened by a large array of natural and human factors. Aside from the national responsibilities that the Kingdom of the Netherlands holds for monitoring nature and biodiversity in these special municipalities, the Netherlands also has international obligations stemming from their participation and membership in global and regional environmental treaties.

This report aims to establish a foundation and define several priority action points for setting up a structural biodiversity monitoring system on the BES-islands, by investigating and contrasting the development, character and organization of biodiversity monitoring in the Netherlands with that of the BES-islands. This research was conducted using purely qualitative research methods; a literature review was conducted, various interviews were conducted in the Netherlands, surveys were distributed amongst actors involved in monitoring on the BES-islands, web-based research was used, and personal communication with a former representative of the Netherlands Antilles Central Government Department of Nature and the Environment as well as advice from two experts from Wageningen Institute for Marine Resources and Ecosystem Studies complemented the research.

The research shows that if the Kingdom of the Netherlands wants to be able to provide complete national and international reporting on biodiversity and nature policy, additional monitoring is required on the BES-islands. Nature monitoring in the Netherlands has existed for more than 10 years for both the terrestrial and marine environment, is very well organised and steered by government demand. Though there are already biodiversity monitoring activities taking place on the islands and there have been several attempts to coordinate monitoring efforts on the BES-islands, monitoring activities are not organised and the necessary foundation for a structural monitoring system is still lacking. Thus, we are faced with a situation where there is quite a lot of data in existence but no infrastructure in place to organise structural terrestrial and marine biodiversity monitoring. Based on the conclusions it is recommendable to set up a monitoring network with all current parties involved in biodiversity monitoring in order to establish agreements on monitoring priorities and information sharing. In addition to this, a data storage and management system must be set up with someone responsible for data maintenance and reporting. A last vital action point is to define monitoring priorities based on the information available in this report and optimize monitoring methods.

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List of acronyms

AGRRRA	Atlantic and Gulf Rapid Reef Assessment
BES	Bonaire, St. Eustatius and Saba
BNMP	Bonaire National Marine Park
CARMABI	Caribbean Research and Management of Biodiversity
CBD	Convention on Biological Diversity
CBS	Dutch central statistics office
CITES	Convention for International Trade in Endangered Species
CMS	Convention for Migratory Species of Wild Animals
DCNA	Dutch Caribbean Nature Alliance
DROB	Spatial Development and Management Service of Bonaire government
EL&I	Dutch Ministry of Economic Affairs, Agriculture and Innovation
GAN	National Authority for Data Concerning Nature
GCRMN	Global Coral Reef Monitoring Network (
GIS	Geographic Information System
ICRI	International Coral Reef Initiative
IMARES	Wageningen Institute for Marine Resources and Ecosystem Studies
I&M	Dutch Ministry of Infrastructure and Environment
MINA	Netherlands Antilles Central Government Department of Nature and the Environment
MWTL	'Monitoring Waterstaatkundige Toestand des Lands'
NACRI	Netherlands Antilles Coral Reef Initiative
NEM	Network for Ecological Monitoring
PBBS	Port Biological Baseline Study
PBL	Netherlands Environmental Assessment Agency
PGO	private data managing organization
RCN	Rijksdienst Caribisch Nederland
RIKZ	National Institute for Coastal and Marine Management
RIZA	National Institute for Water Management and Waste Treatment
SCANS	Small Cetacean Abundance in the North Sea
SCBCB	Society for the Conservation and Study of Caribbean Birds
SCCN	Southern Caribbean Cetacean Network
SNMP	Statia National Marine Park
SPAW	Specially Protected Areas and Wildlife
STCB	Sea Turtle Club Bonaire
STENAPA	St. Eustatius National Parks Foundation
STINAPA	'Stichting Nationale Parken' Bonaire
TMAP	Trilateral Monitoring and Assessment Program
V&W	Dutch Ministry of 'Verkeer & Waterstaat'
WIDECAST	Wider Caribbean Sea Turtle Conservation Network
WSNP	Washington Slagbaai National Park

1. Introduction

With the transition of the islands of Bonaire, St. Eustatius and Saba (BES) from the former Netherlands Antilles to special municipalities of the Netherlands on the 10th of October 2010, the Netherlands gained a significant amount of biodiversity. Between 10,000 and 15,000 species occur on these islands, the area hosts five Ramsar sites and the Sababank is the world's tenth largest atoll. The Ministry of Economic Affairs, Agriculture and Innovation (EL&I) has gained an important new area of responsibility in terms of nature policy and management.

Ecological monitoring can assist in directing management action and conservation of natural areas. It can be defined as 'the collection of information about the state of a system and its changes over time' (Chiappone and Sullivan, 1994). The need for monitoring nature follows from the observation that human actions may have adverse effects on the environment, and thus one of the primary goals of monitoring is to identify and segregate natural fluctuations in communities and populations from changes induced by anthropogenic impacts (Chiappone and Sullivan, 1994).

It is essential that biodiversity on the BES-islands is monitored, particularly as it is threatened by a large array of factors; global scale climatic change places pressure on biodiversity, as do local-scale impacts which can stem from natural phenomena such as hurricanes and natural disasters, but also from human activity on the coasts. Aside from national responsibilities that the Kingdom of the Netherlands holds for monitoring nature and biodiversity in these special municipalities, the Netherlands also has international obligations stemming from their participation and membership in global and regional environmental treaties.

This report aims to establish a foundation for setting up a structural biodiversity monitoring system on the BES-islands and define several priority action points, by investigating and contrasting the development, character and organization of biodiversity monitoring in the Netherlands with that of the BES-islands and former Dutch Antilles. For this purpose the following research questions have been formulated:

1. What is ecological monitoring and how can this best be organized?
2. What are the (inter-)national monitoring and reporting obligations of the Kingdom of the Netherlands and specifically the BES-islands?
3. How has biodiversity monitoring been developed and how is it currently organised in the Netherlands and on the BES-islands?
4. What are the current terrestrial and marine monitoring activities taking place on the BES-islands, and where do the obvious gaps lie in terms of their international obligations?

The research methodology applied was entirely qualitative in nature. A literature review was conducted to research the concept of ecological monitoring. The monitoring and reporting obligations of the Netherlands and the BES-islands were determined through interviews with policy advisors at the Ministry of EL&I and the Ministry of Infrastructure and Environment (I&M), web-based research and personal communication with former Netherlands Antilles Central Government Department of Nature and the Environment (MINA). Research into the organisation and development of biodiversity monitoring in the Netherlands and on the BES-islands was conducted through an interview with a representative of the Netherlands Environmental Assessment Agency (PBL), literature and web-based research, supplemented by personal communication with the former MINA representative. Data to explore the last research question was collected through various surveys sent out to the nature parks in Bonaire, St. Eustatius and Saba, the institute for Caribbean Research and Management of Biodiversity (CARMABI) and the Dutch Caribbean Nature Alliance (DCNA), and from previous interviews conducted by WUR researcher Eira Carballo Cardenas. This information was then organised and structured with advice from expert ecologists from Wageningen Institute for Marine Resources and Ecosystem Studies (IMARES).

The report begins with an introduction to the concept of ecological monitoring and provides the reader with a number of challenges associated with monitoring as well as some success factors to guide sound monitoring systems. This is followed by an overview of the international and national monitoring and reporting obligations of the Kingdom of the Netherlands, and how these obligations apply to the BES-islands, in Chapter 3. In Chapter 4 a general outline of the current status of data management and monitoring in the Netherlands and the BES-islands will be given, painting a picture of two contrasting situations. This is followed by a more detailed outline of current and recommended marine and terrestrial monitoring activities in Chapter 5. Finally, in the last chapter a number of conclusions will be formulated and supplemented by recommendations with priority action points to establish a structural biodiversity monitoring system on the BES-islands.

2. Basic principles of ecological monitoring

Before discussing monitoring obligations and current monitoring activities, it is important to provide a foundation for the concept of monitoring. What is it? Why is it important? How can it best be done?

Monitoring is needed to determine present and future health of natural area ecosystems and to establish empirical limits or variation in natural area resources. Monitoring is also used to identify potential agents of abnormal change and to diagnose abnormal conditions to identify issues in time to develop effective mitigation (Davis, 1993). Put simply, amongst other things monitoring is used to identify problems and find ways to tackle these problems. Approaching this from the perspective of a national government, monitoring can also be used for guiding evidence-based environmental legislation (Lindenmayer and Likens, 2010).

Types of monitoring

Lindenmayer and Likens (2010) define three types of monitoring: (1) curiosity-driven monitoring, which is devoid of specified questions or underlying study design, (2) mandated monitoring, where environmental data are gathered as a stipulated requirement of government legislation, and (3) question-driven monitoring which is guided by a conceptual model and by a rigorous study design. In this report we are mostly concerned with the second and third type. Mandated monitoring, in the case of the BES-islands refers to the monitoring which the islands are obliged to do stemming from Dutch government legislation and island legislation. Chapter 3 of this report attempts to paint a clear picture of what these obligations are. Mandated monitoring does not attempt to identify or understand the mechanism influencing a change in an ecosystem or an entity. The focus is usually to identify trends. It is often coarse-scale and leads to assessments of resource condition, but provides a limited understanding of ecological mechanisms. Question-driven monitoring on the other hand uses a conceptual model which is used to make predictions which can then be tested as part of a monitoring program. This type of monitoring is finer-scaled and often process-based. With question-driven monitoring it is difficult to make valid spatial extrapolations to larger scales; often it is not possible to generalise and apply the findings to other areas .

Naturally, there can be overlap between these two categories. One of the key messages of Lindenmayer and Likens (2010) is that the fundamental characteristics of some of the best examples of *question-driven* monitoring programs, such as well-defined questions, well-articulated conceptual models and rigorous study designs, are features that should be much more widely embraced as part of efforts to improve *mandated* monitoring programs. Furthermore, these authors believe that question-driven, mandated monitoring programmes are likely to be the most efficient use of resources for addressing most ecological problems. This will also be the basic assumption of this paper; an ideal monitoring system for the BES-islands is, as far as possible, mandated through government legislation *and* supported by well-defined questions and sound designs.

It is important at this point to introduce an interesting argument brought forward by McDonald-Madden et al. (2010: 549): 'information gain is not necessarily conservation gain'. Monitoring is generally perceived as a defensible activity in the pursuit of improved conservation results. However, rarely do people assess the relative value of gaining information versus other management activities. Before monitoring is carried out it is important to explicitly ask the question whether spending funds on monitoring is justified relative to funding other actions like strategic research. These authors present a decision tree for deciding when to implement monitoring to improve conservation management (please refer to Appendix 1 for the decision tree). This framework focuses on monitoring which improves management, and ignores other potential reasons for monitoring such as legislative obligations, or mandated monitoring. Within this framework, a decision to direct resources away from monitoring is not driven by reluctance to evaluate conservation investments. It is driven by the desire to maximise expected conservation outcomes given limited resources available. McDonald-Madden et al. (2010) argue that there are a large number of conservation projects where information gain might not maximise conservation gain. Though some of the monitoring which will be described in the following chapters stem from commitments through membership to international treaties and hence can be ignored in the light of this argument, some activities do not stem from obligations. For these activities it is recommendable to use some sort of decision-making instrument such as this decision tree in order to assess the relative worth of monitoring activities.

Failure of monitoring systems

A number of key reasons for the failure of monitoring programs must be highlighted before a clear guideline for successful monitoring programs can be provided. One of the key reasons for failure is the lack of well-formulated questions. Some monitoring programs are driven by short-term funding or a political directive

instead of being underpinned by carefully formulated questions and objectives. The inadequacy of good questions results in poorly focused monitoring programs incapable of delivering effective outcomes (Lindenmayer and Likens, 2010; Stout, 1993). A

second reason for failure is poor study design. A lot of monitoring is done without a sound scientific foundation. Without careful design of monitoring activities, data collected can quickly be invalid or unrepresentative of the area which is being monitored (pers. comm.: IMARES). Poor study design can essentially lead to the failure of a monitoring program. It can result in results not being written up or it makes it difficult to assess the effectiveness of a management intervention (Lindenmayer and Likens, 2010; Stout, 1993). Monitoring designs should be well evaluated in terms of their cost, their outcome and their statistical rigour (pers. comm.: IMARES). Because of this it is vital that before monitoring systems are implemented they are assessed by experts (David, 1993).

Another very important issue is the failure to properly articulate what to monitor. Often when it is difficult to agree on what exactly to monitor, the response is to monitor a large number of things, or a so-called 'laundry list'. However, a poorly focused 'laundry list' can result in diverting those responsible for monitoring from creating carefully posed questions, it can result in many things being monitored badly, it can make a monitoring program too expensive and lastly it can create problems with the statistical design of the program (Lindenmayer and Likens, 2010). An alternative to the laundry list is to use previously defined indicator species or indicator groups as the target of monitoring programs. However, the problem with this is that often it is not even stated in monitoring programs what these species are actually indicative of, nor the circumstances at which they are not appropriate indicators (Lindenmayer and Likens, 2010). Instead of using the two above-mentioned approaches it is important to carefully define questions, using a well-conceived model to help conceptualize a particular ecosystem and make predictions about ecosystem behaviour and response.

A last, important reason why these programs fail is the assumption that there is a single approach to monitoring which is applicable to all programs. It is often not appropriate to measure the same factors in different places. In fact, even within the same habitat type the application of identical monitoring protocols may not be informative due to differences in biota, key ecological processes, or other factors (Lindenmayer and Likens, 2010).

Guideline for successful monitoring systems

Designing a monitoring plan essentially begins with a conceptual model of the ecosystem (please refer to Appendix 2 for a flow diagram). This should consist of a list of system components and a description of their relations: all biotic and abiotic resources and the processes by which they interact. From these components then representative elements are chosen for monitoring (Davis, 1993). A conceptual model of an ecosystem is one way to help identify the questions which must be addressed. Such a model at the beginning of a study helps ensure that all the relevant components are captured in the project design. By understanding the inputs and outputs it is possible to understand the mechanisms for change in an ecosystem and what responses might occur as a consequence of management interventions (Lindenmayer and Likens, 2010).

One of the primary objectives for monitoring in general is watching rates of change. The challenge lies in deciding which rates to watch and which are normal and which are abnormal (Stout, 1993). Thus, at this point it is vital to define clear goals so that parameters which best describe the change to be monitored can be selected for measurement (Allen, 1993). Posing good questions is essential for effective monitoring. Good question-setting must result in quantifiable objectives which offer unambiguous signposts for measuring progress (Lindenmayer and Likens, 2010). Monitoring schemes require construction of explicit and testable hypotheses in order to differentiate indicator responses to natural environmental fluctuations from responses to anthropogenic activities (Kremen et al., 1994).

Monitoring programs must first document the initial or baseline conditions. Baseline data is needed in order to be able to measure 'change' in status over time, or to assess the impact of solutions (Kremen et al., 1994). Often baseline studies are needed to actually decide what is going to be measured. Then, indicators which show change over time need to be identified, and the distributions and abundances of indicator species or species assemblages should be documented (Kremen et al., 1994). The process of selecting which chemical and geo-physical constituents, biological taxa and processes to monitor are likely to be the most difficult decisions in designing a monitoring program. It must be a representative sample of elements that characterizes the structure and function of the entire ecosystem (Davis, 1993). As mentioned previously, choosing a predefined set of indicator species is not recommendable. Ideally, these selections must be reviewed and modified through workshops and symposia and finally should be field tested during design studies (Davis, 1993).

Good design of monitoring programs is an inherently statistical process. Statisticians must be involved in the design phase to deal with issues such as calculations of statistical power to detect trends, detectability of a

particular individual biotic species or chemical element, the optimization of field methods and statistical design, the importance of contrasts between treatments and the value of innovative rotating of sampling methods for increasing interference (Lindenmayer and Likens, 2010). The methods or protocols that are used to monitor must provide an economical and accurate measurement of these parameters and thus of change (Allen, 1993).

Thus, monitoring design must be done carefully. Choices must be made on what to sample, sample size, sample sites and location, and sample frequency. Sampling design must be developed that encompasses variation at large, intermediate and small scales (Stout, 1993). Pilot studies can often be used to determine how many samples are needed, and the size that these should be, to detect differences and provide useful information (pers. comm.: IMARES). Decisions must also be made as to the frequency of sampling taking place. Protocols must produce chronologically collected data that will permit rigorous tests of null hypotheses (Stout, 1993). As a general rule data should be collected in a way that allows comparison of results not only between years but also between sites and in between studies (Allen, 1993). Furthermore, plans for data analysis must be developed *prior* to data collection (Stout, 1993).

Data storage and sharing

A very important issue linked directly to monitoring is data storage and sharing policy. It is of utmost importance that there is a common database in which monitoring data can be stored. Furthermore, data must be collected in a manner which ensures that data is suitable for data analysis and comparison. This supports the above-mentioned fact that data analysis must be planned prior to data collection. A key ingredient for maintaining long records of high quality is the frequent examination and interrogation of these data. These result in important discoveries and stimulate new research and management questions. They also result in the uncovering of errors (Lindenmayer and Likens, 2010).

An important impediment to developing successful monitoring programs lies in the issue of intellectual property and data sharing in the wider ecological management and resource communities. Reasonable and ethical rules of engagement for data sharing between those who gather long-term field data and others who desire access to this data are rare. It is very important that intellectual property issues and the development of better ways of data sharing are addressed in the beginning phases of setting up a monitoring system. Policies regarding public data dissemination should be thought through and stated clearly (Lindenmayer and Likens, 2010).

This brings with it the issue of partnerships. Most successful monitoring plans are built on partnerships between people with different skills: scientists, statisticians, policy-makers and resource managers from government or non-government organizations, universities or research institutes. These partnerships are important to validate policy-relevant and management relevant projects, but also facilitate the flow of information between parties in ways that people from different backgrounds with different expertise can readily understand. Also, partnerships are essential because policy-makers and resource managers often do not know how to frame questions in a way which can be resolved by well-executed monitoring (Lindenmayer and Likens, 2010).

3. Monitoring and reporting obligations

3.1 International treaties

The following treaties and conventions apply directly to biological resources in the BES-islands; the Convention for International Trade in Endangered Species (CITES), Ramsar Convention on Wetlands, Convention on Biological Diversity (CBD), Convention for Migratory Species of Wild Animals (CMS), Cartagena Convention and the Inter-American Convention for the Protection and Conservation of Sea Turtles. Some of these treaties and conventions include commitments in the field of biodiversity monitoring and reporting. Hence, it is important to define these monitoring commitments for the Kingdom of the Netherlands, how these apply to the BES-islands, and whether these obligations have changed after 10-10-10, when the BES-islands took on the status of special municipalities of the Netherlands.

Convention for International Trade in Endangered Species

CITES subjects international trade in specimens of selected species to certain controls. All import, export, re-export and introduction from species covered by the Convention must be authorized through a licensing system. Each Party to the Convention must designate one or more Management Authorities in charge of administering that licensing system and one or more Scientific Authorities to advise them on the effects of trade on the status of the species. The species covered by CITES are listed in three Appendices, according to the degree of protection they need (CITES, 2010). The former Netherlands Antilles were party to CITES Convention and its requirements were implemented on the islands through the National Nature Conservation Ordinance of the Netherlands Antilles. Parties to CITES have legal commitment to comply with certain requirements, unlike with many other treaties or conventions which have commitments which are not legally binding. Some of these commitments apply specifically to monitoring (please refer to Appendix 3); parties must maintain records of trade in specimens of species, and they must provide periodic reports on their implementation of the Convention.

The Netherlands applies EU basic and implementing regulations in their execution of CITES and thus an EU 'protection regime' applies in the Netherlands. Since the Netherlands Antilles and Aruba were not part of the EU, the international CITES protection scheme applied on these islands, which is less strict than the EU's protection regime. Both the Netherlands Antilles and Aruba had their own Management Authority and Scientific Authority. Eric Newton, previous Management Authority for the former Netherlands Antilles was responsible for Netherlands Antilles CITES reporting.

After 10-10-10 the Minister of EL&I received responsibility for CITES permits on the BES-islands. Dienst Regelingen, the Dutch Management Authority has been appointed as the new Management Authority for the BES-islands and CARMABI institute in Curacao has been appointed as the Scientific Authority for the BES-islands. It is now responsibility of the Netherlands to carry out reporting tasks to the CITES convention for the BES-islands.

Ramsar Convention on Wetlands

The Ramsar Convention is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. It is the only global environmental treaty that deals with a particular ecosystem, and the Convention's member countries cover all geographic regions of the planet (Ramsar, 2010). The Kingdom of the Netherlands is party to the Ramsar Convention; they have non-legally binding commitments to comply. There are six Ramsar areas in the Netherlands Antilles; five on Bonaire and one on Aruba.

Reporting commitments are quite general for this convention; parties are required to describe wetland policy and how this is put into practise. However, there are a number of specific questions in the triennial national report directed toward monitoring; they ask whether countries have a national wetland inventory, whether wetland inventory data is maintained and accessible to all stakeholders and whether the country has information about the status and trends of the ecological character of wetlands. The Ministry of EL&I was responsible for reporting for both the Netherlands and the former Netherlands Antilles. Hence, these commitments remain the same for the BES-islands. Alterra is commissioned to execute reporting in the Netherlands, but there is no similar institute commissioned to do so on the BES-islands or in the rest of the former Netherlands Antilles. In general the Netherlands applies EU directives to manage wetlands, but naturally EU guidelines not apply on the BES-islands (until these are appointed as EU territory). Hence, different management guidelines, if these exist, should be applied to the Ramsar areas on the BES-islands.

In the current national reporting very little has been mentioned about the Ramsar areas in the Netherlands Antilles. The last national report of the Netherlands states that there is no complete inventory for the wetlands of the Netherlands Antilles yet. In addition to these triennial reporting commitments, Ramsar Information Sheets must be used to appoint Ramsar areas, and these must be updated every few years. This must also be done for the BES-islands. Hence, it is important to (1.) appoint someone on the BES-islands to make an inventory of the wetlands on the BES-islands and establish a baseline, (2.) store this information in a database which can be used for reporting and (3.) define management guidelines for the Ramsar areas on the BES-islands.

Convention for Biological Biodiversity

The three main objectives of this Convention are the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources (CBD, 2009). Like the previously described convention, commitments of the Kingdom under the CBD are not legally binding. Under the CBD the contracting parties are obliged to, as far as possible, identify components of biological diversity which are important for its conservation and sustainable use, to monitor these and to maintain and organize data derived from identification and monitoring activities (please refer to Appendix 4). In terms of reporting the parties are required to submit reports once every four years on measures it has taken for the implementation of the provisions of the Convention.

The Netherlands Environmental Assessment Agency, Plan Bureau voor de Leefomgeving (PBL), is commissioned for a part of the execution of CBD reporting in the Netherlands, and they are also involved with the Streamlining European Biodiversity Indicators (SEBI) initiative. Reporting on the former Netherlands Antilles was responsibility of the Kingdom of the Netherlands, so formally the Netherlands Antilles including the BES-islands should always have been included in the Dutch national reporting. However, to date nothing specific has been reported on the Netherlands Antilles in the Dutch national CBD reports.

However, the question has been raised: should Dutch CBD reporting not pay special attention to the BES-islands as they host an unusually high amount of biodiversity, which is different from that common to the Netherlands? As a result of this differing biodiversity the islands experience totally different problems regarding nature management. Devoting a separate section in the Dutch national reporting structure especially to the BES-islands should be considered. If this is to be realised sufficient information must be collected on the islands to be able to report on actions being taken and the status of biodiversity. To realise this suitable actors must be commissioned to collect this data on the islands, this data must be stored and accessible to the PBL if they are to include this in Dutch national CBD reporting.

Convention for Migratory Species of Wild Animals

The CMS, sometimes referred to as the Bonn Convention, is the only global convention specializing in the conservation of migratory species, their habitats and migration routes. Migratory species threatened with extinction are listed on Appendix I of the Convention and CMS Parties strive towards strictly protecting these animals, conserving or restoring the places where they live, mitigating obstacles to migration and controlling other factors that might endanger them. CMS promotes concerted action among the Range States of many of these species. Migratory species that need or would significantly benefit from international co-operation are listed in Appendix II of the Convention. For this, the Convention encourages the Range States to engage in global or regional Agreements (CMS, 2004).

Under CMS member parties agree to submitting a triennial report. This reporting is quite brief and mostly consists of yes/no questions which are generally not area-specific. General questions regarding national policy instruments, actions taken and pressures are posed about Appendix I birds, marine mammals, marine turtles, terrestrial mammals, bats and Appendix I species belonging to other taxa. More specific reporting is required for Appendix I species for which the country reporting is a Range State. For these species questions are posed about population size, distribution, obstacles to migration, pressures and activities carried out in favour of these species. For Appendix II species that are the object of CMS agreements and MoU's, parties are obliged to reference to the latest report that has been submitted to the Secretariat of each agreement.

In the Netherlands, the Ministry of EL&I is responsible for reporting to CMS, and Alterra is commissioned to execute this. In the past generally a draft version was sent to the Netherlands Antilles Central Government Department of Nature and the Environment (MINA), where Eric Newton was responsible for adding the relevant information on the Netherlands Antilles. In terms of CMS reporting very little changes after 10-10-10. However, it is important that new responsible parties are appointed on the BES-islands, who will be able to collect sufficient information to report back to the Netherlands for CMS.

Cartagena Convention and SPAW protocol

The Cartagena Convention is an environmental treaty for the Wider Caribbean Region. The Protocol concerning Specially Protected Areas and Wildlife (SPA) is part of the Cartagena Convention and was ratified by the Kingdom of the Netherlands for the Netherlands Antilles and Aruba. Like CITES, it provides varying degrees of protection and regulation to wildlife species according to their conservation status. Annex I of the SPA Protocol lists plant species that are designated for total protection and recovery. Annex II of the SPA Protocol lists animal species that are designated for total protection and recovery; all marine turtles and all cetaceans are afforded total protection and recovery protection under SPA through their listing in Annex II. For marine species such as queen conch (*Strombus gigas*) and spiny lobster (*Panulirus argus*) listed in Annex III, use is regulated in order to ensure and maintain their populations at the highest possible levels (NOAA Fisheries Office for International Affairs, 2010).

The protocol calls for the parties to compile inventories of areas and species, and to monitor protected areas in order to assess the effectiveness of measures taken to implement management and recovery plans (Appendix 5). Officially parties have reporting obligations, but a reporting format is yet to be agreed upon. The design format was on the agenda of the coming Intergovernmental meeting (IGM) of the Caribbean Environment Programme (CEP) of 5-8 October in Jamaica, but is not clear whether the format was agreed upon. The latest format asks parties whether they have; national policies, laws, mechanisms or measures for the protection of Wild Flora and Fauna in place; established any protected areas pursuant to the SPA Protocol; identified all of the endangered / threatened species listed in Annexes I, II, and III of the SPA Protocol that are within their country; and formulated, adopted, and implemented any plans for the management and use of species listed in Annex III.

The SPA Protocol also requires conservation of marine mammals and implementation of the Action Plan for the Conservation of Marine Mammals in the Wider Caribbean. The protocol calls on parties to actively involve in monitoring and reporting of the status of listed species, habitats and ecosystems (Appendix 6).

Inter-American Convention for the Protection and Conservation of Sea Turtles

This is an intergovernmental treaty which provides the legal framework for countries in the American Continent to take actions in benefit of sea turtles. The convention 'promotes the protection, conservation and recovery of the populations of sea turtles and those habitats on which they depend, on the basis of the best available data and taking into consideration the environmental, socioeconomic and cultural characteristics of the Parties' (IAC, 2010). The Kingdom of the Netherlands ratified this convention for the Netherlands Antilles, but not for Aruba.

Parties to the convention are required to submit a yearly report about the conservation and protection action taken by the parties (Appendix 7). This report includes information about species occurring and the phase they are in, important sites for conservation, derived use from sea turtles, threats, capture, as well as the legal framework and conservation efforts. There do not appear to be other concrete obligations in terms of data collection and monitoring. MINA reported to this convention on a yearly basis. As MINA ceases to exist after 10-10-10 these responsibilities must be handed over to Rijksdienst Caribisch Nederland (RCN).

3.2 National reporting

The *Balans van de Leefomgeving*, a publication of the PBL, presents an evaluation of government policy for environment, nature and space. This evaluation can be seen as the Netherlands' new national nature reporting framework and will be published every two years, replacing the three previous PBL publications; *Milieubalans*, *Natuurbalans* and *Monitor Nota Ruimte*.

One chapter in this publication is entirely dedicated to biodiversity and includes reporting on species populations, habitat quality, biodiversity in ecosystems, quality of regional waters, pressure from agriculture, the level of genetic diversity, environmental pressure on nature (over fertilization, acidification and desiccation) and more (PBL, 2010).

To make this publication PBL derives data from the Dutch central statistics office (CBS), private data managing organizations, the Network for Ecological Monitoring (NEM), ministries, the National Institute for Public Health and the Environment, consultancies and research institutes.

The previous *Natuurbalans*, describing nature policy, did not include any information on the Netherlands Antilles. There has been discussion about including the BES-islands in *Balans van de Leefomgeving* in the future. If this is to be realized sources for the necessary information must be assembled about the BES-islands so that PBL will be able to take the islands into their reporting structure.

3.3 Translation into Dutch Caribbean legislation

Former Netherlands Antilles national law regarding nature management and conservation (*Landsverordening Grondslagen Natuurbeheer en –bescherming*) has been translated into a new law (*Wet Grondslagen Natuurbeheer en -bescherming BES*) with the institutional changes which took place on 10-10-10. However, very little has changed with regard to the content of this law. There is still no specific mention of nature monitoring in this law.

The Minister of EL&I is responsible for appointing a management entity to maintain registers of species from Appendix I of the CITES-convention and Appendix I of the CMS, and Annex I and II of the SPAW protocol (Article 5: *Wet Grondslagen Natuurbeheer en –bescherming BES*). No guideline is defined regarding what specifically must be monitored for reporting to these conventions.

The islands remain free to set their own regulations and policy. The governing bodies of Bonaire, St. Eustatius and Saba are required to create a Nature Plan in which account is taken of the obligations and requirements flowing from multilateral environmental agreements in the area of nature management and protection (Article 9: *Wet Grondslagen Natuurbeheer en –bescherming BES*).

The island councils are responsible for the protection and the management of species in the Appendices of CMS, SPAW Convention and the Inter-American Convention for the Protection and Conservation of Sea Turtles (Articles 11, 12 and 13: *Wet Grondslagen Natuurbeheer en –bescherming BES*), and for ensuring that the requirements under these treaties apply. Furthermore, if nature parks appointed by the island councils, are Ramsar areas or areas appointed the SPAW Protocol or the CBD, the requirements set by these relative conventions apply (Article 10: *Wet Grondslagen Natuurbeheer en –bescherming BES*).

The nature related Island Ordinances of the three islands do not specify any monitoring obligations or requirements. It is clear that there are no concrete obligations to monitor in Dutch Caribbean law, nor in local island laws. Hence, at current monitoring nature is not mandated on these islands, even if this is necessary to fulfil international, and hopefully eventually national, reporting obligations.

3.4 Reflection

It can be concluded that the above-mentioned international environmental treaties do not include very concrete nature monitoring requirements. However they all require some form of reporting, and for these reports data is needed which requires supplementary monitoring on the BES-islands.

At the same time, specific monitoring is not mandated on the BES-islands. The islands are free to set their own nature regulations and policy and this currently does not include monitoring regulations. Hence, there is likely to be a gap in terms of what is being monitored on these islands, and what is needed from an international perspective.

If the BES-islands will eventually be taken up into Dutch national reporting in the biodiversity-related sections of the *Milieubalans*, *Natuurbalans* and *Monitor Nota Ruimte*, the necessary data must be made available to PBL and for this additional monitoring must be implemented. The following chapter compares current monitoring in the Netherlands and on the BES-islands, in order to present an indication of what level structural monitoring on the BES-islands would need to reach to comply with Dutch standards and reporting structures.

4. Organization of biodiversity monitoring and data management

4.1 Netherlands

Terrestrial

Terrestrial nature monitoring in the Netherlands is very well organised through NEM. This network is a partnership of government agencies for monitoring of nature. This partnership was grounded in an agreement in 1997. The NEM follows trends in almost all species groups and is known as the backbone in Dutch terrestrial nature monitoring. Its goal is to tune data collection to the information needs of the government (NEM, 2010). NEM began through a meeting between people from different governance levels; from ministries, PBL, CBS and non-governmental nature organisations; and its strength lies in the cooperation of all the members of the network (pers. comm.: PBL).

There are a total of 15 separate monitoring networks in NEM within the eight general categories of mammals, birds, flora, butterflies, reptiles, amphibians, mushrooms and dragonflies. Most of the NEM monitoring networks are run by private data managing organizations (PGO's). These PGOs coordinate the monitoring networks which are made up of volunteers and interest groups collecting data in the field. For each monitoring network a contract is made between the principal (for example ministries, PBL and the Dutch Bird Protection Agency) and the contractor (PGOs). Generally the central statistics office processes this data into nature statistics. Accordingly, when NEM was first set up it was very much CBS representatives who pushed for a robust monitoring methodology for to ensure reproducible data, fit for databases (pers. comm.: PBL).

In turn, the National Authority for Data Concerning Nature (GAN) aims to advance the availability and validity of nature data for the public and private sector and to advance the cooperation between data collectors, data managers and data users. One of their most important tasks is the design and management of the National Databank for Flora and Fauna (NDFF). This is the first complete system which compiles, unifies, validates and promotes the availability of nature data. All data must meet certain minimum requirements, and there is an automatic validity control when data is imported (GAN, 2010).

Marine

In the past monitoring programs in Dutch coastal waters and the North Sea generating data about the state of the ecosystem and the distribution of species and trends were set up autonomously. These programs were often set up due to scientific interest, due to a need for knowledge and often also to assess whether management or policy action was having the desired effect. Since 1971 the National Institute for Coastal and Marine Management (RIKZ) and the National Institute for Water Management and Waste Treatment (RIZA) were commissioned by Rijkswaterstaat to carry out a number of national monitoring programs referred to as the Monitoring Waterstaatkundige Toestand des Lands (MWTL); a number of programs in which a set of physical, chemical and biological parameters in fresh and salt waters are recorded (Smit et al., 2010).

This monitoring network is a legal obligation and obtains information which is used for national water policy. Within the MWTL biotic and abiotic parameters are measured, such as concentration of heavy metals, organic contamination, nutrients, radioactivity and floating particles, but oxygen concentration, salinity, area covered by seagrass, numbers of marine mammals and sea birds also fall under this program. The parameters measured in the MWTL fall under three main categories; safety, water quality and healthy water systems, which are made up out of five, seven and six parameter groups respectively. These parameter groups are in turn made up out of the different parameters which must be measured; for example in the parameter group 'waves', the frequency, direction, wavelength, wave height and dispersal are parameters which must be measured. When the RIKZ and RIZA were discontinued the coordination of the monitoring projects within the MWTL were taken over by the Water Division of Rijkswaterstaat (Smit et al., 2010).

In the recent past several international conventions have entered into force from which reporting obligations ensue. Thus, from the beginning onward MWTL has contributed to the formulation and evaluation of water policy and to the compliance to (inter-)national agreements, amongst others in the context of the Trilateral Monitoring and Assessment Program (TMAP) of the Netherlands, Denmark and Germany, monitoring which arises from the OSPAR convention, and obligations which arise from the EU Water Framework Directive and Bird and Habitat Directive (Smit et al., 2010).

A significant amount of monitoring takes place supplementary to the MWTL. One of the initiatives of the Common Wadden Sea Secretariat is setting up the TMAP. The monitoring parameters of this program are

based on five themes: climate change, supply of nutrients and contaminants, fisheries, recreational activities and agriculture. In the 10th trilateral government conference on the protection of the Wadden Sea it was concluded that the majority of the monitoring parameters defined in EU directives are included in the TMAP programme. TMAP also tries to harmonise with monitoring programs and legislation set by other international agreements such as OSPAR. Monitoring needs set by the OSPAR convention are defined in a number of monitoring programs covering abiotic and biotic parameters as well as habitat-level monitoring. These are accommodated in the MWTL, in TMAP, as well as in IMARES research programs commissioned by the government as statutory research tasks. For monitoring within the Water Framework Directive, chemical, as well as ecological and hydromorphological parameters are collected. In most cases MWTL data is used for this (Smit et al., 2010).

With the MWTL trends can be identified and measured results are compared to standards and targets. Regular inventoried research is carried out into 'new' substances which could potentially have a negative effect on water quality in the future. Adjustments are also made of the list of to be inventoried substances based on European legislation. A part of the information is saved directly in the DONAR-system, managed by Rijkswaterstaat, the central system for the wet sector in which data has been stored since 1994. Another part is saved here after verification or processing. Since 2004 they have been transferring to the WADI-system which will eventually replace the DONAR-system. A continuously larger part of the collected data is available via intra- and internet, also for users outside Rijkswaterstaat (Smit et al., 2010).

4.2 BES-islands

There was no specific budget for data management or an appointed data manager in MINA of the former Netherlands Antilles, nor was there a strategy for long term data storage and sharing. A Canadian consultancy from The Nature Conservancy was hired by MINA to create a centralised biodiversity database, the Dutch Caribbean Biodiversity Explorer (<http://www.dcbiodata.net/explorer/>). However, currently CARMABI is the only actor contributing data, and hence until now the database has focused mainly on Curacao. The idea behind this database was that data on all the islands in the Dutch Caribbean would be stored in it. MINA planned to hand over the database to DCNA (pers. comm.: MINA).

In a meeting of the Antillean Nature Forum organised by MINA in 2001, concerns regarding the lack of coordination in monitoring and in data collection and processing were voiced. The need for a central body to deal with data governance was made clear and a small working group was formed to address this problem. However, to date no central body has been formed (Department of Environment and Nature, 2001).

Nature parks

In general nature monitoring is currently carried out separately by the nature parks on the islands of Bonaire, St. Eustatius and Saba. Stichting Nationale Parken (STINAPA) Bonaire comprises the Bonaire National Marine Park (BNMP), Klein Bonaire, Washington Slagbaai National Park (WSNP); St. Eustatius National Parks Foundation (STENAPA) comprises Statia National Marine Park (SNMP), Quill/Boven National Park and the Botanical Gardens. The Saba Conservation Foundation comprises Saba National Marine Park and Saba's Hiking Trail system and Terrestrial Park (DCNA, 2009a). The each have their own monitoring activities, unless monitoring is part of projects that have been initiated by outside organizations, such as when DCNA developed bird monitoring on all the islands of the Dutch Caribbean (DCNA, 2009a).

Most monitoring in the nature parks is conducted by volunteers or it is carried out by external researchers (please refer to Appendix 8 for an inventory of current monitoring activities). Because monitoring is mostly conducted on a voluntary basis, no demands are placed on the quantity or quality of data and nobody is held accountable for the data. There are also a number of organizations outside the parks which monitor like Sea Turtle Club Bonaire (STCB). There are no clear policies or processes established or agreed upon regarding decision-making on data management on the three islands (pers. comm.: MINA).

The parks make autonomous decisions and rules regarding data ownership, data access and data quality (pers. comm.: MINA). BNMP keeps data in MS Excel sheets in the personal computer of the park manager. Generally data is not shared, with the exception of data submitted to REEF and AGRRA survey programs (pers. comm.: BNMP). Data from WSNP is also generally not shared with third parties, but reporting is shared with the DCNA, Dutch Bird Protection Agency, CARMABI, Stichting DOEN, Postcode Loterij, U.S. Fish and Wildlife Service, Venezuelan Institute for Scientific Research, La Salle Foundation of Natural Sciences, MINA, Bonaire island government and the Society for the Conservation and Study of Caribbean Birds (SCBCB) (pers. comm.: WSNP). STENAPA does not have a specific budget for research and monitoring in the park, nor for data management. The monitoring that does take place is stored in an MS Access database management system. Management believes in 'sharing knowledge' but in practise the park managers make use of most of the data sets and the data is not made public in online data sets. The marine

park staff does share data with Wider Caribbean Sea Turtle Conservation Network (WIDECAST) (pers. comm.: STENAPA). Saba carries out significantly less monitoring activities.

Efforts to devise common protocols

One of DCNA's biodiversity conservation projects described in their 2009 Annual Report regards monitoring protocols and aims for the use of standard biological, physical and socio-economic monitoring protocols to ensure data compatibility and a regional picture of the state and use of natural resources. This has had some results in the terrestrial environment; standard bird watching protocols were discussed in a DCNA Board Meeting in May 2008 after the Dutch Bird Protection Agency provided project funding. Standard protocols were developed with advice from Dr. Adrian del Nevo, and a two-year programme to build capacity for bird conservation was set up (DCNA, 2009a). In terms of the marine environment, workshops are planned in the near future by DCNA to discuss standard protocols based on a report produced by Dr. Kenneth Buchan in 2006 summarizing information available on current monitoring methods employed in the marine parks in the Dutch Caribbean.

The 2009 DCNA Annual Report also mentions Geographic Information System (GIS) for parks as one of their biodiversity conservation projects. They point out that some of the parks are in need to be able to set up databases to store information on their natural resources, monitoring, research and management activities. Their goal is to provide parks with the hardware, software, training and baseline maps necessary for them to begin to accumulate GIS information for their protected areas. In December 2009 the Dutch Bird Protection Agency agreed to fund a pilot study in Washington Slagbaai National Park, and the project was due to commence in 2010.

4.3 Reflection

Nature monitoring in the Netherlands is well developed and organized. Terrestrial monitoring runs on the efforts of volunteers and is organized by a body which tunes governmental demand for biodiversity data in with actual data collection. A separate body controls data validity and maintains a common databank with biodiversity data. Marine monitoring on the other hand is mandated by the government, executed by a government body and supplemented by several monitoring programs stemming borne from regional and international agreements.

Though there have been some attempts to coordinate monitoring of specific topic areas on the BES-islands, it is clear that biodiversity monitoring is significantly less developed in the Dutch Caribbean than it is in the Netherlands. It is also much more fragmented with many small-scale monitoring trials and efforts, but no common strategy or data bank. Data is not shared and thus data quality is not controlled. Furthermore, unlike in the Netherlands, monitoring is currently not steered by government demand.

The following chapter will dive deeper into the status of biodiversity monitoring on the BES-islands and describe the current activities taking place in more detail. Recommended primary actions toward developing a structural biodiversity monitoring system on the BES-islands will be given per topic area.

5. Current and future biodiversity monitoring in the BES-islands

No universal 'off the shelf' technologies exist to assess ecosystem health (Davis, 1993). As mentioned in Chapter 2, it is not advisable to blindly apply the same monitoring protocols to different areas. However, worldwide and within the European Union much time and effort has been dedicated to establishing monitoring guidelines describing what and how to monitor. In September 2010 the European Commission made a decision on criteria and methodological standards on good environmental status of marine waters. Though it is recognised that this is a very general guideline, and one focused on the marine environment, a number of elements from these criteria have been useful to structure the following chapter.

The first 'descriptor' of good environmental status in the EC Decision is that *biological diversity is maintained and that the quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climate conditions*. To determine this, assessment is required at several ecological levels: ecosystems, habitats and species (EC, 2010). This has been used to organise the below description of current biodiversity monitoring activities into 'species' level monitoring and 'habitat' level monitoring. The rest of the descriptors in the EC Decision appear to include impacts on the environment caused by some form of human activity. This has inspired the definition of the last category for monitoring, namely 'human impacts' on the environment. Hence, this chapter will describe existing monitoring activities on the BES-islands on a species level, a habitat level, and in terms of human impacts, for the marine environment as well as the terrestrial environment. Those species, habitats or human impacts for which no monitoring currently exists, but for which literature or interviewees have expressed an urgent need for monitoring, have also been included in the following description.

5.1 Marine biodiversity monitoring

5.1.1 Species

Marine mammals

Protected species

There are a number of marine mammals occurring on the BES-islands which are in Appendix I and Appendix II of the CMS, and in Appendix I and II of CITES. There are also numerous marine mammals protected under Annex II of the SPAW protocol. Hence, a significant number of threatened species of marine mammals, protected by at least three international conventions, occur in the sea around the BES-islands.

Existing data and monitoring networks

A baseline study of cetaceans in the Leeward islands, including Bonaire, was done around 1998 by Debrot. This has not updated since. There is no baseline for the sea around St. Eustatius and Saba, though a baseline study on whales in Saba and St. Eustatius is in progress (pers. comm.: IMARES). The nature parks in Bonaire, St. Eustatius and Saba do not carry out marine mammal monitoring activities at current. Hence, amongst the nature parks no existing monitoring network exists.

The Southern Caribbean Cetacean Network (SCCN) has begun with assessing local cetacean stocks in Curacao. They also want to create a Caribbean data bank connected to their website. Furthermore, according to their website they planned to host a regional training workshop on cetacean stranding response. Participants from Curacao, Aruba, Bonaire, St. Maarten, St. Eustatius and Saba were to be instructed in identification of marine mammal species, sample collection, preparation, handling, transport and storage of marine mammal specimens, data collection and database coordination and identification of national and regional coordination needs (SCCN, 2009). It is unclear as to whether this workshop took place, but SCCN is a regional NGO which has begun monitoring mammals and could potentially be a partner in a future marine mammal monitoring network.

Expressed needs and recommendations

The management of STENAPA has expressed a need for basic species inventories on cetaceans and the establishment for a cetacean monitoring network. Since there is no current baseline data for the three islands, priority lies in updating the existing baseline for Bonaire, and collecting baseline data for St. Eustatius and Saba. It is necessary to collect baseline data in order to assess whether there is need for

structural monitoring of cetaceans. Based on this information priorities can be set and data needs can be established.

The cost to start up a new cetacean monitoring program is expected to be reasonably high. To illustrate: the SCANS (Small Cetacean Abundance in the North Sea) project, initiated in 1993, centred on an intensive sighting survey of the North Sea and adjacent waters using a method known as line transect sampling. The research took place between June and August and transects covered 20,000km² in an area of 890,000km². The cost of the project was around 1.5 million ecu (Hammond et al., 1993). It was believed to be important to repeat such estimates of overall abundance at ten-year intervals, and thus an application was made for a LIFE-Nature project to carry out a SCANS II survey in 2004. The total budget for this project was 3,113,260 euro (Hammond, 2006). It is thus highly recommendable to cooperate with existing networks such as the SCCN.

Sea turtles

Protected species

Similar to marine mammals, there are a number of sea turtles which occur on the BES-islands which are in Appendix I and Appendix II of the CMS and CITES, and are protected under Annex II of the SPAW protocol. In addition to this, sea turtles are protected under the IAC.

Existing data and monitoring networks

There is currently already quite some turtle monitoring taking place on the BES-islands, by organizations independent from the nature parks. Bonaire currently does the most on sea turtle monitoring through STCB, a partner of WIDECAS. They carry out an array of conservation activities, and in terms of monitoring they do satellite tracking of turtles, nest monitoring and in-water surveys (STCB, 2010).

WIDECAS is currently carrying out a monitoring programme in St. Eustatius through the 'St Eustatius Sea Turtle Conservation Program' located on Zeelandia beach. They monitor green, hawksbill and leatherback turtles. The objectives of the program are to; 1. tag all turtles which nest or try to nest on Zeelandia Beach, 2. mark all nests to monitor survival and hatching / emerging success, and 3. relocate nests laid in erosion zone (WIDECAS, 2008). In addition to this, STENAPA has expressed a need to initiate a water table investigation to understand the low success rate of hatchling emergence on Zeelandia beach.

There is currently no structural monitoring taking place in Saba via WIDECAS. The Saba Conservation Foundation did attend a training course in Bonaire in October 2008 hosted by WIDECAS and STCB, sponsored by the DCNA on the 'Research and Management Techniques for the Conservation of Sea Turtles'. The course was attended by rangers from the parks of Saba, Bonaire, St. Eustatius, St. Maarten and Aruba with additional attendees from sea turtle conservation groups in Aruba (WIDECAS, 2008).

Expressed needs and recommendations

Priority lies in assessing the existing data collected on sea turtles. There is quite a lot of data existing on sea turtles in the area and is important to compile this data and analyse this. This is likely to be a challenge because the turtle monitoring data comes from different sources. Hence, the first difficult step is to introduce data sharing amongst the existing monitoring networks. Partnerships must be established amongst the existing networks and the nature parks.

Once this data can be accessed, it must be analysed and used to determine whether the turtles are actually under threat in the sea around the islands. The data can be used to assess what possible solutions could be posed to address this. Furthermore it is important to evaluate the current monitoring methods in use; are these designed properly; are improvements necessary? If monitoring in Saba is deemed useful, perhaps WIDECAS could be facilitated to extend their monitoring activities to Saba.

Sea birds

Protected species

Very little is known on seabirds occurring on the BES-islands. In fact, the only two known occurring SPAW protected sea birds are the *Audubon's shearwater* and *Brown pelican*. There may very well be more protected species occurring on the islands but these are not known.

Existing data and monitoring networks

STINAPA monitored water birds density and abundance in the salinas for two years but this was discontinued in 2010 due to lack of resources (Simal, 2009). In 2009, external research was carried out on seabirds on St. Eustatius by Katherine Lowrie (DCNA, 2009). There have also been various external studies into seabirds on Saba in the 1980's and 1990's (Rojer, 1997), and a baseline on seabird colonies on Saba has been established (pers. comm.: IMARES). However, currently no structural monitoring of seabirds is taking place on the BES-islands.

Expressed needs and recommendations

There has been some form of research into seabirds on all three islands in the past. It would be beneficial to compile and analyse this data to assess the situation and the need for updated baselines to determine whether unknown protected species occur on the island today.

Fish

Please refer to 'Fisheries' under section 4.1.3

Corals

There are a large number of coral species in Appendix II of CITES and Appendix II of the SPAW protocol.

Existing data and monitoring networks and recommendations can be found under 'Coral reefs' in section 4.1.2.

Flora

Annex I of the SPAW protocol is entirely dedicated to protected marine and coastal flora. Specific species will not be discussed separately, but will be covered within the habitats discussed in the following section.

5.1.2 Habitats

Coral reefs

Importance and function

Coral reefs have several very important functions; they support a diversity of marine life, provide ecological services in the form of storm and flood protection, and are also the source of many socio-economic benefits (Bell et al., 2006; Yeemin et al., 2006). Surveys of the ecological status of coral reefs have indicated the ongoing degradation of these ecosystems. They are highly threatened and in decline worldwide (Bell et al., 2006; Clifton, 2003). There are two main categories of pressure on these ecosystems; global-scale climatic change and local-scale impacts which stem from natural phenomena as well as from human impacts on the coast. Human impacts which can contribute are deforestation, the use of fertilizers, herbicides and pesticides in agricultural practises causing an increase in nutrient and sediment loads, modification of habitat through coastal development and tourism, destructive fishing practises and fishing (Bell et al, 2006).

For the coral reefs which fringe the BES-islands there are clear effects from over-fishing, the removal of mangroves, coastal development, eutrophication of seawater due to direct discharge of nutrient rich water, or through indirect means such as when nutrient rich water diffuses through limestone (Jongman et al., 2009). The reefs in Bonaire are under large pressure and coral coverage has decreased since 2005. Threats are especially the increase of macroalgae, the decrease of parrotfish and the predation of juvenile fish through the invasive lion fish. The commercially relevant predator fish populations of the reefs of all the BES-islands have suffered from over-fishing (Jongman et al., 2009).

There are no well-developed coral reefs like on Bonaire on the Windward islands (with the exception of the Saba Bank), but corals do occur. Saba has a small human population so their influence on the marine environment of the coastal zone is relatively small. Human impact on the coastal zone is mostly from run off, diving tourism and fisheries. However, recently, due to the extinction of the white cedar and through overgrazing, erosion has had a detrimental effect on the shallow reefs (Jongman et al., 2009). St. Eustatius merely has several patch reefs.

Existing data and monitoring networks

The International Coral Reef Initiative (ICRI) was launched at the United Nations Global Conference on Sustainable Development of Small Islands Developing States in Barbados in 1994. In 1995, this initiative called on many nations to commit themselves towards increasing research and monitoring of reefs to provide the data for effective management (The Call to Action and Framework for Action) and the Global Coral Reef Monitoring Network (GCRMN) was established as one of the operating units of ICRI (GCRMN, 2008). The Netherlands Antilles Coral Reef Initiative (NACRI) came into being at the Netherlands Antilles National Nature Forum in 2000 in response to the call to action from ICRI to form regional and national initiatives to preserve the coral reefs. NACRI defined one of their priorities as the coordination of monitoring programs across the islands (NACRI, 2010).

A first attempt was made to coordinate data gathering and data management for coral reefs in the area. The idea was to build a central database, but due to lack of human and financial resources this was not realised. They did attempt to reach to an agreement to use standard protocols to monitor reefs in the islands; Saba and St. Eustatius use the global Reef Check Protocol and Bonaire uses the regional Atlantic and Gulf Rapid Reef Assessment (AGRRA) protocol. Summarized data on coral cover and species associated to the reefs is provided to the GCRMN every two years by MINA.

In Bonaire, BNMP staff carry out reef monitoring for the AGRRA protocol which includes recruitment, algae cover and fish counts. A significant amount of external research was carried out in 2009 on the status of the reefs, water quality monitoring, the relationship between grazing and coral recruitment, identification of resilience factors, fish community structure, predatory reef fish and coral cover (DCNA, 2009b).

In St. Eustatius Reef Check protocols are used to monitor the coral by marine park staff (pers. comm.: MINA). Furthermore Coral Watch methods have been used to monitor coral bleaching in 2009. There is no significant external research on coral reefs known to be carried out in 2009 (DCNA, 2009b).

The only form of coral monitoring which took place in Saba was by Paul Hoetjes of former MINA using the Reef Check Protocol. Furthermore, there was external research on fish counts, coral transplantation and fish parasite counts (DCNA, 2009b).

There are maps of reefs of Bonaire and Curacao made by Van Duyl (1985). The only long-term monitoring that has been carried out on the BES-islands has been in the form of permanent quadrats on the Bonaire reefs since 1973, carried out by Professor Rolf Bak (pers. comm.: IMARES).

Expressed needs and recommendations

When asked about monitoring needs, managers from both Bonaire and St. Eustatius call for more coral reef monitoring. Bonaire asks for more research on coral diseases, type and distribution of algal species, lionfish and microbiological processes and St. Eustatius for more research and monitoring on erosion impact on reefs, a monitoring system that ties into coral bleach monitoring, and a monitoring program which investigates water quality, nutrient indicator algae, sedimentation and coral disease.

With the fragmented monitoring and research existing over the three islands, data is scattered and a significant challenge lies in compiling this information in a data bank for storage and analysis. This is directly tied to management. If the existing data can be gathered and analysed this can be used to get an idea of the current situation, and to determine how to proceed.

A priority in terms of the current reef monitoring taking place is to evaluate the monitoring methods/protocols in use. As mentioned previously, DCNA recognized this and has been planning workshops to discuss standard protocols in the marine parks, which includes reef monitoring (pers. comm.: DCNA). Goals of coral reef monitoring must be defined clearly for each of the monitoring parties. This must be followed with an evaluation of whether the methods in use are fit and sufficient to realise these objectives, or whether they are too crude.

A suggested new option for reef monitoring on the BES-islands is building upon Prof. Bak's existing quadrat reef monitoring in Bonaire. Similar quadrats could be set up in St. Eustatius and Saba (pers. comm.: IMARES). It is very important that this is set up by experts who can then define the purpose of the monitoring system. Based on this the correct indicators such as reef distribution and extent, coral cover, coral diversity, diseases, fish density of large predators and herbivores, can be defined and valid methodology can be designed.

Mangroves

Importance and function

Mangroves form a very productive and important marine habitat, particularly as a nursery for many commercial reef fish. The only mangroves which exist occur in the bays of Lac and Lagoen on Bonaire. Lac is a Ramsar site. Research has shown that the mangroves of Lac are under ecological pressure through high sedimentation caused by erosion on land (Jongman et al., 2009). The back of Lac Bay is filling rapidly. This is caused by or contributed to by processes such as terrigenous sediments due to runoff, organic litter production by the mangroves themselves, accumulation of sand inside the bay which originates from coral reefs outside the bay and endogenous sediment production. In most situations expansion due to such processes is not an ecological problem as they have space to freely expand. In Lac however, free expansion of mangroves toward the sea has reduced the effective surface area of the lagoon (Debrot et al., 2010).

Existing data and monitoring networks

Currently there have been no efforts by STINAPA to structurally monitor the mangroves. In July of 2006 Progressive Environmental Solutions decided to implement and carry out a baseline study paired with intensive monitoring until December 2010. The various activities that they are performing as part of this monitoring are: 1.) Nutrient Level Analysis – Ammonia, Nitrate, Nitrite, Phosphates, Ph, Alkalinity recorded bi-monthly, 2.) Dissolved Oxygen, Temperature, Salinity, Water level – recorded 5 days per week at 13 (+1 open ocean control point) monitoring locations, 3.) GPS Recording – GPS point record of monitoring points, general mapping, key die off points and areas of new growth, and 4.) Aerial photographs. The goal is to establish a baseline and determine the most important environmental parameters that impact the overall health of Lac, which will provide STINAPA Bonaire with a view of the current situation in Lac as well as a reference point and context to which they can refer for all future monitoring (Progressive Environmental Solutions, 2010).

The Ministry of EL&I also commissioned IMARES to make an assessment of the Ramsar site Lac Bonaire in which they evaluate the threats Lac is faced with, and come with concrete recommendations as to stopping the filling in of Lac Bay (Debrot et al., 2010). The Ministry is in the process of commissioning IMARES to carry out a pilot monitoring programme for the mangroves in Bonaire which can be used in a future plan for the re-plantation of mangrove forest, as well as a baseline study into bird species occurring in these areas.

Expressed needs and recommendations

The problem of deteriorating mangroves has been recognized and solutions have been suggested in the above-mentioned assessment of the Ramsar site Lac Bonaire, executed by IMARES (Debrot et al., 2010). The priority here lies in analysing and publishing baseline data, and then applying solutions and monitoring their effect; a Lac Mangrove Restoration Action Plan is being created and part of this is to establish a baseline of the Lac mangroves.

When setting up structural monitoring of mangroves, we are looking at long-term infrequent monitoring. The extent of areas covered by mangroves can be measured using aerial photos maybe once every two years. The condition of the mangroves can be determined from total area of dead trees from aerial photos, or using permanent quadrant monitoring (pers. comm.: IMARES).

Seagrass

Importance and function

Seagrass fields are important as a nursery for certain reef fish, for trapping sediment and as a feeding habitat for certain species such as sea turtles. Saba does not have any meaningful seagrass fields due to the exposed coast and seagrass only occurs sporadically. The most important seagrass areas are on Bonaire and St. Eustatius. In Lac Bonaire there is a seagrass field of several hectares. As mentioned in the previous section, Lac is a Ramsar protected area. In St. Eustatius there are unprotected fields of seagrass used as anchoring areas for ships (Jongman et al., 2009).

Existing data and monitoring networks

Very few quantitative studies of seagrass communities on the BES-islands have been carried out, and the seagrass beds of Lac have only been qualitatively described. Existing estimates of the total area of seagrass habitat for the islands is merely a broad estimate (Jongman et al., 2009). Trends in the development of seagrass beds of Lac illustrate that Lac may already be at its environmental and social carrying capacities.

Data and monitoring of sea grass in the BNMP exists. Sabine Engel was hired as a consultant to carry out a survey for queen conch and a sea grass characterization of Lac Bay in 2007, and this could possibly serve as a baseline (Debrot et al., 2010). No data or monitoring of sea grass in St. Eustatius exists.

Expressed needs and recommendations

Research has suggested the threats of seagrass in Lac Bonaire. It is important to evaluate the existing data and to formulate further questions and possible solutions based on the data on Lac Bonaire. If other areas of seagrass in Bonaire are seen as areas of concern, then it is important to conduct a baseline study (including distribution and density, species composition and condition) and formulate objectives and set up a monitoring plan.

When monitoring seagrass areas it is important to determine the distribution and extent of total area, density, species composition and condition (by measuring biomass/m², fouling or epiphyte cover) (pers. comm.: IMARES).

St. Eustatius park management has shown interest in assessing the health of sea grass beds and subsequent health monitoring. It would be of use to do a baseline study in St. Eustatius and then set up a structured system.

Saba Bank

Importance and function

The Saba Bank is the largest underwater atoll in the Caribbean Sea. Research has suggested that this area is a biodiversity hotspot and one of the few areas which is still in pristine condition. Recently new species have been discovered here (Jongman et al., 2009). Due to this, and the fact that it is under threat from anchoring of oil tankers, the Netherlands has applied a request to the International Maritime Organization (IMO) to designate the Saba Bank as a Particularly Sensitive Sea Area.

Existing data and monitoring networks

Much individual external research has been carried out in the Saba Bank, and this is likely to increase significantly with increasing publicity of the area as one where new species are being discovered. However, most of this data is scattered and kept by the individual researchers. Fortunately many of these results have been published in scientific journals, so the findings can be used for further research and possibly future monitoring. Despite the large interest of the scientific community in the Saba Bank, there is no systematic monitoring of the area taking place at current.

Expressed needs and recommendations

Since there is very little known about the Saba Bank, but it is clear that it is unique in terms of its biodiversity, it is important to define what aspects of the Saba Bank are priority to monitor. This could be done through a thorough review of existing data.

A study carried out by IMARES suggests that the effects of fishing on the Saba Bank need to be studied, to ensure that this remains at a sustainable level (Meesters, 2010). This suggests that a priority is to carry out a survey for fishing catch and effort, and to determine locations of fishing on the Bank (see 5.1.3). It has also been suggested that it is important to do a baseline of mapping of coral cover on the Saba Bank in permanent plots, and to do a baseline of fish densities (pers. comm.: IMARES).

Since there is no monitoring in place and it is difficult to access because it is offshore and in deep water structural monitoring is likely to be of quite a high cost. This only underlines the importance to set priorities and formulate good testable hypothesis when carrying out research and monitoring on the Saba Bank.

Deep sea

Importance and function

Very little is known about biodiversity in the deep sea. Within the EEZ of the BES-islands there are underwater trenches and peaks about which little is known. Research of Cairns and Chapman (2001) has suggested that it is quite possible that there are extensive reefs in the aphotic zone.

Existing data and monitoring networks

There is no monitoring taking place and no data available.

Expressed needs and recommendations

A logical beginning is to do a literature survey of existing research of the deep sea in this area. This can be followed by a baseline study. A suggestion is to make an inventory of the mesophotic reefs occurring in the EEZ of the BES-islands (pers. comm.: CARMABI).

A monitoring plan for the deep sea is likely to be expensive due to the location of these reefs. This is not a priority with so many other high-priority problems in the marine environment which must be monitored.

5.1.3 Human impacts

Fisheries

Relevance

Coastal fisheries

On the islands, artisanal fishing often occurs relatively close to shore targeting demersal or reef fish. Traditional coastal fisheries are relatively well-developed in Bonaire and Curacao. However, for these islands fisheries catches represent less than 1% of the annual GDP. The traditional coastal fishery sector is under pressure and the participation in these fisheries is in decline. Hence, maintaining a sustainable and viable coastal fishery sector was one of the main objectives of the Netherlands Antilles Fisheries Policy Plan (Meesters et al., 2010).

The coastal fisheries sector of St. Eustatius comprises 25 fishermen, of which three of which can be considered professional fishermen. Most of the fishermen are parttime, as they have a fixed on-shore job. The aggregated value of the fishing sector is an important factor of annual GDP of the island (White et al., 2006). The Spiny Lobster, *Panulirus argus*, fishing industry is the most important commercial fishery on the island.

In absolute numbers the commercial fishery operating from Saba is 50 people. In relative terms the importance is high as these 50 people make up almost 10% of the economic active part of Saba's population. The lobster fisheries of the Saba Bank, which comprises around 10 boats, are the most economically significant section of commercial Saba Bank fishery. Some fishers also target deep reef fish. The fishery on the Saba Bank has remained relatively stable between 2000-2007 with regards to effort, economic value, and fishing methods (Meesters et al., 2010).

Pelagic commercial fisheries

The Antillean commercial fishery on economically attractive species is poorly developed. In 2009 three local vessels were issued a permit by the Fishery Board to fish in the EEZ. Since 1998 AVATUN, a Venezuelan operator has had Netherlands Antillean permits to fish for tuna with 14 vessels in the EEZ to the north of Curacao and Bonaire. Additionally, since 1996 ALBACORA, Spanish operator, fly the Antillean flag but these vessels do not fish in the EEZ; instead they target large pelagic species on the high seas (Meesters et al., 2010).

In the Dutch Caribbean the impacts of overfishing are mainly within the territorial waters close to the coast and often within the marine park boundaries. Within the EEZ overfishing may be a problem on the Saba Bank, but a large part of this fishing occurs within the territorial waters of Saba (Meesters et al., 2010).

Recreational fisheries

Recreational fishing charters are offered from most of the Antillean islands. Most recreational charter fishing occurs in the open water targeting large pelagic species like wahoo, dolphinfish and marlin. Most recreational fishing takes place within the boundaries of the territorial waters. Captured fish are returned to the sea or the catch is landed for consumption (Meesters et al., 2010).

Current data and monitoring network

There has been surprisingly little data collection in fisheries in the BES-islands. There are no structural monitoring systems in place for coastal or pelagic fisheries any of the three islands.

Coastal fisheries

There are no existing inventories of the Bonaire fisheries sector. However Nagelkerken of Radboud University Nijmegen has carried out a survey of groupers in the sea around Bonaire which can be used as a starting point for further research or monitoring.

From 10 to 18 February 2004 a short inventory of the fishery sector of St. Eustatius was carried out in order to get an insight of the total catch, total fishing effort and catch composition (Dilrosun, 2004) and STENAPA followed this with a fisheries baseline assessment for St. Eustatius Marine Park in 2006 (White et al., 2006).

To estimate the risk of overfishing lobster and reef fish stocks on the Saba Bank is difficult due to the lack of long term data sets (Meesters et al., 2010). There appear to have been three programs which included short-term monitoring or a baseline of small section of the Saba Bank fisheries; two programs commissioned by the Department of Public Health and Environment (Meesters et al., 1996; Dilrosun, 2000) and an investigation of reef fish assemblages (Toller et al., 2010). Legislation is in place which states that all fishers on the Saba Bank must report data on their catches, effort, fishing location and fishing gear to the Fisheries Commission. However, the required infrastructure to collect and analyze this information is not in place at current (Meesters et al., 2010).

Pelagic commercial fisheries

To estimate the risk of overfishing large migratory pelagic species such tuna in the EEZ, structural monitoring will also have to be set up. As argued by IMARES (Meesters et al., 2010) the prevention of overfishing of pelagic species will have to be accomplished in close co-operation with an international organization like the International Commission for the Conservation of Atlantic Tuna (ICCAT). The Netherlands Antilles' (limited) membership of ICCAT was extended in November 2009 and the monitoring requirements, which are catch registrations, need to be adhered to. The implementation of a robust catch recording system and investing in the required capacity to analyze and translate the data in relevant regulation, rules and policies is crucial (Meesters et al., 2010).

Recreational fisheries

At present no catch registration system is in place for the recreational fishery and no fee (recreational fishing license) needs to be paid to fish in waters surrounding the Antillean Islands.

Expressed needs and recommendations

As mentioned above, structural monitoring is key for estimating the threat of overfishing, for both territorial and pelagic fisheries. Accordingly, two action points mentioned in the Management Plan for the natural resources of the EEZ of the Dutch Caribbean are to facilitate the development and implementation of a catch recording system for commercial and recreational fisheries in the territorial waters outside the marine park boundaries and in the waters of the EEZ, and to promote the development of a stock assessment program for species targeted by commercial and recreational fisheries in the territorial waters outside the marine park boundaries and in the waters of the EEZ, including an assessment of conch stocks on the Saba Bank.

It would be reasonable to begin with collecting total catch and effort data, and the composition of the catch, possibly supplemented by length-frequency per target species (pers. comm.: Faisal Dilrosun). The existing baselines can be used to set up these systems.

Recreation

Relevance

The marine environment is used for a large area of recreational activities: kayaking, snorkelling, scuba diving, boating, fishing and wind surfing, all of which can potentially cause disturbance to the marine environment.

Current data and monitoring network

St. Eustatius are currently monitoring visitor numbers, tank usage, beach debris and AIS live large ship and ship anchoring web-based monitoring. Saba also uses AIS monitoring and monitors dive site usage and visiting yacht usage (DCNA, 2009b). Bonaire marine park has a rotation system to control the amount of divers. They do not let any divers in over the capacity on a site (pers. comm.: IMARES).

Expressed needs and recommendations

A study of Lac, Bonaire, by IMARES called for monitoring of human use of the bay and the identification and prioritization of threats (Debrot et al., 2010). It is important to continue monitoring visitor numbers in both the marine and terrestrial parks, and share this data so that it can be used to conduct baselines for environmental pressure.

Water quality parameters: coastal zone monitoring

Relevance

There are many water quality parameters which can affect the status of marine ecosystems and hence should be monitored, such as water temperature. One of the threats to coral reefs is human induced eutrophication. Adverse effects can be losses in biodiversity, ecosystem degradation, harmful algal blooms and oxygen deficiency in bottom waters (EC, 2010). To determine the magnitude of this problem it is important to measure nutrient concentration in coastal waters. Furthermore, it is important to determine that the level of contaminants in the water do not give rise to pollution effects.

Current data and monitoring network

No water quality monitoring programs are known in the waters around the BES-islands. What may of relevance is that currently the Dutch Ministry of Verkeer & Waterstaat (V&W) are funding STENAPA and STINAPA to research the possibility of setting up Port Biological Baseline Study (PBBS) could in Bonaire and St. Eustatius. Conducting regular monitoring can determine whether water ballast from ships is contaminating waters in the harbours.

Expressed needs and recommendations

STENAPA and STINAPA both state monitoring of water quality parameters as one of their future 'monitoring needs'. However, monitoring water quality parameters is a very difficult program to set up (pers. comm.: IMARES).

If V&W does begin a PBBS then this data can be used to assess the water quality in the harbours. Note that this only covers data in harbours and not around the rest of the islands, where nutrients could perhaps enter the water through erosion from land and so forth.

Environmental contamination in food chains

Relevance

Beach litter and other forms of pollution contaminate (marine) food chains. It is important for public health and defined legislation that the level of contaminants in fish and other seafood for human consumption does not exceed certain set levels.

Current data and monitoring network

There have been several individual studies into contaminants on the Leeward Islands; Buth and Ras (1992) made an inventory of land based sources of marine pollution for Curacao, Gerard van Buurt has looked at PCBs in the marine waters around the Leeward Islands and Newton has researched oil contamination in Bonaire (pers. comm.: IMARES). There have been no similar studies for the Windward Islands, and there is no structural monitoring in place.

Expressed needs and recommendations

It has been suggested that a baseline for the BES islands is an important component of biodiversity monitoring (pers. comm.: IMARES). However, it is not a high priority.

5.2 Terrestrial biodiversity monitoring

5.2.1 Species

Bats

Protected species

Insectivore bats play an important function on the islands in controlling insects. Frugivore bats perform ecological roles such as pollinating flowers and dispersing fruit seeds, and in some cases plant species depend largely on bats for the dispersal of their seeds.

The vast majority of the bats occurring on Bonaire and St. Eustatius are endangered or vulnerable species, but none are protected on a regional or international level except the *Tardarida brasiliensis* which occurs on all three islands and is protected under the SPAW-protocol (Carmabi, 2010; Jongman et al., 2009).

Data and existing monitoring networks

Bats are very difficult to monitor as monitoring activities significantly disturb their habitat (pers. comm.: IMARES). A bat survey was started by CARMABI and STINAPA, but this still needs to be finished and published (pers. comm.: IMARES). In the meantime, bats are monitored in WSNP in Bonaire, and recent external research on bat ringing was done by Ariana Garcia in 2009 (DCNA, 2009b).

In St. Eustatius there has been recent external research into making a bat inventory by Scott Pederson (DCNA, 2009b).

Expressed needs and recommendations

Bonaire park management has expressed a need for baseline research including localization, mapping and defining use patterns of caves by different bat species.

Before planning any type of monitoring network for bats it is essential to do baseline studies in Bonaire and St. Eustatius to assess the current status of the species. A priority is thus to if possible use the existing data and finish baseline studies of bats on the two islands.

Birds

Protected species

There are a number of birds occurring on the islands which are threatened in some form (Department of Environment and Nature, 2010). There are two CITES Appendix I bird species which occur on Bonaire, *Peregrine Falcon* and *Yellow-Shouldered Amazon*, or Lora. There are 15 CITES Appendix II species which occur on the three islands, of which some can also be found in Appendix II of CMS. Furthermore, eight birds protected under the SPAW protocol occur on the BES-islands.

Data and existing monitoring networks

On Bonaire terrestrial birds are monitored by WSNP, particularly parrots, parakeets, troupials, doves, pigeons, mockingbirds, thrashers and brown boobies. Water birds in the salinas are also monitored (pers. comm.: WSBP). A baseline for the lora exists for Bonaire, and they are structurally monitored by the Spatial Development and Management Service of Bonaire government, DROB. Terns are also endangered, and they are protected under the SPAW protocol (Jongman et al., 2010). A baseline study of terns in Bonaire has been done and this has made the problem clear, and solutions have been indicated in the form of enlarging their habitat (pers. comm.: IMARES). Flamingos are protected under CITES (Appendix II) and CMS (Appendix II). A baseline is still to be completed based on studies by Eric Newton of former MINA in Bonaire and field studies by Debrot and Nagelkerken (pers. comm.: IMARES). DROB also does flamingo monitoring (pers. com.: DROB). Furthermore, a lot of external research on birds was done in Bonaire in 2009.

In St. Eustatius and Saba the terrestrial parks also carry out some form of bird monitoring (DCNA, 2009b). Standard bird watching protocols were discussed in a DCNA Board Meeting in May 2008 after Vogelbescherming Nederland provided project funding. Standard protocols were developed with advice from Dr. Adrian del Nevo, and a two-year programme to build capacity for bird conservation was set up. Monitoring stations were set up on Aruba, Bonaire, Saba and St. Eustatius and all but Aruba are actively collecting bird data. Draft material for the Washington Slagbaai Bird Guide has been completed and is under review by STINAPA Bonaire. Once this first guide book has been completed drafts will be adapted for the other islands (DCNA, 2009).

Expressed needs and recommendations

It would be beneficial to evaluate these currently used monitoring methods; to redefine objectives for monitoring, and to assess the design of the existing monitoring systems. Also, it is a priority to ensure that the collected data is stored so that it can be used for reporting to the relevant treaties. For terns, further monitoring of the common and least tern is a monitoring need defined by park management in Bonaire (pers. comm.: WSBP). Priority is to apply the proposed solutions and monitor the effect of this. For flamingos, priority lies in evaluating existing data in order to determine the status of flamingos and whether a monitoring program needs to be set up. IMARES suggests a research project into feeding of flamingos.

Some specific areas can be designated as 'priority' in terms of bird baseline studies. Lac Bay, Bonaire, is a Ramsar protected area and thus it is important to create a baseline with bird species diversity and density. A bird baseline is recommendable in all the Ramsar areas.

Cacti

Protected species

There are 15 cacti species in the CITES II Appendix which occur on the three islands. There are also nine species in Appendix I of the SPAW protocol (Jongman et al., 2010; SPAW-RAC, 2010).

Data and existing monitoring networks

There is no current cacti monitoring taking place on the three islands.

Expressed needs and recommendations

Due to the lack of data, if deemed necessary a baseline would have to be established to determine the situation and need for structural monitoring.

Introduced species

Problem

Feral cats, rats and pigs in Bonaire are invasive species and the former two prey on native birds. It is unknown to what extent these cats are controlling the feral rat populations (Simal, 2009). Cats form an even larger problem on Saba (pers. comm.: IMARES).

Data and existing monitoring networks

There is no concrete data available.

Expressed needs and recommendations

WSNP management calls for research into rat density in the park and the potential effect of removing cats on rat population (Simal, 2009). Depending on the acuteness of the problem, research should be set up as soon as possible to find out the effect of removing cats.

Illegal livestock

Problem

The problems for nature posed by livestock on the islands has been known for a long time. The freely grazing livestock leads to over-grazing, erosion and soil degradation. The problem is especially acute in WSBP Bonaire, but must also be considered in the rest of the BES-islands. This problem is not one of international relevance, but due to the acuteness of the problem it is a priority.

Data and existing monitoring networks

Thirty years ago Coblenz (1980) made the first inventory of the nature of this problem. Saba Conservation Foundation appears to be carrying out some form of monitoring and registering free-range goats (DCNA, 2009b). St. Eustatius is starting to take action and between 10% and 15% of livestock is kept fenced in (Jongman et al., 2010). In Bonaire a start has been made by closing off WSNP with fencing.

Expressed needs and recommendations

The priority in terms of illegal livestock is assessing the existing data and finding solutions. As explained above, action is already being taken. The value of monitoring in this process is to measure the effect of actions taken; to continue closing off essential habitat for endangered species, like they are doing in WSNP, and to monitor the effect of the removal of goats. Because there is already essential habitat information on these areas amongst the parks it should be relatively easy to monitor these effects.

5.2.2 Habitats

The overarching problem which we are faced with when assessing the habitats of the BES-islands is that there is a lack of scientific data regarding the habitats which occur on the islands. This type of information is generally provided in a vegetation map.

Vegetation maps

Importance

This type of data is essential for a geographical information system and is important for terrestrial planning. Before can be determined what is priority in terms of monitoring habitat in the terrestrial environment, baseline information is essential.

Data and existing monitoring networks

A landscape ecological vegetation map for Bonaire was published by CARMABI and the Royal Netherlands Academy of Arts and Sciences in 2005 (Freitas et al., 2005). A baseline study on quill forest vegetation in St. Eustatius is close to completion, as well as a baseline study on tree ferns and elfin woodlands on Saba (pers. comm.: IMARES).

Expressed needs and recommendations

A similar baseline for St. Eustatia and Saba is essential in order to determine what type of habitat exists, where this habitat is and how much of it is there. This information is essential in order to obtain in order to determine whether habitats are in danger and which should be monitored.

5.2.3 Human impacts

Recreation

Relevance

Just like in the marine environment, recreational activities on land have the potential to cause disturbance to or directly degrade ecosystem services if they are not carried out in a sustainable manner. These activities can also result in excess waste and pollution which can also do damage to the environment.

Data and existing monitoring networks

All terrestrial protected areas on the BES-islands collect data on visitor numbers in their terrestrial protected areas.

In their assessment of Lac Bonaire, Debrot et al. (2010) mention the potential threats to nature posed by cruise ship day tourists: most of the tourists concentrate in a very small area and certain habitats in this area may experience excessive pressure and degrade. Furthermore, damage may be extensive if the users move to other areas. They also discuss the problem of wastewater management in the Lac area.

Expressed needs and recommendations

The above-mentioned report recommends monitoring human use of Lac bay, which has already been mentioned in section 5.1.3. It is important to determine whether further monitoring of recreation is a priority on the other islands. If so, it is vital that very clear objectives are defined so that time is not wasted in measuring inessential factors.

Environmental pressure of development

Relevance

A large number of activities related to economic development on the islands potentially have detrimental effects on the environment. For example, uncontrolled coastal and inland development washes away soil and leaves the area vulnerable to erosion and unable to provide habitat for species. Furthermore, deforestation also causes erosion and combined with heavy rainfall, this can cause landslides, causing damage to fragile terrestrial areas and bringing sedimentation into the ocean in turn causing damage coral reefs (Wolfs, 2010).

Data and existing monitoring networks

The Ministry of I&M is responsible for spatial planning on the BES-islands. They aim to make spatial development and land use plans for all three islands. A draft has been designed for Bonaire (pers. comm.: Ministry of I&M). St. Eustatius island government is also in the process of establishing a spatial development plan (Planbureau Eilandgebied St. Eustatius, 2010). In addition to this the Ministry of I&M is introducing the obligation for large new businesses to carry out environmental impact assessments before obtaining permits to build.

Expressed needs and recommendations

This is a prime example illustrating the need for cooperation and integration between not only non-governmental organizations, but also government agencies themselves. It is important to eventually integrate information from the Ministry of I&M with data on biodiversity in the terrestrial and marine environment from the Ministry of EL&I. Naturally it will not be possible to indicate any sort of 'cause and effect' relationships without proper research, but it is important that the parties involved begin to see the system as a whole; that economic development and biodiversity are interrelated.

5.3 Reflection

For both the marine and terrestrial environment relatively little monitoring is taking place in terms of human impacts. The nature parks, researchers and NGOs responsible for collecting data are faced with resource constraints and it is likely that other elements were deemed more urgent for monitoring.

It is not surprising that most visible efforts in terms of research and monitoring in the marine environment have been into endangered species and habitats like sea turtles and coral reefs. It is logical that most existing efforts have been placed in areas in which the 'problem' is already known. Increasing research is taking place on the Saba Bank because it is starting to develop a reputation for being a biodiversity hotspot, and because it is under threat. It is clear that significantly less attention has been paid to a habitat like the deep sea as there is relatively very little known about this habitat to date, and because it is costly to research.

Like in the marine environment, most monitoring efforts in the terrestrial environment have been in endangered and flagship bird species like the lora and flamingo respectively. Very little monitoring has taken place in terrestrial habitats. There are a number of unfinished baselines for St. Eustatius and Saba which are necessary to determine the need for future structural monitoring of terrestrial habitats on the islands.

In summary, there is already quite some biodiversity data in existence on the BES-islands. For some species and habitats there is already structural monitoring taking place, for others there has been research by individual scientists in the past but this has not been used for the setting up of structural monitoring, and for some there is no data available at all; either because there has been no research, or because research results have simply not been published yet. Because different parties are carrying out monitoring the data is scattered and sometimes not even used.

It is important to select what the priorities for monitoring are from this overview. When these priorities have been defined, the current status of research and monitoring of these elements described above should be reviewed so that the next steps can be defined accordingly.

6. Conclusions and recommendations

For the Kingdom of the Netherlands to report to the various international environmental treaties which also apply to the BES-islands, data is needed which requires monitoring on the BES-islands *supplementary* to what is taking place at the moment. In addition to this, if the Netherlands wishes to take the BES-islands into their national nature policy reporting structure, the necessary nature data from the islands must be made available for this. However, currently monitoring is not mandated on the BES-islands; the island's nature regulations and policy currently does not include biodiversity monitoring regulations. Hence, if the Kingdom wants to be able to provide complete national and international reporting on the status of biodiversity and nature policy, additional monitoring is required on the BES-islands.

When setting up a biodiversity monitoring plan on the BES-islands it is vital that the overarching goal is not to build up the same type of monitoring system as can be found in the Netherlands. Eventually the system could take on several of the positive characteristics of the Dutch system but it is highly unrealistic to assume that the same system can be built on the BES-islands. First and foremost because the natural environment in the Dutch Caribbean is not comparable to the Dutch one, so a monitoring network for these ecosystems will inherently differ.

The second reason one cannot assume to create a fully running system like the one in the Netherlands is that we are essentially looking at step zero of building up a monitoring system on the BES-islands, whilst nature monitoring in the Netherlands has existed for more than 10 years for both the terrestrial and marine environment. Terrestrial monitoring in the Netherlands is organized through the NEM which tunes governmental demand for biodiversity data in with actual data collection carried out by networks of volunteers, and a separate body controls data validity and maintains a common databank with biodiversity data. Marine monitoring is mandated by the government, executed by a government body and supplemented by several monitoring programs stemming from regional and international agreements.

Though there are already biodiversity monitoring activities taking place on the BES- islands and there have been several attempts to coordinate monitoring efforts on the BES-islands, monitoring activities are not organised and the necessary foundation is still lacking. The major contrast with the Netherlands is also that monitoring on the BES-islands is not steered by government demand. Separate entities carry out monitoring autonomously and they do not share data. There is no common data bank, nor is data quality controlled.

Something which comes forward time and time again in the preceding description of monitoring activities on the BES-islands is that there is a lot of data in existence, but much of this data is scattered and in the hands of many different stakeholders. Data use is key. It is of utmost importance to determine what data can be salvaged and published, so this data can be used to base further monitoring on.

Thus, we are faced with a situation where there is quite a lot of data in existence but no infrastructure in place to organise a structural monitoring system. An institutional arrangement around monitoring must be built up, a system for data storage and sharing must be created and a system for data quality assessment must be included in this. The following basic action points based on the preceding conclusions have been defined:

- **Setting up a network of monitoring partners**

Partnerships must be established between the parties involved in biodiversity monitoring, and some sort of monitoring network must be set up. Representatives from the nature parks and government agencies carrying out monitoring, NGOs currently carrying out monitoring, as well as representatives from the fishermen must come together and agreements on monitoring priorities and information sharing must be established. This is very important to ensure that monitoring efforts are not wasted and data is not lost. Also it is important to create data accessibility and transparency. Within these networks it is important to evaluate and optimize current monitoring methods to create maximum efficiency of all monitoring activities.

- **Data storage and management**

Data storage is key. Before setting up any new monitoring activities a data storage system must be established to collect and store biodiversity data. A database was previously set up by MINA, and perhaps this existing database can be built upon. Things which have to be considered are whether to combine marine and terrestrial data in one database, how data quality is controlled, how data access is controlled and so forth.

Someone must be appointed as responsible for obtaining, compiling and maintaining the data collected through monitoring in this database. Furthermore, this information must be used for reporting to the various international treaties. A practical solution would be to appoint one person in the RCN who is responsible for overall data management and has good communication with those working in the Dutch ministries who are responsible for reporting.

- **Setting priorities**

It is then a great challenge to sit together and decide on priorities for monitoring. The list in Chapter 5 is simply an overview of what has been done, what activities are taking place, how these existing efforts and trials can be built upon, and it indicates obvious gaps in current monitoring. However, resources are limited and choices must be made; priorities have to be defined by all the involved stakeholders. Once these priorities are defined it is important to optimize current monitoring methods; monitoring systems with clear objectives, sound research designs, concrete plans for data analysis, data collection conducted by informed actors and structural analysis of results, must be adopted. Results must be analysed so that informed decisions can be made and subsequently solutions can be applied to problems identified.

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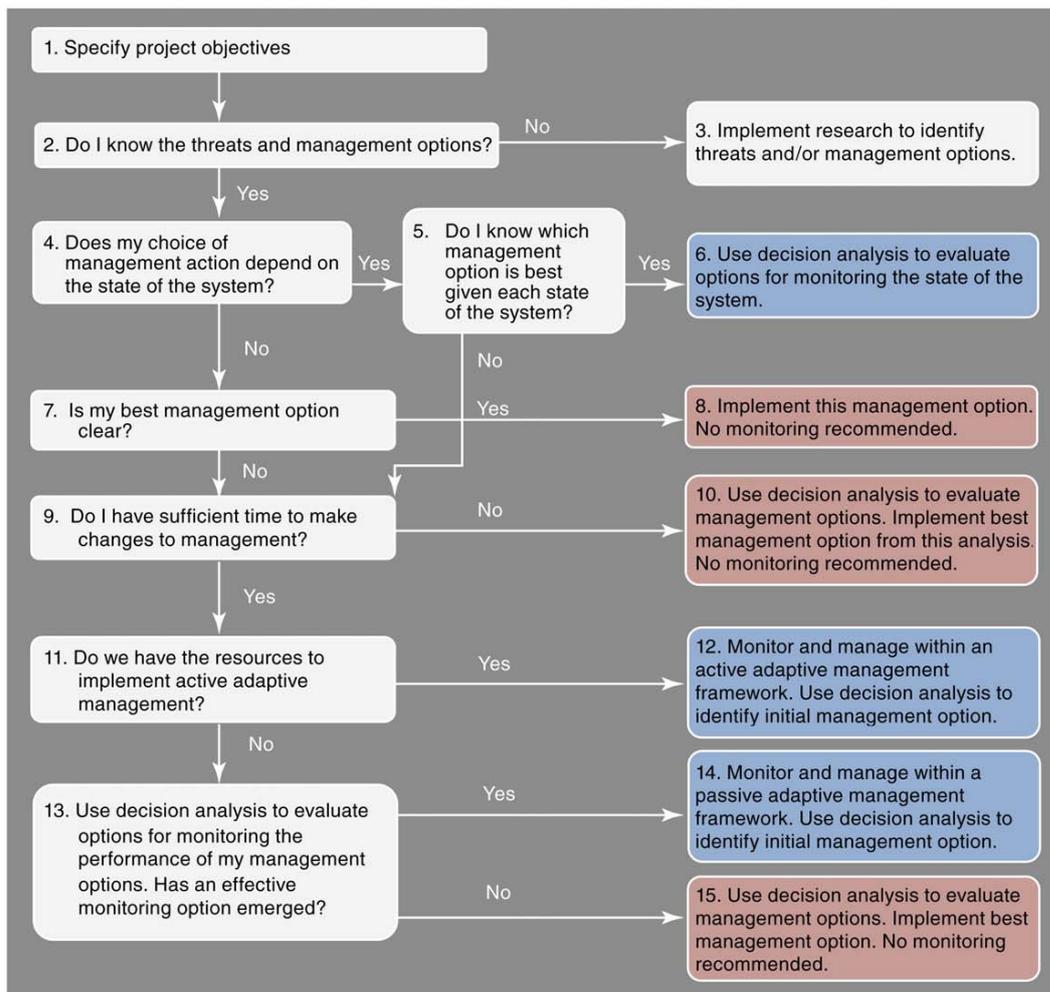
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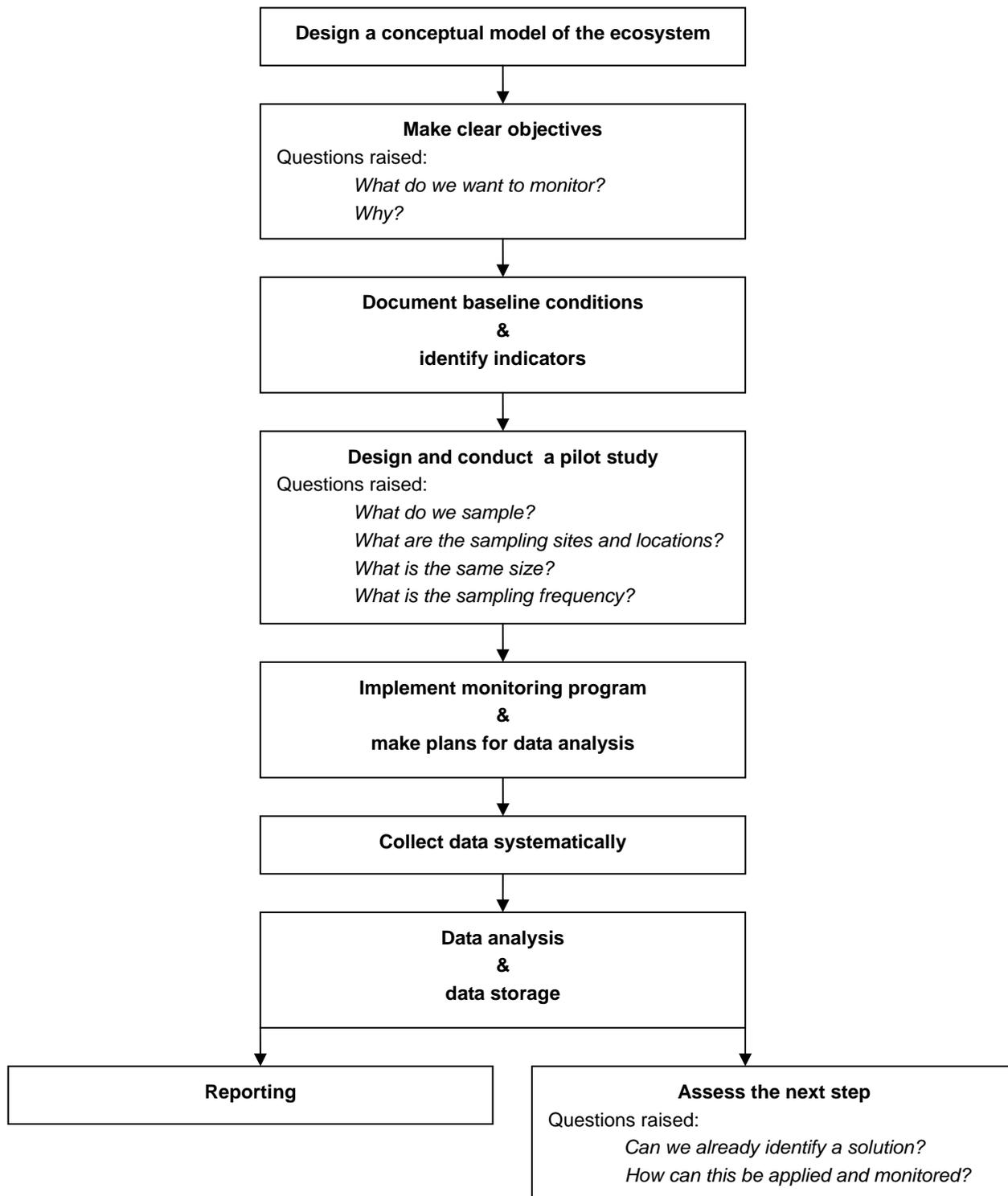
Appendix 1: Decision tree for deciding when to implement monitoring to improve conservation management



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Source: McDonald-Madden et al., 2010: 549

Appendix 2: Flow Diagram for the design of a successful monitoring system



Appendix 3: Monitoring-related requirements of the CITES Convention

(From the: Text of the Convention)

Article VIII : Measures to Be Taken by the Parties

6. Each Party shall **maintain records of trade in specimens of species** included in Appendices I, II and III which shall cover:

(a) the **names and addresses of exporters and importers**; and

(b) the **number and type of permits and certificates granted; the States with which such trade occurred; the numbers or quantities and types of specimens, names of species** as included in Appendices I, II and III and, where applicable, the **size and sex of the specimens in question**.

7. Each Party shall prepare **periodic reports on its implementation of the present Convention** and shall transmit to the Secretariat:

(a) an **annual report containing a summary of the information** specified in sub-paragraph (b) of paragraph 6 of this Article; and

(b) a **biennial report on legislative, regulatory and administrative measures** taken to enforce the provisions of the present Convention.

Source: <http://www.cites.org/eng/disc/text.shtml#VIII>

Appendix 4: Monitoring-related requirements of the Convention for Biological Diversity

(From the: Text of the Convention on Biological Diversity)

Article 7: Identification and Monitoring

Each Contracting Party shall, as far as possible and as appropriate, in particular for the purposes of Articles 8 to 10:

(a) **Identify components of biological diversity important for its conservation and sustainable use** having regard to the indicative list of categories set down in Annex I;

(b) **Monitor, through sampling and other techniques, the components of biological diversity identified** pursuant to subparagraph (a) above, paying particular attention to those requiring urgent conservation measures and those which offer the greatest potential for sustainable use;

(c) **Identify processes and categories of activities** which have or are likely to have significant adverse impacts on the conservation and sustainable use of biological diversity, and monitor their effects through sampling and other techniques; and

(d) **Maintain and organize, by any mechanism data,** derived from identification and monitoring activities pursuant to subparagraphs (a), (b) and (c) above.

Article 26: Reports

Each Contracting Party shall, at intervals to be determined by the Conference of the Parties, present to the Conference of the Parties, **reports on measures which it has taken for the implementation** of the provisions of this Convention and their effectiveness in meeting the objectives of this Convention.

Source: <http://www.cbd.int/convention/articles.shtml?a=cbd-07>

Appendix 5: Monitoring-related requirements of the SPAW Protocol

(From the: SPAW Protocol)

Article 13: Environmental Impact Assessment

1. In the planning process leading to decisions about industrial and other projects and activities that would have a negative environmental impact and significantly affect areas or species that have been afforded special protection under this Protocol, each Party shall evaluate and take into consideration the possible direct and indirect impacts, including cumulative impacts, of the projects and activities being contemplated.

2. The Organization and the Scientific and Technical Advisory Committee shall, to the extent possible, provide guidance and assistance, upon request, to the Party making these assessments.

Article 17: Scientific, Technical and Management Research

1. Each Party shall **encourage and develop scientific, technical and management-oriented research on protected areas**, including, in particular, their ecological processes and archaeological, historical and cultural heritage, as well as on threatened or endangered species of fauna and flora and their habitats.

2. Each Party may consult with other Parties and with relevant regional and international organizations with a view to identifying, planning and undertaking **scientific and technical research and monitoring programmes necessary to characterize and monitor protected areas and species and to assess the effectiveness of measures taken to implement management and recovery plans**.

3. The Parties shall **exchange, directly or through the Organization, scientific and technical information concerning current and planned research and monitoring programmes and the results thereof**. They shall, to the fullest extent possible, co-ordinate their research and monitoring programmes, and endeavour to standardize procedures for collecting, reporting, archiving and analyzing relevant scientific and technical information.

4. The Parties shall, pursuant to the provisions of paragraph 1 above, **compile comprehensive inventories of:**

a) **areas** over which they exercise sovereignty, or sovereign rights or jurisdiction that contain rare or fragile ecosystems; that are reservoirs of biological or genetic diversity; that are of ecological value in maintaining economically important resources; that are important for threatened, endangered or migratory species; that are of value for aesthetic, recreational, tourist or archaeological reasons; and

b) **species** of fauna or flora that may qualify for listing as threatened or endangered according to the criteria established under this Protocol.

Source: <http://www.cep.unep.org/cartagena-convention/spaw-protocol/spaw-protocol-en.pdf>

Appendix 6: Monitoring-related requirements of the MMAP

(From the: Action Plan for the Conservation of Marine Mammals in the Wider Caribbean Region)

Chapter 2.5 Research

32. Research (including surveys, monitoring, and information management) should form an integral part of any conservation or recovery plan for a species or population. In the WCR, **research efforts have not been adequate to identify conservation units (e.g. management stocks), assess their status, or characterize and quantify effects of human activities on them. Emphasis should be placed on:**

- Acknowledgement of scientific uncertainty; and, quantifying and incorporating such uncertainty into decision-making. This may require the application of novel scientific methods as well as greater acceptance of precautionary perspectives in the region.

- **Monitoring through direct observation and the use of non-lethal methods.**

- Socioeconomic research to ascertain how local communities can benefit from the conservation process and be encouraged to protect marine mammals and their habitat.

33. All non-lethal but "invasive" research should meet with internationally accepted standards. **The results of all scientific research should be encouraged to be made available through the RAC and disseminated through relevant scientific and public forums in the WCR and internationally.** Although it is important to be able to justify conservation recommendations with empirical scientific data, in some cases this is not possible even though the threat clearly exists.

Given funding, logistical and other constraints, it may take many years to collect and analyze sufficient data for full assessment of a particular threat factor. In such cases, a precautionary approach should be adopted.

34. **Data collection protocols should be standardized across the WCR so that meaningful comparisons can be made of current and future research results.**

Source: <http://www.cep.unep.org/promotional-material/publications/spaw/mmap>

Appendix 7: Monitoring-related requirements of the Convention for the Protection and Conservation of Sea Turtles

(From the: Text of the Inter-American Convention for the Protection and Conservation of Sea Turtles)

ARTICLE IV: MEASURES

1. Each Party shall take appropriate and necessary measures, in accordance with international law and on the basis of the best available scientific evidence, for the protection, conservation and recovery of sea turtle populations and their habitats:

- In its land territory and in maritime areas with respect to which it exercises sovereignty, sovereign rights or jurisdiction included within the Convention Area; and
- Notwithstanding Article III, with respect to vessels on the high seas that are authorized to fly its flag.

2. Such measures shall include:

[..]

e. The **promotion of scientific research** relating to sea turtles and their habitats, as well as to other relevant matters that will provide reliable information useful for the adoption of the measures referred to in this Article;

f. The promotion of efforts to enhance sea turtle populations, including **research into the experimental reproduction, raising and reintroduction of sea turtles into their habitats** in order to determine the feasibility of these practices to increase populations, without putting sea turtles at risk;

g. The **promotion of environmental education and dissemination of information in an effort to encourage the participation of government institutions, nongovernmental organizations and the general public of each State**, especially those communities that are involved in the protection, conservation and recovery of sea turtle populations and their habitats;

[...]

ARTICLE IX: MONITORING PROGRAMS

1. During the year following the entry into force of this Convention, **each Party shall establish, within its territory and in maritime areas with respect to which it exercises sovereignty, sovereign rights or jurisdiction, a program to ensure monitoring of the application of the measures to protect and conserve sea turtles and their habitats set forth in this Convention or adopted pursuant thereto.**

2. The program referred to in the preceding paragraph shall include, where appropriate, mechanisms and arrangements for the participation by observers designated by each Party or by agreement among them in monitoring activities.

3. In implementing the program, each Party may act with the support or cooperation of other interested States and relevant international organizations, as well as non-governmental organizations.

ARTICLE XI : ANNUAL REPORTS

1. Each Party shall **prepare an annual report**, in accordance with Annex IV, **on the programs it has adopted to protect and conserve sea turtles and their habitats**, as well as any program it may have adopted relating to the utilization of these species in accordance with Article IV(3).

Source:<http://www.iacseaturtle.org/English/download/Texto%20CIT%20ENG.pdf>

Appendix 8: Inventory of existing monitoring activities on the BES-islands

Island/ environment	Monitoring or research	Human use	Species numbers and population	Ecosystems and habitats	General ecological data
BONAIRE					
<i>Terrestrial</i>	Monitoring	-Visitors	-Terrestrial bird population estimates (parrots/ parakeets/ troupials/ doves and pigeons/ mockingbirds/ thrashers) (2x a year) - Water birds presence/absence in the Salinas (4x a year) -Nesting success of parrots (1x a year) -cave-dwelling bats population numbers (ringing)(6x a year) -Colony of Brown boobies at WSNP presence/absence (4x a year)	-Cave census and mapping (6x a year) -Exotic herbivores damage to vegetation (1x a year)	-Microclimate in the caves (6x a year) -Physico-chemical conditions in the Salinas (1x a year)
	External research 2009		-Bird monitoring -Bat ringing	-Salinas research	
	Monitoring and research needs as defined by park management		-Exotic species of carnivores (feral cats and rats) research -Study of the ecological interactions between Yellow oriole, Troupial and Pearly-eyed thrasher -Monitoring waterbird density and relative abundance in Salinas -Monitoring Caribbean coot population numbers and nesting success -Monitoring Common tern population and nesting success -Monitoring Least tern population and nesting success -Yellow-shouldered parrot -Exotic invasive species -basic species inventory	-Baseline research including localization, mapping and defining use patterns of caves by different bat species -Baseline research or biological inventory of different species of fish and invertebrates that inhabit Salinas -Create a vegetation map	-Soil condition research
<i>Marine</i>	Monitoring		-Sea turtles -Fish counts -Lionfish	-Coral reefs: coral cover, coralline algae, macroalgae, damsel and parrot fish abundance (mostly yearly monitoring) NB: using AGRRR protocol Coral bleaching	
	External research 2009	-From Barrels to Augers: Managing a Transition in the Mooring Buoy System of		-Lac Monitoring -Status of the Coral Reefs of	

Island/ environment	Monitoring or research	Human use	Species numbers and population	Ecosystems and habitats	General ecological data
		the Bonaire National Marine Park		Bonaire -Light and Motion Sensor Program: Low Cost Coral Reef Water Quality Monitoring -Relationship between grazing activity and coral recruitment -Predatory reef fish – overfishing and the impact on Damsel fish abundance -Coral cover -Identification of resilience factors -Fish community structure	
	Monitoring and research needs as defined by park management		-Basic species inventory -data on commercial species in NTAs -checking for invasive species		-monitoring water quality parameters
ST. EUSTATIUS					
<i>Terrestrial</i>	Monitoring	-Number of hikers	-Bird monitoring -Orchid diversity and growth -Butterfly diversity and distribution		
	External research 2009		-Bat inventory -Bird inventory and training -Orchid specialist		
	Monitoring and research needs as defined by park management		-Continue orchid research -Stafia Morning Glory research and monitoring -Bird inventory and continuation of monitoring -Butterfly surveys and continuation of monitoring -Antillean Iguana research (population, habitat and behaviour) -Insects: inventory of species and focused research -Plant inventory: complete half completed inventory by New York Botanical Garden	-Vegetation map: impacts of over-grazing -Erosion impacts: mapping watersheds and need for management of run-off	
<i>Marine</i>	Monitoring	-Visitor numbers -Tank usage -Tanker monitoring -Beach debris -'AIS live' large ship and ship anchoring web-based monitoring	-Turtle nesting -Flamingo tongue		-Sedimentation monitoring
	External research 2009		-Mollusc collection -Seabird monitoring	-Corallita (invasive properties)	-Sedimentation
	Monitoring and research needs as defined by		-Species inventories (coral, inverts, fish , cetaceans)	-Erosion impact: on reefs -Employ monitoring system that	-Monitoring program to investigate water quality, nutrient indicator

Island/ environment	Monitoring or research	Human use	Species numbers and population	Ecosystems and habitats	General ecological data
	<p>park management</p> <p>Extra:</p> <ul style="list-style-type: none"> -Initiate research into the feasibility of using video and photographic monitoring methods -Investigate feasibility FAD deployment in fisheries -Manage project with Reef Ball, EcoReef or Biorock: enhance fish recruitment with Artificial Reef deployment -Further socio-economic research and monitoring using Choice Models, further WTP studies, Contingency Valuation methods 		<ul style="list-style-type: none"> -Assessment of health of Statia fishery including conch, lobster and fin fish -Region-wide Flamingo tongue study (researching affects on gorgonian health) -Turtle program: initiate a water table investigation to understand low success rate of hatchling emergence on Zeelandia beach -Establish a cetacean monitoring network -Monitoring lionfish invasion 	<p>focuses on coral reef health and resilience as it ties in to Coral Reef Bleaching Response Monitoring</p> <ul style="list-style-type: none"> -Seagrass health assessment and health monitoring 	<p>algae, sedimentation and disease of corals</p>
SABA					
<i>Terrestrial</i>	Monitoring	-Trail use	<ul style="list-style-type: none"> -Bird monitoring -EPIC seabird atlas data collection -monitoring feral domesticated animals -monitoring and registering free-ranging goats 		
	External research 2009		<ul style="list-style-type: none"> -Bird monitoring -Anole study -Bromeliads 	-Mapping	
	Monitoring and research needs as defined by park management	Unknown	Unknown	Unknown	
<i>Marine</i>	Monitoring	<ul style="list-style-type: none"> -dive site usage -visiting yacht usage -‘AIS live’ large ship and ship anchoring web-based monitoring 		<p>Coral reefs</p> <p>NB: Reef Check protocol</p>	
	External research 2009	-Drilling workshop	<ul style="list-style-type: none"> -Octopus study -Fish counts 	<ul style="list-style-type: none"> -Coral transplantation -Fish parasite counts 	-Sediment cores and traps
	Monitoring and research needs as defined by park management	Unknown	Unknown	Unknown	

