

BONAIRE NATIONAL MARINE PARK

MANAGEMENT PLAN 2022-2028



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Cover Art

Ghislaine Monte

Design

Blendr Branding & Design

Photography

STINAPA Bonaire

Paulo Bertuol

Casimir Roosje

Sabine Engel

Lorenzo Mittiga

Adobe Stock

Unsplash

Chuda de Jongh

Christian König (SHAPE/DCNA)

Kenny Ranking

Casper Douma

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The content of this plan came from numerous sources including, extensive conversations, interviews, workshops and correspondence with STINAPA staff: Leonel Martijn, Edwin Domacassé, Suradno Mercera, Enchomar Wanga, Dustin Abraham, Oscar Ogenia, Shurendy Eugenia, Roxanne Francisca, Mavelly Velandia, Kerenza Rannou, Wijnand de Wolf, Jilly Sarpong and other STINAPA staff members. Enit Scholten provided valuable comments.

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LAND ACKNOWLEDGEMENT

STINAPA acknowledges the Caquetio people, the indigenous people of Bonaire and the traditional owners of the land and sea currently known as Bonaire National Marine Park and pays respect to their descendants today. We recognize the harm, injustice and indignity brought upon enslaved African people on the island. The gruesome legacy of slavery, and the institutionalized racism that followed, continue to impact Bonaire's culture, society and landscape. STINAPA honors the indigenous and enslaved peoples' stewardship of the Bonaire National Marine Park. It is only by recognizing and understanding our troubled past that we can hope to correct our common path. STINAPA commits to creating a future founded on respect for, and understanding of, the histories and experiences of all people on our island.

REKONOSEMENTU DI TERA

STINAPA ta rekonosé e pueblo Caquetio, e pueblo indígena di Boneiru komo e propietarionan tradishonal di tera i laman aktualmente konosí komo Parke Marino Nashonal di Boneiru, i awe ta duna rèspèt na nan desendientenan. Nos ta rekonosé e sufrimentu, inhustisia i indignidat ku a kousa na personanan afrikano. E herensia horibel di sklabilitut, i e rasismo institushonalisá ku a sigui, ta sigui hasi impakto riba Boneiru su kultura, komunidad i paisahe. STINAPA ta duna honor na e tarea di vitó ku e pueblo indígena i na esun sklabisá tabatin pa mantené e tera i awa den Parke Marino Nashonal di Boneiru. Ta solamente dor di rekonosé i komprondé nos pasado problemátiko ku nos por spera di koregí nos ruta komun. STINAPA ta komprometé su mes na krea un futuro fundá riba rèspèt pa, i komprondementu di, e historianan i eksperensianan di tur hende riba nos isla.

EXECUTIVE SUMMARY

The Bonaire National Marine Park was established in 1979. The marine park protects 2,700 hectares of coral reefs, seagrass beds and mangrove forests. Seventy-five IUCN Red List critically endangered, endangered or vulnerable species, and 15 CITES Appendix I species, are recorded in the marine park. The marine park includes two Ramsar sites: Lac Bay (the largest semi-enclosed bay in the Dutch Caribbean) and Klein Bonaire (an uninhabited satellite island located approximately 700 m offshore). Bonaire's coral reefs are considered some of the healthiest in the Caribbean.

The marine park forms the cornerstone of the island economy. Bonaire is consistently ranked in the top five diving destinations in the Caribbean. Year-round trade winds increasingly attract wind- and kitesurf enthusiasts. Nature-based tourism is the largest economic sector on the island accounting for over 38% of the economy and more than half of all jobs.

But success comes at a price. The pace of economic growth since the constitutional change in 2010 has been unprecedented. Rapid population growth and increasing number of tourists are driving land conversion and coastal development. The pressure on the Bonaire National Marine Park has never been greater, and the task of balancing economic development with nature conservation never more acute.

The management plan provides specific recommendations for the period 2022-2028, centered around six conservation strategies:

1. Optimize protection of key habitats and species.
2. Improve sustainable recreation.
3. Encourage sustainable fishing.
4. Control invasive species and disease.
5. Support restoration of key habitats and species.
6. Influence policy and legislation to improve park management.

This management plan was developed in close co-operation with local stakeholders. The plan is organized in eight chapters. This document also serves as the management plan for the Ramsar sites Lac Bay and Klein Bonaire.



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1 | INTRODUCTION

PURPOSE

Management plans are a prerequisite for both National Park status and for recognition under the Cartagena Convention Specially Protected Areas and Wildlife (SPAW) Protocol and are required for sites listed under the Ramsar Convention.

Management plans are an invaluable tool for managers and their staff both to guide management activities and reporting as well as to help build credibility, durability and confidence in the protected area management body. A schematic of how management plans fit within international, regional and global policy and legislation is provided in Appendix C.

SCOPE

This management plan provides background information on the Bonaire National Marine Park with descriptions of the park features, a value statement, and a snapshot of the context within which the marine park operates, including an overview of available resources (human, physical, financial and information).

The plan provides management strategies for the marine park and for the Ramsar sites Lac Bay and Klein Bonaire, which are built on conservation strategies, originally developed by STINAPA staff and stakeholders (2018-2020) as part of their Conservation Action Planning as well as extensive stakeholder focus sessions held from July – September 2021. The plan is designed to guide STINAPA staff in their work for the coming six years.

PROCESS

The Bonaire National Marine Park Management Plan 2020-2028 has been prepared by Parks Work (Parks-Work.com), Duncan MacRae and Kalli De Meyer, in close co-operation with STINAPA staff. It replaces the 2006 management plan for the Bonaire National Marine Park developed by Duncan MacRae.

This approach to management planning was first developed by Parks Work in 2004 and was reviewed and endorsed by members of the World Commission on Protected Areas (WCPA). It is based on IUCN's Protected Area Management Planning guidelines as well as the widely acclaimed Open Standards for the Practice of Conservation and Conservation Action Planning and meets the requirements for both National Park and SPAW site designations.

Gathering input from stakeholders is an essential component of the management planning process and helps to foster collaboration and buy in as well as building broad support from a range of partners and stakeholders for the management plan. A series of stakeholder focus group meetings were held over the course of two months and detailed notes were kept of these meetings, paying particular attention to stakeholder priorities, needs and concerns (see Appendix F). Information contributed and, wherever possible, concerns and issues raised by stakeholders have been integrated directly into the management plan and/or incorporated into the management strategies.

HOW TO USE THIS PLAN

This management plan aims to guide conservation management and decision making for STINAPA management, the marine park manager and staff. The management plan should be seen as a reference tool containing information on the marine park, as required by international guidelines. The strategies and objectives should form the framework for prioritizing work, annual planning, budgeting, monitoring as well as evaluating management effectiveness.



2 | BACKGROUND

The island of Bonaire is situated in the southern Caribbean (12°10'N, 68°15'W) approximately 100 km north of Venezuela. It is one of six islands that comprise the Caribbean component of the Kingdom of the Netherlands alongside Aruba and Curaçao, and the Windward Islands of St. Maarten, Saba, and St. Eustatius (Figure 1).

Bonaire is a crescent shaped island, oriented NW-SE, approximately 40 km long by 11 km at its widest point, with a land area of 28,100 ha. The small uninhabited satellite island of Klein Bonaire is located some 750 m off the western shore of Bonaire and has a land area of approximately 600 ha (see Figure 2). The Southern part of the island is relatively flat and the middle and northern parts are hilly with the highest point, Brandaris located in the Washington Slagbaai National Park, 241 m above sea level.



Figure 1: Bonaire within the wider Caribbean

Bonaire lies outside of the hurricane belt, but hurricane generated storm waves and wind reversals have caused significant damage to coral reefs, the shoreline and shore side properties, including partially demolishing the historic building at Slagbaai, which had to be rebuilt after storm waves from Hurricane Lenny in 1999.

Both Bonaire and Klein Bonaire are surrounded by continuous, fringing coral reefs which start at the shoreline and slope down to around 10-15 m before dropping further seaward to depths in excess of 70 m. Being so close to the shoreline makes Bonaire's coral reefs very attractive for watersport activities, especially scuba diving and snorkeling. In addition to harboring some of the healthiest coral reefs in the Caribbean, Bonaire's other significant natural assets include mangrove forests, seagrass beds, salinas and tropical dry forests.

The Washington Slagbaai National Park, which protects approximately 15 percent of the total land area of Bonaire, was first established in May 1969 (Crestian et al. 2022). The establishment of the Bonaire Marine

National Park followed ten years later in May 1979. The marine park surrounds Bonaire and Klein Bonaire extending from the highwater mark to the 200 ft (60 m) depth contour and includes the entire island of Klein Bonaire. Both are managed by STINAPA Bonaire, a not-for-profit foundation. The island of Klein Bonaire, along with Pekelmeer, Washington Slagbaai and Lac Bay, are four of only 120 designated Ramsar sites in the Caribbean. As such they are recognized as wetlands of global significance under the Ramsar Convention (1971). The Ramsar sites of Klein Bonaire and Lac Bay fall directly under the management of the Bonaire National Marine Park.

The main town of Kralendijk (known locally as Playa) has become the focus of the island's tourism industry with the majority of hotels, dive and watersport centers and restaurants clustered to the south and north of the town. The first settlement and oldest continuously inhabited town in the Dutch Caribbean, Rincon, lies to the north of the island. It has become a cultural and historical center and has seen a significant revival in recent years. The expenditure by tourists on Bonaire is found to be around USD 125 million annually. An estimated welfare of around USD 50 million is contributed by Bonaire's nature to tourism (Wolfs & van Beukering, 2013a).

Bonaire's coral reefs are healthy, but, like coral reefs throughout the world, under threat. Declining water quality due to land-based activities is considered an acute threat to Bonaire's reefs. The marine environment is under direct pressure from water pollution including sewerage waste (the centralized treatment plant only processes waste water for an estimated 10 percent of the island), sedimentation as well as the effects of coastal construction. Overgrazing by goats and donkeys and poor land management practices have a strong negative impact on the terrestrial vegetation and thereby indirectly on the marine ecosystems due

to erosion causing nutrient enrichment and sedimentation. This is exacerbated by an extensive system of unpaved roads which are a significant source of sediment. Disease events coupled with historical overfishing have had a major impact on corals and reef fish populations. Bonaire is vulnerable to the effects of global climate change, which are predicted to include increased storm frequency and intensity, periods of drought, ocean acidification as well as sea level rise.

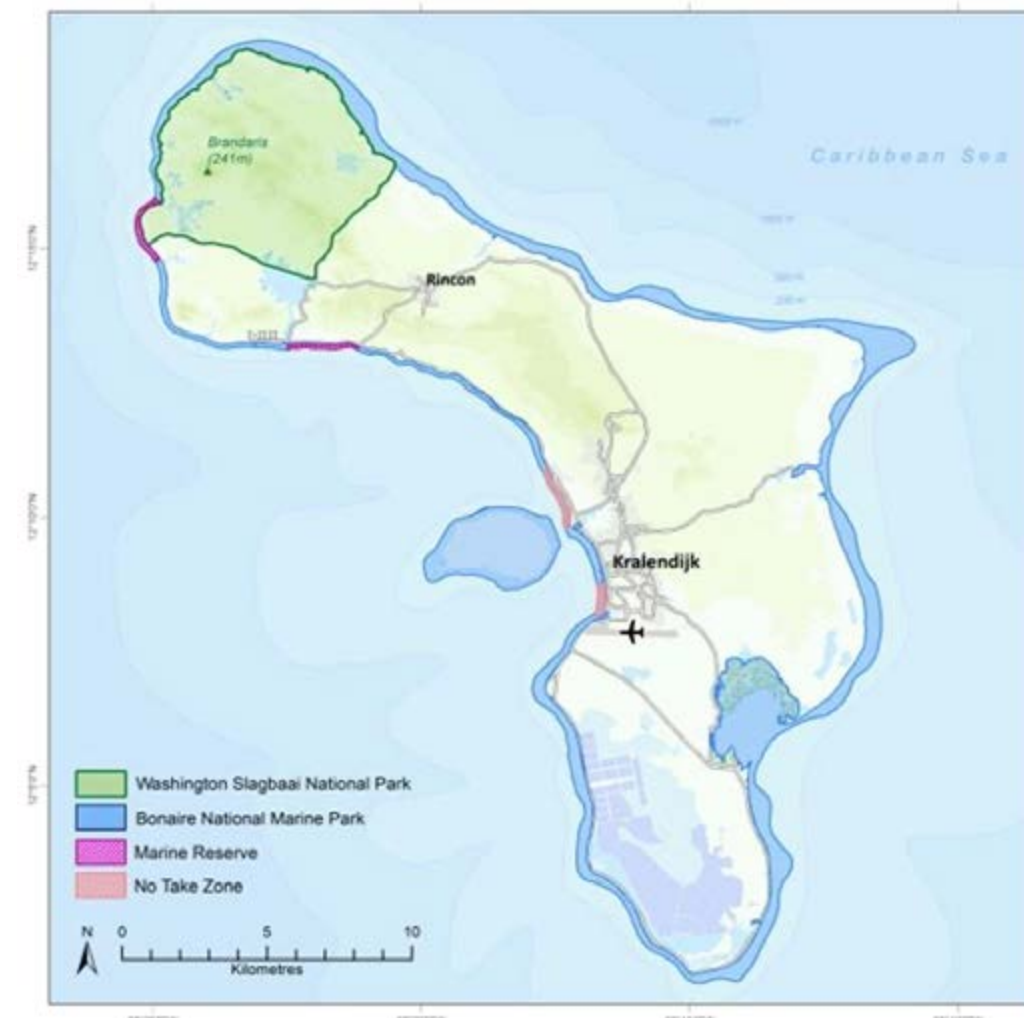


Figure 2: National Parks on Bonaire

PHYSICAL ENVIRONMENT

Climate

The climate of Bonaire is arid tropical characterized by low rainfall, high evaporation rates, year-round high temperatures with little seasonal variation and almost constant easterly trade winds. Average monthly air temperatures range from 25.6°C (February) to 28.4°C (October), and average rainfall is just 490.5 mm/year. Rainfall is unequally distributed geographically. The rainy season generally begins at the end of October and lasts until around the beginning of January; a second, shorter rainy season occurs in June/July (Figure 3). Commonly, no rainfall is recorded during the dry months.

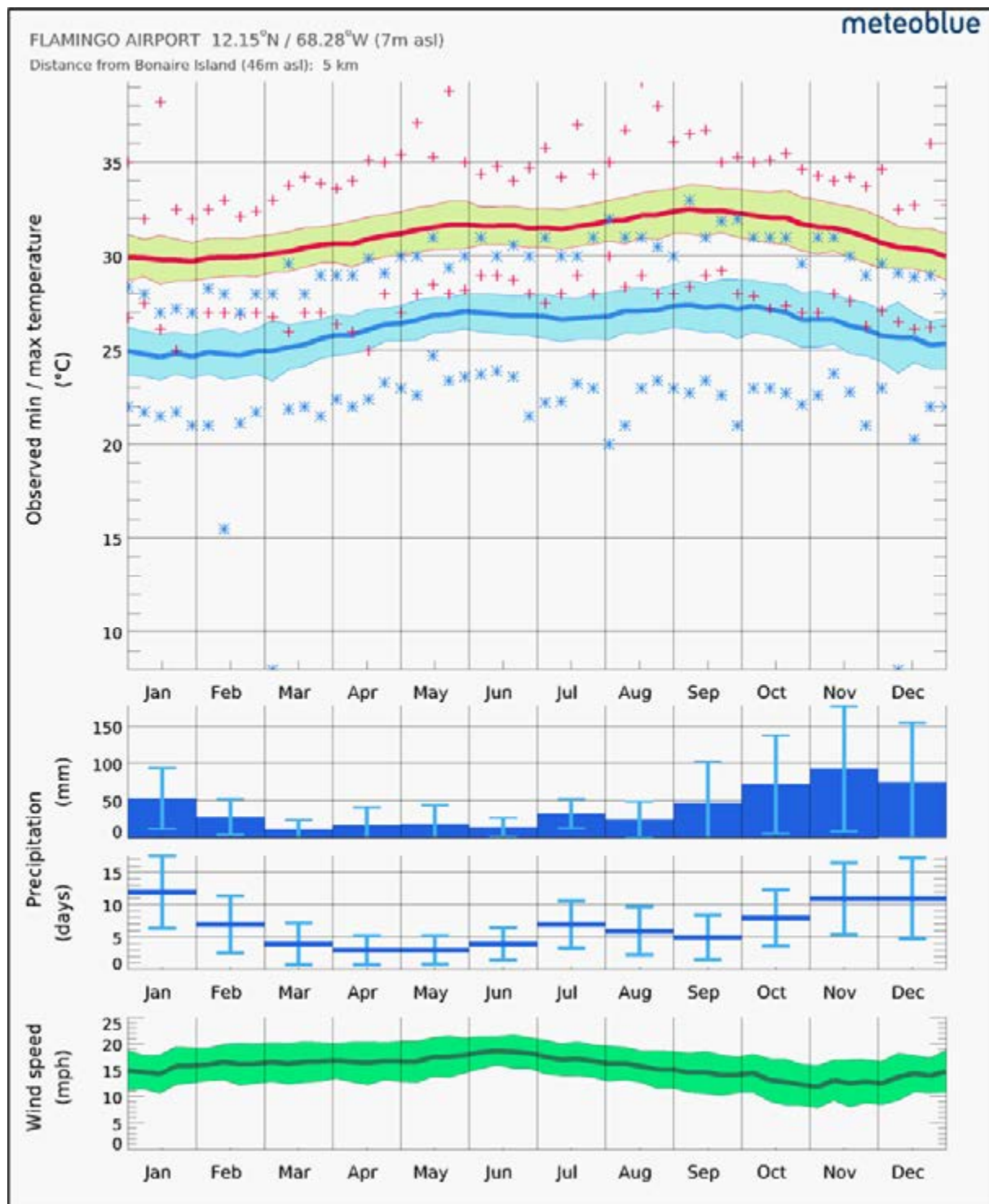


Figure 3: Climate averages at Flamingo Airport (MeteoBlue 2022)

It is generally accepted that reliable hurricane records for the Caribbean do not exist before 1944. Although Bonaire is outside of the hurricane belt, it has been hit by two hurricanes between 1944 and 2010. It also suffered significant shoreside damage on the leeward shore from storm waves generated by Hurricane Lenny in November 1999 and has been hit by four tropical storms. Hurricane Matthew passed north of Bonaire in September 2016 causing little damage to the island as most storm force waves hit Bonaire's wave resistant windward shore. There have been no major hurricanes which have made landfall on Bonaire to date. Figure 4 provides a summary of hurricanes and tropical storms, which have been recorded passing within 60 nm of Bonaire for the period 1851-2019 (Stormcarib, 2020).

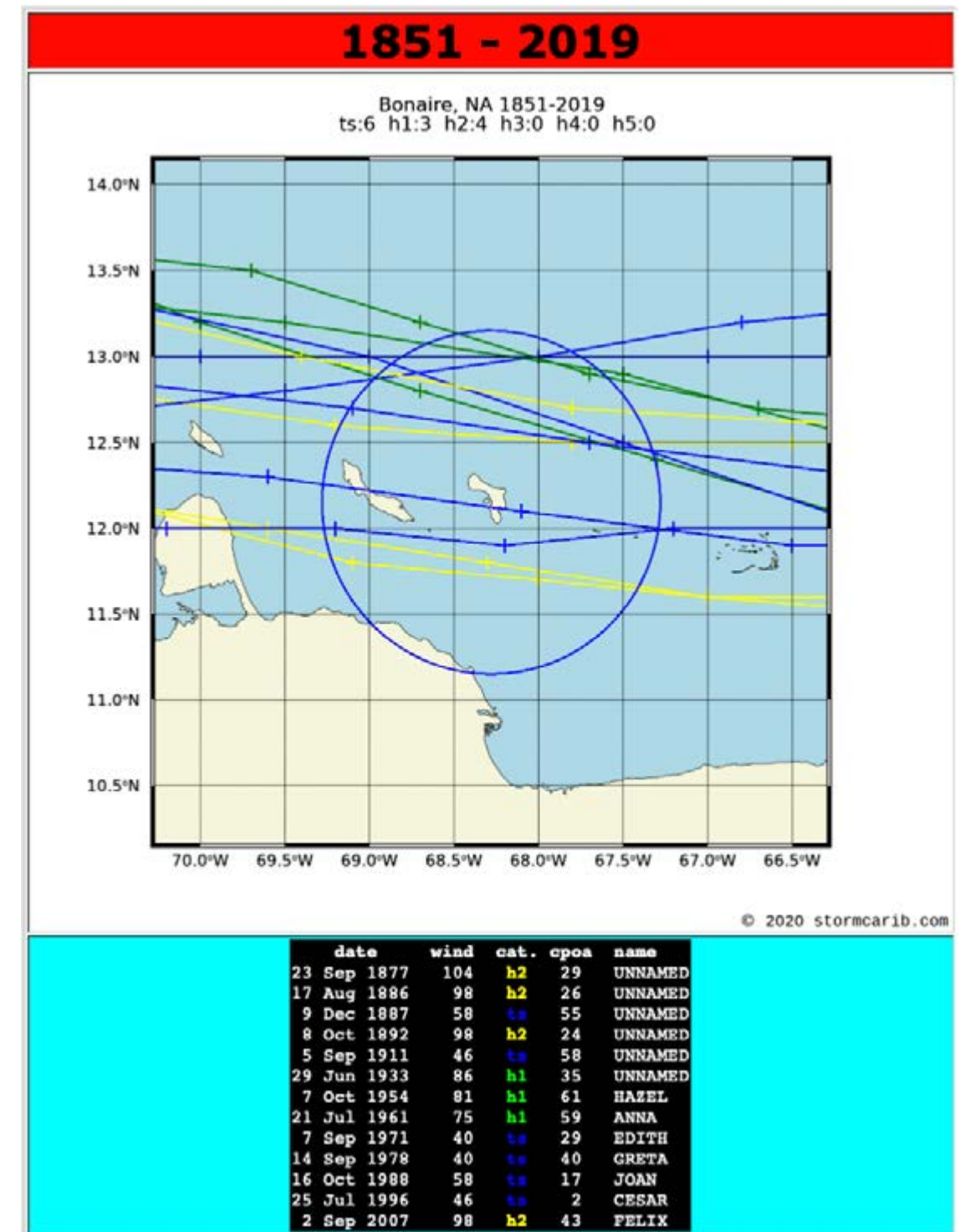


Figure 4: Hurricanes and tropical storms on Bonaire for the period 1851-2019. Note: windspeed is recorded in mph (Stormcarib 2020)

Geology and hydrology

Bonaire lies on a plate boundary, where the South American and Caribbean Tectonic Plates meet and slide past one another. The geology of Bonaire is complex, with the core of the island consisting of strongly folded and faulted rocks of volcanic origin, silica rich sediments and turbidites (debris deposited from an underwater landslide) formed during the Cretaceous era some 120 million years before present (Beets, 1972a, 1972b). Overlying this are later fossil reef and reef-generated calcareous (calcium rich) deposits. It is these limestone formations which make up the coastline in the form of coral-rubble beaches (coral shingle and calcareous sand) or highly weathered 'iron shore', except in the north where low limestone cliffs are found (Buisonje, 1974). The satellite island of Klein Bonaire consists entirely of limestone formations (Buisonje, 1974) which are the remains of emergent reefs.

Substantial changes in sea level have left up to four stranded terraces above the present mean sea level on Bonaire, and one below. These terraces can generally be distinguished by "solution notches" (undercutting caused by chemical erosion), physical erosion and in some cases biological erosion in the elevated seaward facing limestone cliffs.

Bonaire and Klein Bonaire are relatively flat. Little of the southern land area of Bonaire and Klein Bonaire is more than 2 m above sea level, with higher elevations found only in the north and reaching a maximum of 241 m (Brandaris, in the Washington Slagbaai National Park). Roughly two thirds of the island of Bonaire and all of Klein Bonaire are made up of emergent reefs with associated former shorelines and wave eroded benches or solution notches which are a feature unique to these oceanic islands.

The water retention of the soil is poor and most rainfall quickly runs-off either into permanently or temporarily flooded salinas (hypersaline lakes separated from the sea by a coral rubble barrier), or directly into the sea (Roos, 1971). Any water falling on exposed limestone swiftly percolates through the rock into the ground water and eventually discharges into the sea. Because of the combination of the geology, hydrology and soils, the fringing coral reefs of Bonaire are susceptible to damage from poor water management and unsustainable land-based activity. Watershed approaches have been suggested where reef management is integrated into land-based decision making (van der Geest et al., 2020).

Oceanography

Bonaire lies downstream of surface water flow from the direction of St. Vincent and the Grenadines and wind driven currents from Las Roques and Las Aves (Figure 5). When the surface currents strike Bonaire on the windward shore, near Spelonk, they are deflected to the north and south. There are pronounced eddies at the south of the island, around Willemstoren, at the north of the island around Malmok and Boca Bartol and just north of BOPEC. Currents are unpredictable but rarely exceeding 0.5 m s⁻¹. The predominant current movement is toward the north along the leeward shore, but this pattern is complicated by local eddies and upwelling. The speed and direction of deep-water currents are believed to affect the nutrient content and temperature of

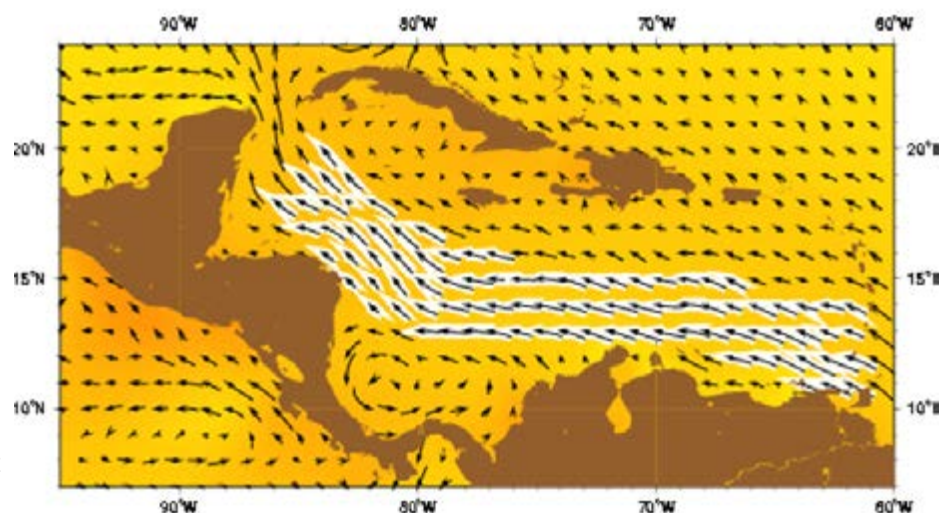


Figure 5: Sea surface currents influencing Bonaire. The Caribbean current that passes Bonaire is represented by the white arrows, flowing from the equatorial Atlantic into the Gulf of Mexico (Gyoryv n.d.)

surface waters (Bak et al., 2014).

The sea water is a constant 34-36 ppt salinity and mean annual water temperatures ranging from 26°C to 28°C (De Meyer, 1998). NOAA's Coral Reef Watch program employs satellite imagery to record variations in temperature. Since at least 2016 annual variations in temperature have triggered observations on coral bleaching, where temperatures are 1°C or more above average for a number of weeks (Eckrich et al., 2020).

Tides are diurnal and the maximum annual tidal range is approximately 1 m, with an average range of 0.30 m during a lunar cycle (Bak, 1977). High tides deposit detritus on the windward shore, which marks the spring tide line. Lac Bay is anomalous as it has a pronounced semidiurnal tidal pattern with two high and two low waters daily. Spring tides cause extended periods (three to four weeks) of very low water in the mangrove areas surrounding the bay causing extensive areas of mangroves at Awa di Lodo and feeder channels around Boca di Coco to dry up, bringing salinities in areas of standing water to over 100 ppt.

One of the most striking features of Bonaire is its bathymetry. By virtue of its location on the edge of a plate boundary, Bonaire is separated from the South American mainland by a deep-water trench. There is a very rapid drop off from the shoreline, and water depths of 500 m can be found between the main island of Bonaire and satellite island of Klein Bonaire which lies only 750 m offshore. Both islands are the visible tip of a seamount that rises abruptly from a depth of 3,000 m (Figure 6). This means that oceanic species such as migrating whales and dolphins as well as pelagic fish (Wahoo, Tuna, Dorado) may be found very close inshore.

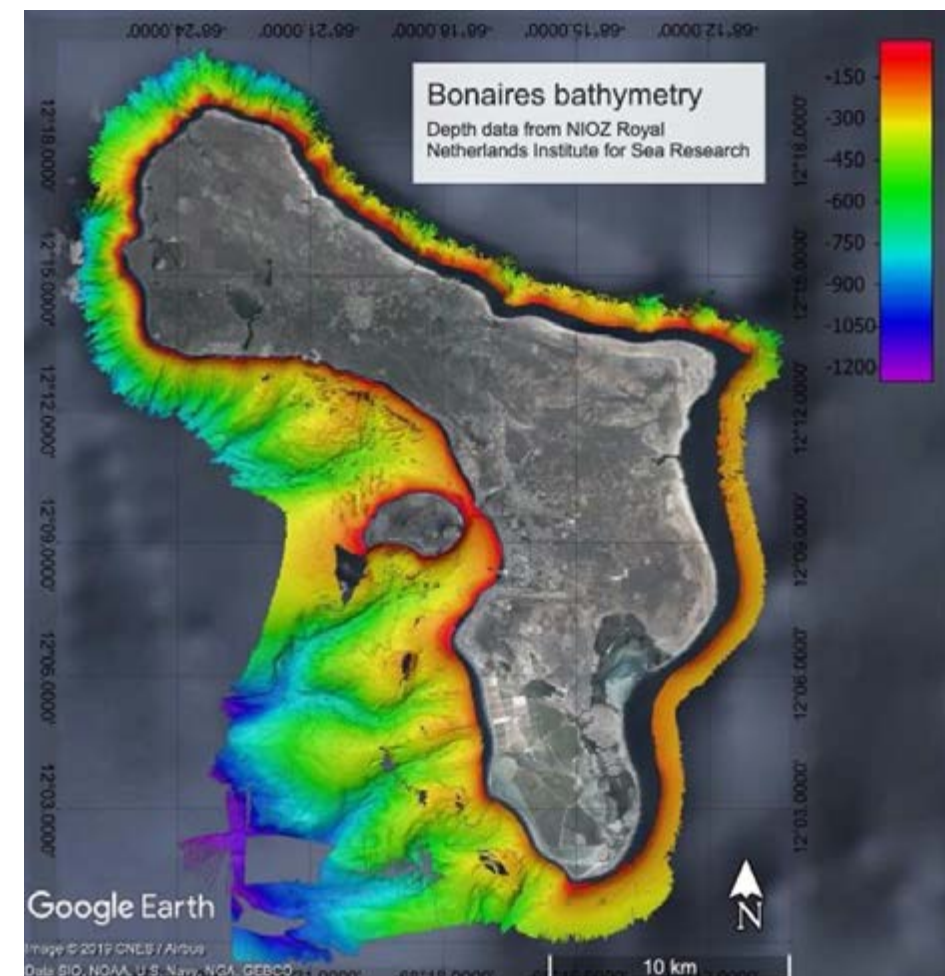


Figure 6: Bathymetry of Bonaire's surrounding waters

HISTORY

The Caquetio Indians of the Venezuelan Central Orinoco Region first populated the islands off the Venezuelan coast; Los Roques, Las Aves, Bonaire and Curaçao around 500 AD. The name Bonaire is thought to have originally come from the Caquetio word 'Bonay', a name that meant low country. The population of Bonaire during the 'Ceramic Age' is not thought to have exceeded 800 to 1,200 people. The main crops were manioc and maize. Agaves may also have been farmed to make nails, needles and string.

The Spanish were the first Europeans to arrive on Bonaire in 1499. In 1526, cattle were brought to the island by the governor – Juan de Ampues. The island became a center for raising livestock such as sheep, goats, pigs, horses and donkeys. The animals were being raised for their skins so they required little tending and roamed freely. The results were large herds of grazing animals that far outnumbered the human population. The only permanent settlement was the village of Rincon, located inland where it was thought to be safe from pirates.

In 1633, the Dutch took possession of Curaçao, Bonaire and Aruba. Curaçao became a center for the slave trade. Bonaire became a plantation island belonging to the Dutch West Indies Company. African enslaved people were forced to work, cutting wood for dye and charcoal, cultivating sorghum and harvesting salt. The ownership of Bonaire changed hands a number of times until 1816, when the island was returned to the Dutch as a result of the Treaty of Paris. Fort Oranje, was built to protect the island and by 1837, Bonaire was the center of government-controlled salt production. The abolition of slavery in 1863 signaled an end to the era of exploitation.

Islanders have traditionally made use of the sea for fishing and exploited other marine resources, such as the mangroves both to harvest food and for material for basket weaving, for boat building, hardening lines and more. Mollusks including chitons (*kokolishi*) and Queen Conch (*karko*) remain popular food items. Isolated fishing village existed at Lac Bay and Playa Frans. Traditional fishing methods include using a hook and line, encircling nets (*reda*), throwing net (*trai*) and fish traps (*kanaster*). Spearfishing was commonplace until it was banned in 1975.

Tourists began arriving on the island after the construction of the Town pier (North pier) in 1940. It was subsequently reinforced in 1961 and renovated in 1986. The Cargo pier (South pier) was built in 1973, and renovated in 1986. The Customs Pier (Middle pier) was completed in 1978. The airport was built in 1943 and in the aftermath of the Second World War, the former internment camps were converted into Hotel Zeebad. Wooden shacks were replaced by stone bungalows and became what is now the Divi Flamingo Hotel. A second hotel, the Bonaire Beach Hotel, was opened in 1962 at Playa Lechi. Dive tourism emerged in the 1960s, and by 1980 there were four dive operations catering to 5,000 divers annually (Info Bonaire, 2021).

GOVERNANCE

On the 10th of October 2010, Bonaire, Saba and St. Eustatius became Public Entities (*Openbare Lichamen*) with special status within the Kingdom of the Netherlands. The government of the Netherlands assumed the task of public administration of the Caribbean Netherlands. The three islands acquired a new status as "special municipalities" (*bijzondere gemeenten*), within the Kingdom, as outlined in article 134 of the Dutch Constitution and as such are not considered part of a province but have a direct working relationship with the National Government. Aruba, Curaçao and St. Maarten form independent countries within the Kingdom.

Various Dutch Ministries have duties and powers relating to the governance of the island and some Dutch Ministries, have a significant presence on the island, including the Ministry of Finance (*Ministerie van Financiën*), the Ministry of Health, Welfare and Sport (*Ministerie van Volksgezondheid, Welzijn en Sport*), and the Ministry of Social Affairs and Employment (*Ministerie van Sociale Zaken en Werkgelegenheid*). Other Dutch Ministries post a liaison charged with the implementation of the Ministry's policies.

At the island level, Bonaire has an Island Governor (*Gezaghebber*) who is responsible for security and public order and who chairs both the Executive Council and Island Council. An Island Secretary is the head of the civil service and provides the Executive Council with advice and support services. Executive power is vested in an Executive Council (*Bestuurscollege*) consisting of three commissioners (*Gedeputeerden*) who must have the support of the majority of the nine-seat elected Island Council (*Eilandsraad*), the island's law-making body. Bonaire is self-governing with the exception of finance, police, telecommunications, education and health.

The Civil Service is divided into four directorates: Spatial Planning & Development (*Ruimte & Ontwikkeling*), Supervision & Enforcement (*Toezicht & Handhaving*), Society & Care (*Samenleving & Zorg*), and Operations & Support (*Bedrijfsvoering & Ondersteuning*).

POPULATION

Since the constitutional change in 2010 there has been an increase in population from 12,000 to over 20,000 (Figure 7). The 2019 population census recorded 20,104 inhabitants on Bonaire. Eighty two percent of the population are Dutch nationals, and 60 percent were born in the former Netherlands Antilles and Aruba. In addition to people from Curaçao and Aruba, the Netherlands and the neighboring countries of Venezuela and Colombia, a significant number of inhabitants came from the Dominican Republic.

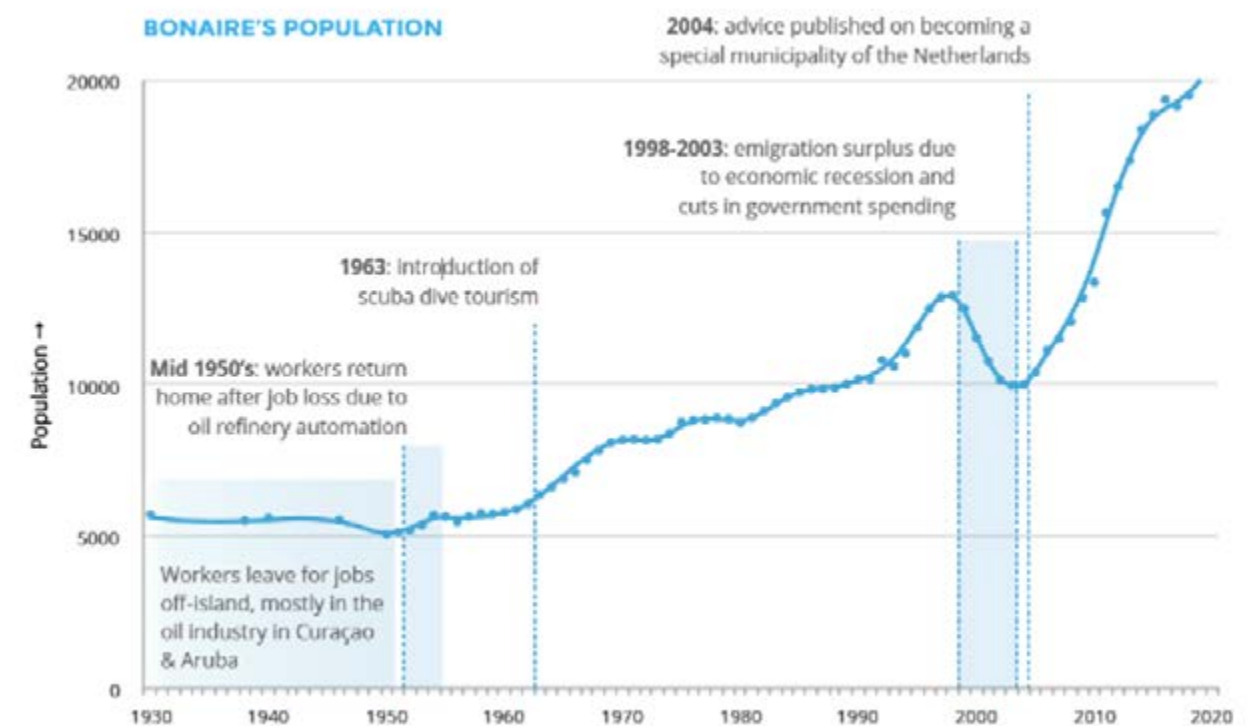


Figure 7: Population changes on Bonaire since the 1930s (Verweij et al., 2020)

The population on Bonaire has been increasing significantly since 2000, and is expected to nearly triple by 2050 to 28,300 permanent residents (CBS 2021) (Figure 8).

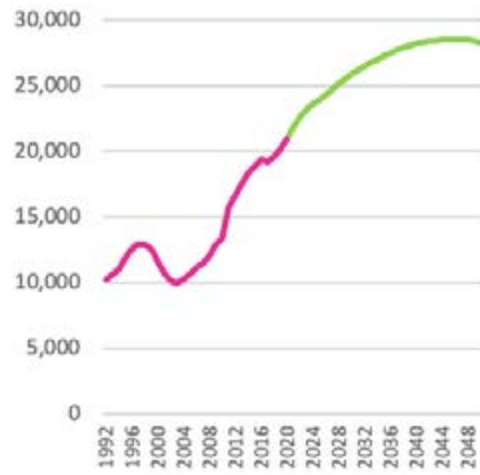


Figure 8: Population forecast Bonaire residents (CBS 2021).

The official languages are Dutch, Papiamentu and English, which are recognized as official languages for legal and administrative purposes in education and the judiciary. At home, 64 percent of the population speaks Papiamentu. Whilst Spanish is widely spoken it is not an official language of the Dutch Caribbean.

ECONOMY

With a GDP in excess of USD 550 million, Bonaire’s economy is heavily dependent on tourism. Business services, real estate and construction are also linked to the growth of tourism on the island. Tourism represents approximately 40 percent of the economy and more than half of all jobs are linked to tourism. The expenditure by tourists on Bonaire is around USD 125 million annually (CBS 2020). The economy has been growing by an average of 2.8 percent per year.

Cargill Salt Company, one of the world’s largest privately held companies, leases the southern part of Bonaire from the Island Government, and uses it as a solar salt extraction plant providing work for over 40 employees. Man-made ponds are filled with sea water and water is gravity fed through the plant to produce salt through solar evaporation. The salt produced on Bonaire is used in water softeners, dyes for the textile industry and processing in the petroleum industry. A third of the salt is shipped to customers in the Caribbean, a third to North America and the rest to Europe and Africa.

BOPEC (Bonaire Petroleum Corporation), a fuel oil storage terminal owned by the Venezuelan oil company PDVSA, declared bankruptcy in March 2021, citing the impact of international economic sanctions on Venezuela. This resulted in the loss of over 83 jobs and the appointment of an interim trustee who is responsible for current operations. From May 2019 to March 2022 the use of the jetties at BOPEC was prohibited due to overdue maintenance. Located on Bonaire’s northeastern shore, the oil terminal functioned primarily as a transshipment and short-term storage facility for

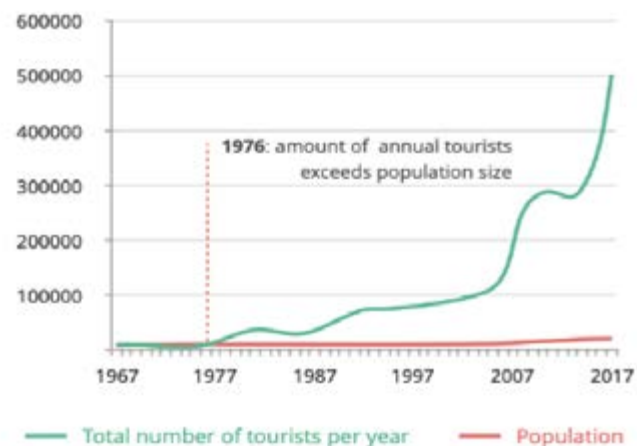


Figure 9: Tourism visitation on Bonaire since the 1960s (Verweij et al., 2020)

multiple grades of refined and non-refined hydrocarbon products from Venezuela and refineries on Curaçao and Aruba and had mixing and blending capabilities for its stored fuels as well as two large, deep-water loading piers (jetties). At its peak BOPEC stored 10 million barrels of oil for transshipment.

Bonaire is currently seeking to diversify its economy by investing in agriculture and the service sector.

Tourism

In 2019 a total of 157,800 visitors (120,000 in 2017, Figure 9) arrived on Bonaire by air through the Flamingo Airport, of which 39 percent came from the Netherlands. An additional 458,000 visitors (400,000 in 2017) arrived aboard cruise boats (Figure 11). The majority of cruise visitors disembark when they arrive on the island (TCB stakeholder meeting 2021), with estimates of around 99 percent of visitors leaving the vessel (Wolfs et al., 2015). Tourist arrival numbers fell dramatically in 2020 and 2021 due to COVID-19 related travel restrictions (Figure 9).

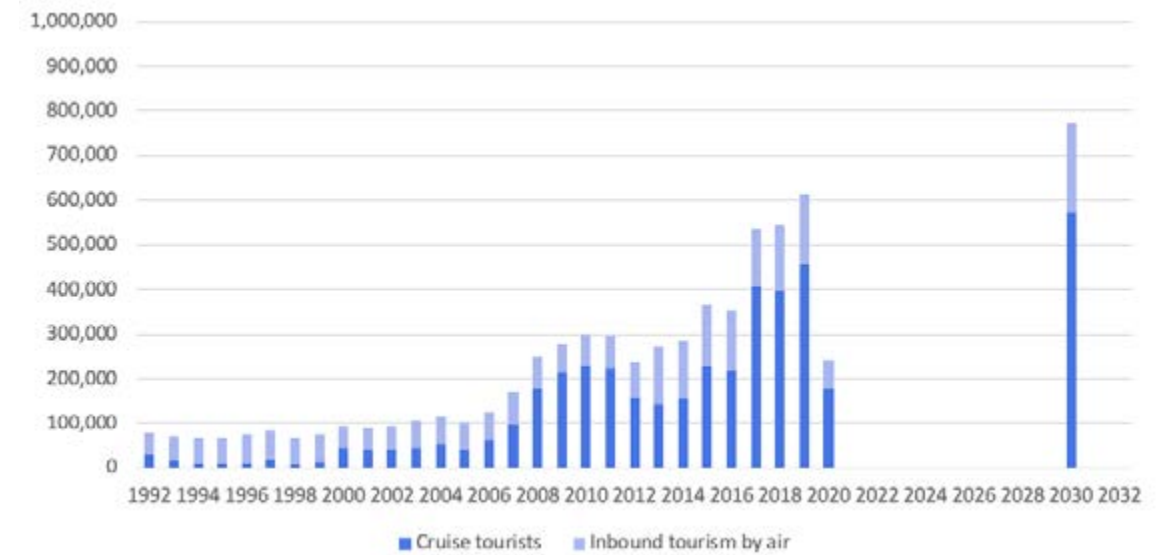


Figure 10: Visitor numbers (OLB 2021)

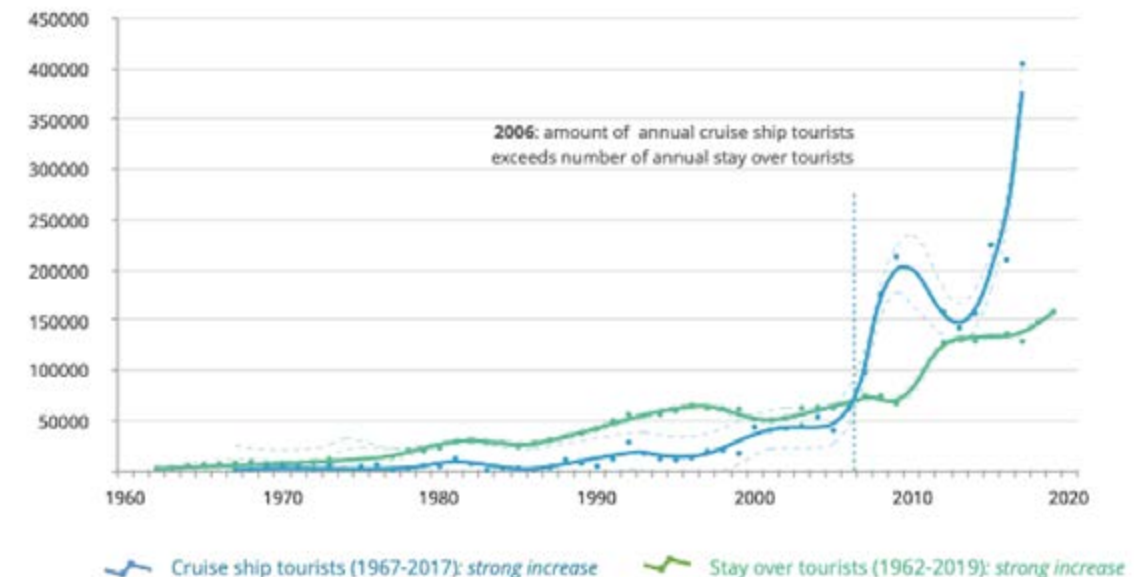


Figure 11: Cruise ship passenger visitation on Bonaire since the 1960s (Verweij et al., 2020)



Figure 12: Visitor distribution through the year (2017)

Peak tourist arrivals occur between October and April, with nearly 80,000 visitors on the island in December. The hotel sector on Bonaire had an average occupancy rate of 68 percent, which was just above the Caribbean breakeven benchmark. The number of hotel rooms is expected to grow by 65 percent between 2019 and 2022 to a total of 2,897 rooms.

Diving and dive related activities are the mainstay of Bonaire’s tourism industry. The island is frequently rated as the number one dive destination for shore diving in the world by the trade press and the health of Bonaire’s coral reefs is considered some of the best in the Caribbean. The development of tourism in harmony with nature is a cornerstone of Tourism Corporation Bonaire’s vision. However, the proliferation of watersport businesses, in particular dive operations, and increasing visitor numbers, is creating issues for the management of Bonaire’s marine resources.



3 | GOVERNANCE

The success of a protected area is directly affected by legal and governance arrangements and their effective implementation. Regulations and guidelines that are fully adopted and well publicized significantly increase the effectiveness of conservation measures. The following information covers the treaties and conventions, legislation, policies, rules and regulations, governing the Bonaire National Marine Park.

LEGAL AND POLICY FRAMEWORK

A range of legislation exists to protect the marine resources around Bonaire and to govern its use. These include International Treaties and Conventions, National Ordinances and Island Ordinances.

The Dutch Caribbean Nature Alliance (DCNA) produced an overview of legislation concerning the use and conservation of the marine environment for Bonaire in a booklet entitled "Handbook of nature legislation on Bonaire" (*Zakboek handhaving natuurbeschermt Bonaire*).

International

The Kingdom of the Netherlands is the contracting party for numerous international Treaties and Conventions including:

- **Convention on Biological Diversity (CBD):** signed by 150 government leaders at the 1992 Rio Earth Summit, and dedicated to promoting nature and human well-being through sustainable development. CBD requires the development of National Biodiversity Strategies and Action Plans.
- **Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES):** an international agreement between governments which aims to ensure that international trade in wild animals and plants does not threaten the survival of the species.
- **Convention on the Conservation of Migratory Species of Wild Animals (CMS/Bonn Convention):** an international agreement that aims to conserve migratory species throughout their ranges.
- **Ramsar Convention on Wetlands (Ramsar):** an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. There are over 2,400 Ramsar sites worldwide and 171 contracting parties (Box 1).



Ramsar sites: Bonaire has four designated Ramsar sites: Lac Bay, Klein Bonaire, Washington Slagbaai (which includes the former Ramsar sites of Goto Meer and Slagbaai) and Pekelmeer. All except the Pekelmeer are managed by STINAPA, and from an integral part of the Bonaire National Marine Park and Washington Slagbaai National Park. Pekelmeer is managed by Cargill Salt Bonaire, as part of the Bonaire Southern Wetland Area and is recognized both as an Important Bird Area by BirdLife International and as a Western Hemisphere Shorebird Reserve (Engel et al., 2022).

SPAW designation: The Bonaire National Marine Park was designated as a SPAW site in 2012. The Protocol Concerning Specially Protected Areas and Wildlife (the SPAW Protocol) has been internationally recognized as the most comprehensive treaty of its kind. The objective of the Protocol is to protect rare and fragile ecosystems and habitats and thereby the endangered and threatened species residing therein. The Caribbean Regional Co-ordinating Unit assists with the establishment and proper management of protected areas, promoting sustainable management (and use) of species to prevent their endangerment and by providing assistance to the governments of the region in conserving their coastal ecosystems.

Box 1: Ramsar and SPAW designations

Regional

Several regional conventions have been developed which are relevant to the Bonaire National Marine Park and marine conservation:

- **Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC)** promotes the protection, conservation and recovery of sea turtles and those habitats on which they depend.
- **Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region (Cartagena Convention):** a comprehensive, umbrella agreement for the protection and development of the marine environment providing a legal framework for cooperative regional and national actions in the Wider Caribbean Region. There are three protocols including the Specially Protected Areas and Species (SPAW) protocol, dedicated to biodiversity conservation. The Convention aims to provide the legal framework for co-operative regional and national actions in the Caribbean. The Convention is supplemented by the Oil Spills Protocol, the SPAW Protocol and the LBS Protocol (see below).
 - ♦ **Specially protected Areas and Wildlife (SPAW)** aims to assist with regional implementation of the broader and more demanding global Convention on Biological Diversity (CBD).
 - ♦ **Oil Spill Protocol** is to ensure a means of responding to oil spills including relevant legislation, contingency plans, capability to respond to an oil spill incident and designation of a national authority in the countries and territories of the Wider Caribbean.
 - ♦ **Pollution from Land Based Sources (LBS)** aims to implement article 7 of the Convention for the Cartagena convention concerning pollution from land-based sources and activities.

The Netherlands participates in several Regional Fisheries Management Organizations (RFMOs), in particular the Western Central Atlantic Fishery Commission (WECAFC), the Western Hemisphere Migratory Species Initiative (WHMSI); as well as in the International Coral Reef Initiative (ICRI) and its Global Coral Reef Monitoring Network Caribbean initiative (GCRMN-Caribbean). As a member of the Overseas Countries and Territories Association (OCTA) of the EU, each island has also signed the Declaration on Oceans supporting the need for maritime conservation.

National

National legislation directly related to the Caribbean Netherlands (commonly known as the 'BES islands', referring to the islands of Bonaire, Saba and St. Eustatius) which is relevant for the management of the Bonaire National Marine Park includes:

- **Nature Conservation Framework Act BES** (*Wet grondslagen natuurbeheer en bescherming BES*) regulates roles, responsibilities and procedures between the Ministry of LNV and the Public Entities with regards to the protection of nature on the islands. It requires the Ministry to develop a Nature Policy Plan for the BES islands as well as linked island level Nature Plans and provides the framework for the establishment of nature parks and development of nature legislation by the governments of the BES islands.
- **Fisheries Act BES** (*Visserij wet BES*) requires the development of the fisheries policy and fisheries management plans for the Caribbean Netherlands.
- **Environment Act BES** (*Wet VROM BES*) addresses environmental pollution and environmental impact assessments and provides the framework for environmental policy by the national and island governments including permitting and inspection, oversight and enforcement of environmental policy.
- **Spatial Planning and Development Framework Act BES** (*Wet grondslagen ruimtelijke ontwikkelingsplanning BES*) is important for guaranteeing more effective integration of policy. The implementation of the spatial planning process needs to be consistent with nature conservation and environmental management efforts. Each island is required to have a spatial plan.
- **Business Establishment Act BES** (*Wet vestiging bedrijven BES*) Regulates what types of business can be established on Bonaire, which has implications for businesses operating in the Bonaire National Marine Park
- **Maritime management act BES** (*Wet maritiem beheer BES*) provides a permitting framework for construction and science related activities inside the Exclusive Economic Zone (EEZ), including the Bonaire National Marine Park. Protecting Maritime Heritage, Maritime (shipping) safety and Maritime nature. It overlaps with legislation protecting the Bonaire National Marine Park.
- **Security Act BES** (*Veiligheidswet BES*) determines tasks, funding and collaboration between organizations on the islands and The Hague in case of incidents and disasters. STINAPA and in particular the Bonaire National Marine Park team is frequently asked to support the Public Entity in disaster preparation and training.

Other relevant Dutch National Ordinances include:

- National Fisheries Ordinance (A.O. 1991, no. 74).
- National Fisheries Resolution (A.O. 1992, no. 108).
- National Prevention of Pollution from Ships Ordinance (A.O. 1993, no. 108).
- National Civil Liability Oil Tankers Ordinance (A.O. 1998, no. 169).
- National Oil Pollution Compensation Ordinance (A.O. 1998, no. 170)
- National Nature Conservation Ordinance (A.O. 2001, no. 41).

Legal Instruments

Bonaire, Curaçao, Saba, St. Eustatius and St. Maarten have signed a Memorandum of Agreement (MoA) regarding the management of marine biodiversity and fisheries in the waters of the EEZ for the Caribbean part of the Kingdom of the Netherlands.

The Fisheries Commission BES was established to meet twice a year to advise the Dutch Minister on fishing regulation and management.

Policy Plans developed for the Caribbean Netherlands (including Bonaire):

- Nature and Environmental Policy Plan Caribbean Netherlands 2020-2030.
- Sustainable Fisheries Plan Caribbean Netherlands 2020-2030.

Island

The legal protection of nature on Bonaire including nature in the parks is regulated by several Island Ordinances (*Eilandsverordening*) and Island Resolutions containing general provisions (*Eilandsbesluit - EBHAM*). These legally binding documents are produced in Dutch. Translations to English are available on STINAPA's website (however these do not contain the most recent updates) and should be used for reference only. For the legal text please refer to the original Dutch versions, which are available online via the National Government website.

- **Nature Ordinance Bonaire** (*Eilandsverordening* A.B. 2008, no. 23): This Ordinance augmented the original Marine Environment Ordinance (A.B. 1991, No.8); and replaced Nature Conservation and Monument Ordinance (A.B 1967, No.7) and Harmful Plant Ordinance (A.B 1991, no.25); provided the opportunity to designate Nature Parks, regulate user fees, permitting, species conservation, nature conservation and a requirement for Environmental Impact Assessments. (A.O. 2019, no.3).
- **Marine Park Management Resolution** (*Eilandsbesluit* A.O. 2010, no. 14): This EBHAM replaced much of the Marine Environment Ordinance (A.B. 1991, no.8) and several island resolutions containing general provisions and regulates admission fees, establishing zones and marine reserves, prohibiting discharge of chemicals, anchoring, removing/placing objects in the marine park, regulating piers, moorings and use of moorings, artificial beaches, use of gloves, fishing gear, conch and lobster regulations, regulating dive businesses (including compressors, rental gear) and special regulations concerning Lac Bay.
- **Nature Management Resolution** (*Eilandsbesluit* A.O 2010 no. 15): This EBHAM contains general provisions for the protection and management of Nature Parks (designated by Nature Ordinance) and regulates the sale of admission fees, prohibiting removing plants and animals, regulations regarding buffer zones, protection of mangroves, designation of dangerous/invasive species, dangerous weapons, and other prohibitions, permitting and designation of STINAPA Bonaire as the management body for nature parks.
- **Island Ordinance Marine Park Bonaire** (*Verordening* A.O. 2019 no.3): In this Ordinance the Bonaire Marine Park was designated as a nature park within the new legislative structure of the framework legislation mentioned above. At the same time the Marine Environment Ordinance (A.B. 1991 no.8) was degazetted.

Other relevant legislation

- **Spatial Development Plan** (*Ruimtelijk Ontwikkelingsplan Bonaire - ROB*). The first version of the Bonaire Spatial Plan was produced in 2010. As part of this process a Strategic Environmental Evaluation took place. Since that time, several minor revisions have been approved. In 2020, the Public Entity announced the start of a general review of the Spatial Development Plan, and began gathering input. Actualized and prior versions of the Bonaire Spatial Development Plan and the Strategic Environmental Evaluation can be found here: <https://www.bonaire-ro.nl/>. The Bonaire Spatial Development Plan includes the designation of the Bonaire National Marine Park, and the location of no fishing zones and no entry reserves. It forms the basis of a 15 m set back from the highwater mark for construction, and includes a description of permitted activities within the marine park. Ramsar sites and their buffer zones are also indicated and designated in the ROB.
- **Building and Housing Ordinance** (*Bouw- en Woningverordening*) (A.B. 1961, no. 17). Regulates building and housing practices, where the Spatial Development Plan provided rules for what can be built where and with which purpose in this Ordinance regulates the technical requirements related to (fire) safety of constructions.
- **Harbor Ordinance** (*Havenreglement*) (A.B. 1975, nr. 33). Regulates shipping and use of the harbor and can be used preventatively.
- **Water Safety Ordinance** (*Waterveiligheidsverordening Bonaire*) (A.B. 1974, no. 5). Regulates speed and activity on the water.



- **Waste Ordinance** (*Eilandsverordening Afvalstoffen Bonaire*) (A.O. 1994, no. 5). Aims to promote responsible spatial development and sustainable environmental management.
- **Sewage Treatment Ordinance** (*Eilandsverordening afvalwater Bonaire*) (A.O. 2012, no. 2). Regulates treatment of sewage from households.
- **Nuisance Ordinance** (*Hinderverordening Bonaire*) (A.O. 1995, no. 4). Provides regulations on prevention and minimizing danger, damage and nuisance for people and environment by businesses). The Nuisance ordinance Bonaire is expected to be replaced by a Business Activities Ordinance BES for which a consultation took place in 2021.

Policy plans

Policy plans which have been adopted and/or recognized by the Island Government of Bonaire include:

- *Integrale Sociaal-Economische Aanpak* (Pourier Report) 1992.
- Tourism Recovery Plan 2021.
- Tourism Master Plan 2017-2027.
- Nature Policy Plan Bonaire 1999-2004.
- Nature Plan Bonaire 2020-2024 (pending adoption).
- Strategic Development Bonaire 2010-2026 (including Blue Economy).
- Policy Vision Agriculture, Food and Fisheries 2014-2029.
- Maritime Disaster Plan Bonaire.

Permitting

Permits and exemptions from prohibitions required by the Island Ordinance Nature Management and its associated EBHAM's are called 'nature permits'. Nature permits are used to regulate activities which could be harmful to the marine environment. On Bonaire a nature permit is required for the installation of piers, walls, buildings, stairs and ladders, sampling live specimen, as well as for the creation of artificial beaches. Nature permits include provisions for commercial activities, including running a business, within the marine park. Nature permits are issued by the Island Government, Department of Spatial Planning and Development (*Directie Ruimte & Ontwikkeling - DRO*).

Nature Commission (*Commissie Natuurbeheer Bonaire*)

As required by the Nature Management Ordinance (*Eilandsverordening Natuurbeheer Bonaire*, Art.3), the task of the Nature Commission is to provide advice to government, asked for or otherwise, regarding the ordinance and nature management in general on Bonaire. The commission consists of between 3 and 9 members, selected by the Island Government by virtue of their expertise. Requests for permits (construction, renovation or research) for activities in the Bonaire National Marine Park, including applications to conduct scientific research, are reviewed by the commission, which takes into consideration the legislation, policies, and guidelines before giving advice.

Enforcement of the Permits and permit conditions

Enforcement of the nature legislation is delegated to the Department of Supervision and Enforcement (*Directie Toezicht en Handhaving - DTH*) and to STINAPA Bonaire. Both parties liaise, monitor and report on activities that relate to permits. Whilst DTH can enforce both criminal and administrative law, in practice they leave criminal prosecutions to STINAPA, and focus on administrative enforcement using the following process:

- Company/Individual receives warning letter;

- Company/Individual receives a pre-announcement of what will happen;
- Company/Individual receives a formal decision by the government (order);
- If at fault, Company/Individual can face period penalties and may face closure.

At present STINAPA can only enforce criminal law.

Bonaire National Marine Park rules and regulations

The management body for the marine park is charged with enforcing the legislation and has the authority to put in place policy intended to safeguard nature. Some regulations are embedded within the legislation and others are stipulations made by STINAPA, for example rules governing diving, the use of gloves and/or the use of public moorings are regulated by law, whilst the entry and exit zone for kite surfers is policy.

The following list has been adapted from information published by STINAPA on their website and is applicable to all users of the Bonaire National Marine Park:

1. The nature fee: All users of the marine park must pay an entrance fee. Known as the nature fee, this can be paid on-line, at STINAPA's head offices, at dive centers, through most watersport providers, and at the entrance to Washington Slagbaai National Park.
2. Orientation: All SCUBA divers must attend an orientation given by the dive operator at the center from which air tanks are obtained before diving in the marine park. The orientation consists of an orientation or briefing and a check out dive which must be supervised by staff at the dive operation. Repeat divers are required to attend a dive orientation and perform a check out dive every time they are back on island.
3. Spearfishing: Spearfishing and the possession of spearfishing equipment is prohibited.
4. Collecting: It is prohibited to remove anything, alive or dead, from the marine park, with the exemption of traditional fishing methods.
5. Gloves: the use of gloves is prohibited in the Bonaire National Marine Park. Divers who must wear gloves due to medical conditions will need to bring a doctor's declaration, not older than 30 days, to the headquarters of STINAPA at Barcadera to get a permit allowing them to use gloves (Art.8 and Art.8 Sect.3).
6. Turtles: turtles, their nests, and their eggs are completely protected in the marine park.
7. A permit issued by the Island Government is required to carry out the following activities in the marine park:
 - Collect conch (*Lobatus gigas*).
 - Construct anything that will hang over the water, will touch the water or will go in the water including ladders, balconies, piers or similar. Even where a building permit has been issued by the Island Government, an additional permit for these structures is still required. Permits are issued to an individual or company.
 - Renovate or alter any structure in, on, or under the marine park.
 - Put, use or dump anything in the Bonaire National Marine Park that could harm the marine environment, including rocks, chemicals, moorings, artificial reefs or wrecks.
 - Remove anything from the bottom or place anything on the bottom in the marine park.
 - Transport SCUBA divers for commercial purposes. Business license for dive schools will require adherence to the articles of the Marine Ordinance.
 - Cut or remove any mangrove trees, except for traditional use.
 - Remove or damage the bottom vegetation in Lac Bay.

- Dig channels, build dams, or extract sand.
- Dump sewage.

Note: Construction on or close to the shoreline requires adherence to Bonaire's construction guidelines.

- Lighting campfires on the beach at any time is prohibited.
- Anchoring is not allowed for boats over 4 m in length (Art.5 Sect.2).
- Regulations for use of public moorings (marked with yellow buoys) include:
 - First come first serve; the moorings cannot be reserved.
 - Boats longer than 45 ft (15 m) may not tie on to the buoy.
 - Only one boat is permitted per mooring, or up to three boats if all are less than 12 ft (3 m).
 - Time limit for using a mooring is a maximum of two hours.
 - Boats are not allowed to stay overnight on public moorings.
 - Sail boats with tall masts or fishing boats with tall bridges are not permitted to use the moorings in front of the airport, (mooring # 36 and 37).
 - Use of public moorings is at your own risk.
- Regulations for navigating in the marine park:
 - Always pass seaward of the moorings, in the dark blue water.
 - Refrain from passing within 50 m of any boat tied to a mooring.
 - Jet skis and water-skiers are required to reduce speed until they are in the dark blue water.
 - Respect international 'rules of the road' to avoid collision at sea.
- Kite surfing is prohibited in Lac Bay (Art.3 Sect.3).
- The use of chemical light sticks is prohibited in the marine park.

MANAGEMENT BODY

Stichting Nationale Parken Bonaire (known as 'STINAPA Bonaire' or 'STINAPA') is a non-profit, non-governmental foundation ('*Stichting*'), established on Bonaire and registered at the Chamber of Commerce (KvK). STINAPA is dedicated to the conservation of Bonaire's natural and historical heritage through the sustainable use of its natural resources. STINAPA is the legally designated protected area management body for the Washington Slagbaai National Park and the Bonaire National Marine Park, which includes Lac Bay and the uninhabited satellite island of Klein Bonaire.

STINAPA Bonaire is governed by a Board. STINAPA's Board is responsible for sound governance ensuring that the foundation operates at all times in accordance with the law as well as its own articles of incorporation and bylaws. The board is responsible for policy decision making, fiscal oversight, including approval of annual Financial Statements, action plans and budgets and bears the ultimate legal and fiscal responsibility for the foundation and its activities. Board meetings are held regularly, minutes of the meetings are taken and circulated with the board and director (STINAPA 2015).

Day to day management of the protected areas is the responsibility of a full time Director and staff. Each park has a full-time Manager, Chief Ranger and Rangers. Park Managers are supported by finance and administration, education, policy, communication and science staff.

MANAGEMENT FRAMEWORK

The management agreement (*beheersovereenkomst*) between the Island Government and STINAPA Bonaire dates back to 1991. Under this agreement STINAPA is named as the management body for the marine park for an indefinite period and required to act as a *pater familias* (*goed huisvader*). This is reflected in the Island Resolution Nature Management (*Eilandsbesluit Natuurbeheer*).

The authority of STINAPA as the management body for the Bonaire National Marine Park was re-affirmed in 2010. The management mandate and reporting obligations that STINAPA has towards the Island Government include requirements to:

Produce an annual budget outlining the cost of management for the marine park.

Report on activities and the condition of the marine park annually.

Provide financial reporting (Financial Statement) for the previous fiscal year.

Furthermore, STINAPA is required to inform all park users about rules and regulations in writing and can request special police powers for their staff.



4 | DESCRIPTION

HISTORY OF THE BONAIRE NATIONAL MARINE PARK

The Bonaire National Marine Park was first established in 1979 through a public-private partnership between the Government of the Netherlands Antilles, the island territory of Bonaire, the National Parks Foundation and World Wildlife Fund (WWF-NL). From its inception the marine park has been governed by STINAPA, a local conservation foundation established to protect nature on the island of Bonaire. STINAPA also manages Bonaire's largest terrestrial protected area, the Washington Slagbaai National Park, which was established in 1968.

The marine park was legally established on 1st January 1985 with the gazetting of the Marine Environment Ordinance (A.B. 1984, no. 21). In 1991 the Dutch Overseas Aid Program (KABNAZ) provided funding to set up a suitable governance structure (Table 1). A revised Ordinance (A.B 1991 Nr.8) came into force that same year, allowing the park to collect admission fees from divers and become self-financing. The introduction of admission fees for divers in January 1992 ensured the long-term continuity of the marine park by providing funds to cover basic management costs.

The marine park was declared a national park by the Minister of Health and Environmental Hygiene on October 18, 1999, by Ministerial Decree (No. 5238/JAZ). As a result of the constitutional change on the 10th October 2010, the National Park status was lost and it was not until September 2012 that the State Secretary of Economic Affairs, Agriculture and Innovation reaffirmed National Park status for the marine park (DGNR-NB/12320985). In 2000, after a long campaign led by STINAPA board member, dive operator and conservation activist, Bruce Bowker, the Island Government of Bonaire purchased the uninhabited island of Klein Bonaire using a combination of public funds and donations. In 2001 the management of the island was handed to the Bonaire National Marine Park.

The Bonaire National Marine Park is known worldwide for its pioneering work and was recognized by UNEP (United Nations Environmental Program) and ICRAN (International Coral Reef Action Network) as a Caribbean Demonstration site. In October 2012, the member states of the SPAW Protocol recognized the Bonaire National Marine Park as a protected area under that protocol (UNEP / CAR IG.31/3). In April 2011 the Dutch State Secretary for Education, Culture and Science, also on behalf of the State Secretary for Economic Affairs, Agriculture and Innovation, included the Bonaire National Marine Park on the Tentative List for World Heritage nomination based on its 'outstanding universal value'.

DESCRIPTION

1961	Protection of turtles
1971	Prohibition of spear fishing
1975	Protection of living or dead / fossilized coral
1978	Installation of moorings initiated
1979	Bonaire National Marine Park established
1980	Installation of moorings completed
	Klein Bonaire designated as a Ramsar site
	Lac Bay designated as a Ramsar site
1985	Bonaire National Marine Park legally established
1991	Marine Environment Ordinance (A.B 1991 Nr.8) revised;
	Bonaire National Marine Park becomes actively managed
1992	Admission fees for divers introduced
1999	National Park declaration by Ministerial Decree (No. 5238/JAZ).
2001	Klein Bonaire included in the Bonaire National Marine Park
	Bonaire National Marine Park designated an ICRAN -UNEP Demonstration site for successful management
2010	National Park status lost due to the constitutional change
2012	Bonaire National Marine Park reaffirmed as a National Park (DGNR-NB/12320985).
2012	Bonaire National Marine Park designated as a SPAW site

Table 1: Timeline for the Bonaire National Marine Park

LOCATION

The Bonaire National Marine Park surrounds the islands of Bonaire and Klein Bonaire extending from the highwater mark to the 60 m depth contour and including both the sea bottom and associated waters as well as the entire island of Klein Bonaire (Figure 13). Depending on the slope of the seafloor, the distance from shore to the seaward extent of the marine park varies between approximately 75 m near Karpata and near no-name beach on Klein Bonaire and 1.6 km at Spelonk on the windward shore.

The geomorphology, bathymetry and location of Bonaire combine to produce a unique marine environment shared only by of Curaçao, and the offshore Venezuelan islands of Las Aves and Los Roques. The marine park encompasses 2,700 ha of fringing coral reef, seagrass and mangrove ecosystems, and contains representative habitats and ecosystems from the shore to intertidal environments and from coral reefs to deep water environments. The satellite island of Klein Bonaire and Lac Bay, the largest semi-enclosed seagrass and mangrove bay in the Dutch Caribbean, are under the direct management of the marine park. Both Klein Bonaire and Lac Bay are Ramsar sites.

Beyond the marine park boundary, Bonaire's territorial waters extend up to 12 nm offshore, whilst the Exclusive Economic Zone extends to the 200 nm limit. In September 2015, the Exclusive Economic Zone was declared part of the Yarari Marine Mammal and Shark Sanctuary.



Figure 13: The boundaries of the Bonaire National Marine Park at 60 m depth

Washington Slagbaai National Park

Located in the northwest of Bonaire, Washington Slagbaai National Park is the first and one of the largest terrestrial protected areas in the Dutch Caribbean. It provides a safe habitat for the island's native species such as the endemic sub-species of parrot (Lora), flamingos, parakeets and iguana. Additionally, many species of migratory birds from North America stop-over in the protected area during their annual migrations and some species have become residents. The Washington Slagbaai National Park protects 15 km of shoreline which falls within the Bonaire National Marine Park. This and the island of Klein Bonaire are the only places on Bonaire where the marine park is fully protected on its landward side. Some beaches within the Washington Slagbaai National Park are important nesting sites for sea turtles.

Territorial waters

The territorial waters defined as the area which extends up to 12 nm from the baseline of a country's coastal state (UNCLOS). This area is under the jurisdiction of the country. Foreign ships (both merchant and military) have right of 'innocent passage'. The right of innocent passage can be suspended if there is a threat to the security of the coastal state. The coastal state can also exercise jurisdiction if:

- Any kind of activities in the territorial vessel has consequences extending to the coastal state;
- There is a threat to the peace of the coastal country;
- There is illicit traffic or smuggling of drugs.

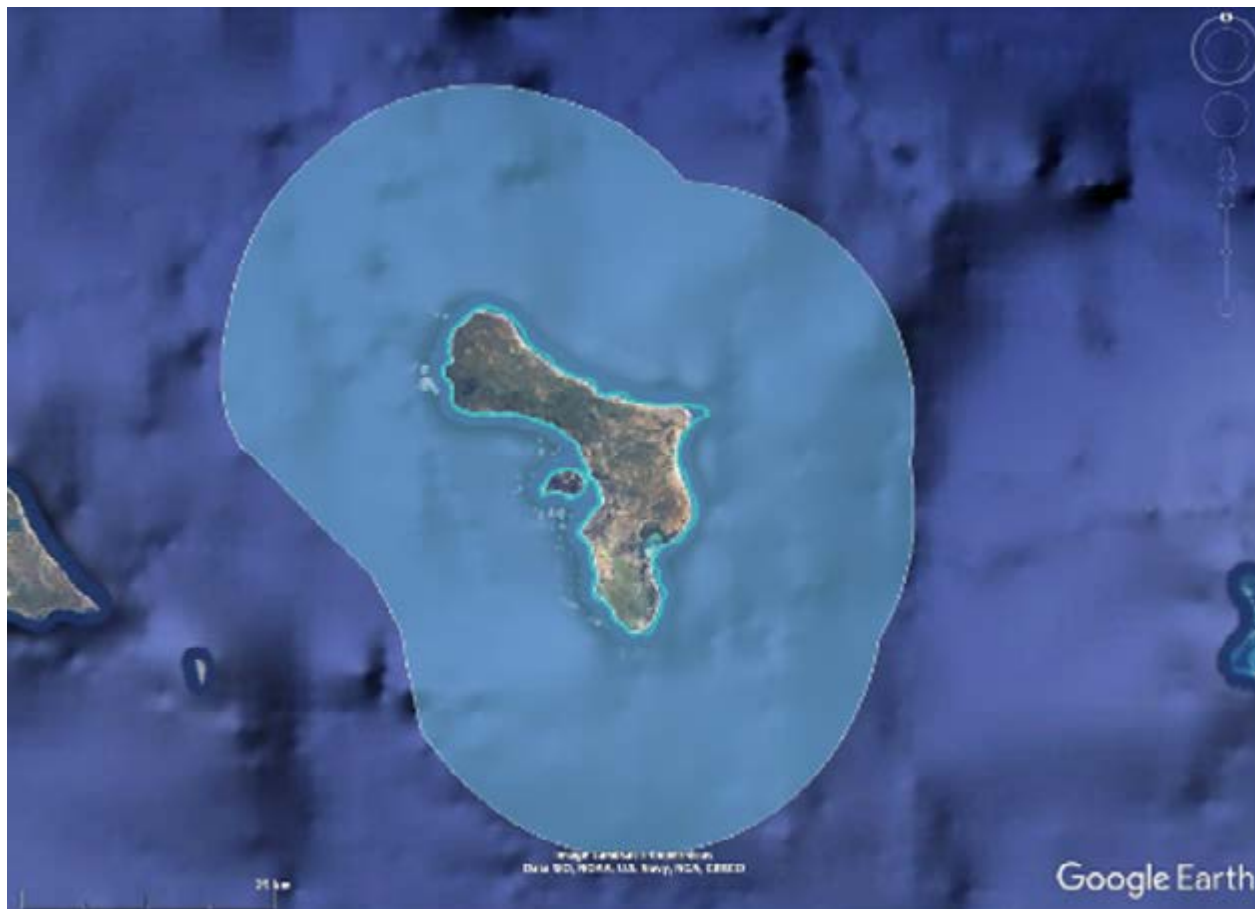


Figure 14: Territorial waters of Bonaire

Yarari marine mammal and shark sanctuary

The Yarari marine mammal and shark sanctuary was declared in 2015 by the Dutch Government (Figure 15). The Sanctuary encompasses all the waters to the extent of the Exclusive Economic Zone around the islands of Bonaire, St. Eustatius and Saba and protects sharks, rays, whales and dolphins from any activities that are likely to have a negative impact upon their populations. The name "Yarari" is an Taíno Indian word, meaning 'a fine place'. The intention is that the Yarari Sanctuary will form part of a network of marine mammal sanctuaries in the region.

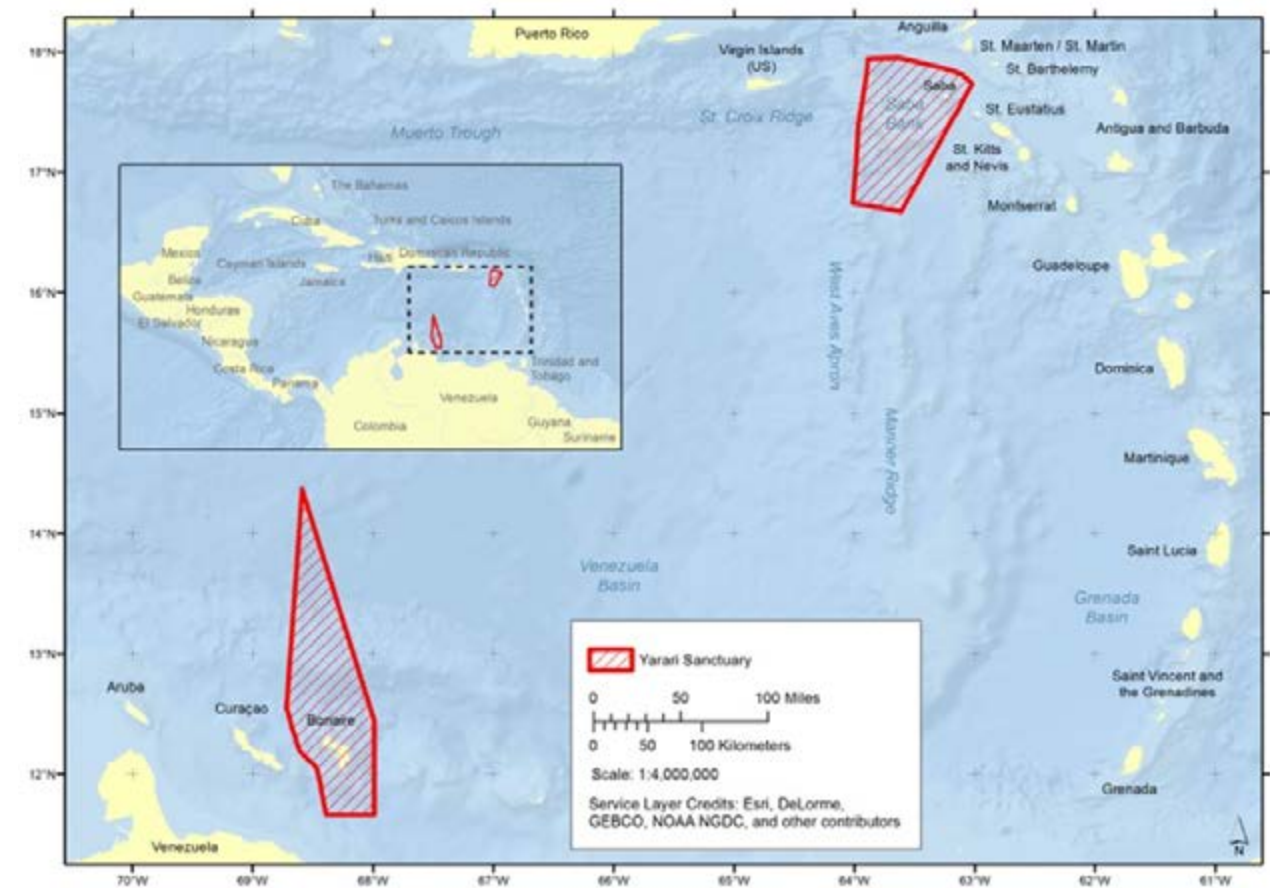


Figure 15: The Yarari Sanctuary

Los Roques Archipelago National Park

In Venezuela, Los Roques Archipelago National Park was created in 1972 to protect a marine ecosystem of exceptional beauty and ecological value dominated by coral reefs, mangroves, and seagrass beds. The park, located about 80 miles (128 km) north of the port of La Guaira in Venezuela, covers 40,61 km².

In 1996, Los Roques was declared a Ramsar site because of its importance as a reservoir of biodiversity and food resources. Historically, fishing has been the major economic activity in the archipelago but has been strictly regulated since the creation of the national park. About 300 fishers take up temporary residence on the island during the fishing season.

Los Roques Archipelago National Park lies east of Bonaire and is thought to be a source of conch, fish and corals larvae, carried downstream on currents between the islands. Pelagic fish, sharks, marine animals and birds are also to migrate between the islands.

NATIONAL DESIGNATIONS

Bonaire National Marine Park

Area:	2,700 ha
Established:	1979
National Park:	Declared in 1999; recognized as a National Park by the Netherlands in 2012

The marine park encircles the island of Bonaire from the highwater mark to the 60 m depth contour. It is a multi-use marine protected area enabling a wide range of recreational activities on which the island's tourism driven economy is heavily dependent. The Park includes a range of ecosystems such as coral reefs, seagrass beds and mangrove forests. These ecosystems host a range of rare and endangered species, such as elkhorn and staghorn corals, and over 400 different species of fish, including elusive frogfish and seahorses. Marine mammals such as Bottlenose dolphins and whales are also frequently spotted foraging its waters (Debrot et al., 2011). The Bonaire National Marine Park includes two Ramsar sites: Lac Bay and Klein Bonaire. Bonaire National Marine Park is regularly ranked in the top five dive destinations in the Caribbean, and it has been designated a UNEP Demonstration Site.

INTERNATIONAL DESIGNATIONS

Lac Bay Ramsar site

Lac Bay [Site # 199]: Designated in 1980. Lac Bay is the largest semi-enclosed bay in the Dutch Caribbean (700 ha). It is part of the Bonaire National Marine Park and includes a shallow sandy bay covered in dense seagrass beds, fringed by red mangroves and separated from the sea by coral debris and red algae banks. Lac Bay is recognized internationally for its importance to migratory and waterbirds and is also known worldwide as the spot where freestyle windsurfing was born. The mangroves provide shelter for fish and invertebrates and contribute large quantities of organic debris to the bay, creating highly productive waters. Lac Bay is an important feeding area for water birds and invertebrates, roosting site for frigate birds, a nursery for (reef) fish and important feeding ground for foraging green turtles.

Lac Bay is located at about 7 km southeast of Kralendijk. The site is an important feeding area for waterbirds, including flamingos (*Phoenicopterus ruber*) and members of the *Pelecanidae*, *Ardeidae*, *Laridae* and waders. Mangroves also support breeding waterbirds, including *Egretta tricolor*, *E. caerulea*, *E. thula* and *Butorides striatus*.

Klein Bonaire Ramsar site

Klein Bonaire Island and adjacent sea [Site # 201]: Klein Bonaire (600 ha) is an uninhabited coral island supporting a sparse cover of shrubs and cacti. Brackish lagoons and fringing coral reefs support a rich marine fauna. The island is surrounded by coral reefs which are heavily utilized by SCUBA divers. Access to the uninhabited island of Klein Bonaire is limited to visits by boat. The sandy beach 'No Name' at Klein Bonaire is particularly valuable, as it is the most important turtle-nesting site on the island.

Klein Bonaire is located about 2 km west of the mainland town of Kralendijk. The coral reefs support an extremely rich marine fauna, and the beaches are used by nesting turtles. The vegetation on Klein Bonaire is of particular interest because it is no longer grazed by animals. There are a few building foundations on the island which are of historical value.

Important Bird Areas (IBAs)

The IBA Programme of BirdLife International aims to identify, monitor and protect a global network of IBAs for the conservation of the world's birds and other biodiversity. Six IBAs have been identified on Bonaire, with one exception, all are recognized within Bonaire's Spatial Development Plan (ROB) and therefore have some legal protection (Figure 16). Birds have been shown to be effective indicators of biodiversity in other animal groups and plants – especially when used to define a set of sites for conservation.

The IBAs on Bonaire cover a range of habitats from coastal lagoons and salt flats to freshwater springs and vegetated hillsides. These are home to a number of species, identified by BirdLife International as 'trigger species' whose presence provides the justification for an Important Bird Area (IBA) designation, such as the Caribbean Coot, Terns, Yellow-shouldered Amazon (locally called Lora). Three of the IBAs (Klein Bonaire, Lac Bay and Pekelmeer) are also recognized as Ramsar wetlands. The IBAs cover more than 24,000 ha. Whilst Dos Pos lies outside of the Washington Slagbaai National Park, it is actively managed by Echo, the parrot conservation foundation.

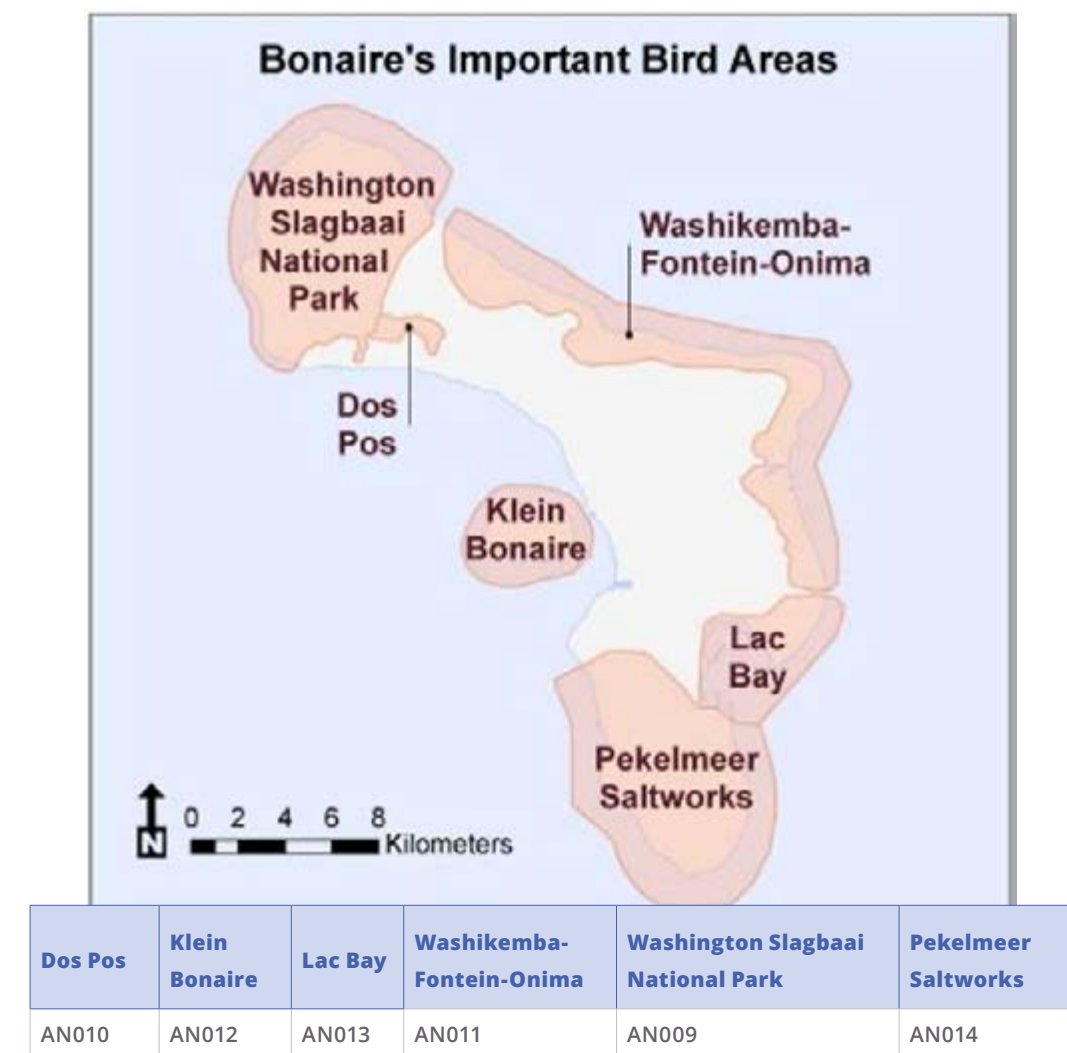


Figure 16: Important Bird Areas of Bonaire (Wells & Debrot, 2008)

The IBA's of Klein Bonaire and Lac Bay are managed as part of Bonaire National Marine Park. The other IBAs with the exception of Dos Pos (AN010) extend 1 km out to sea, and therefore also fall partially within the marine park. Further information on the IBA's of Bonaire is available in Appendix G.

MARINE ENVIRONMENTS

The natural features within the Bonaire National Marine Park (Table 2) can be categorized as follows:

- Open water (pelagic environment): supporting planktonic and pelagic sea creatures including fish and migratory species such as cetaceans (dolphin and occasional whales) and sea turtles
- Seabed (benthic environment): supporting coral reefs, sea grass beds including surface dwelling animals and plants and infauna (burrowing creatures like mollusks and crustacean), invertebrates, reef and bottom living fish
- Intertidal (littoral environment): formed at the interchange between land and sea including mangroves, rocky shores, sandy beaches and dune areas

There is a significant amount of exchange between each of these marine environments with many species spending parts of their life cycle in different areas and moving between environments for feeding and reproduction as well as passive transport by currents and upwelling and a continuous exchange of water and associated marine life from the surrounding deep-water environments.

Open Water	Seabed/benthic	Intertidal
Water	Coral reefs	Mangrove forests
	Seagrass beds	Rocky shore
	Sea mounts	Sandy beach, dunes

Table 2: Key habitats of the Bonaire National Marine Park

The most remarkable ecosystem within the marine park are Bonaire's fringing coral reefs which surround the island starting at the water's edge. They are particularly vulnerable to terrestrial influences including freshwater run-off, sediments, nutrients and all forms of pollution, all of which are major stressors for coral reefs, which are adapted to thrive in low nutrient, low sediment (oligotrophic) water.

Open water environments

Open water environments are full of phytoplankton (microscopic plants), which form the basis of the complex food webs and support not only the island's prolific coral reefs and associated animals, but also zooplankton (microscopic animals) including the juvenile stages of species found in other habitats. There are no known studies of the plankton communities in the waters around Bonaire.

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

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

Location

The open water area within the legally defined marine park is confined to the water column from the shoreline out to the 60 m depth contour. The marine flora and fauna present in the open water around Bonaire has not been well documented.

Condition

There is currently little information on the deep-water environments surrounding Bonaire. A recent expedition by the research vessel *Pelagia* operating within 1 km of the shoreline of Bonaire and Klein Bonaire, discovered species of demersal fish and benthic (bottom dwelling) invertebrates, some of which may be new to science. A recent research voyage which used a deep-water submersible to explore the waters between Bonaire and Klein Bonaire discovered high densities of invasive Lionfish at depths > 140 m and the presence of the rare Six Gilled Shark (*Hexanchus griseus*). Deeper water environments are also known to be home to new species including macroalgae (Ballantine et al., 2019) and cyanobacterial mats.

Value

Bonaire is a true oceanic island and its location adjacent to the South American mainland and at the inflow to the Caribbean Basin make the open water environment around Bonaire unique. Migratory pelagic fish stocks of Tuna, Mahi Mahi and Wahoo are critical to support Bonaire's small-scale fishing industry. Globally endangered cetaceans and sea turtles regularly migrate through Bonaire's waters.

Coral reefs

Bonaire and Klein Bonaire are surrounded by continuous, fringing coral reefs which are home to around 60 different species of corals. Reefs stretch from the shoreline seaward to depths in excess of 70 m, covering an area of some 2,700 ha.

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

On the windward shore, typically for high wave energy environments, the shallow reef environment is dominated by forests of gorgonians, principally seafans, and low growing corals and some areas are dominated by dense algal assemblages, which may have an important ecological role to play. These ecosystems have not yet been well explored.

In addition to supporting a wealth of marine organisms, the coral reefs of Bonaire also support the Islands economy which is dependent on tourism. The structure of the reef protects the coastline and coastal developments from waves and storm surges.

Location

Both Bonaire and Klein Bonaire are surrounded by continuous, fringing coral reefs from the shoreline seaward to depths in excess of 70 m. Extensive stands of Staghorn and Elkhorn Coral are rare since white band disease swept through the Caribbean in the 1980s. The reef slopes from 12 to 25 m continue to show an abundance and diversity of stony coral and other sessile (fixed) organisms. The deeper, lower reef slopes are dominated by plate coral (*Agaricia sp.*) and in places by Encrusting Fan-Leaf Alga (*Lobophora variegata*) or Y-Branched Alga (*Dictyota sp.*), with some Lettuce, Plate and Star Corals in between.

- Reef features of particular interest include:
- Vertical reef slopes can be found at a few known sites on the east coast and on Klein Bonaire. Carl's Hill Annex on Klein Bonaire has a vertical wall stretching from 10 m to 20 m depth. Cliff, Small Wall, Bruce's Rappel and La Dania's dive sites also have walls of interest.
- A double reef stretches from Punt Vierkant in the South of the Island to Salt City dive site. At these sites, a 'second' reef can be found seaward of a sand channel at the bottom of the initial reef slope. The Hilma Hooker wreck is located in the channel between the two reefs.
- A conspicuous geological feature of parts of the reef slope, especially around Karpata on the northwestern shore, are coral spurs and sediment channels which form as a result of the inherent instability of corals at the top of the reef slope causing the reef to collapse locally.
- Spur-and-groove coral formations occur in shallow water in high wave energy environments at Boca Bartol and Playa Benge on Bonaire's northwestern shore.

Bonaire's shallow reefs were surveyed in 1983, and detailed maps were produced of the shallow coral communities to a depth of 10-12 m along the leeward shore and Klein Bonaire (van Duyl, 1985).

Along the windward shore, stony coral development is virtually absent in water shallower than 12 m, where there is an abundance of gorgonians, crustose coralline algae and dense stands of *Sargassum platycarpum*, which may extend to 40 m water depth.

Value

The coral reefs attract around 40,000 tourists a year who take part in diving and snorkeling activity. Cruise ship visitors are also arriving on Bonaire in increasing numbers. The reefs are also valuable as a habitat for many animals and plants which commercial, artisanal and sport fisheries depend on. The building blocks of the reef, hard corals, provide protection to shore side developments by reducing wave energy. Hard corals and calcareous algae along with other organisms with shells produce coral sand which has been used for building and a range of other applications.

The coral reefs of Bonaire are highly diverse and provide habitat for countless creatures, including fish and coral, many species of crustaceans, worms, anemones, jellyfish, mollusks, echinoderms (cucumbers and star fish), bryozoans, sponges and tunicates.

Condition

Scientific research on coral cover, species composition, fish diversity and macro algal cover demonstrate a marked decline in the condition of the reefs of Bonaire since monitoring began in the 1970s (Table 3; Figure 17 & 18). Anecdotal evidence from images and observations by older residents also points to a decline in the state of the reefs.

Depth (m)	Start coral cover %	End coral cover %	Net loss %
10	63	22	65
20	71	6	90
30	60	20	66
40	25	11	56

Table 3: Observations of Karpata fixed photo quadrats 1973-2014 (DCNA, 2018)

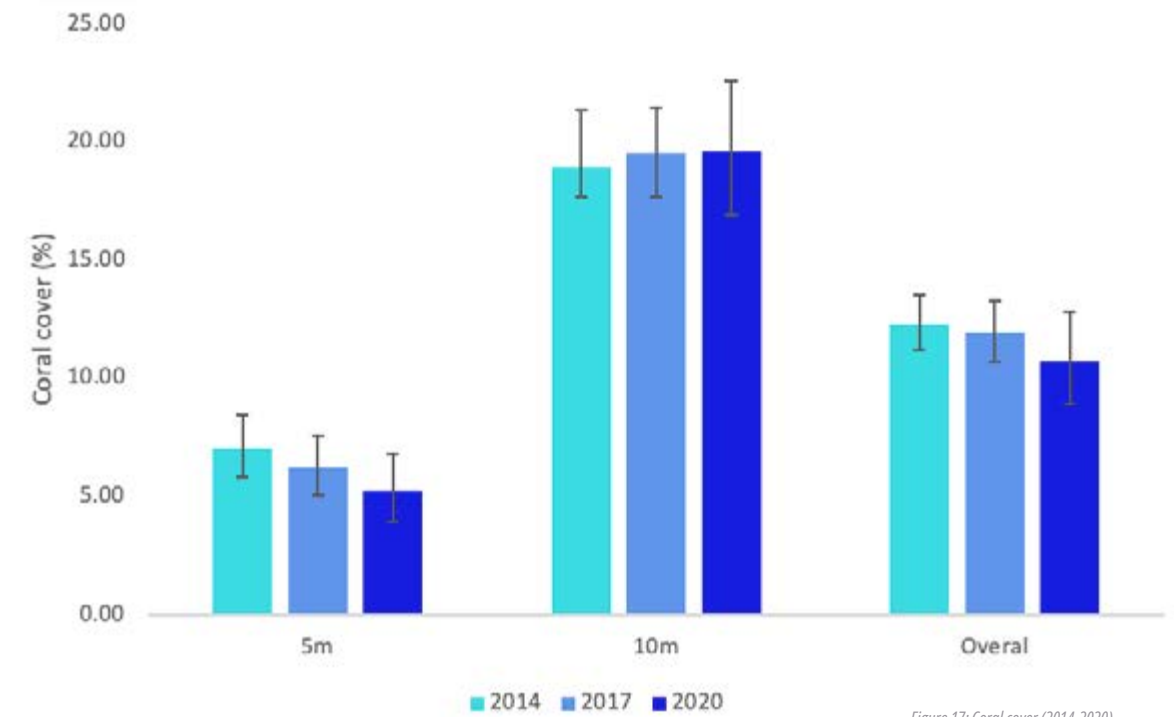


Figure 17: Coral cover (2014-2020)

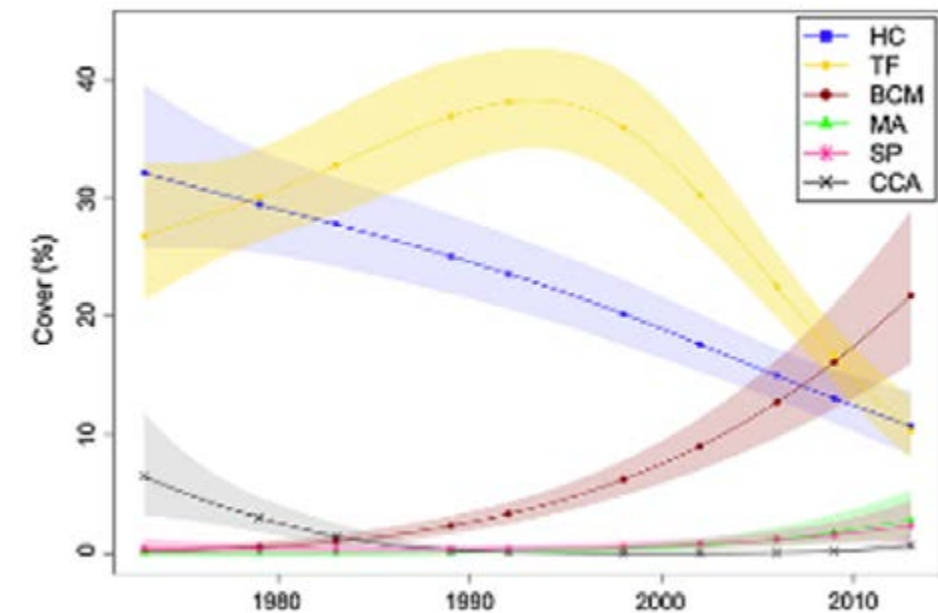


Figure 18: Historical decline of hard coral cover on Bonaire's reefs (de Bakker et al., 2017). Trajectories of change for six benthic groups: hard coral (HC, blue), algal turfs (TF, yellow), benthic cyanobacterial mats (BCM, brown), macroalgae (MA, green), sponges (SP, pink) and crustose coralline algae (CCA, black). Lines represent estimated models (with 95 percent confidence bands) of the change in mean percentage cover over all sites (I, II, III, IV) and depths (10, 20, 30, 40 m)

In 1994, Bonaire was known to support some of the 'healthiest' remaining coral reefs in the Caribbean, with (relatively) high coral cover and diverse populations of fish. There is some debate as to the coral cover of the reefs on Bonaire in comparison to other sites in the Caribbean (for more information see Meesters et.al 2020). It is currently accepted that since the early 1970s the amount of living hard coral on the seabed has significantly decreased. In the healthiest locations living coral cover has fallen from around 70 percent to below 30 percent (CBS, 2020).

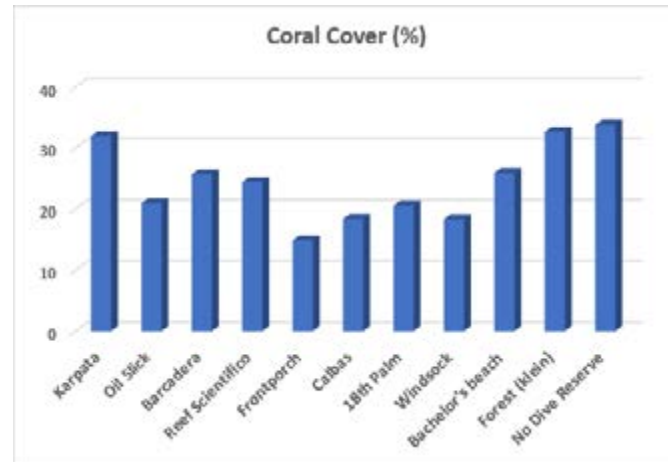


Figure 19: Percent coral cover at 11 sites on the westward side of Bonaire in March 2019. For each site, 15 photos were taken from five 30m transects laid haphazardly between 8 and 20m depth and analyzed using CPCe. Mean percent coral cover (± SE) was 24.3 ± 1.9.

The shift in the state of the reefs is attributed to:

- On-going pollution from land-based sources including nutrients, sediments and chemicals.
- Outbreak of white band disease (1980-1982), which caused the death of 90 percent of the standing stock of Staghorn Coral (*Acropora cervicornis*) and Elkhorn Coral (*Acropora palmata*).
- Mass mortality of *Diadema antillarum* (Black spiny urchin), possibly caused by a pathogen in 1980s.
- Disease outbreaks including yellow band disease (affecting primarily the Boulder star coral *Montastraea sp.*), white plague and black band disease.
- Storm damage from Hurricane Lenny in November 1999 and Omar in 2008.
- Global warming and coral bleaching.

Although Bonaire's reefs have suffered major coral losses, recent trends in resilience have been documented. (Steneck et al., 2019) (Figure 20; Box 2).

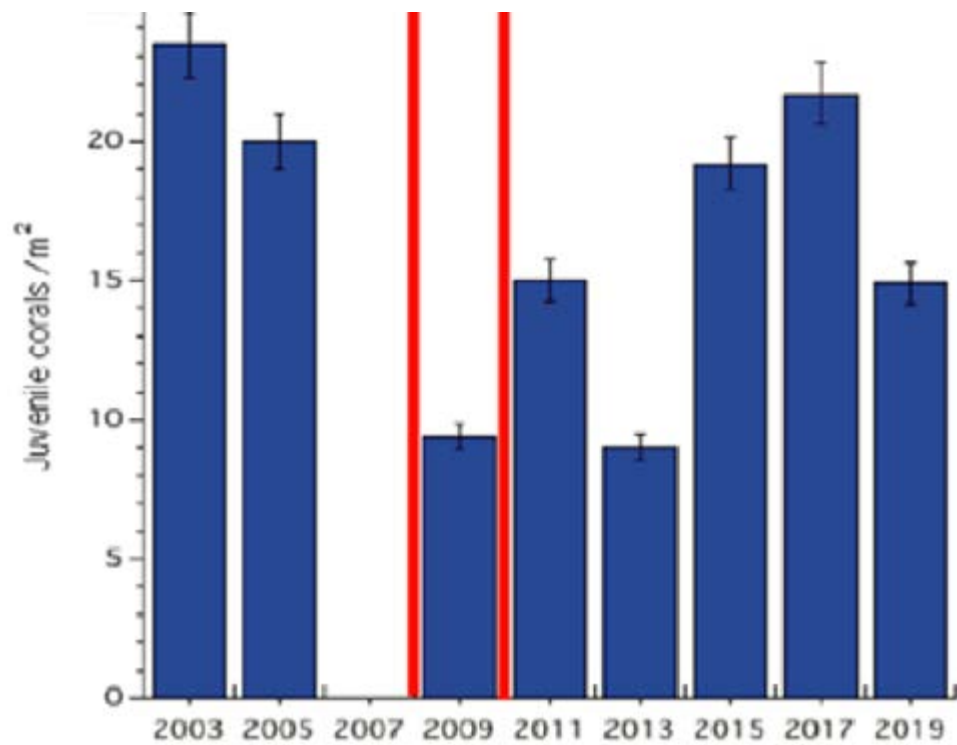
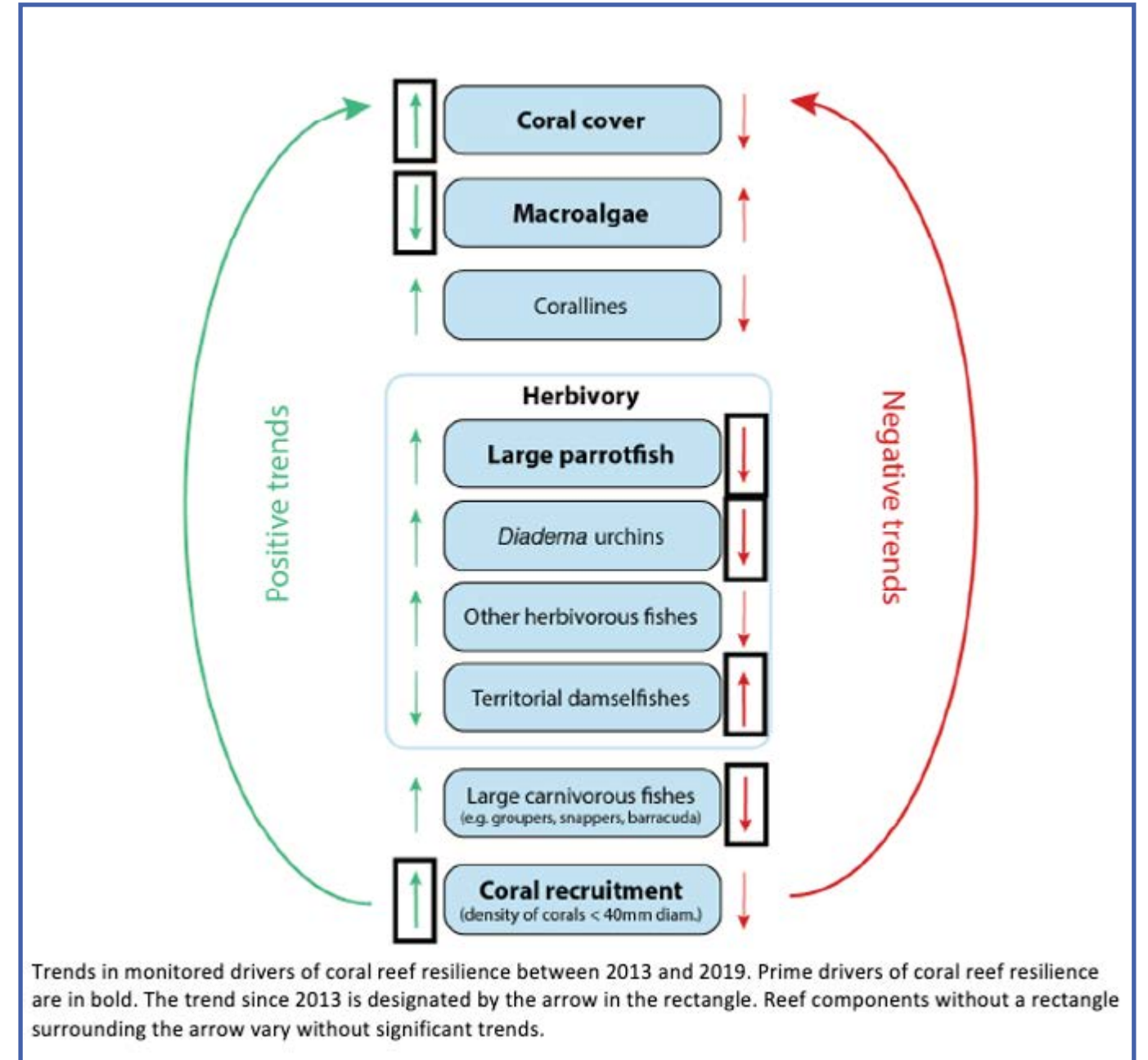


Figure 20: Juvenile coral density (2003-2019)



Box 2: Trends in monitored drivers of coral reef resilience (Steneck et al., 2019)

Seagrass beds

Seagrasses are flowering plants that live underwater. Like land plants, seagrasses produce oxygen. The depth at which seagrasses are found is limited by water clarity which determines the amount of light reaching the plant. Seagrass beds form in shallow coastal lagoon areas.

Seagrass ecosystems are amongst the most productive in the world; an average growth rate of seagrass leaves is about 5 mm per day, with entire stands of seagrass being turned over every 16 weeks with three to four crops annually. In addition, the leaves of seagrasses provide a huge surface area for settlement of epiphytes and epifauna (plants and animals that live on the surface of another organism). For 1 m2 of seabed, a dense seagrass stand may have 20 m2 of leaf area for other organisms to settle on. The productivity of the epiphytes and epifauna can be twice that of the seagrasses themselves.

Through a succession of growth, seagrasses can turn vast areas of unconsolidated sediments into highly productive, plant dominated, structured habitat with a diversity of microhabitats, such as that found within Lac Bay on Bonaire. Many different species of algae also inhabit the waters around Bonaire from the aptly named Sea pearl (*Ventricaria ventricosa*) and Mermaid's Cup (*Acetabularia crenulate*) to the sand-producing calcareous algae (*Halimeda sp.*).

Location

There are two main areas of seagrass on Bonaire, both on the windward shore. Sparse sea grass beds and fringing mangroves can be found at Lagoen, adjacent to the island's landfill whilst the most significant seagrass fields are found at Lac Bay.

Value

The seagrass beds of Lac Bay provide a biological filter system for the waters within the bay. The seagrasses stabilize sediments and attenuate wave action, thereby protecting beaches. Seagrass beds provide a nursery and habitat for numerous commercially important marine animals such as Queen Conch and juvenile fish. Endangered species such as Green Turtle also depend on the well-being of the seagrass for their survival.

Seagrass accounts for 10 percent of the ocean's capacity to store carbon (so-called blue carbon) despite occupying only 0.2 percent of the sea floor, and it can capture carbon from the atmosphere up to 35 times faster than tropical rainforests (UNEP, 2019).

Condition

Until 2017, the seagrass stands in Lac Bay were dominated by Turtle grass (*Thalassia testudinum*) together with Manatee grass (*Syringodium filiforme*) and banks of calcareous alga (*Halimeda sp.*). Data in 2019 confirmed that an invasive seagrass *Halophila stipulacea*, first discovered in Bonaire in 2010, had become the dominant species and continues to spread throughout the bay.

Brown tides (Sargassum) have occurred annually since 2018 when Sargassum washes onto the shore and decomposes in situ, releasing brown water and causing smothering, eutrophication, the release of hydrogen sulphide and anoxic (oxygen depleted) conditions. Sargassum chokes and kills mangroves and seagrass beds.

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

Historically, Queen conch (*Aliger gigas*) in Lac Bay have been subject to excessive fishing pressure. Taking Queen Conch from Lac Bay has been illegal since 1985 without a permit. The population of Queen Conch in Lac Bay made a recovery from 2010 to 2013, but has since been decimated (Figure 21). A recent survey failed to find any sexually mature conch (Engel and Johnson, 2021). Fishing pressure removes individuals before they have a chance to reproduce.

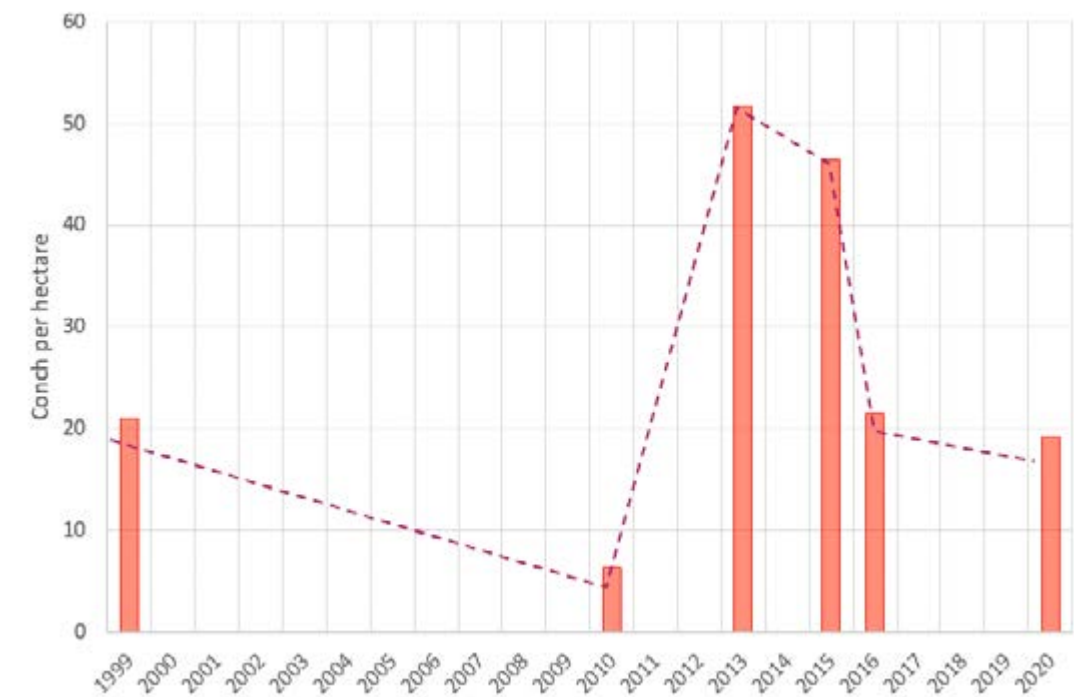


Figure 21: Conch numbers in Lac Bay (Engel and Johnson, 2021)

Sea mounts

Sea mounts act as magnets for fish life, and fishers are routinely drawn to them. Seamounts to the east of Bonaire, seaward of the salt pans, are frequented by sharks.

Deep water sea bottom

Soft-bottom habitats dominate much of the sea floor in deep water, which fall under the management of the marine park in the waters around Klein Bonaire and off the shores of the Washington Slagbaai Ramsar site. The sediments are usually comprised of a mixture of biologically fixed silica and calcium carbonate, as well as clays, silts, and sand sediments. Large varieties of mobile and stationary animals live on and within these sediments. Around Bonaire, these are likely to include mobile echinoderms such as brittle stars and sea cucumbers, crustaceans such as crabs, amphipods, and shrimps, mollusks such as snails and octopods, and a variety of worms such as polychaetes and nematodes. There are also many sessile (fixed) polychaetes, clams, sponges, and other invertebrates. These mobile and sessile animals typically range in size from > 1 cm, to the smallest microbes. Microbes such as bacteria play an important role in breaking down organic material.

Mangroves

Mangrove forests world-wide are under severe pressure and disappearing in an alarming rate. It is estimated that about 60 percent of the total mangrove areas in the world have disappeared. This is mainly due to large scale land clearance for coastal development. Mangroves trees grow in intertidal areas. On Bonaire there are three species of mangroves: Red Mangrove (*Rhizophora mangle*), Black Mangrove (*Avicennia germinans*), White Mangrove (*Laguncularia racemosa*), as well as the closely associated Buttonwood tree (*Conocarpus erectus*).



The mangrove forests on Bonaire, and especially those around Lac Bay, provide diverse habitats for numerous plant and animal species, including invertebrates, reptiles, fish and birds. The mangroves of Lac Bay are also thought to be an important foraging ground for bats.

Important macro invertebrates in the bay include Queen Conch (*Aliger gigas*), Milk Conch (*Macrostrombus costatus*), Cushion Stars (*Oreaster reticulata*), Sea Cucumber (*Holothuria mexicana*), Sea Urchins (*Tripneustes venricosus*, *Lytechinus variegates*, *Meoma ventricosa*) and the Upside-Down Jellyfish (*Cassiopeia frondosa*). The Atlantic Triton (*Charonia variegata*) appears to be no longer present in Lac Bay.

At least 100 different fish species use the mangroves of Bonaire as a habitat (also see Appendix B). The species most likely to be seen, include: Striped Parrotfish (*Scarus croicensis*), Bluehead (*Thalassoma bifasciatum*), Gray Snapper (*Lutjanus griseus*), Schoolmaster (*Lutjanus apodus*) Silversides, Herrings and Anchovies (families *Atherinidae*, *Clupeidae*, *Engraulidae*) as well as Rainbow Parrotfish (*Scarus guacamaia*), Spotted Eagle Rays (*Aetobatus narinari*), various species of Moray Eels and juvenile sharks.

Location

There are two main areas of seagrass and mangrove on Bonaire. Sparse sea grass beds and fringing mangroves can be found at Lagoen, adjacent to the island's landfill and the most significant seagrass and mangrove stands are found at Lac Bay. Sparse mangrove growth is found in the southern wetlands (Pekelmeer and other waterbodies) as well as a fringe at the west coast. Seagrasses can be found in the southern wetlands, as well as sparse beds at the eastern side of Klein Bonaire.

Within the mangrove forests surrounding Lac Bay are a number of islands: Isla Fogon, Isla Pedro, Isla di Yuwana, Isla di Chico, Isla di Rancho. The dominant species is the Red Mangrove (*Rhizophora mangle*) with its distinctive prop root system. About 30 percent is made up of Black Mangrove (*Avicennia germinans*) with occasional White Mangrove (*Laguncularia racemosa*) and Buttonwood (*Conocarpus erectus*) (Davaasuren & Meesters, 2012; Lodder, 2013).

Value

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

Lac Bay supports Bonaire's largest mangrove and seagrass ecosystems. The open water area of the bay is blanketed by seagrass beds and algal meadows. Along the landward edge of the bay is an actively growing fringe of Red Mangroves. The mangrove system in Lac Bay can be classified as 'island mangroves' as opposed to 'mainland mangroves'. One very important ecosystem value of mangroves is its ability to store large quantities of carbon above and below ground. Degradation of the health of mangrove forests is immediately reflected in this potential by the carbon fluxes (Senger et al., 2021).

Within the bay, there is an extensive submerged sandy area (Awa di Mewchi), which is biologically important as it provides a critical habitat for the settlement of larval conch, as well as abundant annelids (worms) and other infauna (animals living in the sediment) which form the basis of the food chain within the bay. At the northern tip of Sorobon an unique calcareous bank is being formed by a lime-secreting marine alga (*Lithothamnion sp.*) (Zaneveld 1958).

Also atypical is the water circulation pattern within the mangroves. The mangrove area consists of two separate but adjacent basins, each with its own water circulation regime. Water circulation to the back of the mangroves is driven not by water flowing in and out of the feeder channels, as might be expected, but by sheet flow. When the water height in the bay reaches a critical level, fresh seawater flows over and around the sand cays and through the mangroves to the very back of the mangroves. The feeder channels are therefore most important in draining water out of the mangroves (Lott 1999).

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

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

Mangroves thrive when environmental conditions are in the appropriate range. For Red Mangrove that is in salinities ranging from 35 ppt to up to 60 ppt, with varying inundation periods. Black Mangrove survives in higher salinities, but die back when inundated over longer periods. White Mangrove can be found in areas with the least inundation. Other factors like N and P play a role as well, and may cause stunted growth (Lodder, 2014). Silting up also contributes to the dieback of mangroves. The combination of these factors is reflected in the zonation of species throughout the forest: Red Mangrove towards the sea, in area with the best hydrological connectivity, mixed stands when the water levels are not varying and salinities are moderate, Black Mangrove towards land side and in areas where Red Mangrove die back. White Mangrove mostly at the interface of sea and land.

The water circulation in the mangrove forest is driven by Bonaire's diurnal tide regime. Both the deeper creeks and sheet flow allow the water to circulate throughout the system. The limiting factor for the hydrological connectivity between the open bay and the back of the mangroves is the spaces between the islands that intersect the bay from northeast to southwest. These limit the water flow from the open bay to the backwaters considerably. In the open bay there is no tidal delay, but throughout the forest there is a delay up to 4 hours for the tide to reach the backwaters (Awa di Lodo). During spring tide sheet flow contributes considerably by bringing water to the Awa di Lodo (Van Zee, 2022).

The well-being of Lac Bay is essential for recreation and watersport, including beach users, snorkelers and kayakers that financially support tourist orientated businesses. The onshore trade winds make the bay an internationally recognized location for windsurfing, where beginners can practice in safety. Traditionally the mangroves have been used for the production of charcoal.

Condition

One of the dominant features of the mangrove system is a significant die-back of Red Mangrove at its northwestern extreme (Awa di Lodo) (Figure 22), thought to be due to hypersaline conditions created by influx of sediments in the north and subsequent, and the subsequent choking of feeder channels on the seaward side resulting in water temperatures of 40°C and salinities of up to 100 ppt (van Moorsel & Meijer,

1993). The status of the mangroves on Bonaire is considered moderately unfavorable (Verweij et al., 2018).



Figure 22: Mangrove loss in Lac Bay (2014-2020)

Dunes and beaches

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

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

Location

Remnant dunes can be found in the Washington Slagbaai National Park at sites on the windward shore. The most extensive sandy beaches are found on the windward coast of Bonaire in sheltered areas such as Boca kokolishi and Playa Chikitu in the Washington Slagbaai National Park, at Lac Cai and Sorobon and on the leeward coast such as Pink Beach, Donkey Beach, Te Amo and Playa Lechi, as well as No Name beach on Klein Bonaire. There are numerous small pocket beaches in coves and inlets along the leeward shore, in the Washington Slagbaai National Park as well as on the north and western shoreline of Klein Bonaire.

Generally, native dune grasses, trailing vines and small perennials are the hardiest species and are found on the seaward face of the dunes. Shrubs and trees are more abundant in the back-dune zone. Bonaire's beaches are mobile and their features depend on the maritime conditions at any point in time. In 1999 Hurricane Lenny for example shifted the major turtle nesting beach on Klein Bonaire, No Name, approximately 500 m eastwards and reduced Pink Beach to coral rubble.

Value

The value of Bonaire's beaches and dunes lies primarily in income from tourism. Tourists expect various physical attributes of the tropical destinations they visit and sandy beaches are definitely one of the features

in high demand particularly amongst cruise boat passengers. Additionally, beaches support fragile but important flora which binds the sand, prevents erosion and speeds further sand accumulation. Beaches are important nesting sites for 3 species of turtles; Green turtles (*Chelonia mydas*) Hawksbill turtles (*Eretmochelys imbricata*) and Loggerhead turtles (*Caretta caretta*) with occasional Leatherback (*Dermochelys coriacea*) nests on the windward shore. No Name beach on the northeastern shore of Klein Bonaire is Bonaire's most important turtle nesting site and is frequently checked for turtle nesting activity by staff and volunteers from the Sea Turtle Conservation Bonaire foundation.

Condition

With the exception of Boca Kokolishi and Playa Chikitu which are protected within the Washington Slagbaai National Park, Bonaire's coastal dunes along the length of the windward shore have been extensively mined for sand with the attendant destruction of flora and threat to wildlife such as nesting turtles and ground nesting seabirds like the Least Tern (*Sternula antillarum*).

The dunes and beaches at Lac Cai and Sorobon are in mixed condition. The Government sanctioned sand mining to the south of the Sorobon Beach Resort, which resulted in a large area of dune being entirely removed along with historical middens and Indian artefacts. This area is now more or less permanently flooded. The result has been severe beach erosion in front of the adjacent resort.

Removal of beach vegetation and localized trampling of seagrass beds, primarily by windsurfers, in front of the windsurf centers at Sorobon has caused further beach erosion. Pink Beach has not existed as a sandy beach since November 1999 when the sand was eroded by Hurricane Lenny. The sand now lies in shallow water in front of the beach and can be expected to re-accumulate over time. The remaining beaches appear stable and in relatively good condition although high levels of visitation at No Name, Sorobon, Te Amo and Donkey Beach have resulted in beach pollution particularly from the use of BBQs.

Rocky shores

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

Location

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

Value

The rocky shores provide essential protection from the sea by acting as a barrier from the pounding waves. Little is known about the many different plants and animals, which inhabit the rock pools. Around Bonaire the rocky shores are intact. The limestone around Bonaire is being continually exposed to chemical, biological and physical erosion. These processes take many years to operate, and result in the formation of iron shore, craggy cliffs and plateaus as well as complex drainage channels.

Condition

Considerable quantities of water borne trash are deposited on Bonaire’s windward shore annually. Whilst some is undoubtedly dumped overboard by vessels, much of this material appears to originate in Venezuela, where sea dumping still occurs. Occasional oil slicks also wash up on the windward shore. The long-term impact of periodic inundation by sargassum is not known.

Saliñas

Saliñas (hypersaline lakes) are an important permanent wetland feature on Bonaire. They are found along the leeward shore, mostly to the north of the island and include Saliña Mattijs, Saliña Bartol, Saliña Funchi, Saliña Wayaka, Saliña Slagbaai, Saliña Frans, Saliña Tam and Goto Lake. Whilst they are hypersaline, they are far from abiotic (devoid of life). Some have significant fish populations. Saliñas are important as foraging, nesting and stop-over areas for many migratory birds, hence the Ramsar designation. The saliñas are also important drainage features and act as sediment traps, reducing water flow and preventing sediment, particularly rain run-off, from adversely affecting coral reefs. The saliñas are often targeted for development for tourism and mariculture industries. However, any change to the saliñas is likely to result in the deposition of excess sediment on the fringing coral reefs. This was the case at Saliña Wayaka, which was opened to the sea to create a suitable site for shrimp aquaculture, smothering and killing the reef.

Located just north of the main town, Saliña di Vlijt, differs from most other saliñas in that much of the surface area is dry for most of the year, creating localized problems with dust and smell. Significant enhancement of the saliña has included the creation of basins to slow water flow and replanting. Harbour Village Marina has acquired parcels of land surrounding Saliña Vlijt, including the saliña, and has the stated intention of dredging and developing the basin. Early environmental impact assessments by experts from the University Simon Bolivar in Venezuela indicted that this would cause a significant problem for Bonaire’s coral reefs by increasing the sediment load for the fringing coral reefs north of the marina.

Bacterial mats

Bacterial mats occur in intertidal areas around the island, particularly within the mangroves of Lac Bay. These bacterial mats cover parts of the ground near the mangroves of Lac Bay and low-lying intertidal areas and may have an important ecological role as well as include chemicals of interest to the pharmaceutical industry. Further investigation is needed.

1993). The status of the mangroves on Bonaire is considered moderately unfavorable (Verweij et al., 2018).

SPECIES

Bonaire’s marine environment is living, foraging and breeding ground, and migratory stop over, for many species that are locally, regionally and globally protected, including mammals, fish, crustaceans, birds and corals (Table 4). This includes at least 796 documented species of plants and animals (Table 5). The shoreline and Klein Bonaire are known to be home to 97 bird species, 9 bat species, and 30 insect species that are important for conservation.

	IUCN Red List			CITES I	CITES II	SPAII II	IBA species
	Critical	Endangered	Vulnerable				
Marine	10	21	44	15	250	46	7
Terrestrial	0	2	7	2	34	4	8
Total	10	23	51	17	284	50	15

Table 4: Species of conservation importance on Bonaire

Corals - black corals	14
Corals - gorgonians	35
Corals - stony	198
Corals - stony, fire coral	3
Crustaceans	17
Cyanobacteria	1
Echinoderms	4
Fish	256
Sharks and rays	32
Cetaceans	29
Manatee	1
Mollusks	11
Plants	188
Turtles	5
Zoanthid	2
Total	796

Table 5: Number of species occurring in the Bonaire National Marine Park



IUCN Red list species

The IUCN maintains a complete list of all the species it considers critically endangered, endangered or vulnerable. A species is Critically Endangered (CR) when it is considered to be facing an extremely high risk of extinction in the wild. A species is Endangered (EN) when it is therefore considered to be facing a very high risk of extinction in the wild (Table 6). A species is Vulnerable when it is considered to be facing a high risk of extinction in the wild.



Group name	Scientific name	English name
Critically endangered		
Corals - stony	<i>Acropora cervicornis</i>	Staghorn Coral
Corals - stony	<i>Acropora palmata</i>	Elkhorn Coral
Fish	<i>Epinephelus itajara</i>	Atlantic Goliath Grouper, Jewfish, Goliath Grouper
Fish	<i>Epinephelus striatus</i>	Nassau Grouper
Fish	<i>Hyporthodus nigritus</i>	Warsaw Grouper
Fish - sharks and rays	<i>Carcharhinus longimanus</i>	Oceanic Whitetip Shark
Fish - sharks and rays	<i>Pristis pectinata</i>	Smalltooth Sawfish
Fish - sharks and rays	<i>Pristis pristis</i>	Large-tooth Sawfish
Reptiles - turtles	<i>Eretmochelys imbricata</i>	Hawksbill Turtle
Reptiles - turtles	<i>Dermochelys coriacea</i>	Leatherback Turtle
Endangered		
Birds	<i>Pterodroma hasitata</i>	Black-capped Petrel
Corals - stony	<i>Orbicella annularis</i>	Boulder Star Coral
Corals - stony	<i>Orbicella faveolata</i>	Mountainous Star Coral
Fish	<i>Anguilla rostrata</i>	American Eel
Fish	<i>Makaira nigricans</i>	Blue Marlin / Black Marlin
Fish	<i>Pagrus pagrus</i>	Red Porgy
Fish	<i>Thunnus thynnus</i>	Atlantic Bluefin Tuna
Fish - sharks and rays	<i>Dipturus laevis</i>	Barndoor Skate
Fish - sharks and rays	<i>Leucoraja ocellata</i>	Winter Skate
Fish - sharks and rays	<i>Rhincodon typus</i>	Whale Shark
Fish - sharks and rays	<i>Sphyrna lewini</i>	Scalloped Hammerhead
Fish - sharks and rays	<i>Sphyrna mokarran</i>	Great Hammerhead Shark
Mammals - cetaceans	<i>Balaenoptera borealis</i>	Coalfish Whale
Mammals - cetaceans	<i>Balaenoptera musculus</i>	Blue Whale
Mammals - cetaceans	<i>Balaenoptera physalis</i>	Fin Whale
Mammals - cetaceans	<i>Eubalaena glacialis</i>	North Atlantic Right Whale
Plants	<i>Guaiacum officinale</i>	Common Lignum Vitae
Plants	<i>Guaiacum sanctum</i>	Roughbark Lignum-vitae,
Reptiles - turtles	<i>Chelonia mydas</i>	Green Turtle
Reptiles - turtles	<i>Caretta</i>	Loggerhead Turtle
Reptiles - turtles	<i>Lepidochelys olivacea</i>	Olive Ridley Turtle

Table 6: Critically Endangered and Endangered species recorded in the Bonaire National Marine Park (IUCN Red List)

CITES species

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival (Table 7). Trade in CITES Appendix I species (Table 7) is permitted only in exceptional circumstances.

Group name	Scientific name	English name
Fish - sharks and rays	<i>Pristis pectinata</i>	Smalltooth Sawfish
Fish - sharks and rays	<i>Pristis</i>	Large-tooth Sawfish
Mammals - cetaceans	<i>Megaptera novaeangliae</i>	Humpback Whale
Mammals - cetaceans	<i>Physeter macrocephalus</i>	Sperm Whale
Mammals - cetaceans	<i>Balaenoptera acutorostrata</i>	Minke Whale
Mammals - cetaceans	<i>Balaenoptera borealis</i>	Coalfish Whale
Mammals - cetaceans	<i>Balaenoptera edeni</i>	Bryde's Whale
Mammals - cetaceans	<i>Balaenoptera musculus</i>	Blue Whale
Mammals - cetaceans	<i>Balaenoptera physalis</i>	Fin Whale
Mammals - manatee	<i>Trichechus manatus</i>	West-Indian Manatee
Reptiles - turtles	<i>Eretmochelys imbricata</i>	Hawksbill Turtle
Reptiles - turtles	<i>Dermochelys coriacea</i>	Leatherback Turtle
Reptiles - turtles	<i>Chelonia mydas</i>	Green Turtle
Reptiles - turtles	<i>Caretta</i>	Loggerhead Turtle
Reptiles - turtles	<i>Lepidochelys olivacea</i>	Olive Ridley Turtle

Table 7: CITES Appendix I species recorded in the Bonaire National Marine Park

Flagship species

Many species of plants and animals may not appear on the IUCN Red List or on the CITES Appendices, yet they are invaluable as keystone or charismatic species, or be of cultural importance to the island. These flagship species were identified by STINAPA staff and other conservation practitioners in 2012 (Box 3).

Queen Conch, is the most common species of conch found in the waters of the marine park, and its meat is considered a delicacy. Other related species in the genus *Lobatus* and *Strombus* are the Hawkwing Conch (*Lobatus raninus*), the Milk Conch (*Lobatus costatus*) and the West Indian Fighting Conch (*Strombus pugilus*). *Lobatus costatus* is taken occasionally by fishers, but is not considered good food as the shell is very thick and there is very little meat (Engel and Johnson, 2021).

Caribbean flamingo	<i>Phoenicopterus ruber</i>
Spinner Dolphin	<i>Stenella longirostris</i>
Queen Conch	<i>Aliger gigas</i>
Frogfish	<i>Antennarius sp.</i>
Sea horses	<i>Hippocampus sp.</i>
Hawksbill turtle	<i>Eretmochelys imbricata</i>
Green turtle	<i>Chelonia mydas</i>
Loggerhead turtles	<i>Caretta caretta</i>

Box 3: Flagship species of the Bonaire National Marine Park

Fish

Between December 1993 and July 1999, approximately 2,000 fish surveys developed by the Reef Environmental Education Foundation (REEF) with support from The Nature Conservancy (TNC) were completed by volunteers around Bonaire and Klein Bonaire. From this data, a total of 362 fish species were reported from 77 sites surveyed, making Bonaire one of the most species rich locations in REEF's Caribbean database (268 species were identified by experts). Further analysis on a sub-set of sites indicated that fish assemblages on Klein Bonaire were distinct from those on Bonaire. Sites within the King Willem Alexander Reserve and Queen Maxima Reserve appeared to be distinct from other sites around Bonaire (Pattengill-Semmens, 2002).

The composition of the fish assemblage on Bonaire reefs is similar to that found throughout the southern Caribbean. The five most frequently sighted species were Blue Tang (*Acanthurus coeruleus*), Bicolor Damsel (*Stegastes partitus*), Stoplight Parrotfish (*Sparisoma viride*), Brown Chromis (*Chromis multilineata*), and Bluehead Wrasse (*Thalassoma bifasciatum*) (Pattengill-Semmens, 2002). In 2021 five more species were added, resulting in a total fish species count for Bonaire of 367 fish species, including the two species of invasive Lionfish (*Pterois volitans* and *P. miles*).

Observations made in 1993 and 1994 demonstrated that Bonaire's reefs supported substantially greater numbers of commercially valuable fish species per survey count than at other sites in the Caribbean such as Saba or Belize (Roberts and Hawkins, 1994). In the same study, Bonaire's reefs were seen to support a very high biomass of groupers and snappers. Later personal observations by Roberts indicated a significant drop in predator numbers and biomass. The decline in number of grouper and snapper has not shown signs of recovery.

Comparing recent data to data collected in the 1950s and 1960s, it is clear that large piscivores have all but disappeared from Bonaire's reefs. Data collected between 1994 and 2003 indicates that the number of carnivorous fish, particularly groupers and snappers which are preferentially targeted by recreational and commercial fishing, have declined significantly (Steneck and McClanahan, 2003). Whilst data collected since 2003 shows fluctuating population numbers, there is little or no signs of recovery (DCNA 2018).

From 2003 onwards, parrotfish populations began to decline. This prompted the passing of enhanced legal protection, including a ban on parrotfish harvest and phasing out of fish traps from 2010 onwards. Data indicates that parrotfish populations stabilized between 2009 and 2015 and the most recent results show promising signs of recovery (DCNA, 2018).

Marine mammals

Around thirty species of marine mammals, including Bottle Nose Dolphin, Spinner Dolphin, Sperm Whale and Humpback Whale, are known to frequent the waters around Bonaire (Table 8). More marine mammal species are likely to use the waters beyond the marine park. Additionally, one West-Indian Manatee was sighted in 2018. Threats facing marine mammals include entanglement, hunting, collision with vessels, noise, marine debris, pollution as well as the predicted effects of climate change.

Scientific name	English	IUCN Red List
<i>Balaenoptera acutorostrata</i>	Minke Whale	
<i>Balaenoptera borealis</i>	Coalfish Whale	Endangered
<i>Balaenoptera edeni</i>	Bryde's Whale	
<i>Balaenoptera musculus</i>	Blue Whale	Endangered
<i>Balaenoptera physalis</i>	Fin Whale	Endangered
<i>Delphinus capensis</i>	Long beaked common dolphin	
<i>Delphinus delphis</i>	Common Dolphin	
<i>Eubalaena glacialis</i>	North Atlantic Right Whale	Endangered
<i>Feresa attenuata</i>	Pygmy killer whale	
<i>Globicephala macrorhynchus</i>	Shortfin Pilot Whale	
<i>Grampus griseus</i>	Risso's Dolphin	
<i>Kogia breviceps</i>	Pygmy Sperm Whale	
<i>Kogia simus</i>	Dwarf Sperm Whale	
<i>Lagenodelphis hosei</i>	Fraser's Dolphin	
<i>Megaptera novaeangliae</i>	Humpback Whale	Vulnerable
<i>Mesoplodon densirostris</i>	Blainville's beaked whale	
<i>Mesoplodon europaeus</i>	Gervais's Beaked Whale	
<i>Orcinus orca</i>	Orca - Killer Whale	
<i>Peponocephala electra</i>	Melon-headed Whale	
<i>Physeter macrocephalus</i>	Sperm Whale	Vulnerable
<i>Pseudorca crassidens</i>	False Killer Whale	
<i>Stenella attenuata</i>	Pantropical Spotted Dolphin	
<i>Stenella clymene</i>	Clymene Dolphin	
<i>Stenella coeruleoalba</i>	Striped Dolphin	
<i>Stenella frontalis</i>	Atlantic Spotted Dolphin	
<i>Stenella longirostris</i>	Spinner Dolphin	
<i>Steno bredanensis</i>	Rough Toothed dolphin	
<i>Tursiops truncatus</i>	Bottlenose Dolphin	
<i>Ziphius cavirostris</i>	Cuvier's Whale	
<i>Trichechus manatus</i>	West-Indian Manatee	Vulnerable

Table 8: Marine mammals likely to be found in the waters around Bonaire

Sharks and rays

An estimated 33 species of elasmobranch are believed to be present in the Dutch Caribbean (Table 9), consisting 28 species of sharks and 5 species of rays (van Beek et al., 2012). There is no dedicated shark fishery on Bonaire, but when fishers catch a shark, they often kill it and throw it back in the water as a deterrent to other sharks.

Common name	Scientific name	IUCN Red List
Family: Whale sharks - Rhincodontidae		
Whale shark	<i>Rhincodon typus</i>	Endangered
Family: Nurse sharks - Ginglymostomatidae		
Nurse shark	<i>Ginglymostoma cirratum</i>	
Family: Requiem sharks - Carcharhinidae		
Caribbean reef shark	<i>Carcharhinus perezi</i>	
Blacktip shark	<i>Carcharhinus limbatus</i>	
Lemon shark	<i>Negaprion brevirostris</i>	
Bull Shark	<i>Carcharhinus leucas</i>	
Tiger Shark	<i>Galeocerdo cuvier</i>	
Oceanic white-tip shark	<i>Carcharhinus longimanus</i>	Critically endangered
Silky shark	<i>Carcharhinus falciformis</i>	Vulnerable
Blue shark	<i>Prionace glauca</i>	
Blacknose reef shark	<i>Carcharhinus acronotus</i>	
Brazilian Sharp-nose Shark	<i>Rhizoprionodon lalandii</i>	
Caribbean Sharp-nose Shark	<i>Rhizoprionodon porosus</i>	
Family: Hammerhead sharks - Sphyrnidae		
Smooth hammerhead	<i>Sphyrna zygaena</i>	
Scalloped hammerhead	<i>Sphyrna lewini</i>	Endangered
Greater hammerhead	<i>Sphyrna mokarran</i>	Endangered
Bonnethead shark	<i>Sphyrna tiburo</i>	
Hammerhead unspecified	<i>Sphyrna sp.</i>	
Family: Mackerel sharks - Lamnidae		
Shortfin mako	<i>Isurus oxyrinchus</i>	Vulnerable
Family: Thresher sharks - Alopiidae		
Thresher shark	<i>Alopias vulpinus</i>	Vulnerable
Bigeye thresher	<i>Alopias superciliosus</i>	Vulnerable
Family: Six/sevengill sharks - Hexanchidae		
Big-eyed sixgill shark	<i>Hexanchus nakamurai</i>	
Family: Sawfishes - Pristidae		
Smalltooth sawfish	<i>Pristis pectinata</i>	Critically endangered
Family: Dogfish sharks - Squalidae		
Cuban dogfish shark	<i>Squalus cubensis</i>	

Family: Kitefin sharks - Dalatiidae		
Cookiecutter shark	<i>Isistius brasiliensis</i>	
Family: Lantern sharks - Etmopteridae		
Lined lanternshark	<i>Etmopterus bullisi</i>	
Family: Houndsharks - Triakidae		
Houndshark unspecified	<i>Triakis sp.</i>	
Family: Catsharks - Scyliorhinidae		
Hoary catshark	<i>Apristurus canutus</i>	
Boa catshark	<i>Scyliorhinus boa</i>	
Family: Stingrays - Dasyatidae		
Chupare stingray	<i>Himantura schmardae</i>	
Bluntnose stingray	<i>Dasyatis say</i>	
Spotted eagle ray	<i>Aetobatus narinari</i>	
Southern stingray	<i>Dasyatis americana</i>	
Family: Manta/devil rays - Myliobatidae		
Giant manta ray	<i>Manta birostris</i>	Vulnerable

Table 9: Shark and ray species of the Dutch Caribbean



Birds

More than 170 species of birds have been recorded on Bonaire, which is of global importance for its resident, breeding and migratory waterbird populations including American Flamingo (*Phoenicopterus ruber*). The flamingos fly to mainland Venezuela to feed in lagoons along the coast of the state of Falcón where hundreds are regularly seen but are not known to breed. The movements of the flamingos within the island and to-and-from mainland Venezuela are poorly known and warrant further research. Bonaire supports significant populations of breeding terns (*Sterna sp.*), including the Cayenne form of Sandwich Tern (*S. sandvicensis eurygnatha*), primarily within Ramsar sites Klein Bonaire (IBA AN012), Washington Slagbaai (IBA AN009) and Pekelmeer (IBA AN014) (Wells & Debrot, 2008). Least terns (*Sternula antillarum*) nest along Bonaire’s exposed windward shore.

Lac Bay is a habitat for flamingos, frigate birds, herons, and pelicans. It is also a roosting site for the endemic sub-species Yellow-Shouldered Amazon (*Amazonia barbadensis*) (Wells & Debrot, 2008). The annual average number of flamingos is an indicator for the health of salt lakes and wetlands. Bonaire has a relatively small, but regionally important, population which since the early 1980s has been stable (Figure 23). Threats facing the birds of Bonaire include habitat loss through development and pollution, predation by invasive cats and rats and disturbance by users.

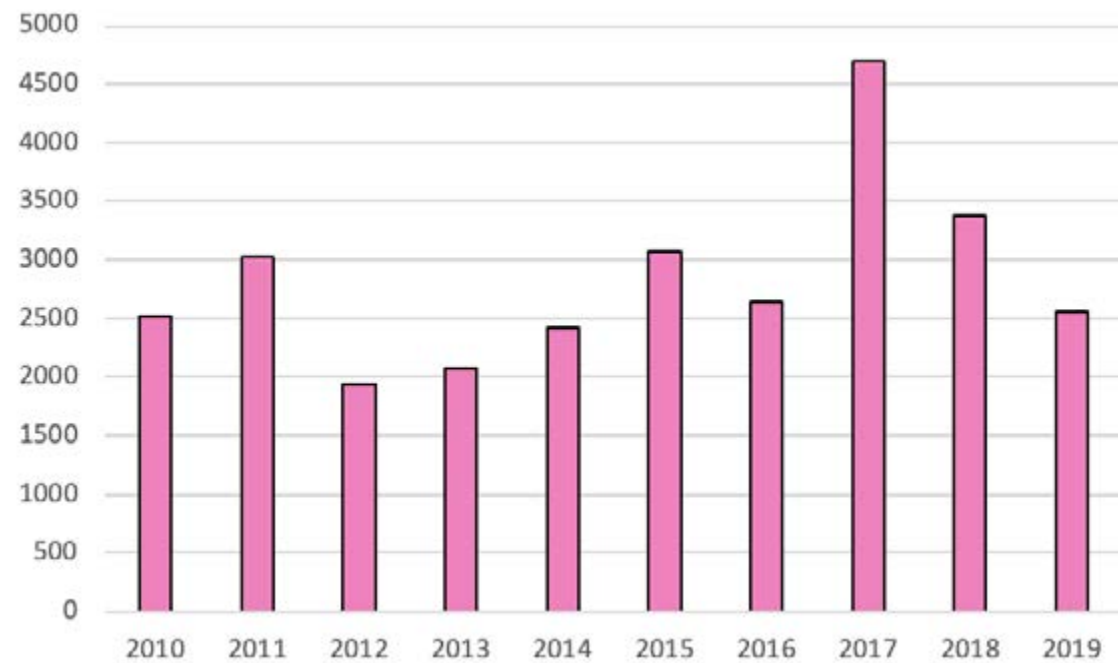


Figure 23: Flamingo numbers since 2010 (CBS 2020)

Sea turtles

Three species of sea turtle are found frequently in Bonaire’s waters: Loggerheads (*Caretta caretta*), Hawksbills (*Eretmochelys imbricata*), and Green Turtles (*Chelonia mydas*). Sightings of Leatherbacks (*Dermochelys coriacea*) and the Olive Ridley (*Lepidochelys olivacea*) have also been documented. Turtles are frequently sighted by divers and snorkelers throughout the marine park. Lac Bay and Klein Bonaire are of particular importance for foraging, and in the case of Klein Bonaire nesting (Figure 24). Bonaire typically produces 10,000 hatchlings per year.

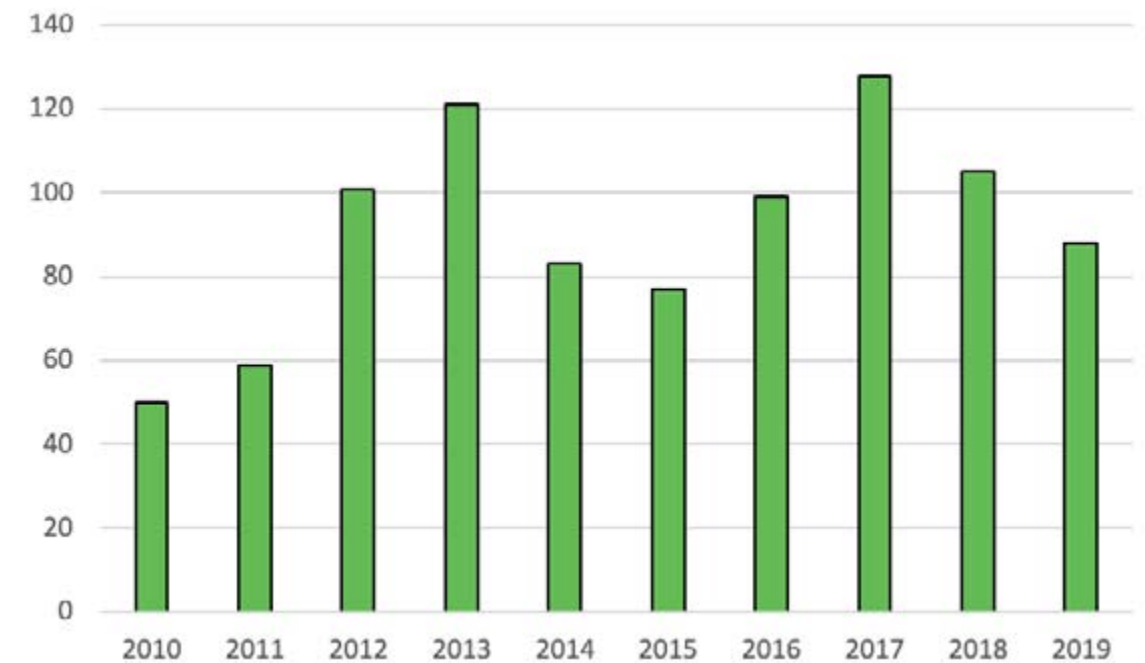


Figure 24: Turtle nest numbers (STCB in CBS 2020)

Sea Turtle Conservation Bonaire (STCB) is a non-governmental, non-profit foundation established in 1992 and dedicated to the conservation on sea turtles. Much of the following information comes from stakeholder consultation with Sea Turtle Conservation Bonaire (STCB) in 2021.

Lac Bay

Lac Bay is a critical foraging area for green turtles. There are around 500 resident green turtles within Lac Bay, which move between the reef and bay.

Threats	Notes
Invasive seagrass	STCB has noted a diminishing growth rate of the green sea turtles within Lac Bay. One possible explanation is that the invasive seagrass <i>Halophila stipulacea</i> . This species has a lower nutritional value than native <i>Thalassia testudinum</i> and is becoming more common within the bay.
Ghost nets	Turtles can become ensnared in trailing lines and ghost nets.
Fishing	Discarded fish sometimes have hooks left in them which are ingested by turtles Some trampling of seagrass occurs.
Water quality	The effect of poor water quality is not well understood but a significant number of turtles suffering from Turtle fibropapillomatosis were observed at Lagoen.
Sargassum	The effect of sargassum inundations on sea turtles is poorly understood.
Hydrofoils	Hydrofoils can cause lethal damage to turtles and there have been incidents of turtles being struck and injured in Lac.

Table 10: Threats to sea turtles in Lac Bay

**Klein Bonaire**

Klein Bonaire is the most important nesting area on Bonaire (50-70 percent of total nests) and has some foraging areas. Six to seven thousand hatchlings per year are recorded on Klein Bonaire. Nesting areas on Klein Bonaire are mostly concentrated over a 2 km stretch centered on No Name Beach (500 m to the right and 1500 m to the left).

Threats	Notes
Trampling nests	Barriers to be placed around nests on No Name beach to prevent trampling.
Garbage	Turtles are known to eat plastic bags, mistaking them for food
Water quality	The effect of poor water quality is not well understood

Table 11: Threats to sea turtles at Klein Bonaire

Other parts of the Bonaire National Marine Park

Sea turtles are often seen feeding and passing through near shore environments. Nests are sometimes found on the beaches around Bonaire. Additional information is available in the STCB annual report 2021.

Pressure	Notes
Fish hooks	Turtles feed on discarded fish remains which may have hooks still in them).
Jet skis	Jet skis are placed in the water by driving trailers over the beach which threatens nests. High speeds of jet skis are also an issue in shallow areas (turtle strikes).
Foils	Hydrofoils can cause lethal damage to turtles as they are unlikely to hear their approach.

Table 12: Threats to sea turtles in the Bonaire National Marine Park

Invertebrates

The most abundant hard corals on shallower reefs include Mustard Hill coral (*Porites astreoides*), Brain coral (*Diploria sp.*), various forms of Star coral (*Montastraea and Orbicella sp.*), Pencil coral (*Madracis sp.*), Flower coral (*Eusmilia fastigiata*), Maze coral (*Meandrina meandrites*), Pillar coral (*Dendrogyra cylindrica*) and the blade form of Fire coral (*Millepora complanata*). In deeper areas and on the reef slope, the coral communities are dominated by plate corals (*Agaricia sp.*), soft corals such as seafans and Wire corals (*Ellisella sp.*). Other coral species often found include gorgonians such as Seafans, Seaplumes, Sea Rods, Sea Whips and, at depths in excess of 20 m, Black coral (*Antipathes sp.*).

Aside from corals, the marine park includes a variety of sponges such as Giant Barrel sponges (*Xestospongia muta*), Stove-pipe sponges (*Aplysina archeri*), Azure Vase sponges (*Callyspongia plicifera*), Ball sponges (*Cinachya sp.*), and Elephant Ear sponges (*Agelas clathrodes*).

Countless other invertebrates inhabit the reefs including Conch, Brittle stars, Magnificent Sea Urchins (*Astropyga magnifica*), Zooanthids, Crinoids, Brittle stars, Corkscrew Anemones (*Bartholomea annulata*), Giant anemones (*Condylactis gigantea*), Spiny Lobsters (*Panulirus argus*), Arrow Crabs (*Stenorhynchus seticornis*), Decorator Crabs (*Microphrys bicomuta*), Caribbean Reef Squid (*Sepioteuthis sepioidea*), Caribbean Reef Octopus (*Octopus briareus*), and Lettuce Sea Slugs (*Tridachia crispate*). In 2017, a new species of Hermit Crab was discovered in the marine park: the Candy Striped Hermit Crab (*Pylopaguropsis mollymullerae*) (Lemaitre, 2017).

CULTURAL HERITAGE

Most of the underwater artefacts and archaeological sites around Bonaire, particularly along the length of the leeward shore, were systematically plundered in the 1950s by treasure hunters. The remains of numerous shipwrecks still litter the reefs along the windward shore, but they are difficult to locate. There is no systematic documentation of wrecks and remains and no new archaeological sites have as yet been identified in the marine park.

The Windjammer Wreck

The Windjammer was one of a series of three-mast iron ships, each designed for speed on the long-haul shipping lanes transporting goods between England and India for the MacIntyre Company. Built in Glasgow, Scotland in 1874 by Barclay, Curl and Company, it measured 239 ft, weighed 378 tons and had a 37 ft beam. Nicknamed the Windjammer, the ship officially sailed under the name the Mairi Bhan, Gaelic for “Bonnie Mary” (Serafini & Salisbury, 2020). On December 12, 1911, a storm blew the ship onto the reef on the northern lee shore in front of what was the BOPEC oil transshipment facility. Having been stripped of useful parts first by the crew and then by islanders, in 2012 it was rolled into deeper water by storm waves and came to rest in 160 ft of water.

Hilma Hooker Wreck

The Hilma Hooker is a 236 ft Dutch freighter built in Krimpen aan den IJssel, the Netherlands. It was originally christened the Midland on May 20, 1951. It was re-registered and re-named a number of times. In 1984, the ship was searched by authorities, who found 25,000 pounds on marijuana on board. The ship was not claimed and harboring the ship became difficult. It was moved to anchorage near Angel City Dive site. On 12 September 1984, the ship began taking on water. Its pumps had failed, and the Hilma Hooker sank.

Klein Bonaire

There are a number of buildings, old stone walls, a well and a quarantine hut on Klein Bonaire. These hark back to a time when Klein Bonaire was a plantation, used primarily for goat grazing. The shell of the supervisors house still stands and the old stone walls dividing the land are still visible. Stories abound about the last time that the quarantine hut was used in earnest. Charcoal was produced on Klein Bonaire and the charcoal circles are still clearly visible along the southern shore.

Salt pans and slave huts

By 1837, Bonaire was a thriving center of government-controlled salt production. The abolition of slavery in 1863 signaled an end to this era of exploitation. The slave huts, which were used to house slaves during the working week, and the salt pans, which were constructed by hand, still exist and are an important historical relic.

Conch piles at Lac Cai

The conch shell piles at Lac Cai were historically added to by conch fishers in Lac Bay and from Los Roques archipelago. These have some historical value as a vision into the past productivity in the Bay. Locally it is believed that it was fishers from Venezuela who build the conch piles and their overexploitation of the bay lead to the collapse of the conch fishery.

Archeological sites

Amerindian encampments have been found dotted around Bonaire. The conch middens and other artefacts adjacent to the old Marcultura building at Sorobon were destroyed by sand mining. Conch middens can be found on the islands at the back of Lac Bay, as are conch midden in the mangroves surrounding Lagoen. Most recently Indian artefacts were found at saliña Slagbaai.



ECONOMY

The expenditure by tourists on Bonaire has been calculated at around USD 125 million annually, an estimated USD 50 million is contributed by Bonaire's nature (Figure 25). Stay-over tourists contribute more to the economy than cruise tourists, and marine ecosystems are more economically significant than terrestrial ecosystems on the island (Wolfs et al., 2015).

The island population as well as tourists consume locally caught fish, predominately pelagic fish which are caught outside of the marine park. Within the marine park Big-eye scad (*masbango*) are caught using encircling nets (*reda*), and the fish are frequently sold on Curaçao, where they command a higher price. The reef-related total commercial fisheries are valued at almost USD 400,000 annually. The recreational fishery value is estimated at an economic value of almost USD 700,000 per annum (Wolfs & van Beukering, 2013b).

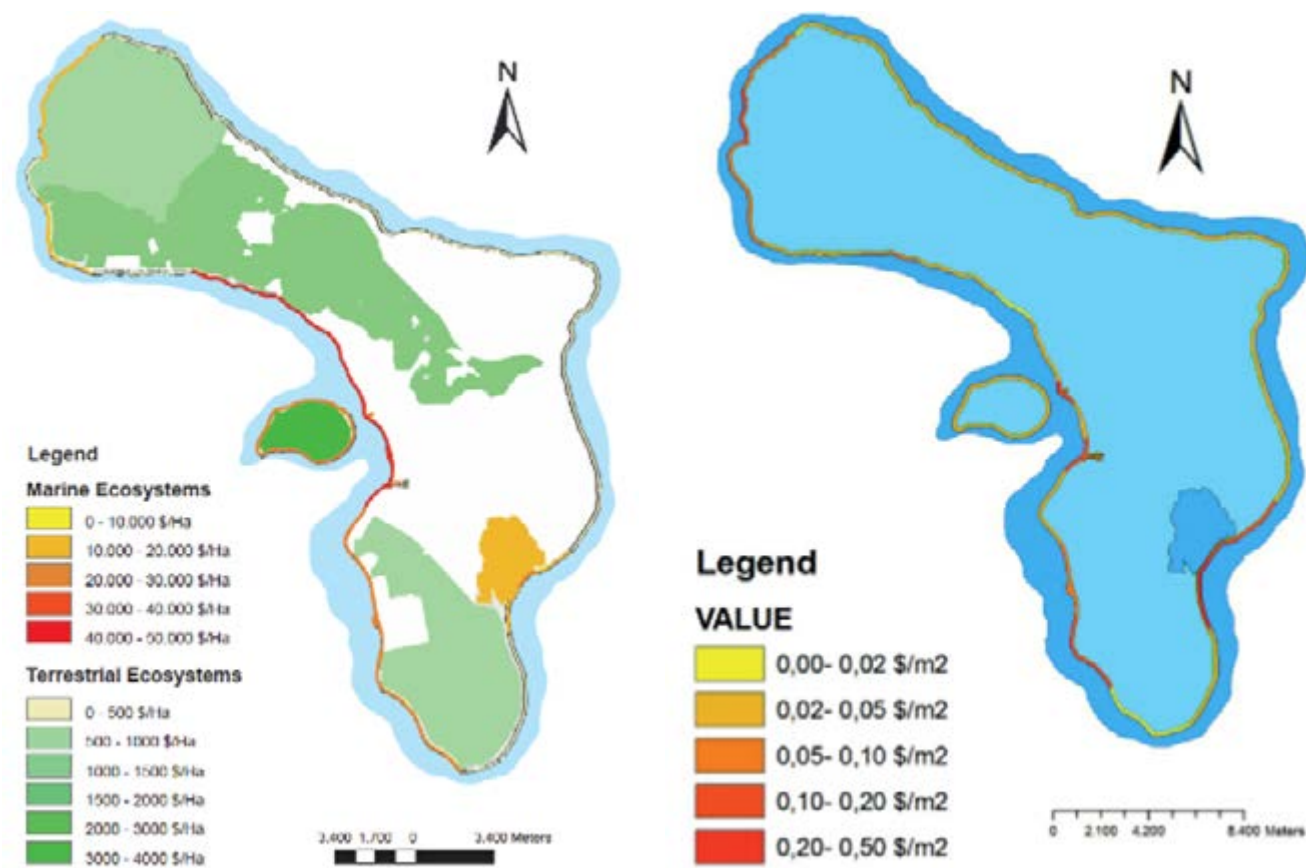


Figure 25: Economic value of marine and terrestrial ecosystems of Bonaire (left). Value of fisheries around Bonaire (right) (Wolfs & van Beukering, 2013a).

OTHER VALUES

Cultural

The island's coral reefs are considered part of the island's cultural identity and cultural heritage, reflected in the Tourism Corporation Bonaire's 2022 publicity campaign with the slogan, "It's in our nature".

Recreation

Bonaire's nature and particularly the coral reef ecosystems are the main reason tourists choose Bonaire as their vacation destination. Tourists come to dive, snorkel and participate in watersport activities. Islanders love to fish from shore or from small boats. Areas such as Lac Cai and Sorobon have a very strong appeal as weekend leisure destinations.

The marine environment of Bonaire is unique in the Caribbean being one of only four true oceanic islands separated from the South American mainland by a deep-water trench. The marine park on Bonaire, which was established in 1979 and has been under continuous active management since 1991, is recognized as a National Park by the Netherlands and as a Demonstration site by UNEP (United Nations Environment Program) and ICRAN (International Coral Reef Action Network). It includes 2,700 ha of globally threatened coral reef, seagrass beds and mangrove forests. Bonaire's reefs are considered some of the healthiest in the Caribbean according to data from the Atlantic and Gulf Rapid Reef Assessment (AGRR) initiative. Bonaire's marine environments include four RAMSAR sites and are home to globally endangered species including 75 critically endangered, endangered or vulnerable on the IUCN Red list, 15 species on CITES Appendix I and 250 on CITES Appendix II. Approximately three quarters of the park is recognized as an Important Bird Area (IBA) by BirdLife International.

Box 4: Bonaire National Marine Park statement of significance.



5 | USERS

Use of the marine park can be broken down into various sectors (Table 13).

Industry	Fishing	Recreation	Other
Salt production	Commercial	Diving	Science
Shipping	Sport fishing	Snorkeling	Education
Water desalination	Recreational fishing	Windsurfing	
[Oil transshipment]	Artisanal fishing	Kitesurfing	
		Kayaking	
		Boating	
		Other: including beach use and swimming	

Table 13: Main user groups for the Bonaire National Marine Park

INDUSTRY

Salt production

Salt production is the oldest surviving industry on Bonaire. Salt ponds cover 10 percent of Bonaire's surface, at Pekelmeer, on the southern tip of the island. Cargill Salt Company produces around 441,000 tons (400,000 metric tons) of salt per year. The salt ponds are gravity fed. Sea water is pumped into the solar salt works and takes approximately one year to crystalize. Brine is periodically discarded into the marine park on the lee shore.

Shipping

Shipping lanes traverse the marine park (Figure 26) providing access to commercial piers located in Kralendijk (Town Pier, Customs Pier), a fueling dock in front of the WEB water desalination, in front of the Cargill Salt Company main entrance (Saliña Pier) a bulk salt loading facility, and formerly to the BOPEC oil transshipment facility. Pilotage is compulsory for all vessels over 50 gross registered tons and only clean, clear oceanic ballast water taken from at least 12 miles offshore is permitted. Vessels without clean, clear oceanic ballast water are refused docking.

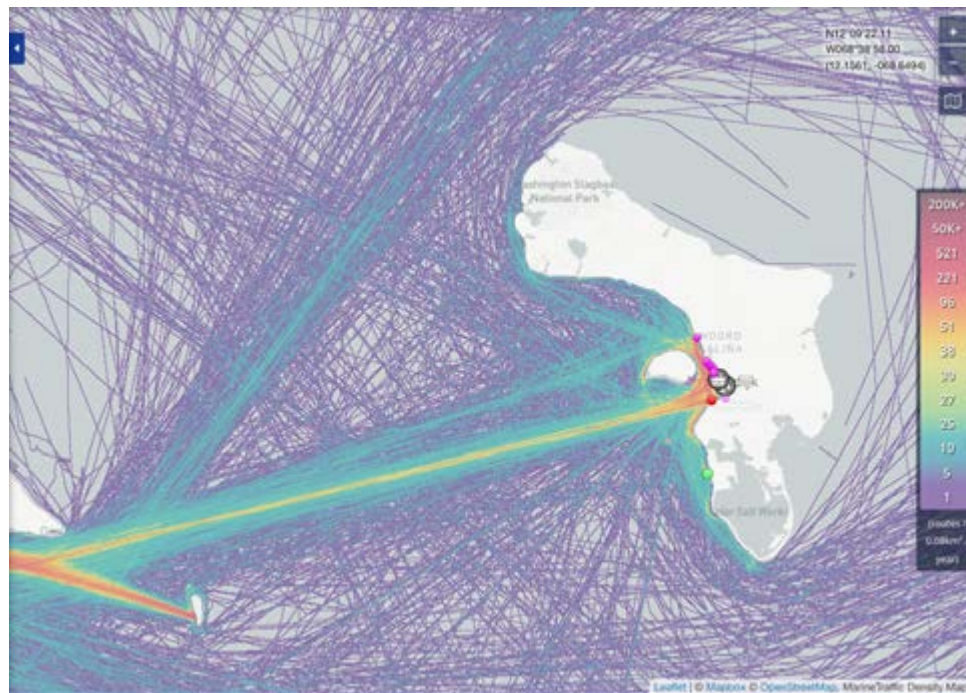


Figure 26: Density of shipping traffic in 2021 (www.marinetraffic.com). Vessels include cargo, tankers, tugs and special craft, pleasure craft, fishing vessels, container ships and gas carriers

Water desalination

The production of drinking water on Bonaire is managed by *Water- en Energiebedrijf Bonaire* (WEB). Sea water is pumped out of the marine park and a reverse osmosis process is used to press seawater through a membrane under high pressure filtering the water and removing all residue and salts. Next, the water passes through a second membrane and becomes extremely pure. Finally, water passes through lime filters to add calcium. No fluoride is added to drinking water on Bonaire. WEB is the only supplier of fresh water on Bonaire and currently produces over 1,600 m3 of drinking water per day. A by-product of reverse osmosis is concentrated brine which is discharged back into the marine park.

Oil transshipment

In September 1975 the Bonaire Petroleum Corporation (BOPEC) built an oil transfer facility with a deep-water port and facilities for transferring oil from ocean-going to coastal tankers. The terminal ceased to function as a storage and trans-shipment facility for crude oil and derivatives in 2020 when the company filed for bankruptcy.

FISHING

Fishing activities include commercial fishing, sport fishing charters, recreational and artisanal fishing. Commercial fishing boats and sport fishing charters generally operate outside of the marine park boundaries although they will frequently trawl for fish along and within the park boundaries. Recreational and artisanal fishing are conducted primarily within the marine park (MacDonald, 2019).

Fishing practices in the marine park are regulated by law (Art. 10 *Eilandsbesluit Onderwaterpark Bonaire* and Art. 11 *Eilandsbesluit Onderwaterpark Bonaire*). Regulations restrict fishing practices, regulate the use of traditional fishing methods including the use of *trai* (caste nets), *reda* (encircling nets), *kanaster* (fish traps) and zoning to accommodate snorkel fishing.

Commercial fishing

There are less than 30 commercial fishers operational on Bonaire of whom 15 to 20 fish on a regular basis. Commercial fishers use the pier at Sorobon and the Fishermen's Pier in front of Kralendijk to moor their boats which they use to fish in pelagic environments outside of the marine park. Popular areas are Red Slave, Spelonk and Malmok. Commercial fishers trawl and handline for fish and primarily target tuna, wahoo, mahi-mahi and marlin along with jacks and barracuda. Commercial fishing takes place almost exclusively beyond the boundaries of the marine park. Most commercial fishers belong to the fishers' co-operative PISKABON.

Overfishing of Bonaire's territorial waters by Bonaire based commercial fishers does not seem to be a potential problem. However, fishers report that their catch diminishes significantly after long liners and trawlers have been seen around the island. Formerly these involved Venezuelan fishing vessels long-lining and in this context, it is also important to note that in addition to pelagic fish, globally endangered sea turtles, sea birds and dolphins are threatened by these illegal fishing activities.

Sport fishing

There are an estimated five sport fishing businesses operational on Bonaire. Charter boats take visitors fishing for pelagic fish outside of the marine park. Boats are generally moored at the Club Nautico Pier or berthed at the Plaza Marina or Harbour Village Marina. Sport fishers trawl for fish and target the same species as commercial fishers as well as jigging for Queen Snapper, Red Snapper, Amberjacks and

Barracuda. There are two fishing businesses, which organize flyfishing in Lac Bay and (illegally) on the Cargill Salt Company property, targeting game fish including Bonefish, Pompano, Cubera snapper and Barracuda. Currently most sport fishing is conducted by businesses which do not have nature permits. It is important to work with the Island Government to change this.

Recreational and artisanal fishing

Recreational fishing plays an important role in the culture of Bonaire and is generally conducted from small boats (> 12 ft) in inshore waters or from the cliff or water’s edge where fishers use a baited hand line to catch reef fish. There are only one or two residents who fish full time. Most fishers have alternative sources of income.

Snorkel fishing has become common practice, targeting small grouper such as Red Hind (*purunchi*), and as a consequence it has been restricted to a small area on the lee shore. Recreational fishing is not regulated through permitting. Some fishers use Lac Bay as their fishing grounds. Chinese and Arab communities are active fishers, often targeting marine resources not caught by other islanders including a variety of reef fish, crabs and echinoderms.

There are around eight fishermen who fish on a regular basis in Lac Bay. Fishers use nets (*reda*) as well as hook and line. They are quick to report foreign fishing vessels and are helpful at removing turtles from nets. There is a small but persistent problem with the illegal harvesting of conch, which is sufficient to keep conch populations from recovering from historical overfishing. Fishers in Lac Bay target grunt, snappers, jacks and barracuda. Parrotfish are used for bait. In the past mangrove oyster (*Crassostrea sp.*) were heavily harvested from the mangrove channels.

Aside from spearfishing, which is prohibited on Bonaire, the traditional fishing practice which has had the greatest impact on fish populations is the use of fish traps (*kanaster*). This has largely been abandoned by fishers on Bonaire. The use of hook and line is preferable to the use of nets and snorkel fishing. Regular clean ups are needed at popular fishing sites to remove lost hooks and lines. Use of casting nets (*reda*) needs to be well regulated and these may not be used in the vicinity of piers as this causes rapid depletion of Bigeye scad (*Selar crumenophthalmus*). Attempts were made in the past to set up mooring points for fishers at bait fishing sites to provide an alternative to the use of stone anchors, but these were unsuccessful.

Many recreational fishers dive from shore and snorkelfish in areas where fishing is not permitted. The regulation of fishing activities by non-residents is also important.

RECREATION

Ten hotspots for recreation were identified through stakeholder consultation (Table 14, Figure 27).

Commercial businesses supplying recreational activities which take place in the marine park include:

Twenty-eight registered dive operators, most of whom are authorized to supply compressed air and all are authorized to provide scuba diving services.

- Fifteen sailing and snorkel tour companies.
- Four windsurf companies.
- Four kitesurfing companies.
- Four boat rental companies.
- Five kayak tour companies.
- Three water taxi businesses.

Within the watersport sector, wind related watersport (windsurfing, kiting and more recently foiling) have become increasingly popular and benefit from year-round trade winds. Lac Bay, a semi-enclosed bay and Ramsar site on the windward shore, is an internationally recognized windsurfing destination. Kitesurfing became established through the early 2000s on the southwest coast of Bonaire at Atlantis (called ‘Kite Beach’). Bonaire has been featured as an outstanding destination for kite surfing in several international publications and the kite surfing community has hosted several international events. A recent trend in the watersport sector is the use of foils, these are special fins with a wing like structure, lifting the riders out of the water, reducing friction, allowing the board or vessel to move faster and with less effort. These are used on Bonaire by windsurfers, kite-surfers, stand up paddle foilers, wing foilers, e(lectric)-foilers. STINAPA is in the process of putting strict controls on the use of foils to protect the marine environment and safeguard the safety of park users.

Hotspots	Main users	Impact
Karpata	Divers and snorkelers	Physical contact with the reef
1000 Steps	Divers, snorkelers, beach lovers	Physical contact with the reef
Chachacha	Swimmers and beach lovers	
Te Amo / Donkey Beach	Beach lovers, snorkelers, divers, party goers	Littering
Bachelors Beach	Beach lovers, snorkelers, divers, party goers	Littering
Pink Beach	Beach lovers, snorkelers, divers	
Kite Beach	Kite surfing	
No Name Beach (Klein Bonaire)	Diving, snorkeling, beach lovers	Human waste, littering, trampling turtle nests
Lac Cai (Lac Bay)	Kayakers, beach lovers, party goers	Trampling of seagrass and littering
Sorobon (Lac Bay)	Windsurfers, beach lovers, fishers, kayakers	Trampling of seagrass and littering

Table 14: Tourism hotspots in the Bonaire National Marine Park



Figure 27: Tourism hotspots in the Bonaire National Marine Park

Dive operations	
4-Wheel Diving	
AB Dive	
Aqua Fun Bonaire	
Bas Diving	
Beyond the Corals	
Black Durgeon Inn and Scuba Centre	
Bon Bini Reef Experience Dive Centre	
Bonaire East Coast Diving	
Bonaire from the Sea	
Bonaire Scuba and Island Activities	
Bonscuba	
Bruce Bowker's Carib Inn	
Buddy Dive	
Buddy Dive at Belmar	
Captain Don's Habitat Dive Operation	
Carib Inn	
Dee Scarr's Touch the Sea	

Div'Ocean
Dive Diva Bonaire
Dive Factory
Dive Friend Bonaire (8 locations)
Divi Dive Bonaire
Epic Tours
Exclusive Diving Bonaire
Flamingo Diving
Great Adventures Bonaire
Harbour Village Dive
Private Divers Bonaire
Sea Donkey Diving
Stay and Dive
TDS
The ScubaDuo
Toucan Diving
Tropical Divers Bonaire
Twilight Diving

VIP Diving
Wannadive Bonaire
Xprodiver
Kayaking
Caribe Watersports and Kayak Tours
Eye Sea Bonaire
Kayak Tours Bonaire
Mangrove Kayak Centre
Ohana Clear Canoe
Outdoor Bonaire
Salty Tours Bonaire
Tropical Travel Bonaire
Windows to the Sea Kayaking
Water taxis
Caribe Water Taxi
Club Nautico Water Taxi
Epic Water Taxi
Sea Cow Water Taxi
Boat rental
BlueBay Rentals
Bonaire Boat Rental
Chogogo Boat Rental
Rainbow Runner Boat Rental
Sunrides Bonaire
Sailing tours
Aqua Fun Bonaire
Bon Bini Luxury Boat Tours
Bon-Sea Bonaire
Bonaire from the Sea
Caribe Watersports and Sailing
Compass Sailing Bonaire
Eye Sea Bonaire
Land and Sea Tours
Mako Tours Bonaire
Melisa Sailing
Rainbow Runner fishing trips
Samur Sailing
Serwanda Bot Adventure
SoloBon Sailing
Tropical Travel Bonaire
Watersports Lucky 7
Woodwind

Kitesurfing
Bonaire Kiteschool
Chogogo Kite
Kiteboarding Bonaire
Windsurfing
Bonaire Windsurf Place
Dunkerbeck Pro Centre
Jibe City
The Frans Paradise
Fishing Charters
Aqua Fun Bonaire
Bonaire Boat Rentals
Fishtales Bonaire
Flying Fish Charters
Le Grand Bleu
Piscatur Fishing Charters
Rainbow Runner Fishing trips
Salty Tours Bonaire
Watersports Bonaire Lucky7
Other
Blue Classroom Freediving
Mermaid Bonaire School
Bonaire Freediving School
Deep Sea Freediving
Paddle Adventures Bonaire
Seacow Snorkelling Bonaire
Windows to the Sea Snorkelling
Technical Diving Services
H2O Visions - snorkeling
Paradise Adventures - snorkeling
Aquaspace
Ocean Oasis Beach Club
Sebastian's Beach
The Beach Windsock
Horse Ranch Bonaire
Waterfront resorts
Sorobon Boutique Hotel
Beaches Ocean View Apartments
Delfins Beach Resort
Bonaire Lighthouse Beach Resort
The Bellafonte Luxury Ocean Front Hotel
Belaire

BelMar Oceanfront Apartments	Elegancia del Caribe
The Bonairian	Bonaire Seaside Apartments
Courtyard Marriot	Playa Lechi Residence
Ocean Breeze Boutique Hotel	Harbour Village Beach Club
Van der Valk Plaza Resort	Eden Beach Resort
Caribbean Court apartments	Chogogo Dive & Beach Resort
Seaside Port Bonaire	Den Laman Condominiums
Dive Inn Bonaire	Sand Dollar Condominiums
Bruce Bowker's Carib Inn	Buddy Dive Resort
Divi Flamingo Beach Resort	Hamlet Oasis Resort
Chachacha Beach Apartments	Captain Don's Habitat
TerraMar Ocean Front Apartments	Coral Paradise Resort
Bonaire Ocean Front Apartments	Black Durgeon Inn
Seaside Apartments	One Ocean

Table 15: Summary of tourism operators in the Bonaire National Marine Park

Watercraft

Many motorized craft use the marine park for recreational purposes, this includes dive and snorkel boats, yachts (private and charter), motorboats (private and hire) and jet skis. The captains of vessels operating within the marine park, including vessels being used commercially, are at present not required to hold a captain's license or any other form of competency certification other than a VHF Radio Operators license. In addition to the commercial use of public moorings, private vessels make often use the public moorings at Andrea, Te Amo and No Name beach.

Non-motorized crafts include hydrofoils, kayaks and Stand-Up Paddleboards (SUPs). Kayaks are used mainly within Lac Bay and occasionally at other sites on the leeward shore.

Jet skis are placed in the water by driving trailers over the beach, which can negatively impact turtle nests. High speeds of jet skis and foils in shallow water create a safety issue for other users and can cause lethal damage to turtles.

Windsurfing

Bonaire's year-round constant trade winds make it an ideal location for all wind related sport, such as wind and kite surfing. Lac Bay has traditionally been the most popular site for windsurfing on Bonaire.

Kite surfing

Kite surfing can currently only be conducted at Kite Beach on the southern lee shore. Most of the people taking part in kite surfing are visitors. Many bring their own equipment. Kite surfing equipment is expensive and degrades quickly in the sun. Kite surf businesses focus predominately on teaching. Stakeholders estimate that daily around 50 to 100 individuals are given lessons. Another 60 to 120 recreational kilters use the space at Kite Beach, with more than 50 kites using the area at any given time. Kite surfing has grown in popularity since 2000 and requires shore side space for participants due to the 20-24 m lines used to attach the rider to the kite. A large area is also required for the kites to be launched. There are 18 small rescue boats at Kite beach, with one in the water for safety at all times.



Adjacent to Kite Beach are two dive sites, as well as the Fishermen's Hut, which is used as a weekend getaway by fishers. There are frequent conflicts between kite surfers and other marine park users. Kite surfing groups feel that kiteboarding is good for the environment and could provide a responsible way to expand tourism.

Sailing

There are 15 companies which provide sailing charters, including popular sunset sails. Most additionally offer snorkel charters and guided snorkeling activities. Much of the focus of their activities is in mid channel and at No Name Beach on Klein Bonaire, where competition for moorings is high. Bare back sailing charters, where guests crew the vessel, are not offered on Bonaire.

Diving and snorkeling

Bonaire is recognized around the world as a top destination for SCUBA diving, with sites for all levels of diving skill and ability. However, the importance and popularity of SCUBA diving in the USA is declining, and the Tourism Corporation Bonaire is actively marketing Bonaire as a more all-round destination. Bonaire hosts around 40,000 divers annually who stay from one to three weeks, diving typically two to four times a day. There are over 85 official dive sites around Bonaire and on Klein Bonaire, most of which have moorings and some 54 of which are accessible as shore dive sites.

More remote dive sites north of Goto Lake are less frequently visited due to the journey time and associated fuels costs. South of Goto Lake, to the southern tip of Bonaire, the leeward shore offers the most accessible diving with the wreck dive at Hilma Hooker being particularly popular. Other popular dive sites include the house reefs in front of dive operations, 1000 Steps and Karpata, the double reef stretching south from Angel City, as well as the dive sites around Klein Bonaire. No figures are currently available to assess dive site use. The Windjammer wreck in the north is not marked, does not have an adjacent public mooring and is only suitable for use by technical divers.

Beaches and shoreline

An unknown number of residents and tourists make use of Bonaire's beaches on a regular basis. Most popular with cruise boat passengers are Sorobon, Bachelors Beach, Donkey Beach, Te Amo and No Name Beach on Klein Bonaire, and these sites are overrun on days when cruise boats are in port.

MARITIME FACILITIES

The current state of both commercial and recreational maritime facilities is a limiting factor for economic activity. Slipways are woefully inadequate, poorly located and many are too steep to be easily used. Recreational and industrial activities are mixed, facilities for yacht crews to dock their dinghies are limited. The availability of public moorings is a regular source of conflict amongst users, particularly for moorings around No Name beach on Klein Bonaire. Stakeholders voiced concerns about the need to address this issue urgently.

STINAPA is committed to assist fishers obtain adequate slipways and moorings for their vessels. A reservation system is needed for public and overnight moorings to better manage use and avoid user conflict. New contracts for private and overnight moorings need to be implemented to better control use.

An inventory of maritime infrastructure for Bonaire was made in 2014 by *Rijkswaterstaat*. While both Rijkswaterstaat and the Island Government have access to this information, STINAPA has not been consistently provided with copies of permit applications or information on permits. Whilst STINAPA is often referred to when a facility is in poor state of maintenance, it is not responsible for the maintenance of maritime facilities.

A point of concern for some years has been the discharge of untreated wastewater by visiting yachts into the marine park. Together with WWF and partners, STINAPA is committed to the installation of a shore side pump-out facility to be located at the Harbour Village Marina (van Erp, 2021).

Industrial facilities

There are several industrial harbor areas within the marine park, including seven commercial piers:

- Cargill Salt Bonaire has a commercial pier (Saliña Pier or Salt Pier) which is used to export salt from their property.
- Oil Trading Bonaire (OTB) has a jetty near the airport (Airport Pier) built in May 2001 that is mainly used to supply jet plane fuel supply (kerosine) to the Flamingo Airport.
- In front of the main town, Kralendijk, the Town Pier (North Pier) was renovated in 2019 and is used primarily by cruise ships. The Customs Pier (New Pier) is used by cruise vessels and larger cargo vessels with a Ro-Ro ramp used by supply vessels.
- A jetty in front of the water utility company, WEB, to the north of Hato is used as a fueling dock (the island's main drinking water production plant is also situated in this area and has its intake right next to the jetty; this area is also used by the largest and oldest scuba diving resorts on the island).
- Two 'T-head' jetties in front of BOPEC were used to transship oil products, including various grades of crude oil and refined oil including orimulsion.

Bonaire has been granted a number of exemptions from international law in relation to marine waste management. These include:

- The Harbor Master may change a ship's route to empty ballast beyond territorial waters.
- IMO acknowledged that Bonaire should be granted an exemption from accepting trash from visiting ships due to the small size of the island.

Marinas

There are two inshore marinas within the marine park:

- Plaza Marina: located in the Flamingo Paradise adjacent to Plaza Hotel with 30 slips for yachts over 30 ft and a planned expansion with 68 slips.
- Harbour Village Marina: at the Harbour Village resort with 80 slips and a fueling station and pump out facility.
- In addition, Club Nautico in Kralendijk has 12 slips on an open dock

Access points and slipways

The main maritime facilities providing access to the marine park users are:

- Boat entry/slipway and moorings Playa Frans.
- Fishermen's' Pier in Kralendijk (extended in 2020).
- Slipways in front of Bonaire Sailing School.
- Slipway at Machi Mimi.
- Pier at Chachacha beach (renovated in 2020).
- Slipway inside Plaza Marina.
- Slipway at Doei Diaz.
- Boat entry near Salt Pier.
- Slipway and Fishermens' Pier in Sorobon.
- Boat entry point and moorings at Lac Cai.

Fish Aggregation Devices (FADs)

With funding from LNV, PISKABON installed five FADs all of which are located outside of the marine park and are intended to relieve fishing pressure on Bonaire's reefs.

FADs are located approximately:

- 4 miles offshore from Slagbaai.
- 0.5 miles offshore from Klein Bonaire.
- 2 miles offshore from Red Slave.
- 9 miles offshore from Sorobon.
- 3 miles offshore from Spelonk.

With the exception of the FAD located offshore from Klein Bonaire, the FADs are used exclusively by commercial fishers and sport fishing businesses. The main catch at the FADs is Yellowfin Tuna, occasional Wahoo, Mahi Mahi and Marlin. There is currently no oversight or management of the FADs. Management of the FADs is urgently needed to ensure upkeep and maintenance.

MOORINGS

The Bonaire National Marine Park is the legally delegated authority charged with the placement, management and removal of moorings in the marine park on Bonaire. STINAPA manages three types of mooring in the marine park: public moorings, most of which are located at dive sites, overnight moorings for visiting yachts, and private moorings for residents and businesses (Table 16).

Location	Number	Buoy	Management	Fee	Use
Public moorings					
Lee shore (including 5 at WSNP; 21 at Klein Bonaire; 2 at Lac)	74	Yellow	STINAPA	None	One boat/mooring under 13 m [or max 3 x 4 m boats], max. 2 hours stay with scope line
Klein Bonaire	4	Red	STINAPA	None	Boats
Overnight moorings					
Kralendijk Bay	51	Red / white & yellow / white	Harbour Village Marina under contract with STINAPA	USD 10 per night. Max. length 18 m. Length of stay depends on immigration rules.	Visiting yachts
Private moorings					
West coast, Punt Vierkant - Hato	118	Various privately owned	STINAPA	USD 450 placement fee then user fee USD 280 per year.	For residents max. length 18 m
Total	118				

Table 16: Mooring overview by type

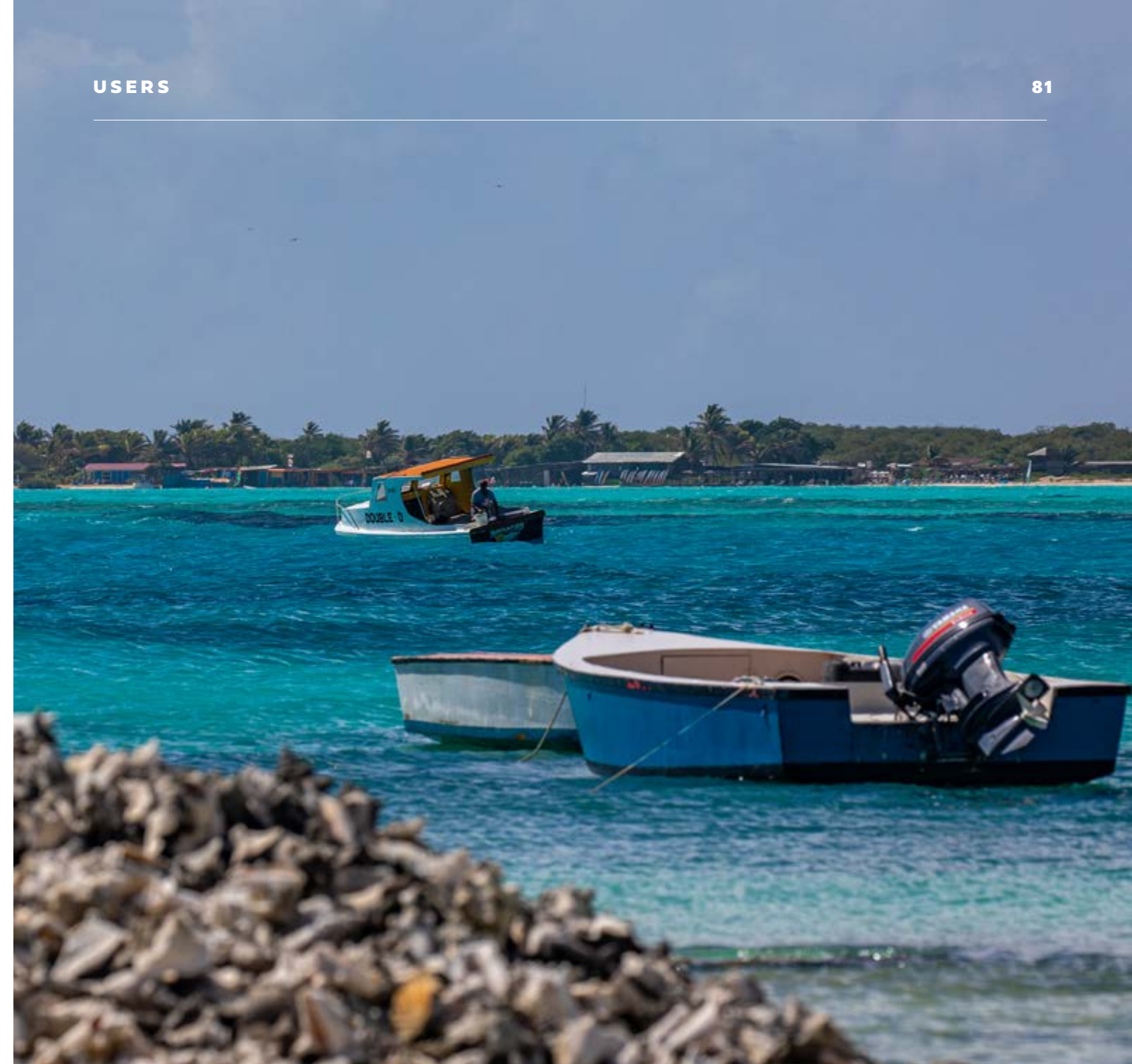
Public moorings

There are 74 moorings for public use which are mostly located along the length of the lee shore and around Klein Bonaire. In the past they were used almost exclusively by dive operators. The first public moorings were constructed using two oil drums, filled with concrete and joined with rebar which were sunk adjacent to the reef at popular dive sites. Over the past 20 years, these have been systematically phased out in favor of drilled Helix moorings. Moorings are marked with yellow PVC buoys which have the site name painted on them. There is a two-hour rule for the use of public moorings. No user fees are charged for use of public moorings in the marine park, and STINAPA undertakes all maintenance of public moorings including buoy- and line inspections, bi-annual repainting of buoys and mooring inspection and repair/replacement. Overnighting on public moorings is prohibited.

On Klein Bonaire there are four moorings provided for use by small recreational vessels at No Name beach, which are marked with red PVC buoys. White demarcation buoys at No Name beach indicate the drop-off zone for water taxis. STINAPA plans to implement a reservation system for the use of public moorings to reduce user conflict.

Overnight moorings

STINAPA created 51 overnight moorings in the Bay of Kralendijk for use by visiting yachts. These are currently serviced by the Harbour Village Marina, who collect yacht mooring fees and undertake small maintenance tasks and repairs. STINAPA undertakes all major mooring maintenance, including replacing



corals when necessary. Overnight moorings are located within the Bay of Kralendijk in front of the main town. STINAPA plans to replace the current mooring block system with Helix drilled moorings which are more secure.

Private moorings

There are currently an estimated 118 private moorings in the marine park, some of which are used by commercial companies and some of which are used by individuals for which an annual user fee is payable to the marine park. Private moorings can only be allocated to local companies and/or individuals for their own use and the vessel for which the mooring is requested must be registered on Bonaire and be less than 18 m. The contract between STINAPA and the user of the mooring stipulates the name and NB number of the vessel which may use the private mooring.

The name of the vessel and/or NB number must be clearly indicated on the mooring buoy for private moorings assigned to individuals.

PERMITTING AND FEES

Nature permit

Businesses and commercial companies using the marine park, for example those providing boating, diving or watersport services, are required to have a nature permit in addition to the permits required to register a business and to legally operate vessels in the waters around Bonaire. Nature permits are issued by the Island Government under advice provided by the Nature Commission. STINAPA is mandated to enforce the regulations of the marine park.

Nature Fee

Recreational users of the marine park are required to pay an admission fee (the 'nature fee'). This is stipulated in legislation. Companies providing services in the marine park are required by law to ensure that their clients have paid their nature fee. The highest number of fee payments were made in 2019 with 80,000 users purchasing the nature fee, this decreased in 2020-2021 due to COVID (Figure 28).

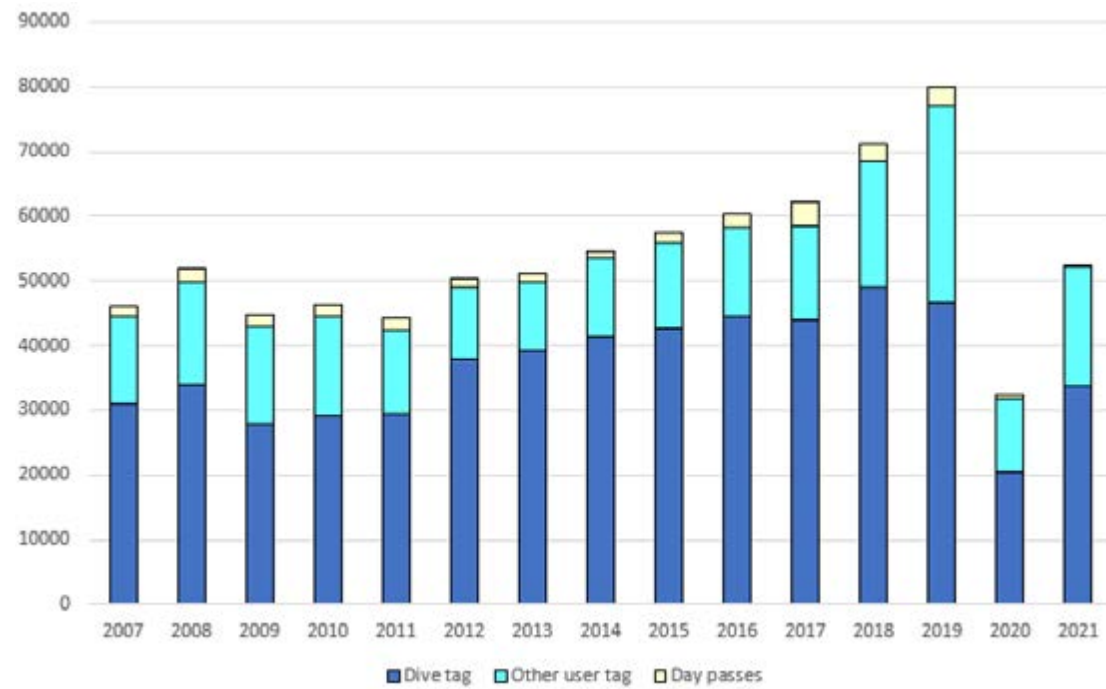


Figure 28: Number of users of the Bonaire National Marine Park who paid the nature fee

The main source of income for the Bonaire National Marine Park comes from the collection of admission fees. Income needs to adequately cover operational costs, including staffing, as well as providing funds to address threats and issues. A key aspect of income is its sustainability; a constant flow of income is required to retain staff and maintain operations and this the key to long-term success. The type and amount of admission fees are outlined in Table 17.

Fee	Amount (USD)
Scuba diver admission fee:	45 per year
Other user admission fee:	25 per year
Private moorings	280 per year
Overnight moorings	10 per night

Table 17: Bonaire National Marine Park fee structure

STINAPA has submitted a proposal to the Island Government to streamline the admission fee system advocating for the following changes:

- USD 40 per person per year admission to the Bonaire National Marine Park for all users (residents are free).
- USD 10 per person per day for cruise ship passengers.
- USD 1,250 per year for use of private moorings.
- USD 35 per night for use of overnight moorings.



6 | THREATS AND ISSUES

A threat to a protected area is defined as any human activity or related process that has a negative impact on key biodiversity features, ecological processes or cultural assets within a protected areas (CBD). An issue is anything with the potential to negatively impact on the conservation of the park's natural resources, for example those related to inadequate finance or poor governance. If not addressed issues could threaten the sustainable conservation and management of the park.

Direct threat	Description	Coral Reefs	Mangroves	Sea Grass	Water Quality	Justification
9. Pollution	9.1 Run-off including household sewage and urban waste water	High	Low	Low	Medium	Sewage makes its way onto Bonaire's coral reefs through inadequate wastewater treatment and use including poorly maintained septic tanks. Sewage is a cocktail of substances, a number of which are dangerous to coral reef ecosystems and those who use them. Sewage is a source of harm to Bonaire's coral reefs and can potentially cause diseases. In addition to sewage, run-off may contain any number of other pollutants such as oil and heavy metals and sediment which will turn the water 'muddy'. Where sediment settles on marine organisms, particularly corals, it smothers and kills them. Changes in land use from vegetated areas to urban areas increases run-off.
8. Invasive / problematic species	8.4 Pathogens and microbes: Stony Coral Tissue Loss Disease	High				Disease: Stony Coral Tissue Loss Disease (SCTLD) was discovered in Florida in 2014 and has since spread throughout the Caribbean. It was found on St. Eustatius reefs in 2019. There is uncertainty as to what causes the disease. 20 species of coral are affected, it leaves bare skeleton in a few months. The disease is spread by physical touch. Other vectors are under investigation including ballast water, which may be responsible for some of the spread. It is highly infectious and most corals are not very resistant to this disease. SCTLD may have first been identified on Bonaire's reefs in August 2022.
5. Biological Resource use	5.4 Fishing and harvesting aquatic resources: unsustainable reef fishing.	High	Low	High	-	Commercial, recreational, sport and artisanal fishing take place in the marine park. Conch is illegally harvested from Lac. There are restrictions on fishing gear, spearfishing is banned and snorkel fishing is severely restricted. Fish protected areas have been set up to safeguard reef fish populations.
1. Residential and commercial development	Unsustainable coastal development for housing, commerce and tourism, including artificial beaches	High	Low	Medium	Low	Building developments for tourism are often carried out in the coastal zone. This presents particular problems with land clearance allowing sediment as well as cement, building material and rubbish to be blown or washed into the sea if preventative steps are not taken. Tourist developments in the coastal zone frequently want to create artificial beaches. Since 1995 there have been plans to dredge and develop Saliña di Vlijt, north of Kralendijk, for tourist accommodation and facilities.
9. Pollution	9.3 Agriculture: nutrients and sediment from soil erosion caused by goats.	High	High		High	There are over 30,000 free roaming goats on Bonaire, which are denuding the island of its native vegetation. Goats target saplings and graze on vegetation, leaving topsoil exposed to rain, increasing erosion and sedimentation in the marine environment, which smothers coral reefs and impacts seagrass beds and mangroves. Sediments may contain toxins.
6. Human intrusions / disturbance	6.1 Recreational activities: unsustainable use, diver damage, tourism including overcrowding of hotspots by cruise tourists.	High	Low	Medium	Low	Lack of knowledge and skills can cause unintended physical damage to coral reefs and/or seagrass beds. Overcrowding of popular sites, particularly by passengers from cruise boats is unsustainable in sensitive coral reef and sea grass environments. In 2019 cruise tourist numbers increased due to shifting government policy. Tourists take tours to No Name beach and Sorobon. Both of these areas are Ramsar sites and very sensitive habitats, without adequate facilities.
8. Invasive / problematic species	8.1.2 invasive nonnative animals: Lionfish	Medium				Lionfish are not native to the Caribbean and arrived as part of a region wide invasion. They have no natural predators. Lionfish are effective predators and voracious feeders and are able to consume fish up to their own body length. They grow and reproduce quickly and are resistant to parasites. They are known to have a significant impact on juvenile reef fish but the effect their rapidly increasing populations will have on Bonaire's reefs is not yet fully understood. Baseline studies have been conducted and there is an active program of removal with volunteer hunters using specially modified spearguns 'ELFs' to catch and kill lionfish. Abundant lionfish have been found in very deep water around Bonaire. There is some economic benefit as lionfish meat is sought after and has high commercial value.
8. Invasive / problematic species	8.1.1 invasive nonnative plants: Halophila			High		The Indian Ocean seagrass <i>Halophila stipulacea</i> is growing in Lac Bay and Lagoen, competing with the local species, <i>Thalassia testudinum</i> . It was first seen in 2011. Turtles have been seen feeding on it, but it is considered to have a low nutritional value. This may cause problems for the health of turtles.
8. Invasive / problematic species	8.2 problematic native plants: Sargassum	Low	High	High	Low	Periodic inundations of sargassum weed on the windward shore of Bonaire have caused havoc and untold harm to seagrass beds, mangroves and the animals which live there particularly in and around Lac, and also affected the Lagoen area.

Table 18: Summary of direct threats to Bonaire National Marine Park

THREATS

The following table (Table 18) refers to the latest version of the Conservation Measures Partnerships (CMP) Conservation Threats Classification v 2.0. This classification is designed to provide a simple, comprehensive, consistent, expandable, exclusive and scalable classification of all direct threats to biodiversity. The framework is the standard for defining threats and is used by a number of global initiatives, including IUCN Red List and METT4 Management Effectiveness evaluations.

The European Union BEST Regional Ecosystem Profile for Bonaire identifies several threats (Table 19) to Bonaire National Marine Park (De Bettencourt & Imminga-Berends, 2015).

Pressures	Cause - impact	Severity
Tourism	Direct damage by visitors, indirect damage due to wastewater pollution and eutrophication	High
Overgrazing	Cause sedimentation and eutrophication	Moderate
Poor water management	Cause sedimentation and eutrophication	Moderate
Coastal zone development	Run-off and erosion (sand, cement, soil) causing sedimentation and eutrophication	High
Artificial beaches	Sedimentation and smothering of corals	High
Pollution	Pollution originating from waste, wastewater, salt company discharge,	Moderate
Climate change	Bleaching, weakens and kills corals	High
Disease	Weakens and kills corals	High
Fishing	Overfishing of reef fish, conch, lobster	High
Physical damage	Trampling of seagrass beds	High
Invasive species	Seagrass	Moderate

Table 19: Pressures facing the Bonaire National Marine Park

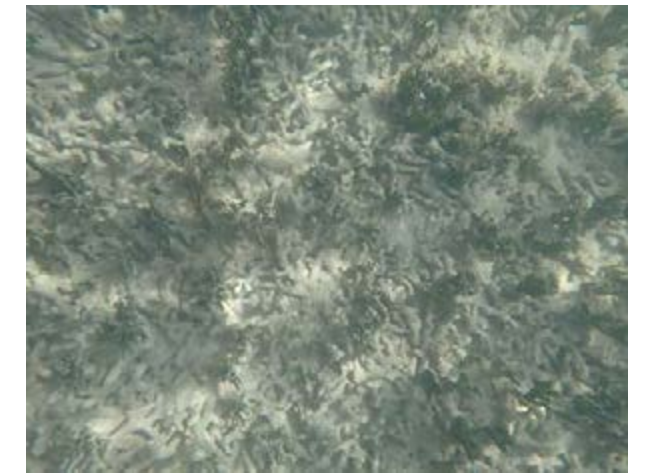
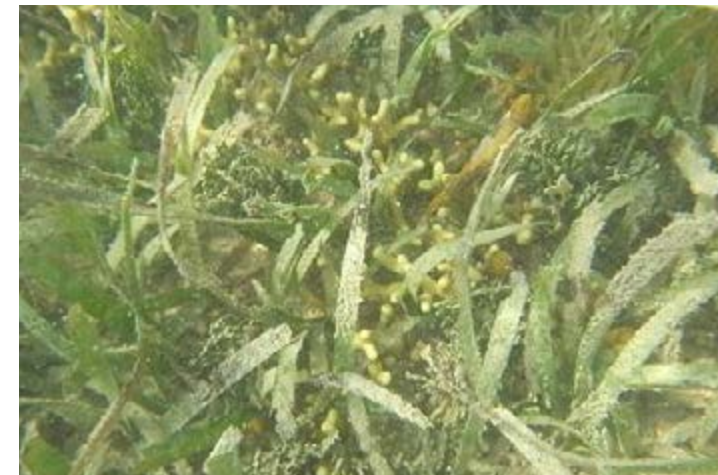


Sargassum-induced brown tide in Lac Bay. Note the dying mangrove trees (photo by Paulo Bertuol)

Sargassum

Periodic inundations of sargassum weed on the windward shore of Bonaire have caused havoc to seagrass beds, mangroves and the animals which live there, particularly in Lac Bay and Lagoen. These 'brown tides' have occurred annually since 2018. Sargassum washes onto the shore, collecting in pockets and decomposes in situ, releasing brown water and causing smothering, eutrophication, the release of hydrogen sulphide and anoxic (oxygen depleted) conditions. Sargassum chokes and kills mangroves and seagrass beds and turn the water brown.

STINAPA has a Sargassum action plan and takes responsibility for clean-up activities in Lac Bay and Lagoen. Over the past STINAPA has only been able to remove less than 5 percent of the sargassum due to insufficient funding and capacity (Figure 29).



Porites divaricata in Lac Bay before (left) and after (right) sargassum (photos by Sabine Engel)

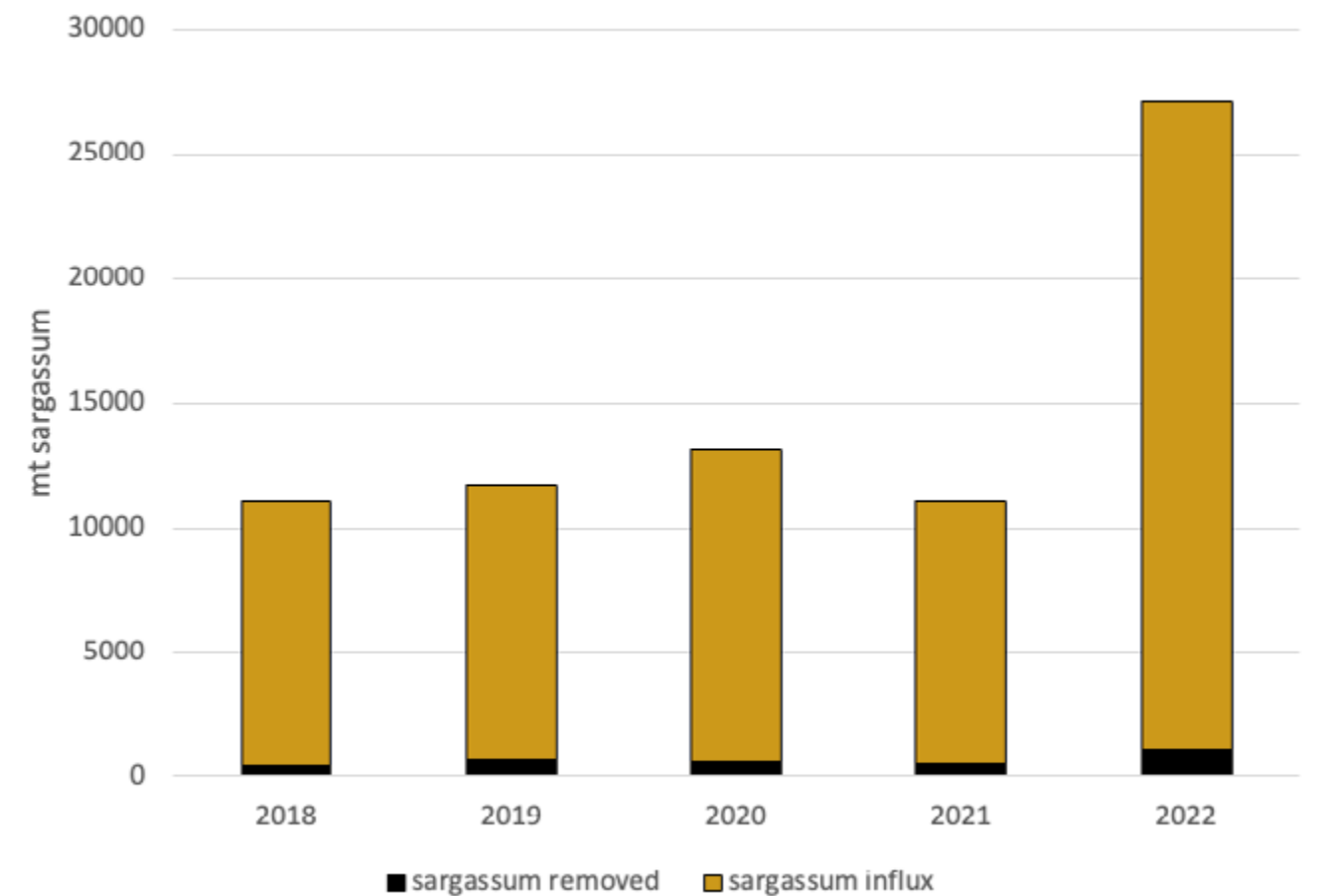


Figure 29: Sargassum influxes on Bonaire since 2018. Highlighted in black the amount of sargassum removed.

Lionfish

Lionfish are not native to the Caribbean and arrived as part of a region wide invasion. They have no known natural predators. Lionfish are effective predators and voracious feeders and are able to consume fish up to their own body length. They grow and reproduce quickly and are resistant to parasites. Lionfish are known to have a significant impact on juvenile reef fish but the effect on Bonaire’s reefs is not yet fully understood. Baseline studies have been conducted and there is an active program of removal with volunteer hunters using specially modified spearguns (so-called ELF’s) to catch and kill lionfish. Abundant lionfish have been found in very deep water around Bonaire. There is some economic benefit as lionfish meat is sought after and has high commercial value.

STINAPA began surveying lionfish in 2011, tracking 24 locations on Bonaire and 12 locations on Curaçao. Surveys recorded lionfish densities along a 200 m transect, at three different depths (15, 25 and 35 m deep). These annual surveys found that the number of lionfish was significantly higher around Curaçao than around Bonaire (Figure 30). Over the following three years, the recorded density of lionfish at study sites around Bonaire remained relatively constant. Whilst there were small shifts between the years of 2011 and 2018, the relative density of lionfish was slightly higher at deeper depths (with the exception of 2018 which showed the highest density at 15 m). Comparison between fished and unfished areas, showed that unfished areas had higher lionfish populations densities.

STINAPA plans to encourage more residents to hunt for lionfish by streamlining the administration of the current system, revising the contract with lionfish hunters and removing the deposit required to receive an ELF.

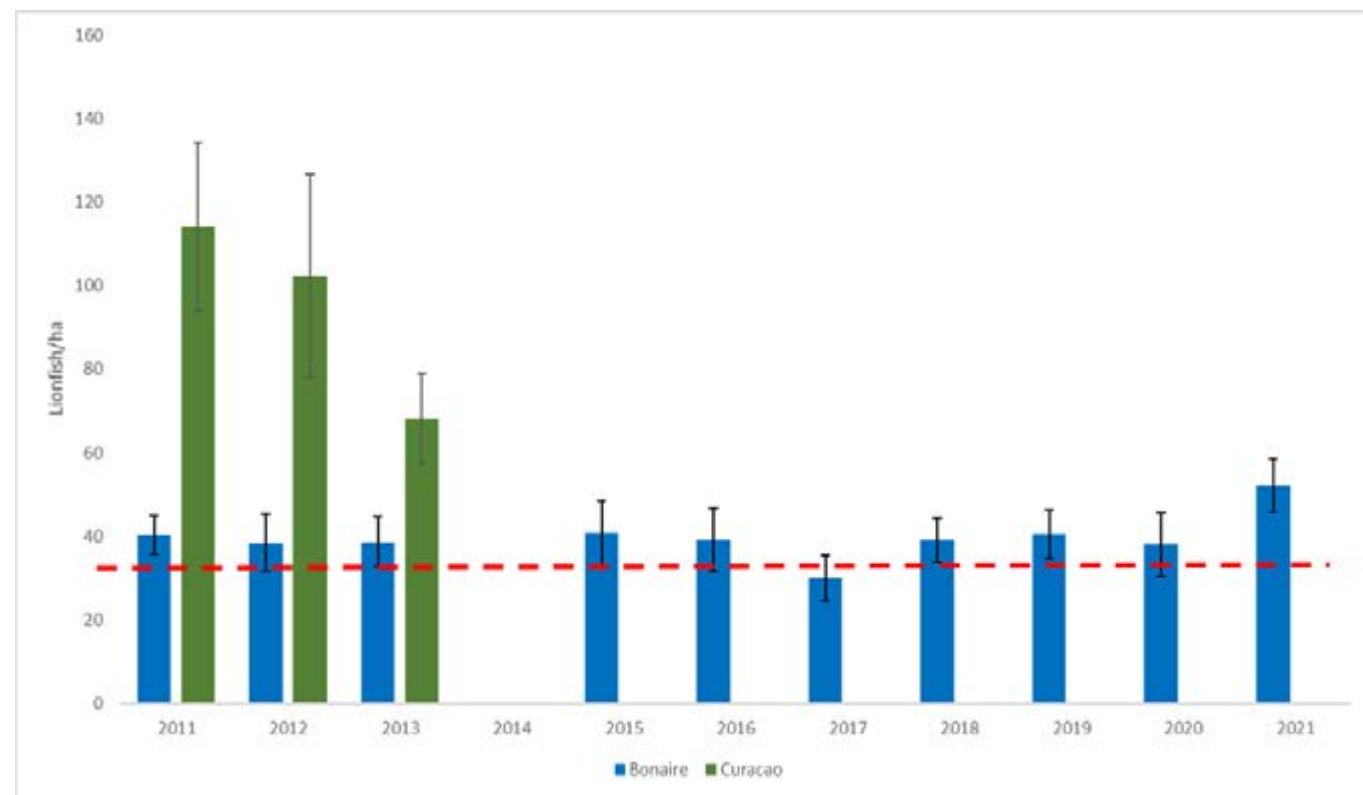


Figure 30: Lionfish density on Bonaire and Curaçao. Note: no data is available from Curaçao after 2013. The Nature and Environmental Policy Plan Caribbean Netherlands 2020-2030 aims to reduce lionfish density on Bonaire’s reefs to less than 35 individuals per ha (dashed red line).

Invasive seagrass

The invasive seagrass, *Halophila stipulacea*, is native to the Indian Ocean, but was discovered in the Caribbean in 2002 and found in Lac Bay in 2010. It has spread quickly, and now accounts for 26 percent seagrass cover in Lac Bay, where it has taken over from native Turtle Grass (*Thalassia testudinum*) and Manatee Grass (*Syringodium filiforme*). This could affect the Green Turtle because the species prefers Turtle Grass, which is more nutritious. *Halophila* grows faster than native species allowing it easily to invade the bay.

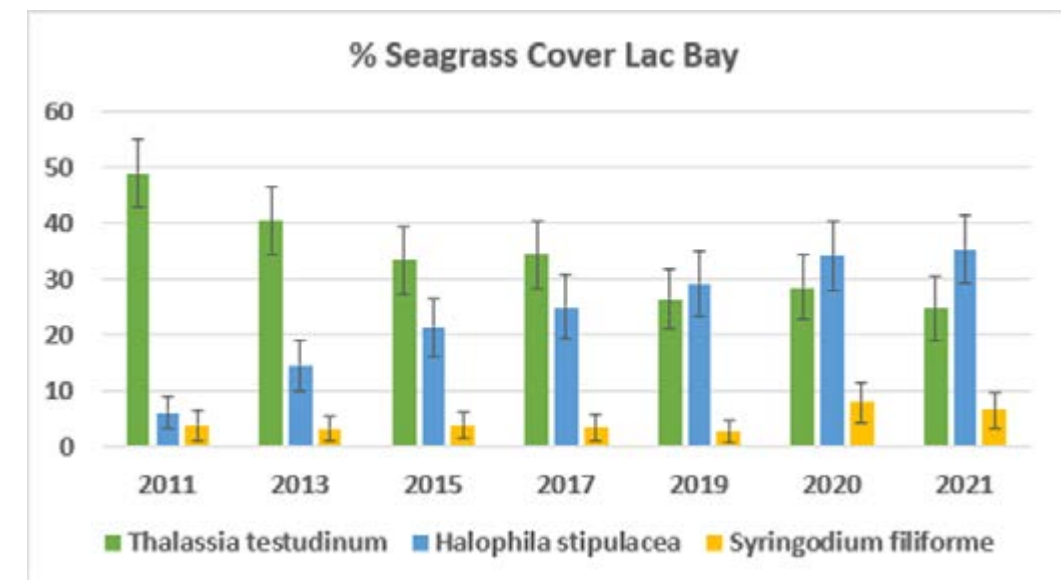


Figure 31: Seagrass cover in Lac Bay (2011-2021).

Stoney Coral Tissue Loss Disease

Since its discovery on the Florida reef in 2014, Stony Coral Tissue Loss Disease (SCTLD) has spread rapidly throughout the Caribbean region causing severe impacts on reef health and biodiversity. Tissue loss diseases are the most virulent and damaging of the documented coral diseases (Aeby et al., 2019), often resulting in severe mortality rates. SCTLD effects upwards of 20 species of coral and at the time of writing, the disease has been confirmed in 17 countries and territories (AGRRA SCTLD dashboard).

The underlying pathogen causing SCTLD has not been identified. Lesion progression on some coral species can be hindered with the use of antibiotics, indicating that the pathogen(s) associated with SCTLD may be bacterial (Aeby et al., 2019; Meyer et al., 2019).

Aquaria studies have shown that SCTLD can be transmitted by direct contact and passively through the water column (Aeby et al., 2019) and field observations confirm both modes of transmission (Precht et al., 2016, Sharp et al., 2020). Modelling suggested the spread between reefs is likely to be associated with slow-moving bottom currents and the accompanying sediment particles (comprising sediment, coral mucus, etc.) (Muller et al., 2020). Transmission appears to be independent of colony densities (Sharp et al., 2020). There may be within-reef transfer of the disease among colonies via animal vectors such as butterflyfish (Noonan & Childress 2020) and fireworms which are actively feeding on the disease lesions. Fireworms have been found to spread disease elsewhere (Sussman et al., 2003).

Black spiny urchin die-off

Diadema antillarum, known as the Black Spiny Urchin, is characterized by its exceptionally long black spines. It is the most abundant and important herbivore on the coral reefs of the western Atlantic and Caribbean basin. When the population of these sea urchins is at a healthy level, they are the main grazers and help

prevent algae overgrowth of the reef. Caribbean populations of the long-spined Black Spiney Urchin were decimated by a disease-induced mass mortality in the early 1980's. The last detailed study to assess population recovery in 2001, indicated a slow, and modest recovery in population numbers. However, there are strong indications that Black Spiney Urchin populations are once again being decimated by disease. This event was first recorded on reefs in St Thomas, and within a month mortality events had been independently observed in St. John, as well as Saba, St. Eustatius, Dominica, Jamaica and St. Vincent.

Climate Change

The full extent of climate change's impact on different habitats and species in the Bonaire National Marine Park is still poorly understood, yet it is expected to be significant (de Bettencourt & Imminga-Berends, 2015; van Beukering et al., 2022). Bonaire's marine and terrestrial ecosystems and the species that inhabit them will be affected, to varying degrees (Box 5). Coral reefs are predicted to be especially vulnerable as higher ocean temperatures and ocean acidification will undoubtedly result in mass coral bleaching events.



Coral Reefs

- Ocean acidification and increased sea surface temperature are projected to trigger mass coral bleaching.
- Severe mass coral bleaching events increase in frequency.
- Increased storms and associated rainfall will cause an increase in terrestrial run-off and resulting sedimentation.
- Stronger and more frequent hurricanes and tropical storms will cause more damage to reefs with less time to recover in between.
- Ocean acidification will impact the formation and maintenance of reefs as it reduces coral growth and increases the rate of dissolution of reefs.
- Reef diseases will become more and more prevalent.

Coastal Ecosystems (mangroves, seagrass beds, salina's, beaches)

- Inundation of coastal habitats resulting from sea-level rise and higher wave energy may result in the inundation of certain coastal habitats.
- Sea-level rise will threaten the functioning of Bonaire's flamingo feeding areas due to a large inflow of seawater.
- Sea-level rise will threaten mangroves as salinity levels will become too high and the water depth too deep.
- Seagrass beds will be under threat from an increased sea surface temperature and changes in salinity.
- Sea level rise and increased rainfall will accelerate the rate of beach erosion.

Invasive Species and Diseases

- Local species will be weakened from the other impacts of climate change and therefore have less resistance to invasive species.

Change in ocean currents

- Current speed or/and direction may be impacted by climate changes.
- Changes in currents may have unprecedented effects on the ecosystems and species that depend on them and the ecological connectivity between islands (e.g. dispersal of coral larvae via currents).

Tourism

- Increase in storms and hurricanes may result in tourists' perception of destination as unsafe.
- Beach erosion and coral bleaching may negatively impact perceptions of destination attractiveness.
- Risk of damage to coastal resort properties by violent hurricanes and other storms.
- Risk of damage to tourist attractions.
- Risk of freshwater shortage due to salinization of groundwater.

Fisheries and agriculture

- Damage to reef habitat and changes in ocean currents will threaten fisheries.

The IPCC Special Report warns that global warming is likely to reach 1.5°C between 2030 and 2052, if business as usual continues. There are therefore only 12 years within which to take the necessary action to keep global warming to a maximum of 1.5°C. Allowing warming of 2.0°C will significantly worsen the risks of drought, floods, extreme heat, poverty for hundreds of millions of people and the loss of almost all coral reefs.

Reduction of CO2 concentrations to the levels necessary to save coral reef ecosystems will require major initiatives to reduce both CO2 emissions and our carbon footprint. Global net human-caused emissions of CO2 would need to fall by about 45 percent from 2010 levels by 2030, reaching 'net zero' around 2050. Such global scale measures will be critical, not only for the survival of coral reefs and many other types of marine life, but also for the stability of human communities.

The IPCC Special Report maps out four pathways to achieve 1.5°C, with different combinations of land use and technological change. Reforestation is essential, as are shifts to electric transport systems and greater adoption of carbon capture technology. There would need to be rapid, far-reaching and unprecedented changes in all aspects of society, including land, energy, industry, buildings, transport, and cities. The costs of doing nothing would be far higher – coral reefs show us how vitally urgent it is to take action now.

Box 6: Revised ISRS Consensus Statement on Climate Change and Coral Bleaching (ISRS, 2018).

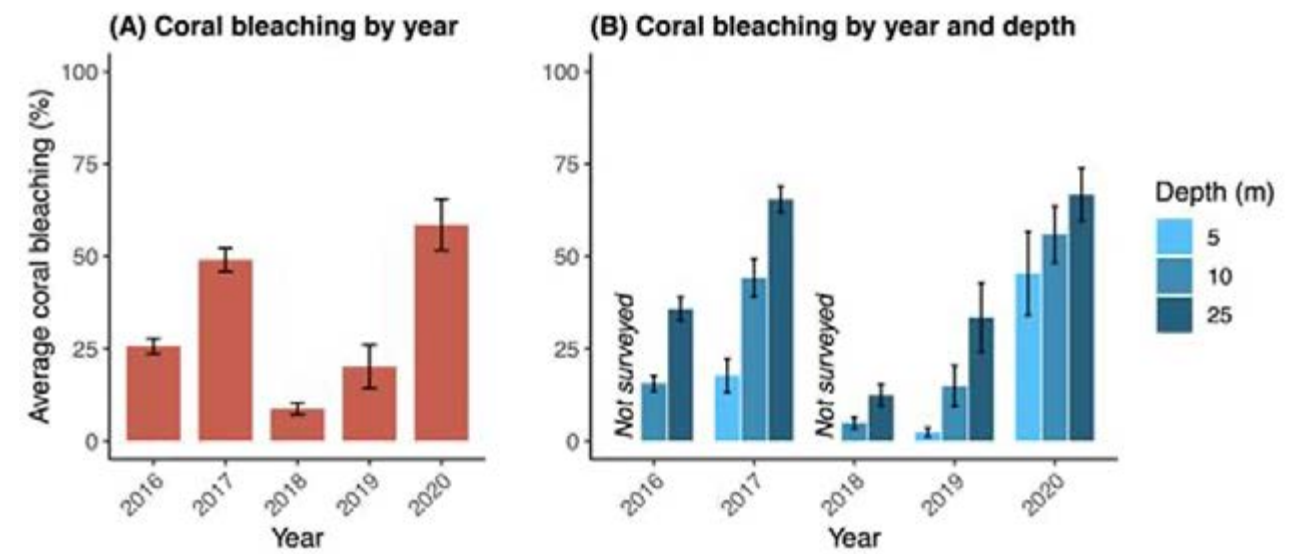
The Caribbean region has a tropical climate, with wet and dry seasons. Bonaire, however, has a dry climate. It is expected that the average temperature will rise 1.4°C. Rainfall is expected to decrease by 5 percent, and the sea level to rise by 0.6 m. Extreme events such as sea storms and droughts are expected to occur more frequently. Climate change will likely impact both the natural and socio-economic situation on Bonaire. The lower lying and coastal areas that host many of the resorts, residential areas, salt ponds, mangroves and (turtle nesting) beaches are likely to become subject to more frequent damage from sea storms. The sea level rise will cause permanent flooding. In addition, sea water temperature rise is already weakening corals' resistance against diseases making these reefs less attractive for dive tourism. The expected decrease in rainfall will further limit growth of natural vegetation. As the roots of this vegetation will then no longer hold the soil together, this will increase the risk of soil erosion. Soil is then flushed into the sea, smothering the coral.

Box 7: Possible impacts of climate change on Bonaire (Verweij et al., 2020).

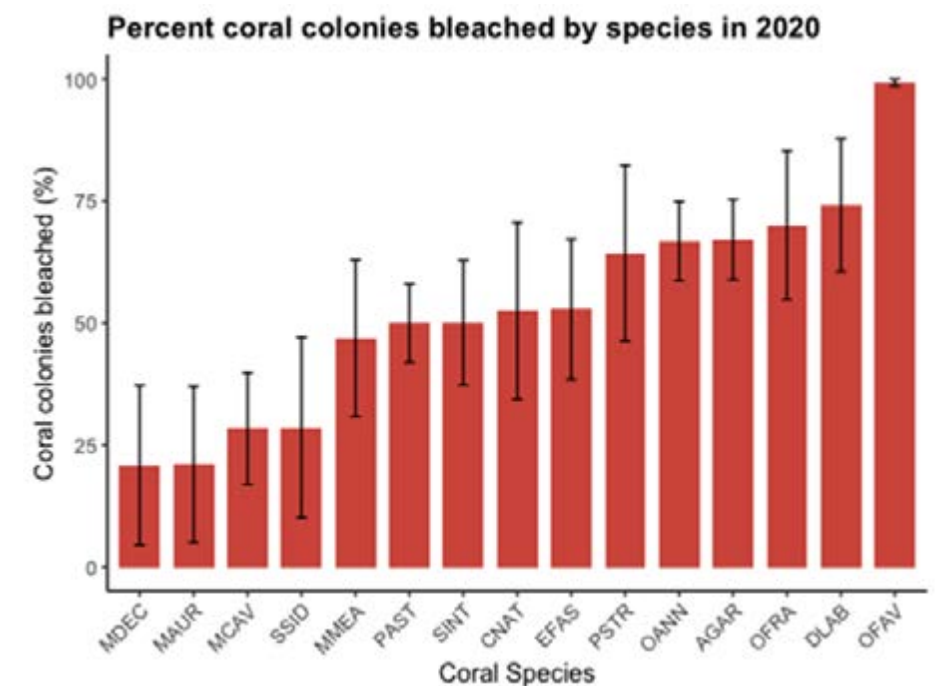
Coral bleaching

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

Mass coral bleaching is becoming more frequent and widespread and poses a major threat to coral reefs worldwide. Mass coral bleaching is a response to thermal stress triggered by high sea surface temperatures or ultraviolet radiation attributed to changing regional and global climate patterns. Since 2016, STINAPA Bonaire has studied the severity of coral bleaching in the Bonaire National Marine Park at 10 sites on the leeward coast. Each year, corals exhibited signs of thermal stress including paling, partial bleaching, and fully bleaching, but no mortality. Since 2016, the year with the lowest percentage of corals affected was 2018 (9 percent) and the year with the highest percent of corals affected was 2020 (61 percent). Corals deeper in the water column were found to be more susceptible to thermal stress, but susceptibility trends by site were inconsistent (Eckrich et al., 2020).



The average percentage (± SEM) of corals affected by bleaching in the Bonaire National Marine Park by: (A) year, and (B) year and depth in 2016-2020 across sites (n = 10 sites). Percentage of corals affected include pale, partially bleached, and fully bleached corals. No bleaching-attributed coral mortality was observed. In 2016 and 2018, bleaching was not surveyed at 5 m depth.



The average percentage (± SEM) of coral colonies affected by bleaching in the Bonaire National Marine Park by species in 2020 across sites (n =10 study sites). Percentage of corals affected include pale, partially bleached and fully bleached corals. No coral mortality was observed. Coral species where less than three individuals of a given species were observed across the entire 2020 dataset were excluded from this figure as there were not enough observations to reliably estimate average percent bleaching.

Box 8: Coral bleaching on Bonaire



Waste water

Waste water is one of the biggest local threats to coral reefs in the marine park. Untreated waste water contains high levels of nutrients, whilst coral reefs thrive in nutrient poor waters. Water quality analysis conducted between 2011 and 2013, and in 2020 found that nutrient concentrations on the reefs were just below the thresholds, which trigger algae and cyanobacteria to take over. Water quality seems to be deteriorating (Slijkerman et al., 2013; Foekema et al., 2022).

Waste water management has received increasing attention on Bonaire since 2000. A European Development Fund (EDF) project financed the construction of wastewater collection and sewerage facility, which cost EUR 20 million. The Dutch government contributed an additional EUR 10 million to this project, linking homes and firms to the collectors. Via an advanced vacuum system, the wastewater is transported to the sewerage treatment plant, which can process up to 2,800 m³ wastewater per day. The wastewater from septic tanks and cesspits is trucked to the sewerage treatment plant. An estimated 22 percent of the freshwater produced by WEB is currently returned for treatment at the sewerage treatment plant (around 40,000 m³ per month). Run-off from roads and roofs is also not treated.

Solid Waste

Solid waste is collected by a private company, Selibon N.V. The island generates around 20,000 mt of solid waste per year. This figure is relatively high due to the contribution by the tourist industry. Open water environments are threatened by pollution from land-based sources. Plastic pollution (macro and micro). Is likely to be affecting the health, reproduction and survival of phytoplankton and zooplankton, which forms the basis of marine food chains along with the other plants and animals that live, feed and reproduce in open water.

ISSUES

It is widely recognized that protected areas require long-term political and financial commitment in order to be effective. STINAPA's Conservation Action Plan (STINAPA, 2020) identified the most pervasive issues facing Bonaire's Parks to be:

- Lack of vision for the island's development.
- Lack of awareness in general about the value of nature and the need for conservation.
- Lack of mainstreaming within government.
- Unreliable commitment to nature conservation.
- Slow implementation of the Nature Permit system.

The Nature Plan for Bonaire 2020-2024 identifies the following constraints, which impact STINAPA's ability to fully protect the Bonaire National Marine Park:

- Nature and environmental policy are low priorities.
- Lack of capacity for nature policy and implementation.
- Lack of structural funding for conservation activities.
- Limited enforcement of nature legislation.
- Out-dated management agreement between government and STINAPA.
- Lack of continuity in the field of nature policy and implementation.
- Adaption of nature legislation without good argumentation.

Inadequate financial support plays a central role in limiting park management effectiveness and causing loss and degradation of natural resources globally. The World Bank, International Union for the Conservation of Nature (IUCN) and others, recognize that serious funding deficits exist worldwide in non-developed regions. Management of protected areas on small islands is known to be disproportionately expensive, as islands are unable to benefit from economies of scale. Marine parks without adequate investment in human and financial capacity will have sub-optimal conservation outcomes (Gill et al., 2017).

Factors effecting the cost of park management include the park's management objectives, accessibility as well as the size of the protected area. Models for predicting protected area management costs developed by Vreugdenhil et al. (2003) are based on cost estimates of 50 management components. Predicted staffing needs are estimated directly from the size of the protected area. Recurrent management costs include staff salaries and related costs, maintenance and field work, outreach, education and community engagement, science and monitoring and enforcement. The Dutch Caribbean Nature Alliance (DCNA) worked with park managers throughout the Dutch Caribbean to provide a detailed framework for park management tasks, which can be used to estimate staffing and recurrent funding needs.

7 | MANAGEMENT PLAN

The framework for the Bonaire National Marine Park management plan is determined by STINAPA's vision statement as captured in the Strategic Plan (2015-2020) and the Conservation Action Plan. This management plan focuses on conservation targets, which together with the threat analysis, provide the basis for the conservation strategies and objectives used to guide management of the Bonaire National Marine Park.

Stakeholder involvement has been a critical element in the development of this management plan. Stakeholders were identified and consulted at the beginning of the process and their feedback has been incorporated directly into the management plan.

VISION

Nature is recognized and treasured as the main resource of Bonaire's sustainable development.

SCOPE

The geographic scope of the Bonaire National Marine Park is defined within the legislation and, by law, extends from the high-water mark to the 60 m depth contour around Bonaire and Klein Bonaire including the sea bottom (benthos) and surrounding waters. The island of Klein Bonaire is included in the marine park. Within the Bonaire National Marine Park are two areas of particular conservation value which have additionally been designated as RAMSAR sites: Lac Bay and Klein Bonaire.

The thematic scope of STINAPA is the management, protection, restoration and sustainable use of the natural, cultural and historical resources (and their intrinsic ecological processes) in the Bonaire National Marine Park.

MISSION

The mission of the Bonaire National Marine Park is to protect and manage the island's natural, cultural and historical resources, while allowing ecologically sustainable use, for the benefit of future generations.

Furthermore, in accordance with their Strategic Plan 2015-2020, STINAPA is committed to manage the Bonaire National Marine Park to:

- Perpetuate, in as natural a state as possible, representative examples of underwater features, biotic (plant and animal) communities, genetic resources and natural processes.
- Maintain viable and ecologically functional populations and assemblages of native species of plants and animals at densities sufficient to conserve ecosystem integrity and long-term resilience.
- Contribute to the conservation of wide-ranging species (such as whales, dolphin, pelagic fish and sharks), migratory birds as well as regional ecological processes and migration routes.
- Promote use for inspirational, educational, cultural and recreational purposes at levels which will not cause lasting biological or ecological degradation to marine resources.
- Take account of the needs and aspirations of the community, including subsistence resource use, in so far as this will not adversely affect the primary management objective.
- Promote and adopt nature-based solutions to climate change.
- Contribute to the economy through nature-based tourism.

CONSERVATION TARGETS

Conservation targets are the ecological systems and processes, habitats, communities and species, that represent and encompass the biodiversity found within the marine park. These are the features that STINAPA most wants to conserve and are the basis for setting conservation goals, carrying out conservation actions and measuring conservation success. Conservation targets within the Bonaire National Marine Park are:

- Coral reefs.
- Mangroves.
- Seagrass beds.
- Water quality.

Conducting a viability assessment informs implementation as part of the adaptive management process. The conservation target viability assessment is based on the following attributes:

- At least one Key Ecological Attribute (KEA).
- At least one indicator for each Key Ecological Attribute (KEA).
- Ranking: very good, good, fair, poor.
- Current and future desired status.
- Justification/documentation.

Key Ecological Attributes are aspects of the conservation target's biology or ecology that if missing or altered would lead to the loss of the conservation target over time. Indicators are species, which can be used to infer the condition of the conservation target. Rankings used the following scale:

- Very good: ecologically desirable status, needs little intervention to maintain
- Good: target is within acceptable range, some intervention necessary
- Fair: target is outside of acceptable range, requires intervention
- Poor: Restoration increasingly difficult, may result in extirpation

The results are presented in Table 20.



ITEM	STATUS
Target: Coral reefs	Fair
KEA: Coral 'health'	Fair
Indicator: Coral cover	Fair
Indicator: Coral recruitment	Fair
Indicator: Algae cover	Fair
Target: Mangrove forests	Good
KEA: Area size	Good
Indicator: Area size	Good
KEA: Species boundaries	Fair
Indicator: Location	Fair
Target: Seagrass beds	Poor
KEA: Area size	Poor
Indicator Area size or cover	Poor
KEA: Species composition	Poor
Indicator: Species composition / invasive species	Poor
Target: Water quality	Fair
KEA/Indicator: Temperature in normal ranges	Not specified
KEA/Indicator: Salinity	Not specified
KEA/Indicator: Oligotrophy	Not specified

Table 20: Conservation target viability assessment

CONSERVATION STRATEGIES

STINAPA has identified the following conservation strategies for the Bonaire National Marine Park:

1. Optimize protection for key marine habitats and species.
2. Improve sustainable recreation.
3. Encourage sustainable fishing.
4. Control invasive species and disease.
5. Support restoration of key habitats and species.
6. Influencing policy and legislation to improve park management.

Enabling strategies are developed to address and improve aspects of the day-to-day management of the marine park. These focus on:

Improve institutional capacity (including good governance and staff development).

- Optimize income generation.
- Provide inclusive nature education for children and youth.
- Communicate effectively (outreach, media, social and communication).
- Monitoring key species, habitats and ecological processes to support protected area management.
- Enforce nature and environmental legislation.

Conservation strategies are a key component of the Open Standards theory of change approach to conservation management adopted by STINAPA in 2018 (see Appendix H).

OBJECTIVES AND ACTIVITIES

Conservation strategy 1. Optimize protection for key habitats and species

Objective 1.1. Generate the necessary information for effective conservation action

- Activity 1.1.1. Identify key biodiversity areas and representative sites
- Activity 1.1.2. Map anthropogenic threats
- Activity 1.1.3. Identify sites for coral, seagrass and mangrove restoration

Objective 1.2. Assess the status of habitats and species

- Activity 1.2.1. Monitor coral reef health
- Activity 1.2.2. Monitor the status of seagrass meadows
- Activity 1.2.3. Monitor the status of mangrove forests
- Activity 1.2.4. Monitor the sea turtle population and nesting beaches (with STCB)
- Activity 1.2.5. Collect baseline data on specific sites vulnerable to change

Objective 1.3. Review zoning policy

- Activity 1.3.1. Create an integrated zoning plan for the Bonaire National Marine Park
- Activity 1.3.2. Review size, location and effectiveness of fish protected areas

Objective 1.4. Address nutrient, sediment and pollution pressures

- Activity 1.4.1. Monitor coastal development (including piers, retaining walls and artificial beaches) and check necessary permits
- Activity 1.4.2. Introduce engine standards for future commercial boat registration in collaboration with the Harbor Master
- Activity 1.4.3. Document, report and address incidents, such as oil spills and boat accidents
- Activity 1.4.4. Enforce regulations on waste water discharge
- Activity 1.4.5. Minimize potential disturbance in ecological sensitive areas, including in-water infrastructure, brine discharge, discharge from reverse osmosis plants, shipping lanes and flight paths
- Activity 1.4.6. Monitor Brown Seaweed (*Lobophora*)
- Activity 1.4.7. Monitor cyanobacterial mats
- Activity 1.4.8. Monitor water quality and help establish water quality thresholds

Objective 1.5. Streamline permitting processes

- Activity 1.5.1. Review and provide advice on nature and construction permit applications and MER procedures for activities in the marine park
- Activity 1.5.2. Work with stakeholders to ensure compliance with environmental legislation
- Activity 1.5.3. Formalize relationship with, and clarify roles and responsibilities between, DTH and DRO to facilitate the issuance and enforcement of nature permits (including administrative enforcement issues)
- Activity 1.5.4. Support the inventory of marine infrastructure
- Activity 1.5.5. Support the *Commissie Natuurbeheer* (CNB)

Objective 1.6. Strengthen surveillance and enforcement

- Activity 1.6.1. Develop and implement a surveillance and enforcement plan (*handhavingsplan*)
- Activity 1.6.2. Update the Law Enforcement Handbook (*Zakboek Handhaving*)
- Activity 1.6.3. Strengthen relationship with, and clarify roles and responsibilities between, KMAR, Customs, Coast Guard and KPCN (including participating in BAVPOL meetings)
- Activity 1.6.4. Check if all commercial users of the marine park have the necessary permits
- Activity 1.6.5. Enforce fishing regulations
- Activity 1.6.6. Provide BAVPOL training for all marine park rangers
- Activity 1.6.7. Improve internal reporting (patrols, warnings, OPV and PV)
- Activity 1.6.8. Address illegal fishing by minors (develop a policy on enforcement activities involving children)
- Activity 1.6.9. Strengthen enforcement in key biodiversity sites (including the marine reserves)

**Conservation strategy 2. Improve sustainable recreation**

Objective 2.1. Strengthen working relationship with businesses operating in the marine park

- Activity 2.1.1. Ensure attendance of all dive operator staff in the mandatory annual orientation
- Activity 2.1.2. Organize an annual open day
- Activity 2.1.3. Improve cruise boat passenger management

Objective 2.2. Develop novel attractions in the marine park

- Activity 2.2.1. Develop policy and criteria regarding sinking of wrecks
- Activity 2.2.2. Create a visitor center for the marine park at Karpata
- Activity 2.2.3. Facilitate public events

Objective 2.3. Improve communication and outreach to marine park users

- Activity 2.3.1. Ensure all users receive orientation and information on fees
- Activity 2.3.2. Maintain, replace and maintain signage on rules and regulations
- Activity 2.3.3. Develop outreach materials on rules and regulations (including diving and snorkeling, fishing, surfing, foiling, drones, flamingos, kayaking, boating, and dolphin watching)
- Activity 2.3.4. Support STINAPA nature and environmental education program
- Activity 2.3.5. Expand the Reef Ranger Course with modules for other users (kayaking, windsurfing, kitesurfing, boating)
- Activity 2.3.6. Develop information for Blue Destination partners
- Activity 2.3.7. Develop guidelines for underwater photography

Objective 2.4. Develop and enforce policy for beaches

- Activity 2.4.1. Develop plans with wind- and kitesurf businesses and local kite surfers to improve the management of the beaches
- Activity 2.4.2. Develop and implement policy on fire pits, garbage and camping on beaches
- Activity 2.4.3. Enforce dog walking regulations

Objective 2.5. Improve safety at sea

- Activity 2.5.1. Liaise with Harbor Master and Coastguard to improve Search and Recovery operations
- Activity 2.5.2. Develop policy regarding use of foils (criteria, zones and rules)
- Activity 2.5.3. Ensure rental and private boats are provided with information on the marine park rules and regulations and safety on water
- Activity 2.5.4. Submit reports to the Harbor Master on relevant maritime incidents and violations
- Activity 2.5.5. Liaise with the Island Government (*eilandelijk rampen coordinator*) on the island disaster plan (*eilandelijk rampen bestrijdings plan*)

Objective 2.6. Improve recreational infrastructure in the marine park

- Activity 2.6.1. Regulate the use of swim lines and other permanent structures
- Activity 2.6.2. Improve access of people with disabilities
- Activity 2.6.3. Improve entrance/exit points for divers and other users

Objective 2.7. Develop and implement an integrated moorings policy

- Activity 2.7.1. Inspect and maintain moorings
- Activity 2.7.2. Develop a reservation system for public moorings and overnight moorings
- Activity 2.7.3. Replace mooring blocks with drilled moorings
- Activity 2.7.4. Streamline application, maintenance and payment processes for private moorings
- Activity 2.7.5. Provide input for the regulation of heavy-duty moorings

Conservation strategy 3. Encourage sustainable fishing

- Objective 3.1. Provide input into and enforce fisheries policy
 - Activity 3.1.1. Monitor Queen Conch populations
 - Activity 3.1.2. Monitor lobster populations
 - Activity 3.1.3. Monitor sharks and rays
 - Activity 3.1.4. Monitor grouper, snapper, grunt populations
- Objective 3.2. Support PISKABON
 - Activity 3.2.1. Develop contract for fishing boat moorings
 - Activity 3.2.2. Facilitate the construction of necessary infrastructure for fishers (including slipways and piers)
 - Activity 3.2.3. Support the management of FADs
 - Activity 3.2.4. Restore Queen Conch populations

Conservation strategy 4. Control invasive species and disease

- Objective 4.1. Control Lionfish
 - Activity 4.1.1. Review contracts and streamline procedure for acquiring ELFs
 - Activity 4.1.2. Organize Lionfish derbies
 - Activity 4.1.3. Monitor Lionfish population
- Objective 4.2. Monitor invasive seagrass (*Halophila stipulacea*)
- Objective 4.3. Minimize the impact of sargassum on marine ecosystems, economy and public health
 - Activity 4.3.1. Implement Sargassum Response Plan
 - Activity 4.3.2. Monitor sargassum influxes
 - Activity 4.3.3. Monitor impact of sargassum on seagrass and mangroves
 - Activity 4.3.4. Organize removal of sargassum from Lac Bay and Lagoen
 - Activity 4.3.5. Explore options to prevent sargassum from entering bays and coves
- Objective 4.4. Prepare for disease outbreaks
 - Activity 4.4.1. Implement the SCTL D Response Plan
 - Activity 4.4.2. Draft a Diadema Disease Plan

Conservation strategy 5. Support restoration of key habitats and species

- Objective 5.1. Facilitate and support coral restoration activities (with Reef Renewal)
 - Activity 5.1.1. Map Staghorn and Elkhorn Coral recovery
- Objective 5.2. Support mangrove restoration efforts (with Mangrove Maniacs)
 - Activity 5.2.1. Open and maintain hydrological channels
 - Activity 5.2.2. Support mangrove propagation and out planting
- Objective 5.3. Facilitate seagrass restoration efforts at Lac Bay and Klein Bonaire (with *Stichting Internos*)
 - Activity 5.3.1. Generate information on sand and sediment dynamics in Lac Bay
 - Activity 5.3.2. Support the out-planting of seagrass around Klein Bonaire
- Objective 5.4. Support reforestation efforts on Klein Bonaire
 - Activity 5.4.1. Remove invasive species (flora and fauna)
 - Activity 5.4.2. Monitor dry forest on Klein Bonaire
 - Activity 5.4.3. Support reforestation with Sabal palm and other native species
 - Activity 5.4.1. Develop a restoration plan for Klein Bonaire

Conservation strategy 6. Influence policy and legislation to improve park management

- Objective 6.1. Provide input to the development of policy, legislation and development plans
 - Activity 6.1.1. Provide input into the spatial development plan (ROB)
- Objective 6.2. Generate adequate structural funding for effective protected area management
 - Activity 6.2.1. Review the Service Level Agreement of the Bonaire National Marine Park
 - Activity 6.2.2. Ensure cruise passengers pay the nature fee
 - Activity 6.2.3. Lobby with National Government for permanent subsidies for protected areas, on par with subsidy structures in European Netherlands.
 - Activity 6.2.4. Improve on-line payment system for nature fee

LOOKING FORWARD

Management and policy decisions made today have long-term consequences. However, the future is uncertain and making these decisions is difficult. This requires thinking about the future and exploring factors that could give rise to possible and probable future environmental challenges and opportunities (Bengston, 2012). Considering the future helps managers and decision makers to anticipate and learn about future opportunities and challenges, helps generate visions to explore the actions they can take to shape the future, and engages relevant stakeholders to test and implement more resilient strategies and management actions.

Resilience and restoration are the key management priorities addressing the future state of the environment on Bonaire. Resilience is defined as the ability of a system to maintain key functions and processes in the face of stresses or pressures by resisting to and then recovering or adapting to change. It can be applied to both ecological systems, including temperate, tropical, and polar regions, and social systems (e.g., human communities) (see Box 10). An extensive report on Reef Resilience in Bonaire National Marine Park was written in 2011, the outcomes of which have been considered for this plan (IUCN, 2011).



Resilience includes three components:

- resistance
- recovery
- transformation

Resistance refers to the ability of a system to tolerate impacts, while recovery refers to the ability of a system to bounce back. Transformation refers to the direction of ecosystem change from a historic baseline in response to certain conditions. The modern concept of resilience emphasizes the ability of coupled social-ecological systems to persist while facing disturbance and change, adapt to future challenges, and transform in ways that sustain the ability to function and provide ecosystem services.

Resilience-based management is defined as using knowledge of current and future drivers influencing ecosystem function to prioritize, implement, and adapt management actions that sustain ecosystems and human well-being. The main goal is to identify and prioritize management actions that enhance ecosystem resilience, which is the capacity of a system to absorb or withstand stressors so that the system maintains its structure and functions in the face of disturbance and change and can adapt to future challenges. Resilience based management is founded on understanding how the system works and directing management actions to protect or enhance natural processes of resilience.

The Island Government and STINAPA have taken concrete steps to strengthen coral resilience and recovery and enforce policies to protect Bonaire's coral reefs: spearfishing was banned in 1971, corals were protected in 1975, anchoring was banned and permanent mooring buoys were installed in 1978, fish protected areas were established in 2008, and many fish species, including all parrotfish, were protected in 2010. Many of these management initiatives are believed to facilitate reef resilience and recovery from stressors such as bleaching (Steneck et al. 2019). Additionally, a wastewater treatment plant was constructed and began operating in 2015 to reduce coastal pollution, following marine management recommendations made by the IUCN Climate Change and Coral Reefs Working Group (IUCN 2011). Lastly, to foster sustainable tourism and recreation, all who dive in the Bonaire National Marine Park must have a diver orientation and are prohibited from touching or removing any marine life or objects. As the resident population of Bonaire grows and tourism resumes following COVID-19 related travel restrictions, Bonaire's government and STINAPA must continue to enact and enforce policies and legislation that safeguards coral reefs, one of Bonaire's most valuable natural resources, in the face of rising climate change related threats (Eckrich et al., 2020).

Ecological restoration, when implemented effectively and sustainably, contributes to protecting biodiversity; improving human health and wellbeing; increasing food and water security; delivering goods, services, and economic prosperity; and supporting climate change mitigation, resilience, and adaptation. Restoration engages stakeholders to repair ecological damage and when combined with conservation and sustainable use, ecological restoration is the link needed to move local, regional, and global environmental conditions from a state of continued degradation, to one of net positive improvement into the future. There are several restoration initiatives within the Bonaire National Marine Park.

Mangrove and seagrass restoration

The Mangrove Maniacs is a volunteer group focused on the restoration of mangroves. In 2021 *Stichting Internos* was the recipient of BEST 2.0+ funding. The Mangrove Restoration Project Bonaire 2021-2023 focuses on four main areas of mangrove restoration for the island:

- Improve water circulation
- Build nurseries
- Reforestation
- Increase education and awareness

STINAPA Bonaire supports the work of the Mangrove Maniacs and *Stichting Internos*.

Coral reef restoration

Active reef restoration has been underway for a number of years in marine park, spearheaded by Reef Renewal Bonaire, with a focus on the branching corals *Acropora palmata* and *A. cervicornis* which have been listed as Critically Endangered by IUCN since 2008. STINAPA is supporting Reef Renewal Bonaire to restore degraded areas of coral reef in the Bonaire National Marine Park, using active coral restoration as a strategy to preserve and enhance the population of coral species, increasing coral abundance and genotypic diversity by adding nursery-grown coral colonies or settled larvae to the wild stocks. These objectives of Reef Renewal are:

- Scaling-up the current restoration activities in Bonaire of branching and boulder corals, integrating coral fragmentation and larval propagation techniques.
- Capacity-building: strengthen and structure the Foundation to ensure project success and sustainability.
- Assisting the development of sustainable and effective restoration projects in the Caribbean, building a network and sharing knowledge among islands that are committed to restoring their local reefs.

For more information visit the Reef Renewal Bonaire Website.

MONITORING AND REVIEW

This management plan is designed to guide management and decision making for the period 2022-2028; The strategies recommended in the plan include specific objectives and activities. The progress on the implementation of this management plan should be captured and should form part of annual management effectiveness evaluations (DCNA's Management Success project) and contribute towards a process of adaptive management. Threats should be critically evaluated and monitored on a regular basis as well as key indicators for each of the marine park conservation targets to assess change and determine trends. Changes should be captured to inform future management and ensure continuity.

This management plan provides a framework for internal and external review as well as the formulation of performance indicators, which will aid the ongoing evaluation of management effectiveness. For this plan to serve the needs of STINAPA, it is critical that it is periodically reviewed and updated. The lifespan of the current management plan is six years. The plan should therefore be reviewed in detail with the Island Government, STINAPA board and staff, and stakeholders in 2028, earlier if necessary, and any necessary adaptations or changes to the management plan formulated at that time. The recommendations above for reviewing and revising the management plan should be seen as guidelines. After the management planning and review process has been consolidated, revisions may become less frequent and/or more specific.



8 REFERENCES

- Aeby, G.S., Ushijima, B., Campbell, J.E., Jones, S., Williams, G.J., Meyer, J.L. & Paul, V.J. (2019). Pathogenesis of a tissue loss disease affecting multiple species of corals along the Florida Reef Tract. *Frontiers in Marine Science* 6: 678.
- Bak, R.P.M. (1977). Coral reefs and their zonation in the Netherlands Antilles. In: *Studies in geology 4, Reefs and related carbonates – ecology and sedimentology*, pp 3-16. Edited by S.H. Frost, M.P. Weiss & J.B. Saunders. Tulsa: American Association of Petroleum Geologists.
- Bak, R.P.M., Hoetjes, P.C., Johnson, A. & Meesters, E. (2014). Part II: Report for individual countries and territories: Bonaire. In: *Status and Trends of Caribbean Coral Reefs: 1970 – 2012*. pp.184 -187. Edited by J.B.C. Jackson, M.K. Donovan, K.L. Cramer & W. Lam. Gland: Global Coral Reef Monitoring Network.
- Ballantine, D., Brooks, B. & Johnson, G. (2019). Some rarely reported deep-water macroalgal species from Bonaire, Caribbean Sea, including *Verdigellas discoidea* sp. nov. (Palmophyllaceae, Chlorophyta) based on submersible collections. *Botanica Marina* 62 (6): 587-593 <https://doi.org/10.1515/bot-2019-0026>.
- Beets, D.J. (1972a). *Lithology and Stratigraphy of the Cretaceous and Danian Succession of Curaçao*. Utrecht: Natuurwetenschappelijke Studiekring voor Suriname en de Nederlandse Antillen.
- Beets, D.J. (1972b). Outline of the Cretaceous and Early Tertiary history of Curaçao, Bonaire and Aruba. In: *Guide to the Field Excursions on Curaçao, Bonaire and Aruba, Netherlands Antilles*. Utrecht: Natuurwetenschappelijke Studiekring voor Suriname en de Nederlandse Antillen.
- Bengston, D.N. (2012) *Environmental Futures Research: Experiences, Approaches, and Opportunities*. General Technical Report NRS-P107. Newton Square: U.S. Department of Agriculture, Forest Service, Northern Research Station.
- BES reporter. (2021). Number of Hotel Rooms Bonaire to Grow 65% in Three years' time. Available from: <https://bes-reporter.com/number-of-hotel-rooms-bonaire-to-grow-65-in-three-years-time/>.
- Brauman, K. A. Daily, G.C., Duarte, T.K. & Mooney, H.A. (2007) The nature and value of ecosystem services: An overview highlighting hydrologic services. *Annual Review of Environment and Resources* 32: 67-98.
- Brown, N.A., Diaz, D., Angarita, I., Boodram, N., Bunting, G., Hadeed, A.C., Fardin, F. & Wege, D. (2019). *Ecosystem profile: The Caribbean islands biodiversity hotspot*. Washington DC: BirdLife International, Critical Ecosystem Partnership Fund.
- CBS. (2020). Trends in the Caribbean Netherlands 2020. The Hague: Statistics Netherlands. Available from: <https://longreads.cbs.nl/ticn2020/>.
- CBS. (2021). Caribbean Netherlands, Bonaire; gross value added, branches. The Hague: Statistics Netherlands. Available from: <https://opendata.cbs.nl/statline/#/CBS/en/dataset/84769ENG/table?ts=1638185566811>.
- Christianen, M. J., Smulders, F.O., Engel, M.S., Nava, M. I., Willis, S., Debrot, A.O., Palsbøll, P.J., Vonk, J.A. & Becking, L.E. (2019). Megaherbivores may impact expansion of invasive seagrass in the Caribbean. *Journal of Ecology* 107(1): 45-57.

- Crestian, A., Coolen, Q., Francisca, R. & van der Ploeg, J. (2022). *Washington Slagbaai National Park management plan 2022-2028*. Kralendijk: STINAPA.
- Davaasuren, N., & Meesters, H.W.G. (2012). *Extent and health of mangroves in Lac Bay Bonaire using satellite data*. Report: C190/11). IJmuiden: IMARES.
- DCNA. (2018). Status of the Dutch Caribbean Reefs. Available from: <https://www.dcbd.nl/sites/default/files/documents/StatusoftheReefs.pdf>.
- de Bakker, D.M., van Duyl, F.C., Bak, R.P.M., Nugues, M.M., Nieuwland, G. & Meesters, E.H. (2017). 40 years of benthic community change of the Caribbean reefs of Curaçao and Bonaire; the rise of slimy cyanobacterial mats. *Coral reefs* 36: 355-67.
- de Bakker, D.M., van Duyl, F.C., Perry, G.T. & Meester, E.H. (2019). Extreme spatial heterogeneity in carbonate accretion potential on a Caribbean fringing reef linked to local human disturbance gradients. *Global Change Biology* 25: 4092-4104.
- de Bettencourt, J. & Imminga-Berends, H. (2015). *Overseas Countries and Territories: Environmental Profiles. Caribbean Region*. Brussels: EuropeAid.
- de Buissonje, P.H. (1974). Neogene and Quaternary geology of Aruba, Curaçao and Bonaire. *Natuurwetenschappelijke Studiekring voor Suriname en de Nederlandse Antillen* 78: 1-293.
- de Freitas, J.A., Nijhof, B.S.J., Rojer, A.C. & Debrot, A.O. (2005). *Landscape ecological vegetation map of the island Bonaire (Southern Caribbean)*. Amsterdam: Royal Netherlands Academy of Arts and Sciences.
- De Meyer, K. (1998). Bonaire, Netherlands Antilles. *CARICOMP—Caribbean coral reef, seagrass and mangrove sites. Coastal Region and Small Island Papers* 3: 141-49.
- Debrot, A.O. & Bugter, R. J. F. (2010). *Climate change effects on the biodiversity of the BES islands: Assessment of the possible consequences for the marine and terrestrial ecosystems of the Dutch Antilles and the options for adaptation measures*. Wageningen: Alterra & IMARES.
- Debrot, A.O., Hylkema, A., Vogelaar, W., Meesters, H.W.G., Engel, M.S., Leon, R., Prud'homme van Reine, W.F. & Nagelkerk, I. (2012). *Baseline surveys of Lac Bay benthic and fish communities, Bonaire*. Wageningen: Alterra & IMARES.
- Debrot, A.O., Meesters, E.H. & Slijkerman, D. (2010). *Assesment of Ramsar site Lac Bonaire*. Wageningen: Alterra & IMARES.
- Debrot, A.O., Witte, R.H. & Scheidat, M. (2011). The marine mammals of the Dutch Caribbean: a comparison between EEZ sectors, contrasts and concerns. In: *A Proposal Towards a Dutch Caribbean Marine Mammal Sanctuary*. pp 93-153. Edited by Debrot, A.O., Witte, R.H., Scheidat, M. & Lucke, K. IJmuiden: IMARES.
- Debrot, A.O., van Bemmelen, R.S.A., & Ligon, J. (2013). *Bird communities of contrasting semi-natural habitats of Lac Bay, Bonaire, during the fall migration season, 2011*. Wageningen: Alterra & IMARES.
- Eckrich, C., Francisca, R.L.F., Rempel, H.S. & Ren, E. (2020). *Coral Bleaching in the Bonaire National Marine Park 2016-2020*. Kralendijk: STINAPA.
- Engel, S. & Johnson, J. (2021) *Report on Queen Conch (Lobatus gigas) Population Monitoring in Lac Bay 2020*. Kralendijk: STINAPA.

- Engel, S., Johnson, J., Bertuol, P. & van der Ploeg, J. (2022). *Bonaire's Southern Wetlands Management Plan*. Kralendijk: STINAPA, OLB & Cargill.
- Foekema, E.F. (2022). *Coastal water quality of Bonaire, St. Eustatius, and Saba during a period of restricted tourism*. IJmuiden: Wageningen Marine Research.
- Geelhoed, S.C.V., Debrot, A.O., Ligon, J., Madden, H., Verdaat, J.P., Williams, S. R., & Wulf, K. (2013). *Important bird areas in the Caribbean Netherlands*. IJmuiden: IMARES.
- Gill, D. A., Mascia, M. B., Ahmadi, G. N., Glew, L., Lester, S. E., Barnes, M., ... & Fox, H. E. (2017). Capacity shortfalls hinder the performance of marine protected areas globally. *Nature* 543 (7647): 665-669.
- Gyorvy, J., Mariano, A.J. & Ryan, E.H. (not dated). The Caribbean Current. Ocean Surface Currents. Available from: <https://oceancurrents.rsmas.miami.edu/caribbean/caribbean.html>.
- ISRS. 2018. Revised ISRS Consensus Statement on Climate Change and Coral Bleaching. Available from: <https://icriforum.org/documents/isrs-consensus-statement-on-coral-bleaching-climate-change-final/>
- Info Bonaire. (not dated). Bonaire's History. Available from: <https://infobonaire.com/about-bonaire/history/>.
- Info Bonaire. (not dated). Birdwatching on Bonaire is a Rewarding Experience. Available from: <https://infobonaire.com/birdwatching-bonaire/#article>.
- IUCN. (2011). *Coral Reef Resilience Assessment of the Bonaire National Marine Park, Netherlands Antilles*. Gland: IUCN.
- Jackson, J., Donovan, M., Cramer, K., & Debrot, A.O. (2014). Part I: Overview and synthesis for the wider Caribbean region. In *Status and Trends of Caribbean Coral Reefs: 1970 – 2012*. pp. 55-154. Edited by J. B. C. Jackson, M. K. Donovan, K. L. Cramer, & V. Lam. Gland: Global Coral Reef Monitoring Network.
- Kenchington, R.A. (1990). *Managing marine environments*. New York: Taylor and Francis.
- Lemaitre, R. (2017). Discovery of a new species of hermit crab of the genus *Pylopaguropsis* Alcock, 1905 from the Caribbean: "den commensal" or "cleaner"? (Crustacea, Anomura, Paguridae). *ZooKeys* 646: 139.
- LNV, I&W & BZK (2020). *Beleidsplan Natuur en Milieu Caribisch Nederland 2020-2030*. Den Haag: LNV.
- Lodder, T. (2014). Identifying the niche of four mangrove species along environmental gradients MSc thesis. Wageningen: WUR
- Lott, C.J. (2001). Lac Bay: Then and Now...: *A Historical Interpretation of Environmental Change During the 1900s. A Site Characterization of Lac Bay for Resource Managers and Naturalists*. Kralendijk: Environics.
- MacDonald, S. (2019) *Roadmap towards effective fisheries management on the Caribbean Netherlands*. Zeist: WNF.
- Meesters, E.H., Bak, R.P., & Van Duyl, F.C. (2020). Commentary: Managing recovery resilience in coral reefs against climate-induced bleaching and hurricanes: a 15-year case study from Bonaire, Dutch Caribbean. *Frontiers in Marine Science* 7: 346.

- MeteoBlue. (2022). *Observed historical climate & weather data for Bonaire Island*. Available from: https://www.meteoblue.com/en/weather/historyclimate/climateobserved/bonaire-island_bonaire%2c-saint-eustatius%2c-and-saba_3513881
- Meyer, J. L., Castellanos-Gell, J., Aeby, G.S., Häse, C.C., Ushijima, B. & Paul, V.J. (2019). Microbial community shifts associated with the ongoing stony coral tissue loss disease outbreak on the Florida Reef Tract. *Frontiers in Microbiology* 2244.
- Muller, E. M., Sartor, C., Alcaraz, N. I. & Van Woesik, R. (2020). Spatial epidemiology of the stony-coral-tissue-loss disease in Florida. *Frontiers in Marine Science* 7: 163.
- Noonan, K.R. & Childress, M.J. (2020). Association of butterflyfishes and stony coral tissue loss disease in the Florida Keys. *Coral Reefs* 39: 1581-1590.
- Obura, D.O., Aeby, G., Amornthammarong, N., Appeltans, W., Bax, N., Bishop, J., ... & Wongbusarakum, S. (2019). Coral reef monitoring, reef assessment technologies, and ecosystem-based management. *Frontiers in Marine Science* 6: 580.
- OLB. (2020). *Natuurplan Bonaire 2020-2024*. Available from: <https://www.dcbd.nl/sites/default/files/documents/2020000661%20Aangepaste%20natuurplan%20Bonaire%202020-2024.pdf>.
- OLB. (2021). *Tourism Recovery Plan 2021*. Available from: <https://www.tourismbonaire.com/includes/tourism-recover-plan.pdf>.
- Pattengill-Semmens, C.V. (2002). The reef fish assemblage of Bonaire Marine Park: an analysis of REEF Fish Survey Project data. *Proceedings 53rd Gulf and Caribbean Fisheries Institute* 53: 591-605.
- Precht, W.F., Gintert, B.E., Robbart, M.L., Fura, R. & Van Woesik, R. (2016). Unprecedented disease-related coral mortality in Southeastern Florida. *Scientific reports* 6: 1-11.
- Roberts, C., & Hawkins, J. (1994). *Report on the Status of Bonaire's Coral Reefs*. St. Thomas: University of the Virgin Islands.
- Roos, P.J. (1971). The shallow-water stony corals of the Netherlands Antilles. *Studies of Fauna of Curaçao and other Caribbean Islands* 37: 1-108.
- Schaap, I., & Slijkerman, D.M. (2018). An environmental risk assessment of three organic UV-filters at Lac Bay, Bonaire, Southern Caribbean. *Marine pollution Bulletin* 135: 490-495.
- Senger, D.F., Hortua, D.S., Engel, S., Schnurawa, M., Moosdorf, N. & Gillis, L.G. (2021). Impacts of wetland dieback on carbon dynamics: A comparison between intact and degraded mangroves. *Science of the Total Environment* 753: 141817
- Serafini, D. & Salisbury, C. (2020). *The Windjammer, Bonaire*. Available from: <https://dreamwrecks.com/windjammer-bonaire-wreck>.
- Sharp, W.C., Shea, C.P., Maxwell, K.E., Muller, E.M. & Hunt, J.H. (2020). Evaluating the small-scale epidemiology of the stony-coral-tissue-loss-disease in the middle Florida Keys. *PLoS One* 15: 11 e0241871.
- Slijkerman, D.M.E., Henkens, R., Debrot, A.O., van der Geest, M., & Mùcher, S. (2019). *Nexus interventions for small tropical islands: case study Bonaire*. Den Helder: Wageningen Marine Research.

- Slijkerman, D.M.E., Leon, R., de Vries, P. & Koelemij, E.I. (2013). *Water quality of the coastal zone of Bonaire: results field monitoring 2011-2013*. Wageningen: IMARES.
- Smith, S.R., Davaasuren, N., Debrot, A.O., Simal, F., & De Freitas, J.A. (2012). *Preliminary inventory of key terrestrial nature values of Bonaire*. IJmuiden: IMARES.
- Smulders, F.O., Becker, S.T., Campbell, J.E., Bakker, E.S., Boässon, M.J., Bouwmeester, M.M. & Christianen, M.J. (2022). Fish grazing enhanced by nutrient enrichment may limit invasive seagrass expansion. *Aquatic Botany* 176: 103464.
- Steneck, R.S., Arnold, S.N., Boenish, R., De León, R., Mumby, P.J., Rasher, D.B. & Wilson, M.W. (2019). Managing recovery resilience in coral reefs against climate-induced bleaching and hurricanes: a 15-year case study from Bonaire, Dutch Caribbean. *Frontiers in Marine Science* 6: 265.
- Steneck, R.S. & McClanahan, T.R. (2003). *A report on the status of the coral reefs of Bonaire with advice on the establishment of fish protection areas*. Walpole: University of Maine.
- STINAPA. (2015). *Strategic Plan 2015–2020*. Kralendijk: STINAPA.
- STINAPA. (2020). *Conservation Action Plan*. Kralendijk: STINAPA.
- Stormcarib. (2012). Climatology of Caribbean hurricanes. Available from: https://stormcarib.com/climatology/TNCB_all_isl.htm.
- Sussman, M., Loya, Y., Fine, M., & Rosenberg, E. (2003). The marine fireworm *Hermodice carunculata* is a winter reservoir and spring summer vector for the coral bleaching pathogen *Vibrio shiloi*. *Environmental Microbiology* 5(4): 250-255.
- UNEP. (2019). *Seagrass—secret weapon in the fight against global heating*. Available from: https://www.unep.org/news-and-stories/story/seagrass-secret-weapon-fight-against-global-heating?_ga=2.138317430.790883108.1636725712-708883088.1636535633.
- van Beek, I., Cremer, J., Meesters, H., Becking, J. & Langley, M. (2014). *The potential Outstanding Universal Value and natural heritage values of Bonaire National Marine Park: an ecological perspective*. Wageningen: IMARES.
- van Beek, I., Debrot, A.O., de Graaf, M. (2013). *Elasmobranchs in the Dutch Caribbean: current population status, fisheries and conservation*. Wageningen: IMARES.
- van Beukering, P., van Oosterhout, L., Schep, S., Duijnmeijer, C., Dullaart, J., Koks, E., Tiggeloven, T., van Manen, S., Buijs, S., de Boer, M., van der Knaap, M., Baertz, A. & Ouwersloot, B. (2022). *The impacts of climate change on Bonaire*. Amsterdam: IVM.
- van der Geest, M., Meesters, E., Mûcher, S. (2020). *Impact of terrestrial erosion on coral reef health at Bonaire: a plea for nature-inclusive watershed-to-reef based coastal management*. Den Helder: Wageningen Marine Research.
- van der Zee, J.P., Christianen, M.J., Nava, M., Velez-Zuazo, X., Hao, W., Bérubé, M., van Lavieren, H., Hiwat, M., Berzins, R., Chevalier, J. & Chevallier, D. (2019). Population recovery changes population composition at a major southern Caribbean juvenile developmental habitat for the green turtle, *Chelonia mydas*. *Scientific reports* 9(1): 1-11.

- van Duyl, F. C. 1985. *Atlas of the Living Reefs of Curaçao and Bonaire (Netherlands Antilles)*. Utrecht: Natuurwetenschappelijke Studiekring voor Suriname en de Nederlandse Antillen.
- Van Erp, G.J.A. (2021). *Marine Waste Water Survey Bonaire 2021*. Kralendijk: WNF, STINAPA, WEB & OLB.
- van Moorsel, G. & Meijer A. 1993. *Base-Line Ecological Study van het Lac op Bonaire*. Culemborg: Bureau Waardenburg BV.
- van Zee, R. (2022). *The role of creeks for tidal exchange in the mangrove forest of Lac Bay, Bonaire*. MSc. thesis. Enschede: University of Twente.
- Verweij, P., Cormont, A., Nel, J., de Rooij, B., Jones-Walters, L., Slijkerman, D., Soma, K., van Eurpen, M., Pourier, S. & Coolen, Q. (2020). *A nature inclusive vision for Bonaire in 2050*. Wageningen: Wageningen Environmental Research.
- Verweij, P., Meesters, H., & Debrot, A.O. (2015). *Indicators on the status and trends of ecosystems in the Dutch Caribbean: indicators, monitoring and assessment methods and capacity estimates*. Wageningen: Alterra.
- Voous, K.H. (1983). *Birds of the Netherlands Antilles*. Zutphen: De Walburg Pers.
- Vreugdenhil, D., Terborgh, J., Cleef, A.M., Sinitzyn, M., Boere, G.D., Archaga, V.L. & Prins, H.H.T. (2003). *Comprehensive Protected Areas System Composition and Monitoring*. Shepherdstown: WICE.
- Wells J. & Debrot, A.O. (2008). Bonaire. In: *Important Bird Areas of the Caribbean: Key Sites for Conservation*. Edited by D.C. Wege & V. Anadon-Irizarry. Cambridge: BirdLife International.
- Willette, D.A., Chalifour, J., Debrot, A.O., Engel, M.S., Miller, J., Oxenford, H.A., ... & Védie, F. (2014). Continued expansion of the trans-Atlantic invasive marine angiosperm *Halophila stipulacea* in the Eastern Caribbean. *Aquatic botany* 112: 98-102.
- Winters, G., Beer, S., Willette, D. A., Viana, I. G., Chiquillo, K. L., Beca-Carretero, P., ... & Rilov, G. (2020). The tropical seagrass *Halophila stipulacea*: reviewing what we know from its native and invasive habitats, alongside identifying knowledge gaps. *Frontiers in Marine Science* 7: 300.
- Wolfs, E. & van Beukering P. (2013a). *What's Bonaire's Nature Worth?* Amsterdam: VU, WUR & LNV.
- Wolfs, E. & van Beukering, P. (2013b). *Fishery value of coral reefs in Bonaire*. Amsterdam: VU, WUR & LNV.
- Wolfs, E., Schep, S., Gallegos, V.L. & van Beukering, P. (2015). *What is Bonaire's Cruise Tourism worth?* Amsterdam: VU, WUR & LNV.
- Wosten, J.H.M. (2013). *Ecological rehabilitation of Lac Bonaire by wise management of water and sediments*. Wageningen: Alterra.
- Zaneveld, J. S. (1958). A Lithothamnion bank at Bonaire (Netherlands Antilles). *Blumea* 4(1): 206-219.

APPENDIX A



RAMSAR SITE

KLEIN BONAIRE

Ramsar Site #201
Designated on May 23, 1980

LOCATION

Klein Bonaire covers 690 ha and lies approximately 750 m offshore from Kralendijk (Figure 32). The Ramsar site boundary includes a buffer zone around the entire island, which lies 500 m from the highwater mark. The buffer zone was recognized in 2021 and due to the steeply sloping near shore bathymetry, the Ramsar site now also includes coral reefs and deep-water environments. With the inclusion of the buffer zone, the official site area is 1,295 ha. Within the buffer zone there are extensive, biodiverse, fringing coral reefs, areas of seagrass as well as deep water environments where the seabed slopes to depths of around 180 m (Figure 33).



Figure 32: Klein Bonaire Ramsar site

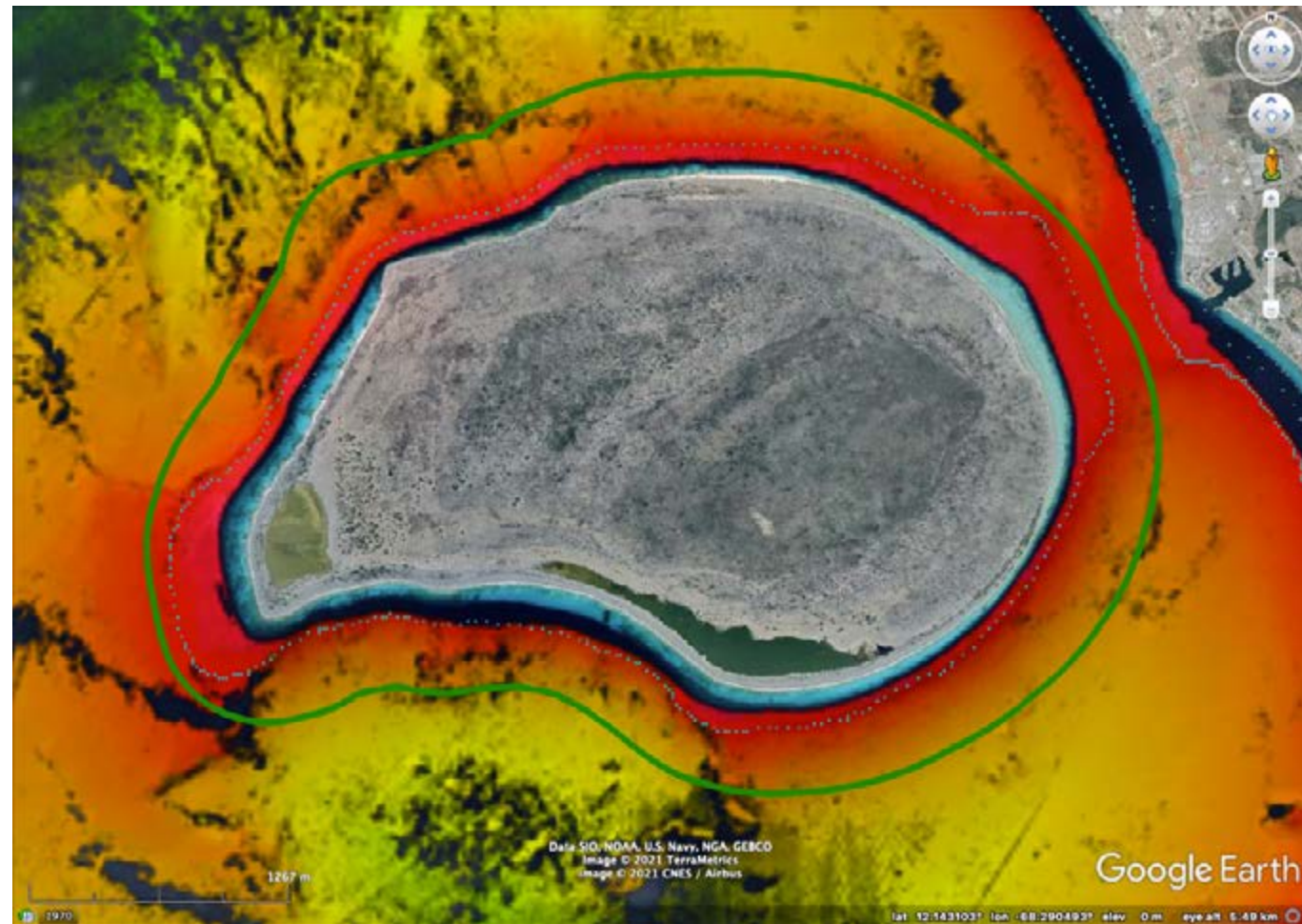


Figure 33: Klein Bonaire Ramsar Site buffer zone extends beyond the legal boundary of Bonaire National Marine Park, and includes deep water environments up to 300 m depth

LEGAL STATUS

In 1868, Klein Bonaire was purchased by Angel Jesurun. The island remained in private hands until 1999. During this period the native trees were removed and the island was heavily grazed by goats, resulting in the growth of scrub across the island. During the 1980s and 1990s plans were developed to develop the island for tourism. Concerned local residents, led by conservation pioneer Bruce Bowker, rallied support for the preservation of the island and established The Foundation for the Preservation of Klein Bonaire (FPKB). After a decade-long campaign the Island Government purchased Klein Bonaire.

Klein Bonaire falls entirely within the Bonaire National Marine Park. Klein Bonaire is protected under the Nature Ordinance (A.B. 2008 No.23) and Island Resolution (A.O 2010 No.15). Klein Bonaire is classified as nature in Bonaire's Spatial Development Plan (ROB), which means that Klein Bonaire can be used for the conservation, restoration, development and management of its landscape, biodiversity and ecological values, as well as for sustainable recreational activities such as walking and beach visitation.

RAMSAR CRITERIA

The following information has been adapted from the 2021 Ramsar Information Sheet.

Criterion 1: Representative, rare or unique natural or near-natural wetland types

Spiritual and aesthetic

Bonaire's ecosystems support tourist activities that depend on the quality of the natural environment, such as diving, snorkeling, kayaking, boating, enjoying beaches, and participating in land activities. The expenditure by tourists on Bonaire is around USD 125 million annually.

Supporting

The freshwater springs on the island provide water for wildlife. The saliñas provide food for migratory birds, while the retention of rainwater and sediments prevents siltation of the reefs. Fishing provides an important source of income and livelihood on Bonaire, also many people fish for recreational purposes. A large part of the catch is composed of reef-dependent species.

Uniqueness

Klein Bonaire is one of the last remaining, uninhabited and naturally vegetated islands of its size in the Caribbean. It has three saliñas, five freshwater springs and sandy beaches making it an important stop-over site for migratory water bird species, breeding site for terns and nesting site for sea turtles. The fringing coral reefs are home to virtually every species of hard and soft coral found in the Caribbean (IUCN, 2011). More than 340 fish species can be found on the reefs surrounding Klein Bonaire, making it one of the healthiest, most resilient and most bio-diverse reefs in the region. Conservation International considers the waters around Bonaire (including Klein Bonaire) to be a hotspot of Caribbean biodiversity.

Criterion 3: Biological diversity

Coral reefs

Bonaire's fringing coral reefs are home to virtually every species of hard and soft coral found in the Caribbean. More than 340 fish species live here, making it one of the healthiest and most bio-diverse reefs in the region.

Beaches

The sandy beaches of Klein Bonaire are the main nesting areas for sea turtles at Bonaire. Each year an average of 60 nests of the critically endangered Hawksbill (*Eretmochelys imbricate*) and the endangered Loggerhead (*Caretta caretta*) turtles can be found here.

Karst

Klein Bonaire has a substantial system of subterranean karst caves that provide access to fresh groundwater. This is the habitat of freshwater shrimps (*Macrobrachium lucifugum* and *Typhlatya monae*). The exact area (ha) and biological diversity of the cave system is still unclear.

Birds

Birdlife International has designated Klein Bonaire as an Important Bird Area for Bonaire. The island is a stop-over point for many species of migratory wetland birds, and an important breeding site for terns, notably regionally important Least Terns (*Sterna antillarum*). Klein Bonaire is also significant for the restricted-range species Caribbean Elaenia (*Elaenia martinica*).

Satinwood

Biodiversity values are recovering after removal of goats in the 1980s. The island has a significant number of threatened West-Indian Satinwood (*Zanthoxylum flavum*).

Bats

The Latin America and Caribbean Bat Conservation Network (RELCOM) designated Klein Bonaire as an Area of Importance for Bat Conservation (AICOM) in December 2018. The cacti on Klein Bonaire have high production rate of flowers and fruits, suggesting high foraging activity of the two nectar-feeding bats that live on Bonaire (*Glossophaga longirostris* and *Leptonycteris curasoae*).

	Rank of extent (1: greatest - 4 least)	Area (ha)
C: Coral reefs	1	60
A: Permanent shallow marine waters	2	56
J: Coastal brackish / saline lagoons	3	32
E: Sand, shingle or pebble shores	4	4
G: Intertidal mud, sand or salt flats	0 (unknown)	
Zk(a): Karst and other subterranean	0 (unknown)	

Table 21: Extent of Ramsar habitats around Klein Bonaire

Criterion 8: Fish spawning grounds, etc.

The shallow reefs (0 to 4 m depth) in the buffer zone around Klein Bonaire harbor dense populations of Elkhorn Coral (*Acropora palmata*) and Fire Coral (*Millepora complanata*). These complex structures provide critical nursery habitat for specific reef fish species, such as juveniles of the Smallmouth Grunt (*Haemulon chrysargyreum*), Mahogany Snapper (*Lutjanus mahogany*), Blue Tang (*Acanthurus coeruleus*), Ocean Surgeonfish (*Acanthurus bahianus*) and Sergeant Major (*Abudefduf saxatilis*).



FEATURES

Geology

Klein Bonaire is relatively flat, with a maximum relief of 7 m and most of the island being no more than 2 m above sea level. Klein Bonaire is made up of emergent reefs with associated former shorelines and wave eroded benches or solution notches which is a feature unique to these oceanic islands.

The water retention of the soil is poor so most rainfall quickly runs-off into permanently or temporarily flooded salinas, or directly into the sea (Roos, 1971). Any water falling on exposed limestone swiftly percolates through the rock into the groundwater and eventually discharges into the sea.

Klein Bonaire is entirely formed from limestone sedimentary deposits, with the middle limestone terrace forming the central part of the island and the lower terrace encircled by sandy and coral shingle beaches. A detailed study of the landscape ecology was carried out and published in 2005 (de Freitas et al., 2005).

Marine habitats

Klein Bonaire is surrounded by continuous, fringing coral reefs which are home to around 60 different species of corals. Reefs stretch from the shoreline seaward to depths in excess of 70 m. There are sparse stands of seagrass around Klein Bonaire, but little is known about its condition. Garbage from the main island can be found littering the eastern shoreline of Klein Bonaire. The impact of terrestrial run-off on Klein Bonaire is unknown.

No Name is the most extensive beach on Klein Bonaire. Other small, pocket beaches exist around the island in small coves. Small dunes can be found at the back of beaches on Klein Bonaire. Generally, native dune grasses, trailing vines and small perennials are the hardiest species and are found on the seaward face of the dunes. Shrubs and trees are more abundant in the back-dune zone. The beaches of Klein are critical nesting sites for 3 species of turtles: Green Turtle (*Chelonia mydas*) Hawksbill Turtle (*Eretmochelys imbricata*) and Loggerhead Turtle (*Caretta carreta*). No Name beach on the northeastern shore of Klein is Bonaire's most important turtle nesting site and is frequently checked for turtle nesting activity by staff and volunteers from the Sea Turtle Conservation Bonaire foundation. The beaches of Klein Bonaire are in generally good condition although No Name beach is disturbed, trampled and often littered by visitors who come in in high numbers, particularly at the weekend.

Rocky shores are found around Klein Bonaire where beaches have not formed. The rocky shores of Klein are intact.

Cultural heritage

Klein Bonaire has seen numerous activities take place through the 19th and 20th century, including charcoal production, lime production, fishing, livestock husbandry (free roaming goats), collection of iguana, crab and conch for consumption, collection of terrestrial plants for medicines and collection of parakeets (*prikichi*) for the pet trade.

Monuments
Lighthouse
Quarantine building
Supervisor hut
Yellowman's house
Fresh water wells
Goat pens

Table 22: Historic monuments on Klein Bonaire

VALUE STATEMENT

The marine environment of Klein Bonaire is unique in the Caribbean being one of only four true oceanic islands separated from the South American mainland by a deep water trench. Klein Bonaire lies within Bonaire National Marine Park, which was established in 1979 and has been under active management since 1991, recognized as a National Park by the National Government of the Netherlands and as a Demonstration site by UNEP (United Nations Environment Programme) and ICRAN (International Coral Reef Action Network).

Klein Bonaire includes 60 ha of globally threatened coral reef, which are some of the healthiest in the Caribbean according to data from the Atlantic and Gulf Rapid Reef Assessment protocol. The entire site is recognized as an Important Bird Area by BirdLife International, and No Name beach is a critical nesting site for sea turtles. Klein Bonaire is a hotspot for tourism, attracting visitors and locals for diving, snorkeling and beach activity, contributing to the income for the island's population employed in restaurants, hotels and other services.

Plant species

The vegetation on Klein Bonaire was heavily degraded up until the 1980s due to grazing by feral goats and collection for charcoal production. A reforestation project started in 2006, focusing on plants with small populations and/or under threat of becoming locally extinct (Table 23). These included native plants that play a significant ecological role for birds or other fauna, such as Watakeri (*Bouyeria succulenta*), Mansaliña Bobo (*Metopium brownei*), Palu di Huku (*Jacquinia arborea*) and Palu di Rhambèshi (*Sideroxylon obovatum*).

Since 2006 a considerable recovery has taken place. Some species are now blossoming and carrying fruits, such as Palu di Huku, Watakeri, Mansali a Bobo, Lumbra Blanku and Uña di Gatu (*Pithecellobium unguis-cati*). These trees are a critical food source for endangered bird species during the dry season. Formerly, the Scaly-naped Pigeon (*Patagioenas squamosa*) and the Yellow-shouldered Amazon parakeet (*Amazona barbadensis*) frequented Klein Bonaire, but prior to 2009 neither had been seen. Since the reforestation efforts ended in 2009, some Scaly-naped Pigeons have been observed on Klein Bonaire (Geelhoed et al., 2013). On Klein Bonaire 76 different species of flora were recorded: 21 trees, 12 shrubs, 20 herbs, 17 species of grasses, 5 succulents and 1 water plant. The seagrass *Halophila engelmannii* (Star Grass) is also listed as Near Threatened by IUCN Red List.

Scientific name	Name (English/Papiamentu)	IUCN Red List	Ramsar Criterion		
			2	3	4
<i>Bouyeria succulenta</i>	White Chank / Watakeri	LC		x	
<i>Erithalis fruticosa</i>	Flambeau / Palu Pretu	LC		x	
<i>Jacquinia arborea</i>	Picrous Bark / Palu di Huku			x	
<i>Metopium brownei</i>	Mansaliña Bobo	LC		x	
<i>Pithecellobium unguis-cati</i>	Crab wood / Beishi di Yuana	LC		x	
<i>Sideroxylon obovatum</i>	Breakbill / Rambèshi			x	
<i>Zanthoxylum flavum</i>	Yellow sanders / Kalabari	VU	x	x	

Table 23: Plant species of international importance on Klein Bonaire

Animal species

There are 94 animal species listed on the IUCN Red List as Critically Endangered, Endangered or Vulnerable that are likely to be found in the Klein Bonaire Ramsar site (Table). The coral reefs of Klein Bonaire were described in 1952 by marine explorer Hans Hass as having 'jewfish flowing over the reef' (Atlantic Goliath Grouper, *Epinephelus itajara* - IUCN Red List Critically Endangered).

Common group name	Scientific name	English	Papiamentu
Corals - stony	<i>Acropora cervicornis</i>	Staghorn Coral	Koral Kachu di Biná
Corals - stony	<i>Acropora palmata</i>	Elkhorn Coral	Koral Kachu grandi
Fish	<i>Epinephelus itajara</i>	Atlantic Goliath Grouper, Jewfish,	djukfes
Fish	<i>Epinephelus striatus</i>	Nassau Grouper	jakupepu
Fish	<i>Hyporthodus nigritus</i>	Warsaw grouper	
Sharks and rays	<i>Carcharhinus longimanus</i>	Oceanic Whitetip Shark	
Sharks and rays	<i>Pristis pectinata</i>	Sawfish, Smalltooth Sawfish	Zaag
Sharks and rays	<i>Pristis pristis</i>	Large-tooth sawfish	
Reptiles - turtles	<i>Dermochelys coriacea</i>	Leatherback Turtle	Drikil
Reptiles - turtles	<i>Eretmochelys imbricata</i>	Hawksbill Turtle	karèt

Table 24: Critically endangered species on Klein Bonaire

USE OF KLEIN BONAIRE

Klein Bonaire is a hotspot for visitors taking part in diving, snorkeling, beach use and other watersport. These are summarized in Table 25. There are 21 dive site moorings around Klein Bonaire.

Use	Notes	English
Beaches	No Name	No Name beach is a hotspot for recreational activities. People visit to snorkel and relax on the beach. The lack of facilities including toilets is an on-going issue. People often bring their own BBQ facilities and feed wildlife. Overnight stays: historically there has been a limit to one night per stay, outside of turtle nesting season.
	Other beaches	Other beaches on Klein Bonaire, within small coves, are occasionally visited and used recreationally by local people.
Hiking		A system of simple low-impact hiking trails is being set up on Klein Bonaire which will allow visitors to enjoy sites of cultural and biological interest and outreach material is planned. The danger currently is that anyone hiking on the island may easily become disoriented and lost.
Watersport	Diving	
	Snorkeling	
	Kite surfing	
Watercraft	Dive boats	
	Hire boats	
	Charters	
	Private	
	Tour boats	Bonaire Destination Service 3 tours, Fiesta 1 tour
Fishing	Artisanal	
	Commercial	

Table 25: Use of Klein Bonaire

STAKEHOLDERS

Meetings were held in the final quarter of 2022 with stakeholders. The main points of feedback are provided below:

- Need for on-site visitor management
- Visitor statistics are needed and carrying capacity needs to be established, particularly at No Name beach
- Mooring management is problematic, and a booking system is needed
- Need to adhere strictly to the no development regulations
- Clarify legislative protection
- Provision of facilities is a source of tension, particularly toilet facilities on the beach
- Increasing use of Klein Bonaire and overcrowding at No Name beach

A summary of stakeholder feedback can be found in Appendix F. The relevant feedback from stakeholders has been integrated into the plan for the coming management period.

CONSERVATION EFFORTS

A reforestation site was established in 2010 at the supervisor's hut (near the well known as Pos di Kas). A second site was created in 2012 adjacent to the huts at No Name Beach. Many of these trees have survived well and are producing seedlings. The conservation of Bonaire's native Sabal Palm inspired the final phase of the reforestation efforts on Klein Bonaire with the planting in 2021 of 300 Sabal Palm seedlings.

MANAGEMENT PLAN

Objective A.1. Develop a shared vision for sustainable recreation

Activity A.1.1. Develop, publicize and enforce a zoning plan

Activity A.1.2. Minimize disturbance to turtle nests (with STCB)

Objective A.2. Strengthen management, surveillance and enforcement

Activity A.2.1. Ensure permanent ranger presence on Klein Bonaire

Activity A.2.2. Meet and greet all visitors, and check payment of the nature fee

Activity A.2.3. Construct a watchtower and ranger post

Activity A.2.4. Ensure all users receive information on rules and regulations

Objective A.3. Improve recreational infrastructure

Activity A.3.1. Improve landing zone at No Name beach

Activity A.3.2. Install dry composting toilets and shade structures

Activity A.3.3. Improve garbage collection

Activity A.3.4. Create hiking trails with signage

Activity A.3.5. Restore monuments



APPENDIX B



RAMSAR SITE LAC BAY

Ramsar Site #199
Designated on May 23, 1980

LOCATION

Lac Bay is located on the southeastern shore of Bonaire, about 7 km southeast of Kralendijk between 12007'35.6" north, 12007'30.3" south, 068014'30.3" west and 068012'51.1" east. It covers 1,550 ha and includes a sheltered 824 ha shallow bay with a 500 m buffer zone (726 ha). This buffer zone includes an estimated 183 ha of the Caribbean Sea (of which 19 ha between 0-6 m deep) with fringing coral reefs and algal beds sloping down in excess of 80 m depth (Figure 34). Lac Bay is located within the Bonaire National Marine Park.



Figure 34: Lac Bay Ramsar Site

Landward, Lac Bay is surrounded along its northern perimeter by agricultural land used for extensive livestock grazing (predominately goats). Lac is the natural catchment area for run-off from surrounding agricultural land. Poor land and water management of surrounding agricultural land has led to a high sediment load accumulating through run-off in the back mangrove area to the north of Lac Bay, the so-called 'Awa di Lodo' (mud waters) (Wosten, 2013).

Approximately 500 m to the south and west of the Lac Bay buffer zone are extensive brackish water ponds are used for salt production and managed by Cargill Salt Company. In the past these ponds also received discharge from an aquaculture facility called Marcultura.

Seawards, outside of the Bay, there are coral reefs and macro-algae beds, deeper water environments and open ocean.

LEGAL STATUS

Lac Bay falls within the Bonaire National Marine Park. Management authority is ceded to STINAPA Bonaire as the management body for the Bonaire National Marine Park, and covered under the management agreement established between the Island Government of Bonaire and STINAPA Bonaire in 1991. Lac Bay is protected under the Nature Ordinance (A.B. 2008 No.23) and Island Resolution (A.O 2010 No.15) and is designated as a Nature Area under Bonaire's Spatial Development Plan (ROB), which means that Lac can only be used for the conservation, restoration, development and management of its landscape, biodiversity and ecological values, as well as for sustainable recreational activities such as walking and beach visitation. It was designated a Ramsar site on May 23, 1980.

RAMSAR CRITERIA

The following information has been extracted from the Lac Bay Ramsar Information Sheet (2021).

Criterion 1: Representative, rare or unique natural or near-natural wetland types

Hydrological services provided

1. Water damage mitigation: this hydrological service concerns reduction of flood damage, dryland salinization, saltwater intrusion and sedimentation (Brauman et al., 2007). This service does apply to Lac Bay in the sense that the reefs and mangroves serve as coastal protection. The annual coastal protection values of the nearshore reef-associated habitats of Bonaire (including Lac Bay) as a whole for short-term (within 10 years) and long-term processes (beyond 10 years) are estimated at USD 33,000 and USD 70,000, respectively. Siltation of eroded sediment takes place in the mangroves and prevents siltation of the coral reefs, which in return safeguards the reefs' coastal protection function.

2. Spiritual and aesthetic: this service concerns provision of religious, educational and tourism values. Bonaire's ecosystems support tourism activities that depend on the quality of the natural environment. These include diving, snorkeling, kayaking, boating, enjoying beaches, wind and kite surfing and participating in land-based sightseeing activities. The expenditure by tourists on Bonaire is found to be around USD 125 million annually, of which around USD 50 million is contributed by Bonaire's nature to tourism. Marine ecosystems are found to be more economically significant than terrestrial ecosystems on the island.

3. Supporting: this service concerns water and nutrients to support vital estuaries and other habitats, preservation of options. This hydrological service also applies to Lac Bay. The lagoon supports a variety of wildlife and landscapes which can be enjoyed by a variety of tourists, while its fish nursery function supports fisheries and the values for snorkeling and scuba diving.

Other ecosystem services provided

Fishing provides an important source of income and livelihood on Bonaire, also many people fish for recreational purposes. A large part of the catch is composed of reef-dependent species. The reef related total commercial fisheries for Bonaire as a whole are valued at almost USD 400,000 annually, while the recreational fishery value is estimated at an economic value of almost USD 700,000 per annum. Lac accounts for more than 95 percent of the seagrass and mangrove habitat on Bonaire which act as a critical nursery for fish species.



Criterion 3: Biological diversity

Lac Bay represents one of the largest natural inland bays in the Caribbean. It contains thriving seagrass beds and actively growing mangroves as well as coral reefs and is the only site on Bonaire where these three ecosystems are continuous. Lac Bay is an important nursery site for conch and many species of reef fish as well as being a critical foraging habitat for the globally endangered Green Turtles and Rainbow Parrotfish (*Scarus guacamaia*). Patches of reefs form behind a barrier of coral rubble that separates the lagoon from the sea. These reefs are an important sleeping area for sea turtles. The fringing reefs are part of the Bonaire National Marine Park which is home to virtually every species of hard and soft coral found in the Caribbean. More than 340 fish species live here, making it one of the healthiest, most resilient and most bio-diverse reefs in the region. Conservation International considers the waters around Bonaire (including Klein Bonaire) to be a hotspot of Caribbean biodiversity. The Ramsar Site supports significant numbers of breeding, wintering and foraging wetland birds (Wells & Debrot, 2008). Breeding birds of particular interest are the Reddish Egret (*E. rufescens*), Snowy Plover (*Charadrius alexandrina*), Wilson's Plover (*C. wilsonia*) (Debrot et al., 2012).

Criterion 8: Fish spawning grounds.

The large areas of mangrove forests and associated seagrass beds of Lac Bay are of great value as nursery habitat for Queen Conch and many important reef fish species including snappers, grunts and groupers. It's the most important fish nursery habitat of Bonaire (Debrot et al., 2012). The fringing reefs around Lac Bay as well have an important nursery function for fish species.

FEATURES

Ecology

Lac Bay is a clear-water, shallow (max. depth some 4.5 m) tropical lagoon of approx. 7 km² opening onto the wave- and wind-exposed east coast of the island of Bonaire. The bay is protected from the open ocean by exposed fringing coral reefs that protect it from wave action. Waves break over the reef, flood the bay, driving a clockwise circulation pattern with water flowing out through a deep-water channel at the northernmost tip of the bay adjacent to Lac Bay creating a rip current. Some patch reefs have formed in the shallow areas of the bay and through the extension of the site into the buffer zone, fringing reefs also add to the ecological character of the site. Lac Bay has two sandy peninsular formations on the seaward side, Lac Cai and Sorobon, north of Lac Bay are large expanses of salt flats and small salinas.

Lac Bay contains actively growing mangroves (around 280 ha) and thriving seagrass and algal beds. Mangroves fringing open waters had highest overall fish densities and species diversity likely due to edge effects and complex shaded structures. The various vegetated sub-habitats all played a unique role for different size classes of different fish species. The central bay and blue pool habitats are known to support Mullet, Ladyfish and Tarpon populations.

Long-term changes driven by mangrove expansion into this non-estuarine lagoon have been steadily reducing the net coverage of clear, well circulated open bay, while the surface of shallow, muddy, stagnant, hypersaline backwaters has been increasing. These backwaters are unable to support either meaningful mangroves, seagrass or algal meadows. Consequently, the long-term biodiversity and ecosystem function of the bay could be at stake and management action is needed to stem further erosion of nursery habitat quality.

The valuable sea grass and mangrove habitats of Lac are essentially trapped in an enclosed bay. As shallow, warm and saline back-water habitat continues to increase in importance in the bay due to the process of land reclamation by mangroves, these current nursery habitats will come under additional salinity stress and likely continue to decrease in coverage and quality at an accelerated rate. Lac Bay also supports large numbers of breeding and wintering shorebirds and seabirds. Some 63 species have recently been recorded. Of these, 31 (49 percent) were migrant, 24 (38 percent) were resident, six (10 percent) occurred both as resident and migrant and two (3 percent) were migrant species that possibly or irregularly breed. The majority of the migratory species are shore birds and waders (76 percent). Among the species recorded were the Magnificent Frigatebird, Osprey, Brown Pelican and several gull and wader species, among which seven species of heron.

Lac Bay includes at least four islands which are important nesting sites for birds: Isla Yuwana, Isla di Pedro, Isla Rancho and Isla Fogon. Past agricultural practices and current feral livestock have caused significant erosion of soils and sedimentation of waters on the landward side of Lac Bay. When they are in-filled by sediment the back-water habitats become shallower, warmer and more saline.

Sediment in the mangroves contains a mean of 94 percent organic matter. The organic matter will also be high in the backwaters, though data are lacking. The sediment in the other habitats predominantly consists of silt and sand (Debrot et al., 2012). Other characteristics include:

- Turbidity and clarity: the mean Secchi disk depth in the back-waters is less than 0.4 m, while it is generally between 4.3±1.5 m and 9.2±2.3 m. The bottom irradiance (percent of surface irradiance) is with 12.2± 4.8 percent lowest in the shallow back-water habitats.
- Temperature: The mean temperature in the back-waters has been recorded 32.3±1.1 °C.
- Salinity: The back-waters and brown mangrove pools are generally hypersaline with mean salinities of 52.1±1.7 g/l and 40.6±4.7 g/l respectively. The other habitats are generally eusaline (Debrot et al. 2012).
- Nutrients: The water is generally oligotrophic.
- pH: Water pH in Lac Bay is alkaline, generally above 7.4.

The maximum water depth within the bay is 4.5 m; tidal range is limited to approximately 0.3 m and shows distinct double high and double low tides. The bay is protected from the open ocean by exposed fringing coral reefs that protect the bay from wave action. Waves break over the reef, flood the bay, driving a clockwise circulation pattern with water flowing out through a deep-water channel at the northernmost tip of the bay adjacent to Lac Cai, creating a rip current.

Habitats

There are four main habitat types in Lac Bay as classified for Ramsar:

- Permanent shallow marine waters (440 ha).
- Marine subtidal aquatic beds (underwater vegetation).
- Coral reefs.
- Intertidal forested wetlands (365 ha).

The site also includes 21 ha of beach and developed areas as well as 17 ha of dry land (low and middle terrace). The site and its habitats are mostly unfragmented, although there are threats to the connectivity via water flow through the network of channels at the site.

There is a significant amount of exchange between each of these marine environments with many species spending different parts of their life cycle in different areas and moving between environments for feeding and reproduction as well as passive transport by currents and upwelling and a continuous exchange of water and associated marine life from the surrounding deep-water environments.

Coral reefs

The fringing coral reefs in front of Lac Bay form a shallow, high wave energy barrier across most of the bay and include some of the best developed stands of Elkhorn Coral remaining on Bonaire. Seaward from Lac Bay, typically for high wave energy environments, the shallow reef environment is dominated by sea fans and low growing corals and some areas by dense algal assemblages, which are believed to have an important ecological role to play. In the back reef there are isolated dense stands of Staghorn Coral (*Acropora palmata*).

Seagrass

The seagrass beds of Lac provide a biological filter system for the waters within the bay. This gives the water its striking azure blue color which is an essential feature to attract tourists to the area, which in turn supports local businesses. The seagrasses also prevent terrestrial sediments from reaching the reef where they would smother and kill coral reef organisms. The seagrass beds also provide a nursery and habitat for numerous commercially and recreationally valued marine animals such as Conch and juvenile fish. Internationally endangered species such as turtles also depend on the well-being of the seagrass for their survival.

Until 2017 the seagrass stands in Lac were dominated by Turtle Grass (*Thalassia testudinum*) together with Manatee Grass (*Syringodium filiforme*) and banks of calcareous alga (*Halimeda sp.*). Data in 2019 confirmed that the invasive seagrass *Halophila stipulacea* had become the dominant species and continues to spread throughout the bay.

Brown tides have occurred annually since 2018; these occur when Sargassum collects in pockets and decomposes, releasing brown water and causing smothering, eutrophication, the release of hydrogen sulphide and anoxic (oxygen depleted) conditions. This destroys stands of mangroves and seagrass beds, and turns the water of the bay brown.



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

Historically, Queen Conch populations within Lac have been subject to excessive fishing pressure (Table 26). Taking conch from Lac Bai has been illegal since 1985. The population of Queen Conch (*Aliger gigas*) in Lac made some recovery from 2010 to 2013, but has since been decimated through over-harvesting. A recent survey failed to find any sexually mature conch (Engel and Johnson, 2021), resulting in small individuals being removed before they have had a chance to breed. This has meant those animals removed have not been replaced by juveniles.

Year	Number of Queen Conch counted
1999	111
2010	28
2013	228
2015	205
2016	95
2020	85

Table 26: Queen Conch in Lac Bay. Data for 1999 from Lott, 2001. (Engel & Johnson, 2021)

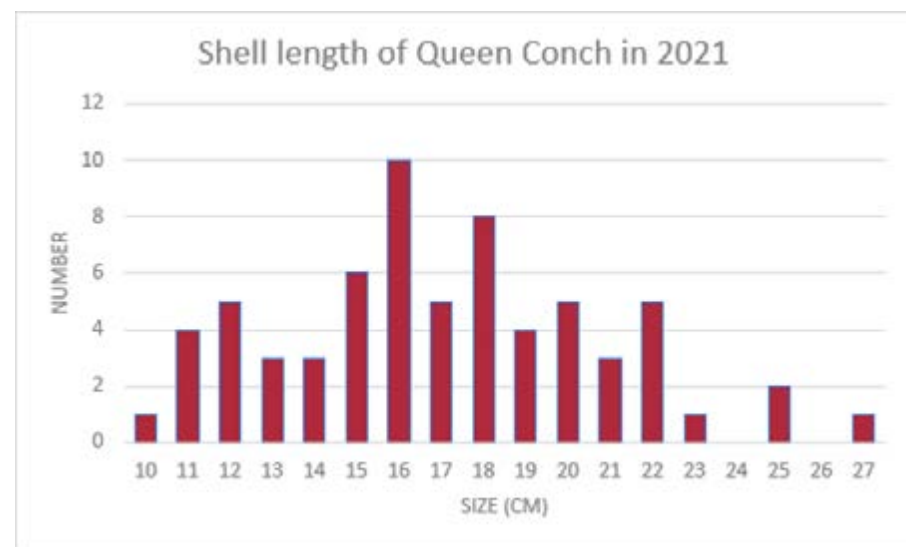


Figure 35: Queen Conch shell length 2021

Mangroves

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

Many species of waders and shorebirds, such as both color morphs, normal and white, of Reddish Egret (*Egretta rufescens*), Tricolored Herons (*Egretta tricolor*), Green Heron (*Butorides virescens*), Great Egrets (*Ardea alba*), Snowy Egrets, (*Egretta thula*) and Great Blue Heron (*Ardea herodias*) can be found in the mangroves. Many of the smaller shorebirds, both Greater and Lesser Yellowlegs species, dowitchers, sandpipers, plovers, including the rare Collared Plover (*Charadrius collaris*) from South America, are here in winter or on migration. Magnificent Frigatebird (*Fregata magnificens*), Brown Pelican (*Pelecanus occidentalis*), Little Blue Heron (*Egretta caerulea*), Black-crowned Night Heron (*Nycticorax nycticorax*) and Yellow-crowned Night Heron (*Nyctanassa violacea*) are recorded in the mangroves. The mangroves of Lac are also thought to be an important foraging ground for protected bat species.

The mangroves of Lac act as a filter for water being washed off the land by preventing harmful sediments smothering the coral reef. By establishing themselves successfully, the mangrove trees become a thriving habitat for many other plants and animals as well as an important nursery for many species of fish. Fish using the mangroves as a nursery include Schoolmasters (*Lutjanus apodus*), Gray Snapper (*Lutjanus griseus*), Great Barracuda (*Sphyraena barracuda*) and the Four-eye Butterflyfish (*Chaetodon capistratus*) (Lott, 2001).

Dunes and beaches

Dunes can be found around Sorobon and the beaches on the windward shore, and around Klein Bonaire. Generally, native dune grasses, trailing vines and small perennials are the hardiest species and are found on the seaward face of the dunes. Shrubs and trees are more abundant in the back-dune zone. Within the Lac Bay Ramsar site, sandy beaches can be found at Sorobon and Lac Cai.

The dunes and beaches at Sorobon are in mixed condition. Sand mining has destroyed many dunes. The result has been severe beach erosion. Removal of beach vegetation and localized trampling of seagrasses in front of the windsurf centers at Sorobon has caused beach erosion.

Bacterial mats

Bacterial mats in intertidal areas around the island, particularly within the mangroves of Lac Bay. These bacterial mats that cover parts of the ground near the mangroves of Lac and low-lying intertidal areas may have an important ecological role. Further investigations are required. Similar blue/green algae found on Curaçao has been found to contain important chemicals that can be used in various medications.

Culture and history

One of the earliest villages on Bonaire was situated at Lac Cai. There are derelict fishing huts (for example at Isla Ranchero), historical wells (for example at Puitu Boka di Limon) and old lime ovens used for the production of limestone. The conch piles found at Lac may have been originally made by Indians and later augmented with shells left by fishers from Islas de Rocas, Curaçaoan fishers, as well as local conch fishers.

Socio-economic

The island economy which is highly dependent on nature-based tourism which in Lac Bay is dominated by windsurfing and kayaking activities as well as beach use at Lac Cai and Sorobon. Lac has approximately 8 semi-artisanal fishermen who regularly fish in the bay and provides a safe mooring for a similar number of commercial fishing boats at Sorobon. The artisanal fishing activities based at Lac Cai and the commercial fishing boats which dock at Sorobon and fish outside of the bay, raise income for a small number of local fishers, only 2-3 of whom are dependent on the fishery as a sole source of income. Fish is sold to restaurants and service providers locally. Three commercial kayak tour companies operate from Lac Cai, employing guides and managers. The Mangrove Centre has permanent headquarters located opposite Kreek di Coco on the road to Lac Cai. Four commercial windsurf companies operate from the sandy peninsular at Sorobon in addition to two restaurants and one stay over resort, Sorobon Boutique Hotel. Lac Bay is a hotspot for tourist activity with cruise boat visitors visiting in high numbers.

VALUE STATEMENT

Significance

The following summary of significance has been adapted from the Ramsar Information Sheet.

Ramsar Site Lac Bay (1,550 ha) is part of the Bonaire National Marine Park. It includes a sheltered inland Bay of 824 ha bay and a 500 m buffer zone (726 ha). This buffer zone includes 183 ha of open sea (of which 19 ha between 0-6 m deep) with fringing coral reefs and acro-algal beds, which slope down to 80 m depth. The site is located on the southeastern shore of Bonaire, 7 km southeast of Kralendijk. Lac Bay is the largest inland bay in the Dutch Caribbean and Bonaire’s most significant lagoon. It contains thriving seagrass beds and mangroves. It is an important nursery for conch and many species of reef fish. It is a critical foraging ground for 500 resident, globally endangered, Green Turtles.

Around 790 ha of the bay are shallow sea, with seagrasses and 365 ha of mangrove forests. The maximum water depth within the bay is 4.5 m. Lac Bay is separated from the ocean by a submerged barrier reef, behind which, patch reefs have formed. North of Lac Bay are large expanses of salt flats and small salifñas.

The site supports significant numbers of foraging, breeding and wintering shorebirds and seabirds. These include the Magnificent Frigatebird (*Fregata magnificens*), Osprey (*Pandion haliaetus*), Brown Pelican (*Pelecanus occidentalis*), gull species, tern species (*Laridae sp.*), waders and eight heron species. The site is an important for tourism and recreation which causes some disturbance and pollution.

Key species

On Bonaire, the mangrove forests and sea grasses of Lac Bay on the east coast of the island are of essential value as a breeding and foraging habitat for resident and migratory birds and as a nursery area for important coral reef fish. Especially important is the role of the mangrove creeks as a habitat for the near threatened Rainbow Parrotfish. The key plant species of Lac Bay are listed in Table 27. *Halimeda opunta*, a calcareous algae important to the ecology of the bay, is also found throughout the site along with other macro algae species including *Avrainvillea nigricans*, *Acetabularia crenulate* and *Batophora oerstedii*.

English	Scientific name	Dutch	Papiamentu
Black Mangrove*	<i>Avicennia germinans</i> (= <i>nitida</i>)	Zwarte Mangrove	Mangel blanku
Buttonwood*	<i>Conocarpus erecta</i>		Mangel blanku
Shoalgrass	<i>Halodule wrightii</i>		
White Mangrove*	<i>Laguncularia racemose</i>	Witte Mangrove	Mangel blanku
Red Mangrove*	<i>Rhizophora mangle</i>	Rode Mangrove	Mangel tam
Wigeon grass	<i>Ruppia maritima</i>	Snavelruppia	
Eelgrass, Manatee Grass*	<i>Syringodium filiforme</i> (= <i>Cymodocea manitorum</i>)		
Seagrass*	<i>Thalassia testudinum</i>		

Table 27: Key plant species of Lac Bay. All species are included in the IUCN Red List and listed in SPAW Annex III. *named in specific legislation.

Species	Phylum	Other sites this species was recorded
<i>Caulerpa sertularioides</i>	Chlorophyta	Lagoen, Tori's reef, pier at boat dive center Marriott
<i>Caulerpa cupressoides</i>	Chlorophyta	Baby beach
<i>Caulerpa racemosa</i>	Chlorophyta	none
<i>Caulerpa mexicana</i>	Chlorophyta	Lagoen
<i>Caulerpa verticillata</i>	Chlorophyta	Pier at boat dive center Marriott
<i>Halimeda opuntia f. trilobans</i>	Chlorophyta	Pier at boat dive center Marriott
<i>Halimeda incrassata</i>	Chlorophyta	none
<i>Avrainvillea digitata</i>	Chlorophyta	none
<i>Acetabularia crenulata</i>	Chlorophyta	Pier at boat dive center Marriott
<i>Thalassia testudinum</i>	Seagrasses	none
<i>Syringodium filiforme</i>	Seagrasses	none
<i>Halophila stipulacea</i>	Seagrasses (invasive)	none

Table 28: Macro algae species found at Lac Bay (pers. comm. Sabine Engel 2021)

Green Turtle	The aggregation of green turtles in Lac Bay is much larger than elsewhere along the coast of Bonaire. Green turtles captured there are bigger than those found elsewhere, perhaps as a result of the composition and high densities of sea grasses in the bay.
Yellow-shouldered amazon	While the Lac mangrove thickets were formerly used by the Yellow-shouldered Amazon (Voous 1983), this no longer appears to be the case (Smith et al. 2012, Debrot et al. 2013). In former times, the species was actively persecuted by man and the surrounding woodlands suffered more extensive disturbance by agricultural activity and charcoal burning (Freitas et al. 2005). Under such circumstances, the mangroves of Lac Bay apparently served as a roosting area for the lora. However, as awareness about the value of this bird has increased, and its persecution decreased, the species apparently no longer needs the shelter in isolation provided by the mangroves of Lac Bay and is no longer using this area. Also, the quality of the woodlands in many areas of Bonaire has improved in recent decades, which also probably offer the Yellow shouldered Amazon a wider range of habitat options (Geelhoed et al. 2013).
Reddish Egret	The Reddish Egret ranked among the top 10 most abundant species of the salt flat habitat in Lac Bay. Lac Bay may be of local significance as a breeding and foraging site for this species (Geelhoed et al. 2013).
Nassau Grouper	Up until the early 1990s various grouper species had been documented for Lac Bay, among which the threatened Goliath Grouper and Nassau Grouper. Most of these species have largely disappeared from the waters of Bonaire due to overfishing in the past and have not since recovered. No groupers were recorded in Lac Bay during 2012 surveys (Debrot et al. 2010).
Other fish species	Threatened grouper species and other species have been recorded like: Mutton Snapper (VU); Yellowmouth Grouper (VU); Snowy Grouper (VU); Queen Triggerfish (VU) and Hogfish (VU).
Coral	Coral species like: Boulder Star Coral (both <i>M. annularis</i> EN and <i>M. franksi</i> VU); Mountainous Star Coral (EN); Pillar Coral (VU); Lamarck’s Sheet Coral (VU) and Elliptical Star Coral (VU).
Queen Conch	Conch fishing in Lac Bay is forbidden without a permit under Marine Ordinance of 1991. Nevertheless, a small but persistent problem with conch harvesting exists.

Table 29: Key animal species of Lac Bay

Lac is an important site for juvenile turtle development (van der Zee et al., 2019). Other animal species of importance to the Lac Bay ecology are oysters, crabs, iguana and Lionfish (*Pterois miles*) which is an invasive predator.

USE OF LAC BAY

The sandy beaches of Lac Cai and Sorobon attract beach lovers as well as other forms of recreation including:

- Kayaking and kayak tours (principally from Lac Cai and Kreek di Koko).
- Windsurfing (from Sorobon).
- Snorkeling and snorkel tours within the mangroves at Lac Cai (entrance to Puitu).
- Scuba diving (particularly along the barrier reef from Lac Cai and by boat from Sorobon).
- Boating/fishing on the windward shore departing from the pier at Sorobon.
- Artisanal fishing with some use of fish traps.
- Horseback riding.

Diving on the east coast of Bonaire is restricted by rough seas and inaccessible dive sites. Not all tour operators offer trips to Lac Bay (Sorobon) because of the lack of facilities.

Fishers

A pier at Sorobon serves as a safe mooring for commercial fishers, who fish in open water beyond the bay. A concrete slip at Lac Cai serves local fishing boats. Approximately eight fishers use the bay as a fishing ground on a regular basis. Historically fishing boats were launched into the bay from a number of different spots, but these are rarely used now.

Windsurfing

Turn markers in the bay indicate when windsurfers should turn back before they reach shallow water and seagrass beds vulnerable to trampling. Tie off points and roped channels help to guide windsurfers in and out of the water with minimal damage to the surrounding seagrass beds.

Kayaking

Kayak operators make use of the beach at Lac Cai to launch their kayaks or enter via Kreek di Koko. Mangrove channels are artificially maintained by kayakers and fishers to allow access to, for example, Puitu, a shallow mangrove embayment. Kayak racks have been installed at Kreek di Koko for kayak storage.

Toilets

Public composting toilets and changing facilities were installed at Lac Cai early in 2000, but these soon fell into disrepair due to lack of maintenance. Public toilets at Sorobon are in poor repair and discharge into a steel tank, which is likely to drain freely into the bay. Resorts have their own facilities but passive wastewater discharge into the bay is a concern.

STAKEHOLDERS

STINAPA works with numerous stakeholders whilst managing Lac Bay and the Bonaire National Marine Park. These include, but are not limited to, those listed in Table 30. Stakeholders were consulted in 2021 for this management plan; further details of these consultations can be found in Appendix F.

Group	Representation
Dive operators	Bonaire Adventures Scuba Diving, Bonaire East Coast Diving
Windsurf companies	Jibe city, The Windsurf Place, The Frans Paradise, Sorobon Beach
Kayaking companies	Windows to the Sea, Mangrove Center, Hans Outdoor Bonaire
Industry	Cargill Salt Company
Fishing	Local fishers, Sorobon fishers, fly fishers
NGOs	Sea Turtle Conservation Bonaire, Reef Renewal Bonaire, Mangrove Maniacs

Table 30: Key stakeholders at Lac Bay

THREATS AND ISSUES

Sedimentation

The most significant threat to the ecological functioning of the bay is believed to be the process of accelerated infilling which is caused principally by poor land and water management around the Bay and is exacerbated by extensive over grazing by free roaming animals, mostly goats. This causes sediment to be washed and blown into the mangroves surrounding the bay.

Eutrophication

Dung from feral grazers increases eutrophication in the watershed. Additionally, such as biological productivity in the bay itself including leaf litter production by mangroves, gradually clogs channels and slows water circulation. Consequently, on average the bay has been losing 2.34 hectares of open water each year.

Sand accumulation

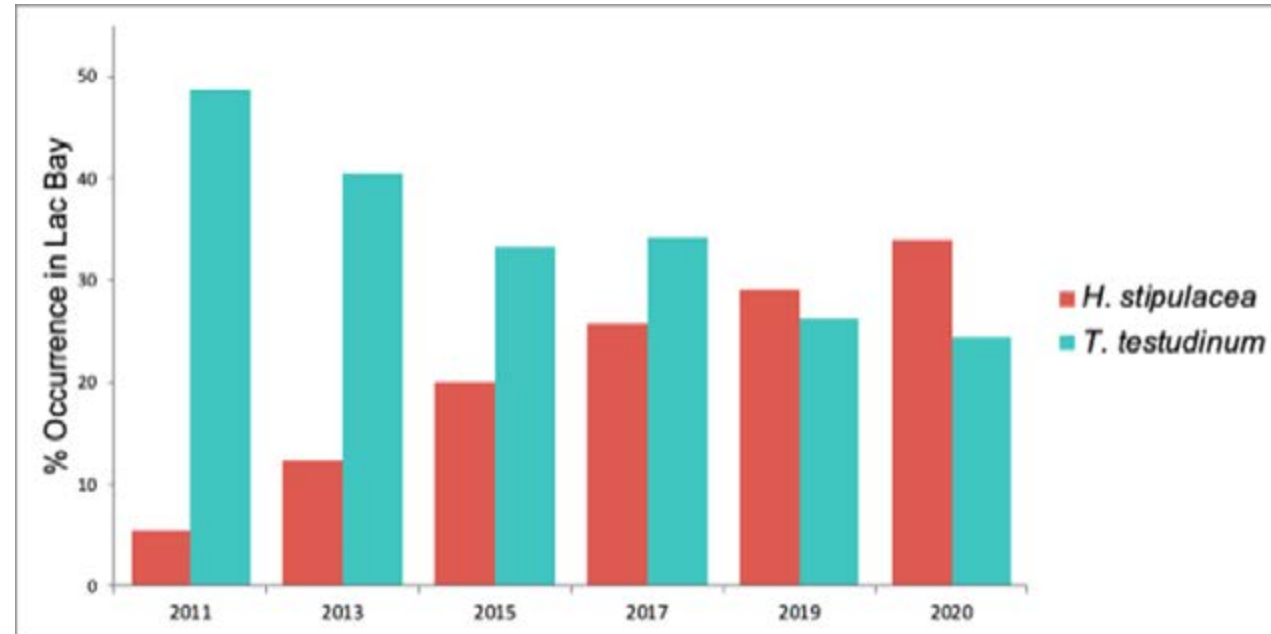
The gradual accumulation of sand within the bay, coming both from external sources and generated in situ by calcareous algae such as *Halimeda sp.*

Foiling

Turtles have been found decapitated, which is attributed to foils. Turtles are unable to hear foils and therefore can't move out of the way in time. Of the four windsurf companies based at Sorobon, three are currently renting out foils.

Invasive species

In recent years, invasive seagrasses have taken over living space from endemic seagrasses (Box 11). *Halophila stipulacea* a small tropical seagrass native to the Red Sea, Persian Gulf, and the Indian Ocean, invaded the Mediterranean Sea 150 years ago through the Suez Canal, but has generally remained in insulated, small populations across this basin. In 2002 it was reported in the Caribbean Sea, where within less than two decades it spread to throughout the Caribbean nations reaching the South American continent. Unlike its invasion of Mediterranean, in the Caribbean *H. stipulacea* creates large, continuous populations in many of the areas it colonizes (Winters et al., 2020).



Herbivorous fish are critical in reducing invasive seagrass densities, and therefore protection of these fish is key to build resistance to invasive species. Management to protect (herbivorous) fish will pay back in a resilient ecosystem!

Over time, the invasive seagrass has been increasing in Lac Bay, primarily in the center (grazed by turtles (Christianen et al., 2019)) and in the areas of the bay where sargassum removed native seagrass. This means that turtles are heavily grazing the native seagrass. Therefore, it is important to reduce other stressors on the native seagrass: reduce nutrient inflow (water measurements show that the bay is not oligotrophic anymore), but also reduce impacts of disturbance, as trampling. As an example: in high season many windsurfers go into the prohibited area and stand in the seagrass (pers. comm. Smulders F. 2021).

Box 11: Invasive seagrass and implications for management (Smulders et al., 2022)

CONSERVATION EFFORTS

A number of habitat restoration projects are taking place in Lac Bay:

- Improving water circulation by maintaining and improving water channels.
- Creating nurseries to propagate mangrove seedlings for out planting.
- Reforestation at selected sites to increase vegetation cover and reduce erosion.

MANAGEMENT PLAN

Objective B.1. Develop a shared vision for sustainable recreation

Activity B.1.1. Review, publicize and enforce a zoning plan

Activity B.1.2. Formalize use of fish traps (*kanaster*)

Activity B.1.3. Explore options to reduce sediment deposition

Activity 8.1.6. Explore options to open new channels for use by kayakers



Objective B.2. Strengthen management, surveillance and enforcement

Activity B.2.1. Ensure permanent ranger presence

Activity B.2.2. Check all visitors on the payment of the nature fee

Activity B.2.3. Limit the number of groups and group size of kayak operators and restrict night time access

Activity B.2.4. Construct watchtowers at Sorobon and Lac Cai

Activity B.2.5. Prohibit motorized boats in the mangroves

Activity B.2.6. Regulate horse riding in Lac Bay

Activity B.2.7. Address karko fishing and fishing in seagrass meadows

Objective B.3. Improve recreational infrastructure

Activity B.3.1. Improve and maintain recreation facilities at Sorobon and Lac Cai (swim lines and signboards)

Activity B.3.2. Maintain infrastructure to prevent trampling of seagrass

Activity B.3.3. Construct an education boardwalk in the mangroves

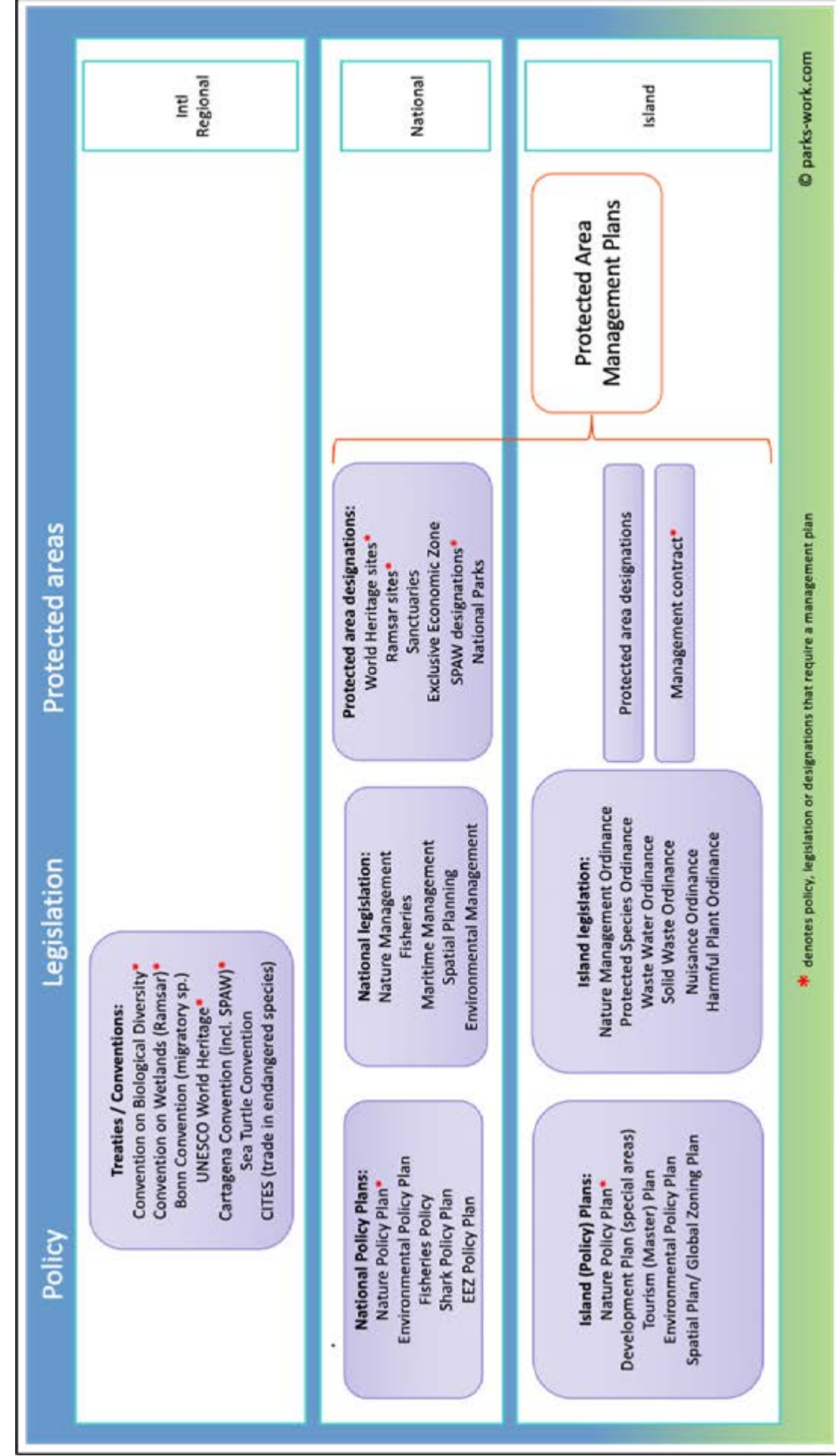
Objective B.4. Improve communication with stakeholders

Activity B.4.1. Ensure all users receive information on rules

Activity B.4.2. Improve kayak guide training and permitting system

Activity B.4.3. Ensure all users receive information on rules and regulations

LEGISLATIVE AND POLICY FRAMEWORK



ZONATION

	Zone	Focus	Location	Level of protection
Biodiversity	Bonaire National Marine Park	National Marine Park	Around the entire island from High Water to 60 m isobath	Mid: Legally managed use
	King Willem -Alexander Reserve	Marine reserve	Along the shoreline to the 60 m isobath	Highest: Reserve
	Queen Maxima Reserve	Marine reserve	Along the shoreline to the 60 m isobath	Highest: Reserve
Fisheries	Fishing and snorkel fishing allowed	Reef fisheries management	Between Harbour Village and Chachacha beach and from Plaza to Punt Vierkant	Mid: Legally managed use
	Fishing allowed; Snorkel fishing prohibited	Reef fisheries management	Throughout the Marine Park with the exception of the other designated fishing areas	Mid: Legally managed use
	Fish reserves	Reef fisheries management	Bonaire has two no-fishing areas that were established in 2008: one from Plaza resort to Chachacha beach and one from Harbour Village to the end of the Hato housing area	Highest: Legally designated reserve
	Lobsters Take Zone	Lobster fisheries management	Seasonal, east coast 1st November to 30th April Lobster can only be taken from Willemstoren to Malmok larger than 12cm (from between the eyes to the beginning of the tail)	Highest: Legally designated reserve
Users	Anchoring zone	Cruise ship anchoring	Kralendijk	Mid: Legally managed use
	Kite surfing zone		Kite Beach - ATLANTIS	Mid: Legally managed use
	Wind surfing zone		Lac Bay	Mid: Legally managed use
	Dogs on Beach Prohibition	Dogs prohibited from walking on the beach	Beaches	Highest: Legally prohibited
	Mast height restrictions		Airport shoreline	Highest: Legally prohibited

Within the marine park, there are two reserves and a number of other areas that have been identified for specific management measures. Streamlining and clarifying marine park zoning is an action point for management for the coming period. Whilst the 'geographic boundaries' of the Bonaire National Marine Park and the Marine Reserves are identified in the legislation, the highwater mark as a boundary is not yet been fixed for legal purposes. STINAPA has accepted *de facto* responsibility for beach management on the southern shore, management of the buffer area around Lac Bay out to the roads surrounding the bay and management of the deep-water environment around Klein Bonaire.

Explanation	Links
Established in 2008, Article 13.2 <i>Eilandsbesluit Onderwaterpark Bonaire (EO)</i> . The rationale for establishing Fish Protected Areas is that juvenile fish residing in these areas are able to mature and reproduce and that, as they grow, some will 'spill-over' into nearby areas. This results in 1) areas where fish are able to grow large enough to reproduce and 2) increased catch of fishers.	A 2003 study by Tim McClanahan and Robert S. Steneck issued the initial advice on the Fish Protected Areas.
From May 1 to October 31, it is prohibited by law to catch lobster in the waters around Bonaire, Klein Bonaire and in Lac. Venezuela also has prohibited the catching of lobster during the same period. Do not catch, buy, serve, sell or eat fresh lobster from May 1st to October 31st. When lobster season opens again on November 1st, lobster may be taken only between Willemstoren and Malmok, on the east coast. Lobster that is taken during this period must be larger than 12 cm if you measure from between the eyes to the beginning of the tail, meaning that you do not measure the tail. Spiny lobsters breed and spawn when the ocean is warm during the summer and female lobsters may produce hundreds of thousands of eggs twice during the reproductive season. She lays the eggs and holds them under her tail for up to ten weeks, until they are ready to hatch. It is strictly prohibited to take lobster during this time.	ARTICLE 11 ISLAND RESOLUTION UNDERWATER PARK AB 2010 # 14
Playa Lechi (Sunset Beach), Playa Lechi (south start of boulevard), Playa Chachacha, Playa Pal'i Mangel, Bachelor's Beach, Salt pier to Willemstoren, Pinkbeach, Pelike, Sorobon, Lac Cai, Nukove, Tolo, Thousand Steps, Klein Bonaire	

	Zone	Focus	Location	Level of protection
Lac Bay	White	Quiet area		
	Blue	Windsurf and kayaking zone		
	Yellow	Snorkeling, swimming, kayaking		
	Green	Guided kayaking and snorkeling		
	Orange	Guided snorkeling		
	Red	Swimming, snorkeling and general beach recreation		
	Buffer zone			

Explanation	Links
As Lac Bay is a very important natural and wildlife area, a large part has been set aside to give the wildlife space without disturbances by recreation and fishing activities. Therefore, in this area no commercial recreational activities or private kayak trips, can be developed and no infrastructure should be placed to facilitate access to the area. Access to the areas is limited to occasional educational/cultural tours to for example Isla Yuwana, research and traditional fishing only. For research in the marine park a permit is required. For other activities written approval by the Marine Park should be obtained. Fishers have traditionally access to all of the Bay. However, they prefer other areas such as Puitu and Pariba di Cai for fishing and these areas are outside the white zone. Occasionally they will enter the white zone but this is on such a limited base that the effect to the wildlife will be very minimal.	
This is the open water area of the bay and will be used for windsurfing and kayaking. This area is deep enough not to create disturbance for sea grass beds and other shallow water areas. Access to this area is in front of the windsurf centers. The area is demarcated with swim lines to protect the sea grass beds. Care should be taking to avoid accidents with fishing boats that use the same area when returning from the sea. This is limited to certain time periods and has never posed a problem. Newcomers however should be made aware of this. At the shallow end of the bay turn markers are placed to indicate the beginning of the shallow bay area, where the white zone begins. Windsurfers and kayaks need to turn around and not venture beyond these turn markers. For wind surf competitions rules and regulations are set up	
This area is located near the coral dam and around the patch reefs. As this area is mainly a sandy area with patch reefs relatively little damage can be done here. People tend to go here for snorkeling on the patch reefs and kayaking combined with snorkeling. For the kayaks in this area a few moorings should be placed so they can tie off the kayaks and need not to anchor. Since anchoring is prohibited in the marine park and a carelessly tossed anchor can cause damage to the patch reefs. Around the patch reefs the general marine park rules apply that you are not allowed to touch the coral or and organisms living on and around the reefs, etc. More information about the park regulations can be found in the numerous leaflets produced by the marine park	
This area runs from the Cai peninsula to the area known as Kreek di Coco. Since the beginning this area has been used by kayak operators for guided tours in the mangroves also guided snorkel tours can be carried out here. The area has been designed to control the kayaking and concentrate the activities in a particular area. Here facilities can be provided such as a designated landing area for kayaks and opening existing tunnels for kayak groups and snorkel groups to explore the mangroves. Providing an interesting area for the kayaks and snorkelers it can be assured they will not venture into the white zone. Limits on the number of groups and size of the groups need to be set to keep the activity within acceptable environmental limits. The following guidelines are suggested: Two kayak groups of 10 persons maximum in the morning and two in the afternoon. For snorkel groups it is suggested one group of 10 people maximum in the morning and one such group in the afternoon. The reason for one group of snorkelers is that they are likely to do more damage because of the tendency of them to stand in the shallow sea grass beds and thereby damaging them. The tours carried out have to be under supervision of a guide. The guides should be properly trained and have followed a course by the marine park in which the rules and regulations of the Bonaire National Marine Park are explained and proper behavior to be adopted while in the field. Currently dive masters and instructors are required to follow such training already and the existing training program can be adapted to the specific circumstances in Lac Bay. Private kayak owners are allowed to use this area as well, under the condition that they have followed the course given by the marine park for tour guides as well	
This zone is set aside for guided snorkeling. The area is too small to provide a good kayak tour but is very interesting for a snorkel trip. Here there are no sea grass beds within the area, only outside, therefore a proposed maximum of two groups of 10 in the morning and afternoon is suggested. Here, a guide needs to supervise the tour and for these guides the same applies as described in the section about the green zone	Link 11: Bonaire National Marine Park.com
This zone does not have any specific guidelines other then it is used for swimming, snorkeling and general beach recreation. This area has been created mainly for safety reasons as the bay is used heavily by other watersport enthusiasts. Care should be taken of course not to damage sea grass beds by trampling. These areas however are demarcated by swim lines.	
On the landward side of Lac Bay, a buffer zone needs to be created as proposed in the Nature Policy plan 1999-2003. The buffer zone allows for the control of developments in the vicinity of the bay. In a buffer zone rules and regulations are made to allow certain developments or ban activities completely if deemed detrimental to the preservation of the area. For Lac Bay a buffer zone of 500 m landward from the high-water mark is proposed. The buffer zone needs to be divided into two zones; 0-100 m: Designated setback zone and 100-500 m: controlled land use that it is compatible with Lac Bay's designation as a national park and Ramsar site	



Figure 36: Reserves (strict protected)



Figure 38: No-fishing areas



Figure 37: Snorkel fishing zones



Figure 39: Lobster fishing zone (season and size restrictions apply)



Figure 40: Max height restrictions



Figure 41: Anchoring area



Figure 42: Dog walking prohibitions





Figure 43: Lac Bay Zoning. Key: White = natural and wildlife area, Blue = open water – windsurf and kayaking, Yellow = Kayaking and snorkeling, Green = guided kayak and snorkel tours, Orange = guided snorkeling, Red = swimming and beach recreation.



Figure 44: Designated kite surfing area (in yellow). Note: The scale of the map above does not adequately reflect the relatively small entry and exit zone for kite surfers.

APPENDIX E



RAMSAR SITES

The extension of the Ramsar sites on Bonaire in 2021 included a 500 m of buffer zone. This increased the management responsibilities of STINAPA beyond the legal boundary of the marine park. The existing 'zones' in Bonaire National Marine Park are outlined below.

		STINAPA - Bonaire National Marine Park
RAMSAR SITES	Klein Bonaire	The marine park has direct management of the island of Klein Bonaire out to the 60 m depth contour. The Ramsar buffer extends 500 m from the shoreline. STINAPA's management authority therefore extends beyond the park boundary.
	Lac Bay	The marine park extends from the highwater mark to the 60 m depth contour outside of the bay. The Ramsar buffer extends 500 m shoreward. De facto, STINAPA has management responsibility for nature management out to the roads surrounding the bay and shared management responsibility for the peninsulas at Sorobon and Lac Cai.
	Washington Slagbaai	The Ramsar buffer zones and STINAPA's de facto management authority extends 500 m offshore around the Washington Slagbaai National Park
	Harbor area	Management authority over the harbor areas and piers and by extension as far as Karel's Beach Bar north of the harbor is shared with the Harbor Master.
	Marinas	Since the Plaza and Harbour Village Marinas are continuous with the marine park, the Bonaire National Marine Park has de facto authority for nature management in those areas.
	Saliñas	With the exception of saliña Vlijt, saliña Tam and saliña Frans, all saliñas fall under the direct management authority of STINAPA. Most are tidal and could therefore logically fall within the geographic scope of the marine park's management authority
	Southern shoreline	STINAPA has assumed management authority over the beaches above the high-water mark along the southern shoreline, due in large part to regulations put in place to safeguard sea turtles and their nests.

Table 32: Management responsibility and designation

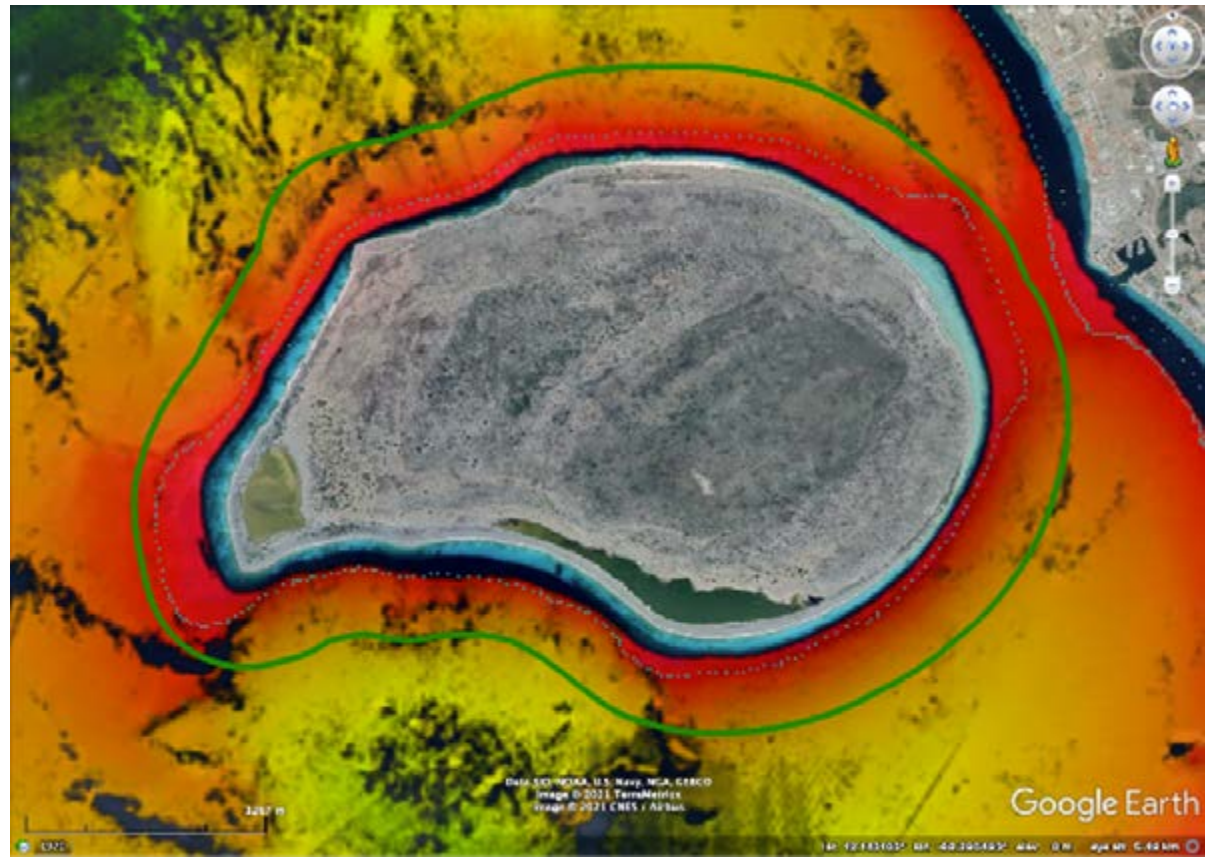


Figure 45: Klein Bonaire Ramsar Site includes deep water environments

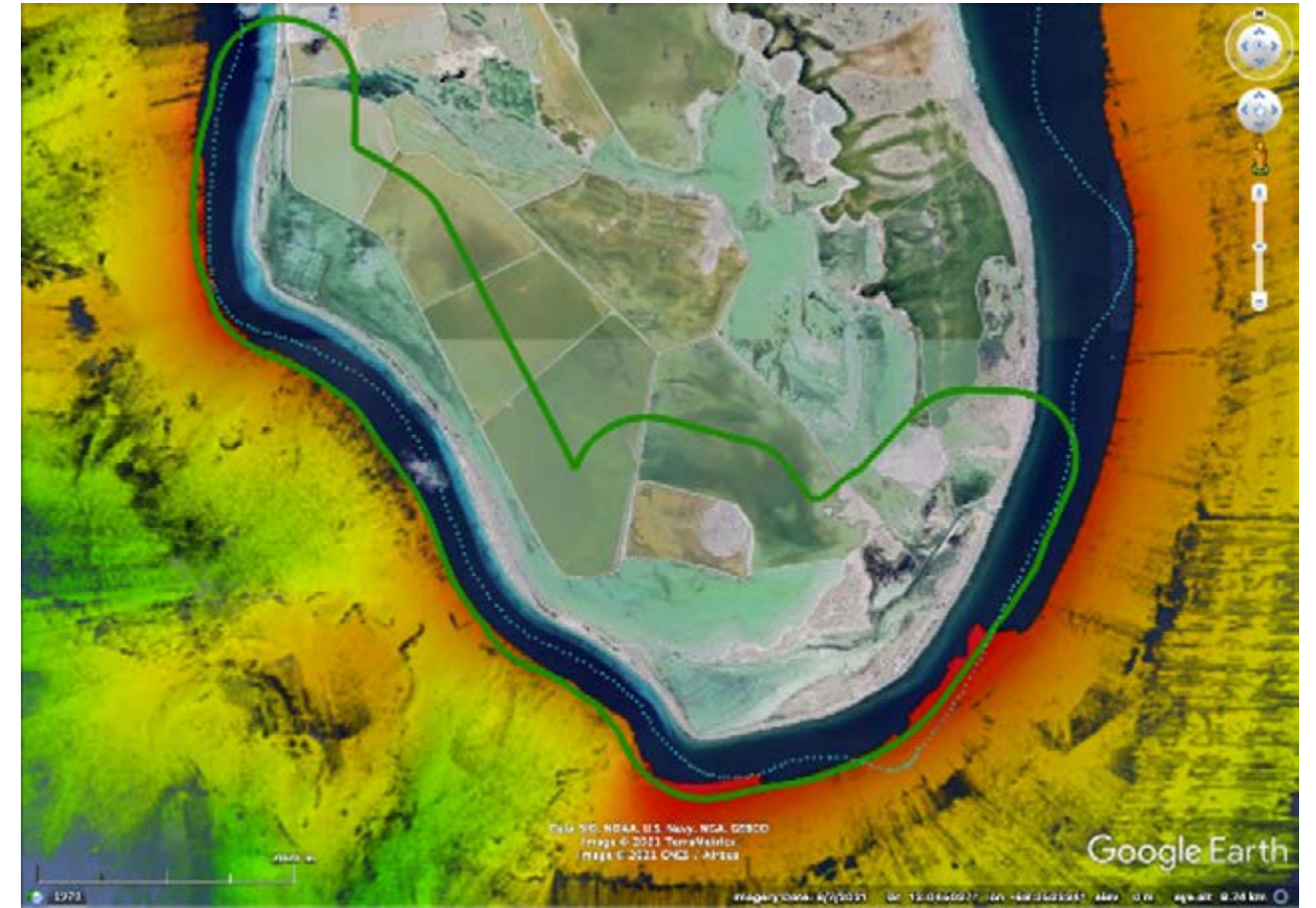


Figure 47: The buffer zone of the Pekelmeer Ramsar site extends beyond the Bonaire National Marine Park boundary



Figure 46: The Washington Slagbaai Ramsar site extends beyond the boundary of the Bonaire National Marine Park



Figure 48: The buffer zone of the Lac Bay Ramsar site extends beyond the Bonaire National Marine Park boundary

APPENDIX F

STAKEHOLDER CONSULTATION

OVERVIEW

STINAPA works with over 200 stakeholders and partners, including the Island Government, enforcement agencies, the tourism industry, businesses, the education sector, agricultural and fisheries and non-governmental organizations (NGOs). A summary of stakeholders and partners is provided below:

Group	Stakeholder / partner
Regional partners	Dutch Caribbean Nature Alliance (DCNA), Specially Protected Areas and Wildlife Regional Activities Centre (SPAW-RAC), Gulf and Caribbean Fisheries Institute (GCFI)
National Government	LNV, BZK, OCW, I&W and <i>Rijkswaterstaat</i>
Civil society	<i>Vogelbescherming</i> , WWF-NL, IUCN-NL, <i>Natuurmonumenten</i>
Island Government and quasi-governmental institutions	Island government (OLB), Harbor Office, Department of Spatial Development (DRO), Legal Department (JAZ), Agriculture Department (LVV), Public health Department, Tourism Corporation Bonaire (TCB), Chamber of Commerce (KvK), Selibon, WEB, BIA
Health Care	Fundashon Mariadal
Enforcement agencies	Police (KPCN), Coast Guard, Royal Marechaussee (KMar), Customs (<i>Douane</i>), Department of Enforcement (DTH), Public Prosecutors office (OM)
Tourism sector	CURO (Dive Operator Association), BONHATA (Hoteliers Association), WAB (Watersport Association Bonaire), watersport operators including windsurf, kitesurf and snorkeling companies, boat hire companies, sail boats
Businesses	Cargill Salt Company
Education, Universities	Primary and secondary schools, Jong Bonaire (after school program) WUR, Naturalis, KITLV
Fishing	PISKABON
Agriculture	KRIABON (Agricultural co-operative)
NGOs	Echo Foundation, Sea Turtle Conservation Bonaire, Reef Renewal Bonaire, Bonaire Duradero, Bon Béré, Mangrove Maniacs, Wild Conscience, Donkey Sanctuary, Bonaire Wild Bird Rehab, Terra Barra, FUHIKUBO, BONAI.
Press	Extra Bonaire, Bonaire Reporter

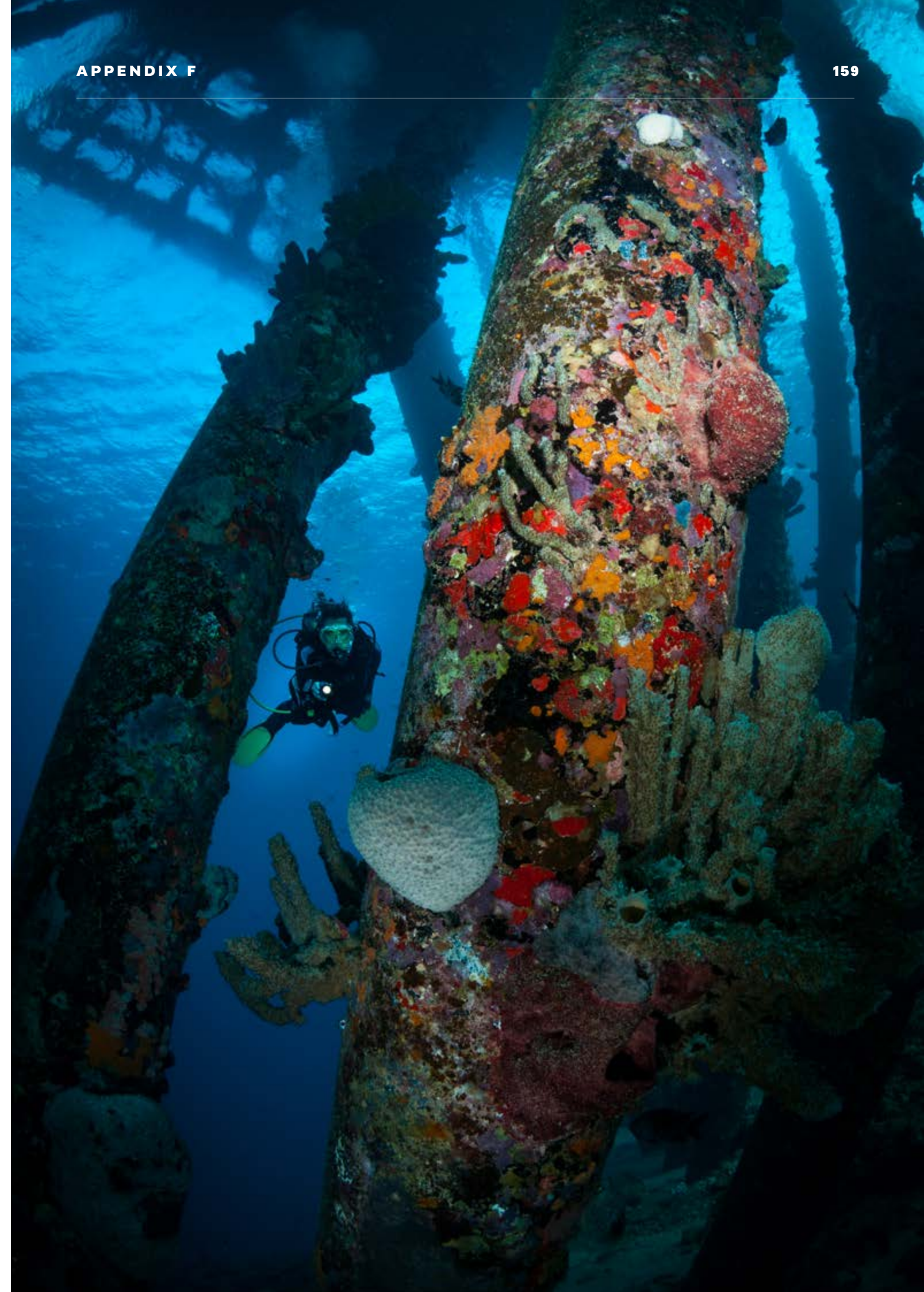
Table 33: Stakeholders

STAKEHOLDER CONSULTATION

Over 20 stakeholder consultation meetings (focus group meetings) were held on Bonaire over the course of two months in the summer of 2021 during the development of this management plan. Detailed overview of stakeholder priorities, concerns and areas for collaboration can be found below. Common concerns amongst stakeholders included:

Institutional	
	Roles of STINAPA, OLB, ministries, NGOs
	Communication (internal and external)
	User fees (and management)
Marine Park	
	Moorings: management and use
	Kite surfing: location and capacity
	Diver access from shore (development)
Klein Bonaire	
	Management of Klein Bonaire
	Visitor management and carrying capacity
	Mooring management (booking system)
	No development
	Clarify legislative protection
	Provision of facilities
	Overcrowding at No Name
	Expanding use of Klein Bonaire and activities
Lac Bay	
	Roles of NGOS
	Zoning plan
	Carrying capacity
	Kayak operators
	Fishing
	Provision of facilities
Threats	
	Wastewater
	Coastal Development
	Sargassum

Table 34: Common concerns of stakeholders (2021)



Group	What is going well (in no particular order)	Priorities (in no particular order)		Concerns (in no particular order)	Collaboration (in no particular order)
STINAPA	<ul style="list-style-type: none"> - Maintaining the moorings - Improved communication with police - History of the marine park - Fishers and residents appreciate the marine park and its value 	<ul style="list-style-type: none"> - STINAPA employs people who are nature focused, not business focused - redefining job description, increased pay to attract and keep staff - Involve rangers with the science and monitoring [nature unit] - Working together more effectively internally - Define the marine park boundary - STINAPA to manage public beaches - Online reservation system for moorings - Education to encourage long term change - Marine park plan that can be implemented for management 		<ul style="list-style-type: none"> - Too many people office based, not working in the field - Internal structure does not overlap, units not working together - Internal communication lines - Lack of nature focused vision in STINAPA - Nature unit work should be island / management focused - Lack of communication about the park - No support for the nature fee - Lack of clarity on when to check for tags - Online fees system is difficult to enforce - Nature permit for business, people operate and don't charge the fee - Enforcement - youth 13-16 year old, repeat offenders, target with communication - New businesses importing labor - Businesses installing swimming lines without guidance - Boat hire (no knowledge of rules, no license) 	<p>Suggestion: Work with construction companies for renovation of historical sites on Klein Bonaire (in return for press coverage)</p>
	<p>Communication (internal and external)</p>	<ul style="list-style-type: none"> - Klein Bonaire - priority natural area, plan for management - Moorings always a problem at Klein Bonaire - More shades at Klein Bonaire - Limit people numbers at Klein Bonaire - Admission hut for Klein Bonaire - Klein Bonaire tourist management - Lac presence - STINAPA needs to be responsible - Sand infilling at Lac - Management plan for Lac Bay; vision and collaboration 		<ul style="list-style-type: none"> - Mooring use, CURO customers pay the lion share of the fees - Lack of authority to implement rules and regulations - STINAPA working effectively with fishers - Conch harvesting at Lac - Lac of capacity to patrol Lac permanently - Maintenance contracts at Lac - Too many people operating at Lac; set limits, manage Lac - Fish permit management (permits don't pass through families) - Lac beach maintenance, rubbish on beaches - Management of pet dogs - Clarification of legislation to make it easier to use - Lack of rangers (increased work load with waste water and fee checking) - STINAPA being called for various incidents, including donkeys in traps - Lack of support for enforcement; snorkel fishing or threatening rangers not seen for 2-3 years and often dropped. 	

Group	What is going well (in no particular order)	Priorities (in no particular order)		Concerns (in no particular order)	Collaboration (in no particular order)
STINAPA	<ul style="list-style-type: none"> - The marine park protects the whole island - which is unique - Involvement of groups and organizations - Community engagement 	<ul style="list-style-type: none"> - Ramsar is owned by OLB - Emergency funding should be focused on mangroves, management plan development, sargassum, goats, enforcement. - Sargassum response plan - Water quality 		<ul style="list-style-type: none"> - Sargassum - Clarity of roles and responsibilities for Government and STINAPA, other NGOS working in the marine park - Lack of integration of spatial development, tourism and nature plans - Invasive species - erosion - Lack of clarity of rules and regulations (who sets, owns, publishes rules?) - Rules and regulations ineffective and are being broken - Distribution of income from fees - who is working in the park should be compensated - OLB should have ownership of the marine park management plan - Management should consider what the park will be like in 75 years - Expansion of the park beyond the 60 m which was the recreational dive limit. 	<p>Suggestion: Work with construction companies for renovation of historical sites on Klein Bonaire (in return for press coverage)</p>
Island government					
<i>Public Entity Bonaire (Openbaar Lichaam Bonaire)</i>	<ul style="list-style-type: none"> - Manager is doing a great job of communicating rules - Interest in stakeholders - Follow up with legislation and enforcement - Sargassum clean up - Research - Nature in schools 	<ul style="list-style-type: none"> - Wastewater “if you don’t do anything about wastewater the rest of the issues won’t really matter” - Expediting the permitting process - Working on institutional structure - Easy Win: keeping people from making artificial beaches 		<ul style="list-style-type: none"> - Wastewater; limited proper treatment, most enters the environment, more than in 2015 (date of last investigation) - Development; spatial plan enforcement - Resilience - wastewater - Permits, lack of diver orientation - Institutional structure; need to work together on threats - Enforcement - Increasing tourism - Safety in the Marine Park (boat hire) - Regulations review; updated species list, new sport updates, make legislation usable - Communicate what can and can’t be taken from the park - Communication with tourists and residents - Communication and enforcement of rules 	<ul style="list-style-type: none"> - Communication; inflight and airport, OLB can help facilitate stakeholders (WNF) - Communication; profile the marine park to all visitors - Identify stakeholders who can profile the marine park effectively. - Institution; nature commission with STINAPA (issues with nature and environment permits to be tackled) - Policy development focused on managing cruise tourists
<i>Public health</i>		<ul style="list-style-type: none"> - COVID - communicable diseases - Lifestyle changes - “Bounce back better” - Become independently financed 		<ul style="list-style-type: none"> - Sargassum and public health - NO cohesive strategy to tackle large problems, too many changes and plans/requirements to adhere to with institutions and ministries. 	<ul style="list-style-type: none"> - Sargassum - Wastewater

Group	What is going well (in no particular order)	Priorities (in no particular order)		Concerns (in no particular order)	Collaboration (in no particular order)
Enforcement agencies					
Directie Toezicht & Handhaving	<ul style="list-style-type: none"> - STINAPA step up to do work other should be doing e.g. mooring permits, nature permit - Great work removing sargassum 	<ul style="list-style-type: none"> - Coastal development - Permitting for businesses and construction - Clear communication between STINAPA, DRO and DTH 		<ul style="list-style-type: none"> - Coastal development - People putting walls to collect sand to expand their beach - Tar pit at the old BOPEC storage site 	<ul style="list-style-type: none"> - Formalize partnership - Review nature permit conditions - enforcement plan for companies operating without a nature permit - Work together to actively seek new buildings under construction - Revision of ROB (spatial plan)
Public prosecutor	<ul style="list-style-type: none"> - Handling sargassum - Current manager improved enforcement, standing with government - Dedication of STINAPA team - Education and outreach on SCTL - Achievements with limited resources - Dog walkers, illegal fishing 	<ul style="list-style-type: none"> - Illegal building / use of the marine park - Carrying capacity, managing groups not adhering to rules and regulations 		<ul style="list-style-type: none"> - Lack of permits (correct administrative procedure) makes criminal prosecutions difficult - Limited time in court, expiration of statute of limitations for small cases. - Communicating the value of nature - Overfishing, importing protected species without permits - Illegal building; beaches, piers - Oil spills from boats - Growing population 	<ul style="list-style-type: none"> - Issue and management of permits for Kayakers on Lac - Prosecuting big companies (pollutions, violators) - Establish a robust permitting process - Communication to identify administrative and criminal process (work on warnings and written documents to develop case portfolios) - Work on process for 'short fines'
Harbour Master	<ul style="list-style-type: none"> - Good vision and mission - Appreciate STINAPA's role in balancing nature and sustainable development - STINAPA's enforcement work helping police who lack capacity. 	<ul style="list-style-type: none"> - Safety on the water - Pollution at sea - Construction of marine facilities 		<ul style="list-style-type: none"> - Progress at the expense of nature - Pier construction on shoreline residential houses - Construction of a new container port - Upgrading moorings to accommodate larger vessels - Bureaucracy with budgets being managed through OLB - Poor management of cruise tourism tours of the island - Dangerous crossings between Bonaire and Curaçao - Fishers not equipped correctly - Jet skis are a grey area (seem to only have international rules with speed limits) - Foreigners using the park without knowing rules and regulations - Boat owners not knowing mooring application procedures 	<ul style="list-style-type: none"> - STINAPA reports to Harbor Master, who then take action - Harbor Master overlaps with the marine park if there is a threat to nature (anchoring, beaching, boats speeding in shallow water) - Harbor Master in the process of making a maritime group (Douane, coastguard, police, Harbor Master) - Collaboration for development of piers and a new container port in the marine park. - Work with Harbor Master on sargassum to clarify roles - Installation of weather stations

Group	What is going well (in no particular order)	Priorities (in no particular order)		Concerns (in no particular order)	Collaboration (in no particular order)
Industry					
Marinas - docks	<ul style="list-style-type: none"> - The marine park drives the economy - Willing to pay for the park - Limited beaches bring a different kind of tourist 	<ul style="list-style-type: none"> - Harbor space - Safety - Moorings - Pollution management - Boat management in wind reversal 		<ul style="list-style-type: none"> - Water quality; sedimentation from landscaping near Plaza - Exhaust fumes and oil leaks from dive operators - Fishing at No Name - Ghost nets from pier/dock fishers - Encircling nets - Safety on the water - boat hire should require a license - Too many boats in the marine park - Moorings; reservation system, fee to use the moorings - Trawlers - fishing near swimming areas (safety) - Rules broken by rental boats - Better enforcement of building rules - Future developments (Ocean breeze, Water village, dock permissions) - Kite surfing; too many kites, becoming unsafe but is popular and should be encouraged / managed. 	<ul style="list-style-type: none"> - Plans for future pump out facilities at Plaza - Klein Bonaire: tourist numbers, outreach, facilitates - Report incidents to STINAPA - Facilitate ranger visits and connections to stakeholders
NGOs					
WWF	<ul style="list-style-type: none"> - Progress with enforcement and collaboration - Policy staff member is useful - Mooring system - Klein Bonaire cleaning - Presence with issues on the water - Projects; wastewater, reef/shark monitoring - Sargassum (take the lead) - Project partnerships - Collaboration 	<ul style="list-style-type: none"> - Climate change - Roles and responsibilities - Collaboration - Vision for the island shared among major players - Sustainable fisheries - Coastal construction 		<ul style="list-style-type: none"> - Climate change - planning, awareness, mitigation, lack of data, next steps - Public perception, more patrolling - Pollution; wastewater, run-off - Hotspots: cruise ships, piers, coastal development - Understanding the role of STINAPA - Role of organizations within the NEPP - Funding and capacity - Considerate communication of sensitive (wastewater) projects and outcomes - Updated information on the no-take reserves 	<ul style="list-style-type: none"> - Sustainable financing - Wastewater management - Advocacy - Defining roles - Mainstreaming climate change - Collaboration (Allianza model) - Lobbying (not activism) - Sustainable fisheries - Lac RESEMBID, seagrass work
Reef Renewal Foundation	<ul style="list-style-type: none"> - Increased efforts in education and awareness - Management and maintenance of moorings - Regulations for fishing 	<ul style="list-style-type: none"> - Water quality assessments - Identifying polluted areas - Sustainable finance - Working with dive shops for outreach - Using volunteers effectively - Working with universities to provide students for research. 		<ul style="list-style-type: none"> - Law enforcement - Cultural differences - Coastal development; lack of enforcement - Permits - permit process too slow, effects funding applications - Self-promotion independent of STINAPA or government - Out planting sites selected using historical information, not current data 	<ul style="list-style-type: none"> - RESEMBID funds for restoration project in Lac - Publish joint reports and articles - Public acknowledgment - social media, reports - Collaborate on site selection

Group	What is going well (in no particular order)	Priorities (in no particular order)		Concerns (in no particular order)	Collaboration (in no particular order)
Sea Turtle Conservation Bonaire	<ul style="list-style-type: none"> - Recent improvements in communication - Help with retrieving dead turtles - Collection of trash from Klein Bonaire 	<ul style="list-style-type: none"> - Klein Bonaire – 70 percent of turtle nests - Lac - 500 resident green turtles - Sustainable development of Klein Bonaire 		<ul style="list-style-type: none"> - Beach BBQs / firepits - Trampling, umbrellas, signs being dug in - Litter and light pollution - People harassing turtles - Boat strikes (numbers unknown) - Other threats (dogs, wild cats, invasive terrestrial plants) - Invasive seagrass - Ghost nets in Lac - Too many tourists on Klein Bonaire, can't place barriers around all nests - People visiting Klein Bonaire without permits - Jet skis being launched using trailers on Beaches - Foils on windsurfers likely to be decapitating turtles - Rules being broken; speeding boats, illegal beach activities and boat parties, resort visits to Klein Bonaire without permits, - Marine park fees not being paid by water taxi users - Excess tourism and placing nest barriers (nests take up most of the beach) 	<ul style="list-style-type: none"> - Retrieval of dead turtles - Management of trash on Klein Bonaire - Increased rangers in Lac and Klein Bonaire, willing to help with training for rangers (to improve patrols and communication)
Other	<ul style="list-style-type: none"> - The existence of the marine protected area - National level legal protection for Klein Bonaire 	<ul style="list-style-type: none"> - Facilities management; hiking trails, overnight stays, toilets, shade, BBQ pits - Reforestation projects - Fees charged for visiting Klein Bonaire 		<ul style="list-style-type: none"> - Lack of communication and outreach - Lack of interest in nature on Klein Bonaire - Klein Bonaire excluded from planning events - Lack of ranger commitment on Klein Bonaire - Safety on Klein Bonaire - people walk and get lost - Increased activity on Klein Bonaire - Feeding animals (birds) - Invasive cats and flora - People stepping on coral, garbage disposal 	<ul style="list-style-type: none"> - Against increasing activities on Klein Bonaire, but has ideas on hiking trails, overnight stays, toilets, shade, BBQ pits - Fees - Reforestation work
Stichting Internos		<ul style="list-style-type: none"> - Channel maintenance - water circulation - Nurseries for mangrove plants - Reforestation - Outreach - education 		<ul style="list-style-type: none"> - High erosion rates and sedimentation of back portion of mangrove. - Sargassum, dieback of seagrass and mangroves also render soil toxic for regrowth - Stagnant ponds forming through excess sedimentation - Lac is silting up, perhaps becoming shallower - Beach erosion at Lac Cai - Invasive seagrass - Overgrazing by turtles - Unmanaged recreational use (illegal wastewater and irrigation with greywater in Sorobon) - Increased visitation to the islands - Eutrophication (sargassum, wastewater) - Seagrass loss at Sorobon (trampling by windsurfers) - Sand extraction - Coral damage from windsurfers - Illegal fishing activity (channels being blocked) - Fly fishing at Sorobon - Rules being broken 	<ul style="list-style-type: none"> - Recording and reporting infractions - Improve communication with LNV and RCN - Increasing presence of STINAPA at Lac - Improve communication - Sustainable financing

Group	What is going well (in no particular order)	Priorities (in no particular order)		Concerns (in no particular order)	Collaboration (in no particular order)
Klein Bonaire (not defined as a group previously)	<ul style="list-style-type: none"> - 70 percent of Bonaire's turtle nests on Klein Bonaire, 2km cantered on Klein Bonaire some nests on small beaches. - Saliñas are important - All invasive grazers have been removed 	<ul style="list-style-type: none"> - Control - facilities on No Name - Increase carrying capacity of Klein Bonaire; moorings - Increase activities; trails - Restricted access - No development - Guided tours - Beach signage - Zoning plan for Klein Bonaire (snorkel spots, trails) - Reef restoration sites 		<ul style="list-style-type: none"> - Mooring management - Overcrowding - Turtle hatchling success reduced by 50 percent in busy areas. Lighting, beach use and structures will have an impact. - Threats to turtles include ice, BBQs, trampling, dogs, umbrellas - Effect of increased use on corals - Increased coral mortality of out planted colonies - More supervision on No-name - Carrying capacity; balancing environment and visitation - Locals unaware of rules; improve outreach to variety of audiences - Use of concrete block by fishers - Waste water from Bonaire and open sewage systems on visiting boats (dive and sail boats) - Boats visiting from Curaçao (mostly for regatta, boat parties, fishing tournaments and events) - Kite surfers and jet skis at Klein Bonaire 	<ul style="list-style-type: none"> - Enforcement of rules (clear communication, improved signs, tourist briefings) - Zoning plan for Klein Bonaire and its communication
FUHIKUBO	<ul style="list-style-type: none"> - STINAPA do a good job of protecting species - Good work on Klein Bonaire 	<ul style="list-style-type: none"> - Involve local people - Development of facilities at Klein Bonaire 		<ul style="list-style-type: none"> - No management plan for Klein Bonaire - No shared vision for Klein Bonaire - Image of STINAPA within local community - Kayaking permissions in mangroves - Boats using moorings for more than 2 hours - Fencing turtle nests on No Name restricting beach access - Removing invasive species from Klein Bonaire - Kayak access from Bonaire to Klein Bonaire and kayaking in the saliñas; use and safety issues. - Protection of Playa Frans - Development of any saliñas due to sedimentation of reefs - Access to Goto; flamingo disturbance 	<ul style="list-style-type: none"> - Re-build fisherman's hut at Carl's hill - Ranger presence on Klein - Create a culture / history plan for Klein Bonaire, Lac Bay, Goto Lake - Partial restoration of 2 buildings on Klein Bonaire - Showcase historical activities on Klein Bonaire - Carrying capacity for Klein Bonaire (suggestion) - Development of walking trails (some work already done) - Name change No-Name beach - Work with locals on hiking tours of Lac - Videos being produced on history of fishing in the marine park
PISKABON		<ul style="list-style-type: none"> - PISKABON is used to share information through a central point - Facilities for fishers - slipways - More communication and conversation - Finding a sustainable life/income balance for fishers 		<ul style="list-style-type: none"> - Not catching many fish as the sharks eat them all - Fishers coming from Curaçao using gill nets - Relationship between OLB and STINAPA and fishers not understood - Kite surf restrictions at Red Slave - Kite surf conflict with bait collectors - Fish scared by kites and the shade they create - Damage to Eddy's property 	<ul style="list-style-type: none"> - Would like a meeting with more stakeholders and fisherfolk, continuous meetings. - Rich history and knowledge with some fishers - Fishers would like to understand more about why the fish stocks have been reduced, even over the last 16 years.

Group	What is going well (in no particular order)	Priorities (in no particular order)		Concerns (in no particular order)	Collaboration (in no particular order)
Commercial operators					
Dive companies	<ul style="list-style-type: none"> - The marine park has been successful for so long, made Bonaire a leader in conservation - Some improvements in communication 	<ul style="list-style-type: none"> - Effective communication of the nature fee and the work/responsibilities of the marine park - More effective relationship with the board of STINAPA - Ship wreck on southwest corner at Klein Bonaire - Access and opening dive sites; piers, Windjammer, east Coast - Mooring strategy 		<ul style="list-style-type: none"> - Disconnect between STINAPA and Dive Companies - CURO's relationship and the functioning of the Board of STINAPA - Efficient fee collection, amount of time spent on administration of fees by STINAPA. - Enforcement of no-fishing zones - Lack of visible enforcement by rangers - Threats: Development (waste water, mass tourism, imported sand, construction) - Access; entry/exit points, Town Pier dive site, access to reserve in the north, moorings at Andrea/Donkey beach - Klein Bonaire: Moorings at no name should focus on small recreation vessels - Nature education should be main streamed, more local kids involved with the ranger program - Enforcement; fishing in front of dive operators - Impact of terrestrial erosion on marine park Resources - Shifting focus on tourism value/margin/ tourist characteristics (high paying, exclusive vs budget, mass market) 	<ul style="list-style-type: none"> - Nature fee: Make nature fee less about administration and more about conservation - Dive sites: Access / open and manage Town Piers and Windjammer dive sites, explore priority moorings at Klein Bonaire with CURO
Windsurf companies	<ul style="list-style-type: none"> - Zoning plan for Lac seems to work 	<ul style="list-style-type: none"> - Increased ranger support at Lac 		<ul style="list-style-type: none"> - Lack of enforcement in Lac Bay - Number of visitors - Communication; awareness of rules - Nature and number of cruise tourists using toilet facilities and not purchasing refreshments or hiring equipment) - Sand - infilling of the bay, shallowing and warming water, having an impact on the environment - Seagrass die-off - Sargassum management (removal of too much sand from sites where sargassum has been removed) - Pollution - litter from within the bay (historical tar) - Permits for development, working with government - Threat; Divers interfering with fish traps, Conch harvesting in Lac, Bait fishing in Lac - Fee is too high and should be charged at the airport - Charge cruise tourists the nature fee - Sunblock environmental impact - Use of foil boards should be allowed, not in Lac (too shallow) - Kite surfers take up to much space in Lac 	<ul style="list-style-type: none"> - Protecting seagrass bed - Communication between windsurfers and STINAPA

Group	What is going well (in no particular order)	Priorities (in no particular order)		Concerns (in no particular order)	Collaboration (in no particular order)
Kayaking companies	<ul style="list-style-type: none"> - Glad the marine park exists and offers protection - Appreciate Ramsar status of Lac for extra protection 	<p><i>Interpreted from notes:</i></p> <ul style="list-style-type: none"> - Effective zonation - Access to the mangroves and channels 		<ul style="list-style-type: none"> - Increasing use - Plastic pollution in the mangroves - Variable conditions (seemingly cycles in state of resource) - Degradation of benthic organisms - Observed reduction in juvenile fish, birds, scorpion fish, cushion stars. - Increase in invasive seagrass - Stand Up Paddleboard use (SUP) - People accessing channels without knowing rules - Recreational users; climbing trees, fishing at Puitu, racing boats, walking on seagrass. - Fishing in Kreek di Coco - Use of electric boats and boats with motors in areas where they shouldn't be. - Fish lines and nets in the mangroves (three fishermen allowed to use traps, nets allowed if registered with STINAPA) - Sargassum removal - Noise pollution from planes flying over Lac (caused by a shift in the flight paths) - Mix of commercial and recreational users - recreational users increasing and not knowing the rules. - 'One group per location' rule and its effectiveness - Commercial operators without a permit - Permitting procedure - Kayak rentals by windsurf centers - commercial? - Public use and commercial use of the mangroves - Commercial permit owners enforcing access rights incorrectly - OLB and commercial operators 	<ul style="list-style-type: none"> - Maintaining channels and clearing overgrowth - Information on usage - Education; communication to improve understanding of mangroves, build bird watching hut, improve signage
Kitesurf companies	<ul style="list-style-type: none"> - Improved communications with STINAPA - Removal of Sargassum - Making rules - Monitoring water quality 	<ul style="list-style-type: none"> - More emphasis on kite surfing: the sport is expanding globally, Bonaire is not keeping up. - More space for kite surfers, current space is sufficient for lessons, not recreational kiting. - Closure of Margate Bay and Vista Blue for safety and to help protect the reef - Sites opened for wave kiting at Red Slave, Lac Cai - Safety: one boat always available for emergencies 		<ul style="list-style-type: none"> - Not enough space, usually 50 kites in the water - Lack of facilities of the number of cruise visitors (people relieving themselves in bushes around the south of the island) - Fee payment simplified and enforced on tourists who are often unaware of the fee. - Marine park rangers approaching whilst in the water; boat collision could happen. - Commercial operators, tourists and local kite surfers using a limited space - Divers using site 'reserved' for kilters - Diver behavior under water; damaging the environment - Conflict with fishers using the launch site and approaching kilters very closely - Fishers traditionally using space allocated for kilters - Boat and jet ski users using site 'reserved' for kilters - Speeding boats on Sundays (when there is less enforcement) 	<ul style="list-style-type: none"> - Foils increasing in popularity, would like to work with STINAPA to clarify concerns around foils help with defining zones - Disseminate information on paying the fee - help in reporting violations, if possible, send an app with the date, time, registration number

Group	What is going well (in no particular order)	Priorities (in no particular order)		Concerns (in no particular order)	Collaboration (in no particular order)
Sailboat and snorkeling companies	<ul style="list-style-type: none"> - Mooring system shows the island cares about reefs - Addition of toilets at Te Amo 	<ul style="list-style-type: none"> - Marine park undervalued by visitors - More quality destination spots 		<ul style="list-style-type: none"> - Marine park is not visible as part of daily life - Rules ineffective because there is no control - Price of international insurance to enable work with cruise ships - Relationship with Government strained because of exclusion from discussion about port fee increase - Lots of new projects starting on Bonaire - Limited sites to visit resulting in hotspots for visitation - Lack of beach and facility management - Lack of facility on Klein Bonaire 	<ul style="list-style-type: none"> - Managing moorings - Communication with cruise passengers - Improve communication between STINAPA and tour companies
Watersport Association Bonaire (WAB)	<ul style="list-style-type: none"> - Communication improved recently, appreciate feeling heard - Proud of environmental status of the marine park 	<ul style="list-style-type: none"> - 100+ dive sites, would like more even distribution for users - Create hotspots for use, using facilities as 'honey pot'; site include Kite Beach, Te Amo, 1000 steps, No name, Pink Beach, Lac Cai, Sorobon - Communication between parties - Expansion of kite surfing and foil sport 		<ul style="list-style-type: none"> - Diversity of users, lack of space - Lack of (toilet) facilities, - Impact of ad-hoc toilets in bushes - Are all boat engines the same (cruise ship, 4 stroke, 2 stroke)? - Spectator value of extreme sport not taken advantage of - Insufficient moorings - Fees system; outreach - enforcement by tour operators makes things confrontational, web fees don't work for kite surfers, people need to know what they are paying for. - Captains license requirements; need to differentiate between large and small boats - Too many permits being released - Ban of foil sport - Safety roles and responsibility; search and rescue - Fishing 	<ul style="list-style-type: none"> - Nature fee tags - Mooring use - Permitting for watersport - Nature committee - Use of captain's license for management, WAB members supportive but want flexibility

APPENDIX G



IMPORTANT BIRD AREAS

	Bonaire	Klein Bonaire	Lac Bay
IBA NUMBER	6	AN012	AN013
Protection	50%	Y	Y
Area (hectares)	23,830	1,810	2,075
Number of bird species	214		
IBA species	10	3	3
Threatened bird species	2		1
Restricted range bird species	3		2
Biome-restricted bird species	2		2
Congregating bird species	10	1	

APPENDIX H



CONSERVATION ACTION PLAN

Conservation Strategies are a key component of the Open Standards 'theory of change' approach to conservation management adopted by STINAPA in 2018. STINAPA has identified the following Conservation Strategies:

- Improving the sustainable use of the Bonaire National Marine Park: IF STINAPA understands the impacts of users to its conservation targets and the revenue generated by specific user groups/activities, and updates its marine park management plan, determines hotspots/problem areas and develops interventions, and identifies new opportunities for sustainable use, improves stakeholder involvement and improves awareness and enforcement of rules and regulations, THEN the use of the marine park will be more sustainable.
- Improving sustainable use in Lac Bay (mangroves and sea grass): IF criteria for sustainable use are incorporated in a coherent management plan, supported by government and other stakeholders, and if management capacity is adequate, THEN effective enforcement of legislation will lead to a regulated private sector and other users and compliance with the management plan.
- Reducing invasive species in the Bonaire National Marine Park: IF the community acknowledges the threat of invasive species to the marine park, and measures are taken to prevent the importation of such species, and programs for monitoring and control of such species are in place, THEN the threat of invasive species (to the biodiversity) in the marine park is minimized.
- Sustainable reef fishing: IF there is participatory management and effective communication between stakeholders including fishers and government and if a monitoring program for fisheries is in place informing adaptive management and regulations and if effective regulations are enforced, fishers and consumers are more aware and comply with regulations, THEN fishing will be displaced from the coral reefs and the pressure on them is reduced.
- Influencing policy, regulation and management: IF nature is considered a dominant factor in Bonaire's development and if knowledge gaps of residents and tourists' impacts on nature are filled and if nature conservation policy guidelines for soil-, water-, vegetation- and wetlands-management, and the economic growth strategy are in place, THEN, the direct impacts of residents and tourists on natural resources will be reduced, the run-off and land-based discharges will be retained, and a regulated coastal development will be implemented, leading to an improvement of terrestrial and marine ecosystems, water quality, and sustainable development and recreation.
- Climate change readiness on Bonaire: IF knowledge and information on climate change is collected and analyzed together with enabling partners, and if expertise is engaged, and compelling messages highlighting the climate change effects and potential mitigations are addressed to the target audiences, THEN climate change guidelines, best practices and strategies to mitigate and adapt to its effects on Bonaire can be developed.

BONAIRE NATIONAL MARINE PARK

RESEARCH AND MONITORING AGENDA 2022

	Rationale	Management Goal	Key Objective/s		Research Question	Indicators	Description of Research Design and Methodology (if known)
Coral reefs					Coral reefs		
Coral reef health general	Global and local stressors are negatively affecting coral reef health. STINAPA needs regular monitoring to document trends in coral reef health to drive future research and management.	Minimize chronic and acute disturbances to coral reefs	Provide stakeholders and policy makers information necessary to respond to stressors; manage local stressors to minimize chronic and acute disturbances to coral reefs				
Coral reef health resilience trends	Global and local stressors are negatively affecting coral reef health. STINAPA needs regular monitoring to document trends in coral reef resilience indicators to drive future research and management.	Promote resilience trends	see above				
Bleaching	Coral reefs worldwide have suffered numerous mass bleaching events; documentation is needed to inform policy makers and stakeholders	Manage local stressors to improve coral reef resilience; Inform and influence policies	Document and disseminate information on frequency and intensity of coral bleaching in the Bonaire National Marine Park				
Flagship species					Flagship species		
Shallows - Acropora	After massive die-offs in the past 50 years, Acropora species are re-establishing themselves in the shallow reefs; documenting recovery or subsequent mortality is crucial information for local and international stakeholders	Document protected species recovery and safeguard and/or facilitate local conditions that brought about that recovery	map Acropora patches every few years to document expansion or die-off; determine stressors		Is Acropora coral cover expanding in the shallow reefs of Bonaire? What are the main stressors of Acropora corals (disease/predators)?	percent cover/m2 Acropora from 2-6 m depth on the west coast of Bonaire; incidence of disease/predation	aerial imagery combined with in-water mapping exercises - every 3-5 years
Fish biomass trends	Coral reefs are historically overfished; Monitoring may determine effectiveness of fish protected areas and fisheries regulations and also whether key species for reef health are declining	Maintain high levels of herbivorous fish species; Prevent overfishing of remaining fish - both herbivorous and carnivorous	monitor trends in biomass/ density of protected/key fish species; determine effectiveness of no fishing zones		Is the biomass/density of carnivorous fish and herbivorous fish declining (both within/outside of no fishing zones and in general)?	Fish biomass/density (carnivorous/ herbivorous)	AGRRA fish transects every 2 (11 sites) - 3 (115 sites) years

Adapted from the original, please see the Digital Appendix 'Institutional Documents' for the full version with additional columns.

	Rationale	Management Goal	Key Objective/s		Research Question	Indicators	Description of Research Design and Methodology (if known)
Key species & fish schools, transect-count surveys, STCB	Baseline stock data and trend lines of species aid sound management of the marine environment and its resources	Understand trends of and develop management strategies for CITES species, keystone fish species and fish schools	Determine trends for species of interest and inform managers and the public		Sighting frequency, are the numbers stable/decreasing/increasing, where is the highest abundance and diversity for each species of interest?	Numbers of sea turtles, sharks, rays, barracudas, tarpons, rainbow & midnight parrotfish; fish schools (creole fish, creole wrasse, black durgon, blue tang, palometa, chub, bar jack, black margate, horse-eye jack, schoolmaster, yellowtail snapper), environmental indicators (e.g. visibility), disturbance and number of observers (trained/not trained)	Transect-count surveys, 108 surveys per year, distance sampling
Sharks and ray occurrence	Sharks and rays are protected species - very little is known about their presence	Protect threatened species	Document occurrence and frequency of sightings		Which species of sharks and rays frequent the Bonaire National Marine Park and how often?	Species of shark/ray, location, frequency	Dedicated observers fill in surveys on every dive
Coastal Development					Coastal Development		
Baseline/periodic monitoring during/after construction	Coastal development affects the coral reefs directly (coral physical damage) and indirectly (sand/silt, thrusters moving sand, etc.); Bonaire National Marine Park documents damage to the coral reef by development activities to 1) demonstrate these damages to local/national government 2) potentially claim damages	To work together with the local and national governments and developers so that activities do not or minimally affect the nearby coral reef	Document damages to the coral reef directly or indirectly caused by coastal development		Are corals directly damaged by activities? Are corals/water quality indirectly negatively affected by activities?	Coral health/cover; Sand cover; water quality parameters (nutrients/sediments)	permanent transects, water quality monitoring
Water Quality Monitoring					Water Quality Monitoring		
Water quality monitoring - nutrients	The health and resilience of coral reefs are steered by a complex combination of environmental and biological conditions, which include stressors such as run-off, sewage, climate change).	Assess the effectivity of measures taken to improve water quality.	Obtain quantitative information on the physical, chemical, and biological characteristics of water via sampling		What are the (trends in) water quality indicators that are critical for coral health.	Temperature, dissolved oxygen, pH, conductivity, ORP, nitrates, bioindicators, and turbidity	
Water quality monitoring - sediments	ditto	ditto	ditto		ditto	ditto	ditto
Water quality monitoring - point-source pollution	ditto	ditto	Obtain quantitative information on isotopes of interest via sampling		Can the source of the pollution be determined? How have the channels affected water circulation in Lac Bay -Will the addition of a culvert improve overall conditions of the northern portion of the mangrove forest	isotopes of interest? T, sal/EC,pH, TDS, DO	under development measure with HOB0 sensors (light and pressure), reefnet depth

	Rationale	Management Goal	Key Objective/s		Research Question	Indicators	Description of Research Design and Methodology (if known)
Improving water circulation at Lac Bay	Improving seawater input to the mangrove forest to the north of Lac Cai will improve forest health	Improve seawater flow through the northern area of Lac Bay	Add culvert to allow seawater to enter northern area of Lac Bay			Improved water conditions behind the beach of Lac Bay	monitor water quality
Mangroves in Lac/southern coast					Mangroves in Lac/southern coast		
Mangrove monitoring					Mangrove monitoring		
Mapping of mangrove channels - new and old	An extensive network of channels will improve water circulation	Mangrove restoration	To generate updated maps of current channel configuration		What is the current configuration of channels throughout the mangroves	Length of channels, area covered, water quality parameters in good range	Using GPS data and mapping (Google Earth, QGis)
Monitoring mangrove outplants along the southwest coast	A healthy mangrove fringe will reduce wave action and anchor sediments	Mangrove restoration	Coastal protection (second: increase biodiversity, blue carbon)		Will a fringing mangrove forest along the southwest coast help mitigate the negative effects of climate change?	number of seedlings planted, survivorship, erosion, flood damage	monitor mangrove growth, erosion along coast, damage after significant storms
Improving backwaters of Lac Bay	Erosion is causing sediments to fill the backwaters of Lac Bay mangrove forest areas - interventions are needed to improve mangrove forest health	Mangrove restoration	removal of sediment		Will the removal of excess sediment from the backwaters of the mangroves lead to an overall improvement of mangrove health?	mangrove health indicators (growth rate, biomass production, etc.), new growth	monitor mangrove growth
Monitoring reforestation efforts Fofoti	Reforestation at Fofoti is a measure to decrease the degradation of the backwaters of Lac	Mangrove restoration, reforestation	Obtain data to guide reforestation efforts		Can the source of the pollution be determined? How have the channels affected water circulation in Lac Bay -Will the addition of a culvert improve overall conditions of the northern portion of the mangrove forest	isotopes of interest? T, sal/EC,pH, TDS, DO	under development measure with HOBO sensors (light and pressure), reefnet depth

	Rationale	Management Goal	Key Objective/s		Research Question	Indicators	Description of Research Design and Methodology (if known)
Seagrasses in Lac Bay, Lagoen and Klein Bonaire					Seagrasses in Lac Bay, Lagoen and Klein Bonaire		
Seagrass monitoring (Halophila, other invertebrates)	Seagrasses and associated fauna) are protected and their distribution is limited; stressors include invasive species, coastal development, sargassum	Seagrass restoration	Determine how seagrasses are affected by stressors; use knowledge to develop plans to protect native seagrasses		Is native sg outcompeted by Halophila? How much seagrass is affected by sargassum influxes?	percent cover seagrass by species; density of associated inverts	plots surveyed annually
Queen conch monitoring	Conch are endangered due to overfishing; they are protected but illegal fishing occurs regularly and the population is extremely low	Conch population recovers to a sustainable level	Determine density of conch in Lac Bay		What is the density of Queen Conch in Lac Bay?	numbers of conch per plot	plots surveyed annually
Dry forest and salinas of Klein Bonaire	in development?						
Sharks and rays					Sharks and rays		
Shark tagging project	Sharks are protected species but very little is known about their presence and home range	Protection of threatened species	Determine home range/patterns of common species of sharks using the Bonaire National Marine Park		How far do common shark species travel/how often in the Bonaire National Marine Park	presence/absence over time of tagged sharks	individual sharks are tagged and receivers are strategically placed and serviced/downloaded periodically
Sea turtles					Sea turtles		
Transect-count surveys STCB	Sea turtles are protected in Bonaire. Threats include poaching, habitat loss and disease.	Determine population trends (and other information) of foraging sea turtle species to inform management decisions.	Determine if foraging sea turtle populations (green and hawksbill) are stable or increasing.		How many green and hawksbill sea turtles live in our waters and are their populations stable/increasing/decreasing?	Number of foraging sea turtles (green and hawksbill turtles) counted on Bonaire's west coast (incl. Klein Bonaire)	Transect-count surveys, 108 surveys per year, distance sampling
Net-capture surveys STCB	Lac Bay is a green turtle hotspot, an important foraging area for juveniles and sub-adults; See above	Determine population trends (and other information) of Bonaire's foraging sea turtle population to inform management decisions.	Determine if foraging sea turtle populations (green and hawksbill) are stable or increasing.		How many green sea turtles live in Lac Bay, is their population stable/increasing/decreasing, are they healthy (fibropapillomatosis), and what are their growth rates?	Number of foraging sea turtles captured in Lac; growth rates of sea turtles captured in Lac; incidence of FP	Net-capture surveys, 72 surveys per year.

	Rationale	Management Goal	Key Objective/s		Research Question	Indicators	Description of Research Design and Methodology (if known)
Marine mammals				Marine mammals			
Hydrophone monitoring	Marine mammals are protected species that migrate through Bonaire;	Use knowledge acquired to inform stakeholders and influence management plans and policy	Determine presence/seasonality of marine mammals and share knowledge with partners		Which species of marine mammals use the Bonaire National Marine Park - how often, which season?	Species of marine mammals (min number) passing the location of the hydrophone - season/frequency	Hydrophone recordings - 1 of 6 minutes recorded - almost continuously for one year; analysed by researchers
Marine mammal observation data	Endangered and protected species	Collect and share knowledge to influence management plans and policy	Document strandings; document sightings; share info		Which species of marine mammals use the Bonaire National Marine Park - how often, which season?	Species/size/date of marine mammals stranded in or sighted in the Bonaire National Marine Park	Observational data
Lionfish				Lionfish			
Lionfish monitoring	Invasive lionfish are actively controlled by STINAPA and dedicated volunteers; With no natural predators, these fish pose a serious threat to the coral reef	Prevent the decline of native fish populations as a result of the lionfish invasion	Control lionfish populations to a low density		What is the density of lionfish in the Bonaire National Marine Park?	Density of lionfish at several depths annually	Transects at several depths at over 20 sites
Limits of Acceptable Change				Limits of Acceptable Change			
Tourism	STINAPA must manage recreation in a sustainable manner to conserve the integrity of the natural resources in park	Provide recreational opportunities without negatively affecting the natural resources	Offer sustainable recreational activities; Visitors obey park rules; monitor natural resources that may be affected by recreation		Are visitors negatively affecting flora and fauna? What new recreational opportunities may the park offer without jeopardizing the natural resources? Are visitors violating park rules? What is the best way to get visitors to follow park rules?	Quantify activities that currently negatively affect nature (corals/birds disturbed x times/day/site); Number of visitors violating park rules/where; which orientation results in better behaved visitors?	in development
Net-capture surveys STCB	Lac Bay is a green turtle hotspot, an important foraging area for juveniles and sub-adults; See above	Determine population trends (and other information) of Bonaire's foraging sea turtle population to inform management decisions.	Determine if foraging sea turtle populations (green and hawksbill) are stable or increasing.		How many green sea turtles live in Lac Bay, is their population stable/ increasing/decreasing, are they healthy (fibropapillomatosis), and what are their growth rates?	Number of foraging sea turtles captured in Lac; growth rates of sea turtles captured in Lac; incidence of FP	Net-capture surveys, 72 surveys per year.
Limits of Acceptable Change				Limits of Acceptable Change			
Sargassum monitoring	Recent and chronic sargassum influxes are damaging seagrasses and mangroves and associated fauna in the Bonaire National Marine Park; STINAPA must monitor and quantify these influxes as well as prepare for future influxes	Minimize ecological damage caused by Sargassum	Quantify amount of sargassum entering Lac Bay and Lagoen; the amount removed; determine seasonality; improve prediction of influx		What percent of incoming sargassum is removed? Using satellite imagery, how can we better prepare for influxes? How can we increase the percent of Sargassum removed?	Daily images of Sargassum along the downwind edge of Lac Bay and Lagoen; weight of sargassum removed	in development
Seagrass/mangrove damage from Sargassum influxes	Recent and chronic sargassum influxes are damaging seagrasses and mangroves and associated fauna in the Bonaire National Marine Park; the damage caused by these influxes needs to be documented and shared with local and national governments and use for future management						

APPENDIX J

**BONAIRE
NATIONAL
MARINE PARK
RANGERS**

A photograph of three men, identified as Bonaire National Marine Park Rangers, standing in front of a mural. The man on the left is wearing sunglasses and a white t-shirt. The man in the middle is wearing a blue cap, sunglasses, and a white t-shirt. The man on the right is wearing a white t-shirt with a logo that reads "STINAPA BONAIRE NATIONAL PARKS FOUNDATION". The mural behind them features a large sea turtle and other marine life. The background is a bright blue wall with a window.

STINAPA
BONAIRE
NATIONAL PARKS FOUNDATION



JUDITH RAMING
Marine Park Manager



EDWIN DOMACASSE
Chief Marine Park Ranger



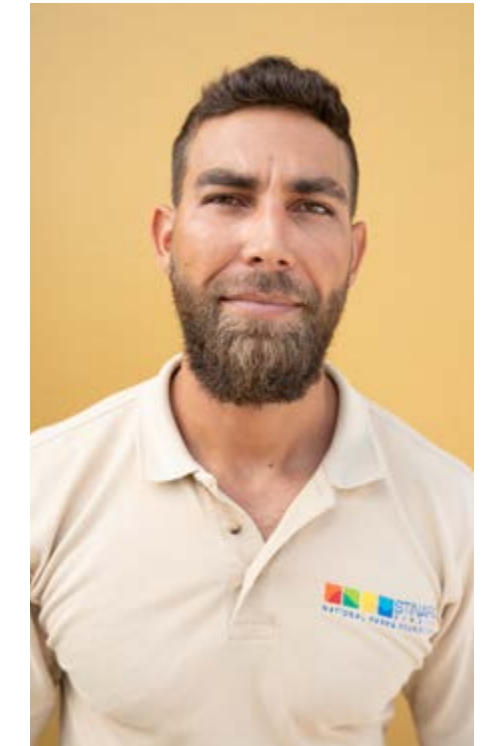
D'ANGELO MARTIJN
Marine Park Ranger



ENCHOMAR WANGA
Marine Park Ranger



GEDION CICILIA
Marine Park Ranger



DUSTIN ABRAHAM
Marine Park Ranger



LEO MARTIJN
Chief Marine Park Ranger



MAVELLY VELANDIA
Marine Park Ranger



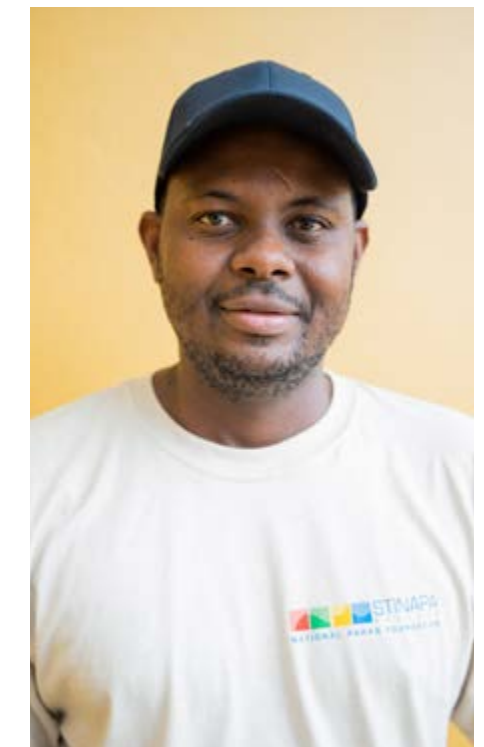
OSCAR OGENIA
Marine Park Ranger



MELISSA R. RESTREPO
Marine Park Ranger



SURADNO MERCERA
Marine Park Ranger



JONATHAN TRENIDAD
Marine Park Ranger



Barcadera 10
Kralendijk, Bonaire
+599 717-8444 | info@stinapa.org



Plaza Reina Wilhelmina 1
Kralendijk, Bonaire
+599 715-5330 | info@bonaigov.com