Description of the Outstanding Universal Value (OUV) of the Proposed Marine Nomination Properties of the Bonaire and Curaçao Marine Parks (BCMP)

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Summary

This report describes the possible Outstanding Universal Value of the potential World Heritage nomination that combines the Bonaire National Marine Park (BNMP) and the Curaçao Marine Park (CMP) from the ecological, geological and biodiversity perspective. According to World Heritage natural criteria, these correspond to criteria (vii) (aesthetic and spectacular natural phenomena), (viii) (geological and geomorphic processes), (ix) (ecological and biological processes), and (x)(biodiversity), as defined by the Operational Guidelines for the Implementation of the World Heritage Convention (UNESCO 2017).

Based on expert advice to expand the size of the initial proposed nomination, which only included BNMP, and recent policy action towards reinforced management implementation of the Curaçao Underwater Park, the Curaçao Underwater Park is considered to be a necessary addition to expand the total area for the nomination. This expansion intends to strengthen the Outstanding Universal Values (OUV) for a successful UNESCO World Heritage bid. We here document the OUV of the proposed nomination by combining the Bonaire National Marine Park and the Curaçao Underwater Park for a single nomination, known as a serial site with two components, herein referred to as the Bonaire and Curaçao Marine Parks (BCMP). This report also highlights the benefits of and opportunities for further strengthening the OUV: by 1) extending the boundaries of the two MPAs – landward and seaward, and 2) considering additional areas that include wetlands, pelagic areas and deep benthic habitat. Such an expansion would benefit 1) the geological values by encompassing examples of visible geological history (criteria (viii)); 2) the ecological values by including different habitats forming part of the connectivity continuum (criteria (ix)); and the biodiversity and conservation values by including a larger number of endemic and threatened species and their key life-cycle stages (criteria (x)). In this report the additional areas are considered as part of the buffer zone, as local authorities need to consider the feasibility of legal protection and management for a larger area. Many of the values discussed in this report face important threats and have suffered documented declines in recent decades. This report does not address those issues or discuss possible management measures but only focusses on the values present and how these might contribute to potential OUV.

Description of the components

The proposed nomination BCMP consists of two components comprising the Bonaire Marine Park and the Curaçao Marine Park. The two components of this serial site are located in two different jurisdictions of the Kingdom of the Netherlands: Bonaire falling under the jurisdiction of the Dutch Caribbean and Curaçao being a constituent country. The Bonaire National Marine Park (BNMP) is a predominantly marine area made up of a fringing reefs surrounding the entire island of Bonaire. Its boundary is the 60m isobath and extends at its furthest 200m offshore. The full terrestrial area of Kleine Bonaire (approx. 7 km^2) falls inside the boundaries of the BNMP. Habitats include coral reefs, non-coral reefs, seagrass beds, rocky shores, beaches and mangroves. A small area of salt flat which lies inside Lac Bay is also included. The Curaçao Marine Park (CMP) is entirely marine as its land boundary is the high tide mark and its seaward boundary is the 80m isobath. CMP is a marine park that covers 21.7 km of coastline and extends to 100 m offshore. Both protected areas are part of documented key biodiversity areas (EU BEST).

While buffer zones have not yet been confirmed, it is suggested that all the Ramar Sites of Bonaire and the proposed Ramsar Sites of Curaçao be considered as buffer zones (some of these, such as Klein Bonaire and Lac Bay, already lie within the nomination area). It is also recommended that some of these areas could be considered as additional components for the nomination. Additional buffer zones are proposed in the 12 nautical mile Territorial Sea around Bonaire and Curaçao and some parts of the EEZ. For Bonaire, any seaward extension beyond the 60m isobath is aided by

the designation of the entire marine zone around Bonaire as the Yarari marine mammal and sharks Sanctuary in 2015.

<u>Description of values</u>

The reefs of the Bonaire and Curaçao Marine Parks (BCMP) form an outstanding example of healthy and diverse oceanic island reef nearshore systems that are equally accessible to local communities, recreational users and scientists. The semi-arid island climate ensures crystal clear waters with year-round low turbidity and minimal seasonal variation. The relatively small size and Caribbean location ensure that these reefs are accessible for artisanal fisheries, recreational and scientific use, yet still contribute via connectivity to the health of the Large Caribbean Marine Ecoregion. The global rarity and significance lies in the high coral cover and high fish biomass which is in close proximity to the inhabited islands. The presence of 52 marine species listed on the IUCN Red List of Threatened Species that can be seen during recreational dives and highlights the conservation value of the area. Many of these are easily available for scientific study. The irreplaceability of the nomination is further proven by the large number of island endemics; the key biodiversity areas and Ramsar Sites. The relatively small area includes highly diverse reef structures resulting in a high density for species, community and habitat diversity of coral reefs and non-coral benthic habitats. Depending on the site, within the space of a few hundred metres a variety of tropical reef-associated habitats including rocky shores, beaches, salt flats, mangroves, seagrass beds and caves are present, legally protected, visible and also accessible to the public.

Criteria (vii) (spectacular natural phenomena) the reefs of the Bonaire and Curaçao Marine Parks (BCMP) are outstanding examples of fringing coral reefs on offshore islands that have evolved to be among the most diverse reef in the Caribbean. These reefs are perfectly representative of a semi-arid oceanic Island near-shore marine ecosystem. While like other reefs in the region and even worldwide, these reefs have experienced important declines in recent decades, their comparatively high cover of living corals is increasingly rare particularly in the Caribbean and indicate better coral health compared to most other regions. Large schools of colourful diverse pelagic and reef fish further attest to ecosystem health which is ensured by the presence of key associated habitats including: rocky shores, beaches, salt flats, mangroves, seagrass beds, caves and neighbouring pelagic areas. The reefs and associated habitats serve as breeding, nesting, nursery, feeding and resting areas for endemic, migrant and threatened species of birds, turtles, fish and marine invertebrates. The health of the ecosystem can be ascribed to high water quality (as has been documented in various scientific studies, e.g. Gast et al. 1999) and which is primarily due to the specific interplay of geology, oceanography and meteorology. Low rainfall, lack of major rivers and coastal mountains, distance from the South American continent and isolation by deep basins all result in a narrow temperature variation and low risk of coral bleaching, low turbidity and low terrestrial runoff, while lack of agriculture adjacent to the reefs greatly limits high-nutrient effluents. Finally, the continuous east to west Caribbean current maintains a constant flow of nutrient-poor tropical water from the Atlantic. Important megafauna such as sea turtles, several IUCN Red listed fish species and flocks of flamingos are abundant and can be frequently and reliable seen (Prins et al. 2009).

As pointed out by Beek et al. (2014a) the undeveloped coastline areas of the Bonaire National Marine Park and Curaçao Underwater Park offer spectacular sea views of crystal clear water in different shades of blue, contrasted by green coastal vegetation, white sandy beaches and hypersaline saliñas in different shades of pink. Underwater, there are 13 distinct seascape features and 8 distinct coral reef communities. Several seagrass communities also contribute to a complex and attractive diversity of seascapes, each with its own complement of fishes and other associated fauna.

Thanks to environmental stability and exceptional habitat diversity these islands boast amongst the best-developed reefs in the Caribbean, and some of the highest documented species richness and endemicity in numerous taxa, from marine molluscs and algae to sponges and fishes. Due to the high aesthetic quality of the marine life and seascapes in the proposed nomination properties concerned, Bonaire and Curaçao consistently rank among the top Caribbean dive destinations in the recreational dive literature (see Table 10).

However, even after giving additional consideration and reviewing documentation for this criteria we consider that at this time there is insufficient evidence that the BCMP is distinct enough from other areas to meet the conditions for OUV in criteria (vii).

Criteria (viii) (geological and geomorphic processes): The leeward Dutch Caribbean islands are the south western most part of the Antilles arc. The islands emerge from the seamounts of the Leeward Antilles ridge with the Venezuelan Basin and Roques Basin to the north. The strategic upstream location of these islands with respect to current flows within the Caribbean have allowed them to play an exceptional role for dispersal of marine life throughout the region for the last 9-7 million years (Ma) (Iturralde-Vinent 2006). Due to their geographic position in the southern Caribbean and close to the South American continent, they also have largely enjoyed protection from hurricanes (NOAA 2017) and low rainfall (Sarmiento 1976). At the same time these oceanic islands are located far enough off the mainland coast that their ecosystems do not suffer from riverine sediment or salinity fluctuations as is typical in continental shelf reefs and which limit coral growth in most of the shallow shelf areas of Venezuela (Weil 2013). Hence, the proposed nomination provides an outstanding example of how geological and geomorphologic features are closely entwined with biophysical processes. They provide a rich and invaluable record of the ongoing dynamic adaptation of coastal environments to global change and continue to be of great geo-scientific interest.

Coastal wind-driven upwelling in the southern Caribbean cools surface waters slightly (Rueda-Roa & Muller-Karger 2013) and additionally buffers the coral reefs from bleaching episodes (Eakin et al. 2010). These same conditions offer the best opportunity for these reefs to maintain a healthy condition and continue to play their important role in the region well into the future.

We further highlight the active ongoing processes of habitat transformation whereby inland seawater bays are being transformed into land-locked saline bays by the natural processes of bio-acrretion and bioconstruction. All intermediate phases of this process are easy to see and study within the BCMP nomination. Finally, we discuss the presence in the BCMP of three additional, scientifically-neglected, framework-building communities that are based on calcareous algae and vermetid gastropods and that are adapted to accrete reefs in habitats that are unsuitable to coral growth. Nevertheless, a full discussion of geomorphological features (such as marine terraces, beaches, caves, etc) and geomorphological processes (such as erosion, bioconstruction, etc.) remains wanting and a full evaluation for criteria (viii) will need to wait until additional work is done.

Due to the unique geographic and meteorological situation which has afforded it a longstanding central role within the Tropical Atlantic in terms of biodiversity the proposed nomination may qualify as "irreplaceable" for OUV criteria (viii). Our Comparative Analysis found no tropical coral reef World Heritage properties combining a similar interplay between geology oceanography and meteorologyl as the basis for a prolonged and convincing role in the biodiversity of a whole biogeographic province. Hence, criteria (viii) may provide a basis for irreplaceable OUV and enlistment as a marine World Heritage Site (mWHS).

Criteria (ix) (ecological and biological processes): The proposed BCMP encompasses all the biophysical and ecological processes that characterise a natural and sustainable reef ecosystem: the highest carbonate production rate for coral reefs in the Caribbean, large coral colonies and a high parrotfish grazing rate (Beek et al. 2014a). These attributes of reef health (and presumed resilience) contribute to the highest levels of hard coral cover and one of the lowest levels for macroalgal coverage for reefs in the Caribbean (Beek et al. 2014a). Beek et al. (2014a) indicate that for criteria (ix), the indicators of parrotfish or herbivore biomass, carbonate production or coral reef growth, % hard coral cover and % algal cover have been little used before. This suggests that the chosen attributes may fill a gap in the World Heritage List for OUV related to coral reef ecological processes.

Also, the process of "connectivity", is included at four of the seven identified levels in this proposed nomination (sea to land, sea grass & mangrove to reef, shallow reef to deep reef, coastal to pelagic). Hence we add exceptional connectivity as important attribute of healthy reef processes. Additional levels of connectivity would be included by expanding the boundaries of the proposed nomination to include components in the EEZ such as part of the Yarari Sanctuary. The hydrologic, oceanographic and geophysical attributes key to maintaining the integrity of the proposed nomination include the consistently high water quality due to the combined effects of continuous water circulation and fortuitous geological and meteorological factors which restrict sediment and freshwater stressors. With an oasis of marine life in relatively barren tropical ocean waters positioned at a critical upstream position within the Tropical Western Atlantic Province, the proposed nomination has played a key role in the process of reproduction, dispersal and colonization by marine organisms in the Caribbean, and continue to do so today (Albrecht et al. 2013, Baldwin et al. 2014). As reefs in the region continue to decline rapidly (Jackson et al. 2013), the proposed nomination where partial reef recovery can be documented in certain areas, represents the last best hope for regional coral reefs. The relative importance of the proposed nomination area's reefs will continue to increase in the future due to their exceptional health and resilience.

Aside from possessing strict coral reefs, based on hard corals, the reef systems of Bonaire and Curaçao also possess actively growing reef-forming communities that are based on coralline algae and vermetid gastropods, in addition to hard coral communities. These so-called "rodolith reefs", "lithothamnion reefs" and "porolithon-vermetid reefs" extend active calcification and reef formation into habitat zones where corals are unable to form reefs (Becking & Meesters 2014, Focke 1977b, 1978b, Zaneveld 1958). These include shallower high-energy surf zones and deeper low-light zones. Hence the coral reefs of these properties are not "just" isolated coral formations, but are complemented by other framework-building communities starting from the shore and extending into deep shelf habitat. To our knowledge, these arguments have not been used to justify Outstanding Universal Value for other World Heritage Sites or potential nominations on the Tentative List.

We conclude that the proposed nomination possesses sufficient inherent and lasting integrity to continue to sustain the local exceptional biodiversity as well to serve their role as a major storehouse and source of regional biodiversity.

Criteria (x) (biodiversity): The BNMP and the CMP have about 650 species of marine fish (Robertson & Cramer 2014), 745 species of marine molluscs (Coomans 1958, de Jong & Coomans 1988), 430 species of marine algae (Vrooman & Stegenga 1988) and 201 species of marine sponges documented for the two components (ie. Bonaire and Curacao combined (Soest, various papers), our Comparative Analysis shows that the species richness of many groups surpasses that of other mostly large biotically rich areas of the Caribbean and even the Pacific (Table 19).

Curaçao and Bonaire lie in the Caribbean biodiversity hotspot (Meyers et al. 2000) and together possess 202 endemic species so far only known from the ABC islands or having an otherwise very limited distribution in the southern Caribbean (see Appendix 2). The present nomination area, possesses 123 island endemic species of which 63 are marine and 60 are terrestrial thanks to the coastal terrestrial habitat included in the BNMP. The CMP has no terrestrial habitat within the nomination area and hence has no terrestrial species. The largest number of endemic species are accounted for by sponges (31 endemics; various papers by Soest and colleagues), marine gastropods (26 endemics), terrestrial beetles (15 endemics, Debrot 2006) and birds subspecies (9 endemics, Voous 1983). To strengthen the argument for connectivity particularly land to sea and island to island connectivity, the nomination would benefit from the addition of the Ramsar wetlands in Bonaire and new to be proposed Ramsar wetland sites in Curaçao (such as Klein Curaçao) i.e. a landward extension either as contiguous areas to CMP and BNMP or as additional components. Klein Curaçao in particular would be a good addition to complement the values protected in Klein Bonaire.

The proposed nomination area harbours 56 IUCN Red List species (counting VU, EN and CR species but excluding NT species as these carry no special recognition beyond IUCN) of which 39 are classified as Vulnerable (VU), 11 as Endangered (EN) and 6 as Critically Endangered (CR). Four of the species are terrestrial and 52 are marine. This amounts to 39% of the 132 IUCN Red Listed marine endangered species documented for the Caribbean and Western Central Atlantic. This is a very high proportion of all Red Listed marine species considering the small size of the proposed nomination and is largely due to the fact that most IUCN Red Listed marine species have a wide distributional range.

"Irreplaceability" (uniqueness or rarity) is arguably the most important concept for assessing the potential of a site to be considered of OUV (Schmitt 2011). Due to its unique concentration of biodiversity and endemism the combined nomination property may qualify as "irreplaceable" for OUV criteria (x).

Conclusions

In this report, many new arguments based on the review of additional documentation are presented that greatly reinforce the argument for the natural World Heritage criteria (vii), (viii), (ix), and (x). These arguments build a strong case for successful nomination of the Bonaire National Marine Park and the Curaçao Underwater Park properties as a proposed Nomination for World Heritage. However, there would be additional benefits to including existing and proposed Ramsar sites in Bonaire and Curaçao on land, and also to consider deeper benthic areas and pelagic areas located in the Territorial Seas of both islands as well as their EEZs. The marine additions could add seamounts, pelagic habitat of marine mammals, sharks, commercially important and threatened pelagic and/or deep water fish species and marine birds. The further expansion of the proposed nomination would also contribute to greater ecological connectivity and improved integrity. The terrestrial additions would add components in the inter-tidal zone and habitats such as rocky shores, beaches and dunes and additional wetlands important for birds, crabs and other species. Such additions would not necessarily need to be no-take zones, although additional no-take zones would be recommended and restrictions on illegal, unregulated and unreported fisheries (IUU) would be essential even within any buffer zones.

The long history of favourable conditions for reef development and steep topographic reef slopes have provided the basis for high habitat richness and varied and attractive reef-scapes with a large number of well-documented benthic reef communities (criteria (vii)). BNMP has also scored as a top dive destination for the last two decades, consistently winning international recognition from sport divers. **However, like Beek et al. (2014) we are also not convinced that the BCMP is distinct enough from other areas to meet the conditions for OUV under criteria (vii)**. The waters of the proposed nomination area are known to harbour 52 marine endangered species (Table 18). This is a very high proportion (39%) of all threatened marine species of the Greater Caribbean considering the small size of the proposed nomination. This is largely due to the fact that most IUCN Red Listed marine species have a wide distribution.

Outstanding geological history reflecting the creation of the Caribbean Sea and its Leeward islands of the Dutch Caribbean and Venezuela, and the resulting unique geographic position affords shallow reef communities protection for the destructive force of hurricanes sediment and osmotic stress and even from coral bleaching (criteria (viii)). **Our Comparative Analysis found no tropical coral reef properties combining a similar interplay between geology, oceanography and meteorology as the basis for a prolonged and convincing role in the biodiversity of a whole biogeographic province. We suggest criteria (viii) may provide a basis for irreplaceable OUV. However, both our description of OUV for criteria (viii) remains incomplete, as is our comparative analysis. Futher work would be needed.**

The justification for OUV is supported by healthy reef processes that impart the highest coral cover and greatest demonstrated coral reef resilience of the Caribbean region. As a consequence, the relative importance of the reefs of the proposed nomination will continue to increase in the future due this exceptional health and resilience (criteria (ix)). **We conclude that the proposed nomination possesses sufficient inherent and lasting integrity to continue to sustain the exceptional ecological processes that underpin the rich biodiversity, as well as to fulfil the role as a major source of biodiversity for the greater Caribbean region.**

The exceptional combination of geographically and meteorologically mediated environmental stability and habitat diversity have created conditions for the development of an exceptionally high and well-documented level of species richness and endemism compared to other areas in the tropical western Atlantic (criteria (x)). The presence of many of the region's threatened species further illustrates the adequate integrity and interaction between the connectivity of criteria (ix) and the biodiversity of criteria (x). **Due to its unique concentration of biodiversity and endemism the joint nomination properties may qualify as "irreplaceable" for OUV criteria (x).**

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Recommendations

For successful nomination buffer zones should be considered. This can easily be achieved by including current legally designated island conservation areas as buffer zones, such as the Ramsar Convention Wetlands and protected areas on land and sea. Potential areas are discussed for both Bonaire and Curaçao. Inclusion of buffer zones on land and at sea will also contribute greatly to integrity. Where possible, these areas could also be considered as additional components for the proposed nomination, which would increase the total area of land and sea in the nomination.

Specific consideration should be given to including at least some part of the 12-nautical mile Territorial Sea as part of the propsed nomination. A 12-mile zone seawards extension would protect an additional 9 primarily-pelagic IUCN Red List species (for a total of 65 IUCN Red List Globally Threatened species), expand the fish fauna by about 300 primarily pelagic species, and a variety of benthic habitats and expand the properties by large areas of deepwater mesophotic reefs that will contribute significantly to combined resilience. The overal endemicity and biodiversity would also increase as results show that many species and ecological processes have not yet been described in these islands but have been found to increase in other areas where benthic research has been conducted in deep marine waters. Such a change in boundaries would also strengthen the different levels of connectivity and allow for future discovery of new undocumented attributes related to OUV produced by any future research. None of the North Western Atlantic marine pelagic provinces has any marine World Heritage sites. Therefore, the addition of a large pelagic zone, part of the Inter American Seas Pelagic Province, to the nomination property will fill an important biogeographic gap for conservation on the World Heritage List. This would also significantly support the central aim of the World Heritage Committee to achieve a representative, balanced and credible World Heritage List (Abdullah et al. 2013).

Finally, as Bonaire and Curaçao are two islands in the chain of Leeward Islands, the nomination will benefit by being designed in such a way as to encourage and facilitate a future extension. These could be Las Aves and Los Roques in Venezuela, as previously discussed in the Bonaire World Heritage International Workshop held from 30 April to 5 May in 2003. This workshop included participants from Bonaire, Curaçao and Venezuela. Some exchange between scientists from the ABC islands, the Netherlands and Venezuela has already taken place including discussion of such a collaboration (Bustamante 2002 and Bustamante et al. 2008) and exchanges have occurred between the BNMP and Los Roques. Los Roques Archipelago has been a Venezuelan national park since 1972. It is already a Ramsar Site and recognized IBA site and was designated a shark sanctuary in 2012. Due to its remoteness and management it has among the lowest levels of human ecological impact in the Caribbean and represents intact and well-connected coastal ecosystems (Elise et al. 2017). Recent assessments show that it also possesses exemplary fish faunas (Elise et al. 2017), that may be considered as a benchmark for overfished coral reef fish faunas throughout the region. Local park management enjoys broad community support from the various stakeholders which guarantees a sustainable future for the park (Garcia-Melon et al.

2012). Thanks to effective management Los Roques has also successfully maintained its importance to seabird colonies for the last 50 years since the earliest surveys (Bosque et al. 2015). (For further information we refer to Appendix 1). A planned, phased approach for serial transnational sites has been successful in the past for natural World Heritage Sites. This is particularly in recognition of the large areas required to fully represent ecological values and issues related to connectivity. Examples for Europe include the Wadden Sea and Beach Forests of the Carpathians.

1 Introduction and assignment

1.1 Introduction

The Bonaire National Marine Park (BNMP) has been formally considered for potential World Heritage inscription since 2003. The Bonaire World Heritage International Workshop held from 30 April to 5 May in 2003, included participants from Bonaire, Curaçao and Venezuela and discussed a possible serial transboundary nomination named the "Southern Caribbean Islands". Bonaire Marine Park has been on the inventory of properties suitable for inscription on the World Heritage List (the Tentative List) since 2011. In 2015, an expert group concluded that the BNMP could only attain a successful nomination if it were part of a larger area (Expertgroep 2015). This recommendation was based on two preparatory reports by WMR (formerly IMARES) which outlined the steps needed for a successful nomination (Cremer & Meesters 2012; Beek et al. 2014a). The first area proposed for extension of the nomination was the territorial sea surrounding the BNMP (i.e. the 12 nautical mile zone or 12 nm). Due to the paucity of available research and consequent lack of detailed knowledge about the biodiversity of this zone (Beek 2016), it was concluded that even with addition of the 12 nautical mile zone surrounding the BNMP, a sufficiently convincing case for OUV could not be made. During 2016, based on correspondence and mutual commitment to pursue a UNESCO World heritage status for the BNMP, the Minister of Education Culture and Science of the Netherlands, J. Bussemaker committed additional financial support for this initiative.

Following the advice of local experts (Wolfs Company), the Steering Group[1] decided in 2016 that the best option to expand the nomination property should come in the form of a collaboration with Curaçao. As Bonaire is small and marine ecosystems are large and transboundary in their ecological connectivity, it is important to consider the largest area possible to make a strong case for OUV. In combining the natural marine areas of Curaçao and Bonaire the status of a "transboundary‟ initiative in the geopolitical sense (and as used within UNESCO to denote collaboration between neighbouring states) does not apply. According to the UNESCO Operational Guidelines only a Contracting State to the World Heritage Convention can nominate a potential World Heritage Site. In this case, both Curaçao and Bonaire are part of the same Contracting State which is the Kingdom of the Netherlands.

Cooperation between Bonaire and Curaçao enlarges the total surface area of the nomination property. From 2016 onwards, the government of Curaçao has started to take major steps towards institutional reinforcement of the CMP indicating that Curaçao can now be considered a strong partner for collaboration. There is a great deal of knowledge and documentation available on the biodiversity of the CMP thanks to decades of coral reef research that will contribute directly to the natural values (and potential OUV) of the combined area and which will improve the chances for a successful nomination. A nomination including both Bonaire and Curaçao is to have a larger area with more natural values that may have greater integrity than a single small area. Additional consideration has been given to engaging with neighbouring islands in Venezuela. This collaboration begun over 15 years ago. However, little progress is possible at this time due to Venezuela's internal challenges.

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[1] Steering Group: Stuurgroep voor de nominatie van het Bonaire National Marine Park voor Wereld Erfgoed status.

1.2 Background

In 2010, the Dutch commission for review of tentative listings for world heritage nomination (Commissie Herziening Voorlopige Lijst Werelderfgoed) made an inventory of important cultural and natural heritage sites, located in the Kingdom of The Netherlands. The Bonaire National Marine Park (BNMP) was added to this revised Tentative List in 2011 representing the only currently listed natural heritage site within the Kingdom of The Netherlands.

At the request of the Ministry of Agriculture, Nature & Food Quality (LNV), supporting the Executive Council of Bonaire in their preparation of the nomination file, WMR (formerly IMARES) described the requirements for a definitive and successful nomination of the BNMP (Cremer & Meesters, 2012). This "roadmap" identified several actions to be taken.

In 2013, one of the candidates for a cultural nomination withdrew from the Tentative List after a negative judgement of its nomination file. This demonstrated the necessity of evaluating all the proposed nominations. The 'Rijkdienst voor het Cultureel erfgoed' therefore asked all the candidates to report on the potential chances of a successful nomination.

In 2014, in cooperation with Wolfs Company Bonaire and on the authority of the Ministry of LNV WMR investigated and reported on the likelihood that the BNMP nomination would be successful. WMR described the identification, the boundary and the buffer zone of the BNMP property; and also described the justification for the property under the criteria (vii) and (ix). This work included a description of and some of the features and processes that are part of the Outstanding Universal Value (OUV), (Beek et al. 2014a). WMR also added a list of comparable World Heritage Sites to compare with in the Comparative Analysis (CA) as part of the nomination file (Beek et al. 2014a). Based on this report the Executive Council of Bonaire (Bestuurscollege van Bonaire) approved the proposed nomination of the BNMP and recommended nomination to the Ministry of Education, Culture and Science (OCW).

In the report of Beek et al. (2014a) the potential OUV of the BNMP was described by appointing five attributes to each of the two UNESCO criteria (vii) and (ix)), justifying the nomination of the BNMP on the Tentative list. Criteria (vii) is about unique aesthetic values and criteria (ix) concerns the essential ecological processes that contribute to the OUV. In the preliminary study of the Comparative Analysis (Beek et al. 2014a) the uniqueness of the BNMP was partially based on comparisons to World Heritage Sites with comparable features. It was concluded that the aesthetic values (criteria (vii)) should be more distinguished in relation to comparable World Heritage Sites with coral reefs.

The ecological processes selected in that assessment that are essential for the protection of threatened Coral Reef species were deemed unique as they have not yet been described in any other coral reef World Heritage nomination. The integrity of the BNMP to preserve the identified OUV was considered proven, although the lack of a buffer zone on the island-side of the property was considered to be a threat for the conservation of the unique values of the BNMP. The need to identify and describe the values and linkages of the potential buffer zones to the BNMP was emphasized (Criteria (ix)).

In 2015, the 'Expertgroep Beoordeling Werelderfgoednominaties' judged the potential chances for a successful nomination of all the candidates on the Tentative List and ranked them. The Bonaire National Marine Park (BNMP) was deemed to have high nomination potential but additional work was clearly necessary to document and make the OUV evident.

The main observations/recommendations of the ***Expertgroep Beoordeling Werelderfgoed-nominaties*** (2015) on the initial OUV report (Beek et al. 2014a) were as follows:

1) The connectivity between nature in the 12-mile zone, the nearby coral island territories or the adjacent terrestrial natural values needs to be more extensively addressed. This would likely make a stronger case for the OUV. At present, the ecosystem is only described based on the limited chosen criteria while this should first be based on an extensive description.
2) The assessment should be expanded beyond the BNMP to include the terrestrial ecosystem of Bonaire, the coral islands of Venezuela and/or Curaçao.
3) More attention should be devoted to criteria (x). This criteria could give a strong argument for OUV even though the comparative analysis (Beek et al. 2014a) is ambivalent about this.
4) For criteria (ix), more emphasis is needed on ecological processes and the relationships between the different components of the ecosystem as this is a key justification for OUV that is adopted by Beek et al. (2014a).
5) The substantiation of criteria (vii) is weak in the report, stating that it depends on evidence yet to be delivered.
6) Several matters alluded to in the report need to be explicitly stated. The claim that the reefs of the BNMP are one of the most beautiful and best protected needs to be substantiated.
7) Convincing proof or testimonies of authoritative scientists are needed in support of the Outstanding Universal Values.
8) Based on the report it is impossible to decide whether the right attributes were chosen. To do that more extensive basic natural history description is needed.
9) The potential for expansion within the Kingdom of the Netherlands or transboundary collaboration with neighbouring states needs to be further explored. As described, the BNMP as property is not unique enough which means that expansion will be essential.
10) As the report indicates, existing conservation zones (Ramsar sites, terrestrial park, reserves etc.) can be designated as buffer zones for the nomination property. In doing this the function of the buffer zone needs to be kept in mind: protection of the property from disturbance and/or contamination as a consequence of external developments.

In summary, the advice of the Expert Group was a) to nominate a larger area, as the Outstanding Universal Value (OUV) of the BNMP was not convincingly proven within the present boundaries, making additional research necessary; b) to better describe the ecological coherence with the natural values in the 12-mile zone and the nearby coral islands as this might supply more and better arguments for the OUV, and a new judgement in 2017 could follow, and finally; c) advise on the potential for criteria (x) to be investigated in greater depth.

1.3 Scope

The ultimate goal of this initiative is to help determine the best design of a potential World Heritage Site that includes the strongest case of Outstanding Universal Value and Integrity while also ensuring good protection and management of these natural values. However, the scope of this assignment is more limited. The primary purpose of this assignment is to address the recommendations of the Expert Group (2015) so it can serve as decision-making support for the Ministry of OC&W's "Rijkdienst voor het Cultureel erfgoed". At the end of 2017, this national government service intends to decide on which of the several potential Dutch nominations should be pursued. A positive decision can only follow if it is clear that the nomination properties have clear descriptions of and justification for OUV and good prospects for a successful nomination. Hence, this assignment does not represent a full nomination dossier.

Outstanding Universal Value

For successful nomination a property needs to be both of outstanding universal value (OUV) have demonstrable integrity and adequate protection and management. Outstanding Universal Value is defined by UNESCO (2016) as "cultural and/or natural significance which is so exceptional as to transcend national boundaries and to be of common importance for present and future generations of all humanity. As such, the permanent protection of this heritage is of the highest importance to the international community as a whole". To be deemed of Outstanding Universal Value, "a property must also meet the conditions of integrity and/or authenticity and must have an adequate protection and management system to ensure its safeguarding" (UNESCO 2017). UNESCO uses a scientific framework of criteria to evaluate areas that may be of Outstanding Universal Value and to inform choices when nominating or inscribing such sites (Abdullah et al. 2013).

OUV is justified when a nominated property qualifies with one or more of the following:

- Irreplaceable
- Distinct / Unique / Superlative/ Globally important
- "fills a gap" i.e. not already found in an existing WH site (as part of OUV)

With integrity is meant that the property:

- can be maintained for future generations in current or an improved state (sufficient not to be vulnerable to external threats), resilient to climate change and anthropogenic activities (UNESCO 2017).

While OUV relates more to **inherent values** of the property to be nominated, integrity largely depends on **conditions** required for its maintenance for future generations. Little can be done about inherent values of a site or object but conditions can and must be created or set in place that can guarantee longterm preservation of the inherent OUVs of the property. Therefore, the design of the site is important with due consideration being given to what is included in the nomination such as habitats and features, the size of each component and the combined area, and the exact boundaries. Management measures such as proper buffer zones, protective legislation, financing, etc. are also key to ensuring that OUV can be maintained in the longterm. These issues can be addressed to allow for integrity but only become relevant after the OUV has been established. In this report we focus on OUV and the topic of integrity falls outside the scope of this report. Clarity on the potential for OUV is the first priority for deciding on whether to proceed with the nomination process. Integrity must be ensured and determined based on the OUV and associated attributes. Certain aspects of integrity can be improved by the choice of appropriate boundaries, properly designating buffer zones and by guaranteeing quality of management. Nevertheless, we do note that some aspects of integrity – particularly size and connectivity, are closely linked to OUV particularly for criteria (ix). Many of the values discussed in this report face important threats or have suffered documented declines in recent decades. This cannot be denied (e.g see Debrot et al. 2017a). However, this report does not cite those studies, address those issues or discuss possible management measures to deal with threats or declines. but only focusses on the values present and how these might contribute to potential OUV.

A property may possess OUV in terms of any one of number of ten criteria. These criteria are in turn based on so-called "attributes". Table 1 shows the four natural criteria that appear pertinent to this potential nomination (criteria (vii), (viii), (ix), and (x)) and examples of attributes relating to each of these criteria.

Table 1. List of four pertinent criteria for the proposed combined Bonaire and Curaçao UNESCO World heritage nomination bid and the main attributes (source: UNESCO 2017).

- Criteria **(vii)** & related attributes of OUV
    - superlative phenomena, natural events
    - scale, size, aggregations, density, depth, extent…
- Criteria **(viii)** & related attributes of OUV
    - Geology, geomorphology, marine and coastal processes, physical oceanography, geochemical processes
    - Form, sediment, erosion, deposition….
- Criteria **(ix)** & related attributes of OUV
    - Biogeochemical, Biological, ecological or evolutionary process (& connectivity/ life- cycle/migration)
    - Unusual scale, size,
    - Distinctive, unusual, multi-species aggregations
- Criteria **(x)** & related attributes of OUV
    - Endemic/restricted ranges species
    - Globally Threatened (as determined by the IUCN Red List of Threatened Species)
    - Genetic, sub-species, species, communities and assemblages, habitats.
    - Significant % of a species' range, population, life-cycle etc. e.g. migratory species breeding/feeding/nesting or spawning aggregations etc.

Territorial sea/ 12 nm zone

Further documentation of the potential values of the 12-mile zone falls outside the scope of current report. A preliminary synthesis of information provided for the 12-mile zone has been produced by Beek (2016). As indicated in that report, the deep reef and deep sea have major potential to contribute many new endemic species that can help bolster the nomination bid either as part of or as buffer zone to the proposed nomination. Inclusion of the 12-mile zone has high potential to increase the biodiversity as well as unique species (criteria (x)). For instance, van Soest et al. (2014) were able to describe 13 new species of sponges based on only 4 four short submersible dives to depths of 240 m off Curaçao and Bonaire. If the marine 12-mile zone is included in the proposed nomination this would also add about 300 additional fish species and 11 IUCN Red List species to the already dazzling biodiversity of the nomination property. Addition of the 12-mile zone will also strengthen connectivity and integrity. Also, the marine geography and geology of the Territorial Sea has not been assessed for the potential contribution to criteria (viii).

Comparative Analysis

For the Comparative Analyses the current choice of global WH is largely geared towards comparisons of biodiversity, i.e. criteria (x). As a next step separate synthesis tables based on different subset of global WH sites might be needed to clarify OUV according to each separate criteria and particularly for the priority attributes under each criteria. This means that as OUV is refined, and depending on the exact boundaries of the final proposal, there may be additions or removals to the current list of sites for comparison. The most appropriate sites for comparison are island and coral reef sites for criteria (vii), sites related to tectonic history and reef building/sedimentary processes for criteria (viii), marine sites listed for connectivity and reef productivity/resilience/fish herbivory for criteria (ix), and other tropical island coastal and marine ecosystems for criteria (x). The key sites of comparison are the existing natural WH sites in the tropical Atlantic due to biogeographic similarities. Other protected areas in the Caribbean are also included particularly the Seaflower Biosphere Reserve in Colombia and Man and Biosphere Reserve in the neighbouring downstream ecoregion of the South Eastern Caribbean and the Los Roques Archipelago Ramsar Site in Venezuela. These are upstream from the Dutch Antilles which are also part of the Leeward Antilles. These issues are addressed in more detail in Chapter 8.

1.4 Aim and assignment

The specific objectives for this assignment are six-fold:

- To expand the description of OUV to the expanded potential nomination area which is composed of both the BNMP and the CMP.
- To produce a more exhaustive description of the ecosystems present in and relevant as buffer zones for the new and expanded proposed nomination.
- To describe ecological connectivity between the components of the proposed nomination, the potential buffer zones and the marine 12-mile zone.
- To describe natural values under criteria (x) and evaluate it as a potential nomination criteria.
- Based on the above conduct a more extensive Comparative Analysis for each criteria and the relevant attributes of OUV, based on a definitive selection of comparable world heritage properties.
- Make an updated assessment of the Outstanding Universal Value of the new nomination property based on the selection of criteria (vii), (ix) and possibly (viii) and (x).

An analysis of World Heritage sites and Biosphere Reserves in the Tropical Northwest Atlantic coastal Biogeographic Province was undertaken in June 2006 and identified several opportunities for potential marine World Heritage that recognised the importance of connectivity. One of these suggested areas was the Southern Caribbean islands - Islas del Caribe Sur (Curaçao and Bonaire, Netherland Antilles; and Las Aves and Los Roques, in Venezuela) to be considered as a serial and transboundary nomination (Bustamante 2002, Bustamante & Paris 2008). This followed on from earlier work carried out in Bonaire in 2003 where a workshop was hosted that developed the idea of a serial transnational site between the Leeward Islands. As exchanges have previously taken place with Venezuela and due to the ecological connectivity and shared geologic history, we provide an initial compilation of information on the Venezuelan protected areas of Los Roques Archipelago National Park (a Ramsar Site) and Las Aves Islands (Appendix 1). We believe that these areas could ultimately be a valuable option for renewed WH collaboration in the future as soon as feasible. The addition would contribute significantly to connectivity, increase the area of the different habitat types and add several irreplaceable important bird areas. However, due to the the remoteness of these island groups and resulting lack of scientific study, the full complement of values to be gained with the addition of Los Roques and the Aves Islands has yet to be compiled and fully documented.

1.5 Acknowledgments

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2 Identification of the components

2.1 Summary

Bonaire and Curaçao form part of the Dutch ABC islands (Aruba, Bonaire and Curaçao). The ABC islands are part of the Leeward Antilles, islands which include some of the offshore islands of Venezuela, which are part of the Federal Dependencies of Venezuela (Las Aves Archipelago and Los Roques Archipelago, Blanquilla and La Ochilla (a military base)). The islands of Bonaire and Curaçao are in the southern Caribbean Sea, approximately 65 to 90 km north of Venezuela (Fig. 1).

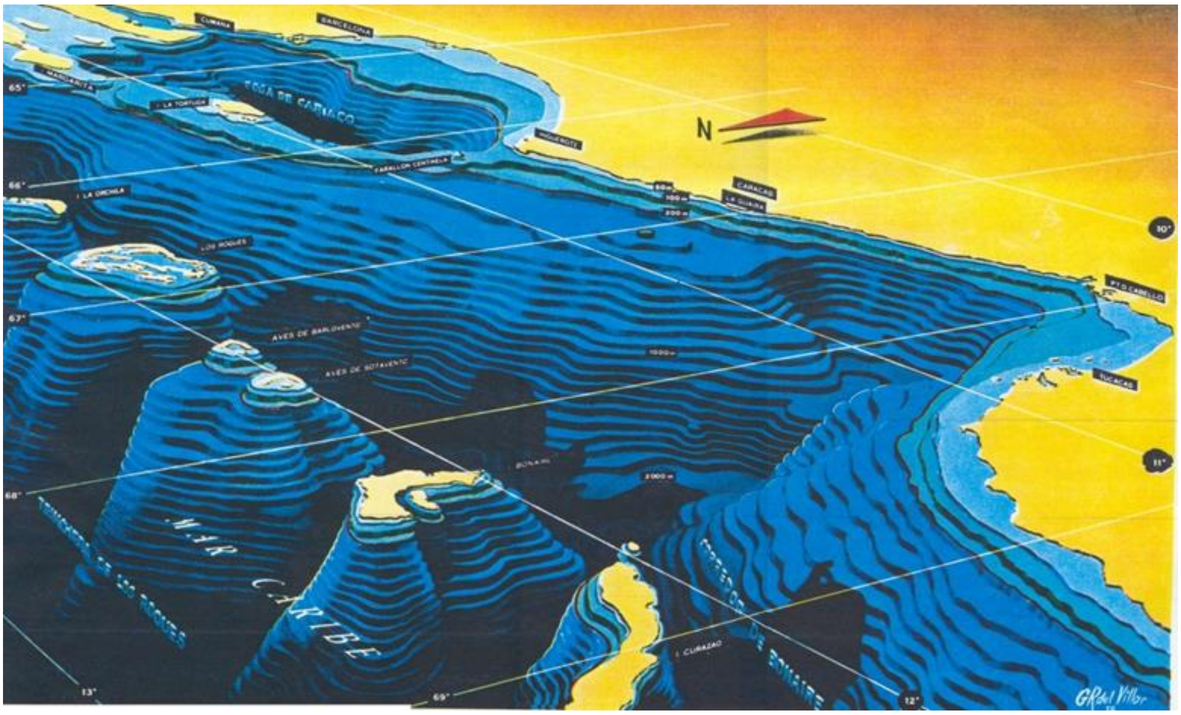

Figure 1. **Deep water profiles around Bonaire, Curacao and other islands of the Leeward Antilles ridge off the coast of Venezuela. (From: Smith et al. 2002).**

2.2 Context

2.2.1 ABC Islands

The ABC islands are offshore islands north of the coast of Venezuela and are the westernmost islands of the Lesser Antilles. "Aruba (12°31' N, 70°10' W) is the nearest Dutch island to mainland Venezuela and is located 27 km north from Paraguaná peninsula. The maximum depth between Aruba and the Venezuelan coast does not exceed 135 m, whereas the islands of Bonaire and Curaçao are separated from South American mainland by a deep water trench (c. 1000 m, Fig. 1). All the Leeward islands are relatively flat with the highest peak reaching 378 m at Mount Christoffel (Curaçao). Curaçao is the largest of the 3 ABC islands, (61 km long; surface area of 444 km2, and is the most populated of the Leeward Islands with about 160,000 inhabitants. Bonaire is the least densely populated island of European overseas entities in the region, with about 63 inhab./ km2. The islands of Curaçao (12°10' N, 68°59' W) and Bonaire (12°10' N, 69°16' W) are characterized by the presence of several inland bays surrounded by mangroves (Table 4, Fig3. 3, 7) (Vaslet & Renoux 2016).

The ABC islands with the Venezuelan islands form an island archipelago that constitutes a biogeographical sub-region with most of their flora and fauna similar to that from South America and the western Caribbean region.” (Vaslet & Renoux 2016).

Biogeography

The proposed nomination is located in the southern Caribbean (Fig. 2), an area recognized as a distinct marine biogeographic province for both marine molluscan diversity (Diaz 1995) and fish diversity (Spalding 2007, Robertson & Cramer 2014). The terrestrial habitat includes two plant ecoregions: Venezuelan Mangrove and Aruba-Bonaire-Curaçao cactus shrub (Sotomayor 2003).

Figure 2. Marine Ecoregions of the Caribbean with arrow pointing to the Southern Caribbean ecoregion. (From: Spalding et al. 2007).

Due to their geographic position close to the south American mainland, they simultaneously enjoy protection from hurricanes damage. As oceanic islands located just off the continental shelf and having a steep volcanic island slopes affords additional protection from sediment and salinity stress. Coastal wind-driven upwelling in the southern Caribbean additionally buffers the coral reefs from bleaching episodes. These same conditions offer the best opportunity for these reefs to maintain good condition and continue to play their important role in the region well into the future.

Climate

“Climate in the Caribbean region results from the encounter of northeast and southeast trade winds in the Inter Tropical Convergence Zone (ITCZ). Locally, climate and rainfall are directly related to island topography. The ABC islands have a semi-arid climate, in contrast to most Caribbean Islands, with mean annual rainfall between 400 and 550 mm and mean temperature of about 28°C (Meteorological Service of Netherlands Antilles, average 1971-2000. (Vaslet & Renoux 2016)

Wind and wave action related to prevailing winds mean that “the protected western (leeward) and exposed eastern (windward) shorelines are strikingly different. The windward shore is a very high wave energy environment characterized by rough water conditions and constant waves breaking against limestone cliffs or reefs. Wind and water conditions on the leeward shore rarely exceed Beaufort Force 4, with only moderate swells affecting the northern and southern extremes of the island.” (BNMP Management Plan, De Meyer & McRae 2006).

Oceanography

“Winds and marine currents exert a major influence on species distribution and migration in the Caribbean region. Two main currents flow from the western Atlantic towards the Caribbean Sea: the North Equatorial current that comes directly through the Lesser Antilles and the Guyana current. This latter current flows along the coastal regions of South America, receiving waters enriched in nutrients from Amazon and Orinoco river systems before reaching the southern part of the Lesser Antilles (Trinidad and Tobago islands) (Vaslet & Renoux 2016).

The resulting flow of these two main currents in the Caribbean Sea becomes the Caribbean current. This current transports significant amounts of water north-westward into the Gulf of Mexico via the Yucatan current (Spalding 2004)” (Vaslet & Renoux 2016).

“Bonaire is located close to where Atlantic water flushes into the Caribbean Basin through the leeward island chain. Bonaire lies down stream of surface water flow from the direction of St Vincent and the Grenadines and wind driven currents from Las Roques and Las Aves (see Fig. 9). When the surface currents strike Bonaire on the windward shore, near Spelonk, they are deflected to the north and south. There are pronounced eddies at the south of the island, around Willemstoren, at the north of the island around Malmok and Boca Bartol and just north of BOPEC. Currents are unpredictable but slight, rarely exceeding 0.5 m s^{-1}. The predominant current movement is toward the north along the leeward shore, but this pattern is complicated by local eddies and upwelling. Water conditions are stable, with a constant 34-36 ppt salinity and mean annual water temperatures ranging from 26°C to 28°C (De Meyer 1998a). The speed and direction of deep water currents are thought to affect the nutrient content and temperature of surface waters.” (BNMP Management Plan; De Meyer & McRae 2006).

Visibility and water quality

The components are constantly buffeted by fresh, clear, nutrient-poor oceanic water of the Caribbean Current that is characterized by a constant salinity of 35 ppt. This water flows clockwise across the Caribbean basin and is the main surface circulation in the Caribbean Sea. Average ocean surface current velocity along the Netherlands Antilles is high (70 cm/sec), which allows excellent water exchange and water quality along most reefs (Fratantoni 2001; Gyory et al. 2005; Lutz & Ginsburg 2007). Exceptions are the areas on the lee side of Bonaire near the town of Kralendijk (Slijkerman et al. 2013) and in Curaçao downstream from the centre of Willemstad (Gast et al. 1999). However, on most Bonaire reefs as well as on all reefs of the Curaçao Underwater Park, which is located in the sparsely-developed up-stream eastern portion of the island, the water quality is among the best in the Caribbean.

Vigorous water transport and a steep reef profile that allows disturbed sediment to quickly settle out to deep waters away from the reef, and contributes to high transparency. Duyl (1985) has mapped the main sand shutes that transport loose sediment away from the reef to deep water where they pose a much reduced threat to coral growth. Water transparency is a key parameter measured in coral reef studies and in reef zones it is typically 20-30 m (Bak 1975, Duyl 1985). In lagoonal situations where sediments settle in shallow water, visibility is generally much lower (e.g. Kuenen and Debrot 1995, Debrot et al. 2012b). Erosion due to severe overgrazing by roaming livestock can lead to sediment and nutrient input into coastal waters and form an important potential threat to coral health on both islands. Fortunately, most runoff passes through mangrove and seagrass lagoons, inland bays and salinas before entering the sea. These serve as effective sediment traps, and sequester most sediment before it gets a chance to harm the reefs. In addition, these marine parks lie in a semi-arid climatic zone of generally low rainfall (Beers et al. 1997, Freitas et al. 2005). As a consequence, runoff is also limited due to lack of rainfall and osmotic stress to coral reefs due to freshwater input is also very low.

Geology

The islands of the Lesser Antilles define an 850-km long curve from Anguilla (Sombrero Island) in the north to Grenada and the Leeward Antilles off the coast of Venezuela (Dutch ABC islands, Aruba) (Vaslet & Renoux 2016). The Leeward Antilles ridge (also referred to as the Aves Arc) emerges from the sea as a string of little islands and atoll-like archipelagoes off the coast of Venezuela.

The leeward Dutch Caribbean islands islands were created by collision of the South American and Caribbean tectonic plates. Islands' basement is formed by a succession of deepwater volcanic and sediment deposits of Cretaceous and Early Tertiary origin that have since been uplifted. Islands igneous rocks indicate that they formed as part of an island arc that was situated on the leading edge of a plate moving from the west (Pacific Ocean) into the Caribbean plate (Iturralde-Vinent 2006, Vaslet & Renoux 2016).

Variation of sea level that occurred during the Quaternary, combined with a slow tectonic rise of the islands (which continues today), and active coral reef growth allowed the formation of limestone terraces along the fringes of the islands (Dutch Caribbean Biodiversity Explorer database, Vaslet & Renoux 2016).

Seabed

The Territorial Sea of Bonaire reaches greatest depths to the north of the island with depths exceeding 2500m at the edge of the Los Roques Basin. To the south the Territorial seas of Bonaire and Curacao do not exceed 1500 m depth. At the southern EEZ boundary depths reach about 1000 m, in contrast to the northern edge of the EEZ, depths exceed 3000 m in the Venezuelan Basin.

2.2.2 Ecosystems and habitats

The terrestrial ecosystem of the Leeward Antilles Islands include xeric shrubland, mangrove, saline lakes, dunes, rocky shores, cliffs, caves and beaches. The marine habitats in the nearshore zone include bays surrounded by mangroves, seagrass beds, coral reefs and non-coral reef habitats. The Venezuelan archipelagos and islands have more mangrove than the ABC islands. Whereas the ABC islands have more xeric shrubland as they are larger, higher above sea-level and of older age.

The inland bays of the Bonaire and Curaçao marine parks harbour mangroves, seagrass beds and algal fields. Several inland bays have become closed off from the sea and possess hypersaline lakes, or salinas. that are an important habitat to flamingoes, nesting terns and also function as an important stop-over habitat for many migratory wading bird species. In Bonaire, the 700 ha Lay Bay is a shallow, clear-water lagoon that contains more than 90% of Bonaire’s mangrove woodland (c. 80 ha). Like other mangrove forests of these arid islands, this mangrove system is a non-estuarine mangrove system which, aside from limited seasonal inflow of freshwater from terrestrial runoff, is not dependent on freshwater input (Debrot et al. 2010, Dilrosun et al. 2012, Vaslet & Renoux 2016). Fringing reefs rim the shallow waters fully around both Bonaire and Curaçao and are among the healthiest reefs in the Caribbean (>30% of live coral cover) (Bak et al. 2005, Jackson et al. 2014, Vaslet & Renoux 2016).

As a total, Curaçao has an estimated 8 hectares of seagrass habitat, mostly limited to the shallow waters of inland bays (Green & Short 2003). The largest seagrass beds occur in the Spanish Water Bay and are dominated by *Thalassia testudinum*, which has historically been the main species in all of Curaçao’s bays (Kuenen & Debrot 1995, Sustainable Fisheries Group 2015). Recently these seagrass beds have been invaded by the non-native seagrass *Halophila stipulacea*, a species that is rapidly expanding throughout the eastern Caribbean (Willett et al. 2014).

An estimated 55 ha of mangrove habitat are found in Curaçao (Debrot & de Freitas 1991; Pors and Nagelkerken 1998) The largest mangrove area is currently still found in Spanish Water Bay (FAO 2007), but mangroves are also found along the north-eastern and eastern coast in the few wave-sheltered lagoons, and in many of Curaçao's inland bays (FAO 2010). *Rhizophora mangle* is the dominant species, and other species include *Laguncularia racemosa, Avicennia germinans*, and *Conocarpus erecta* (Pors & Nagelkerken 1998). Like seagrass, mangroves provide structure and habitat that serve as an essential nursery and juvenile feeding habitat for many commercially important reef species, among which snappers, grunts, barracuda and the West-Indian spiny lobster (Nagelkerken & Van der Velde 2002, Hylkema et al. 2014, Sustainable Fisheries Group 2015). Along its open coasts, Curaçao is surrounded by a narrow fringing reef that occurs between 20 and 250 m from the coast and at depths from 0 to 80 meters and covers an estimated area of 7.85 km^2 (Vermeij 2012).

2.2.3 Species

In he Caribbean, shallow marine environments form part of the large marine ecosystem (LME) of the Caribbean Sea, in which at least 12,046 marine species from 31 animal and 2 plant phyla have been reported (Miloslavich et al. 2010). At the island level, relatively low rates of endemism are observed for marine taxa due to high degree of connectivity resulting from a combination of the influence of currents, the dispersive larval life stage of most marine species and species migration. The Caribbean and Antilles currents ensure larval transportation among islands thus enhancing genetic exchanges and limiting isolation of populations.

Large ranging and highly migratory marine species, which include many fishes and sharks, sea turtles, marine mammals and seabirds, occur throughout the Caribbean region during different stages of their life cycle. Among the marine fauna, 61 marine gastropods are restricted to islands of the Dutch Leeward islands, one marine crinoid (*Nemaster grandis*, echinoderm) is endemic to ABC islands, northern Venezuela and Colombia, and one marine fish, *Starksia springeri* is restricted to Curaçao (Vaslet & Renoux 2016). Table 2 provides a partial overview of the numbers of endemic species for the ABC islands. See Appendix 2 for a full listing of species.

Table 2. Endemic species (terrestrial, freshwater, marine species) occurring in the ABC islands as a whole. Information on threatened endemic species is also indicated# (adapted from Vaslet & Renoux 2016 and partially corrected based on Debrot 2006 and including the newest plant discovery by Griffith et al. 2017).

	Plants	Invertebrates	Fishes	Reptiles	Birds
Caribbean Islands	6,550	-	65 (freshwater)	469	163
ABC + Colombia/ Venezuela	-	-	-	-	-
ABC : total = 213 spp. + 42 subspp.	22	26 marine molluscs 31 sponges 15 sp. + 5 subspp. terrestrial molluscs 65 sp. + 7 subspp. of terrestrial invert.	5	9 sp. + 3 subspp.	22 subspp. (1 VU)
Aruba	14	28	5	3	13 subspp.
*	4	21		1	2 subspp.
**	10	19	5		11 subspp.
Bonaire	17	16		1	14 subspp.
*	0	26	5	2	2 subspp.
**	17	9	5	1	12 subspp. (1 VU)
Curaçao	19	33	1	1	15
*	0	32 (1 VU)		3	3
**	19	13	2	1	12
Proposed nomination BCMP	5	26 marine gastropods 31 marine sponges (> 20 terrestrial) invertebrates)	5 marine fish 1 marine shrimp	4	9 (6 endemic subspecies)

*ABC Endemic

**Regional Endemic: species endemic to ABC islands and northern Venezuela-Colombia region. For details please see Debrot 2006.

The IUCN Vulnerable (VU) Yellow-shouldered Amazon (*Amazona barbadensis*) is an emblematic bird species which has a disjunct distribution, occurring both in Bonaire, margarita Island in patchy areas in northern Venezuela. The population in Bonaire (about 1,000 ind.) represents more than 10% of the global population (less than 10,000 ind.). However, 60% of the island population occurs outside protected areas (Williams 2012, Wells & Debrot 2008).

2.2.4 Key Biodiversity Areas

Key Biodiversity Areas are a conservation tool that can be used at different scales to identify priorities for conservation. The World Database of Key Biodiversity Areas is managed by BirdLife International. It provides data on global and regional Key Biodiversity Areas (KBAs), including Important Bird Areas and Key Biodiversity Areas identified by the BirdLife International Partnership, Alliance for Zero Extinction, and additional collaborating parties (www.keybiodiversityareas.org/). Table 3 can be used to help identify the additional terrestrial components or buffer zones for the nomination.

Table 3. Summary of the KBAs identified for Bonaire and Curaçao (Vaslet & Renoux 2016).

	Total KBA	Total area of KBA (km2)	Name
Bonaire	6	288.9	BON-1 - Bonaire Marine Park BON-2 - Washington- Slagbaai & Dos Pos BON-3 - Terrace Landscape Middle Bonaire BON-4- Klein Bonaire BON-5 - Pekelmeer Saltworks BON-6 - Washikemba- Onima & Bolivia area
Curaçao	6	272.1	CUW-1 - Christoffel- Shete Boka Terrestrial Parks & North-east coast CUW-2 - Malpais-St Michiel & Rif- Marie CUW-3 - Curaçao Underwater Park to Oostpunt CUW-4 - Klein Curaçao CUW-5 - St Jorisbaai and Kueba di Noordkant CUW-6 - San Juan - Santa Cruz & Pos Spaño

2.2.5 Protected Areas

While a relatively large number of key biodiversity areas have been identified (see previous section 2.2.4), few of these have any form of special management or protection. Table 4 below shows the actual protected areas that have legal protection.

Table 4. Summary of Protected Areas in ABC Islands (Vaslet & Renoux 2016).

	Total area of PA	Name
Bonaire	Over 5,600 ha (created in 1969)	Washington Slagbaai National Park
	2,700 ha (created in 1979)	Bonaire National Marine Park
	Bonaire EEZ (2015)	Yarari marine mammal and sharks Sanctuary
Curaçao	2,300 ha (created in 1978)	Christoffel Park
	470 ha (created in 1994)	SheteBoka Park
	600 ha of marine area and 436 ha of inland bay habitats (created in 1983)	Curaçao Marine Park

2.3 Components

This proposed nomination expands the original proposal of a single contiguous site – Bonaire National Marine Park to include the Curaçao Marine Park (CMP) on Curaçao. The subsequent sections distinguish between the two islands the values inside the two protected areas.

2.3.1 Bonaire and its National Marine Park

Bonaire lies between latitudes of 12º2�something and 12º19‘ N and longitudes 69°10' to 68°44'W. The island is 40 km long and 12 km wide at its widest point. Its total surface area measures 288 km^2. The Bonaire National Marine Park surrounds the islands of Bonaire and Klein Bonaire, extending from the high water mark to the 60 m depth contour. The area includes the sea bottom and associated waters (De Meyer & MacRae 2006), as well as all inland waters with an open connection to the sea (Lac, Lagun, Plaza Resort Marina and Harbour Village Marina).

The Bonaire National Marine Park consists of both a marine and terrestrial component. The marine component of the property is the underwater area of Bonaire and Klein Bonaire, from the high water mark to the 60 m depth contour, including the Lac Bay.

The Lac Bay is an integral component of the BNMP and is situated along the coast on the south east side of Bonaire. The Lac area contains a few major vegetation types (Freitas et al. 2005) ranging from salt flats and coastal barrens to xeric woodlands and mangroves, seagrass beds and coral reefs (Geelhoed et al. 2012). It is the largest bay of Bonaire with an area of approximately 7 km^2 situated on the wave-exposed eastern side of the island. It consists of a shallow basin, protected from wave exposure by a barrier *Lithothamnion*-reef (Zaneveld 1958) and a superb coral reef on the outside. The bay is connected to the sea by a narrow channel which is about 8 m deep. Lac also contains the largest seagrass beds of Bonaire, and of the Dutch Caribbean (Debrot et al. 2012b). The soft-bottom flora of the bay is dominated by dense seagrass meadows with *Thalassia testidinum* and the calcareous algae *Halimeda incrassata* and *opuntia*. Other common marine plants include the seagrass *Syringodium filiforme* and the seaweed *Avrainvillea nigricans*.

The bay is bordered almost completely by the mangrove *Rhizophora mangle* and *Avicennia germinans.* Other mangrove species that are present in the bay are *Conocarpus erectus and Laguncularia racemosa*. The mangroves, seagrass beds and shallow coral reef of Lac provide shelter and nursery habitat for fish and invertebrates and contribute to the fish populations on the reef (Nagelkerken et al., 2000; Hylkema et al., 2014) as many fish species show ontogenetic shifts in habitat use during different life stages and migrate from their nursery grounds to the coral reef (Ogden and Ehrlich, 1977 in Nagelkerken et al., 2000). Lac is particularly important for a number of globally endangered species. It is home to the endangered Green Turtle, *Chelonia mydas*, and the Caribbean Queen Conch, *Strombus gigas*, and to the globally endangered corals *Acropora palmata* and *A. cervicornis* (Aronson et al. 2008a, b) and the Rainbow Parrotfish, *Scarus guacamaia*, a prominent species in the bay (Debrot et al. 2012b). It is an important bird area for at least 29 species of migratory waterbirds (Debrot et al. 2012a). Finally, it is also a hotspot for genetic diversity in the mangrove *Rhizophoa mangle*, the most prominent mangrove of the Caribbean (Albrecht et al. 2013).

The shallow waters of Lac provide foraging areas for several species of wading birds and terns. Numbers of Greater Flamingo, *Phoenicopterus ruber,* regularly meet the 1% regional Important Bird Area (IBA) threshold criteria for wetlands of international significance (Wege & Anadon-Irizarry 2008). Lac Bay has an important concentration of the Reddish Egret (*Egretta rufescens*) an IUCN "Near Threatened" (NT) species which nests in the mangroves of the bay (Debrot et al. 2013). Lac enjoys legal designation both as an island conservation area and as international Ramsar wetland site. The salt flats are of local significance to nesting terns.

The terrestrial component is the uninhabited island of Klein Bonaire and the current terrestrial buffer zone of 500 meters surrounding the shores of Lac Bay. The coordinates of the central points of the BNMP and of Klein Bonaire are shown in Table 5.

The island of Klein Bonaire is an integral part of the BNMP and is protected as a Ramsar site. It is approximately ca 800 m offshore from Kralendijk on mainland Bonaire. The total size of the island is 7 km^2, the area of the surrounding waters is 13.5 km^2. Klein Bonaire supports a sparse cover of shrubs and cacti. It comprises brackish lagoons and fringing coral reefs supporting a rich marine fauna. Breeding Least Terns (*Sternula antillarum*) are of regional importance for the population. In addition to terns, Klein Bonaire is a known breeding habitat for wading birds (Snowy plover, *Charadrius alexandrina* and Wilson's Plover*, C. wilsonia*; Wells & Wells 2006) and egrets (Vouus 1983). Information on abundance and distribution of the two resident IBA trigger species (Bare-eyed Pigeon, *Patagioenas corensis*, and Caribbean Elaenia, *Elaenia martinica*) is scarce (Geelhoed et al. 2012). The woodlands are recovering since complete removal of goats from the island (Debrot 1997). A brief biological inventory of the flora and fauna is available from Debrot (1997) while the vegetation has also been mapped (Freitas et al. 2005). On Klein Bonaire many dozens of Green Turtle (*Chelonia mydas*) and Hawksbill Turtle (*Eretmochelys imbricata*) nests hatch successfully each year (STCB 2014, 2015).

Table 5. Coordinates of the central points of the two parts of the Bonaire National Marine Park; Bonaire and Klein Bonaire.

Id n°	Name of the component part	Coordinates of the Central Point	Size in Hectare
001	Bonaire	12° 10′ 53″ N 68° 16′ 35″ W	3,940
002	Klein Bonaire	12° 9′ 24″ N 68° 18′ 41″ W	700
	Total for the Bonaire component		4,640

2.3.2 Curaçao and its Marine Park

Curaçao lies between latitudes 12°2'80" to 12°23'30"N and longitudes 69°10'00" to 68°44'30"W. The island is 61 km long and 12 km wide at its widest point. The surface area measures 444 km^2. The Curaçao Underwater (marine) Park is located off Curaçao's southeast coast. It stretches from Lijhoek at Janthiel along 21.7 kilometres (13.5 miles) of shoreline from the high-water mark to a distance of 100 m from shore, to and around the most eastern tip of the island at Oostpunt. The park includes 217 hectares of pristine fringing reefs. The coordinates of the property are shown in Table 5. The Marine park extends from the low water level to 100 m off shore.

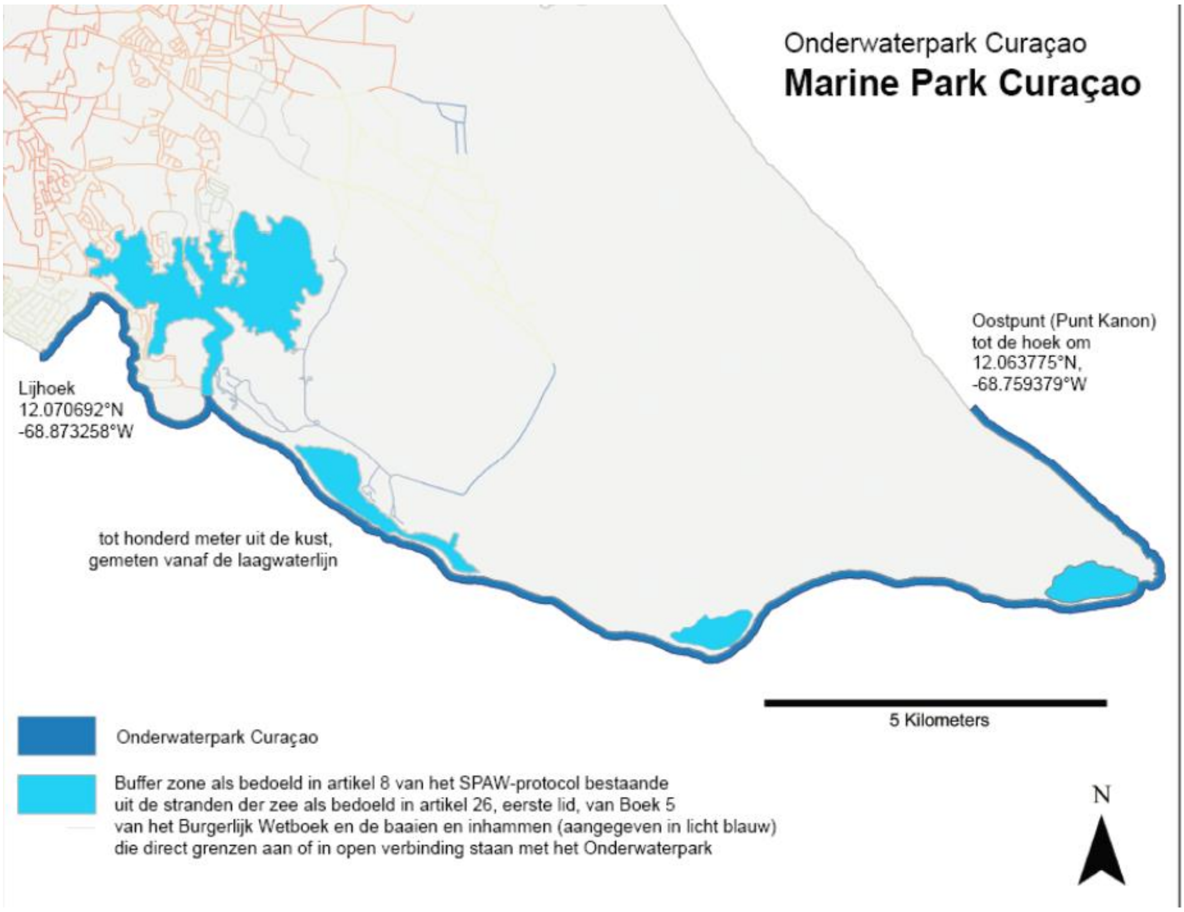

Figure 3. Map showing the 21.7 km long and 100-m wide coastal reef strip of the new, 2017, Curaçao Marine Park.

Table 6. Coordinates of the Curaçao Underwater Park.

Id n°	Name of the component part	Coordinates of the western Point	Coordinates of the eastern Point	Size in Hectare	Map N°
001		12.070692°N -68.873258°W	12.063775°N, -68.759379°W	217	
	Total Component				

The Curaçao Underwater Park (CMP), was established, but not officially decreed by law in 1983, and originally stretched along 20 km of shore from the most eastern tip of Curaçao to the west. The larger Park included 600 hectares of reef and 436 hectares of inland bays and was initially managed by the Carmabi Foundation until funds ran out at the turn of the century (Carmabi: Caribbean Research and Management of Biodiversity). After an island wide survey in 2015, the Curaçao Government renewed its ambition to legally install the CMP. This will include some newly discovered areas with reefs with coral cover exceeding 60% and avoid areas that have suffered from recent coastal development (e.g., the Jan Thiel area), the original Curaçao Marine Park boundaries were moved to form the new CMP. The boundaries (Table 6) and installment of the new CMP were approved by the Council of Ministers in August 2016.

The area harbours a functional ecological network of five habitat types: coral reefs, mangroves, seagrass beds seaweed fields and coralline algae "*Lithothamnion*" fields. The CMP shelters a well-developed coral reef community supporting high levels of marine diversity. The reef flat and crest harbour extensive populations of the endangered Elkhorn coral (*Acropora palmata*). Due to its abundance and branching morphology, *A. palmata* also plays an essential role in the maintenance of healthy and productive fish and invertebrate populations by providing shelter to these reef organisms (Gladfelter & Gladfelter 1978). The fore reef is dominated by species of the *Montastraea* spp. complex (Bruckner & Bruckner 2003a), which positively contribute to biogeochemical and physical processes on reefs such as community calcification, nitrogen fixation and wave energy dissipation. *Montastraea* reefs also provide essential habitat to support high densities of reef associated fish species (Mumby et al. 2008). The three inland bays included in the area harbour seagrass beds and/or mangrove habitats. These habitats are ecologically strongly interconnected with coral reefs as many reef organisms, especially juvenile fish obligatorily spend at least one phase of their life cycle (generally their juvenile life stage) within mangroves and/or seagrass beds before moving to coral reefs for their adult life phase.

The reefs of Curaçao occur mostly along the leeward coast and harbour about 68 coral species and high coral coverage compared to other sites in the Caribbean (up to 70-80% of coverage in some sites) (Bruckner and Bruckner 2003, Vermeij et al. 2012, Jackson et al. 2013). Along the protected south shore, average live coral cover is currently estimated to be 23.2% on average (Vermeij 2012a). In some areas, especially in the marine park, coral cover often exceeds 30%, higher than the Caribbean-wide average of 20% (Jackson et al. 2013). Reefs along the islands' windward shores are less well developed except for some local, very well developed coral communities. Around Curaçao large inland bays are found harbouring mangrove and seagrass communities serving as nursery habitats for many reef fish species. Coral reefs in the marine park, far removed and up-current from coastal development, locally demonstrate continued coral growth, and in some areas coral cover is as high as 70% (Vermeij 2012). The shore is mostly consisting of steep cliffs and rubble beaches. From there, a 50-200m wide shallow reef flat with only scattered patchy coral communities gradually slopes to a drop-off starting between 7-15m depth (Bak 1975). From here the fore reef slopes steeply downward at 45-90° to a second drop-off around 80-90m. In most locations, the first drop-off often turns into a sandy terrace around 50-60m that gently slopes to deeper water until the second drop-off begins. In general, coral cover and diversity increase from the high-water mark towards the first drop-off, whereby the habitat changes from a sandy bottom to a consolidated reef of Pleistocene limestone rock covered by living corals. Coral cover and diversity remain high crossing the drop-off down to mesophotic depths (below 30m), after which both decrease to around 80m where coral growth becomes extremely sparse (Bruckner and Bruckner 2003a).

In terms of reef-building corals Curaçao is high in species diversity. The high level of species richness is found in few other areas in the Caribbean- the Cayman Islands and nearby Aruba and Bonaire, (Miloslavich et al. 2010). Curaçao is therefore often considered a hotspot of biodiversity in what is already one of the five richest hotspots for biodiversity and endemism on Earth (i.e. the Caribbean) (Stehli & Wells 1971; Bak 1977). Relatively healthy reefs can still be found around Curaçao near the north-western tip of the island, at the entrance of Spanish Water Bay, on the eastern side of Klein Curaçao and especially along the southern coast from Fuik to Punt Kanon, i.e., within the Curaçao Underwater Park. These locations are often characterized by more than 30% coral cover and the presence of Acroporid and other threatened coral species (Dilrosun et al. 2012). Reefs within the CMP are locally increasing in coral cover and are ranked among the best three reef systems left in the Caribbean (Jackson et al. 2013). Coral reefs in the CMP act as a source for coral larvae as corals produce on average up to 200 times more larvae per square meter of reef compared to corals on reefs near developed coasts elsewhere on the island (Hartmann et al. in press). The same is true for fish (Huijbers et al. 2013). Reef communities within the CMP harbour numerous threatened marine species (e.g., marine mammals, scleractinian corals, sea turtles etc., for detailed overviews, see: CARMABI 2013, CARMABI response to Oostpunt Development Plan).

Vertical zonation of coral species indicates that species' distributions are influenced primarily by depth and wave energy (Duyl 1985). *Montastraea* spp. are stony, reef-building coral species providing the structural backbone for Curaçao's shallow, fringing reefs (Bruckner & Bruckner 2003a). Historically, *Montastraea faveolata*, *M. annularis*, and *M. franksi* were the most abundant live corals in Curaçao's shallow waters. Patches of acroporid species do still occur, sometimes very abundantly, especially within the Marine Park (Bruckner and Bruckner 2003). However, coral cover, health, and species composition on Curaçao's reefs have changed significantly (with reductions up to 24%) over the last three decades (Vermeij 2012, Waitt 2017). In many reef areas, turf algae are now the dominant benthic cover (Sandin et al. 2007; Vermeij 2012). Whilst Curaçao's reefs are degrading in general, they are still amongst the healthiest reefs in the Caribbean particularly for the reefs in the CMP that remain in near pristine state relative to historic baselines (Bouchon et al. 2008; Sandin et al. 2007; Vermeij 2012, Jackson et al., 2014). In this area, dense communities of *Acropora cervicornis* (staghorn coral), *A. palmata* and colonies of the *Montastraea annularis* species complex are commonly found (Bruckner & Bruckner 1997). Corals at Oostpunt produce more coral larvae (up to 200 times) compared to reefs near the island's main urban area (Hartmann et al. in press). Due to its upstream position, reef communities within the CMP are likely seeding downstream areas (including reefs on Curaçao, but also beyond, e.g., on Aruba) with their larvae (Vermeij 2012b).

The highest average fish biomass on Curaçao (159 – 219 g m^{-2}, found at sites from Klein Curaçao and including all of the proposed boundaries for the new Curacao Marine Park, is relatively high for Caribbean standards, but lower than values associated with proper ecosystem function (Waitt 2017). While herbivore biomass is relatively high (58 – 89 g m^{-2}) in certain areas around Curaçao (Klein Curaçao to Willemstad, including the CMP and near Bullenbaai), herbivores in other areas on the island have decreased significantly in abundance to as low as 26 g m^{-2} (Waitt 2017). On healthy Caribbean reefs, biomass of herbivorous fish should be around 70 g m^{-2}, but preferably above 100 g m^{-2} (Edwards et al. 2014). Apex predators are mostly absent due to their regional sensitivity to overfishing, making up only 5.8% of total reef fish biomass (Sandin et al. 2007; Vermeij & Nijssen 2011).

The number of reported fish and coral species is 657 and 68, respectively (Vermeij 2012b). Newman et al., (2006) reported large groups of predatory fish commonly observed within the CMP. Spawning aggregations of many fish species have been observed on the reefs within the CMP. Examples include Yellowtail Snappers, *Ocyurus chrysurus*, Dog Snappers, *Lutjanus jocu*, and multispecies parrotfish spawning aggregations (Carmabi 2012). Both the abundance of herbivores and predatory fishes exceed 50gr/m^2 making the Oostpunt reefs one of the most "fish-rich" areas in the Caribbean (Newman et al., 2006). The CMP comprises three inland bays (i.e., Fuik Bay; 0.55 km^2, Lagun Blanku; ~0.23 km^2, and Awa di Oostpunt; ~0.40 km^2) which are connected to the open ocean and with bottoms are almost completely covered by seagrass beds. Turtle-grass (*Thalassia testudinum*) is by far the most abundant sea grass species in all three inland bays. Fuik Bay also supports a well-developed forest of Red Mangroves (*Rhizophora mangle*). An average of 13 fish species dominates the fish community in each of these inland bays. Of these species, 60% are highly dependent on seagrass beds and/or mangrove for nursery habitats (Nagelkerken & van der Velde 2004). In addition, the three inland bays harbour high densities of juvenile reef fishes that obligatorily spend their earliest life stages inside the bays before they move to the nearby coral reefs where they spend their life as adults (Nagelkerken et al. 2000b, c). Several distinct underwater habitats are found near Oostpunt such as arches and many caves. Both are used by large fish that like to dwell in such structures (Vermeij 2012b).

Three sea turtle species regularly nest on Curaçao's and Klein Curaçao's beaches and are common in the CMP: Green turtles, Hawksbills and more occasionally Loggerheads. The Olive Ridley and Leatherback are rare visitors. Green Turtles predominantly feed in the seagrass beds in the island's inland bays (e.g. Oostpunt, BokaBartol, Awa di Oostpunt, Spanish Water) (Sybesma 1992, Hoetjes 2006, Dilrosun et al. 2012). In addition, many gastropod molluscs species are reported from the waters off Oostpunt, Fuik and St. Jorisbaai (Coomans (1958), Jong & Kristensen (1965) and Jong & Coomans (1986), including rare endemic gastropod molluscs such as *Bailya marijkae* from Awa di Kabes.

3 Potential buffer zones and their roles in resilience and connectivity

3.1 Summary

Buffer zones are a tool to support a successful nomination as they contribute to maintaining integrity and supporting effective protection and management. This is particularly important when a proposed nomination has a relatively small area. Buffer zones are critical to contribute to both ecological connectivity and longterm resilience between separate components particularly in the marine environment. With the exception of Klein Bonaire and Lac Bay Bonaire, both the BNMP and the CMP are very narrow properties of at most a few 100 meters wide that lie close to shore. Due to their narrow width and close proximity to land, the potential for negative impacts from land is high. Because of this, buffer zones are recommended to support the proposed nomination bid. These buffer zones should be formally recognized in the management plans, and ideally have some legal status to support protection. Buffer zones are not part of the proposed nominated area although they may be critical to maintaining integrity. Any attributes of OUV must be documented within the boundaries of the proposed nomination and not include any values in the buffer zones (UNESCO 2017).

Our proposal for the nomination joins two components which are the Bonaire and Curaçao marine parks. These two marine parks both have valuable adjoining natural areas that are of high potential value as buffer zones (or as landward or seaward extensions). Several of these areas already have a conservation designation in the existing insular planning legislation on both islands and are recognised as Ramsar Sites or as key biodiversity areas (Debrot & Wells 2008, Wells & Debrot 2008, Vaslet & Renoux 2016). Here we present and discuss a number of potential buffer zones, which could also be extensions or boundary modifications for the respective components of the proposed nomination. For both islands the identified potential buffer zone areas include several protected (Ramsar) wetlands and coastal conservation lands.

For Bonaire the three terrestrial buffer zones and single recommended marine buffer zone are:

1) the coastal areas of the Washington-Slagbaai National Park including the Brasiel-Labra area.
2) the Terrassenlandschap Midden-Bonaire.
3) Zuidelijk Bonaire.

All three of these carry "Island Park" status in the Bonaire Island Nature Plan. Within these areas there are subareas with additional legal protection status. These are the saline lagoons of Slagbaai, Goto and the Pekelmeer which all carry Ramsar status, while the Pekelmeer area also carries the "Strict Reserve" status in the Bonaire Nature Plan.

For Curaçao potential buffer zones are the legally designated conservation areas of:

1) the peninsula of Caracasbaai .
2) the whole Spanish Water which will be designated as a SPAW buffer zone for the new marine park.
3) the undeveloped and as yet undesignated coastal zones of the former plantations of Fuik, Duivelsklip and Oostpunt harbor coastal woodlands and lagoons that will be designated as a SPAW buffer zone for the new marine park.
4) the marine 12-mile zone of island territorial waters of Curaçao, including Klein Curaçao as a new to be designated Ramsar site.

All or part of the marine 12-mile zone of island territorial waters of Bonaire and Curaçao are also recommended as very valuable buffer zones. In addition, due to the designation of the Yarari marine mammal and sharks Sanctuary, it may be possible to designate some additional deep benthic areas as buffer zones in the EEZ of Bonaire. Seamounts would be particularly appropriate due to their role in connectivity.

3.2 Background

The IUCN defines buffer zones as "areas peripheral to a specific protected area, where restrictions on resource use and special development measures are undertaken in order to enhance the conservation value of the protected area." Furthermore, buffer zones have been suggested as a particularly suitable practice for climate change mitigation, as they may facilitate the shifting of species' populations from reserves to adjacent lands according to the climatic needs of species. Buffer zones were indicated as necessary for a successful bid for the original BNMP nomination. Based on the evaluation of previous background reports (Beek et al. 2014a) and Beek (2016) it was suggested to describe the potential buffer zones in more detail. From an ecological perspective two criteria are important to consider while reflecting on buffer zones. These are size (determined based on factors such as the objectives for creation of buffer zones, availability of land, traditional land use systems, threats and opportunities) and ecology (buffer zones vary depending on their focus on the landscape, habitat and/or species conservation).

In this context, enhancement of conservation depends on maintaining:
a) ecological resilience and
b) connectivity between ecosystems, key habitats, species and processes, in time and space.

3.3 Resilience

Ecological resilience refers to the ability of an ecosystem to maintain key functions and processes in the face of stresses or pressures, either by resisting or adapting to change (Nystrom & Folke 2001), Holling 1973). Coral reef resilience refers to a reef ecosystem's ability to recover from disturbances and prevent shifting to an algal-dominated state (Marshal & Schuttenberg 2006). Maintaining resilience in an ecosystem means supporting the health and function of associated habitats, organisms, and ecosystem processes. Key ecological processes that support the resilience of ecosystems like coral reefs include high levels of herbivory, population connectivity, and effective recruitment (IUCN 2011).

Connectivity refers to ecological linkages associated with neighboring and distant habitats and is essential for ecological resilience. Connectivity within and between (protected) areas is important for maintaining biodiversity, fish stocks, and especially important for maintaining ecological resilience (IUCN 2011).

Mumby & Hastings (2008) reports that connectivity is important for supporting ecological processes (e.g., herbivory), promoting reef resilience. For example, connectivity between coral reefs and mangroves can increase grazing of herbivorous fish on adjacent reefs herbivorous fish remove algae, and therefore, can promote coral growth and reef resilience. Mangroves in the Caribbean have been shown to increase the resilience of offshore coral reefs in response to disturbances such as hurricane damage (Mumby & Hastings 2008). Mangroves serve as nursery habitat for herbivorous fishes that clear macro algae from the reef; thus, connectivity between mangroves and reefs helps corals recover from disturbance and enhance their rates of recovery.Proper buffer zones on land such as coastal wetlands e.g. salinas and lagoons thus act as natural buffers by filtering water by vegetation and soil and stabilization of soils will reduce sediment load runoff and reduce the level of sediments, pollution and nutrients reaching coral reefs (Mumby & Steneck 2011).

IUCN (2011) documented and compared several common indicators of coral reef health and presumend resulience for Curaçao (and Bonaire and compared these to sites throughout the Caribbean (Fig. 4). Both Curaçao and Bonaire rank very favorably for major indicators of presumed resilience withing the Caribbean region.

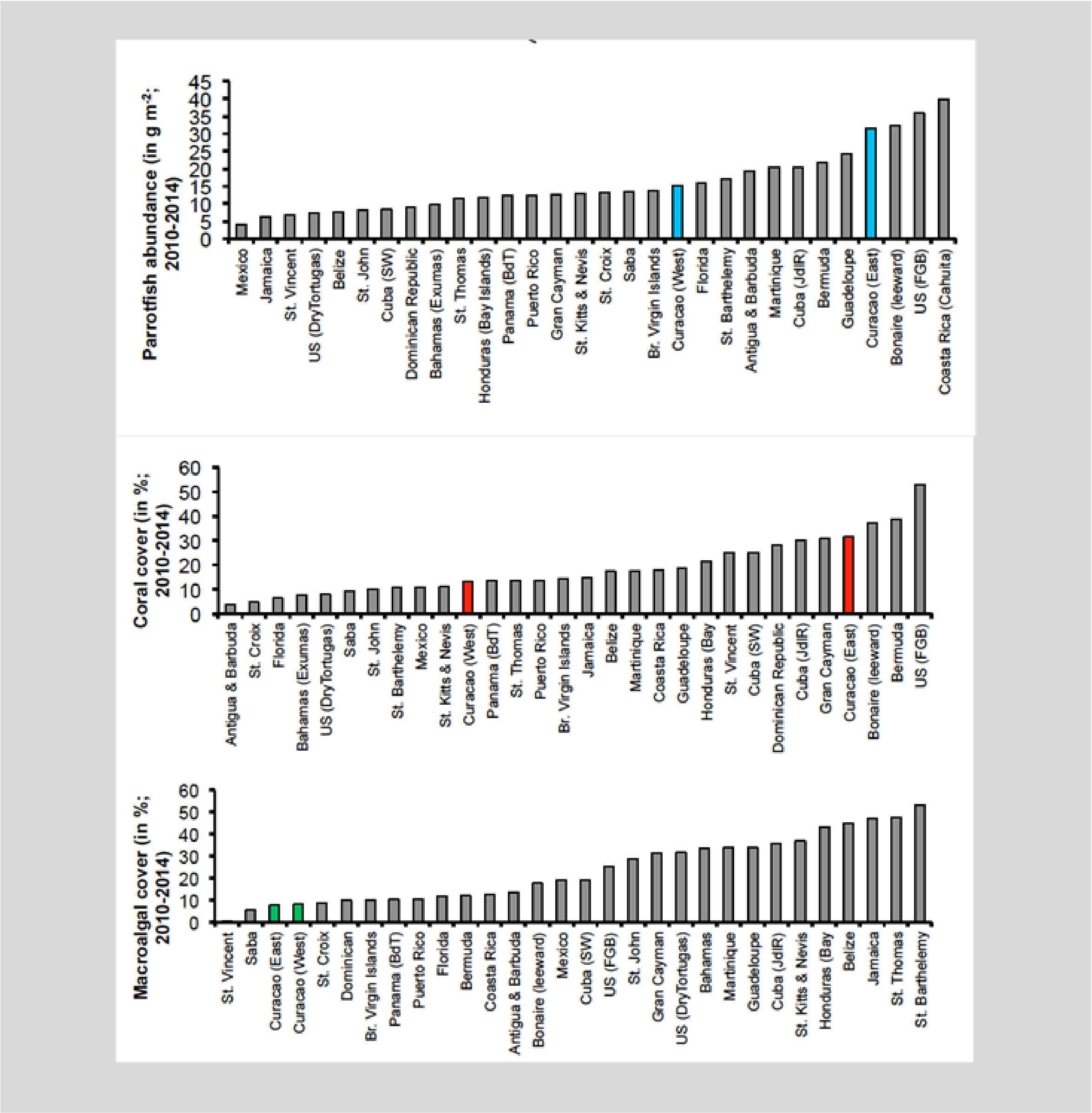

Figure 4. Overview of commonly used metrics for coral ecosystem health and resilience of Curaçao's coral reefs in comparison to other Caribbean islands and nations (from Vermeij 2017).

Demonstrated resilience

While many studies have documented the vulnerability of the reefs and marine systems of the nomination areas of both Curaçao and Bonaire (e.g. Bak & Nieuwland 1995, Bries et al. 2004, Bak et al. 2005, Debrot & Criens 2005, Debrot & Bugter 2010, Debrot et al. 2011, Slijkerman et al 2011, Hylkema et al. 2014) a few studies document actual (partial) resilience for the reefs of the proposed nomination (Debrot et al. 2005, Debrot and Nagelkerken, 2006, Steneck et al. 2015). With this is meant the ability to actually recover after a documented poor condition. One example of the recovery of coral cover comes from a recent study of coral cover at an area in Barcadera (Fig. 5). In this area coral cover across a transect with the least coral cover averaged 15% in the depth range of 0-5 m in 2016, while in the 10 - 20 m zone in which the reef normally achieves full development (reef crest) coral cover was significantly higher (33%).

Most remarkable is that the shallow zone in question was an area that was covered by *Acropora cervicornis* till the early 1980s (Duyl 1985). That species has since disappeared as a consequence of an epidemic disease (white band disease) but have been replaced by a dense community of head corals in the last 3 decades, eventhough in most areas coral reefs have declined over the last 30 years (Bak et al. 2005). This has been substantiated by field work in 2016 as well as by aerial photos of the specific area (Haitsma & Debrot 2016). In a scale of 1 to 10 this dive site is given an aesthetic value of "8" (Reef Support N.V, pers. comm. 2016).

Figure 5. Transect with the least coral cover at Barcadera through an area where a former high cover Acropora community (1980s) has since been replaced with a fairly dense head-coral community (Haitsma & Debrot 2016).

Likewise, based on long-term monitoring, Steneck et al. (2015) conclude positive recovery of coral cover and several other key reef ecosystem parameters since 2003. For both Curaçao and Bonaire, there also are documented indications of recovery of *Acropora cervicornis* after it was virtually wiped out in the mid 1980s (Vermeij 2012a,b, IUCN 2011). Several common indicators of coral reef health and presumed resilience such as parrotfish densities, coral cover and macro-algal cover are among the best for both Bonaire and Curacao reefs (Vermeij 2017). In more general terms, IUCN assessed the resilience of the reefs of the Bonaire National Marine Park and concluded that Bonaire's reefs are among the healthiest and most resilient reefs of the Caribbean (Vermeij 2017). Finally, Debrot & Nagelkerken (2006) document signs of recovery of the Black Sea Urchin (*Diadema antillarum*) for Curaçao, after this species also suffered mass mortalities in the early 1980s. Likewise seaturtles have been increasing in abundance since the early 1990s (Debrot et al. 2005).

3.4 Bonaire

3.4.1 Washington Slagbaai National Park

Washington Slagbaai National Park is a 5,643 hectare nature sanctuary located in the northwest part of Bonaire. It is a safe habitat for various terrestrial endemic and threatened species. Parrots, flamingos, parakeets, iguanas and many other species of birds and reptiles can be found in this protected area.

The park covers a diversity of habitats ranging from coastal lagoons to vegetated hillsides. Key values include its habitat value for Yellow-shouldered Amazon, nesting terns and foraging Caribbean Flamingos. Most of the area is legally protected either as an island park or with Ramsar status and actively managed. The coastlines provide breeding areas for the Common Tern, Least Tern and regionally important numbers of Sandwich with 1% or more of the regional populations (Wells & Debrot 2008, Debrot et al. 2009). The number of Caribbean Flamingos, which is the national bird of Bonaire, uses the coastal habitats in the park for foraging and regularly exceeds the regional population threshold of 500 birds. The largest numbers are present at Goto Lake. Small numbers occasionally breed in Saliña Slagbaai. The saliñas provide habitat for a wide range of other resident and migratory wading birds (Simal et al. 2010). Key threats include overgrazing by feral goats and pigs. Ramsar sites Slagbaai and Gotomeer lie within the National Park and are shallow, permanent, saline lagoons, isolated from the sea by a bank of beach rock. Brine shrimp (*Artemia*) and brine flies (*Ephydra*) provide valuable food sources for birds. The lagoons are resting and foraging areas for many birds, and a staging area for a variety of Nearctic breeding species.

3.4.2 Terrassenlandschap Midden Bonaire (Middle-Bonaire terrace landscape)

This landscape (approx. 3350 ha) comprises all four terrace types (Lowest-, Middle, High and Higest Terraces) found on Bonaire and protects both part of the leeward and windward coasts (Eilandgebied Bonaire 1999). This provides protection against potential runoff or at least provides oppoertunity to manage these areas in order ot prevent significant runoff and sedimentation that could end up in the sea. It is geologically interesting due to its relative complexity (de Buisonje 1974). It contains characteristic landscape units and corresponding vegetation types and the whole area of the "Highest Terrace" landscape of Bonaire. The latter landscape has also the least disturbed limestone vegetation types of the island (Fig. 6) that are only found in that landscape (de Freitas et al. 2005) and in which a number of (very) rare plant species occur (e.g. the endemic *Maytenus tetragona, Krugiodendron ferreum, Ficus brittonii, Amyris ignea, Maytenus versluysii* and *Ximenia americana*) (de Freitas & de Lannoy 2013). Protection of the bufferzone will also provide for the enhanced enjoyment of the dive experience of divers (Debrot & Nagelkerken 2000).

Figure 6. The vegetation of the terraces of Middle Bonaire are dominated by evergreen bushes and trees like centuries-old rare Wayaká Shimaron, *Guaiacum sanctum*. (Photo: A. Debrot).

3.4.3 Southern Bonaire (Zuidelijk Bonaire)

The Pekelmeer saltworks IBA and Ramsar site is situated in the potential terrestrial buffer zone of the Southern Bonaire saline wetlands. The total area of this IBA covers about one fifth of the island of Bonaire with its 6,197 ha, of which 4,203 ha is land. Bonaire contains different landscape types (de Freitas *et al.,* 2005). Freitas *et al.,* (2005) divided Bonaire into seven main landscape types with a number of subtypes. Landscapes and habitats intricately connected to the marine ecosystem are Beaches (with 3 subtypes), and the Salinas (2 subtypes) which are particularly well-represented in southern Bonaire. Out of the four mangrove species that occur on Bonaire, three mangrove species (the Red Mangrove (*Rhizophora mangle*), the White Mangrove (*Laguncularia racemosa*), the Black Mangrove (*Avicennia germinans*) are found within some of the vegetation types present here. The mangroves are listed as protected in the Bonaire nature ordinance because of their limited distribution and their keystone role in ecology (particularly nursery function for reef fishes) (Smith et al. 2012).

The Pekelmeer is a shallow seawater lagoon located between a ridge of recrystallized coral debris (beach rock) and a commercial saltworks, linked to the open sea by an artificial channel. Sparsely vegetated, the site provides a flamingo nesting sanctuary and supports one of the most important nesting colonies of Caribbean Flamingo in the Caribbean (1,000 pairs). It serves as an important feeding area for pelicans, herons, bitterns, etc., and various migratory shorebirds (Prins et al. 2009). Key IBA values in this area include the nesting colony of the Caribbean Flamingo, and nesting colonies of various tern species. A 0.55 km^2 area in the northern part of the area where the majority of the flamingos nest, has been designated as Flamingo Breeding Reserve since 1969. A section along the southwest side has been proposed as a “Strict Reserve” and the remainder (excluding the crystallizer basins for the saltworks on the western side) as an “Island Park”. Only the 0.55 km^2 “Flamingo Sanctuary” and the Pekelmeer enjoy island legal protected status and

Ramsar wetland status, while most of the area is used as saliña by the Cargill company for solar salt production. Pekelmeer (saltworks) is globally significant for Caribbean flamingos. A maximum of 1,300 pairs nesting in 1996 was recorded (Wells & Debrot 2008). More recently up to 2500 pairs have been documented (Birdlife International 2012). Fig. 7 shows the location of these three main potential terrestrial buffer zones as well as the location of relevant Ramsar sites within these areas.

Ramsar sites (all lie inside the above-listed island protected nature zones)

The Ramsar sites registered for Bonaire are Lac, Pekelmeer, Klein Bonaire, Gotomeer and Slagbaai Lagoons (Table 7). The latter two have recently been merged into one site. All lie in the nature areas presented above but two are already formally part of the BNMP (Klein Bonaire and Lac Bay). The remaining three areas could also individually be added as designated buffer zones to help bolster the combined Bonaire and Curaçao nomination property in terms of both resilience and connectivity.

The Flamingo Sanctuary at Pekelmeer is one of the most important breeding grounds for the Southern Caribbean Flamingo population. Slagbaai and Goto lagoons are foraging and breeding site for flamingos and other birds like pelicans and herons.

Table 7. Description of the Ramsar sites of Bonaire.

Area	ha	position	Description	Ramsar site	IBA	Protection status
Slagbaai	90 (Ramsar) 7529 (IBA)	12º16'N 068º25'W	shallow, permanent, saline lagoon, isolated from the sea	no. 203	AN009	National park
Gotomeer	150 (Ramsar)	12º14'N 068º22'W	shallow, permanent, saline lagoon, isolated from the sea	no. 202	AN010	Protected park lands
Lac Bay	824 (Ramsar) 6197 (IBA)	12º02'N 068º19'W	Magroves, seagrass beds, reefs	no. 200	AN013	Part of BNMP
Pekelmeer	557 (Ramsar) 6197 (IBA)	12º02'N 068º19'W	hypersaline lagoons	no. 200	AN014	Protected park Lands
Klein Bonaire Island & adjacent sea	686 ha (Ramsar) 2050 (IBA)	12º10'N 068º19'W	coral island with shrubs, cacti and brackish lagoons	no. 201	AN012	BNMP

3.4.4 The marine 12-mile zone

The ecological significance of an extension of the proposed nomination to include the marine 12-mile zone is evaluated by Beek (2016). Beek (2016) concluded that the 12mile zone contains some attributes that will strengthen the OUV to some extent, such as the recent discovery of 13 species of sponge new to science on the deeper reef of Bonaire (based on only four submersible dives (Soest et al. 2014) and the presence of some species endemic to the Southern Caribbean Ecoregion. Based on this assessment it will also add about 300 fish species to the protected biodiversity and 9 species to the total of IUCN Red List species present. Additional deep sea expeditions indicate that further studies of deep water biodiversity are likely to yield a wealth of new species. Also, potential offshore sea mounts within the 12-mile zone of Bonaire may be worth investigating, by mapping the seafloor through a bathymetric survey. Seamounts have high levels of endemism and are often associated with benthic-pelagic interactions. These potential habitats, structures and new species in the 12-mile zone of Bonaire could greatly add to the OUV of the BNMP. Seamounts are known to have high levels of endemism.

The demonstrable additional values of including the 12-mile-zone as part of the proposed nomination amount to:

a) A doubling of the coral area inside the nomination property. Fifty percent or more of (deep) coral reef habitat lies at depths greater than 60 m and legally outside the current BNMP and CMP properties. Both deep sea benthos and open seas pelagic surface habitat, which are coupled yet distinct, are then included.
b) Addition of 9 pelagic IUCN Red List species (excluding near threatened (NT) tuna and shark species) but including the critically endangered Caribbean endemic Black-capped Petrel (*Pterodroma hasitata*) that is not uncommon in the pelagic environment that it uses as a feeding area (Prins et al. 2009).
c) Other known ecological processes such as non-coral reef building and pelagic processes e.g. vertical migration

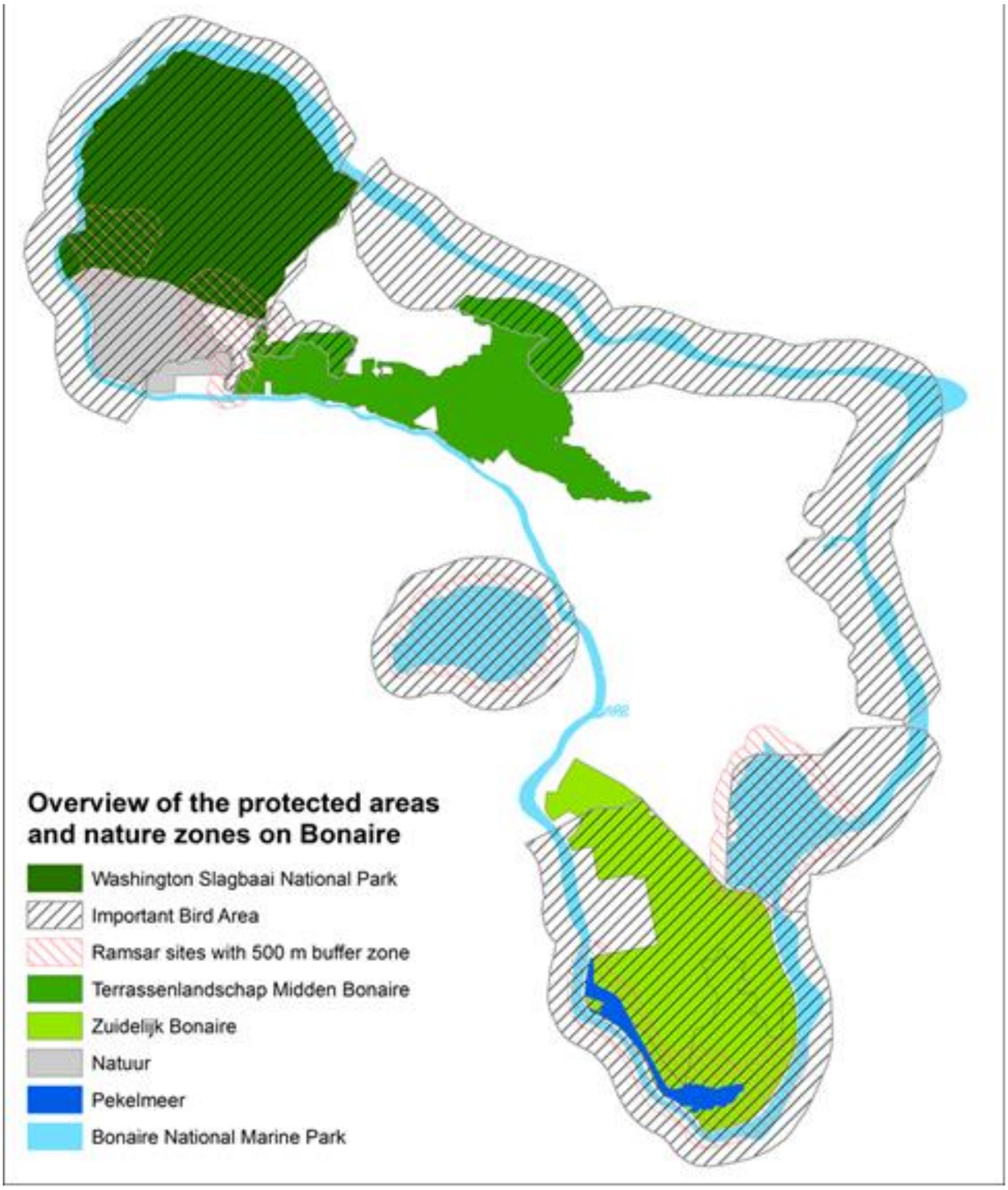

Figure 7. Map of Bonaire showing the location of the three protected principal potential buffer zones as discussed as well as the location of the designated Ramsar sites within these protected areas.

3.5 Curaçao

Fig. 8 shows a map of potential terrestrial bufferzones relevant to the Curacao Marine Park and as discussed below.

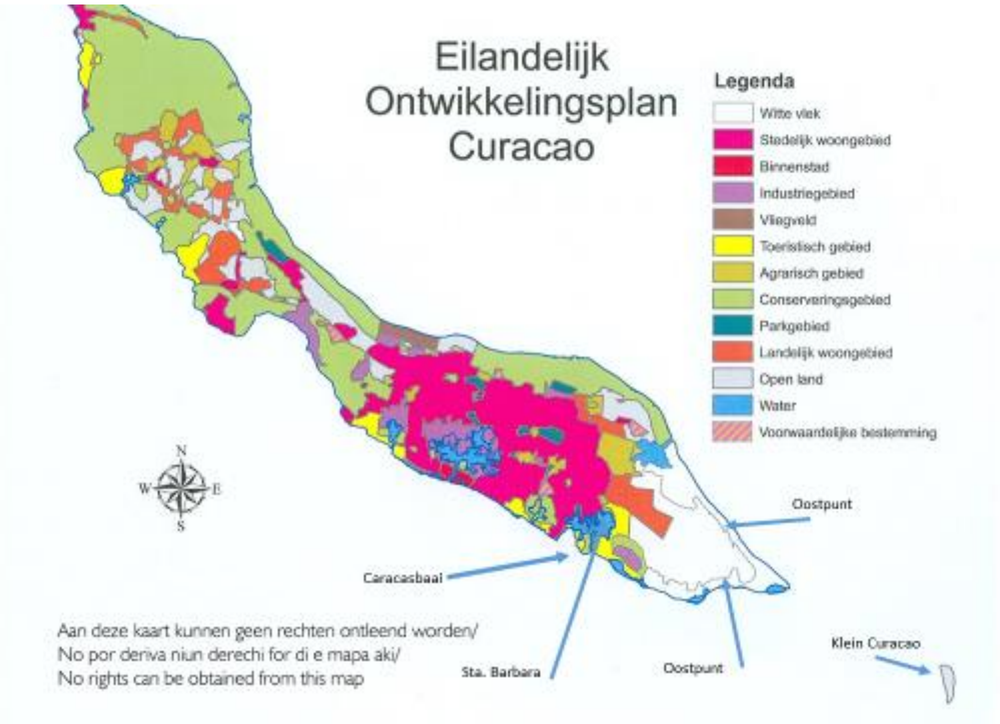

Figure 8. Map of Curacao showing the terrestrial buffer zones (Caracasbaai, Sta. Barbara, Oostpunt and Klein Curaçao) of potential value to the Curacao Marine Park nomination component.

3.5.1 Caracasbaai Peninsula

The coral reef on the western side of the opening of the Spanish Water is luxuriant, with coral cover exceeding 50%. The reefs surrounding the entrance of Spanish Water harbor significant populations of critically endangered Elkhorn Coral (*Acropora palmata*). The Caracasbaai peninsula came into existence as the result of an earthquake that resulted in a massive submarine land-slide (de Buisonjé & Zonneveld 1976). This relatively small 'conservation area' in the Island Development Plan is the only area on the island where both of the least disturbed limestone landscape (*Haematoxylon-Bourreria* Terrace and *Coccoloba-Erithalis* Terrace) and vegetation types (*Haematoxylon-Randia* type and *Coccoloba-Erithalis* type resp.) occur (Beers et al. 1997). Geomorphologically the Kabrietenberg (Fig. 9) is important because it is one of the very few (limestone) hills in the relatively flat eastern side of the island (Debrot & de Freitas 1991). Rare plant species include *Mammilaria mammilaris, Ficus brittonii, Capparis linearis, Celtis iguanaea* and the presence of *Tillandsia flexuosa* on an ungrazed rock boulder representing a patch of relict vegetation of the island before goats were introduced (Debrot & de Freitas 1993).

Besides a natural beach vegetation two mangrove areas can be found, one on the leeward coast of the peninsula (Punta Cabayé) and one along the coastal zone of the Kabrietenbaai. Mangrove areas comprise less than 0.1 % of the surface area of Curaçao (Debrot & de Freitas 1991) and relatively undisturbed beach vegetation is only sporadically found on the island (Stoffers 1956). Unpolluted mangrove areas have important ecological and coastal protection functions (Debrot & de Freitas 1991).

Also faunistically the area is valuable: two of the threatened raptor species of the island breed , roost and hunt there: White-tailed Hawk, *Geranoaetus albicaudatus*, and Barn Owl, *Tyto alba bargei* (de Freitas 1986, de Freitas 2010). The peninsula area also fits the habitat requirements (better developed vegetation types, mangrove area and adequate tree species) for the rare Scaly-naped Pigeon (*Patagioenas squamosa*) that also occurs in the nearby Sta. Barbara area (Voous 1983, de Freitas 2010). The rare Caribbean Elaenia (*Elaenia martinica*) also occurs in the area (de Freitas 1986, Voous 1983, Debrot & Wells 2008). Over 20 bird species occur in the area,amongst which the endemic Brown-throated Parakeet (*Aratinga pertinax pertinax*) (de Freitas 1986; Voous 1983; de Boer et al. 2011).

Ten of the 28 terrestrial snails that have been found on Curacao, occur on the peninsula.Three of these species occur outside Curaçao only on Aruba and/or Bonaire (B*rachipodella raveni, Cerion uva* and *Tudora megacheilos*). The *T. megacheilos* subspecies (*kabrietensis*) is restricted to this part of the island only (Wagenaar Hummelinck 1990). 11 of the 52 butterfly and moth species found in more recent times on the island occur in the Caracasbaai peninsula area. Of these 11 species three species are very rare on the island *(Chlorostrymon simeathis, Chiomara asychis, and Pyrrhopygopsis socrates) and one (Chlorostrymon simeathis*) of which has only been found on the peninsula (Debrot & Miller 2004). The area of the Caracasbaai peninsula has also very important historical and cultural values due the presence of Fort Beekenburg and other structures in the area.

Figure 9. View across the terrestrial conservation area of Caracasbaai and potential buffer zone to the CMP (Photo: A. Debrot)

3.5.2 Spanish Water Bay and the Mangroves of Sta.Barbara)

Spanish Water is a large inland bay which harbours extensive mangrove and seagrass habitats that are ecologically and physically linked to the well-developed nearby coral reef systems. Spanish Water harbours approximately 15.5 ha of relatively healthy mangrove forests representing almost 30% of the total surface covered by mangroves on Curaçao. Spanish Water also harbours approximately 40 ha of seagrass habitat. Hence Spanish Water includes the largest area covered by these communities on Curaçao (Hof et al. 1995, Debrot & de Freitas 1991). Red Mangrove trees are found along large parts of the shoreline of the bay. Near shore, the shallower parts of the bay are dominated by Turtle-grass up to 3 m depth. Mean seagrass cover is 81% (Nagelkerken & van der Velde 2002). Mangroves and seagrass beds support crucial ecosystem functions and services (e.g., prevention of erosion) and positively stimulate fish communities on nearby coral reefs (Mumby et al. 2008). In Spanish Water, they support numerous economically and ecologically valuable reef fish species and declining populations of invertebrates as the Spiny Lobster and the Queen Conch (*Strombus gigas*) (Pors & Nagelkerken 1998). Mangroves dissipate wave energy and shelter a great diversity of organisms such as sponges, crustaceans, bivalves, fishes, ascidians, hydrozoans and bryozoans (Hunting et al. 2008). Seagrass beds contribute significantly to nitrogen fixation (Mumby et al. 2008) and harbor diverse and highly productive epiphytic assemblages, comprised mainly of microscopic diatoms and red, brown, green and blue-green algae (Moncreiff 1992).

The large areas covered by mangrove and seagrass serve as feeding and nursery grounds for a large number of reef fish and invertebrate species. Examples include the threatened Rainbow Parrotfish (*Scarus guacamaia*) and the fact that 60% of the island's snapper population (Lutjanidae) was born in this inland bay. Therefore, the bay acts as a "source" community capable of seeding distant "sink" communities around the entire island of Curaçao. Various economically and ecologically valuable Curaçaoan fish species thus depend on nursery habitats (i.e., mangroves and seagrass beds) located inside the Spanish Water. These include many piscivorous species (Lutjanidae, Sphyraena) structuring local food webs herbivorous species (Acanthuridae, Scaridae) reducing algal proliferation on reefs and high densities of prey fish (Haemulidae) further structuring trophic relationships with Curaçaoan fish communities (Nagelkerken et al. paper in review). Coastal fisheries off the south shore of Curaçao target numerous species that highly depend on the nursery habitats harboured by Spanish Water. Spanish Water shelters the highest densities of commercial fish species of all inland bays on Curaçao. These include the Schoolmaster (*Lutjanus apodus*), the Mahogani Snapper (*Lutjanus mahogany*), the Great Barracuda (*Sphyraena barracuda*), the Grey Snapper (*Lutjanus griseus*) and the Yellowtail Snapper (*Ocyurus chrysurus*) (Nagelkerken & van der Velde 2002). The biomass of these commercially important species on a coral reef doubles when adult habitat is connected to mangroves and seagrass beds, such as those found in the Spanish Water (Mumby et al. 2004).The coral reef on the western side of the opening of the bay is luxuriant, with coral cover exceeding 50%. The reefs surrounding the entrance of Spanish Water harbor significant populations of critically endangered Elkhorn Coral (*Acropora palmata*) and Staghorn Coral (*Acropora cervicornis*).

Since the early 1990's, the area of Spanish Water is recognized for its great biodiversity within the bay itself and on its adjacent coral reefs (Debrot & de Freitas 1991). Parts of the inland bay are covered with Red Mangroves (*Rhizophora mangle*) and large areas of the bottom harbor seagrass beds, mainly Turtle-Grass (*Thalassia testudinum*), but also Midrib Seagrass (*Halophila baillonis*) and Manatee Grass (*Syringodium filiforme*) (Pors & Nagelkerken 1998). On Curaçao, at least 69 animal species need mangrove habitats to survive, including 41% of the total number of bird species on the island (de Freitas et al. 1992). In Spanish Water, mangrove forests provide habitat for various species of crustacea and mollusca (Pors & Nagelkerken 1998) and harbor the highest diversity of mangrove-associated sponges on the island (Hunting et al. 2008). The bottom of Spanish Water harbours thirteen different seagrass and algal community types (Kuenen & Debrot 1995), which support numerous species of fish, lobsters and shrimps (Pors & Nagelkerken 1998).

3.5.3 Coastal woodlands and lagoons of Oostpunt

The coastal limestone hills and cliffs which stretch from Caracasbaai eastward to Oostpunt are a striking feature of the relatively flat eastern side of the island. This area begins at the bay of Caracasbaai which is a deep water harbour created by an earthquake that resulted in a massive submarine land-slide (De Buisonjé & Zonneveld 1976). The limestone hills and cliffs in the area of Oostpunt harbor a number of rare plant species, amongst which the cacti *Mammilaria mammilaris* and *Opuntia curassavica*. These areas are also home to threatened bird species like the White-tailed Hawk, the Curaçao Barn Owl (an endemic subspecies for Curaçao) and the rare Scaly-Naped Pigeon (Debrot & de Freitas 1991).

The shores between Spaanse Water and Oostpunt directly border the Curaçao Underwater Park. While not designated as part of the Underwater Park, the shore zone and adjacent lands are an integral part of the marine ecosystem and should be managed together with it (Salm & Clark 1984). The terrestrial areas constitute important habitat for shore birds. The area also harbours numerous lagoons of local importance to flamingos, migratory waterbirds, seabirds and reef organisms (e.g. Awa Blanku, LagunBlanku, Saliña di Patu, Awa di Oostpunt). Large sections of coastline and inland water courses have been designated as conservation habitat for the Oostpunt area and are of great potential value as terrestria buffer zones to the Curacao marine park nomination component (Fig. 10). This is in addition to the marine bufferzones designated for the Curacao Marine Park in 2017 (see Fig. 3). The saliña at Oostpunt contains the largest (c. 2 ha) and least disturbed saline meadows of the rare *Salicornia perennis-Batis maritima* vegetation type (Beers et al. 1997). Both species are extremely rare elsewhere in the region and only found in Lac Bay, a Ramsar site established earlier on the nearby island of Bonaire (Debrot et al. 2010). A rare *Coccoloba uvifera-Crossopetalum rhacoma* vegetation type is present around Fuik Bay (Debrot & de Freitas 1991). Furthermore, the eastern part of Curaçao remains undisturbed by human activities and as such is the only area on Curaçao where coastal vegetation gradually transforms from marine to inland vegetation types, representing intact vegetation zonation patterns typical for the Southern Caribbean.

Lagoons

The area ("Oostpunt") has been spared from any form of human disturbance on shore including four inland bays bordering the CMP (Fuikbay, Langun Blanku, Awa Blanku, and Awa di Oostpunt) in which mangroves and seagrass beds are found. These bays will be designated as buffer zones already for the new CMP that will also become a protected area under the SPAW protocol. The inland bays (i.e., Fuik Bay; 0.55 km^2, Lagun Blanku; ~0.23 km^2, and Awa di Oostpunt; ~0.40 km^2) are connected to the open ocean and its bottoms are almost completely covered by seagrass beds. Turtle-grass (*Thalassia testudinum*) which is by far the most abundant sea grass species in all three inland bays. Fuik Bay also supports a significant amount of Red Mangroves (*Rhizophora mangle*). The waters in the bays are the clearest of all inland bays on Curaçao and are a little below average sea water salinity (Nagelkerken et al. 2000a). Three hyper-saline lagoons are also found along the coast and water exchange occurs largely underground through the porous coral rubble accumulations that separates these lagoons from the sea. The largest of these hyper-saline lagoons is Awa Blanku, just east of Lagun Blanku, whereas the two other small hyper-saline lagoons are found 2 km east of from Awa Blanku. These areas are designated as aquatic bufferzones for the new to be installed Curaçao Marine Park. On Curaçao, multiple Important Bird Areas (IBA) are located, in which the flamingo feeds, or nests. Based on Wells & Debrot (2008), the following estimates are provided:

Curaçao has a small but important presence of 200 to 300 flamingos. Thes animals also regularly fly out to Venezuela where food is more plentiful or on to Bonaire. The Jan Kok, St. Michiel and Janthiel salt ponds have received protection since 1997 due to their importance for the population. However the lagoons of, Oostpunt, that serve as aquatic buffer zones to the CMP, serve as a resting place for flamingo's in Curaçao such that flamingo sightings in the CMP are regular. Klein Curaçao fulfills a similar function and serves as a resting place for flamingo's migrating between Curaçao and Bonaire.

The inland bays connected to the ocean harbour dense populations of lobsters, conch (Awa di Oostpunt and Lagun Blanku) and are the only place on Curaçao where the Red Sea Star (*Oreaster reticularis*) is found, one of only two species of the tropical sea star family Oreasteridae known from the western Atlantic Ocean The seagrass beds are used by Green Turtles as a foraging area (Vermeij, 2012b). Various turtle species use the beaches and inland bays of Oostpunt for nesting or foraging (Debrot et al., 2005). The seagrass habitats of Fuik Bay and Awa di Oostpunt shelter juveniles of the commercially valuable and declining populations of the Spiny Lobster (*Panulirus argus*) (Jalink & Donkersloot 1985). Like many marine species with meroplanktonic larvae, the Spiny lobster has a post larval stage that moves from the oceanic plankton to inshore nurseries to avoid predation until they reach adult stage and migrate to adjacent coral reefs (Acosta & Butler

1999). Thus, the seagrass beds sheltered by the inland bays of the area are critical for the early life cycle of the Spiny Lobster, different conch species and fish.

Nagelkerken et al. (2002) demonstrated the ecological importance of these bays. Juveniles of at least 17 Caribbean reef-fish species are critically dependent on these bays before they move to the nearby coral reefs where they spent their life as adults (Nagelkerken et al. 2000b, c). In comparison to islands lacking these habitats, complete absence or low densities were observed for 11 of the 17 species. The main species that highly depend on these habitats are the Yellowtail Snapper (*Ocyrus chrysurus*), Striped Parrotfish (*Scarus iserti*), Sailors Choice (*Haemulon parrai*), Bluestriped Grunt (*Haemulon sciurus*), Schoolmaster (*Lutjanus apodus*), Gray Snapper (*Lutjanus griseus*), Redtail Parrotfish (*Sparisoma chrysopterum*) and Barracuda (*Sphyraena barracuda*) (Nagelkerken et al. 2000a). Preserving these nursery habitats (i.e., mangroves and seagrass beds) for both ecologically (e.g., parrotfishes) and economically important species (e.g., grunts, snappers and barracudas) is critical as stocks for all these species have been greatly depleted throughout the Caribbean due to overfishing (Hof et al. 1995, Bruckner & Bruckner 2003b). The inland bays of Oostpunt contribute approximately 50% of all individuals of certain ecologically and economically important fish species (CARMABI 2012).

In 1983-1984, the Black Sea Urchin (*Diadema antillarum*) suffered mass mortality throughout its entire geographic range. Coupled with overfishing, the >95% reduction of the species caused a sharp decline in herbivory rates on Caribbean reefs, which have led to overgrowth of coral by macro algae, subsequently resulting in dramatic changes in reef community structure throughout the Tropical Northwestern Atlantic Province (Carpenter 1990). The entrance of Lagun Blanku shelters the second most important concentration of the Black Sea Urchin on Curaçao (2.7/m^2) (Debrot & Nagelkerken 2006). Hence, shallow, wave-sheltered rocky habitats as the entrances of Awa di Oostpunt and Lagun Blanku likely play a particularly important role as refuges for this important species and will eventually aid the recovery of this sea urchin in the Caribbean (Levitan 1991, Bak 1985).

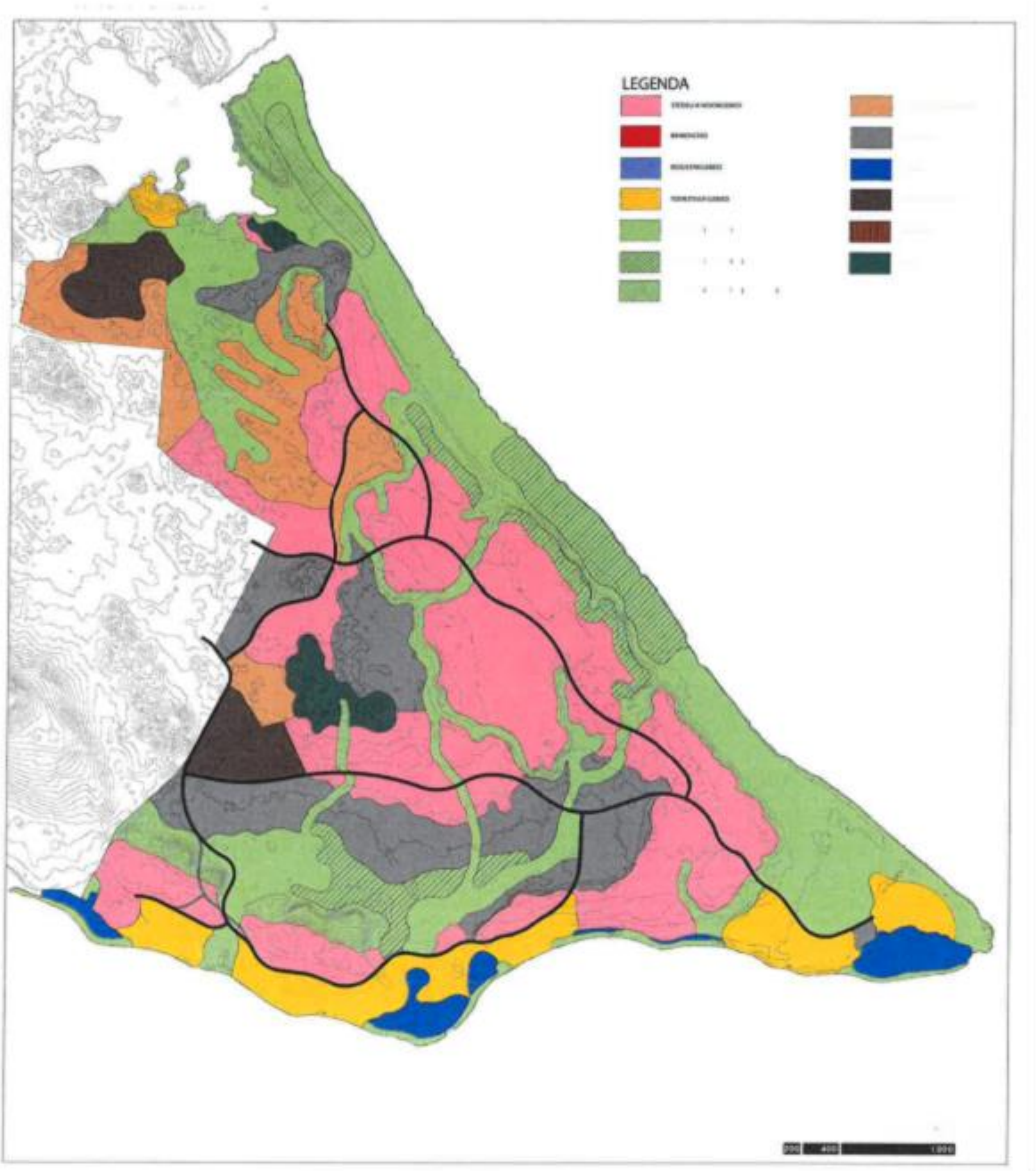

Fig 10. Green zones along the coast and in the inland watercourses are legally established conservation areas in Oostpunt (see Appendix 3) that can serve as buffer habitat for the Curaçao World heritage component nomination.

3.5.4 Klein Curaçao (general description)

Klein Curaçao is an offshore island (surface area: 130 hectares) situated about 11 km south-east of Curaçao and approximately 65 km north from the Venezuelan coast. Klein Curaçao is included in Curaçao's Territorial Sea. Klein Curaçao is uninhabited and of global importance for its breeding population of the Least Tern (*Sterna antillarum*). The island consists entirely of limestone deposits and its central part consists of Lower Terrace limestone (De Buisonjé 1974). It is rimmed by a zone of recent or sub-recent coral shingle. On the southwest shore of the island lies a 600 m long stretch of recent calcareous sand (De Buisonjé 1974), facing calm and shallow waters whereas the rest of the island's shore is rocky and wave exposed. Most of the island lies less than 2 m above sea level, with a maximum altitude of 4.7 m in the east where there is a ridge of coral rubble (Buurt 2006). In the past, the island had a low limestone ridge with a maximum height of about 7 m, but the island was mined for phosphates (guano) from 1871 to 1913 and the ridge was levelled (Stienstra 1991). In early colonial times the extinct Caribbean Monk Seal, *Monachus tropicalis*, occurred iregularly on the island (Debrot 2000). An archaic-age indian shell middens has been found on the island (A. Debrot, pers. comm.), substantiating historical accounts that in prehistoric times the island was frequented by indians to collect sea turtle eggs. The island has one fresh- and one brackish-water carst well that hold water year-round and which were of importance to fishermen and temporary inhabitants of the past (A. Debrot, pers. obs.). Since 2000, after goats had been eradicated from the island, a reforestation project by Carmabi has reintroduced native coastal shrubs and trees, with a result that the island has some of the best remaining strand vegetation in the territory of Curaçao. (Debrot 2015). The fringing coral reef surrounding Klein Curaçao is characterized by a narrow submarine terrace (<150 m wide) which gradually slopes from the shore to a drop-off between 7 to 12 m depth at the western side of the island, after which it slopes off steeply, sometimes interrupted by a small second terrace at 50 to 60 m, and ends in a sandy plain at 80 to 90 m (Bak 1975). At the east side the reef flat turns into a steep vertical wall at a depth of approximately 10 m that continues to depths of 80-100 m where a rubble plane starts that further extends to deeper water. The vertical wall contains many caves, some of which are more than 10 m wide and 40 m deep. In addition, the eastern side of Klein Curaçao is surrounded by a near pristine Caribbean coral reef system supporting an enormous diversity of marine organisms.

Klein Curaçao holds great historical value as many relicts relating the past of the island can still be found; (1) The abandoned lighthouse of Klein Curaçao which was first built in 1850 by the government was destroyed by a hurricane on 22/23 September 1877 and a new lighthouse was built in 1879 and again rebuilt in 1913, is still watching over the island; (2) A wrecked tanker, the Maria Bianca Guidesman which washed to shore is still standing on the eastern coast of the island, and (3) Over two hundred cannons from the 17th and 18th century lie across the bottom on Klein Curaçao's eastern coast, (4) coastal ranchos made from beach rock and used as campsite shelters by fishermen of the past, (5) Archaic-age prehistoric indian shell middens (camp) site.

Klein Curaçao has become a privileged destination for tourists and locals for recreational purposes. More than 600 people visit the island every week and represent a significant source of income for specialized tour operators (Debrot & Wells 2008). Klein Curaçao is also a regular stop for local fishermen which have built a few fishing shacks where they sometimes stay for several days. The island is considered of high scenic value by the local community of Curaçao. In 2017 the council of Ministers decided that, based on aforementioned values, Klein Curaçao is to become a RAMSAR area and listing is now in progress.

Klein Curaçao possesses the longest stretch (600m) of natural sandy beach within Curaçao's jurisdiction, where beaches rarely exceed a 100m in length (Debrot & Pors 1995). As a result, Klein Curaçao's beaches are since long renowned for their importance as nesting grounds for local sea turtles (Debrot & Pors 1995). Klein Curaçao is the single most important sea turtle nesting area within Curaçao's jurisdiction (Debrot & Pors 1995), especially for the critically endangered Hawksbill Turtle (*Eretmochelys imbricata*) and the endangered Green Turtle (*Chelonia mydas*) (Debrot et *al*. 2005). Nesting occurs foremost during the months October and November (Debrot et *al*. 2005). Anecdotal evidence suggests that nesting by Endangered Loggerhead (*Caretta*

caretta) also occurs on Klein Curaçao (Sybesma 1992). Critically endangered Leatherback (*Dermochelys coriacea*) and vulnerable Olive Ridley (*Lepidochelys olivacea*, Warana) are frequently encountered on Klein Curaçao's coral reefs but have never been reported nesting on the island (Debrot et *al.* 2005). Despite the small size of Klein Curaçao, an average of ~200 nests are recorded annually on this island (STCC/ Carmabi, unpubl. data). Although no exact information exists regarding the population size of marine turtle species in the waters of Klein Curaçao, they are frequently reported in the area by boaters, snorkelers and divers.

Nesting female turtles, eggs and hatchlings are particularly exposed and vulnerable to biotic and abiotic threats (Dow et al. 2007). On Klein Curaçao, with the exception of occasional harassment by humans, most of these threats are absent and/or very rare and therefore crucially important to ensure the reproductive success of the endangered Green Turtle (*Chelonia mydas*) and critically endangered Hawksbill (*Eretmochelys imbricata*).

Marine mammal sightings occur regularly around Klein Curaçao and include the following species: the Short-finned Pilot Whale (*Globicephala macrorhynchus*), the Humpback Whale (*Megaptera novaeangliae*) and especially Spinner Dolphins (*Stenella longirostris*) (Debrot 1998). The reef flat and crest of the fringing reef off the eastern coast of Klein Curaçao harbors dense populations of Elkhorn Coral (*Acropora palmata*) and various patches of the Staghorn Coral (*Acropora cervicornis*).

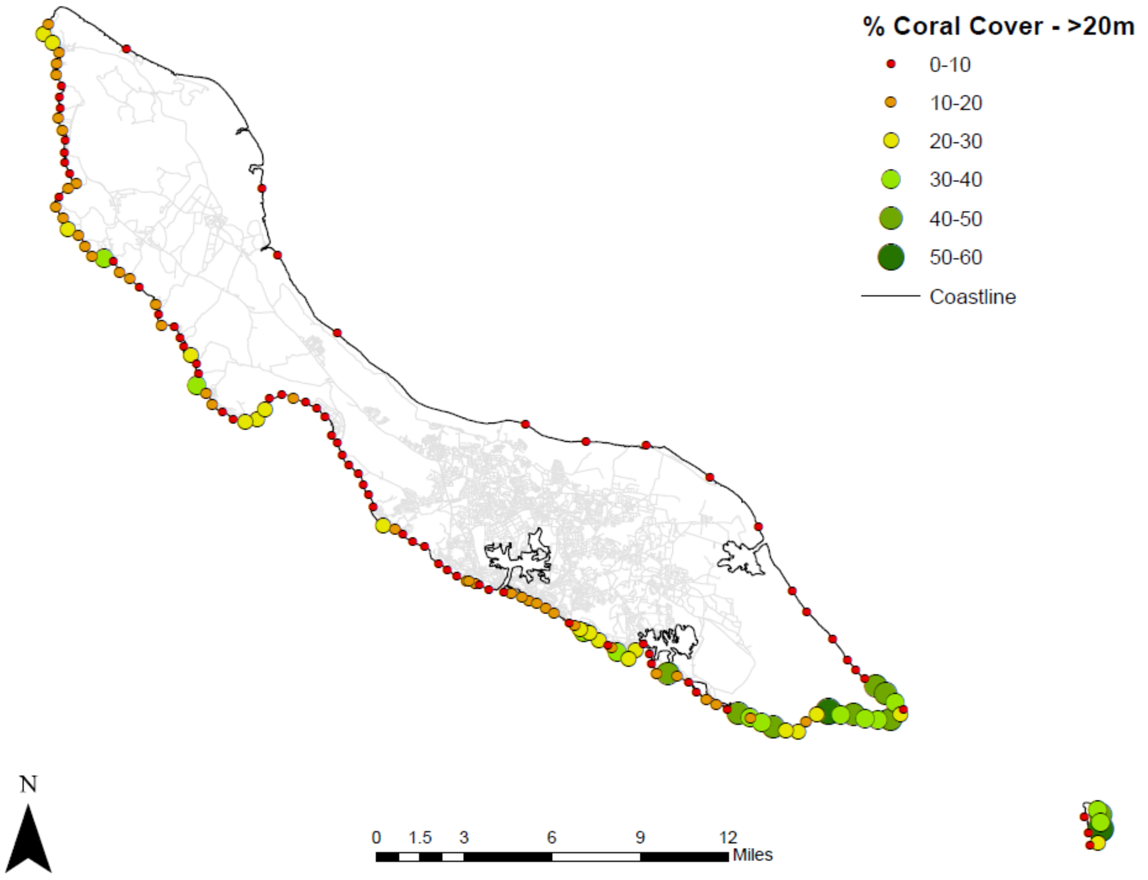

Figure 11. Coral cover in Curaçao as percentage for depths to 20 m shows how important the reefs of the Curaçao Marine Park are at island level. (Source: Waitt 2017)

The acroporid species are both listed as Critically Endangered on the IUCN Red List and as Threatened under CITES Appendix II. Two Endangered species, listed on the IUCN Red List, the Boulder Star Coral (*Montastraea annularis*) and the Mountainous Star Coral (*Montastraea faveolata*), dominate the reef community on the deeper fore reef and cover 100% of the bottom in certain areas (MJA Vermeij, pers. obs.). Other coral species listed as Vulnerable under the IUCN Red List are also commonly found, examples include Pillar Coral (*Dendrogyra cylindrus*), Lamarck's Sheet Coral (*Agaricia lamarki*) and the Elliptical Star Coral (*Dichocoenia stokesii*). Colonies of the

Pillar Coral on Klein Curaçao are particularly large and abundant compared to the reefs of the main island of Curaçao (MJA Vermeij, unpubl. data). Coral reefs around Klein Curaçao remain in a near-pristine state and are well developed. Reef systems capable of maintaining themselves are becoming increasingly rare and as such Klein Curaçao shelters one of the few remaining healthy Caribbean reef communities and thus serves as a unique representation of Caribbean reef communities in general. Klein Curaçao, along with the eastern reefs of the main island of Curaçao harour the highest average coral covers of the island (Fig. 11). The shallow reefs (0 - 4 m depth) of the proposed Ramsar site harbor dense populations of the Elkhorn Coral (*Acropora palmata*) and large stands of Fire Coral (*Millepora complanata*), which both provide complex structural habitats for specific reef fish species that are crucial for these species as hiding places and nursery habitats (Nagelkerken 1974). Especially juveniles of the Smallmouth Grunt (*Haemulon chrysargyrum*), Mahogany Snapper (*Lutjanus mahogany*), Blue Tang (*Acanthurus coeruleus*), Ocean Surgeonfish (*Acanthurus bahianus*) and Sergeant Major (*Abudefduf saxatilis*) depend on the habitat provided by these (hydro)corals as critical nursery habitat (Nagelkerken et *al.* 2000a).

The coral reef communities of Klein Curaçao harbour an exceptionally large abundance of hard and soft corals, gorgonians, sponges and a range of encrusting organisms. They provide habitat for numerous fish species, crustaceans and echinoderms (Fig. 12). The reef flat off the east/ southeast coast of Klein Curaçao harbours two valuable marine community types: dense populations of the Elkhorn Coral and dense fields of gorgonians.

Figure 12. Schools of planktivorous Black Durgeon triggerfish, *Melichtys niger,* and the smaller Grey Chromis, *Chromis lineatus,* above luxurious reefs of the east coast of Klein Curaçao (Photo: Mark Vermeij).

Both communities sustain major ecological processes as gross community calcification and nitrogen fixation. Dense populations of these branching species dissipate wave energy and thus protect the coast (Mumby et *al.* 2008). Elkhorn Coral also ensures healthy and productive reefs by providing shelter to an enormous amount of other reef organisms (Gladfelter & Gladfelter 1978), including both adult fish and their juveniles (Nagelkerken 1974). Both Elkhorn Coral and equally abundant Fire Corals provide shelter to juvenile fish, thus supporting productive fish communities (Nagelkerken 1974). On the coral reefs included in this proposal, grunts

(Haemulidae), snappers (Lutjanidae) and Squirrelfish (Holocentridae) primarily use the habitat provided by Elkhorn Coral and Fire Corals (Vermeij MJA, unpubl. data). Similar functions are assumed for gorgonian communities that further shelter significant numbers of herbivorous fish, especially Acanthurids, but also predatory fish as groupers. The fore reef of Klein Curaçao is characterized by extremely high coral cover. Fields of the Vulnerable Pillar Coral (*Dendrogyra cylindrus*) are commonly found between depths of 5 to 8 m. Two Endangered species, listed under the IUCN Red List, the Boulder Star Coral (*Montastraea annularis*) and the Mountainous Star Coral (*Montastraea faveolata*) cover large areas of the forereef in this proposed Ramsar Area (Vermeij MJA, unpubl. data). Coral cover on these reefs currently exceeds that of the earliest historic baselines for Caribbean reef systems (Vermeij MJA, unpubl. data).

4 Criteria (vii) – Natural phenomena

4.1 Background

To demonstrate the Outstanding Universal Value according to World Heritage natural criteria (vii), the Operational Guidelines for the Implementation of the World Heritage Convention UNESCO require the nominated property "to contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance" (UNESCO 2017). Criteria (vii) was used as one of the two criteria in the application to get Bonaire Marine Park on the World Heritage Tentative List, based on the statement that 'The flora and fauna of the Bonaire Marine Park are extremely varied and well conserved' (UNESCO 2011). This aesthetic criteria alone is not sufficient to justify OUV that is necessary to become a World Heritage Site and should be used as an additional criteria besides one or more of the other three natural criteria (Badman et al. 2008). Criteria (vii) relates to aesthetic or visual aspects and how visitors perceive and experience the property as well as superlative natural phenomena. This assignment specifically included elaboration on the aesthic values represented. The fish aggregations of Bonaire and Curaçao have not been fully documented. Further work in this area has the potential to strengthen the argument for criteria (vii) for this proposed nomination.

4.2 Statement of values

Establishing global significance under any criteria requires a site to be distinct, unique and superlative in some way. For criteria (vii) "*aesthetic or superlative natural phenomena*" tend to reflect records for size, densities or some other measure. The indicators to quantify the attributes identified under criteria (vii) that according to Beek et al. (2014a) still needed to be described with more precision include: (1) water clarity that can be quantified by visibility/secchi disk (m); (2) morphological diversity of the fringing reef by visual contrast or popularity with divers; (3) reef fish visual sightings by maximum size of schools and maximum size of individual fish (tarpon, large snapper spp., large grouper spp.); (4) globally endangered species by visual sighting frequency of turtles; and (5) migratory birds by visual sighting frequency and flock size of flamingos. Finally, we point out that the BCMP nomination area has been regarded as among the top dive locations worldwide for the last two decades. All these are values found inside the current boundaries of the proposed BCMP nomination.

In this section we provide more extensive description of (2) the morphological diversity of the fringing reef by visual contrast; (3) reef fish functional diversity; (4) globally endangered species by visual sighting frequency of turtles and IUCN Redlisted fishes; and (5) migratory birds by visual sighting frequency and flock size of flamingos.

4.3 Justification

Justification for inscription links only to OUV and attributes and explains global importance/significance beyond local/national scales (UNESCO 2017).

- It is distinct in landscape diversity compared to most other Caribbean marine WHS with reefs located on continental platforms or on continental islands (this is because of geological diversity and steep island slopes)
- It is distinct in terms of fish diversity due to a combination of healthy processes habitat diversity and good connectivity (as well as relatively low fishing pressure and restrictions on destructive fishing practices).

- It has high and increasing sighting frequency of endangered species such as flamingos and sea turtles (already 100% success for directed excursions) thanks to active protection of charismatic species and active breeding populations.

4.4 The fringing reefs with its diverse landscapes, reefscapes and fauna

Below the surface the reefscapes present are diverse and range from gradually-sloping coral-covered fore-reef slopes, to steep vertical drop-offs, and so called "double reefs" (Duyl 1985). On the windward sides of the islands the reefs are located somewhat deeper. The general profile of the leeward fringing reefs as provided by Bak (1975) is a gradually sloping terrace of 30 m to 150 m width, followed by a drop-off at 7 to 12 m. This is then followed by a gently sloping fore-reef. This may be interrupted by an inclined terrace at 50 to 60 m depth, before continuing with a vertical drop-off at 70 to 80 m and ending at a sandy plain at 80 to 90 m depth (Bak 1975). On windward coasts the shallow reefs are generally more dominated by dense forests of *Sargassum* or in certain cases sea whips and sea fans, which constitute totally distinct underwater seascapes.

The Bonaire National Marine Park is of exceptional beauty and consists of 27 km^2 hectares of fringing coral reef, seagrass beds and mangroves (De Meyer & MacRae 2006) and is the habitat of over 61 species of hard coral (Bak 1975, Moorsel 1983, Weil & Knowlton 1994, Vermeij et al. 2003) and over 500 species of reef fish. This represents 70% of coral species found in the Southern Caribbean and 90% of those found in the ABC Islands (Miloslavich 2010). Three species of endangered marine turtles nest on the beaches of Bonaire and Klein Bonaire (STCB 2014, 2015). On Curaçao these species nest in largest numbers in areas outside the CMP (Debrot & Pors 1995, Debrot et al. 2005), e.g., on Klein Curaçao (~200 nests annually, data from Sea Turtle Conservation Curaçao), which will be a buffer zone. However, both the Green Turtle and the Hawksbill are common in both components and sightings of seaturtles occur on almost all dives (Debrot et al. 2005, STCB 2014, 2015).

High under water visibility

The nomination components are constantly buffeted by fresh, clear, nutrient-poor oceanic water of the Caribbean Current that is characterized by a constant salinity of 35 ppt. This water flows clockwise across the Caribbean basin and is the main surface circulation in the Caribbean Sea. Average ocean surface current velocity along the Netherlands Antilles is high (70 cm/sec), which allows excellent water exchange along most reefs (Fratantoni 2001, Gyory et al. 2005, Lutz and Ginsburg 2007). Exceptions are the areas on the lee side of Bonaire near the town of Kralendijk (Slijkerman et al. 2013) and in Curaçao downstream from the centre of development around Willemstad (Gast et al. 1999). However, on most Bonaire reefs as well as on all reefs of the Curaçao Underwater Park, which is located in the sparsely-developed up-stream eastern portion of the island, the water quality is among the best in the Caribbean.

Vigorous water transport and a steep reef profile that allows disturbed sediment to quickly settle out to deep waters away from the reef, and contributes to high transparency. Duyl (1985) has mapped the main sand shutes that transport loose sediment away from the reef to deep water where they pose a much reduced threat to coral growth. Water transparency is a key parameter measured in coral reef studies and in the reef zones it has typically been between 20 and 30 m (Bak 1975, Duyl 1985). In lagoonal situations where sediments settle in shallow water, visibility is typically much lower (e.g. Kuenen & Debrot 1995, Debrot et al. 2012b). Erosion due to severe overgrazing by roaming livestock can lead to sediment and nutrient input into coastal waters and form an important potential threat to coral health on both islands. Fortunately, most runoff passes through mangrove and seagrass lagoons, inland bays and salinas before entering the sea. These serve as effective sediment traps, and sequester most sediment before it gets a chance to harm the reefs. In addition, these marine parks lie in a semi-arid climatic zone of generally low rainfall

(Beers et al. 1997, Freitas et al. 2005). As a consequence, runoff is also limited due to lack of rainfall and osmotic stress to coral reefs due to freshwater input is also very low.

4.4.1 Coastal landscape aesthetic diversity

The coastlines of Bonaire and Curaçao comprise a variety of coastal landscapes varying from limestone cliffs and ragged promontories to white sandy pocket beaches or course coralline-boulder beaches often adjoined by shallow seagrass-covered and mangrove-lined lagoons or hypersaline ponds. All these coastal habitats have their distinctive evergreen vegetation (Beers et al 1997, Freitas et al. 2005) that combine to provide an attractive yet rugged combination of natural vistas. The flamingos and marine birds add further visual contrast to this spectacular coastal seascape. User surveys in both Curaçao (Debrot & Nagelkerken 2006) and Bonaire (Debrot et al. 2012b) demonstrate that users such as recreational fishermen, divers, boaters and beach-goers consider undisturbed natural landscapes as critical to a high-quality user experience (Debrot & Nagelkerken 2006, Debrot et al. 2012b).

4.4.2 Reefscape diversity

The fringing coral reef was formed by considerable Holocene reef accumulation (at least 16 m) at the leeward side of Bonaire upon several pre-Holocene submarine terraces. A *Montastrea annularis* dominated reef first grew from a terrace at more than 28 m to a depth of 12 m below sea level, closely following the Holocene transgression. This was followed by an *Acropora palmata* dominated reef growing on a much shallower terrace closer to shore and near sea level (Focke 1978). Today the latter reef no longer exists and is gradually being replaced by big head coral communities (e.g. Haitsma & Debrot 2016). The *Montastrea* community is still a dominant reef type on the upper reef slope (10 m) on both islands and has been impacted much less than the shallow coral communities.

When reefs develop in a bathymetrically uniform area, their communities will be similar and the resulting reefscapes will also often be similar. Thanks to a steep bathymetry that also happens to span the whole depth range of active reef growth, together with a complex Pleistocene geological history, the reefs of the Bonaire and Curaçao Marine Parks have been blessed with a diversity of at least 13 different reefscapes. According to extensive reef mapping done by Duyl (1985) there are important documented differences in the mix of reef morphology between the Bonaire Marine Park and the Curaçao Marine Park. Seascape diversity is higher in Curaçao but classical reef development is more advanced in Bonaire. In Bonaire, fore-reef slopes along much of the coastline ends at about 30 m in a shallow sandy slope (Duyl 1985, Becking & Meesters 2014). In Curaçao, this is only the case on the exposed windward side of the island where this deep sand terrace displays scattered patch reefs and adult conch aggregations. Combining Bonaire and Curaçao is not just a question of “more of the same”. Because of actual inter-island differences, the combination of both islands into one World Heritage site means a net higher diversity of reefscapes for the combined designation.

Many of the reef features and reefscapes to be described in this section, also have important ecological functions for specific groups or organisms (e.g. shelter, spawning aggregations, feeding areas). High diversity of reef features and reefscapes contribute to both high (Alpha) diversity within the coral communities and high (Beta) diversity between those communities (Valiela 1984). The diverse landscape features, high habitat diversity and high biodiversity of these lesser Caribbean make them to be among the best, most resilient and most aesthetically diverse of the Caribbean region. The reefscape features that can be found in the joint nomination properties include:

4.4.3 Sill reefs

Sill reefs can be found at the entrances to inland waters. Examples of these can be seen on Bonaire at Lac Bay and at locations like Oostpunt Bay and Spanish Water Bay and Janthiel Bay in Curaçao. These reefs play a key role in the gradual transformation of inland waters to saliñas and eventually dry land as filling-up occurs over thousands of years. In the Leeward Dutch islands, inland lagoons typically started out as inundated river valley systems after the last ice age ended about 10 thousand years ago (Boekschoten 1982). These reefs grow at the entrance of inland bays up to the point where the open sea connection of inland bays is reduced and eventually totally closed for open water movement. Consequently, sill reef development plays a key role in the transformation of mangrove-bordered inland waters to briny saliña wetlands which are so important as foraging areas for migratory shorebirds.

4.4.4 Double reefs

Double reefs exist at several locations in both Curaçao and Bonaire. The term "double reefs" refers to where the reef crest community, typically at depths of around 5-10 m, is followed in slightly deeper waters by an elevated ridge of coral growth. In Curaçao, these are only found at Holiday Beach and at Porto Marie both of which lie outside the Curaçao Marine Park (Duyl 1985). The critical determinant for these reefs is a gradual reef slope followed by a sand plateau at depths where significant coral growth is still possible (20-25 m). In Bonaire, numerous double reefs are located of the west coast between the Plaza Hotel and the salt pier (Duyl 1985).

4.4.5 Reef terraces

During the Pleistocene ice ages, when sea levels were much lower than today, active reef growth led to development of flat reef terraces, several of which are above current sea level but also below sea level (Alexander 1961, Kruyswijk 1983). These terraces are a typical feature of the reefs of Curaçao and Bonaire. The centre of terraces typically have the highest accumulation of sand which will interfere with coral growth. This is a zone where sea whips come to predominate (Duyl 1985). Therefore, submerged terrace reefs typically show highest coral density on their margins. The centre of the shallow terrace is even referred to as the barren zone community for this reason (Bak 1975, 1977).

4.4.6 Reef slopes

Due to the volcanic origin of these islands and the generally steep island slopes, most areas of the reefs of these islands display steep slopes of an average of 45^{o} (Duyl 1985) (Fig. 13). This is typical in many areas with eroded terrace slopes or otherwise less pronounced terrace development. Reef slides occur naturally along slopes where the reef structure has collapsed (Duyl 1985). They represent the inexorable work of gravity that will tend to transport reef debris down the reef slope and ultimately beyond the reef ecosystem into the mesopelagic zone surrounding the islands.

Figure 13. Typical reef slope in the CMP. Photo: M. Vermeij.

4.4.7 Reef walls

Reef walls are an exciting feature of the reefs of Curaçao and Bonaire. This feature can be experienced at many places and are a prime object of many marked dive locations. These are typical of areas with inundated coral reef terraces dating from earlier geological epochs when the sea levels were as much as 60 m or more below the current sea level. In Curaçao, in the Caracas Bay area, there are also pronounced reef walls but there they have been formed in more brittle sedimentary sandstone agglomerates that broke off and slid away creating the most protected deep water harbor site of the island. Curaçao has many more reef walls than Bonaire (Duyl 1985).

4.4.8 Reef caverns and ledges

Caverns are a typical feature of coralline rock terraces (Fig. 14). Typically, these will have formed during a period of emersion due to dissolution of carbonate rock by rainwater. The many submerged reef terraces possess caverns and dissolution ridges (Focke 1978a) to testify of their period when they were once part of dry land. These are features of great interest to divers but also form lairs for large fish like groupers or hiding places for secretive nocturnal species (Fig. 15). The shallow reef terrace may occasionally display a small bank edge formation which can also display a notch (Duyl 1985) creating a sort of small cave like shelter.

Figure 14. Underwater cavern near Punt Canon, Oostpunt in the Curaçao Marine Park, 2003. Photo: M. Vermeij.

Figure 15. "Banded cave shrimp" (spec. indet.) 20-m inside a marine cave at Punt Canon, Curaçao Marine Park, at the interphase between volcanic (upper) and coralline rock (lower). Photo: M. Vermeij.

4.4.9 Reef sinkholes

Sinkholes are a feature often associated with calcareous reef areas. Sinkholes generally originate during periods of emersion of calcareous rock. Through dissolution of calcium carbonate, cavern systems are created at former ground water levels of the caverns. In areas where such caverns collapse a sink hole may be formed. Today, sinkholes can be seen in terrace landscapes both on land and in the sea of Curaçao and Bonaire. The best known former sinkhole that has been developed as an important dive attraction is the sinkhole just outside Lac Bay Bonaire. It is known as "white hole" and is especially attractive to divers and snorkelers as a place with large schools of tarpon and as a place where Green Turtles aggregate to sleep at night (A. Debrot, pers. obs.). Sinkholes may connect marine and terrestrial groundwater and play an active role in the hydrology of bays in areas with calcareous rock formations. This is also the case in Lac where these so-called "wowo di awa" may pump fresh or brackish groundwater out into the bay. One sinkhole in Lac is known as Boca Djukfis, referring to the large grouper that formally could be found there.

4.4.10 Reef boulders

All along the coasts of Curaçao and Bonaire the diver and snorkeler can expect to encounter reef boulders. These are typically large chunks of coast that have eroded due to intertidal "notch formation (Focke 1978b) and subsequently broken off and come to rest at levels varying between a few to hundreds of meters of water. Such boulders often provide fish and lobsters with hiding places, thus contributing to reef biomass and diversity.

4.4.11 Reef sands

Healthy coral reefs normally have many species of bioeroders that chip away at the reef structure producing white coral sand. Bak et al. (1984) calculate a production of 3.3 kg m^2yr^{-1}. Aside from corals there are also many smaller reef organisms like coralline and calcifying algae, foraminifera and molluscs that contribute to coral sand and sediment formation. There are many invertebrate species that seek shelter in sandy areas. As a consequence, sandy areas are also important feeding areas for many reef fish that may have specialized mouthparts (e.g. Gerridae) or even barbels (goatfishes) with which to exploit this reef scape feature. Other fish species, such as garden eels, neon gobies and tile fish will build their burrows in such areas (Fig. 16). Sandy reef habitat is especially important for many burrowing molluscs, including many of the endemic molluscs of our islands (Coomans 1988). It is where lizardfish, Flying Gurnards (*Dactylopterus volitans*) and sting rays are most common.

Figure 16. The Rozy Razorfish, *Xyrichtys martinicensis*, one of many reef fish species that prefer to shelter in sand. Photo: D. Warren.

4.4.12 Spur and groove reef formation

A classical reef structure along sloping reef floors is the so-called spur and groove formation. This may be more or less pronounced according to the local extent of reef development. According to Duyl (1985) this classical reef feature is much more common on the reefs of Bonaire than on Curaçao, suggesting a longer period of undisturbed development for the reefs of Bonaire. One area with a pronounced spur and groove reef structure is Boca Bartol on Bonaire (Duyl 1985). The "spur" is due to conditions favouring coral growth whereas the "groove" forms as a channel funnelling sand away from the reef. Due to constant sand movement and sand "showers", coral growth in the groove is inhibited thus reinforcing the contrast between the spur and the groove.

4.4.13 Seamount reefs

Seamount reefs are reefs that have formed on submerged islands. These are found on both Curaçao and Bonaire and contribute to reef-scape diversity. They are often major points of aggregation for large fish species. They may also play a role as a location for spawning aggregations of certain reef fish species. On Curaçao, the best-known seamount is found off *Punt Halve Dag* at Cas Abao. This lies outside the Curaçao Marine Park. In Bonaire, several seamount reefs are known to lie relatively close to shore, both on the lee side and on the windward side of the island. These sites lie outside the Bonaire National Marine Park and are particularly visited by fishermen targeting deep-water snappers.

4.4.14 Promontories

Promontories are areas of the coast that project seaward from more sheltered areas. These are typically areas with either extensive shallows or steep slopes. As they project seawards they act as funnels for longshore currents and will often display strong and variable currents and heightened wave intensity (Duyl 1985). Because of these features, promontories are of value to spawning fish that want to protect their offspring by getting them away from the reef predators as quickly as possible. Promontories, just like seamounts are an important habitat feature for spawning fish aggregations. Fishermen will use these to fish for semi-pelagic species either by drifting or on anchor (e.g. flying fish and Rainbow Runner, *Elagatis bipinnulata*) (Fig. 17).

Figure 17. Pelagic migratory Rainbow Runners, Grastelchi Laman, *Elagatis bipinnata*, targeted by artisanal fisheries at promontory reefs during their seasonal migration. Photo: M. Vermeij.

4.4.15 Patch reefs

In areas with shallow sea slopes and where sediments are not too excessive, the patch reef is a typical type of classical reef structure. As the reef grows it creates hard substrate which allows more corals to settle and in turn speeds up patch reef formation. Because most reef areas of Bonaire and Curaçao are basically steep, patch reefs have typically not been an important feature of our shallow reefs. Patch reefs are found in bay habitat like Lac in Bonaire and Oostpunt in Curaçao. Today, patch reef formation is still important in deeper waters of 30 m along the north coast of Curaçao at the bottom of the reef slope and where a gently sloping sandplain begins.

4.5 A colourful and diverse fish fauna

Coral reef fishes are noted to be highly specialized in morphology, locomotion, colour, behaviour, food habits and life cycles (Smith 1978). The conditions that foster high habitat diversity are an important contributor to the observed high fish abundance and variety noted for the reefs of the marine parks of both Curaçao and Bonaire. This is because a diversity of habitats provides conditions suitable to an equally diverse variety of fish habitat-specialists. Due to the habitat diversity as ultimate driver of biological diversity, and the comparatively low fishing pressure thanks to favourable socio-economic conditions of the islands concerned the reefs possess a myriad of colourful reef fish that represent a key aesthetic aspect of these reefs. Part of this assignment was specifically to provide more in-depth detail on the aesthetic diversity of the 650 or more fish species present.

The fish communities of the marine parks of Curaçao and Bonaire have been subject to numerous studies (e.g. Bruckner & Bruckner 2003, Bruggeman 1994a, b, 1996, Rooij et al. 1995a, b, 1996; 1998, Hawkins et al. 2007, Hylkema et al. 2014, Luckhurst & Luckhurst 1977, 1978a,b, Nagelkerken & Van der Velde 2004, Nagelkerken et al. 2000, 2002, Pattengill-Semmens 2002, Pinheiro et al. 2016, Sandin et al. 2008) and are well-documented. Nagelkerken (1979) studied the biology of the Grasby (Purunchi) at oostpunt and Fuik. Leloup & van der Mark (1984) provide data on grouper densities on the reefs in the Oostpunt area while Debrot & Nagelkerken (1997) studied densities of the balloonfish. Nagelkerken (1970, 1974) provided quantitative insight into densities of fish in shallow *Acropora* and *Millepora* reefs on the reefs at the east end of Fuikbaai. Geest & Langevoort (1995) studied the rich flatfish communities of the inland bays of Curaçao, while Dorenbosch & Verberk (1999), Nagelkerken et al. (2001) and Nagelkerken et al. (2002) examined the fish communities and important nursery function of the Fuik lagoon and the lagoon of Oostpunt.

The most important conclusions from these studies is that Bonaire and Curaçao have high densities of principally small fishes in comparison to other reefs throughout the region. This is a direct effect of the relatively low fishing pressure on these reefs compared to the reefs of most other Caribbean island nations where poverty is higher. The most abundant fish groups are planktivores and herbivores (Sandin et al. 2008), whereas it is clear that the density of large reef piscivores (such as groupers and snappers) have greatly decreased in abundance as a consequence of about three decades of intensive spearfishing between 1950 and 1979 when spearfishing became illegal (Debrot & Criens 2005).

Here we provide some insight into the ecological basis for the "colourful and varied fish fauna" for which the commission requested additional information. Coral reef fishes are typically distinguished ecologically in terms of food habits based on which trophic guild they belong to. This is strongly influenced by overall shape, means of propulsion and the architecture of the mouthparts which may serve to detect, seize, grasp or hold prey and also to crush or grind various food items (Westneat and Alfaro 2005, Fishelson & Delarea 2014). For instance, mojarras have protractible mouthparts to suck small invertebrates with out of sandy habitat, goatfish detect their prey using barbles, while butterflyfish have pointed beaks with which they can pluck food out of crevices (Fig. 18).

Figure 18. The Banded Butterflyfish (*Cheatodon striatus*) specializes in small invertebrates and even eats individual coral polyps. Photo: M. Vermeij.

Studies by Sandin et al. (2008) show that the mid-depth (20 m) fringing reefs of Bonaire and Curaçao, are healthier than reefs on most other Caribbean islands, and supporting relatively high fish biomass and high coral cover. They further found that approximately one half of the fish biomass is composed of planktivorous species. This underlines the importance of the influx of food to the reef food web thanks to ocean currents that pass the islands. Other feeding guilds represented include roving herbivores, territorial herbivores, mobile invertebrate feeders, sessile invertebrate feeders, piscivores, carnivores, and omnivores (Ferreira et al. 2004). In addition, the reef is regularly visited by many species of pelagic fishes that live around or migrate past the island reefs.

Colour plays an important role in intraspecific communication in fishes. Hence, fish will display different colour patterns to communicate their intentions (for instance reproduction) to others. Other fish will use colour as camouflage to either escape detection by predators or for their own ambush style of hunting (Fig. 19). Others will use colour to mimic their prey. An example of this is the Trumpet Fish (*Aulostomus maculatus*) which colours the top of its head yellow (Fig. 20) when preying on yellow juvenile Bluehead Wrasse (*Thalassoma bifaciatum*) but blue when hunting Blue Chromis (*Chromis cyanea*).

Figure 19 Groupers are typical ambush predators; the Grasby, *Epinephelus cruentatus*. Photo: S. Lima.

Figure 20. A master in disguise: A Trumpet Fish (*Aulostomus maculatus*) carrying its "juvenile Bluehead Wrasse" hunting coloration. Photo: S. Lima.

The most highly specialized form of feeding is displayed when two or more different species join forces for mutual benefit. For instance, juvenile Ocean Surgeonfish (*Acanthurus bahianus*) will school together with parrotfish to benefit from schooling while avoiding agonistic interactions with members of its own species (Debrot & Myrberg 1988), while Bar Jacks (*Caranx ruber*) will join larger benthic species (like Southern Stingray (*Dasyatis americana*) to form hunting pairs (Fig. 21). One of the most beautiful examples of feeding symbiosis is displayed at so-called cleaner stations where juveniles of several fish and crustacean species will feed on skin parasites of larger fish species (Fig. 22).

Figure 21. Bar Jack (*Caranx ruber*) paired up with an American Stingray (*Dasyatis americana*) during hunting. Photo: M. Vermeij.

Figure 22. A "cleaning station". Juvenile Spanish Hogfish (*Bodianus rufus*) cleaning Creole Wrasse (*Clepticus parrae*). Photo: M. Vermeij.

4.6 Frequent sightings of globally endangered marine megafauna (sea turtles, Red Listed marine fish and Caribbean flamingos)

4.6.1 Sea turtles

In the last decades the legal and actual protection of sea turtles has dramatically improved in both Bonaire and Curaçao. As a consequence, the sighting frequency for sea turtles, has improved so much that it is difficult to conduct a dive on these islands without seeing a sea turtle (Debrot et al. 2005). Sea turtle sighting can reliably be offered as an ecotouristic product to visitors in both the BNMP and the CMP, whereas this was impossible three decades ago (Sybesma 1992). There are five sea turtles that occur in the nomination properties (Table 8). The most common ones, and at the same time those that can be reliably encountered in different areas of the nomination properties are the Green Turtle and the Hawksbill. The former is most common in seagrass areas where it feeds on seagrass and seaweed, whereas the latter is most common on the reef where it forages on sponges.

With exception of Panama, the beaches of Klein Bonaire display the highest density of nesting Hawksbill and Loggerhead Turtles in the southern Caribbean (Becking et al. 2016). The nomination properties are rapidly increasing in importance as a foraging area for these species (Debrot et al. 2005; Bjorndal et al. 2017). The area of Lac appears to be one of the best foraging habitats in the region for the Green Turtle where the highest turtle density of the whole Caribbean is found (Bjorndal et al. 2017).

On Bonaire, the STCB (Sea Turtle Conservation Bonaire) has been monitoring nesting for the last 20 years. The most important nesting beach is that of Klein Bonaire where annually between 30 and 50 Hawksbill nests are laid and between 10 and 20 Loggerhead nests (STCB, 2014, 2015). In addition, about 20 (principally Hawksbill) nests are laid annually on the main island of Bonaire. Whereas regionally both species are rapidly declining in abundance, in Bonaire there are small but significant increases in nesting numbers over the last 20 years and large increases in the numbers of foraging turtles (STCB 2014, 2015).

Table 8. Marine Turtles found in Bonaire and Curaçao.

Name				IUCN category	SPAW Annex	CMS Annex	CITES Appendix	IAC
Scientific	Common	Local	Dutch					
Caretta caretta	Loggerhead	Kawama	Onechte Karetschildpad	LC	II	I, II	I	Y
Chelonia mydas	Green Turtle	Turtuga blanku	Groene zeeschildpad	EN	II	I,II	I	Y
Dermochelys coriacea	Leatherback	Drikil	Lederschildpad	VU	II	I,II	I	Y
Eretmochelys imbricata	Hawksbill	Karet	Karetschildpad	CE	II	I,II	I	Y
Lepidochelys olivacea	Olive Ridley	Turtuga bastardo	Warana	VU	II	I, II	I	Y

The best-known former marine sinkhole that has been developed as an important dive attraction is the sinkhole just outside Lac Bay Bonaire. It is known as the "white hole" amongst divers and is especially attractive for large schools of 100 or more Tarpon and as a place where more than 30 green sea turtles aggregate to sleep at night (M. Nava & S. Engel, pers. comm.).

Curaçaoan sea turtles (mainly Green and Hawksbill turtles, though 5 species occur around the island) nest foremost on Klein Curaçao. Since 2014, sea turtle nesting activities are monitored continuously for Curaçao and Klein Curaçao. Annually, around 200 nesting activities (mostly Green

Turtles) are recorded for both islands of which 95% take place on Klein Curaçao indicating the importance of this island as a breeding area for endangered sea turtle species. On 22 March 2017 The Council of Ministers decided to nominate the island of Klein Curaçao a Ramsar site, because the island is the most important Green Turtle nesting area.

4.6.2 Threatened IUCN Red List fish species that frequent the nomination

Several large IUCN threatened and vulnerable reef-associated fish species are found on the reefs and reef-related habitats of the nomination properties (Table 9). Tarpon are common and easy-to-spot species of sandy reef and lagoonal habitats both in the BNMP and the CMP. Large schools of Tarpon exceeding 100 fish of 1-1.5 m at a time hang out in "tarpon alley" and in "white hole" at Lac Bay, Bonaire, for instance where they form a dependable and impressive attraction for divers. Bonefish (*Albula vulpes*, Near Threatened) are common in sandy habitats of Lac Bay where they typically can be detected as they form muddy waters ("muds") in the otherwise clear lagoonal waters while feeding on the bottom. Rainbow Parrotfish are particularly abundant in their nursery areas in Lac Bay (Hylkema et al. 2014) where large individuals are easy to spot from the fisherman's pier at any time of the day (A. Debrot, pers. observ.).

Seahorses are found in shallow waters throughout the island and typically stay in the same area for long periods which makes it very easy for divers to alert each other as to where they can see the species. Among the spectacular endangered rays, the most common one to see on the reefs while diving is the Spotted Eagle Ray, *Aetobates narinari* (NT) but also the Endangered Giant Manta, *Manta birostris* (Fig. 23).

Table 9. Threatened IUCN Red List fish species that frequent BCM.

Name				IUCN category
Wetenschappelijk	Engels	Lokaal	Nederlands	
Balistis capriscus	Grey Triggerfish	Pishiporko fluitdo	Grijze trekkervis	VU
Balistes vetula	Queen Triggerfish	Pishiporko rabi gai	Koningin trekkervis	VU
Megalops atlanticus	Tarpon	Sabalo	Tarpoen	VU
Lachnolaimus maximus	Hogfish	Hokvis	Zwijsvis	VU
Lutjanus analis	Mutton Snapper	Kapitan	Schaapssnapper	VU
Lutjanus cyanopterus	Cubera Snapper	Caranja		VU
Scarus guacamaia	Rainbow Parrotfish	Gutu Kedebe	Regenboog Papegaaivis	VU
Epinephelus itajara	Goliath Grouper	Djukvis	Reuzenzeebaars	CR
Epinephilus stiatus	Nassau Grouper	Jakupeper	Nassaubaars	EN
Mycteroperca intersitialis	Yellow-mouth Grouper	Djampou	Geelbekbaars	VU
Hippocampus erectus	Lined Seahorse		Zeepaardje	VU
Manta birostris	Giant Manta	Chuchu	Reuzen Manta	VU
Rhyncodon typus	Whale shark	Tintorero	Walvishaai	EN

Figure 23. Giant Manta, *Manta birostris*, on the reefs of the CMP component of the proposed nomination (photo: Mark Vermeij).

The Giant Manta ray occur more sporadically. Whale sharks also visit the islands regularly (Debrot et al. 2013) and provide a spectacular experience. Due to the variety of rare endangered marine fauna that frequent the reefs of the nomination property and the steady and dependable presence of a number of these, divers are almost guaranteed of seeing spectacular fauna. As a consequence, these nomination properties are consistently ranked as being among the top dive destinations of the Caribbean (Table 10). Bonaire has received world's #1 ranking by the diving public as a shore dive destination for 23 years. Shore diving is actually pretty unique to these islands due to the fact that the reef typically starts at the shore. In most dive destinations and marine parks the reefs are largely accessible offshore by boat. Another key factor is the excellent visibility as judged by the diving public. In Curaçao, several dive locations of the CMP rank among the best dive spots of the island. The big problem here is that most of the CMP is not accessible from land due to ownership issues. Because most of the dive sites of the CMP are only accessible by boat, their ranking by the diving public is a poor indicator of how good they really are.

Table 10. International recreational diver ranking of Bonaire and Curaçao dive destinations. Also local ranking of Curaçao dive sites. Where the rank relates to a dive site or the Curaçao Marine Park (CMP) and not to the whole island of Curaçao, this is indicated.

Year	Source	Category	underwater visibility	Bonaire rank	Curacao rank
2004	Rodale’s Scuba Diving Magazir	worlds best shore diving		1	-
2009	Orbitz	diving Caribb		5	8
2011	Everything Everywhere	diving Caribb			9
2012	Scuba Diving Magazine	top 100 readers choice diving		1 (Atlantic & Caribb)	
2013	book your dive	top 5 Curacao dive sites			Leyhoek (CUP)
2014	Travel.US	best Caribbean island		-	5
2016	Scuba Diving Mag.	shore diving Atlantic		1 (7 scuba awards in 2014)	2
2016	Scuba diving mag.	night dive sites world		6 (Fluorescent dive)	
2017	Frommers travel guide	snorkel Caribb		6	CUP: 4
2017	CruiseCritic	snorkel Southern Caribb		2	3
2017	Scuba diving mag.	best macro dive atlantic	visibility 50- 100ft (both Cur & Bon)	1	3
2017	Dive Magazine	best diving world		9	-
2017	Caribbean Trading	best dive Latin America & Caribb		5	10
2017	Scuba diving Magazine	top 100 readers choice awards		3 x # 1 (12 diving awards)	
2017	scuba diving resource	top dive sites Curacao	visibility 50- 100ft.		CUP & Klein Cur
2017	scuba diving smiles	top 5 dives sites Curacao			Tug boat (CUP)

4.6.3 Common flocks of flamingos

Bonaire is of global importance for water bird populations including the Caribbean Flamingo The species is found all along the northern coast of South America from north-eastern Brazil to Ecuador, the Caribbean region and Mexico. Breeding takes place in Yucatan Mexico, Cuba, Hispaniola, the southern Bahamas, Bonaire, northeast Colombia, Venezuela and the Galapagos islands. In the past, the species was almost extirpated by hunting, especially for its colourful feathers. However, since the introduction of protective measures after WWII, the species has shown strong recovery (Birdlife 2016). The recovery of this species from the brink of extinction is one of the major conservation successes.

Flamingos are fairly nomadic throughout the year, following resources that have shifting patterns (e.g. Boylan 2000, Del Hoyo et al. 1992, Espino-Barros & Baldassarre 1989a, 1989b). Although they are non-migratory birds, they can move to different patches within sites, but also between sites up to hundreds of km apart. In Bonaire, migration does not occur all at once, but in successive waves (Birdlife 2008).

Typical habitats where flamingos are found includes saline lagoons, muddy flats, and shallow lakes, which can be coastal or inland. Flamingos move around during the year, as they adapt to shifting food availability and available breeding sites (Baldassarre & Arengo 2000, Del Hoyo et al. 1992, Elphick et al. 2001, Sprunt 1975). The Caribbean Flamingo is listed on various international conservation lists (Birdlife 2008) which states that the Caribbean flamingo is not severely threatened but that care is needed in international perspective. Wells & Debrot (2008) stated that over the last 10 years the numbers of flamingos have fluctuated between c. 1,500 and 7,000 breeding individuals (though most normally averaging c. 5,000). The breeding colony of Bonaire has long been the most important and best protected breeding colonies in the southern Caribbean (Voous 1983). To this day it remains a stable factor in a region characterised by socio-economic uncertainties, variable breeding success and questionable management.

Due to the large numbers of flamingos in Bonaire, and the use of the BNMP areas of Lac Bay and Klein Bonaire for feeding and the coastal zone for movement between feeding areas, it is a bird that cannot be missed when visiting the BNMP. Though numbers are lower in the areas adjacent to the CMP, the species is always to be seen flying along the CMP if sought for (A. Debrot, pers. comm.).

4.6.4 “Lighthouse” of Catatumbo

After sunset one can witness a unique atmospheric phenomenon from within all areas of the CMP. At the horizon in southwesterly direction towards the marine lake of Maracaibo in Venezuela there is a small area of intense lightning, known as Relámpago del Catatumbo (Tarazona et al. 2006), where lightning storms occur 160 nights a year, and which may last practically all night. Lightning strikes occur as frequently as 280 times per hour. This phenomenon can be seen for up to 250 miles away and has been used by Caribbean seafarers for centuries for navigation in the southern Caribbean along the continental coasts of Venezuela and Colombia. According to local lore this lightning gave an early warning to the city of Maracaibo in 1595 when Sir Francis Drake’s tried to capture Maracaibo by night. His ships were illuminated by the lightning and the attack was successfully withstood. This phenomenon is world renown and is listed in the Guinness Book of World Records for the most lightning activity in the world. The exact cause of this phenomenon remains unknown, but is probable due to a combination of unique topography and atmospheric circulation (IFLScience[2]).

4.7 Conclusions

The clear nutrient-poor Caribbean Current waters flowing unobstructed over the geologically rich and bathymetrically steep oceanic reefs to create exceptional scenic vistas with large and colourful aggregations of fish as they gather around the steep walls and mountainous coral formations as well as under reef ledges caused by various sea level changes in the geological past. Under the surface, encounters with any number of endangered or redlisted species of fishes, rays and/or turtles can hardly be avoided, while above water, flocks of flamingos shear over the wave tops as terns and Frigate Birds scan the horizon from high overhead for signs of baitfish. For the seasoned diver, drift dives on the reefs of the wave-exposed east coast are sure to yield sightings of Caribbean Reef Sharks or Blacktip Reef Sharks or Spotted Eagle Ray. Thanks to environmental stability and exceptional habitat diversity these islands are recognized as part of the Caribbean marine biodiversity hotspot. They boast about the best-developed reefs in the Caribbean, and the highest documented endemicity in numerous taxa, including marine molluscs and algae. Due to the high aesthetic quality of the marine life and seascapes in the nomination properties concerned, Bonaire and Curaçao are consistently scored among the top Caribbean dive destinations in the recreational dive literature.

5 Criteria (viii) – Geological and geomorphic processes

To demonstrate the Outstanding Universal Value according to World Heritage natural criteria (viii), the Operational Guidelines for the Implementation of the World Heritage Convention UNESCO require the nominated properties "to be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features" (UNESCO 2017).

Beek et al. (2014a), presented and discussed some of the aesthetic values and ecological/biological processes for which BNMP showed outstanding universal values. During the course of our study we believe to have found evidence suggesting that:

a) the nomination may also represent an outstanding and unique testimony to the tectonic history of the formation of the Caribbean Sea and its reef ecosystems. The tectonic history of Bonaire and Curaçao has imparted special geographic conditions that have lasting favorable consequences for reef development and a lasting special role for the two components of the proposed nomination with respect to biodiversity in the Caribbean and tropical western Atlantic; and

b) evidence of historical and significant on-going geomorphological processes in the form of sedimentation and calcification associated reef-forming communities including those based on the largely overlooked reefs based on coralline algae and vermetid gastropods (as opposed to corals; see section 6.8).

In this chapter our focus is to principally highlight item (a) and also briefly discuss the active processes of habitat transformation by which inland seawater bays are converted by natural processes into land-locked saline bays. We also point out the presence of numerous examples of all intermediate phases of this process.

While several geomorphological features such as marine terraces, beaches, caves, salt flats, hypersaline lakes and open seawater bays are cursorily discussed throughout this report, no thorough geological description or assessment is provided. Also, principal active geomorphological processes such as erosion, bioeriosion, deposition, bioconstruction and bio-accretion are presented discussed from the geological point of view. Consequently, and as pointed out elsewhere, a full evaluation for criteria (viii) will remain wanting until further work is done.

5.1 Statement of values

- Rich lithology due to complex geological history
- Rich marine habitat and landscape diversity as a consequence of diverse lithology and complex geological history
- Active processes of habitat transformation of inland seawater bays to land-locked saline bays and presence of numerous examples of all intermdiate phases of this process.
- Long-lasting geographic protection against hurricane damage due to geographic position (as a result of geological history)
- Long-lasting geographic protection against stressful continental influences
- Long-lasting geographic protection against coral bleaching thanks to wind-driven upwelling

- Long-lasting geographic importance for regional maintenance of biodiversity due to the oceanographic circumstances.

5.2 Justification

The movement of the tectonic plates which led to the creation of the Caribbean Sea through the closing of the Panama isthmus, resulted not only in the creation of the Caribbean islands, and leeward islands ridge in particular, but also in the pattern of currents through this semi-enclosed sea. The ensuing circulation patterns are of key importance for the dispersal of biodiversity throughout te region and also for the climate effects felt through the Gulf Stream and its impact on North Atlantic and Western European climate and weather. Bonaire and Curaçao serve as major scientific geological markers attesting that attest to geological history and climate phenomena that have wide reaching effects beyond the Caribbean Sea and its islands (e.g Martis et al. 2002).

5.3 Geological and geographic history: root causes for lasting favourable geographic conditions for reef development

Summary

Curaçao and Bonaire have a long geological history beginning in the Pacific Ocean during the Cretaceous and are much older than most of the other leeward Antilles which are of later volcanic origin. The geological and plate tectonic history of the islands of Bonaire and Curaçao, has led to a high diversity of magmatic igneous, marine sedimentary and accretionary reef rock formations in these islands which help underpin the diversity of nearshore reef-associated habitats able to support the rich and unique biodiversity present in this combined Bonaire and Curaçao nomination property. Thanks to their exceptional geographic and geologic history, they have consequently always played a key role in studies of the development of the tectonic history of the region (Wright and Wyld 2011). Their geographic position off the northeast coast of south America has remained unchanged since the upper Miocene (7-9 Ma) (Itturalde-Vinent 2006). This placed these islands in a strategic upstream location with respect to current flows within the Caribbean and allowed them to play an exceptional role for dispersal of marine life throughout the region, long before the isthmus of Panama fully closed during the Pliocene-Holocene epochs (3.7-0 Ma) (Iturralde-Vinent 2006). This is for instance in contrast to the Sea Flower WH site of the Colombian San Andres archipelago that appears to sit at the center of an isolated gyre of the western section of the Caribbean Sea (Prada Triana & Taylor 2011). Recent research has shown that even today fish larvae from these islands disperse as far as the Gulf Stream (Baldwin et al. 2014). In addition, thanks to their location relatively close to the South American mainland, hurricanes tend to be diverted away and thus creating even better conditions which have allowed a long and productive history of reef development. Simultaneously, their separation from the mainland provides protection from continental stress factors of freshwater and sediment loads that limit reef development on the continental shores of Venezuela (Weil 2003). Finally, their location close to the main upwelling zone of the Caribbean also provides protection from sea-surface warming and the deleterious effects of coral bleaching. Heron et al. (2017) indicate that during the past 3 years, seventy-two percent of World Heritage reef properties have experienced severe and/or repeated heat stress. They further predict that twice-per-decade severe bleaching will be apparent at 25 of the 29 World Heritage reefs (86%) by 2040, as driven by projected climate change. As regional upwelling has been implicated as a likely cause for reduced bleaching stress in the southern Caribbean (Eakin et al. 2010), the reefs in this region may also make a lasting contribution to the wider regional role of the southern Caribbean reefs as a storehouse of coral reef biodiversity.

Introduction

The Caribbean Sea originates from the Jurassic breakup of Pangea when North America, South America and Africa started separating (Pindell and Kennan 2001). The proto-Caribbean Sea thus served as an ecological corridor between the western Tethys and the eastern Pacific since the Early Jurassic and also played important roles in ocean circulation and exchange of terrestrial biota between the various continents. Since about the Jurassic–Cretaceous transition, volcanic islands, shallow banks, and ridges have been always present in the paleogeographic scenario of the region. However, according to Iturralde-Vinent and MacPhee (1999) these lands were generally ephemeral. Only after the Middle Eocene (~40 Ma) have permanent lands been available within the Caribbean geographic setting (Iturralde-Vinent 2006) allowing for the development of the present-day terrestrial biota of the Caribbean Islands (Iturralde-Vinent 2006).

Plate tectonics

The leeward Dutch Caribbean islands have played a pivotal role in models for the tectonic evolution of the Caribbean Plate because they contain both on land exposures of CCOP rocks and Cretaceous magmatic arc assemblages (Beets et al., 1984, White et al., 1999, Kerr et al., 2003, Thompson et al., 2004). Seminal studies on the crustal magmatic rocks of these islands are by Beets 1972 (Curaçao), Beets et al. 1984, 1996 (Aruba) and Klaver, 1976, Beets et al., 1977, 1984, Thompson et al., 2004 (Bonaire), while de Buisonje (1974), Bandoian & Murray (1974) and Fouke et al. (1996) discuss the calcareous rocks of these islands.

It is generally accepted that the Caribbean Large Igneous Province (CLIP), which presently underlies the Caribbean, originated in the Pacific, according to Bosschman et al. (2014) some 2-3 thousand km east of the Galapagos hotspot. While formerly, the crust of the Leeward Antilles ridge on which Bonaire and Curaçao are situated, were thought to represent the western segment of the Cretaceous–early Cenozoic Great Arc of the Caribbean, which obliquely collided, with the continental margin of northern South America in early Cenozoic time (Hypolite & Mann 2009), most recent insights suggest that there actually were three distinct arcs, today represented by the Greater Antilles, the Aves Ridge, and the ECLA arc (Fig. 24), (Wright & Wyld 2011, Bacon et al. 2015).

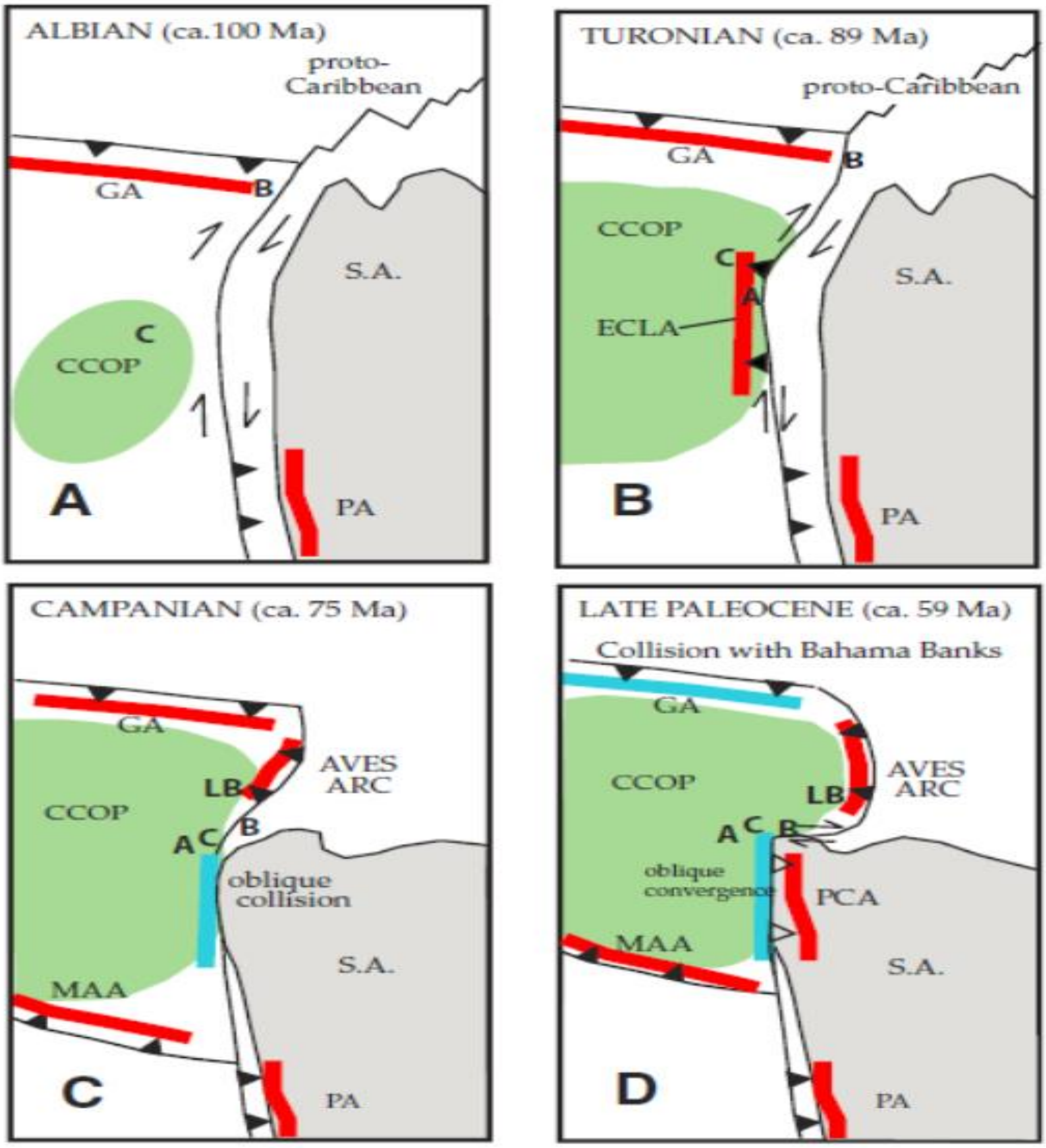

Figure 24. Geodynamic model for the Cretaceous to Palaeocene plate tectonic evolution of northern South America and the southern Caribbean in four time sketches. Source: Wrigth and Wyld 2011. Sequential time sketches show development and positioning of Curaçao, Aruba and Bonaire. Abbreviations: CCOP—Caribbean-Colombian Oceanic Plateau; ECLA—ECLA arc; GA— Greater Antilles arc; LB—La Blanquilla; MAA—Middle American arc, Panama, and Costa Rica; PA—Peruvian arc; PCA—postcollisional arc; S.A.—South America; STEP—STEP. Colours: Red = active arc; blue = collided arc.

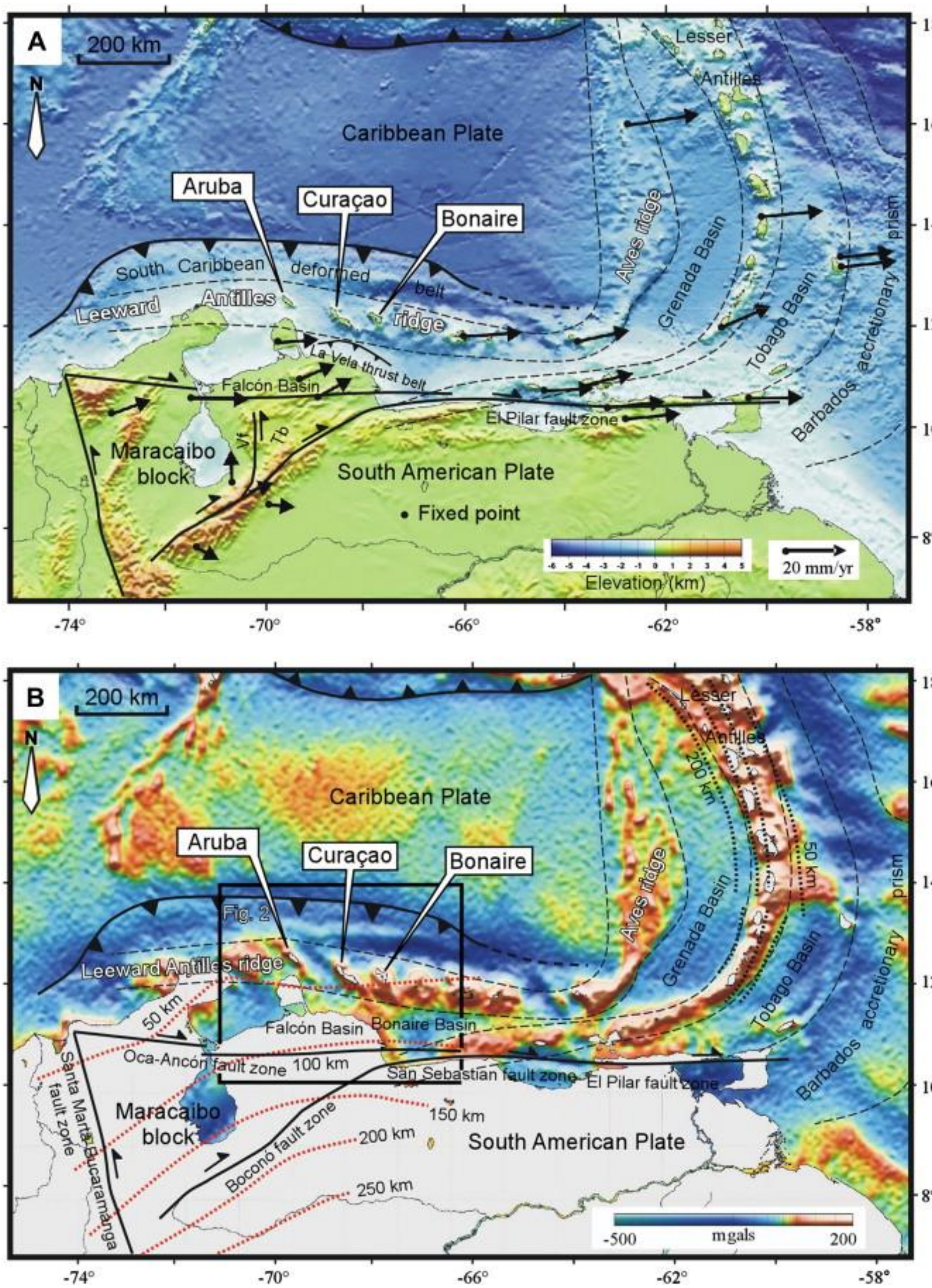

Figure 25. A) Topographic bathymetry of the southeastern Caribbean showing subduction zone north of the Leeward Antilles ridge and rates of eastwards movement of the Leewards Antilles ridge islands; B) free-air gravity maps for islands currently experiencing slow (0.05 mm/yr) rates of tectonic uplift (Herweijer & Focke 1978). From: Hippolyte & Mann 2011.

Rich lithology

Most of the Greater Antilles contain magmatic-arc rocks of Early Cretaceous through Eocene age (Pindell et al. 2005). The Lesser Antilles, Aves Ridge, and Grenada Basin represent an arc/remnant arc/back arc basin triad formed during the Late Palaeocene–Eocene arc rifting and back arc basin formation (Bouysse 1988). The Lesser Antilles contain the modern arc produced by subduction of Atlantic Ocean floor beneath the eastern Caribbean (Fig. 25). In contrast, the rocks of the Dutch Caribbean islands show evidence of being emerged since the Late Cretaceous Wright & Wyld (2011). Cretaceous ammonite molluscs dating from the Turonian age (89-94 Ma) have been documented for Aruba (MacDonald 1968) while ammonites dating from the Albian age (100-113 Ma) have been documented for Curaçao (Wiedman 1978) and Bonaire (Wright & Wyld 2011).

While there are similarities, there are also major differences in geology between Curaçao and Bonaire. Curaçao essentially has one type of Cretaceous bedrock but Bonaire composed of two different stratigraphic units. The north-western part of the island is of Early to Late Cretaceous epiclastic/hemipelagic strata, the southwestern part of the island is principally volcanoclastic (Wright & Wyld 2011).

"The geology of Bonaire is complex, with the core of the island consisting of strongly folded and faulted rocks of volcanic origin, silica rich sediments and turbidites (debris deposited from an underwater landslide) formed during the Cretaceous era some 120 million years before present (Beets 1972a, Beets 1972b)). Overlying this are later fossil reef and reef-generated calcareous (calcium rich) deposits. " (BNMP Management Plan, De Meyer & McRae 2006).

Bandoian & Murray (1974) distinguish seven well-developed terraces present at heights of between 5 and 90 m above sea level (asl) on Bonaire. These represent two episodes of terrace formation. The highest terraces of 70 and 90 m were formed in the oldest period. This was followed by a period of lower sea level during which erosion occurred and after which sea level rose again, leading to newer marine deposits onto the old. Later, relative sea level receded again, leading to eolianite (windblown, dune) deposits at levels of 50 m and higher. Continued regression of sea level then led to at least four terrace deposits between 50 and 10 m heights asl. Finally, the 5m terrace was formed once sea levels returned to current levels after a major regression of sea level to 60 m below sea level (bsl) due to glaciation. During that period several submarine terraces were also deposited. The latter are discussed by Focke (1978a). Schellman et al. (2014) have re-examined the dating of various interglacial limestone terraces. They conclude that more studies are needed on sea level history and uplift rates and that correlations to reef stages should not be made. Middle Terrace I could be at least as old as 400,000 y before present, BP) but could also be more than 500,000 y old.

In conclusion, the geological and plate tectonic history of the islands of Bonaire and Curaçao, has led to a high diversity of magmatic igneous, marine sedimentary and accretionary reef rock formations in these islands which help underpin the diversity of nearshore reef-associated habitats able to support the rich and unique biodiversity present in this proposed nomination.

Protection from hurricanes: Middle to upper Eocene rocks of riverine origin in the island of Bonaire contain pebble components that were tracked to Precambrian to Triassic massifs in northern Colombia and Venezuela. These detrital components confirm the previous hypothesis that Bonaire and the Leeward Antilles were attached to South American mainland (Zapata et al. 2015). So while it is clear that the islands have since changed in exact position, all three ABC-islands have nevertheless been stably situated off the north-eastern corner of the South American mainland since the upper Miocene (7-9 Ma) (Itturalde-Vinent 2006).

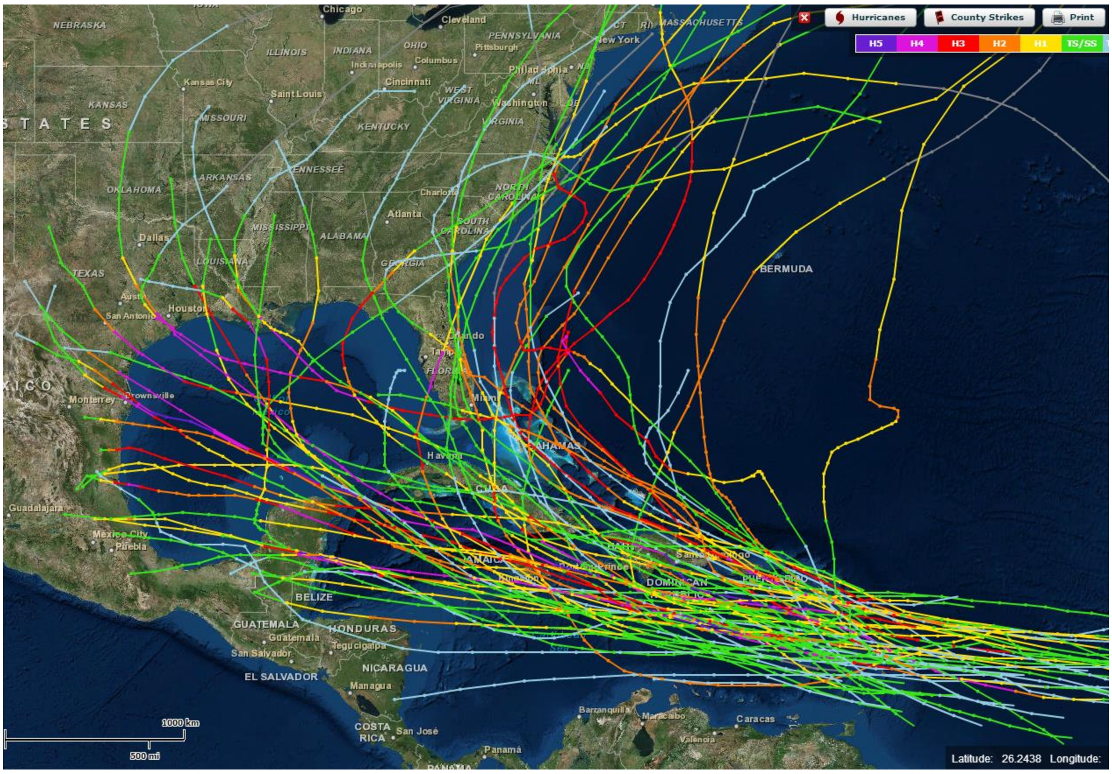

Figure 26. Historic track records of major hurricanes in the Western Atlantic Americas shows how the leeward Dutch islands lie well outside the hurricane alley. Source: NOAA, USA, 2017.

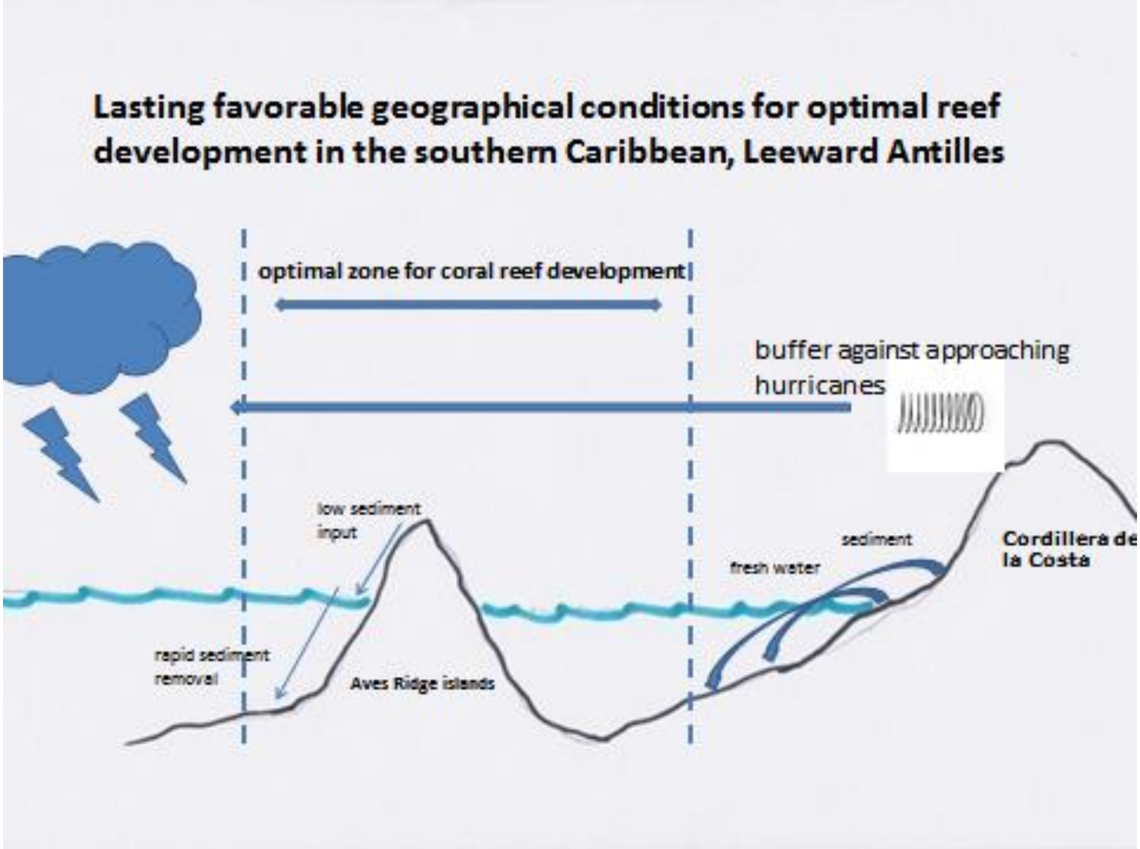

Figure 27. How geology, geography and meteorology conspire to produce optimal conditions for unstressed coral reef development that have existed since the Upper Miocene (7-9 Ma). Diagram: A. Debrot.

Hurricane paths are largely determined by upper trade wind flows, the position and strength of the Azores Highbut are further influenced by a number of factors[2]. These trade winds will generate upwelling near the coastal area of Venezuela, making the sea surface temperature in the southern Caribbean less warm. As hurricanes enter the Caribbean from the Atlantic and approachclose to the South American continent the air in the south quadrant that spirals inward towards the center of the hurricane, has to travel over mountainous terrain. The trade winds which drive them westward tend to weaken. This may particularly be the case because of the coastal mountain range of Venezuela, an off-shoot from the Andes. When the tradewinds lose force, the Coriolis effect has more influence on where a storm moves[3]. In the southern Caribbean this means a force to the north and hence away from the coast of Venezuela (Fig. 26). Hurricanes are fuelled by warm surface waters but as they approach the continent and partially move over land and its obstructions, or coller waters, they tend to lose force particularly in the southern quadrants.

In addition, as the islands in the southern Caribbean are at a greater distance from the Azores High in the northeast of the Atlantic Ocean, the system tends to propagate in a more north-westerly direction due to the Coriolis effect. On the other hand, when the Azores High is positioned in the western Atlantic Ocean, the systems will propagate in a more westerly direction, with a less intensive southern quadrant over the southern Caribbean.

Due to the geographic position of the nomination area in the southern Caribbean these factors have structurally conspired to safeguard the area from the most damaging hurricane effects throughout the ages. This in turn has contributed to conditions allowing thousands of years of low hurricane frequency (Fig. 27) and exceptional coral reef growth. For instance, Meyer et al. (2003) studied in situ preservation of reef framework rock showed that up to the late Pleistocene age (125,000 years ago) an average of 93% of corals were preserved in growth position whereas other areas of the Caribbean subject to high hurricane frequency had much lower proportions of corals in growth position. This gives proof of longstanding protection of the reefs of the southern Caribbean against hurricane damage.

Protection from continental sediments:

Reef growth is often constrained in shallow shelf areas along continents (Cortes & Risk 1985, Slaymaker et al. 2009, Fabricius 2014) and large continental islands (Cortes 2003) by the presence of rivers due to high sediment input and low salinity. The coast of Venezuela is influenced by outflow from the Amazon and the Orinoco rivers as well as other smaller rivers. Therefore, on the mainland coast of Venezuela well-developed reefs are only found in limited areas to the west (Weil 2003). The reefs of the proposed BCMP nomination area are constantly buffeted by fresh, clear, nutrient-poor oceanic water of the Caribbean Current that is characterized by a constant salinity of 35 ppt. This water flows clockwise across the Caribbean basin and is the main surface circulation in the Caribbean Sea. Average ocean surface current velocity along the Netherlands Antilles is high (70 cm/sec), which allows excellent water exchange and water quality along most reefs (Fratantoni 2001; Gyory et al. 2005; Lutz & Ginsburg 2007). These marine parks futher lie in a semi-arid climatic zone of generally low rainfall (Beers et al. 1997, Freitas et al. 2005). As a consequence, runoff is also limited due to lack of rainfall and osmotic stress to coral reefs due to freshwater input is also very low. Due to the geological history of bay formation (Boekschoten 1982) most runoff passes through mangrove and seagrass lagoons, inland bays and salinas before entering the sea. These serve as effective sediment traps, and sequester most sediment before it even gets a chance to harm the reefs. Sill reefs can be found at the entrances to inland waters. Examples of these can be seen on Bonaire at Lac Bay and at locations like Oostpunt Bay and Spanish Water Bay and Janthiel Bay in Curaçao. These reefs play a key role in the gradual transformation of inland waters to saliñas and eventually dry land as filling-up occurs over thousands of years.

In the Leeward Dutch islands, inland lagoons typically started out as inundated river valley systems after the last ice age ended about 10 thousand years ago (Boekschoten 1982). During the ages, sill reefs have grown/ still grow at the entrance of inland bays up to the point where the open sea

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[1] www.windows2universe.org/earth/Atmosphere/hurricane/movement.html

[3] www.windows2universe.org/earth/Atmosphere/hurricane/movement.html

connection of inland bays is reduced and eventually totally closed for open water movement. Consequently, sill reef development plays a key role in the transformation of mangrove-bordered inland waters into briny saliña wetlands which are so important as foraging areas for migratory shorebirds. This process that creates habitat diversity can be seen in action today.

This all means that due to their geographic position close to the south American mainland, they not only enjoy certain "buffering" from hurricanes (Fig. 27) but at the same time are located far enough off the mainland coast that their ecosystems do not suffer as badly from sediment or salinity fluctuations as is typical of shallow continental shelf (Cortez 2003, Fabricius 2014) and high "continental" island reefs elsewhere (Perry 2011).

Reef structure and seascape diversity:

The fringing coral reefs of the BCMP was formed by considerable Holocene reef accumulation (at least 16 m) (at the leeward side of Bonaire upon several pre-Holocene submarine terraces). A *Montastrea annularis* dominated reef first grew from a terrace at more than 28 m to a depth of 12 m below sea level, closely following the Holocene transgression. This was followed by an *Acropora palmata* dominated reef growing on a much shallower terrace closer to shore and near sea level (Focke 1978). Today the latter reef no longer exists and is gradually being replaced by big head coral communities (e.g. Haitsma & Debrot 2016). The *Montastrea* community is still a dominant reef type on the upper reef slope (10 m) on both islands and has been impacted much less than the shallow coral communities.

The nomination area is rich in marine benthic habitats communities and landscapes. This is due to the diverse geology and steep topography which gives a varied seascape with caverns, plateaus reef faces and promontories which all support distinct macrobenthic communities (Duyl 1985). In both reef structure and seascape diversity, there are important differences between Bonaire and Curaçao (Duyl 1985). A diverse geology and steep topography in turn have contributed to the development of the limestone terraces and other limestone features (through the processes of reef growth (calcification by corals, coralline algae. vermetid gastropos and other organisms) as mediated by various bioerosive processes over tens of thousands of years.

Protection from coral bleaching:

Surface water temperatures in the Caribbean are typically highly stratified in the upper 1200 meters; weakly stratified between 1,200 and 2,000 meters and uniform below 2000 meter. Because of the exchanges with the open Atlantic, there is little seasonal variation in surface water temperatures, ranging from 25.5ºC in the winter to 28ºC in the summer (Gyory et al. 2005, Lutz & Ginsburg 2007). Bottom temperatures are close to 4ºC and salinity is slightly less than 35 parts per thousand (ppt) [3]. Water conditions around Bonaire are stable, with mean water temperatures varying from 26.5°C in February to 28.7°C in October and a constant 34-36 ppt salinity (Bak 1977)[4]. The maximum annual tidal range is approximately 1 m, with an average range of 0.30 m during one lunar cycle (Bak 1977).

The southern Caribbean is climatologically different from the rest of the Caribbean in being an unusual arid zone (Sarmiento 1976). It also differs oceanographically as it has also always been an area of exceptional productivity due to seasonal wind-driven upwelling along the north-eastern continental coast of South America (Sturm 1991). Consequently, this area possesses the most productive fisheries of the region and is intensively visited by migrating cetaceans (Debrot et al. 1998). The proposed nomination lies close enough to the upwelling area to benefit from its productivity (i.e., influx of zoo- and phytoplankton), but far enough away to not suffer from increased nutrient availability known to promote plankton and algal growth. High marine productivity also made this area of special importance to breeding seabirds creating economically important guano deposits (Westermann 1949, Stienstra 1991) and migrating cetaceans (Debrot et al. 2011b, Prins et al. 2009).

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[4] http://www.ospo.noaa.gov/data/cb/TS_vs/vs_ts_multiyr_CuraçaoandAruba.png

Another effect of the upwelling is that the southern continental margin of the Caribbean shows lower than average annual sea surface temperatures compared to surrounding waters (Rueda-Roa & Muller-Karger 2013) providing partial protection from regional coral bleaching events. For example, high ocean temperatures in 2005 caused the most severe bleaching event in the Caribbean Basin, yet the thermal stress was lower off Venezuela, including Los Roques, Aruba, Bonaire and Curaçao (Eakin et al 2010).

So, notwithstanding some notable exceptions (e.g. Bries et al. 2004), due to their geographic position close to the South American mainland, BNMP and CMP not only enjoy protection from hurricane destruction but also lie close to a large upwelling zone that supports and protects the islands' rich biodiversity from thermal stress.

5.3.1.1 Conclusions

The leeward Caribbean islands, including the three Dutch Antilles islands of Aruba, Bonaire and Curaçao, have lain in a strategic upstream location with respect to current flows within the Caribbean and allowed them to play an exceptional role for dispersal of marine life throughout the region for the last (9-7 Ma). Due to their geographic position close to the south American mainland, they also have largely enjoyed protection from hurricanes thanks to the coastal mountains along much of the adjoining Caribbean coast of Venezuela. At the same time these oceanic islands are located far enough off the mainland coast that their ecosystems do not suffer from sediment or salinity fluctuations as is typical in continental shelf reefs. A combination of geological and meteorological features provides further structural protection from osmotic and sediment stress.

Coastal wind-driven upwelling in the southern Caribbean additionally buffers the coral reefs from thermal stress and associated bleaching episodes. Finally, generally favourable socio-economic conditions, comparatively high per capita GDP and the rule of law (even though much less than perfect) have prevented the most severe forms of environmental deterioration seen elsewhere in the region. These same conditions offer the best opportunity for these reefs to maintain a superior condition and continue to play their important role in the region well into the future.

This nomination provides an outstanding example of how geological, geomorphologic, oceanographic and meteorological features are closely entwined to ensure healthy biophysical processes that are able to support high biodiversity and endemism. There is a rich and invaluable record of the ongoing dynamic adaptation of coastal environments to global change, which continue to be of great geo-scientific interest.

"Irreplaceability" (or uniqueness or rarity) is arguably the most important concept for assessing the potential of a site to be considered of OUV (Schmitt 2011). Due to its geographic uniqueness and the ensuing long-lasting ecological significance of the area, not only far into the past but also clearly into the future, this nomination may qualify as "irreplaceable" for OUV criteria (viii). The nomination represents key stages in the formation of the Caribbean Sea and both its geologic and oceanographic development. While the Southern Caribbean Marine Ecoregion is not relevant to geological oroceanographic criteria, it can be seen that these do provide the basis for potential global significance in relation to ecological processes and biodiversity within the tropical Atlantic.

6 Criteria (ix)- Ecological and biological processes

6.1 Background

To demonstrate the Outstanding Universal Value according to World Heritage natural criteria (ix), the UNESCO Operational Guidelines for the Implementation of the World Heritage Convention require the nominated property "to be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plans and animals" (UNESCO 2017). Beek et al. (2014a) elaborated on some of the ecological and biological processes for which BNMP and CMP showed potential outstanding universal values. These attributes of criteria (ix) were: (1) high calcification; (2) high parrotfish grazing; (3) longevity of large coral colonies; (4) high percentage coral cover and low percentage algal cover; and (5) coral larval replenishment. To this all were here add strong and extensive evidence of connectivity as a sixth important process contributing to OUV under criteria (ix).

In order to invoke criteria (ix) in a site nomination, "a State Party must demonstrate that the site is an exceptional example of ecosystems or communities of OUV and their underlying processes and is large and intact enough to maintain these" (UNESCO 2017). Here we extend these values to include the CMP and document and discuss a sixth attribute: (6) extensive connectivity at seven different spatial scales varying from highly local to region-wide, and in both directions between land and sea. While OUV and integrity are distinct concepts (UNESCO 2017), integrity – particularly size and connectivity, are closely linked to OUV especially with respect to criteria (ix) for the mWH Theme (11): connectivity (Abdulla et al. 2013). A seventh attribute (7) on the role of non-coral reef building communities has been presented under criteria (viii) and may be more relevant to criteria (ix).

Criteria (ix) was used as the second criteria in the application to get Bonaire Marine Park on the World Heritage Tentative List, based on the statement that 'The excellent state of conservation of the ecosystems has major significance for the entire region'. Recent research using genetic techniques demonstrate that for many different species (e.g. sea currents transport larvae to other islands and as far as Florida, with the potential for replenishing the respective species throughout much of the Caribbean. Nevertheless, several large-scale studies of genetic structure in Caribbean reef fishes and corals demonstrate one or more genetic discontinuities within the region the most important one being that between the eastern and western Caribbean (Baums et al. 2005, Taylor & Hellberg 2006, Vollmer & Palumbi 2007, Foster et al. 2012). Plate tectonic insights show that these islands have played an important role as a strategically positioned genetic storehouse for the region since the Upper-Miocene (7-9 Ma) when the rise of Central America began divert ocean currents north to the Gulf Stream (Iturralde-Vinent 2006). In this report we contribute convincing evidence that connectivity at various spatial scales that greatly reinforces the OUV concerning criteria (ix). Hence criteria (ix) would appear to be a primary criteria for this proposed nomination.

6.2 Statement of values

The ecological and biological processes for which BNMP and Curaçao have outstanding universal values are: (1) high calcification; (2) high parrotfish grazing; (3) longevity of large coral colonies; (4) high percentage coral cover and low percentage algal cover; and (5) coral larval replenishment. (all these arguments have been presented by Beek et al. (2014a) and will not again be presented in detail here). In this report we add to those arguments convincing evidence that connectivity at various geographic scales is also an attribute that great reinforce the justification for criteria (ix) for the proposed nomination.

6.3 Justification

The proposed nomination differs from many other marine protected areas and other marine World Heritage Sites due to its relatively small size and the narrow area of coral reef between the coastal habitats and the deeper waters. The steep drop-off contributes to the high density of habitats in a small area as well as the high levels of connectivity as the basis for the range of ecological and biological processes inherent to healthy reef growth. The accessibility of the reefs further ensures that commercial, scientific and recreational use is not restricted by distance or cost of access, while also aiding protection and management.

6.4 Description: reef processes

The maintaining of healthy reefs has been challenging, but has succeeded reasonably-well in Bonaire and Curaçao. Coral reefs throughout the Caribbean have suffered the effects of human activities, including overfishing, nutrient pollution, and global climate change. Yet despite systematic deterioration of reef health, there still occurs appreciable variability of reef conditions across Caribbean sites. Various studies conclude the fact that reefs of Bonaire and Curaçao differ positively (together with Bermuda, Flower Garden Banks, Texas) in status compared to reefs elsewhere in the Caribbean region. However, while Bermuda is hardly to be considered "Caribbean" and has low diversity reefs, and the Flower Garden Banks are remote as they are far off-shore, Bonaire and Curaçao are among the few places where semi-healthy reefs are still easily accessible to the public directly from shore. Geography and geology are important root casuses for this fortuitous status. Another important cause is the fact that the islands have long experienced favourable socio-economic conditions and generally high GDPs compared to most of the Caribbean. For instance in 2013, Curaçao, along with Aruba, the Cayman Islands, St Maarten, St Martin, the Turks and Caicos Islands and the US Virgin Islands were ranked as high income islands[5]. As a consequence, the cumulative fishing pressure on the reefs and the use of destructive fishing practices, which could easily spiral out of hand under poor socio-economic conditions, has remained relatively low. Beek et al. (2014a) have discussed the documented (1) high calcification levels; (2) high parrotfish grazing; (3) high longevity of large coral colonies; (4) high percentage coral cover and low percentage algal cover; and (5) effective coral larval replenishment as these processes occur with the BNMP.

In section 6.6 we extend the similar considerations to the Curaçao Underwater Park and discuss connectivity as one critical reef process that is essential not only for resilience but also in defining the regional significance of the joint nomination properties.

6.5 Bonaire

In Bonaire, all the reefs up to 60m depth have been incorporated into BNMP and are proposed for the Bonaire component of the nomination. Beek et al. (2014a), elaborated on the ecological and biological processes for which BNMP has outstanding values. It was concluded that although the general ecological processes forming biogenic coral reef frameworks can be found anywhere in the world. However, Caribbean reefs are particular and notably different from Indo-Pacific reefs and Bonaire's coral reefs are notable within the Caribbean Sea. Bonaire has one of the healthiest coral reefs in the Caribbean in terms of coral cover, fish biomass, resilience, and long-term stability. Bonaire National Marine Park has remained relatively stable in terms of coral cover over the last three decades (Kramer 2003, Jackson et al. 2014), has at this moment the best conserved and least degraded coral reef in the entire Caribbean Sea (Jackson et al. 2014) and has a comparatively high reef resilience to extreme global heating events and hurricanes (Wilkinson & Souter 2008, IUCN 2011, Jackson et al. 2014).

In terms of resilience to climate change Bonaire's reefs are showing among the best future prospects for long-term survival within the region (Bruckner 2012; Edwards et al. 2011). Coral populations in Bonaire exhibit many features indicative of high resilience, including high coral cover, high levels of recruitment and high numbers of corals surviving and growing to larger sized coral formations (Bruckner 2012). The indicator values are summarized in Table 11.

In addition, Sandin et al. (2008) reported that the mid-depth (20 m) fringing reefs of Bonaire and Curaçao remain healthier than reefs on many other Caribbean islands, supporting relatively high fish biomass and high coral cover. They report that for the reefs of Bonaire and Curaçao, approximately half of the fish biomass is composed of planktivorous species, with the balance comprised of herbivorous and carnivorous species. Only a small fraction (<7%) of the fish biomass was composed of apex predators, predominantly due to the essential absence of large groupers and sharks from these reefs. The relatively low abundance of large groupers and sharks nevertheless do not prevent the reefs from demonstrating ecological resilience (IUCN 2011, Vermeij 2012 a,b, Haitsma & Debrot 2016, Debrot & Nagelkerken 2006).

In terms of coral cover, across these islands an average cover of 26.6% was reported. The quantification of coral cover of Sandin et al. (2008) is consistent with similar studies in the past (Bak & Nieuwland 1995, Bak et al. 2005). Although the estimates of Sandin et al. (2008) remain well below the reports of over 40% coral cover in the 10-20 m depth range at the beginning of their sampling in the early 1970s (Bak et al. 2005), coral cover of these islands appeared to have not suffered as much coral loss compared to other Caribbean reefs. Elsewhere the average coral cover is reported to be only 10% (e.g. Gardner et al. 2003, Schutte et al. 2010).

Throughout the Caribbean most formerly coral-dominated reefs are seaweed reefs, especially in specific regions such as in the eastern Caribbean and at specific locations such as in the Dominican Republic. For the reefs of Bonaire, corals still occupy a larger area than any other benthic groups, such as macro-algae (seaweed) (Figs. 28, 29, 30).

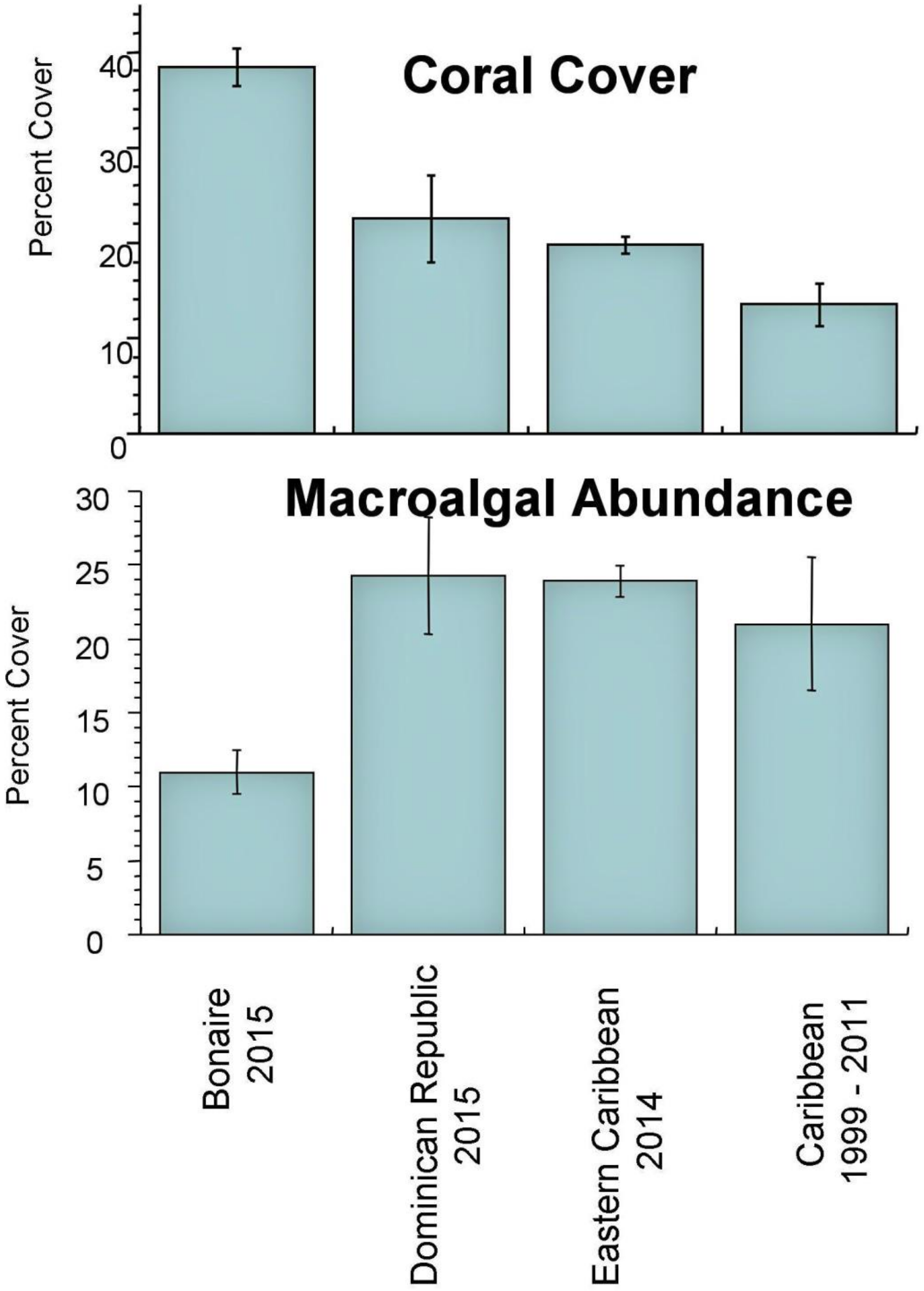


Figure 28. Comparisons of the abundance of live coral and macro algae for Bonaire, Dominican Republic, the eastern Caribbean (Steneck et al in prep) and the wider Caribbean (Jackson et al. 2014, from Steneck et al. 2015).

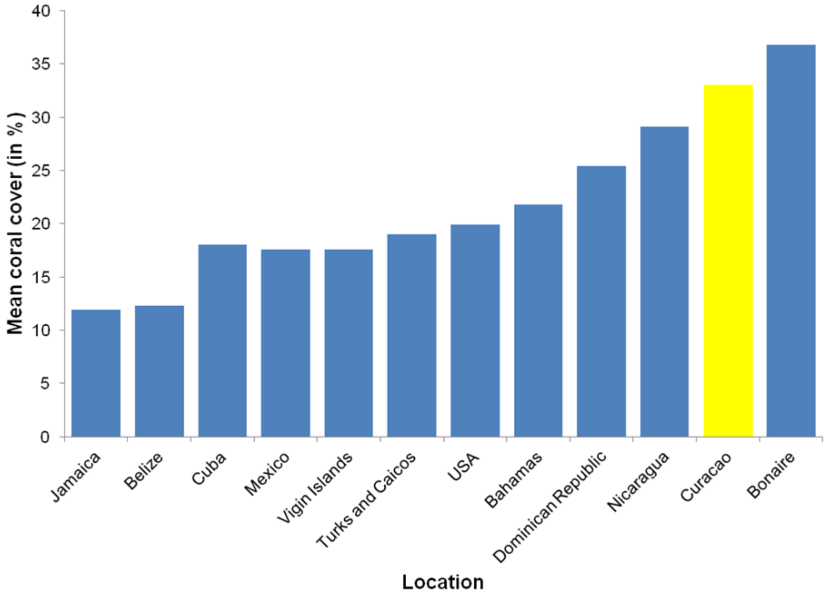


Figure 29. Based on the AGGRA dataset that was mainly collected during the 1980's, one can see that Curaçao and Bonaire has relatively "healthy" reefs compared to many other locations in the region. However, such a relative measure by no way means that reefs on the island do not degrade, but just that they likely degrade slower (Vermeij 2012).

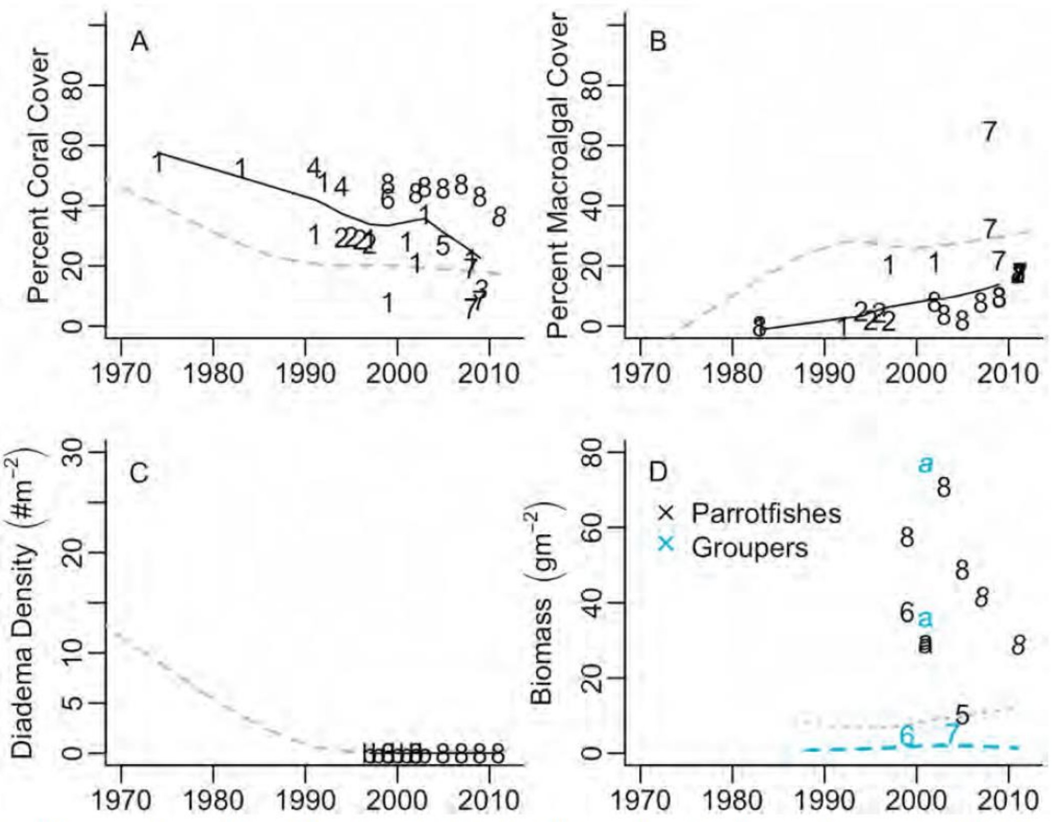


Figure 30. Figure taken from Jackson et al (2014) representing the change in primary ecologiocal indicators. Average percent cover of live corals (A) and macroalgae (B), density of Diadema antillarum (C), and biomass of groupers and parrotfishes (D) in Bonaire. Dotted line represents the average of Caribbean data collected for this report, solid lines are drawn through data presented for Leeward Bonaire; additional data from Windward Bonaire are indicated by italic text. Codes refer to individual studies which can be found in Jackson et al. (2014).

6.6 Curaçao

More than 68 species of corals are found in Curaçao's waters, and live coral cover is currently estimated to be 23.2% on average (Vermeij 2012). The most abundant live corals in Curaçao's shallow waters (< 20 m depth) were *Montastraea faveolata, M. annularis, and M. franksi*. *Montastraea* spp. are stony, reef-building species that provide the structural backbone for Curaçao's shallow, fringing reefs (Bruckner & Bruckner 2003a). Over the last three decades, coral cover, health, and species composition on Curaçao's reefs have changed significantly (Vermeij 2012). Overall, live coral cover has decreased by as much as 24%, and coral reef growth has declined (Bak et al. 2005, Vermeij, 2012). Jackson et al. (2014) report that coral cover declined by 50% but coral recruitment in identical settlement panel experiments declined by more than 80% between 1979-1981 and 1998-2004 so that the decline in recruitment cannot be attributed entirely to a simple decline in the abundance of parental colonies (Jackson et al. 2014). In addition, numbers of "juvenile" corals (< 4 cm) on the reefs at Curaçao decreased by only 55% but these small corals can be as much as 13 years old (Vermeij et al. 2011). There was also a dramatic shift in juvenile coral composition: mean density of juveniles of brooding species decreased on average by about 10 recruits/ m^2 whereas that of spawning species increased by 1-2 recruits/m^2. In many reef areas, turf algae are now the dominant benthic cover (Sandin et al. 2007, Vermeij 2012). The data from Curaçao strongly suggest that increased macro algal abundance is a major factor in the reduced recruitment of corals (Jackson et al. 2014).

In contrast to the above worrisome trends, positive signs are reported also. Increasing recruitment rates of *Diadema*, an important reef herbivore, indicate that its populations might be recovering after the massive die- off in the 1980s (Vermeij 2012). More recently, and in addition to Sandin et al. (2008), it was reported that Bonaire's and Curaçao's coral reefs still remain among the healthiest in the Caribbean (Jackson et al. 2014, Steneck et al. 2015). Although the reefs have suffered bleaching disturbances similar to the plagued reefs throughout the Caribbean, they uniquely show signs of recovery. This provides evidence of the resilience of the reefs.

Table 11 provides and overview of key ecological indicators for the components of the BCMP. The highest average fish biomass on Curaçao (159 – 219 g m^{-2}, found at sites from Klein Curaçao and including all of the proposed boundaries for the new Curacao Marine Park, is relatively high for Caribbean standards, but lower than values associated with proper ecosystem function (Waitt 2017). While a Caribbean indicator for total fish biomass of a healthy reef does not exist, relatively healthy reefs in the Pacific with intact ecosystems show total fish biomasses between 270 - 510 g m^{-2} (Sandin et al. 2008). While herbivore biomass is relatively high (58 – 89 g m^{-2}) in certain areas around Curaçao (Klein Curaçao to Willemstad, including the CMP and near Bullenbaai), herbivores in other areas on the island have decreased significantly in abundance to as low as 26 g m^{-2} (Waitt 2017). On healthy Caribbean reefs, biomass of herbivorous fish should be around 70 g m^{-2}, but preferably above 100 g m-2 (Edwards et al. 2014). Apex predators are mostly absent due to their regional sensitivity to overfishing, making up only 5.8% of total reef fish biomass (Sandin et al. 2007; Vermeij & Nijssen 2011). Moray eels (Muraenidae spp.) are the dominant predator on many reefs (Johnson 2011).

Table 11. Ecological processes in Bonaire and Curaçao and related indicators.

Proces	Bonaire	Curaçao	reference
Calcification rate Kg/m^2/y	+9.52 to +2.3 kg CaCo3 (leeward sites) +0.98 to -0.98 kg CaCo3 (windward sites)		Beek et al. 2014a
High parrotfish grazing (biomass parror fish g/m2)	32.30	Island average: 15.20 Jackson et al. 2014 (CMP: 57.9) (Klein Curaçao: 83.2)	Beek et al. 2014a, Waitt 2017
Diadema density (#/m^2)	1.5	3	Jackson et al. 2014
High percentage coral cover and low percentage algal cover	Coral about 20%	Coral (Islandwide average) 17% CMP: 29% Klein Curaçao; 24% Macro algae Island wide average: 11% CMP: 12% Klein Curaçao: 10%	Jackson et al. 2014, Waitt 2017
Abundance of juvenile corals (#/m^2)		Island wide: 5 CMP: 9 Klein Curaçao: 15	Beek et al. 2014a

6.7 Ecological connectivity at different geographic scales

Summary

In this section we describe ecological connectivity at seven different levels. These are connectivity between: a) sea and land, b) sea grass-mangrove and reef, c) shallow reef and deep reef, d) coastal and pelagic, e) epipelagic and mesopelagic, f) between one island another neighbouring island and g) between island groups and the region.

All these seven levels of connectivity are essential for proper ecological functioning of the diverse and complex coastal marine ecosystems represented. Within and between the properties as currently proposed for the expanded nomination with Curaçao we present scientific evidence of functioning connectivity for all levels of connectivity. Except for the described levels of (d) and (e) as the current nomination properties do not possess pelagic habitat. This is one reason why inclusion of the 12-mile zone for Bonaire is highly recommended and would greatly support both the global significance under criteria (ix) and integrity for all the natural criteria.

Introduction

Many complex processes occur in coastal marine ecosystems. These include biological, physical and chemical oceanographic processes that drive how ecosystems function and how animal populations adapt, make use of, survive and thrive in different areas and under different conditions in different phases of their life cycle. Hence, ecological connectivity in time and space is an essential condition for healthy ecosystem functioning (and resilience as discussed above). Processes that drive these different aspects of connectivity include sea surface and deep currents, upwelling and eddies, erosion and run-off, the passive and active movement or habitat selection of organisms and nutrient cycles. Ecological connectivity in biological populations manifests itself in different ways, for instance in terms of recruitment levels, genetic similarity, feeding behaviour, habitat selection, and migration.

At present, connectivity is an important expression of the ecological processes that occur with and add value to the proposed nomination. Therefore, the description of important linkages between habitats and the discussion of significant ecological inter-connectivity at different geographic scales is considered as an aspect of criteria (ix). Nevertheless, we choose to discuss connectivity here as related to the proposed buffer zones, or preferably an extension of the boundaries. We not only discuss the importance of inter-connectivity to be safeguarded by defining buffer zones but also give a full description of the high level of current connectivity between the components of the nomination and the habitats represented in the various proposed buffer zones.

Ecological connectivity is described to occur at seven different levels for the proposed nomination site combining Bonaire (BNMP) and Curaçao (CMP) (Fig. 31). This is connectivity between sea and land, b) sea grass-mangrove and reef, c) shallow reef and deep reef, d) coastal and pelagic, e) epipelagic and mesopelagic, f) between one island another neighbouring island and g) between island groups and the region. All these levels of connectivity are essential for proper ecological functioning and for ecological resilience to change.

Below we discuss and illustrate how connectivity manifests itself at the different levels, and highlight the current state of knowledge on how these processes take place in the context of the Bonaire and Curaçao combined nomination. Connectivity pertains to such ecological aspects as movement (seasons, migrations, diurnal, tidal etc.), life cycle (feeding, breeding, nesting, and nurseries) and nutrient flux and changing species assemblages (IUCN 2016). Discussions of connectivity therefore are most intricately linked to criteria (ix).

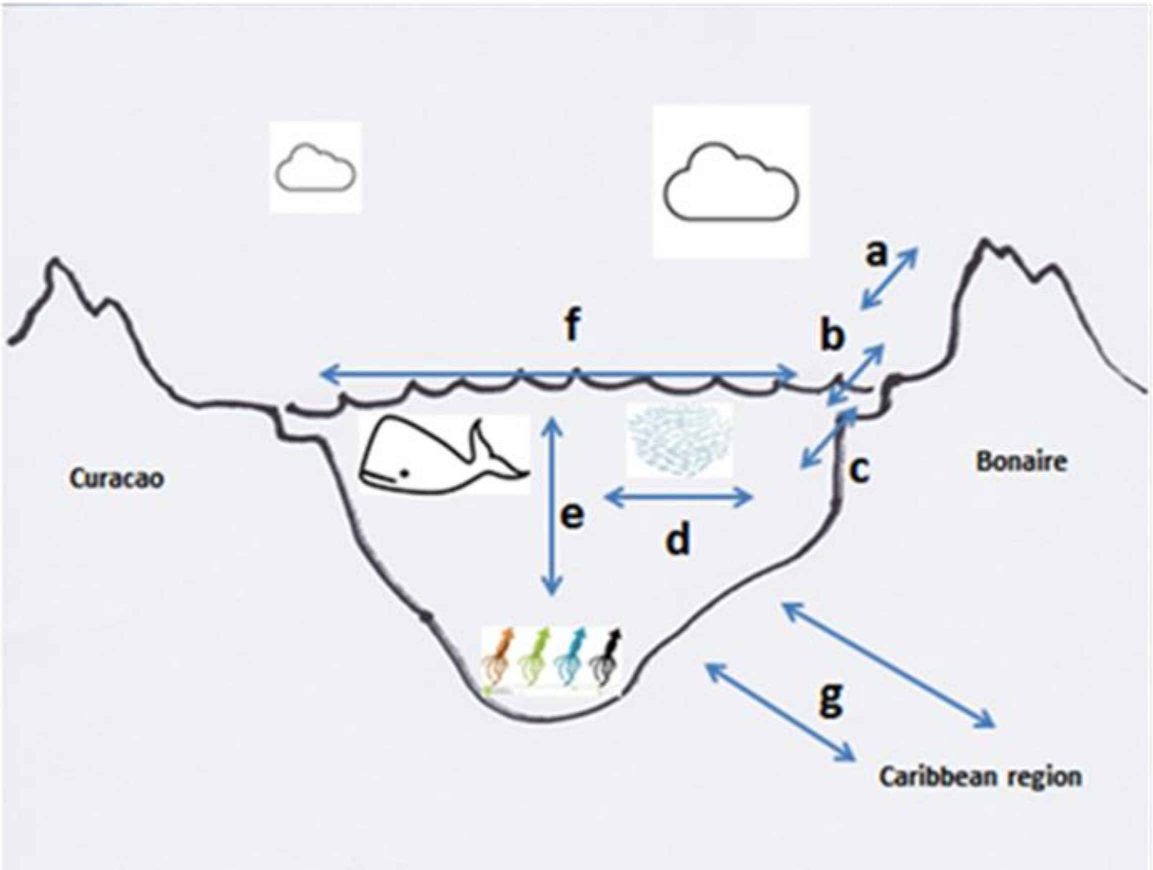


Figure 31. Bonaire-Curaçao combined Marine nomination property. Ecological connectivity at different levels in a continuum: a) sea to land, b) sea grass & mangrove to reef, c) shallow reef to deep reef, d) coastal to pelagic, e) epipelagic to mesopelagic, f) island to island and g) islands to region. Diagram: A. Debrot.

6.7.1 Sea- land connectivity

Nutrients, freshwater and sediment influx
The ecological link between sea and land is demonstrated in many different ways. Firstly, the land forms an important source of nutrient runoff to the reefs. These are an important cause for the so-called island-mass effect of nutrient enrichment around islands (Doty & Oguri 1956). In addition, there is surface runoff of sediment and freshwater as well as subterraneous runoff of freshwater. The former brings a great deal of sediment with it and forms the basis for continued mangrove expansion which in the CMP and BNMP are found in coastal lagoons that are integral parts of these marine parks and help to buffer the reefs from sediment and freshwater influx. Freshwater run-off reduces salinity of surface waters in inland water bays and lagoons which limits access by many normal reef fish species and creates conditions that allow small species to dominate and form population blooms that serve as food for the flamingo (Kristensen 1970, Kristensen & Hulscher-Emeis 1972). Freshwater run-off, both from the surface and subterranean occurs to a great extent into lagoons and creates favourable conditions for mangrove growth (Pors & Nagelkerken 1998).

Freshwater fauna
Curaçao and Bonaire have about 10 species of freshwater shrimp and 10 species of freshwater fishes that obligatorily spend part of their life history in the sea. Almost all demonstrate principally the catadromous habit whereby the juveniles spend their early life stages in the sea while the adult life stage is in seasonal streams and rivulets of the islands (Hoedeman 1958, Debrot 2003a, b, Hulsman et al. 2008). Many species are also truly amphidromous, and capable of surviving the dry season in brackish lagoon habitat (such as the karst wells of Klein Bonaire) once the seasonal rivulets dry up (e.g. hinterlands of Lac) (see, Debrot 2003a,b).

Land crabs
Land crabs, particularly, *Gercarcinus ruricola* and *G. lateralis* which may live kilometres away from the sea as adults, migrate annually to selected locations along the shore to deposit their eggs and mate before returning back inland (Fig. 32). These important herbivores depend on the land-sea connection for their survival and have disappeared in areas with excessive urbanization due to the fatal consequences of motorized traffic and other barriers to their movement. The same is true for the land hermit crab, *Coenobita clypeatus*, which is ubiquitous along undeveloped coastlines but largely absent in urbanized areas (Hazlett 1966, Wilde 1973).

Figure 32. ***Gecarcinus ruricola*****, in the coastal woodlands of Bonaire: Photo: A Debrot.**

Seabirds

The shores of these marine parks are used as nesting habitat by several species of seabirds, particularly terns in regionally significant numbers (Voous 1957, 1983, Debrot et al. 2009). These animals bring nutrients into the reef zone from food caught offshore and excreted as excrement. In bygone eons this often led to the build-up of guano deposits that have for the large part been mined during the colonial period (eg. on Klein Curaçao and in cave deposits of Oostpunt, Curaçao) and up into the mid-20th century (Westermann 1949). Nevertheless, the same process, connecting sea and land within a nutrient cycle, continues to this date. Many terrestrial birds of the conservation and buffer zones connected to the mangrove habitat actually use the mangroves as roosting areas (Debrot et al. 2014), where they deposit nutrients through excretion.

The shores and beaches

The shore zones of sandy and pebble-beaches of these marine parks possess high densities of molluscs (Nagelkerken and Debrot 1995) that serve as food for wading shorebirds during their migratory stopover on the islands. These birds also visit the muddy shores of the lagoons that are part of both marine parks for the same reason (Debrot et al. 2014). The beaches of the marine parks are known breeding areas for 4 species of sea turtles (Debrot et al. 2005, STCB 2014, 2015). Focke (1978b) has described the species zonation found on different rocky shore types.

6.7.2 Seagrass and mangrove to reef connectivity

Mangroves seagrasses and the coral reef form one interconnected ecological continuum. The linking between these components has been extensively studied, both on Bonaire and on Curaçao, especially with respect to marine fish species, and the information provided here is largely taken directly from Debrot et al. (2012).

The role mangroves and seagrasses play as nurseries for fish and decapods has long been known (Heck et al. 2003, Sheridan & Hays 2003, Nagelkerken 2009) (Fig. 33). The presence of these habitats enhances the diversity, density and biomass of fish populations of nearby reef ecosystems

(Nagelkerken and van der Velde, 2002, Nagelkerken et al. 2012, Dorenbosch et al. 2004, Mumby et al. 2004). Recent otolith and stable isotope studies on various reef fish species have provided direct evidence for the life-cycle migration of fishes from seagrass beds or mangroves to nearby reefs (Chittaro et al. 2004, Verweij et al. 2008, Nakamura et al. 2008) and provide strong support for this nursery role. High food abundance, low predation pressure through structure and shade, and a good environment to intercept fish larvae have been hypothesized to be the main drivers for the nursery function of seagrass beds and mangroves (Laegdsgaard and Johnson 2001, Verweij et al. 2006). However, the importance of enhanced food provisioning by nursery habitats has been recently disputed (Nakamura & Sano 2005, Grol et al. 2008) and fish may actually trade-off growth for reduced predation risk (Grol et al. 2011, Kimirei et al. 2013).

Figure 33. Juvenile grunts seeking shelter amongst mangrove roots in the CMP. Photo: M. Vermeij.

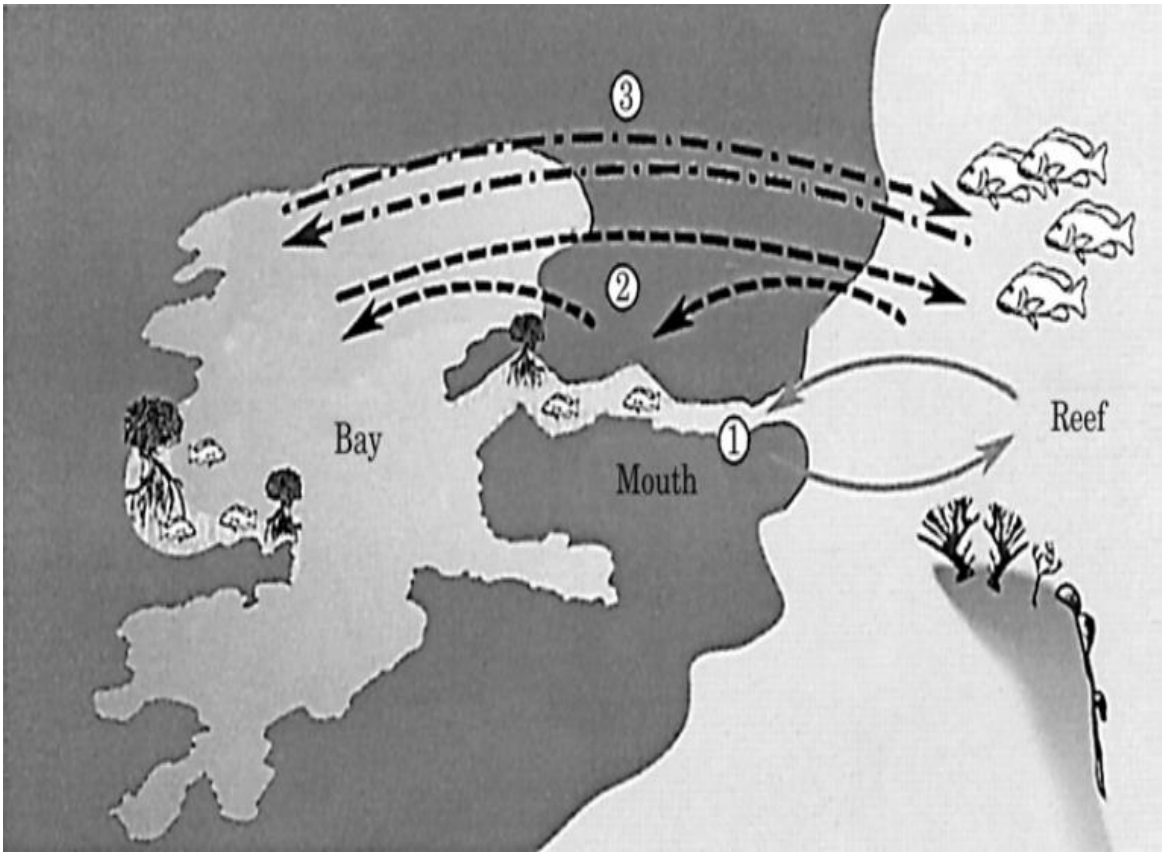


Figure 34. Three types of migration among nurseries and the coral reef. Route 1 depicts a "Short Distance" life cycle use, route 2 the a "Stepwise" Post-settlement Life Cycle Migration (PLCM), and route 3 a "Long Distance" life cycle use by different species of fish PLCM (Figure from Cocheret de la Moriniere et al. 2002).

Mangroves and seagrass beds are structural parts of the BNMP (e.g. Lac Bay and Lagun) and are found in potential buffer zones of the CMP (e.g. Spaanse Water, Fuikbaai, Awa di Oostpunt) (see Fig. 3). The seagrass bed vegetation of both bays, their marine flora, their mangrove associated sessile sponge and coral faunas as well as anthropogenic stressors have been well described (Hoek et al. 1972, Kuenen & Debrot 1995, Debrot et al. 1998, Vermeij et al. 2007, Hunting et al. 2008, Debrot et al. 2012a, Debrot et al. 2012b). Almost all seagrasses and mangroves on these islands are found in association with inland lagoons that are separated from the sea by narrow channels that are shallowest at the seaward entrance of the lagoon due to development of so called "sill reefs" (see section 4.3.1.3). A few exceptions are known of seagrass beds along the most sheltered portions of the leeward coasts of the islands of Curaçao and Bonaire (for instance in the protected waters on both sides of the channel between Klein Bonaire and Kralendijk and inside Caracas bay on Curaçao) but these occurrences are largely very vulnerable to disruption by seasonal groundswell due to storms. In our recent studies of the nursery function of different lagoonal habitats of Lac, Bonaire, four "nursery fish species" of Lac, Bonaire, (*Acanthurus chirurgus*, *Lutjanus griseus*, *Scarus guacamaia* and *Sphyraena barracuda*) showed distribution patterns suggesting a "step-wise" post-settlement life cycle migration (Cocheret de la Morinière et al. 2002, Nagelkerken et al. 2000b, Fig. 34) from open water habitats to more isolated inland habitats, before moving to the coral reef (Nagelkerken et al. 2000b, c). For these species, small juveniles predominated in seagrass and/or mangrove fringe habitats in the bay, while larger juveniles and/or sub-adults predominated deeper in the mangrove system (fringes along the blue and dark pools). Thus the full variety of niches that occur in the mangrove ecosystem are all occupied by different life stages of many different fish and crustacean species that use the reef as their principal adult habitat.

6.7.3 Shallow reef to deep reef connectivity

The links between shallow and deep reefs have been studied in Curaçao. However, worldwide this is a relatively new field of inquiry. The reefs that occur in the deepest half of the photic zone, 30 m to approximately 150 m are referred to as meso-photic reefs where corals depend less on the sun as an energy source. Beyond that, at depths of 150-200m is the beginning of the dysphotic zone (or twilight zone) where illumination is too weak for photosynthesis. The penetration of light depends on the turbidity of the water and the distance from the shore. The waters surrounding Bonaire have a high visibility and therefore the photic zone may reach deeper than is common in other coastal localities.

Depth has been previously shown to be an important environmental factor governing the structure and composition of biological marine communities (Torruco et al. 2003, Syms et al. 2004, Hogg et al. 2010, Becking et al. 2006). With depth come decreasing effects of wave energy, lower levels of light and changes in the light regime, lower temperatures and lower biological productivity (e.g. Engelen et al. 2005a).

All studies to date have shown mesophotic reef communities to contain diverse benthic communities, including unique depth-endemic species (e.g. Lesser & Slattery 2009, Bongaerts et al. 2010). Photosynthetic reef building corals were found to live in habitats at deeper depths (> 30 m) than previously believed possible. Current evidence suggests that mesophotic coral reefs may serve as important refugia and nursery habitats for certain fish populations and act as potential sources and sinks of shallow coral larvae (Lesser & Slattery 2009). As human-induced global warming proceeds, deeper reef habitats may turn out to be crucial to maintaining coral reef biodiversity and ecosystem function (Harris et al. 2013). It has been suggested that degraded shallow reefs (<20m) are increasingly reliant on recruitment of larvae from elsewhere, and that brood stocks in other habitats - such as mesophotic reefs (30 – 150 m) for example - could play a key role in managing coastal seascapes (Slattery et al. 2011).

Many coral and sponge species that are found in the shallow reefs are also found in the upper mesophotic zone, and may therefore serve as a refuge for endangered corals and sponges (Bridge et al. 2013). However, research by Oppen et al. (2011) and Bongaerts et al. (2010), suggests otherwise and emphasizes the need for further research on deep reefs. Engelen et al. (2001) studied genetic diversity within *Sargassum* populations in different depth zones around the island of Curaçao and was able to demonstrate high within-stand genetic variation that was consistent with large populations of outcrossing species but also significant genetic differentiation between shallow and deeper stands. Coral reefs in the CMP have been found to act as a critical source for coral larvae as corals of the CMP produce on average up to 200 times more larvae per square meter of reef compared to corals on reefs near developed coasts elsewhere on the island (Hartmann et al. in press). The same is true for fish (Huijbers et al. 2013). This is also a strong indication for intergity of the reefs concerned.

So while the refuge role for corals is likely but certainly not proven, the role as a refuge for large vulnerable fish species seems more certain. It is for instance known that deep slope piscivores such as snappers will move up to higher levels of the reef at night to feed. When pursued by spearfishing Scuba divers, large piscivorous target fish will typically flee to deep water. Finally, during deep water submarine dives in 2000, those large reef piscivores typically rare at shallow depths, were seen to not be uncommon at depths of 80 m and deeper (A. Debrot, pers. obs.). Several of these, like the Goliath grouper, *Epinephelus itajara*, even use mangroves as nursery areas, thus linking deep waters to inshore areas once again by means of life-cycle migration (Koenig et al. 2007). Juvenile deep-water snappers, like the Silky Snapper, *Lutjanus vivanu*s, use sandy beach shallows as nursery habitat in Curaçao (A. Debrot, pers. obs.).

6.7.4 Coast to pelagic connectivity

This aspect of linkage has been little studied. One key driver of this process is the continuous movement of surface water currents. The predominant movement of the waters of the Caribbean current that passes these islands is from east to west (Beek 2016). Annual seasonal visits by commercially important bait fish schools, cetaceans and migratory gamefish like tunas wahoos and dolphin fishes also occur. These species interact with the coastal zone in several ways. The bait fish represent a net influx of energy into the reef system, because they will typically come close to the reef when pursued by larger pelagic fishes like and tunas and dolphin fish. In that process they serve as an input of food for the larger reef piscivores as well. These baitfish schools, particularly of the Bigeye Scad, are also the largest single fishery of Curaçao by total weight (Couperus et al. 2014) (Fig. 35).

Figure 35. Fishermen harvesting Bigeye Scad, *Selar crumenopthalmus*, at sunset off Curaçao: Photo: F. Dilrosun.

While the intentional movement of large mobile species like fish and cetaceans is important, the passive movement of plankton into the reef system and the spawning and movement of gametes away from the reef are critical examples of pelagic to coastal coupling. The community structure of the reefs of these parks has been studied by Sandin et al. (2008) and shows that small planktivores are very important to the reefs of these islands. Their ecological role is to sequester as much food and energy as possible from the dilute stream of plankton passing over the reef. This then makes an important contribution to the build-up of the standing stock of biomass as the planktivores serve as food for small piscivores and they in turn are consumed by large piscivores. Engelen et al. (2001) studied genetic connectivity in benthic Sargassum weed populations surrounding the island of Curaçao and found the currents at the island tips to be critical for genetic connectivity at the island level.

The role of eddy formation in the wake of islands certainly plays a critical role in inter-island connectivity and retention of larvae (Emery 1972, Heywood et al. 1990, 1996). The occurrence of large eddies in the wake of Bonaire is known to fishermen that use them to fish for deep water snappers without interference by currents. On wind-calm days large circular eddies can be seen in coastal areas from the air (A. Debrot, pers. Obs). Three large eddies tend to form between Klein Bonaire and Malmok, Bonaire, and take coastal water several kilometres offshore before bringing it back to shore (A. Debrot, pers. Obs.).

6.7.5 Epipelagic to mesopelagic connectivity

The upper epipelagic layer of the sea where photosynthesis takes place is the main source of food and energy input into the mesopelagic. Considerable input is derived from the continuous rain of flocculated organic material known as "marine snow" (Aldredge and Silver 1988). During deep sea dives in 2000 with the Johnson-sea-Link II of the Harbour Branch Oceanographic Institution and in 2013 with the Cura-sub, of the substation Curaçao, marine snow was observed from about 200 m and deeper in the BNMP and the CMP (A. Debrot and L. Becking, pers. Obs).

Important coupling between the epi- and mesopelagic zones is derived from the daily vertical migration of mesopelagic fishes (Waters 1980, Hopkins and Baird 1985, Marchal and Lebourges 1996), cephalopods (Gilly et al. 2006) and crustaceans (Youngbluth 1975) that come up to the surface at night to feed. These species are known for the CMP and the BNMP especially from the stomach content of stranded deep-diving beaked whales that feed on these species (Debrot et al. 1998) (Fig. 36). So while these processes connecting the epi- and mesopelagic are clearly evidenced to occur, they have so far not been the topic of scientific research in the CMP and the BNMP.

While the current nomination does not include pelagic habitat, there is the possibility to either extend the two existing components or to add additional components in the territorial sea or EEZ. It is also possible that the territorial sea and EEZ may be considered as part of a marine buffer zone. This is discussed in chapter 3 and section 6.7. As epipelagic and mesopelagic habitat and connectivity occur outside the current boundaries of the proposed nomination, extending the boundaries of the proposed nomination would also enable the addition of this type of connectivity.

Figure 36. Cuvier's Beaked Whale, *Ziphius cavirostris*, off Curaçao. Photo: Dutch Caribbean Coast Guard.

A final and very important aspect of coupling between the epi- and mesopelagic zones is the phenomenon of upwelling. Upwelling in the CMP and BNMP is generally both local and seasonal (Bak 1972, Sturm 1991). The islands lie in the southern Caribbean zone of wind induced upwelling that stretches from Trinidad to Colombia. The centre of this upwelling zone lies 500 km to the east in the vicinity of Margarita island but extends fully west along the north coast of Venezuela (Sturm 1991). This process brings cold-nutrient rich waters to the surface and stimulates phytoplankton growth which in turn serves as a food source for reef planktivores as well as schools of pelagic baitfish (Couperus et al. 2014).

6.7.6 Island to island connectivity

This aspect has not been studied much. Aside from the relatively predictable unidirectional flow of water from east to west from which connectivity between the two islands, and the fact that most marine organisms from fishes to corals have pelagic larvae, from which ecological connectivity can be reasonably inferred, the direct ecological connection between the CMP and BNMP is difficult to prove. However, Nagelkerken et al. (2002) did study island to island connectivity though on a smaller scale (Bonaire-Klein Bonaire). That study shows how the absence of important nursery habitats like seagrass and mangroves impacts the fish species present on small islands like Klein Bonaire and Klein Curaçao.

Simal et al. (2015) demonstrate how nectarivorous bats will travel between Curaçao and Bonaire. From this it can be inferred that the much smaller numbers of fish-eating bats (*Noctilio leporinus*) on both islands must also move freely between the islands when on fishing forays. The same is true for flamingos for which it is known that they fly to Venezuela and back to Bonaire on a daily basis during the breeding season for feeding purposes (Boer 1979). The meaning of and needs for ecological connectivity for different species groups may differ substantially and need not involve only connectivity through seawater.

6.7.7 Regional connectivity

Several studies on regional genetic connectivity in marine organisms have included samples from the BNMP or the CMP. Studies have been done looking at genetic connectivity in fishes (Baldwin & Johnson 2014), West-Indian Spiny Lobster (Kough et al. 2013) gastropod molluscs (Diaz-Ferguson et al. 2010, 2011), corals (Baums et al. 2005, Foster et al. 2012), echinoderms (Richards et al. 2015) and pelagic larvae in general (Quian et al. 2015). While at the same time these studies demonstrate very long distance connectivity between the southern Caribbean and Florida (Baldwin and Johnson 2014), they also demonstrate partial isolation, and hence also unicity, of the southern Caribbean biogeographic province (Diaz-Ferguson et al. 2010, 2011). Interestingly, results by Kough et al. (2013) suggest the existence in the Caribbean of off-shore larval nurseries for long-lived larvae like that of the West-Indian Spiny Lobster that spend about a year in the planktonic stage. Foster et al. (2012) show gene flow connectivity for the dominant reef-building coral, O. annularis from the Netherlands Antilles at levels of up to several 100 kms within the Caribbean. As in the studies by Baums et al. (2005) on the coral *Acropora palmata*, their results further support the notion of important genetic barriers and reduced mixing between the western and eastern Caribbean. Richards et al. (2012) find evidence of cryptic speciation in two commensal sponge amphipod species and identify the southern Caribbean as one of those centres of endemism. DeBiasse et al. (2016) also find cryptic speciation and shared phylo-geographical breaks in the Caribbean for the sponge Callyspongia vaginalis and its invertebrate commensals. For the commensal brittle star *Ophiotrix suensonii*, Richards et al. (2015) demonstrate genetic connectivity across more than 1700 km in parts of the Caribbean, yet genetic isolation in other parts of the Caribbean.

Many stocks of commercially important pelagic fish species are migratory moving through the Caribbean and other areas of the tropical Atlantic in set annual patterns (Oxenford 1999). The migratory patterns of these fish species, which include tunas, swordfish, wahoo and dolphinfishes (Oxenford 1999), are an important aspect of regional connectivity. Likewise, Becking et al. (2016) show how sea turtles from Bonaire migrate great distances throughout the Caribbean during their life cycle.

A number of recent studies using the most advanced genetic techniques available on different groups of marine organisms demonstrate important connectivity of the marine biota of the Curaçao-Bonaire joint nomination area to the rest of the Caribbean. At the same time the results underline the fact that it is part of a unique southern Caribbean biogeographic province as well as the fact that the islands undoubtedly possess much more hidden endemicity than previously realized.

Other evidence of connectivity includes the results of satellite tracking of breeding sea turtles from Bonaire. There is strong connectivity of Bonaire island turtles throughout the Caribbean (Fig. 37) (Stapleton et al. 2013).

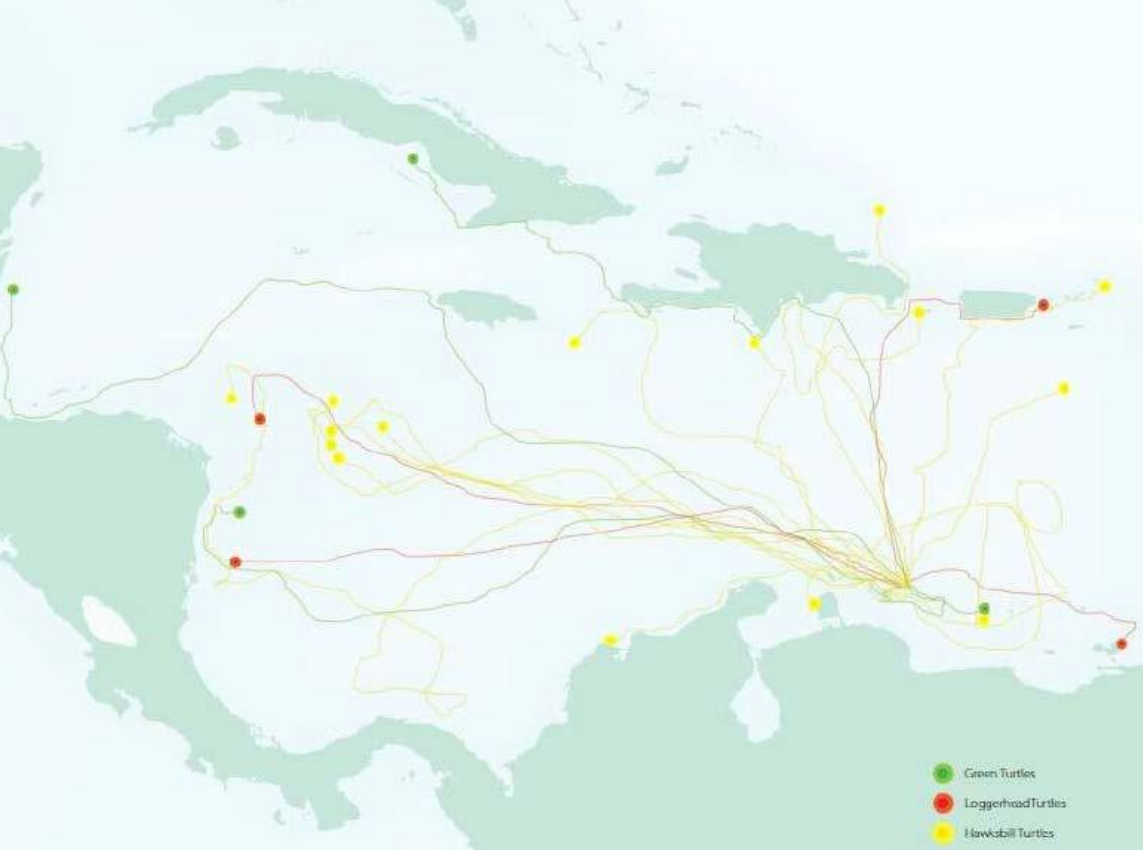


Figure 37. Migration patterns of sea turtles tracked in 2013 from Bonaire island (Stapleton et al. 2013, Sea Turtle Conservation Bonaire)

6.7.8 Conclusions on ecological inter-connectivity

Ecological connectivity at seven different levels for the potential combined Bonaire and Curaçao Curaçao nomination is described, illustrated and documented based on research. These are connectivities between:

a) sea and land,
b) sea grass-mangrove and reef,
c) shallow reef and deep reef,
d) coastal and pelagic,
e) epipelagic and mesopelagic,
f) between one island another neighbouring island and
g) between island groups and the region.

All these seven levels of connectivity are essential for proper ecological functioning of the diverse and complex coastal marine ecosystems represented. Processes that drive these different aspects of connectivity include sea surface and deep currents, upwelling and eddies, erosion and run-off, the passive and active movement or habitat selection of organisms and nutrient cycles. "Non-contiguous sites connected by currents may result in a higher level of integrity if designed appropriately, but connectivity science is largely at early stages to be able to assess this with confidence" (UNESCO 2017). It can be concluded that five of the seven essential system components and processes needed for the required ecological connectivity at all levels can be demonstrated or reasonably inferred to be functioning in the combined Bonaire and Curaçao nomination area. Only two of the described levels (d and e) are not guaranteed within the current combined nomination properties as these do not possess pelagic habitat. This is one reason why inclusion of the 12-mile zone for Bonaire is highly recommended.

6.8 Active reef growth bolstered by three dominant framework building calcifying communities

Since the 1950s when coral reef ecological science began in earnest once SCUBA technology had been developed, most coral reef ecology has, understandably, been devoted to the coral community as the primary calcifying component of the coral reef ecosystem. Yet there are at least three other, mostly-overlooked calcifying communities that form part of the strongly zoned coral reef ecosystem. These biological communities actively accrete calcium carbonate to form distinct reef structures in areas outside the principal zones of coral growth. All three are based largely on coralline algae. These so-called lithothamnion reefs, porolithon-vermetid reefs and rodolith reefs, extend active calcification and reef formation into habitat zones both shallower and deeper than where corals are able to form reefs. To our knowledge, these arguments have never been used in any previous WH nomination as part of OUV for natural heritage. The calcification by coral reefs is therefore also complemented by calcification by both shallow and deep non-coral reefs.

6.8.1 Vermetid/Porolithon intertidal reefs

In the Mediterranean, Red Sea and subtropical north Atlantic of Bermuda, extensive intertidal reefs are constructed by vermitid gastropods and coralline algae (Safriel 1974, Ben-Eliahu and Safriel 1982, BenEliahu et al. 1988, Gherardi & Bosence 2005). De Oliveira Soares et al. (2011) describe comparable algal/vermetid reef forming processes for the Fernando de Noronha and Atol das Rocas Reserves in the Tropical Western Atlantic of Brazil, a World Heritage Site, where corals only play a secondary role. Gherardi & Bosence (2005) point out that such reefs may even show vertical extension rates close to the maximum rates recorded for corals and stress that these communities too are dominant framework builders. Focke (1978b) has described the high extent to which such reef-building communities are closely associated with current coral reef formations of the island. The so-called vermetid/Porolithon are found on all shores but are most strongly developed under heavy wave exposure on the north-east coasts of the islands where they form extensive intertidal shelves that may be more than 10 m wide and 1.5 m above mean sea level (Fig. 38). These communities are dominated by the vermetid gastropod *Spiroglyphus irregularis* and the coralline algae *Porolithon pachydermum* and *Lithophyllum congestum* (Focke 1977b). The intertidal benches thus formed, consist of a network of interconnected pools that serve as foraging areas for shorebirds such as Oyster Catchers and egrets during quiet spells in the fall hurricane season (A. Debrot, pers. obs.).

Figure 38. A close-up section of the flat intertidal bench at Onima, BNMP, which is an actively growing vermetid/Porolithon reef. November 2016. Photo: A. Debrot).

On both Bonaire and Curaçao, it is these limestone formations which make up the coastline in the form of coral-rubble beaches (coral shingle and calcareous sand) or "iron shore", except in the north where low limestone cliffs are found (Zonneveld et al. 1972) 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 (from: Meyer & McRae 2006).

6.8.2 Shallow "Lithothamnion" banks

At select locations in shallow back reef habitat and sill reef situations which are generally characterized by reduced wave stress conditions, so-called "*Lithothamnion* banks" occur. In the CMP these can be witnessed at Oostpunt (A. Debrot, pers obs.) while in the BNMP a large *Lithothamnion* bank has been described for the shallow sill waters at the mouth of Lac Bay (Zaneveld 1958). While such reefs have long been known from higher latitudes (Zaneveld 1958), very few such structures have been described from the tropics. In Bonaire the principal species forming the *Lithothamnion* bank at the entrance of Lac appear to be one species of *Lithothamnion* and one species of *Goniolithon*, both of which are coralline red algae (Fig. 39). Hence, while coralline algae are common constituents of the coral reef itself, in certain situations unfavourable to coral growth, they can clearly accrete calcium carbonate to produce distinct reef structures.

As pointed out by Foster et al. (2013), these and other coralline algal reef formations, which are generally termed rhodolith or maërl beds, have been little investigated by marine ecologists. This is because even in clear, shallow water, their lack of vertical structure in the water column makes them difficult to distinguish from entirely soft bottoms. So even though Zaneveld (1958) was early to point to the presence of such structures in the Caribbean Netherlands, nobody has actually further mapped these communities or investigated their ecology. Further development of the OUV for the BCMP will benefit from additional research on these non-coral calcifying communities.

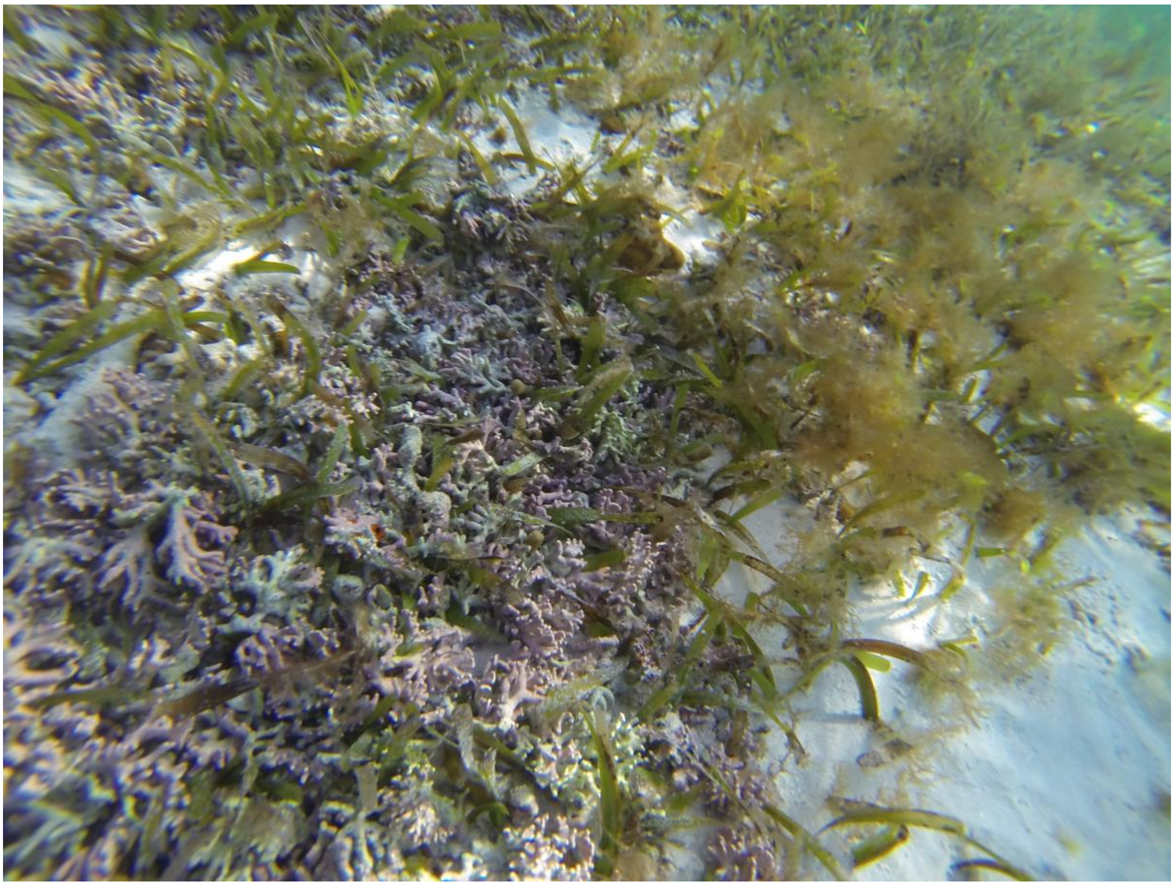


Figure 39. Actively growing Lithothamnion reef at Lac Bay, Bonaire, November 2016 (Photo: S Engel).

6.8.2.1 Rhodolith beds

Rhodoliths are nodules of coralline algae that typically occur at depths above 150 m, forming large expanses of hard bottom habitat and rank as one of the world’s four largest macrophyte-dominated benthic communities (Amado-Filho et al. 2012). Even so, rhodolith beds are poorly known in the Caribbean. For instance, in Guadeloupe their occurrence was only described recently, in 2013 (Pena et al. 2013) while for Bonaire and Curaçao their occurrence was first documented in 2014 (Becking and Meesters 2014). There is growing evidence that benthic communities dominated by crustose coralline algae may contribute to significant rates of calcium carbonate accretion (Becking & Meesters 2014). Furthermore, rhodolith beds provide structural complexity that serves as habitat in large areas where corals are largely absent and thus help bolster biodiversity and benthic primary productivity of nearshore systems (Amado-Filho et al. 2012), and protect the system from the deleterious effects of coastal erosion. Thus rhodolith beds also provide the valuable ecosystem service of coastal protection, particularly important given future projections of sea level rise related to climate change.

6.8.2.2 Deep and cold-water reefs

Coral communities typical for Bonaire’s and Curaçao’s MCEs are dominated by Agaricids (Goreau & Goreau 1973, Bak et al. 2005, Bongaerts et al. 2013), that are efficient at capturing light in low light environments (Titlyanov 1981). *Agaricia lamarcki* and *A. grahamae* (Bongaerts et al. 2010, Kahng et al. 2010, Bongaerts et al. 2013), in particular, comprise a substantial part of hard substrate communities below 30m. Other species that are common in the shallows but also occur down to 80 m depth, are *S. intersepta, M. cavernosa* and *M. pharensis* (Bak 1975, Vermeij & Bak

2003, Bongaerts et al. 2013). Whereas the upper mesophotic zone still harbours nearly all coral species found on the shallow reef which could hence be considered depth generalists (Bak 1977, Bongaerts et al. 2010), communities occurring deeper (> 70m) in the mesophotic zone consist predominantly of deep-water specialists such as *A. grahamae* and *A. undata* (Bongaerts et al. 2015b), while they can locally be outnumbered by other species such as *Madracis pharensis* (Bongaerts et al. 2015b). Colonies of A*. grahamae/undata* can dominate up to 100% of the benthos in some locations between depths of 70 to 85 m (Hoeksema et al. 2017a). Such domination by corals at greater depths has only rarely been observed elsewhere (such as at 70-90 m in Hawaii, Kahng & Maragos 2006, Pochon et al. 2015, in Hoeksema 2017). These features are found inside the nomination areas but also extend much deeper. The presence of much of such habitat bordering but just outside the current nomination make an extension of the boundaries seaward or having components that include greater depths quite valuable to the nomination.

Alltogether, approximately 25 reef building coral species are found in the upper MCE, down to ~6 at 60 m (Bongaerts et al. 2015a) and only 2-3 coral species occur around 80-90 m depth (Bongaerts et al. 2015b). The upper mesophotic is therefore often considered as a transition zone between the shallow reef and the lower mesophotic (Bongaerts et al. 2015a), a claim extended to other regions of the world (Kahng et al. 2014). Towards deeper parts of the mesophotic zone, calcareous red algae become increasingly more abundant (Bak 1975), where they often cover the underside of plating Agariciids at the lower mesophotic (Hoeksema et al. 2017a). Particular observations taken for the MCEs off Bonaire have revealed living hard coral to be present down to 45m and the remaining MCE to be mostly covered by sand and patchy hard bottom, with the exception assemblages of fan corals and sponges at 90-100m depth (Becking & Meesters 2014). Seawards extension of the boundaries of the current nomination would be valuable.

Several species of azoxanthellate corals are known to form reef structures in waters below the photic zone within the Caribbean region (Dawson 2002, Reed 1992, Reed et al. 2002), including the southern Caribbean (Reyes et al. 2005). During deep-water submersible dives off Curaçao and Bonaire in 2000, deep-water structure-forming azooxanthellate scleractinians were documented at 7 different deep-water sites and included species well known for reef formation elsewhere: *Lophelia pertusa, Dendrophyllia alternata, Maderpora oculata, Madracis myriaster* and *Solenosmilia variabilis* (Reed & Pomponi 2001). Only a small portion of this potential is included in the current boundaries of the proposed nomination. We therefore recommend (inclusion of the deep reefs as would be achieved by) including the 12-mile pelagic habitat zone and its seabed as a formal buffer zone as this would greatly bolster the nomination by contributing to integrity. Even more advantageous would be to include some of these habitats by a seaward extension of the boundaries of the marine protected areas or by protecting additional components that are not adjacent as new additions to the proposed nomination. Such additions would expand the biodiversity of habitats and species, and the ecological connectivity thus adding both increased area and depth of protection for the natural values that constitute the OUV of the proposed nomination.

Conclusion on non-coral framework-building reef communities

Aside from possessing coral reefs, the reef systems of Bonaire and Curaçao also possess actively growing reef-forming communities that are based on coralline algae and vermetid gastropods, as opposed to corals. These alternative reefs extend active calcification and reef formation into habitat zones where corals are unable to form reefs. Hence the coral reefs of these properties are not “just” isolated coral formations, but are complemented by other framework-building communities starting from the shore and extending into deep shelf habitat. To our knowledge, these arguments have rarely been used in any natural WH nominations.

7 Criteria (x)- Species and Habitats

7.1 Background

To demonstrate the Outstanding Universal Value according to World Heritage natural criteria (x), the Operational Guidelines for the Implementation of the World Heritage Convention UNESCO require the nominated property "to contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation" (UNESCO 2017).

Criteria (x) relates to the conservation importance for globally threatened species (IUCN Red List of Threatened Species) and work related to endangered ecosystems (IUCN Red List of Ecosystems). Caribbean corals listed as (critically) endangered (68 species) are used in this chapter to strengthen the case for criteria (x) (Keith et al. 2013).

Thanks to a steep bathymetry that also happens to span the whole depth range of active reef growth, together with a complex Pleistocene geological history, the reefs of the Bonaire and Curaçao Marine Parks have been blessed with a diversity of at least 13 reef structural features that combine to make for diverse, variable and exciting reefscapes. At least 26 different coral reef communities have been described. Many of these reef features and communities also have important ecological functions for specific groups or organisms (e.g. shelter, spawning aggregations, feeding areas). The high diversity of reef features and habitats can be seen to have contributed to both high Alpha diversity within the coral communities and high Beta diversity between those communities. The diverse landscape features, high habitat diversity and high biodiversity of these Leeward Antilles Caribbean islands combine to make them among the best, most resilient and most diverse of the Caribbean region.

7.2 Statement of values

The current potential nomination property can be characterized by being located in a biogeographically strategic position within the Caribbean, possessing high habitat quality and high habitat diversity. The geophysical and ecological factors, as well as the relatively low exploitation levels and user-stress, all contribute to maintaining the high level of biodiversity and endemism.

Biodiversity
With about 650 marine fish species, 745 marine molluscs, 430 marine algae and 201 marine sponges documented for the proposed nomination area, comparative analysis shows that the species richness of these important marine groups surpasses that of other biotically rich areas of the Caribbean (such as Puerto Rico in the case of marine algae) and even the Pacific. For fishes and for molluscs the southern Caribbean has furthermore been demonstrated to be among the top centres for endemism (Diaz 1995, Smith et al. 2002).

Endemism
Endemism is a special aspect of biodiversity. It refers to the narrow distributional range of certain species that can be considered "unique" to that area. The proposed nomination as currently defined possesses 123 island endemic taxa (species and subspecies combined). The largest number of these are accounted for by sponges (31 endemics), marine gastropods (26 endemics), terrestrial beetles (15 endemics) and bird subspecies (9 endemics). Collaboration with Curaçao increases the number of endemics from 101 (Bonaire only) to 123 species (Bonaire plus Curaçao). This is largely due to the large number of endemic marine gastropod molluscs described for Curaçao. At present

Curaçao is at a slight disadvantage with respect to total endemism compared to Bonaire because it has no terrestrial habitat forming part of the nomination. However, if the recommended terrestrial buffer zones (such as the Caracasbaai conservation area or others) could be included as part of the nomination property (i.e. not as buffer zones), then Curaçao will exceed Bonaire in terms of endemism and contribute about 20-30 additional endemic species to the total count for endemic taxa. So the collaboration with Curaçao clearly greatly enhances the combined endemism count for the proposed nomination as each island contributes its unique endemic species.

Threatened species (IUCN Red List)
A total of 79 IUCN Red List species considered Near Threatened (23), Vulnerable (39), Endangered (11) or Critically Endangered (6) have been documented for the current nomination property. While mentioned here, Near Threatened species are excluded from species lists for comparison purposes as they are not used by IUCN for decision making. Even though the surface area of the proposed nomination is only a small percentage of the total area of the Caribbean marine biodiversity hotspot, it further also is home to almost all the Caribbean marine species requiring protection (90%) and renders some of the best long-term conservation value to many reef-associated species. However, in this respect, collaboration with Curaçao does not contribute significantly to the number of internationally recognised endangered species as the overlap in marine species representation is 100%. However, it does increase the total area of habitat protected by 217 ha.

Addition of the 12-mile zone
Addition of the twelve-mile zone as part of the nomination area to the nomination bid contributes significantly to the biodiversity value of nomination. This will:

a) add 300-350 principally pelagic and deep-sea fish species to the combined fish fauna offered protection;
b) add about 15 IUCN Red List pelagic bird and fish species to the total list of endangered species included;
c) add protection to many new, as yet undescribed and potentially endemic species (as this zone (60 m and deeper) includes much poorly-explored deep reef habitat, that possesses many as yet undescribed species of sponges and fish) and possibly seamounts.

7.3 Justification

The high marine and coastal biodiversity found in the proposed nomination fills a "conservation" gap by adding potential World Heritage recognition in the Southern Caribbean Marine Ecoregion, which has no World Heritage Sites and very few protected areas. Also, the terrestrial areas in BNMP are recognised as Aruba-Bonaire-Curaçao cactus scrub and Coastal Venezuelan Mangroves (Sotomayor 2003), two ecoregions not found on other Caribbean Islands outside the Leeward Islands chain. This proposed nomination recognises the potential benefit of including Venezuela as a partner as this megadiverse country has several islands neighbouring Bonaire that are ecologically linked to the ABC Islands. Los Roques Archipelago is a National Park that is also a Ramsar Site and would make an ideal additional component as it shared a similar ecological role and geological history to the ABC islands. However, it is not currently feasible for the Kingdom of the Netherlands and Venezuela to prepare a joint serial transboundary nomination. Therefore, it is proposed that a future serial transboundary extension be considered as a potential subsequent phase.

7.4 Reef habitat diversity

Thanks to the steep bathymetry that also happens to span the whole depth range of active reef growth, together with a complex Pleistocene geology history (see chaper 5), the reefs of the Bonaire and Curaçao Marine Parks have been blessed with a diversity of at least 13 reef structural features that combine to make for diverse, variable and exciting reefscapes. While reef structural features describe "seascape diversity", biological communities represent "habitat diversity".

As a consequence of the rich array of habitat conditions, a concomitantly rich variety of reef benthic communities can also be found in the shallow reef areas of both marine parks. Duyl (1985) describes no less than 26 structurally different reef assemblage types that develop under the locally different constraints of wave, current, sediment stress and light levels. The pronounced reef zonation found on these islands was first described by Bak (1975). Later Duyl (1985) provided more extensive description as well as mapping of these reefs of both islands. Such extensive mapping of reef characteristics has been done in very few places in the world. Since their description, the reefs of the island have been impacted by coral diseases, the Diadema die-off and hurricane wave surges. Some, especially the shallow communities have almost disappeared or been seriously modified. Nevertheless, the reefs of Curaçao and Bonaire remain among the best in the Caribbean, as attested by many world-renown coral reef authorities. For the depth zone of 0-10 m Duyl distinguished 8 clusters of reef communities. While a number of shallow-water coral reef assemblages have suffered severely due to virtual total loss of the dominant coral species (the *Acropora palmata* and *A. cervicornis* groups of coral assemblages), in areas away from anthropogenic disturbance and pollution, partial recovery (to a different community composition) can be documented. The following "habitats" can be described at the biological community level:

7.4.1.1 Shore zone

This zone is a composite patchwork of sand, rubble, hard bottoms and beach rock. Coral growth is sparse but presence of scattered corals is common. The most common corals are *Millepora* (not a true coral), *Diploria clivosa, D. strigosa, Siderastrea radians* and *Porites astroides*.

7.4.1.2 Acropora palmata group (5 different coral assemblages)

This group of coral assemblages are confined to the depth range in which *A. palmata* is found: 0.5-6 m. The five different assemblages are distinguished based on the accompanying species. These in turn depend on the level of wave exposure at the given location. At locations with heavy wave energy *A. palmata* moves its distribution to deeper water where it then co-occurs with many head corals. The species is well adapted to regeneration following breakage by wave action and its communities were typically the closest dense reef community found close to shore.

7.4.1.3 Acropora cervicornis group (3 different coral assemblages)

This group of coral assemblages are confined to the depth range in which *A. cervicornis* is found: 1-10 m. The three different assemblages are distinguished based on the accompanying species. At locations with heavier wave energy *A. cervicornis* is located in deeper water where it then co-occurs with many head corals. This species is also well-adapted to regeneration following breakage. This community formerly was typical of sandy or rubble bottoms.

Both *Acropora* species suffered serious losses due to appearance of the white band disease in mid 1980s. As a consequence, today *Acropora* reefs have become rare where they formerly fulfilled important functions in coastal protection and as fish habitat (Nagelkerken et al. 2007). More recently both species have been coming back in areas where they are not limited by human factors such as eutrophication or pollution. *Acropora cervicornis* is successfully being used for reef restoration in Bonaire and elsewhere in the Caribbean (Becker et al. 2001, Young et al. 2012, Schopmeyer et al. 2007)

7.4.1.4 Foliate/finger coral group (5 coral assemblages)

Typical corals of this group are *Millepora, Agaricia agaricites, Madracis mirabilis, Porites porites* and *Eusmilia fastigiata* (Fig. 40). These communities were typically found in uneven and restricted patches at various depths but not in association with *A. palmata* which was restricted to sites with heavy water movement. Duyl (1985) suggests that these groups seem to be able to exploit small scale disturbances more efficiently than head corals. All species commonly co-occurred with other species in other communities.

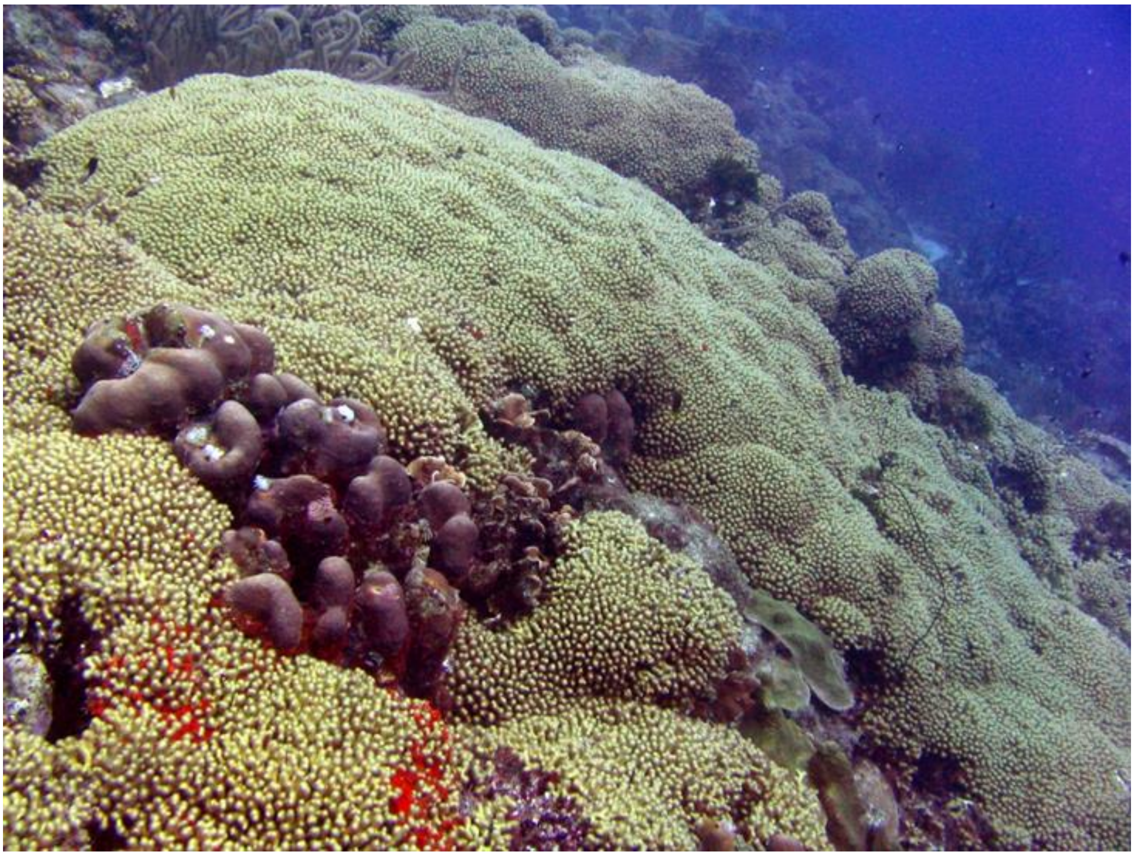


Figure 40. Typical foliate/finger coral group (Duyl 1985) with dominance of *Madracis mirabilis*. This species is well adapted to unstable sandy habitat. Photo: S. Lima.

7.4.1.5 Head coral group (3 coral assemblages)

This group of assemblages is characterized by the absence of *Agaricia* and dominance of head corals, the principal ones of which being *Orbicella annularis, faveolata and frankesi, Diploria clivosa, strigosa and labyrinthyformis, Montastrea cavernosa, Siderastrea siderea, Dichocoenia stokesii, Colpophyllia natans* and *Meandrina meandrites* and *Stephaocoenia michellini*. Representatives of this group are found in all reef zones and all wave energy environments (Duyl 1985).

7.4.1.6 Head/foliate coral group (3 coral assemblages)

The dominant corals in this group were the head corals of *Orbicella spp*. and *Agaricia agaricites*. This group of assemblages was found in all zones of the reef terrace and the drop-off zone in all wave energy environments (Duyl 1985). Most notable of all is the Pagoda community in which *O. faveolata* plays a key role in shaping the sea scape. It only occurs in the (deeper) lower terrace and slope communities. The pagoda community is found especially in western Curaçao but not so much in the CMP as the latter is situated in eastern Curaçao. However, in the BNMP it is found in areas from Boca Bartol to Goto (Duyl 1985). Thus on both islands its preference seem to be for the most wave-sheltered zones of the island.

7.4.1.7 Sea whip group (3 assemblages)

Common sea whips were *Pseudopterogeorgia americana* and *P. acerosa, Plexaura flexuosa* and *P. homomalla*, and the sea fans of *Gorgonia* (esp *ventalina*). They co-occurred in many other coral assemblages but generally played a minor role in terms of total coverage. Sea whips and fans are much less dominant on Curaçao and Bonaire reefs than on reefs described from elsewhere. Sea whips are highly adapted to sedimentation so these are also likely to dominate communities where sedimentation is greater (Fig. 41). These communities are most common in the mid reef terrace zone (Duyl 1985). One of the three communities, dominated by sea whips combined sea fans is especially common in the upper terrace zone of the highest wave energy environments (Duyl 1985).

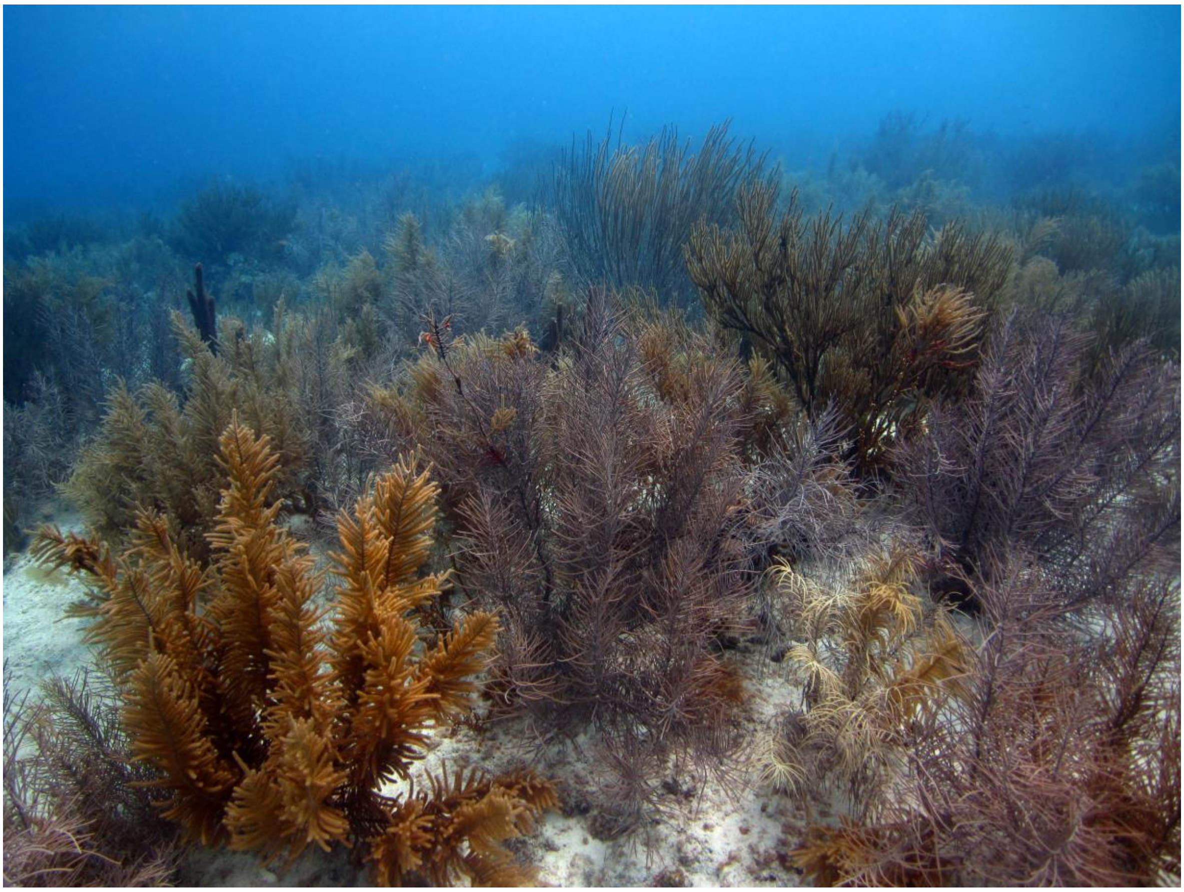


Figure 41. The sea whip group (Duyl 1985): adapted to sand-stressed habitat. Photo: M. Vermeij.

7.4.1.8 Marine plant group (3 plant assemblages)

The reefs of the islands have a variety of marine plant communities. Hoek (1969) and Hoek et al. (1975, 1978) extensively describe the algal vegetation types of both islands. Most notable were the communities dominated by *Sargassum* as found on the exposed coasts of northern and eastern wind and wave exposure (Bak 1975, 1977). Along the leeward coasts of the islands the Sargassum community is only found at the eastern most tip of the island at Punt Canon in the CMP. Engelen & Breeman (2001) and Engelen et al. (2001, 2005a, b) have studied various aspects of the ecology of *Sargassum polyceratium* in the CMP and around the island of Curaçao. On the costal fringing reefs of both islands the only seagrass beds that are found are patches of Manatee Grass, *Syringodium filiforme* (Fig. 42). Turtle Grass, *Thalassia testudinum*, is only found inside coastal lagoons such as Spaanse Water in Curaçao and Lac Bay in Bonaire. The latter of these bays form part of the joint nomination area. The seagrass communities of both of these bays have been quantitatively described (Kuenen & Debrot 1995, Debrot et al. 2012). So for Lac Bay at least seven separate seagrass communities can be distinguished (Debrot et al. 2012) that differ greatly from the three described by Duyl (1985) for the coral reef.

Figure 42. A Green Turtle feeding in a sparse Manatee Grass bed (*Syringodium filiforme*) on the protected reefs of the south coast of Curaçao. Photo: Hans Pleij.

7.5 Biodiversity and endemism

The proposed nomination is centrally located in the southern Caribbean, an area recognized as a distinct marine biogeographic province for both marine molluscan diversity (Diaz 1995) and fish diversity (Spalding 2007, Robertson & Cramer 2014). The differences may reflect the fact that these areas represent distinct continental faunas that were separated by the Inter-American Seaway during most of the history of the Caribbean Basin. These areas could be viewed as distinct and unique hotspots for marine biodiversity (Smith et al. 2002).

The long history of favourable conditions for reef development and steep topographic reef slopes have provided the basis for high habitat richness supporting a large number of well-documented benthic reef communities. For these reasons these islands boast about the best-developed reefs in the Caribbean, and some of the highest documented species richness and endemicity in numerous taxa, from marine molluscs and algae to sponges and fishes (other taxa have been less well researched). At the same time, these same conditions offer the best circumstances for these reefs to maintain a superior condition and continue to play their important role in the region well into the future.

The reefs of Curaçao and Bonaire are characterized by a pronounced depth zonation of communities (Bak 1975, 1977, Duyl 1985, Bongaerts et al. 2013). So, aside from having coral communities "within" which a high intrinsic diversity (Alpha-diversity) the fact that the reefs of these islands actually consist of several different coral communities (at the different depths) means that the reefs also benefit from a high diversity "between" zoned communities (Beta-diversity). The alpha and beta diversity combine to yield overall high species diversity (Gamma diversity) (Valiela 1984).

The leeward Dutch Antillean ABC-islands form part of the Caribbean biodiversity hotspot (Myers et al. 2000) based both the high level of documented terrestrial and marine biodiversity amounting to no less than 255 endemic taxa (179 nominate species) 163 which are terrestrial or freshwater taxa and (58 plus 31 sponges and plus 3 more fishes; i.e. 92) which are marine taxa. The extant endemic terrestrial species include 42 endemic vertebrate taxa and 20 gastropod taxa, many of which have been documented in the current tentative joint nomination property. Bonaire has also been shown to be hotspot for genetic diversity in the mangrove *Rhizophoa mangle*, the most prominent mangrove of the Caribbean (Albrecht et al. 2013).

Marine and brackish water fishes: 650 spp. (5 endemic)

Smith et al. (2002) provide distributional maps for the approximate 987 fish species that are found in the shallow to deep waters of the ABC islands (and thus also deep waters around the nomination properties and indicate that the combined Bonaire and Curaçao nomination property lies inside the second-most diverse fish area of the Caribbean that is found along the north coast of South America (Venezuela and Colombia). This area is also the second most important region of the Caribbean as far as endemism and unique species are concerned (Smith et al. 2002, Fig. 43). Both the abundance of herbivores and predatory fishes exceed 50gr/m^2 making the reefs of the Curaçao Marine Park one of the most "fish-rich" areas in the Caribbean (Newman et al. 2006).Of these fish species about 650 are nearshore species typical of coral reefs (Beek et al. 2014a). Hence, if the marine 12-mile zone is included as an integral part of the nomination, this would add about 300 additional fish species to the biodiversity of the nomination property.

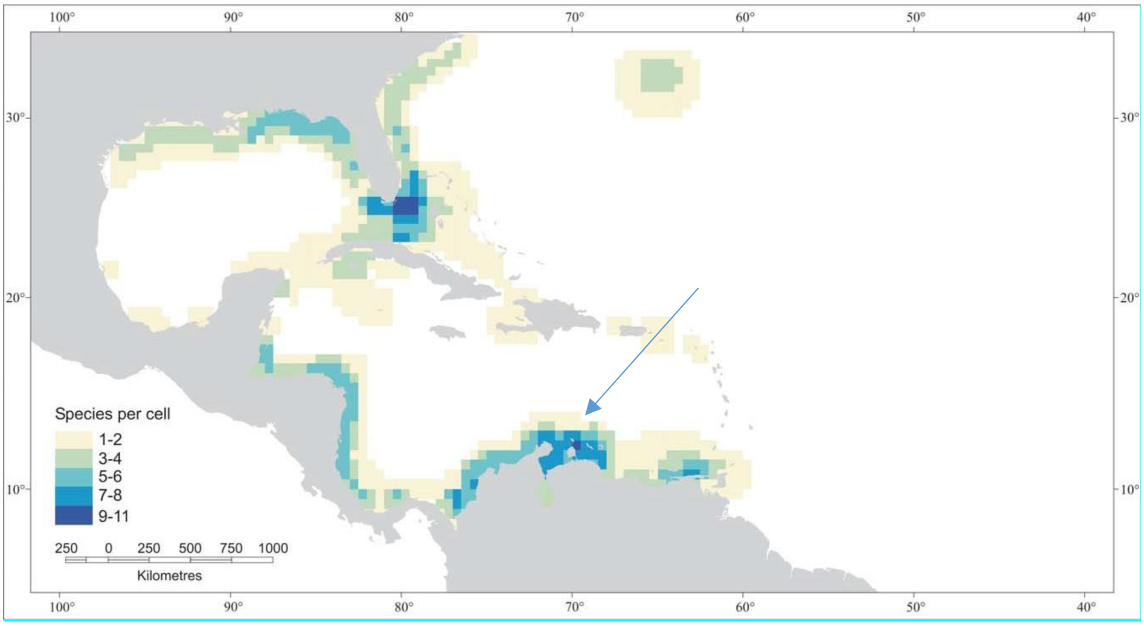


Figure 43. The combined distribution of the 75 regional endemic fish species with the smallest areas of distribution (3-116 cells) from: Smith et al. 2002. Arrow point to the location of Curaçao and Bonaire witin the southern Caribbean.

Marine molluscs: 745 spp. (26 endemic)

De Jong & Coomans (1988) document a total of 723 marine gastropod species for the ABC-islands of the Dutch Caribbean. After subtracting 155 species recorded only for Aruba or based on small numbers of specimens of undocumented collection localities, the total gastropod fauna for these islands is estimated at a conservative 568 species. The non-gastropod molluscs are discussed by de Jong & Kristensen (1968). These amount to at least 160 bivalve species and 17 other molluscs. The total documented (mainly shallow) marine molluscan fauna for Bonaire and Curaçao is 745 species. Almost all are certain be present in the proposed nomination components, as the latter include all shallow reef waters of Bonaire and the most pristine waters of Curaçao.

Marine sponges: 201 spp. (31 endemic)

Marine sponges of Curaçao and Bonaire amount to 201 species as documented in several studies on this diverse and well-studied group (Alvarez et al. 1998, Diaz et al. 1987, 1993, Hadju & van Soest 1992, Soest 1978, 1980, 1981, 1984, 2009, 2017, Soest et al. 1991, 1994, 2010, 2012, 2014, Soest and Weerdt 2001, Weerdt 2000, Weerdt et al. 1999). Almost all are certain to be found in the component nomination areas.

Marine algae: approx. 430 species (endemic: unknown)

Marine algae are documented in numerous studies (Hoek 1969, Hoek et al. 1972, Stegenga & Vroman 1988, Vroman & Stegenga 1988). In total more than 350 species were recorded with reasonable certainty from Curaçao. Stegenga & Vroman (1988) conclude that the flora of the southern Caribbean rivals some of the richest floras of the Caribbean. For instance, for Puerto Rico, an island much more extensive coastal habitats than Curaçao and possessing the richest known algal flora of the Caribbean, counts a total of 384 different species. The algal flora of Bonaire amounts to 206 species (Vroman & Stegenga 1988). Algal floras of Aruba and Bonaire only have 40% in common. Assuming 60% of species on Bonaire are shared with Curaçao, due to their closer proximity to each other, we estimate the combined marine algal flora of these islands to amount to 350 + 80 = 430 species. The tentative joint nomination property hence has:

Terrestrial fauna and flora (documented for the terrestrial part of the Bonaire National Marine park)

Flora: 76 plants (5 endemic)
Reptiles: 8 species (4 endemic)
Land snails: 12 species (7 endemic)

The current nomination property includes more than 7000 ha (i.e. 7 km^2) of terrestrial coastal mangroves, marshes and woodlands. These are located around the shores of Lac Bay, Bonaire as a formally designated 500 m buffer zone for this RAMSAR site (Geelhoed et al. 2013) and also the Island of Klein Bonaire. Based on biological inventories done for these areas, indicative faunal lists can be provided. This is particularly interesting because of the fact that these islands form part of the Caribbean biodiversity hotspot based on endemic species (Meyers et al. 2000). Many of the endemic terrestrial plant and animal species for these islands also form part of the fauna and flora of the current nomination property. The islands of Curaçao and Bonaire are particularly rich in endemic species. Debrot (2006) lists 221 endemic taxa (179 nominate species) documented for these islands, 163 which are terrestrial or freshwater taxa and 58 which are marine taxa. The extant endemic terrestrial species include 42 vertebrate taxa and 20 gastropod taxa (i.e. 62 taxa), many of which (20, i.e. 33%, see above) are currently represented in the terrestrial component of the Bonaire Marine Park.

The nomination property further borders approximately 26 km of undeveloped shoreline in Curaçao and 130 km of undeveloped shoreline and narrow intertidal habitat in Bonaire. This means that practically all shore and sea birds of these islands actually make use of and are found in the current joint nomination property. The value of adding coastal terrestrial habitat to the Curaçao nomination component should be quite evident.

Based on the available terrestrial faunal and floral inventories, we here provide and discuss the terrestrial biodiversity of the current tentative nomination property. Debrot (1997) provides a faunal inventory for the 6 km large island of Klein Bonaire which formally falls within the nomination property as an integral part of the BNMP. His species list amounts to 76 terrestrial plants, which include the following five endemic plants (sensu Debrot 2006): *Agave vivipare, Mayteneus versluysii, Melocactus macracanthius/curvispinus, Ritterocereus griseus, Subpilocereus repandus, and* two IUCN Red List plants: *Guaiacum officinale* and *Zanthoxylum flavum.*

The area has the following documented terrestrial/ freshwater vertebrates: 35 bird species (33 on list Debrot, 1997 plus *Columba squamosa* and *Butorides rufescens*) of which 6 are endemic subspecies. Debrot (1997) lists 8 reptiles and amphibians for Klein Bonaire, four of which are endemic and 2 of which are endangered sea turtles which intensively nest on the beaches of the island. Twelve freshwater and terrestrial snails have been documented for the island of which 7 are endemic.

The total count for endemic plant, vertebrate and mollusc taxa for Klein Bonaire stands at: 22 species and subspecies. If the documented endemic invertebrates were to be included the total tally would easily exceed 30 endemic terrestrial taxa for this island.

Avifauna: 104 species (9 endemic subspecies)
For Lac Bay, the other principal terrestrial component of the current tentative nomination site, Debrot (1999) compiled 54 documented bird species records. More recent studies on the bird fauna of this site documented 63 species for this area for the fall season of 2011 (Debrot et al. 2014). Based on these newer observations the bird list for the Lac area now exceeds 70 species and includes 9 of the 22 endemic bird subspecies documented for the ABC islands. In addition, based on Debrot (1997, 1999) Prins et al. (2009), Boer et al. (2012), and Debrot et al. (2014), for the nearshore waters and intertidal habitat of the 150 km of coastline of the BNMP and CMP a total of 55 common and 22 rare sea and shorebirds have been documented, as well as a total of 24 common and 3 rare land birds.

Hence, the total documented avifauna for the combined Bonaire and Curaçao nomination property amounts to a total of 104 birds of which 79 species are common while 25 are rare. Of these 9 are endemic subspecies.

Appendix 2 shows a listing of all endemic species according to their distribution between Bonaire and Curaçao. Marine endemic species documented for the BNMP and the CMP amount to 64 species (26 marine molluscs, 31 marine sponges, 5 marine fish, 1 shrimp, 1 echinoderm) so far only known from these islands or else having a very small distributional range in the southern Caribbean). When the terrestrial endemics present in the current Bonaire nomination property are included, the total adds up to 123 endemic taxa (species and subspecies) (Table 12). Combining the Bonaire and Curaçao nomination areas increases the combined number of endemic taxa largely due to the large number of endemic marine gastropod molluscs described for Curaçao. Considered separately, the current Bonaire nomination property (BNMP) has more endemic taxa than the Curaçao nomination property. However, this is only due to the fact that the current Curaçao Underwater Park nomination property has no terrestrial habitat. If the potential Curaçao buffer zones were to be included (e.g. Janthiel and/or Caracasbaai) then the list of combined endemic taxa would increase by more than 20 to between 140 and 150 taxa for the proposed nomination properties.

Table 12. The number of endemic species (and subspecies) in various taxonomic groups contributed to the proposed nomination properties by the nomination properties of Bonaire and Curaçao. The sixty-four marine species indicated with an asterisk (*).

Taxonomic group	**Bonaire**	**Curaçao**	**Bonaire and Curaçao Marine Park**
Annelida	1	0	1
Beetles	16	0	16
Birds	9	9	9
Butterflies	1	0	1
Marine and brackish water fishes*	5	5	5
Heteroptera	3	0	1
Mammals			0
Marine crinoids (Echinodermata)*	1	1	1
Marine Gastropods*	4	25	26
Plants	5	0	5
Pseudoscorpions	1	0	1
Reptiles	4	0	4
Rotatoria		0	0
Scorpions	2	0	2
Shrimps*		1	1
Spiders	1	0	1
Sponges (Porifera)*	31	31	31
Subterranean/freshwater isopods, etc.	8	0	8
Terrestrial Molluscs	7	0	7
Thysanura and Machilida	1	0	1
Ticks	0	0	0
Water-striders	1	1	1
Grand Total	**101**	**81**	**123**

7.6 IUCN Red List species

A total of 56 IUCN Red List species considered Vulnerable (39), Endangered (11) or Critically Endangered (6) have been documented for the current nomination property. If the marine 12-mile zone is added, an additional 9 IUCN Red List species would be offered protection (1 EN, 8 VU) for a total of 65 threatened Red List species.

The Caribbean island marine hotspot hosts a total of 132 marine IUCN Red Listed species (disregarding NT species which have no official status as being threatened). Of these 52 marine species (39%) are present in the nomination which corresponds to less than 1 thousandth of the total Caribbean island marine hotspot area. This indicates a much higher abundance than proportional to surface area. Table 13 provides an overview of these species.

Table 13. List of threatened species found in the joint nomination property (B = Bonaire; C = Curaçao) and 11 of the adjacent 12-mile zone (offshore) based on the Red List criteria CR, EN, VU. Six of the species listed are terrestrial. Of the offshore species listed, two have also been documented from the near shore and reef areas (yellowfin tuna and sperm whale).

Scientific name	Common names (Eng.)	Population trend	Red List Status	Property
Birds				
Hydrobates leucohous	Leach's Storm-petrel	decreasing	VU	BC
Pterodroma hasitata	Black-capped Petrel	decreasing	EN	BC
Amazona barbadensis	Yellow-shouldered amazon		VU	B
Corals - stony				
Montastrea annularis (s.l.)	Boulder Star Coral	decreasing	EN	BC
Acropora palmata	Elkhorn Coral	stable	CR	BC
Dichocoenia stokesii	Elliptical Star Coral	decreasing	VU	BC
Agaricia lamarcki	Lamarck's Sheet Coral	decreasing	VU	BC
Oculina varicosa	Large Ivory Coral	unknown	VU	BC
Dendrogyra cylindrus	Pillar Coral	stable	VU	BC
Mycetophyllia ferox	Rough Cactus Coral	unknown	VU	BC
Acropora cervicornis	Staghorn Coral	stable	CR	BC
Montastrea faveolata	Boulder star coral	decreasing	EN	BC
Montastrea franksi	Bumpy Star Coral	decreasing	VU	BC
Millepora striata	Bladed Box Fire Coral	decreasing	EN	BC
Fish - sharks and rays				
Sphyrna mokarran	Great Hammerhead	decreasing	EN	BC
Manta birostris	Giant Manta Ray	decreasing	VU	BC
Carcharhinus longimanus	Oceanic Whitetip Shark	decreasing	VU	BC
Isurus oxyrinchus	Shortfin Mako	decreasing	VU	BC
Pristis pectinata	Smalltooth Sawfish	decreasing	CR	BC
Rhincodon typus	Whale Shark	decreasing	EN	BC
Sphyrna lewini	Scalloped hammerhead		EN	BC
Alopias superciliosus	Bigeye Thresher Shark		VU	offshore
Alopias vulpinus	Thresher Shark		VU	offshore

Cetorhinus maximus	Basking Shark		VU	offshore
Carcharhinus longimanus	Oceanic white-tip shark		VU	offshore

Fish - teleosts

Kajikia albida	White Marlin	decreasing	VU	offshore
Epinephelus itajara	Atlantic Goliath Grouper	unknown	CR	BC
Coryphopterus alloides	Barfin Goby	unknown	VU	BC
Thunnus obesus	Bigeye Tuna	decreasing	VU	offshore
Megalops atlanticus	Tarpon	decreasing	VU	BC
Rhomboplites aurorubens	Vermilion Snapper	decreasing	VU	BC
Lutjanus cyanopterus	Cubera Snapper	decreasing	VU	BC
Lachnolaimus maximus	Hogfish	decreasing	VU	BC
Epinephelus striatus	Nassau Grouper	decreasing	EN	BC
Psilotris boehlkei	Boehlke's Goby	unknown	VU	BC
Balistes capriscus	Gray Triggerfish	decreasing	VU	BC
Coryphopterus eidolon	Pallid Goby	unknown	VU	BC
Hyporthodus flavolimbatus	Yellowfinned Grouper	decreasing	VU	BC
Hyporthodus niveatus	Snowy Grouper	decreasing	VU	BC
Coryphopterus lipernes	Peppermint Goby	unknown	VU	BC
Mycteroperca interstitialis	Yellowmouth Grouper	decreasing	VU	BC
Mola mola	Ocean Sunfish	decreasing	VU	offshore
Makaira nigricans	Blue Marlin	decreasing	VU	offshore
Coryphopterus personatus	Masked Goby	unknown	VU	BC
Elacatinus prochilos	Broadstripe Goby	unknown	VU	BC
Anguilla rostrata	American Eel	decreasing	EN	BC
Coryphopterus thrix	Bartail Goby	unknown	VU	BC
Thunnus thynnus	Atlantic Bluefin Tuna	decreasing	EN	offshore
Coryphopterus tortugae	Patch-reef Goby	unknown	VU	BC
Coryphopterus venezulelae	Sand-canyon Goby	unknown	VU	BC
Hyporthodus nigritus	Warsaw Grouper		CR	BC
Epinephelus flavolimbatus	Yellowfinned Grouper		VU	BC
Hippocampus erectus	Lined Seahorse		VU	BC

Mammals

Trichechus manatus	West Indian Manatee	decreasing	VU	BC
Physeter macrocephalus	Sperm Whale	unknown	VU	BC
Leptonycteris curaçaoe	Southern long-nosed Bat		VU	B

Plants

Halophila baillonii	Clover Grass (seagrass)	decreasing	VU	B
Guaiacum sanctum	Holywood Lignum-vitae		EN	B
Guaiacum officinale	Roughbark Lignum-vitae		EN	B
Xanthoxylum flavum	West Indian Satinwood		VU	B

Reptiles - turtles				
Chelonia mydas	Green Turtle	decreasing	EN	BC
Eretmochelys imbricata	Hawksbill Turtle	decreasing	CR	BC
Dermochelys coriacea	Leatherback Turtle	decreasing	VU	BC
Caretta caretta	Loggerhead Turtle	decreasing	VU	BC
Lepidochelys olivacea	Olive Ridley		VU	BC

7.7 The key significance of the BCMP to IUCN threatened coral species

The BCMP nomination is of particular significance to many threatened coral species. The two acroporid species present are both listed as Critically Endangered on the IUCN Red List and as Threatened under CITES Appendix II. In many areas of the BCMP these species have been vigorously coming back after they were nearly decimated throughout the Caribbean in the mid-1980s. Two Endangered species, listed on the IUCN Red List, the Boulder Star Coral (*Montastraea annularis*) and the Mountainous Star Coral (*Montastraea faveolata*), dominate the reef community on the deeper fore reef and cover 100% of the bottom in certain areas (MJA Vermeij, pers. obs.). Other coral species listed as Vulnerable under the IUCN Red List are also commonly found, examples include Pillar Coral (*Dendrogyra cylindrus*), Lamarck's Sheet Coral (*Agaricia lamarki*) and the Elliptical Star Coral (*Dichocoenia stokesii*). Colonies of the Pillar Coral on Klein Curaçao are particularly large and abundant compared to the reefs of the main island of Curaçao (MJA Vermeij, unpubl. data). Coral reefs around Klein Curaçao remain in a near-pristine state and are well developed. Reef systems capable of maintaining themselves are becoming increasingly rare and as such Klein Curaçao shelters one of the few remaining healthy Caribbean reef communities and thus serves as a unique representation of Caribbean reef communities in general. Klein Curaçao, along with the eastern reefs of the main island of Curaçao harour the highest average coral covers of the island. The shallow reefs (0 - 4 m depth) of the proposed Ramsar site harbor dense populations of the Elkhorn Coral (*Acropora palmata)* and large stands of Fire Coral (*Millepora complanata*), which both provide complex structural habitats for specific reef fish species that are crucial for these species as hiding places and nursery habitats (Nagelkerken 1974).

“In order to invoke criteria (x) a State Party has to demonstrate that the site is critical habitat for the conservation of species of OUV and / or supports exceptional levels of biodiversity in terms of species and / or habitat richness.” (IUCN 2016). Both the Bonaire and Curaçao components of the proposed nomination possess a diversity of distinct coral reef communities as described in detail by Duyl (1985). Shallow reefs are dynamic, which mean that the exact position of these communities have in many cases changed since their initial description. Nevertheless, these communities with their distinct species associations and appearance are still found in abundance on the reefs of both Bonaire and Curaçao.

The total number of threatened species listed above for Bonaire and Curaçao combined is 65 species. For only Bonaire, which has terrestrial areas inside the nomination property, is also 65 species, but for exclusively Curaçao this is 59 species. Bonaire is also a hotspot for genetic diversity in the most important mangrove species of the Caribbean, *Rhizophoa mangle* (Albrecht et al. 2013). The difference is due to the fact that in contrast to Bonaire, the Curaçao nomination property does not possess terrestrial habitat nor seagrass beds. It should be seriously considered to include some coastal terrestrial habitat in the Curaçao nomination component, as this clearly would boost even further the number of endemic species and contribute to potential OUV.

Finally, the total number of endangered species listed above for the offshore areas (12-mile zone) recommended to serve as buffer zone (for Bonaire) is 15 species. As a consequence, we can conclude that the combination of the proposed Bonaire and Curaçao nomination areas does not significantly add to the list of internationally endangered species.

"Irreplaceability" (uniqueness or rarity) is arguably the most important concept for assessing the potential of a site to be considered of OUV (Schmitt 2011). Due to is geographic location and its unique concentration of biodiversity and endemism the proposed nomination properties may qualify as "irreplaceable" for OUV criteria (x). This makes the Southern Caribbean Marine Ecoregion globally significant for biodiversity as a "non-avian" Key Biodiversity Area (IUCN 2016).

8 Should criteria (x) and (viii) be part of the assessment?

Thanks to a steep bathymetry that also happens to span the whole depth range of active reef growth, together with a complex Pleistocene geological history, the reefs of the Bonaire and Curaçao Marine Parks have been blessed with a diversity of at least 13 reef structural features that combine to make for diverse, variable and exciting reefscapes. No less than 26 different coral reef communities (Duyl 1985) and seven seagrass bed communities (Debrot et al. 2012) have been described for the current nomination properties. Many of these reef features and communities also have important ecological functions for specific groups or organisms (e.g. shelter, spawning aggregations, feeding areas). The high diversity of reef features and habitats can be seen to have contributed to both high Alpha species diversity within the coral communities and high Beta diversity between those communities.

With about 650 marine fish species, 745 marine molluscs, 430 marine algae and 201 marine sponges documented for the joint nomination area, comparative analysis shows that the species richness of many groups surpasses that of other biotically rich areas of the Caribbean. The area as currently defined, possesses 130 island endemic species, which is remarkable by any standards. The largest number of these are accounted for by sponges (31 endemics), marine gastropods (26 endemics), terrestrial beetles (15 endemics) and birds subspecies (9 endemics).

Finally, a total of 56 IUCN Red List species considered Vulnerable (38), Endangered (11) or Critically Endangered (6) have been documented for the current nomination property. Even though the surface area of the nomination property is only a small part of the total area of the Caribbean marine biodiversity hotspot, it is further also home to a large proportion of the Caribbean marine IUCN Red List species requiring protection (42%). Key Biodiversity Areas (KBAs) such as Important Birds Areas (IBAs) are often used to assess criteria (x) (Abdullah et al. 2013). For Bonaire two IUCN IBA's form part of the nomination area, while others are advanced by us as terrestrial buffer zones (see chapter 3). Ideal would be to include these areas as part of the nomination and not as mere buffer zones because then their biodiversity will also contribute to OUV. If they are only included as buffer zones they will only contribute to the integrity of the proposed nomination.

Based on our assessment, we conclude that the nomination property is outstanding in terms of criteria (x). This is contrary to Beek et al. (2014a) who concluded that the BNMP did not fill a gap in terms of habitat types or species. Now, based on our more extensive assessment and inclusion of the CMP as part of the proposed nomination, we suggest, based on the comparative analysis below, that criteria (x) likely represents a criteria displaying OUV.

The high biological diversity and endemism is shown to be a consequence of long-lasting stable conditions favourable to coral reef development that stem from a unique geographical and meteorological situation created by Caribbean plate tectonics. Based on this more extensive geological and geographic assessment, we suggest that criteria (viii) is also a criteria displaying outstanding universal value on which to base a successful nomination.

Nevertheless, the description of geological values we provide in this contribution remains incomplete. However, this is essential for a full discussion and fitting comparative analysis for criteria (viii).

9 Comparative Analysis

9.1 Summary

Spalding et al. (2007) describe 12 ecoregions within the Tropical Northwest Atlantic marine nearshore and continental biogeographic province. This province has less than 1% of its marine province protected by World Heritage and only 3 marine WH sites indicating that this region is not "over represented". None of these sites is present within the Southern Caribbean Ecoregion. We conclude that our Comparative Analysis shows that the joint WH nomination properties seem to fill a regional gap in terms of biodiversity. Our nomination properties belong to marine ecoregions which are not yet well-represented on the World Heritage List.

The Caribbean Islands are also recognized as a biodiversity hotspot (Vaslet & Renoux 2016) and key biodiversity areas have been identified on both Bonaire and Curaçao based on endemic species and/or endangered species present (see Chapter 2). These areas are recognized as Ramsar Sites (Bonaire) or being listed soon (Curaçao).

However coral reefs and associated ecosystems represent a significant proportion by area and number of total natural World Heritage Sites. Beek et al (2014a) expressed doubts about the OUV potential of the BNMP in terms of biodiversity. That may have been premature because in this contribution we have been able to uncover an unusually high concentration of both shared biodiversity and endemism for the BNMP and CMP. Contrary to the preliminary assessment by Beek et al. (2014a) we can conclude that the proposed nomination property (or even likely, either property by itself) appear to be able to fill a gap in terms of biodiversity. This is thanks to the high concentration of species over a relatively small area, as is made possible by the long-standing geographic setting. Our proposed nomination properties lie in a regional hotspot for reef fish and marine gastropod endemism and even for Red Mangrove genetic diversity.

Isolation, together with the longstanding geographical and meteorological buffering of these islands against hurricanes and sediment stress has supported evolutionary processes which allow high biodiversity endemicity in both the terrestrial as well as marine realms. The proposed nomination is an outstanding example of how geological and geomorphologic features are closely entwined with marine biophysical processes. They consequently provide a rich and invaluable record of the ongoing dynamic adaptation of coastal environments to global change and continue to be of great geoscientific interest. The biophysical processes have been discussed by Beek et al. (2014a) and further elaborated here. These processes are expressed as consistently high coral cover and calcification rates, extensive connectivity and genetic exchange. The evolution of nine endemic bird subspecies indicate the active process of evolution and this will continue into the future on these relatively well-protected islands.

The proposed nomination lies in a transitional zone influenced mainly by the steady clear and nutrient-poor Caribbean Current but with an important seasonal enrichment thanks to the unique Southern Caribbean upwelling zone. This creates a unique set of biological and ecological processes that draw many cetacean and seabird species to the southern Caribbean. Frequent sightings of flocks of flamingos, sea turtles and IUCN Red Listed fish species contribute to these reefs consistently scoring among the top dive destinations of the Caribbean Sea.

In this chapter we provide comparative analyses as made possible by the descriptive assessments we provide above. We provide reassessments of the OUV potential of the BCMP nomination area for criteria vii and ix, as first partially done by Beek et al. (2014a) as well as fully new assessments of the OUV potential for values relating to criteria viii and x. Our main conclusions are as follows:

Criteria (vii): We concur with Beek et al. (2014a) and are also not convinced that the BCMP is distinct enough from other islands and coral reefs already inscribed on the World Heritage List to meet the conditions for OUV in criteria (vii).

Criteria (viii): Due to its unique geological, geographic, oceanographic and meteorological situation which has afforded it a longstanding central role within the Tropical Atlantic in terms of biodiversity, the proposed nomination properties might qualifies as "irreplaceable" for OUV criteria (viii). However, our description of current and ongoing geological diversity and processes is not complete, and neither is the comparative analysis.

Criteria (ix): We concur with Beek et al. (2014a), as was the case with their assessment of the single property (BNMP), that the proposed combined property possesses demonstrated resilience, and sufficient inherent and lasting integrity to continue to sustain the local exceptional biodiversity, as well as to continue to fulfil its role as a major storehouse and source of regional biodiversity.

Criteria (x): Comparative Analysis shows that the species richness of many groups surpasses that of other biologically rich areas of the Caribbean and even the Pacific. "Irreplaceability" (uniqueness or rarity) is arguably the most important concept for assessing the potential of a site to be considered of OUV (Schmitt 2011). Due to its unique concentration of biodiversity and endemism, the proposed nomination properties may qualify as "irreplaceable" for OUV criteria (x).

9.2 Introduction

A critical step to demonstrate Outstanding Universal Value is to demonstrate global significance of an area from an international viewpoint (UNESCO 2017, paragraph 52). This is carried out by conducting a "Global Comparative Analysis." IUCN, the Advisory Body on natural heritage to the World Heritage Committee, recommends using biogeographic classification and global conservation priority setting systems to help determine if a nomination "fills a gap" on the World Heritage List. If a nomination is similar to an existing WHS then it is rarely considered to have OUV unless it exceeds the values of the previously nominated property.

Comparing a new nomination to existing WH sites helps to build a case for global significance. As biogeography is based on the differences between regions, if a nomination is located in an unrepresented biogeographic area this finding suggests that the values in a nomination may not already be recognized in existing World Heritage Sites. States Parties are encouraged to consult analyses of the World Heritage List, Tentative Lists (UNESCO 2017, paragraph 71) and to consult specific thematic studies (UNESCO 2017, paragraph 72) such as Abdulla et al (2013), Bertzky et al. (2013) and Mitchell et al. (2013). The comparison between sites helps to rank these areas with the view that those with the highest ranking may be sufficiently distinct to have World Heritage status. It is important to recall that only the World Heritage Committee determines is found to have Outstanding Universal Value and Integrity, and it is only this intergovernmental body that can inscribe a nomination to the World Heritage List. IUCN describes the World Heritage Convention as representing the "geography of the superlative." This chapter aims to determine if the values described for this nomination are outstanding and also sufficiently distinct from other areas to deserve designation as a World Heritage property. The chapter aims to make the case for potential OUV. It needs to be pointed out that many of the values discussed in this report face important threats and have suffered documented declines in recent decades (Debrot et al. 2017a). This report does not address those issues or discuss possible management measures but only focusses on the values present and how these might contribute to potential OUV.

Valid Comparisons

Under criteria (vii) comparisons are valid for all island or marine World Heritage Sites. Many visual and aesthetic aspects of islands such as landscape, water colour and clarity, and seascapes are similar across the globe. The natural phenomenon that may be found in the property such as fish aggregations, significant bird nesting areas or "rookeries" could also be relevant and are not limited to the Caribbean in general. However, the specific species forming the aggregations may be distinct.

For criteria (viii), comparison is required with other sites addressing aspects of Plate Techtonics particularly related to (limestone) island formation or the geomorphological processes related to erosion, sedimentation and reef accretion are relevant. The latter attributes would be limited to latitudes where coral and non-coral reef communities are able to grow. In the Caribbean, valid comparisons can be made with the World Heritage Sites in Cuba and the Lesser Antilles (Dominica and Saint Lucia).

Two important distinctions need to be made for a representative Comparative Analysis for criteria (ix) and (x). Firstly, it must be recognized that Pacific and Indian Ocean coral reef sites are integrally different from Atlantic coral reef sites. These differences are relevant to the assessment of global significance, hence the value in using biogeographic classification systems to support the analysis. As a rule Atlantic reefs have much lower species richness and there are large differences in the dominance of particular fish and coral families. There are also differences in ecological processes; for instance, a recent study on the global disparity in the resilience of coral reefs provides a strong argument for coral reef processes in the Caribbean being distinct from the Indo-Pacific. In their comparison of reefs between ocean basis they found that total herbivorous fish biomass in the indo-pacific averaged threefold higher than in the Caribbean while parrotfish biomass was nearly twice as high as in the Caribbean and the maximum biomass was 12 times higher than in the Caribbean (Roff & Mumby 2012). This suggests a systematic and structural difference between how reefs are structured and function in the different ocean basins. Hence, quantitative comparisons based on common metrics may not be appropriate.

A second major factor to consider in comparing coral reefs is whether they are associated with a larger "continental shelf" or whether they are oceanic in nature. These two classes of reefs also differ structurally in several ways that makes one on one comparison between these categories problematic. Neither of these two matters were considered when Beek et al. (2014a) conducted their preliminary Comparative Analysis.

In this section, the nomination is first compared with 48 marine World Heritage Sites. Due to the large ecological differences between the Atlantic and other oceans, the comparison then focuses on 3 comparable sites in the Tropical North Western Atlantic (3) and 1 comparable site in the Tropical South Western Atlantic (the Fernando de Noronha and Atol das Rocas Reserves of Brazil). It must be kept in mind that the current choice of global WH largely is geared towards comparisons for criteria (x) on biodiversity. As a next step, separate synthesis tables based on different subset of global WH sites might be needed to clarify OUV according to the key attributes for all the relevant natural criteria. This means that as the Comparative Analysis is refined, there may be additions or removals to the current list of 48 WH sites for comparison.

The Caribbean WH sites that require comparison are found in Belize, Cuba, Dominica, Mexico, Saint Lucia and USA. Additional Sites with marine and coastal values can be found on national Tentative Lists e.g. for France (Martinique), Grenada and St Vincent and the Grenadines. A review of protected areas in the region with global recognition has identified additional protected areas particularly worthy of comparison, in particular: the Seaflower Man and Biosphere Reserve in Colombia and the Los Roques Archipelago National Park, a Ramsar Site in Venezuela. These protected areas are not currently on the Tentative List for Colombia or Venezuela. Shortly before any nomination dossier is finalised it will be necessary to review the Global Comparative Analysis with the final boundaries and agreed attributes of OUV and an additional review of the Tentative

List of other Caribbean States Parties to the World Heritage Convention. It may also be appropriate to consider other UNESCO Man and Biosphere Reserves or Ramsar Wetlands.

9.3 Biogeographic gaps

Terrestrial and marine biogeography follow separate yet complementary classification schemes. As BNMP and CMP components have a relatively small proposed terrestrial area this section focuses on marine biogeography. However, as the terrestrial buffer zones could be included as landward extensions or additional components to the nomination it is worthwhile to refer briefly to terrestrial biogeography.

According to Udvardy (1975) the nomination falls into the Neotropical terrestrial biogeographic realm and the Venezuelan dry forest biogeographic province, though the ABC islands were not specifically considered. The Nature Conservancy (TNC) has specifically considered Caribbean island ecoregions and has identified Coastal Venezuelan Mangroves and the Aruba-Curaçao-Bonaire cactus scrub as a distinct type of Xeric Shrublands (Sotomayor 2003) found in both Bonaire and Curaçao and not found in other Caribbean Island States. However, there will be some similarities with ecosystems in Colombia and Venezuela, particularly the Guajira-Barranquilla xeric scrub, a xeric shrubland ecoregion in Colombia and Venezuela (Castellanos & Pardo 2000).

Marine biogeographic classification systems have been developed for nearshore and continental, pelagic and deep-sea realms and provinces. They have been given the greatest attention in the nearshore coastal zone (Spalding et al. 2007, Robertson & Cramer 2014). The nomination falls under the Tropical Atlantic Marine Realm and Tropical Northwestern Atlantic Marine Province (Spalding 2007). The Inter American Seas Pelagic Province (Spalding et al. 2012), which looks at the upper 200m water column in off-shelf waters, would be relevant for any additional components added in the EEZ and the 12 nautical mile territorial sea of Bonaire and Curaçao (Abdulla 2013). For certain areas in the EEZ and territorial sea the benthic biogeographic provinces based on the Global Open Ocean and Deep Sea (GOODS) classification system published by UNESCO would also be relevant (Watling et al. 2013).

The Tropical Northwest Atlantic marine nearshore and continental biogeographic province has less than 1% of its marine province protected by World Heritage and only 3 marine marine WH sites. This indicates that this region is not "over represented". None of these sites is present within the Southern Caribbean Ecoregion. We conclude that our Comparative Analysis shows that the joint WH nomination properties seem to fill a regional gap in terms of marine biodiversity. Our nomination properties belong to marine ecoregions which are not yet well-represented on the World Heritage List. By fulfilling an important "geographic gap" not yet fulfilled in any other WH site, nomination would contribute significantly to the World Heritage Committee's Global Strategy of developing a "balanced and credible" World Heritage List (UNESCO 2017).

In the tropical Northwestern Atlantic, three marine WHS (Belize Barrier Reef, Sian Ka'an in Mexico and the Everglades in the USA) sites that have been enlisted principally for marine values, are all continental shelf properties. The Everglades and Sian'Kaan have a mangrove forest and seagrass bed focus, while only the Belize marine WH site has a strong coral reef component. Several current tentative sites have a predominantly coral reef orientation (e.g. Misquito Keys, Nicaragua, Jardines de la Reina, Cuba, Reef Systems of the Cuban Caribbean, St Vincent and the Grenadines and Grenada (transboundary site) and Martinique) but all are reefs associated with expansive shallow shelf systems. While there are terrestrial sites with some coastal areas that have similar values (e.g. St Lucia and Cuba), there is only one current marine WHS in the Tropical Northwestern Atlantic with a predominant reef focus that are also primarily oceanic in nature. This is the 65,000 km^2 Sea Flower Marine Protected Area of the San Andres Archipelago of Colombia (Taylor et al. 2013). Nevertheless, the Bonaire and Curaçao joint nomination properties remains distinct from other World Heritage Sites and other sites on national Tentative Lists (see also Beek et al. 2014a).

The marine protected area that is geographically close, located in the Southern Caribbean region and most likely to be compared to BCMP is Los Roques Archipelago National Park. It covers 221,120 ha and is one of the largest marine parks in the Caribbean Sea. It is not on any tentative list for nomination but would be an attractive area to add to the network of WH sites in the future. While compared to Bonaire and Curaçao, the available scientific documentation for Los Roques and Aves islands biodiversity has yet to be fully compiled and extensive information is likely to be held in the Universities and institutions in Venezuela and thus possibly mainly in Spanish (see Appendix 1), future extension of the proposed nomination to include Venezuela would be welcome. In the neighbouring Southwestern Caribbean Marine Province, the Seaflower Man and Biosphere Reserve also shared some similar values with the Leeward Islands.

The reefs of Bonaire and Curaçao have developed along relatively steep island slopes in a unique geographic zone with relatively low rainfall and low hurricane impact frequency. Even though predicted climate change may alter some of these conditions in time, these have been and will continue to be relatively unchanging geographic circumstances that will continue to favour reef growth for the near future. Low rainfall and consequently low freshwater and low terrestrial sediment discharge translate into both reduced sediment stress and reduced osmotic stress to which most coral species are quite vulnerable. The generally steep slopes of the reefs further favour rapid removal of sediments from the reef system. This is in contrast to most Caribbean reefs associated with larger islands (and the mainland continental shelves, which have developed in environments with much less bathymetric contrast and in which sediment accumulation create additional stressors to coral growth. Because a large portion of the reefs of the current nomination properties are also typically located at depths greater than 10 m, reef damage due to rare hurricane events has also only been limited to the shallowest sections of the reefs while the deeper reefs have remained healthy as a source of resilience to the shallower reefs. We further indicate that the proximity of the coastal mountain range continental South America serves to deflect normal hurricane force away from the area to allow for long-term relatively uninterrupted reef growth. This has led to some of the most ecologically resilient and high-cover reefs in the Caribbean which have provided the basis for exceptional marine biodiversity and endemism.

In conclusion, we present evidence that shows why the reefs of the southern Caribbean have been and likely will continue to serve as the storehouse of coral biodiversity for the whole tropical Western North Atlantic. Many isolated Pacific reef WH sites have developed unique endemic fauna but yet do not play a demonstrated regional role as source of biodiversity. Our Comparative Analysis found no tropical coral reefs combining a similar interplay between geological, geographic, oceanographic and meteorological properties as the basis for a prolonged and convincing role in the biodiversity of a whole biogeographic province.

9.4 Global Conservation Priorities

There are several global conservation priority schemes which serve to guide global importance for conservation. Of the various schemes available, those most relevant to the BCMP include Terrestrial and marine biodiversity hotspot schemes, Terrestrial and marine Global 200 priority ecoregions and important bird areas (IBAs). Various conservation prioritization schemes recognize the Caribbean as a conservation hotspot (Myers et al. 2000, Vaslet & Renoux 2016). The Caribbean region qualifies as a hotspot due to its high level of endemism of species and due to the threats facing species and habitats.

We here provide some information on relevant IBA's of both Bonaire (Wells & Debrot 2008, Geelhoed et al. 2013) and Curaçao (Debrot & Wells 2008). These are considered to be an important opportunity for conservation in the Caribbean biodiversity hotspot (Anadón-Irizarry et al. 2012). Such an extended scheme could recognize the xeric scrub vegetation and the flamingo nesting area (Wege et al. 2010).

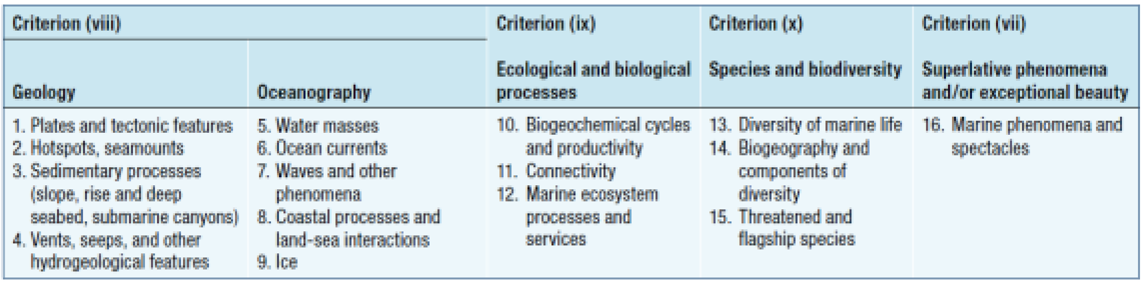
Table 14. Key Biodiversity Areas in the proposed boundaries of the nomination (Vaslet and Renoux 2016).

	All KBA	Proposed Nomination
Bonaire	BON-1 - Bonaire Marine Park BON-2 - Washington- Slagbaai & Dos Pos BON-3 - Terrace Landscape Middle Bonaire BON-4- Klein Bonaire BON-5 - Pekelmeer Saltworks BON-6 - Washikemba- Onima & Bolivia area	BON-1 - Bonaire Marine Park BON-4- Klein Bonaire
Curaçao	CUW-1 - Christoffel- Shete Boka Terrestrial Parks & North-east coast CUW-2 - Malpais-St Michiel & Rif- Marie CUW-3 - Curaçao Underwater Park to Oostpunt CUW-4 - Klein Curaçao CUW-5 - St Jorisbaai and Kueba di Noordkant CUW-6 - San Juan - Santa Cruz & Pos Spaño	CUW-3 - Curaçao Underwater Park to Oostpunt (only some of the KBA is included in CMP)

Table 14 illustrates that a number of KBAs are not included in the current proposed nomination and could be considered as additional components. Such additions would further support the argument for meeting the needs for global conservation priorities.

9.5 Marine World Heritage context

Table 15. Marine World Heritage context for OUV in terms of criteria viii.



Criterion (viii)		Criterion (ix)	Criterion (x)	Criterion (vii)
Geology	Oceanography	Ecological and biological processes	Species and biodiversity	Superlative phenomena and/or exceptional beauty
1. Plates and tectonic features 2. Hotspots, seamounts 3. Sedimentary processes (slope, rise and deep seabed, submarine canyons) 4. Vents, seeps, and other hydrogeological features	5. Water masses 6. Ocean currents 7. Waves and other phenomena 8. Coastal processes and land-sea interactions 9. Ice	10. Biogeochemical cycles and productivity 11. Connectivity 12. Marine ecosystem processes and services	13. Diversity of marine life 14. Biogeography and components of diversity 15. Threatened and flagship species	16. Marine phenomena and spectacles

In order to place BCMP in the context of other natural and mixed World Heritage Sites it is useful to consider which broad natural variables to use for comparison. As BCMP is an island, coastal and marine area and contains coral reefs, seagrass and mangrove habitats these are a useful basis for comparison. It is also relevant to consider areas inscribed under criteria (vii) and (ix), and areas nominated and not inscribed. The biogeographic context in the Neotropics and Caribbean is also important.

Geological, physical oceanographic and biological themes with potential for Outstanding Universal Value under the World Heritage Convention (from Abdullah et al. 2013). The IUCN thematic study on Marine Natural Heritage (Abdulla et al. 2013) identifies 16 themes to guide marine World Heritage nominations, and biogeographic gaps (table above). In the following assessment BCMP exploits the themes relevant to criteria (vii) (aesthetic values), (ix) (ecological processes) and (x) (species, habitats). Criteria (ix) includes marine Theme (10) biogeochemical cycles and productivity, Theme (11) connectivity, Theme (12) marine ecosystem processes and services (Abdulla et al. 2013) (Table 15).

As of October 2014, there were 228 (197 natural and 31 mixed sites) World Heritage properties inscribed under one or more of the four natural criteria: aesthetic values and superlative natural phenomena (vii), geological, geomorphological or earth history values (viii), ecological and biological values (ix) and biodiversity and conservation values (x). Just over 70 of these natural sites are either recognized in the UNESCO World Heritage Marine Programme (46 marine and coastal World Heritage properties) or have coastal and island components that can be added as a potential basis for comparison with BCMP (an additional 26 World Heritage properties).

Only those sites in tropical and semitropical waters where coral reefs are found, between 30 degrees north and 30 degrees south latitudes, are most relevant for comparison. This selection is further refined to sites with significant coral reefs, mangroves and seagrass (or two of these three habitats) resulting in 24 World Heritage Sites identified in Table A3 (Appendix F). Out of this selection several are listed for both criteria (vii) and (ix): Great Barrier Reef, Shark Bay (Western Australia), Belize Barrier Reef Reserve System, Lagoons of New Caledonia, Phoenix Islands Protected Area (Kiribati), Tubbataha Reefs Natural Park (Philippines), Aldabra Atoll (Seychelles), Papahanaumokuakea (USA), Rock Islands Palau, and Rio Platano Biosphere Reserve (Honduras).

Some sites have criteria (vii) but not (ix) in common with BCMP: Ningaloo Coast (Australia), Komodo National Park (Indonesia), Ujung Kulon National Park (Indonesia), Sian Ka'an (Mexico), Puerto-Princessa Subterranean River National Park (Philippines), Lord Howe Island Group (Australia), Pitons Management Area (Saint Lucia). Additional sites have criteria (ix) but not (vii) in common with BCMP: Ogasawara Islands (Japan), East Rennell (Solomon islands), Alexander von Humboldt (Cuba), Everglades (USA), Area de Conservacion de Guanacaste (Costa Rica), and Cocos Island National Park (Costa Rica).

Out of this group, it is possible to set aside sites for which there is little detail on the marine environment (although we keep those in the Caribbean) such as East Rennell, Puerto Princessa and Ogasawara.

Excluded from this comparison in Table 19 are estuarine and wetland sites such as Banc d'Arguin (Mauritania), Bigagos Archipelago (Guinea Bissau), Wadden Sea (Denmark, Germany and Netherlands), The Sundarbans (Bangladesh) and Sundarbans National Park (India) and the high latitude sites (above 30 degrees) in the northern and southern hemisphere without diverse and extensive coral reefs such as the Brazilian Atlantic Islands (Fernando de Noronha and Atol das Rocas Reserves) which are of special significance to our global comparative analysis under criteria (ix). Some sites which are not considered marine WH are also relevant: Desembarco del Granma National Park (Cuba), which has uplifted marine terraces, karst topography and geomorphic features of global significance (UNEP WCMC Datasheets). "The terraces of Cabo Cruz form the most singular coastal landscape in Cuba and are the world's largest and best preserved coastal limestone terrace system.

Most of the marine components of the above properties are not comparable in size and are much larger than the 2,700 hectares of coral reef, seagrass beds and mangroves of the Bonaire National Marine Park. The justification for OUV for Bonaire is its interconnected ecosystem of representative habitats from the shore to intertidal environments and from coral reefs to deep water environments, with associated high biomass of herbivorous fish, particularly parrotfish.

A shortlist of properties with all these habitats and their main features are identified in Table 19 and include the Great Barrier Reef, the Belize Barrier Reef, the Lagoons of New Caledonia, Sian Ka'an, Phoenix Islands, Tubbataha Reefs and Aldabra Atoll.

BNMP ranks lower than existing marine World Heritage sites based on size, area and variety of corals or mangroves or seagrass, size of sea bird flocks or schools of fish. There are no records of spawning aggregations or other superlative natural marine phenomenon in the brief statement of OUV. Further analysis would need to review the IUCN Evaluation report and the nomination dossier.

9.6 Global and regional comparisons

Establishing global significance under any criteria requires a site to be distinct, unique and superlative in some way. However, each criteria has its own specific requirements (UNESCO 2017, Badman et al. 2008).

9.6.1 Criteria (vii), superlative natural phenomena,

To establish global significance under criteria (vii) it is useful to select some attributes for comparison. This section looks at (1) water clarity (as has been documented in many coral reef ecological studies); (2) morphological diversity of the fringing reef based on the diversity of seascape features and distinct biological communities or popularity with divers; (3) reef fish visual sightings by maximum size of schools and maximum size of individual fish; (4) globally endangered species by visual sighting frequency of turtles and redlisted fishes and sharks; and (5) migratory birds in Lac by visual sighting frequency and flock size of flamingos.

The reefs of the proposed nomination are outstanding examples of fringing coral reefs that have evolved to be among the most diverse reefs in the Caribbean. Thanks to longterm environmental stability and exceptional habitat diversity the reefs concerned are among the reefs with the highest cover of living corals in the Caribbean, and have large schools of colourful fish and are of internationally esteemed aesthetic value to divers. This can be ascribed to high water quality (as has been documented in various scientific studies) and which is primarily due to the interplay of favourable geological, oceanographic and meteorological conditions.

In addition, the high per capita GDP has contributed to protect the reefs from over exploitation so common in poorer areas of the Caribbean. Important megafauna such as sea turtles, several IUCN Red Listed fish species and flocks of flamingos are abundant and can be frequently seen. We here describe 13 distinct seascape features and 8 distinct coral reef communities and several seagrass communities that contribute to a complex and attractive diversity of seascapes, each with its own complement of fishes and other associated fauna. Due to their high aesthetic quality of marine life and seascapes in the nomination properties concerned, Bonaire and Curaçao are consistently scored among the top Caribbean dive destinations in the recreational dive literature.

Most of the above attributes are already present in the Belize Barrier Reef, the Sea Flower and the Sian Ka'an Biosphere Reserve.

Beek et al. (2014a) concluded that if BCMP were to use the same arguments for criteria (vii) as existing marine WH properties it would not rank highly. **Even after contributing considerable additional descriptions and documentation towards this criteria we are also not convinced that the BCMP is distinct enough from other areas to meet the conditions for OUV in criteria (vii).**

9.6.2 Criteria (viii)- geophysical, oceanographic and meteorological features

The islands of the Lesser Antilles define an 850-km long curve from Anguilla (Sombrero Island) in the north to Grenada and the Leeward Antilles off the coast of Venezuela (Dutch ABC islands, Aruba). (Vaslet & Renoux 2016). The Leeward Antilles ridge forms a string of islands off the coast of Venezuela.The leeward Dutch Caribbean islands islands were created by collision of the South American and Caribbean tectonic plates. Islands' basement is formed by a succession of deepwater volcanic and sediment deposits of Cretaceous and Early Tertiary origin that have since been uplifted . Islands igneous rocks indicate that they formed as part of a island arc that was situated on the leading edge of a plate moving from the west (Pacific Ocean) into the Caribbean plate. (Iturralde-Vinent 2006, Vaslet & Renoux 2016) Variation of sea level that occurred during the Quaternary epoch, combined with a slow tectonic rise of the islands (which continues today), and active coral reef growth allowed the formation of limestone terraces along the fringes of the islands. (Dutch Caribbean Biodiversity Explorer database). (Vaslet & Renoux 2016)

The leeward Dutch Caribbean islands lie in a strategic upstream location with respect to current flows within the Caribbean and this has allowed them to play an exceptional role for dispersal of marine life throughout the region for the last 9-7 Ma. This is for instance in contrast to the Sea Flower WH site of the Colombian San Andres archipelago that appears to sit at the center of an isolated gyre of the western section of the Caribbean Sea (Prada Triana & Taylor 2011). Due to their geographic position close to the south American mainland, they simultaneously enjoy protection from hurricanes damage. As oceanic islands located just off the continental shelf and having steep volcanic island slopes affords additional protection from sediment and salinity stress. Coastal wind-driven upwelling in the southern Caribbean additionally buffers the coral reefs from bleaching episodes. These same conditions offer the best opportunity for these reefs to maintain a healthy condition and continue to play their important role in the region well into the future.

The conditions for reef development compare favorably to conditions within the Sudan WH site. The latter reefs have developed in the semi-enclosed Red Sea, in an area of widely distributed shallow barrier reefs, and currents driven by water density differences caused by temperature and salinity differences. Temperature and salinity greatly constrain coral reef development in that area, in contrast to our proposed nomination. In other areas, for example in the lagoon of New Caledonia, coral growth is limited by temperature fluctuations caused by shifting cold and warm currents while on the Belize Barrier Reef, coral growth close to shore in the coastal lagoons is limited by the estuaries due to input of fresh water and turbidity. In the proposed BCMP, the lack of terrestrial fresh water runoff, and the persistent flow of clear, nutrient-poor oceanic water results in low levels of turbidity and high light penetration (visibility can even reach 70 m but is generally 20-30 m) and create practically unrivalled conditions for coral reef development.

Aside from possessing strict coral reefs, based on corals, the reef systems of Bonaire and Curaçao also possess actively growing reef-forming communities that extend active calcification and reef formation into habitat zones where corals are unable to form reefs. Hence the coral reefs of these properties are not "just" isolated coral formations, but are complemented by other framework-building communities starting from the shore and extending into deep shelf habitat. To our knowledge, these arguments have rarely been explicated in any coral reef WH nomination bids. Comparison with the Belize Barrier Reef and the Sian Ka'an Biosphere Reserve shows some marked differences and similarities.

Due to is unique geological, geographic, oceanographic and meteorological situation which has afforded it a longstanding central role within the Tropical Atlantic in terms of biodiversity the joint nomination properties could qualify as "irreplaceable" for OUV criteria (viii).

9.6.3 Criteria (ix), ecological processes

The proposed property encompasses all the biophysical and ecological processes that characterise a natural and sustainable coral reef ecosystem: the highest carbonate production rate in the Caribbean, large coral colonies and high parrotfish grazing rate (Beek et al. 2014a). These components of a resilient result in the highest hard coral cover and one of the lowest macroalgal coverages for reefs in the Caribbean (Beek et al. 2014a).

Also, the process of "connectivity" as we have described, is ensured at 5 of the identified 7 levels in the current nomination property. This provides a significant contribution to the integrity of the proposed nomination as does the consistently high water quality due to the combined effects of healthy water circulation and fortuitous (geological and meteorological) factors which restrict sediment and freshwater stressors. With an oasis of marine life in relatively barren tropical ocean waters positioned at a critical upstream position within the Tropical Western Atlantic Province, the proposed nomination has played a key role in the process of reproduction, dispersal and colonization by marine organisms in the entire marine province, as research shows they continue to do today. Coral reefs in the CMP act as a source for coral larvae as corals produce on average up to 200 times more larvae per square meter of reef compared to corals on reefs near developed coasts elsewhere on the island (Hartmann et al. in press). The same is true for fish (Huijbers et al. 2013). These are strong indications of current integrity of the CMP. As reefs in the region continue to rapidly decline, the proposed nomination has demonstrated resilience and has among the highest resilience of coral reefs throughout the Caribbean. It may represent the last best hope for regional coral reefs. It can be anticipated that the relative regional importance of the proposed nomination area's reefs will continue to increase in the future. Beek et al. (2014a) had concluded that the BNMP alone, already "encompasses all the biophysical and ecological processes that characterise a natural and sustainable ecosystem". **We concur with that assessment and conclude that the proposed combined Bonaire and Curaçao nomination possesses sufficient inherent and lasting integrity to continue to sustain the local exceptional biodiversity as well as to continue to fulfil its role as a major storehouse and source of regional biodiversity.**

9.6.4 Criteria (x) Biodiversity

There are two criteria recognised for biodiversity values: (ix) and (x). BCMP can be considered under criteria (x) because of the high documented biodiversity and endemism and the fact that a large range of species representative of the Southern Caribbean ecoregion are present. Tables 15 and 16 present BCMP biodiversity in the form of species richness and compares it to numbers from other marine World Heritage Sites in different tropical regions of the world.

Another aspect of biodiversity is the importance for globally threatened species, this relates to the presentation of Global Conservation Priorities. An overview of 25 near treatened (NT) species, 4 threatened terrestrial species and 52 threatened marine species of coral, sea grass, fish and marine turtles present inside the proposed nomination is given in Table 18. These represent 39% out of a total of 132 IUCN Red Listed marine species for the Caribbean Islands Hotspot (including the whole Western Central Atlantic) (CEPF 2010, IUCN Red List 2014). The extent to which the threatened species are present – quantitatively and proportionally to the species' global occurrence - determines whether this makes BCMP unique and irreplaceable for the protection of species threatened with extinction (Bertzky et al. 2013). Most IUCN Red List species do not appear to congregate in large numbers inside the proposed BCMP except that, with exception of Panama, the sea turtle nesting beach of Klein Bonaire shows the highest Green Turtle and Loggerhead nesting density in all of the Caribbean (Becking et al. 2016).

Bonaire and Curaçao lie within the Caribbean island marine hotspot (Meyers et al. 2000, Wege et al. 2010) which is considered the heart of Atlantic marine diversity (Wege et al, 2010). It is estimated that 8-35% percent of the species from major global marine taxa are found in the hotspot. The shallow marine environment contains 25 coral genera (BCMP has 65 species), 117 sponges (BCMP has 201), 633 molluscs (BCMP has 745!), more than 1,400 fishes (BCMP has approximately 650 on the reefs), 76 sharks (BCMP has 20, Beek et al. 2014b), 45 shrimp, 30 cetaceans (BCMP has 18, Debrot et al. 2011b) and 23 species of seabirds (Wege et al. 2010).

Documented coral diversity is comparable to other Caribbean protected sites but mollusc, sponge algae and fish species numbers are consistently higher (Table 16). The properties even have a higher diversity of marine algae than most Pacific protected sites and comparable documented fish and bird diversity. The least number of meaningful comparisons of documented diversity could be made to Indian Ocean sites.

Table 16: Number of species in Bonaire and Curaçao Marine Parks compared to marine World Heritage sites from other relevant regions.

Region	Coral	Mollusc	Sponge	Algae	Fish	Birds
Caribbean	+/ -	+	++	+	+	-
Indian Ocean	-	NC	NC	NC	+/-	-
Pacific Ocean	-	-	-	+	+/-	+/-

-- : much lower
- : lower
+/- : comparable
+ : higher
++ : much higher
NC: not comparable due to lack of data

When comparing the number of species per unit area between the nomination properties and protected sites in the Caribbean, Indian Ocean and the Pacific, it is clear that the proposed nomination rivals protected sites in all oceans (Table 17). This in part is because of its inherent marine biodiversity and because it is a site of limited size compared to most of the much larger areas. As the size of a protected area increases, the number of additional species protected will slowly become less and ultimately taper off until a maximum is reached in the form of an asymptote. In the case of our nomination area it seems that the asymptote on the species area curve has likely not been reached for many taxa, which would argue for the addition of more marine WH sites in the future. On the other had large protected areas can encompass the complete life cycles of many more species rather than a small proportion of its range.

Table 17. Species richness density of Bonaire and Curaçao Marine Parks compared with marine World heritage sites from other relevant regions.

Region	Coral	Mollusc	Sponge	Algae
Caribbean	+	++	++	++
Indian Ocean	+	++	++	++
Pacific Ocean	+	++	++	++

-- : much lower
- : lower
+/- : comparable
+ : higher
++ : much higher

To make a similar comparison for the degree of endemism between WHS, data for endemic species of other WHS is necessary. Data on the number of endemic species for other WHS is poorly available and rarely used as an argument for OUV. As this has rarely been reported for other WHS, proper comparison cannot be made between the BCMP and other actual or potential WH sites.

Eventhough the proposed nomination clearly bustles with biodiversity, it does not host all endangered species for the Caribbean island hotspot. The number of IUCN Red Listed marine endangered species documented for the Caribbean and Western Central Atlantic is 132 species. This area, better known as FAO Fishing Area 31, stretches from North Carolina to Brazil and has a total surface area of about 15 million km^2 of which 1.9 million km^2 comprises shelf area (< 200 m deep) (Stevenson 1981). With a total area of much less than 1-thousandth the size of FAO Fishing Area 31, the waters of the proposed nomination area are known to harbour 52 marine threatened species (after excluding terrestrial and NT species, Table 18). This is a very high proportion (39%) of the total number of threatened marine species for the Greater Caribbean considering the small size of the proposed nomination and is largely due to the fact that most IUCN Redlisted marine species have a wide distributional range.

Table 18. IUCN threatened species found in the current BCMP nomination areas, including the current terrestrial areas (of the BNMP). UNESCO does not make comparisons based on NT species. While these are listed for general reference they have been excuded from calulations and comparative analysis.

Tax. group in Bonaire Curaçao MP	NT*	VU	EN	CR	Grand Total (NT excluded)
Birds	4	2			2
Corals - stony	2	6	3	2	11
Fish - sharks and rays	8	3	3	1	7
Fish - teleosts	10	20	2	2	24
Gastropods	1				0
Mammals - bats		1			1
Mammals - cetaceans		1			1
Mammals - manatee		1			1
Plants - seagrass		1			1
Plants - terrestrial plants		1	2		3
Reptiles - turtles		3	1	1	5
Grand Total	**25**	**39**	**11**	**6**	**56**

Tax. group	NT	VU	EN	CR	**Grand Total** **(NT excluded)**
WC Atlantic marine spp.	46	81	35	16	132
BCMP **marine only**	25	37	9	6	52
BCMP/WC Atlantic ratio marine spp. Only!	54%	44%	26%	37%	39%

When including the current terrestrial habitat, total of 56 IUCN Red List species considered Vulnerable (39), Endangered (11) or Critically Endangered (6) have been documented for the current nomination property. Finally, if the marine 12-mile zone is added, an additional 9 IUCN Red List species would be offered protection (1 EN, 8 VU) for a total of 65 Red List species.

Table 19. A comparison of selected marine World Heritage Sites species diversity by taxonomic group. Source: adapted from IUCN World Heritage Evaluation Report, 2012 UNEP WCMC/ UNEP SPAW Protocol.

Tropical North Atlantic	**Site**	**Natural criteria**	**Size (ha)**	**Corals**	**Molluscs / Sponges**	**Algae**	**Fishes**	**Birds**
Netherlands	**BNMP & CMP**		**4,860**	**65**	**745/201**	**430**	**650**	**104**
Mexico	**Banco Chinchoro BR**	(vii)(x) Not inscribed	144,360	95	104 / 35	135	199	135
Colombia	**Seaflower BR**		65,000 km2.	48 (scleractinian) 54 (octocorals)	28 / ? 23 crustacean/ 17 echinoderm	163	300	155
Venezuela	**Los Roques Archipelago National Park**		221,120 (210,064 marine)	61	140/60 200 Crustaceans 45 Echinoderms		304	92
Belize	**Belize Barrier Reef**	(vii)(ix)(x)	96,300	100	?	247	500	187
Cuba	**Desembarco del Granma National Park**	(vii) (viii)	32,576 ha: 26,180 ha terrestrial and 6,396 ha marine (Altitude : -180m to 460m.)					
USA	**Everglades**	(viii)(ix)(x)	592,920	?	?	?	275	366
Mexico	**Sian Ka'an**	(vii)(x)	528,000	83	103 / 24	171	175	339
	Other World Heritage Sites							
Australia	**Great Barrier Reef**	(vii)(viii)(ix)(x)	34,870,000	600	4,000 / 1,500	450	1,625	242
Brazil								
Vietnam	**Ha Long Bay**	(vii)(viii)	150,000	232	211 / 19+	91	400	200
UK	**Henderson Island**	(vii)(x)	3,700	29	305 / ?	?	190	19
France	**Lagoons of New Caledonia**	(vii)(ix)(x)	1,574,300	510	802 / 151	322	1,695	105
Australia	**Ningaloo Coast**	(vii)(x)	705,015	300	650 / 155	1	738	200
Kiribati	**Phoenix Islands Protected Area**	(vii) (ix)	40,825,000	200			500	44
Palau	**Rock Islands Southern Lagoon**	(vii) (ix)(x)	85,00	401		119	746	56
Australia	**Shark Bay**	(vii) (viii)(ix)(x)	2,197,300	95	218		323	230

Comparative Analysis (Table 19) shows that the species richness of many groups surpasses that of other biotically rich areas of the Caribbean and even the Pacific. "Irreplaceability" (uniqueness or rarity) is arguably the most important concept for assessing the potential of a site to be considered of OUV (Schmitt 2011). **Due to its unique concentration of biodiversity and endemism the joint nomination properties may qualify as "irreplaceable" for OUV criteria (x).** Due to lack of scientific study in Venezuela, it is not clear what values can be expected in Los Roques and the Aves Islands (other than size and shark nursery habitat) that are not already present in the proposed nomination.

9.7 Integrity and resilience

The factors underlying integrity are intactness and wholeness. More specifically, to meet the conditions of integrity, a property must (UNESCO 2017):

a) include all elements necessary to express its Outstanding Universal Value;
b) be of adequate size to ensure the complete representation of the features and processes which convey the property's significance; and
c) must not suffer from adverse effects of development and/or neglect.

Considerations that can help address the requirements of integrity and resilience (aside from the listed a) posessing all essential habitat "elements", b) having adequate size and c) management to limit effects of development) include the use of buffer zones and ecological corridors.

9.7.4 Elements necessary to express OUV

Common to all criteria

- All features or attributes needed to support OUV
- All required habitats

Criteria (vii)

- Landscapes/seascapes and views/vistas to appreciate aesthetics
- Range of geophysical conditions that delimit or constrain the ecology and biodiversity

Criteria (viii)

- Full range of ecological processes and elements needed to maintain such processes into the future

Criteria (ix)

- Range and variety of habitats and communities
- Connectivity between populations, communities and habitats

Criteria (x)

- Sufficient number of individuals to support a species' population
- Sufficient area of habitat to support a population
- Sufficient life cycle stages
- Significant proportion of a global population

9.7.2 Essential habitats, processes and size

Small protected areas can be vulnerable to insufficient size to maintain sufficient habitat to support ecological processes and healthy populations of communities of species. In the marine environment in particular, many organisms have large ranges with life cycles taking place throughout a single or even multiple ecoregions. This is the case for most marine mammals, marine turtles and many birds (e.g. shorebirds, wading birds and seabirds). For many species there is a critical threshold of the population below which survival may not be viable.

Natural WH sites range in size reflecting the needs of OUV and integrity. Therefore, in its evaluation reports, IUCN, regularly comments on the size of components The smallest sites tend to have OUV based on features that are easily incorporated into a relatively small area e.g. Puerto Princessa, Philippines and Vallée de Mai Seychelles where…."the size of existing biodiversity sites varies greatly over several orders of magnitude (Table 20), from less than 1 km^2 in the Vallée de Mai Nature Reserve (Seychelles) to more than 400,000 km^2 in the marine Phoenix Islands Protected Area (Kiribati)" (Bertzky et al. 2013) "on average, the 156 biodiversity WH sites (mean size 16,149 km^2 and median size 3,014 km^2) are considerably larger than other natural and mixed WH sites (2,859 km^2 and 471 km^2), and 92% of all existing biodiversity sites exceed 100 km^2, with 67% even exceeding 1,000 km^2."

The WHS Operational Guidelines (UNESCO 2017) define serial properties as properties that include two or more component parts which are not contiguous but re etc. some functional linkages. Thee component parts can be located in a single country (serial national property) or in multiple countries (serial transnational property). Serial properties can be nominated as a whole series during one nomination cycle, or in parts over several nomination cycles. Single properties can also become serial properties through the subsequent addition of component parts.

Serial approaches allow OUV to be recognized where a single property cannot sufficiently capture the key values, and thus would fail to meet the criteria and/or conditions of integrity (Engels et al. 2009). In the case of serial properties, the WH Convention requires the series as a whole – and not necessarily its individual component parts – to be of OUV. However, the Operational Guidelines further specify that "each component part should contribute to the OUV of the property as a whole in a substantial, scientific, readily defined and discernible way" (UNESCO 2017). Such approaches are particularly relevant in the biodiversity context where functional linkages, or connections, are not only common but often critical, and occur at multiple scales. Together with buffer zones, serial approaches can also improve the resistance and resilience of biodiversity WH sites.

A serial approach is especially recommended wherever several candidate sites represent the same ecoregion or ecosystem type, but where individual sites imight be too small to meet the criteria and/or conditions of integrity on their own. In addition to size, one way to address the ecological sustainability of protected areas is by ensuring corridors of connectivity that allow dispersal.

Table 20. Comparison of size of proposed components with existing World Heritage, Ramsar and Man and Biosphere Reserves in the Caribbean. Information pertinent to marine OUV comparisons is given in bold letters.

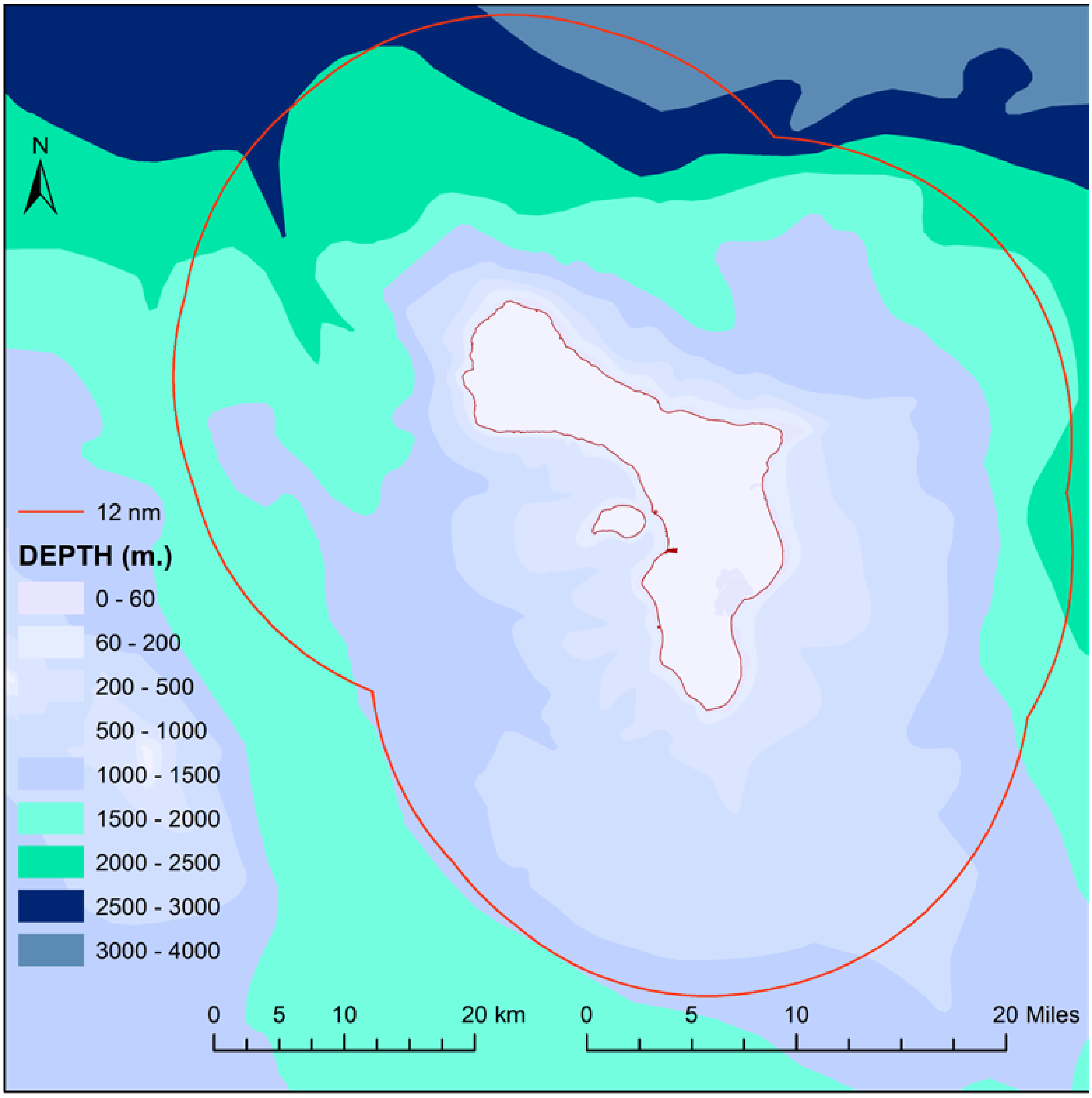
Country: site	**Designation**	**Surface area**	**Features**
Netherlands: BNMP + CMP	**Proposed Nomination**	**4860 ha (3940+920)**	From -80 m to 0m.
Belize: Belize Barrier Reef	Marine WH Site	96,300 ha	
Colombia: Seaflower Biosphere Reserve	UNESCO MAB	650,000 ha	From –4000 m to 2 m
Cuba: Alejandro de Humboldt National Park	WH (not marine)	71,140 ha **2,641 ha marine area** 220 m depth	From -220m to 1,168m
Cuba: Desembarco del Granma National Park	WH (not marine)	41,863 ha **6,396 ha marine area** 32,576 ha: 26,180 ha terrestrial and **6,396 ha marine with a terrestrial buffer zone of 9,287 ha.**	From -180m to 460m.
Mexico: Banco Chinchorro Biosphere Reserve	UNESCO MAB Nomination rejected by the WH Committee	144,360 ha	
Mexico: Sian Ka'an Biosphere Reserve	Marine WH Site	528,000 ha, **120,000 ha marine area**	
Saint Lucia: Pitons Management Area	WH	2,909 ha and 2,909 ha and **875 ha marine area** marine area	
Venezuela : Archipiélago Los Roques Ramsar Site	Ramsar	213,220 ha	
Venezuela : Laguna de la Restinga	Ramsar	5,248 ha	

9.7.3 Boundaries and buffer zones

In its evaluation reports, IUCN regularly comments on the boundaries of nominations and the components for serial sites. For instance, it:

- Considers the future addition into the inscribed property of areas of the transport corridor currently designated as buffer zones, if warranted, to provide additional protection to migratory patterns; (In this case the latter would particularly regard areas of the territorial sea and EEZs adjoining the two marine parks and linking them; Fig. 43)

- Requests the States Parties to consider the future enlargement of components in consultation with IUCN and the World Heritage Centre, to at least the established minimum size of 50 ha, and to strengthen the protection level within buffer zones and the improvement of ecological connectivity especially between component parts, and further recommends interested States Parties to ensure that component parts included in any future extensions exceed minimum requirements to fully meet integrity, protection and management requirements;



Depth (m.)	Area (ha)
60	4432.4
200	7522.9
500	31825.6
1000	92284.2
1500	85273.8
2000	76512.3
2500	39942.2
3000	15526.9
4000	5833

Figure 43. Proposed areas in the Territorial Sea and EEZ surrounding Bonaire as additional components or buffer zones.

No specific marine zones deeper than 60m have yet been identified for the buffer zone or potential additional components.

Table 21 provides some examples of how the case can be strengthened for OUV by adding additional marine areas to the nomination in addition to BNMP and CMP.

Table 21. How adding components in the open ocean/deep sea or extending the marine boundaries seaward could strengthen the case for OUV and improve integrity.

Attribute	**BNMP & CMP**	**12 nautical mile zone & EEZ** (Beek 2016) see map in Annex
Species		+ Undescribed (new to science) + Migratory species such as the threatened sea turtles, sharks and marine mammals
Island Endemic	130	
Fish species	650	+ 300-350
IUCN Red List species	56	+ 9
Depth	60m	> 60m
Habitats and communities	Reefs seagrass beds and mangroves	Rhodoliths Deep reef habitat +undocumented habitats and communities
Seabed features		seamounts
Processes/connectivity		c) shallow reef and deep reef, e) epipelagic and mesopelagic, f) island to island
Biogeography	Southern Caribbean Marine Ecoregion	+Interamerican seas pelagic province

9.7.4 Threats and resilience

As one of the key values of the property is its high degree of naturalness. It is therefore imperative to avoid any further developments that could lead to fragmentation of the property. In other words, "naturalness" must not only be present but also must be ensured for the future by taking the proper management measures.

Provision of sustainable tourism and recreation is an important management objective and subject to major spatial and management restrictions through zoning. In spite of these measures, there are concerns about growing tourism and recreation driven by increased visitation e.g. associated with cruise ships. Such demand could increase with the World Heritage designation of the park. Invasive alien species, which is a key threat throughout the region (including both marine park areas (Debrot et al. 2011), requires effective control measures particularly to avoid impacts to the fragile fresh and brackish water ecosystems that are present in the property. The following matters need to be considered and where appropriate, must be addressed through management.

- Habitat loss
- Invasive species
- Fisheries and unsustainable use
- Coastal development
    - Pollution, eutrophication and coral disease
    - Habitat loss
- Climate change
    - Hurricanes, storm surge and wave action
    - Sea level rise
    - Sea temperature rise
    - Ocean acidification

9.7.5 Protection and management

In principle, a designated protected area has "clearly defined geographical spaces, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature [...]" (Dudley 2008), and therefore already has legal protection and management in place.

As both components of the nomination are recognised as protected areas in Bonaire and Curaçao, this suggests that these areas are protected from threats. However, as neither BNMP nor CMP were established with the proposed OUV and World Heritage in mind, it is necessary to ensure that the legal protection and management addresses and mitigates the possible effect of threats to the OUV represented inside the nomination area(s). Such threats can occur within the proposed boundaries e.g. through destructive fishing practices or habitat degradation. As the marine area are not no-take zones, and therefore subject to some fishing activities as well as recreational use, specific considerations are needed to ensure the proposed attributes of OUV are fully incorporated into protection and management measures. Threats, e.g. from coastal development or shipping/cruise ships, outside the boundaries of the property could also pose impact potential OUV inside the boundaries e.g. by releasing pollution in the form of solid waste or effluent; or by harming migratory or wide-ranging species.

The steep reefs of these oceanic islands do not lend themselves easily to destructive modern mechanized commercial fishing as is typical of continental reefs, and fishing remains largely artisanal up to this day. These islands form an intricate part of the Dutch Kingdom and have been blessed with among the highest per capita GDP in the Caribbean region. As poverty much less compared to most of the Caribbean, there is also much less pressure to exploit the fish stocks. Also from a management perspective, Curaçao and Bonaire differ from other Caribbean islands. Although there is fishing pressure on both islands, gear types are limited predominantly to gill netting of baitfish and legal hook-and-line fishing. Though enforcement is not absolute, Bonaire and Curaçao are uncommon in the Caribbean in maintaining legal limitations against spearfishing (Hoetjes et al. 2002). Consequently, limited exploitation due to the combined effects of socio-economics and management contribute to the relatively high total fish biomass observed by for instance Sandin et al. (2008) and Steneck et al. (2015). The most severe forms of exploitation and man-caused environmental deterioration seen elsewhere have been averted. Furthermore, on both islands, the important contribution of biodiversity to sustainable development are widely recognized such that the reefs are actively managed and form part of the tourism strategy for sustainable economic development. Particularly in the case of Bonaire, the level of coral reef management is internationally recognized as being exemplary (Dixon et al. 1993, 1994, 2000). For instance, along with three other Marine Protected Areas, the Bonaire National Marine Park, was designated as a best practice demonstration site by the International Coral Reef Action Network (ICRAN) in 2001.

The Yarari Marine Mammals and Sharks Sanctuary (or “Yarari Sanctuary”) was officially established in 2015 over the EEZ of the Dutch Overseas Territories (OTs) of Saba and Bonaire. Along with the nearby 143,256 km^2 French AGOA Sanctuary and other western North Atlantic marine mammal sancturaries (which include the Dominican Republic, Bermuda and USA) Yarari forms part of a network of protected areas to guarantee essential habitat to large migratory species like threatened marine mammals and sharks. The Netherlands government continues taking active steps towards effective implementation of the Yarari Sanctuary (Debrot et al. 2017b).

9.8 Conclusions

The global comparative analysis identified several opportunities to build the case for BCMP as a distinct and important area potentially worthy of international recognition.

Less than 1% of the North West Tropical Atlantic Province has protection through World Heritage, and there is no coverage in the Southern Caribbean. In addition to the importance for marine biogeography, the terrestrial desert and xeric shrublands found in Bonaire and Curaçao and Venezuelan mangrove ecosystems are not yet represented on the World Heritage List or on any national Tentative Lists. The integrity of BCMP is guaranteed by the terrestrial protected areas which conserve several coastal areas, including five Ramsar sites in Bonaire and proposed sites in Curaçao.

By combining the Curaçao and Bonaire marine parks for a nomination consisting of two components for UNESCO WH designation, yields a system that is large and diverse enough to encompass most ecological processes needed to ensure conditions for ecological resilience. The research further emphasizes the biogeographic geographic unicity of the area, in combination with favourable environmental conditions and high habitat diversity, as the evident cause of the high documented level of marine biodiversity. The nomination area is clearly part of a unique southern Caribbean biogeographic province and possesses much more (hidden) endemicity than heretofore realized.

While attributes of OUV are present within the proposed boundaries of BCMP, additional values could be included with an enlarged marine and terrestrial area. Furthermore, a larger area would greatly enhance the integrity and protection afforded to the values. Possible marine extensions could include Klein Curaçao, mangrove and seagrass areas in Curaçao and deeper area of the seabed and pelagic areas in both territorial seas and the shared EEZ. Whether or not the boundaries are extended it is highly recommended that terrestrial and marine buffer zones are included to ensure connectivity between the two components and the terrestrial protected areas on both islands.

Quality Assurance

Wageningen Marine Research utilises an ISO 9001:2008 certified quality management system (certificate number: 187378-2015-AQ-NLD-RvA). This certificate is valid until 15 September 2018. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V.

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Annex 1: Los Roques and Las Aves Archipelagos, Venezuela: potential UNESCO World Heritage site

by

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Abstract

The Los Roques and las Aves oceanic coral reef archipelagos of Venezuela lie in a biogeographically unique area of the Caribbean and possess extensive lagoonal seagrass beds mangroves and shallow macroalgae meadows rich with sea life. These areas form part of a biogeographic unity together with Bonaire and Curaçao as part of the Leeward Antilles ridge islands. Both archipelago's are areas of low human impact. While the Aves islands remain uninhabited and are an area of restricted fishing activity, Los Roques, has been a managed park since 1972. While both archipelago's represent similarly rich biodiversity values, Los Roques has been much better documented than Las Aves. Los Roques is the largest coral reef marine protected area of Venezuela. It is about 157 km from Venezuela's mainland coast and covers about 225,153 ha. It is a recognized Important Bird Area (IBA) of Venezuela on account of its large seabird breeding colonies. Notwithstanding year-round habitation by about 1500 people and receiving 75 thousand visitors a year it has among the lowest levels of human ecological impact in the Caribbean and represents intact and well-connected coastal ecosystems. Recent assessments show that it also possesses exemplary fish faunas (Elise et al. 2017), that may be considered as a benchmark for overfished coral reef fish faunas throughout the region. In 2012, Los Roques was designated as a shark sanctuary on account of its documented importance as a shark nursery area. Local park management enjoys broad community support from the various stakeholders who have a convergent and largely shared vision regarding a sustainable future for the park. Thanks to effective management Los Roques has also successfully maintained its importance to seabird colonies for the last 50 years since the earlies surveys. Even though the area has been found to be vulnerable to climate change and how this appears to affect regional oceanographic processes, the geographic location of these archipelago's, the current management regime, and which largely safeguard them from most hurricane damage, and the current management regime, have been effective in protecting the unique biodiversity and coastal ecosystems of these intact coralline island systems.

Introduction

We here provide a preliminary assessment for the option of seeking a Transboundary World Heritage nomination including the Los Roques Archipelago National Park, and Aves archipelago, Venezuela. These two island groups are located along a line stretching east from Bonaire. Los Roques is a wetland of exceptional importance as a reservoir of food resources and biodiversity. In 1996 it was included in the list of wetlands protected by the Ramsar Convention (Convention on Wetlands of International Importance- rsis.ramsar.org) ratified by Venezuela in 1988. This Venezuelan national park was founded in 1972 (Decree N° 1.061- Creation of Los Roques National Park). It is about 157 km from Venezuela's mainland coast and covers about 225.153 ha the entire park including its internal and surrounding waters (Rodriguez 2003) of the so-called "Ecoregion Southern Caribbean Sea" (wwf.panda.org). Los Roques (11°51′27″N 66°45′27″W) is unique in being an atoll that formed on a non-volcanic island (Méndez 1978). Its highest point is 130 m and its deepest waters are up to 1700 m deep. The existence of numerous keys (42) and two large coral barriers, one from north to south (24 km) and the other from east to west (32 km) provides a variety of marine environments ranging from sandy beaches, rocky beaches with strong waves, very calm water bays, coastal or barrier reefs, mangrove areas, lagoons and salt, among others (Rodriguez 2003). The Aves islands, are distributed in two clusters; Aves de Barlovento (12°01′00″N 67°14′00″W) and Aves de Sotavento (11°58′48″N 67°39′23″W), which lie almost precisely between Bonaire and Los Roques (Fig 1) and consist of small, low-lying sandy or mangrove vegetated islands. Together with other islands like Curaçao and Bonaire that lie in a band along the coast of Venezuela, these archipelago's are all islands of the Leeward Antilles ridge. This ridge was formed by subduction of the Caribbean plate under the South American continental plate (Silver et al. 1975). This process began at least 75 Ma years ago, long before closure of the Central American isthmus (Iturralde-Vinent 2006, Neill et al. 2011). Their geographic position off the northeast coast of south America has remained unchanged since the upper Miocene (7-9 Ma) (Itturalde-Vinent 2006). Both archipelagos (Los Roques y Las Aves) form part of the climatic subzone lying in a band from Cumaná in Venezuela to Santa Marta in Colombia, along the Caribbean Coast Range. These include the lesser Antilles from Margarita island to Aruba (Ginés & Yepez, 1960). These areas share oceanographic and climatic characteristics such as low rainfall, clear oligotrophic oceanic waters and sea surface temperatures that fluctuate between 25 and 29ºC during the course of the year (Cervigón 1992).

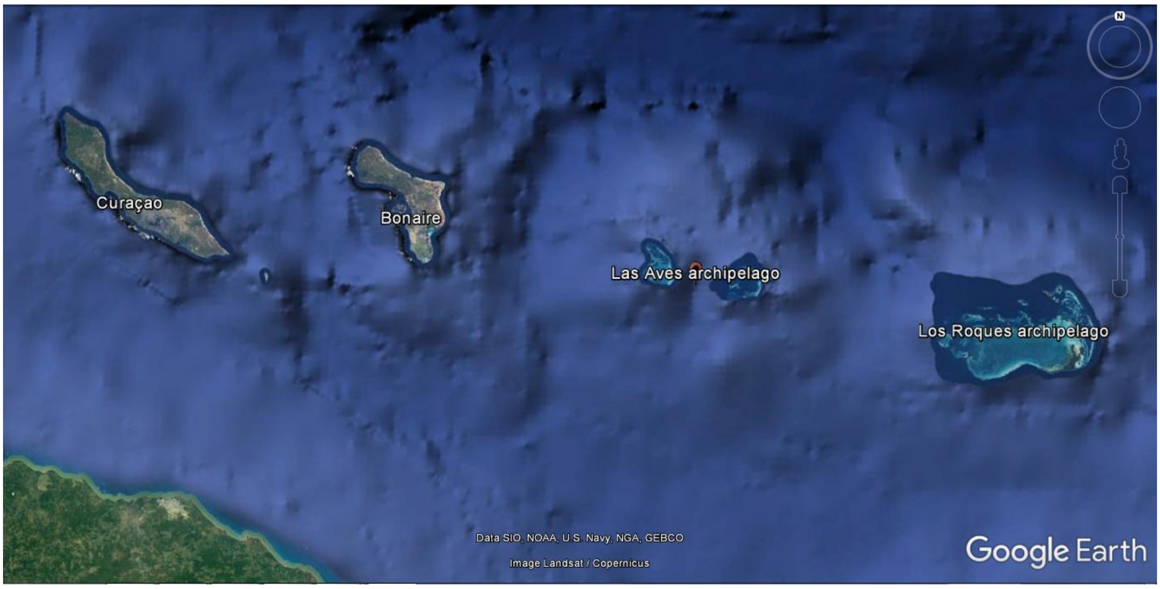

Fig. 1. Google earth overview of Curaçao, Bonaire, las Aves and Los Roques, in front of the Venezuelan coast.

Fig. 2. Drone image of Aves de Barlovento islands, Venezuela, November 2016. The large island in foreground is Isla Sur and the island to the left in the background is Isla Oeste. (Photo: J. van Eenennaam).

Biodiversity

Together with the ABC islands of the Dutch Caribbean both archipelago’s lie in an area of exceptional biodiversity (Miloslavich 2010). Bustamante (2002) and Bustamante and Paris (2008) identify the Southwest Caribbean Islands (from Bonaire to Los Roques) as an ecoregion without a World Heritage Site (WHS) and thus highlight the value of designating such an area. They consider that a WHS based on one or more islands or island groups in the Southwest Caribbean Islands ecoregion to meet the following criteria: 1) outstanding biological and geological value; 2) relatively high conservation status; 3) threatened by current or potential intensive use (tourism and fishing); 4) includes no-take areas; 5) a focus for local, national and international conservation efforts and organizations; and 6) located in a marine ecoregions with poor WHS representation (Bustamante & Paris 2008).

Much more information is available on the biodiversity of the ABC islands than for the two Venezuelan archipelago’s discussed here. This is for instance in part reflected in in a much lower documented species number per km of coastline for Venezuela (37/km) than for the ABC-islands (117/km) (Miloslavich et al. 2010). However, even much less remains known about the coral reefs of the Las Aves archipelago than about those of the Los Roques archipelago. These undisturbed, biodiverse archipelago’s merit much more scientific and conservation attention than they have so far been granted, and the scientific literature on these archipelagos is both scarce and scattered. To help draw attention to the biodiversity of these areas and to serve as a primer to further initiatives, we here present a new ecological and conservation synthesis and bibliography.

Early information on the biodiversity of the Aves islands are given by de Buisonjé et al. (1957), van der Werf et al. (1958) and Ginés and Yepez (1960). In 2011, 14 coral species and between 20 and 40% of coral cover was documented from a number of stations in the Aves islands by A. Yranzo (A. Yranzo -unpublished data). Alevizon & Brooks (1975) reported coral cover levels as high as 75 - 85% three and a half decades earlier. Like the general situation of coral reefs in the Caribbean, reefs from Los Roques National Park have been affected by diverse factors such asdiseases and climate change just like in other areas of the world (Villamizar 2014). Bastidas et al. (2012) describe extensive coral mortalities in Los Roques after a major bleaching event in 2010. For instance, on monitoring reefs declines in coral cover between 1999 (Villamizar et al. 2003) and 2011 amount to an average of about 37% (Villamizar et al, 2014). Nevertheless the barrier reefs, fringing reefs, patch reefs and bank reefs of this Park, remain the most coral-diverse oceanic reef system of Venezuela, and one of the best conserved in the Caribbean. Notwithstanding important outbreaks of white band disease among the acroporid corals of Los Roques (Cróquer et al. 2005), the park protects one of the few areas of the Caribbean that has retained relative high densities of *Acropora* reefs (Villamizar et al. 2014), since the mid-1980 when the species declined precipitously throughout the Caribbean. The area has been found to be vulnerable to climate change and how this appears to affect regional oceanographic processes (Villamizar & Cervigón 2017). The archipelago boasts about 61 species of corals, 200 species of crustaceans, 140 species of molluscs, 45 species of echinoderms, 77 species of sponges (also Diaz et al. 1987) and about 370 species of fish, including 23 species of sharks (Ramírez & Cervigón, 2003; Tavares, 2005).

Several recent marine biological inventories have been conducted. For instance, Jimenez *et al.* (2014) recently describe no less than 49 species of mollusc associated with the reef-building *Orbicella annularis*. Gomez *et al.* (2014) describe no less than 53 species of macroalgae associated with reefs between 12 and 22 m. Other papers giving information on marine macroalgae and seagrass beds of Los Roques are by Garcia and Gomez (2007), Gomes et al. (2013) and Vera (1993). More than half of the species found constituted new records for Los Roques. Reef surveys for corals have been recently reported by Villamizar *et al.* (2014) while Noriega and Fuentes-Carrero (2014) provide a recent assessment of reef-associated echinoderms. Finally, Peres-Castresana *et al.* (2014) provide new information on reef-associated phytoplankton of Los Roques, while Yranzo and Villamizar (2014) describe 22 species of reef-associated octocorals (Fig. 3). Lopez et al. (2008) studied cryptofauna associated with dead coral colonies. The most abundant taxonomic groups were sipunculids (57.29%), followed by polychaetes (20.45%), and crustaceans (14.76%). Petrash et al. (2012) studied thrombolites created by microbial mats in the shallow waters of a restricted hypersaline lagoon at Los Roques and generated insights with which to better understand lithification in Precambrian microbialites.

Fig. 3. Luxurious gorgonian stands at Cayo Sal, Los Roques Archipelago, 2015. (Photo A. Yranzo).

Alevizon and Brooks (1975) reported 44 species of fishes from patch reefs in the Aves islands. Croquer et al. (2010) discuss 2003 and 2004 monitoring data on the benthic and fish communities of Dos Mosquises Sur and Madrizquí at Los Roques National Park, and Caiman and Cayo Norte at Morrocoy National Park. While as with coral communities, fish community structure did not change over time, and fish communities were dominated by herbivores (Pomacentridae, Scaridae and Acanthuridae), large piscivores (e.g. Lutjanids and Serranids) were significantly more abundant in Los Roques than in Morrocoy (see also Posada et al. 2003). However, fish densities are high in protected areas; for example, ~16 individuals/10,000 m² were observed in Bonaire, where it has been protected since 1979 (J.H. Choat pers comm. 2012) and 9.30 ± 3.79 ind/1,000 m² were recorded in Los Roques, where fishing is restricted (Debrot et al. 2008). During a one-week visit to Aves de Barlovento, in November 2016, J. van Eenennaam observed ample Baracuda, *Sphyraena barracuda*, Bar Jacks, *Caranx ruber*, Spanish Mackerel, *Scomberomorus maculatus*, Cero Mackerel, *S. regalis*, Wahoo, *Acathocybium solandrii* Shirki/Wowo Amarillo, *Lutjanus vivanus,* Sabonechi, *Etelis oculatus* Rondu *Rhomboplites aurorubens*, Gatu, *Epinephelus guttatus*, Yellow-mouth Grouper, *Mycteroperca interstitialis*, Amberjack, *Seriola spp.,* Black Jack, *Caranx lugubris,* and also large West-Indian topshell, *Cittarium pica* This would suggest that the populations of large reef and reef-associated piscivores are in fairly good condition. Boomhouwer et al. (2010) and Romero et al.(2011) tried to predict and verify spawning aggregation sites at Los Roques based on physical reef characteristics and local fisherman knowledge. Elise et al. (2017) compared fish populations of 21 areas including Marine Protected Areas throughout the Caribbean. Of these Los Roques Archipelago, was the most isolated. They found that Los Roques displayed the highest species richness, density of piscivores, and an abundance of large species of all areas studied and recommend that Los Roques may serve as a benchmark for healthy reef fish assemblages in the Caribbean (Fig. 4).

Fig 4. Large coral formations, high coral cover and adult snappers at Madresqui island, Los Roques Archipelago, March 2015. (Photo: A. Yranzo).

On the other hand, it is important to note in the mollusk group, the presence of the queen conch or pink conch (*Lobatus gigas*) which is the largest gastropod mollusk in the Caribbean region (Appeldoorn, 1997; Chakalall and Cochrane, 1997, cited by Shapira 2007), and it is considered that there is a significant population in archipelago Los Roques (Fernández 2002). Brownell (1977) and Weil and Laughlin (1984) studied reproduction and growth in various *Lobatus* species of Los Roques. At the regional level, there are various governmental agreements for the extraction and marketing of this mollusk in the Caribbean. *Strombus gigas* is included in the list of Endangered Species of the World Conservation Union (IUCN), and in November 1992 was included in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). In 2000, a general moratorium was established for capture of conch, prohibiting take throughout the year. The same holds for both Aves islands. Work (1969) discusses the ecology and systematics of 125 species of molluscs of Los Roques. Los Roques is also home to the rare endemic cone shell, *Conus duffyi*, a species listed as VU by the IUCN Red List (Petuch 1992). More recently, this species has been considered to be a subspecies of *Conus mappa* (Kohn 2014).

Of all crustaceans, lobsters have the highest ecological value and tradition of fishing in the archipelago. The three species reported for Venezuela, *Panulirus argus*, *P. guttatus* and *P. laevicauta* are present. The most abundant of these species is *P. argus* and has been studied in the archipelago by many authors (Cobo *et al.* 1972. Ginez *et al.* 1978; Ginez and Rodriguez 1979; Soriano 1984; Hauschild and Laughlin 1985; González and Posada 1988). Recent quantitative lobster stock assessment are lacking, so the current population status of the species remains unknown. However, the substantial increase in catches over the years allows us to infer that this species is in a vulnerable situation.

With regard to sharks in the archipelago have been reported up to a total of 23 species, some of which have their populations located in the area and others are frequent or temporary visitors because of its character of oceanic and migratory species. The most common species in the Archipelago Los Roques are blacktip sharks (*Carcharhinus limbatus*), caribbean reef shark (*Carcharhinus perezi*), lemon shark (*Negaprion brevirostris*) and cat shark (*Gynglimostoma cirratum*). Through research studies (mark-recapture), made by Tavares (2001a, 2001b, 2005 and 2007) has been determined that the archipelago Los Roques is a shark breeding area; for example where the young are born and remain until reaching adulthood. Since the focus of the conservation of species, this aspect is quite relevant because the archipelago would be producing new recruits or individuals who eventually played and will replace those that have been extracted from the population "via fishery". Towards implementing its Plan de Acción Nacional (PAN) for the conservation for sharks, in June 2012 Venezuela designated Los Roques as a shark sanctuary (Official Gazette N°39.947). Recent research (e.g Tavares 2005, 2008, 2009) had demonstrated the importance of the shallow waters of Los Roques as a shark nursery area.

Fig. 5. Black mangrove stand (Avicennia germinans) on Isla Oeste, Aves de Barlovento islands, Venezuela, November 2016. (Photo: J. van Eenennaam).

The flora of Los Roques amounts to 34 plant species, most prominent of which are four mangroves: the red mangrove, black mangrove, white mangrove and buttonwood. The vegetation includes several catci such as melocacti and Opuntia and candelabra cacti primarily on Gran Roque (Inparques, 2017). Bisbal (2008) discusses the terrestrial vertebrates of these island groups. May-July in 1973, LeCroy (1978) documented 37 species of birds during six weeks on Francisquí, Los Roques. Since then, 92 bird species, more than half of which are migratory, have been documented from the archipelago and the islands also possess important seabird rookeries. Important nesting colonies can be found of the brown pelican (*Pelecanus occidentalis*), the red-footed booby and brown booby (*Sula sula* and *S. leucogaster*), the laughing gull (*Larus atricilla*), the common, least, and bridled terns (*Sterna hirundo, S. antillarum, S. anaethetus*), the brown noddy (*Anous stolidus*) and the lesser noddy (*Anous minutus*) (Luy 1997, Lentino & Rodner 2002, Bosque et al. 2002, Escalans 2003, Escalans et al. 2009) (Fig. 6). More than 90 species of marine and terrestrial birds have been reported for Los Roques Archipelago (Lentino et al. 1994) and new species continue to be added (Fernández-Ordóñez et al. 2015). A black-colored subspecies of the bananquit (*Coereba flaverola lowii*) is endemic to Los Roques while the local yellow warbler (*Dendroica petechia obscura*) and common ground-dove (*Columbina passerina tortugensis*), are only found in the Venezuelan Caribbean Islands (Lentino, et al. 1994). On account of its exceptional value as a seabird breeding area Birdlife International recognizes the Parque Nacional Archipiélago Los Roques as one of Venezuela's 72 Important Bird Areas (IBA's) (Lentino & Escalans 2009, Denevish et al. 2009). Based on recent surveys, Bosque et al. (2015) conclude that, in contrast to many other areas in the Caribbean where seabird nesting populations have been in decline, all the major the seabird nesting colonies of Los Roques National Park as documented 45 years earlier, were still active in 2001 and maintained comparable breeding populations. In 1973, during a visit to the Aves Islands, AOD saw extensive breeding by both brown boobies (on the ground) and red-footed boobies (in the mangroves) at the westernmost anchorage of Isla Sur.. At that time fishermen robbed booby nestlings to use as bait in fish traps (AOD, pers. comm.). Today the Aves Islands remain an active seabird breeding area (Fig. 6).

Fig. 6. One of about 50 nests of the Brown Booby, Sula leucogaster, on Isla Oeste, Aves de Barlovento, November 2016. (Photo: J. van Eenennaam).

Four sea turtle species nest in Los Roques (Guada 2003). Of particular importance are the nesting beaches for the hawksbill turtle, *Eretmochelys imbricata* (De los Llanos 2002). Terrestrial reptiles include the endemic lizard subspecies *Gonatodes vitattus roquensis*, *Cnemidophorus nigricolor*, (SCNLS 1956) and *Gynmnodactylus antillensis* also found in Bonaire, Curaçao, La Orchila, Las Aves. An updated checklist of reptiles of these islands is provided by Rivas et al. (2012) while new additions continue to be made. Most recently Ugueto et al. (2013) established the presence of *Gymnopthalmus lineatus* and *Thecadactylus rapicauda* for the Aves archipelago. The only native land mammal of the archipelago is the fishing bat (*Noctilio leporinus*) (Gondelles 1997). Los Roques is undoubtedly visited by at least six cetaceans: *Balaenoptera edeni, Megaptera novaeangliae, Delphinus* sp., *Stenella frontalis, Stenella longirostris*, and *Tursiops truncatus* (Acevedo 2001).

History and Economy

In 1866, the Dutch began extraction of guano from Los Roques. Many current names of keys in the archipelago originated during this period when these islands still had no permanent habitation (e.g. Northeast Key: Nordisquí, Sails Key: Selesquí) (ParksWatch 2002). While the archipelago has been used by man since prehistoric times as a conch fishing area (e.g. Schapira et al. 2009), permanent habitation only began about the middle of the 20th century (ParksWatch 2002). Antczak (1991, 1993) Antczak and Antczak (1991, 1999 2005), Antczak and Antczak (2015) and Antczak et al (2017) report extensively on the pre-colonial archaeology of the Los Roques archipelago and the archipelago of Las Aves. Since 1963, the Los Roques Scientific Foundation (FCLR), has run a Marine Biology Station on Dos Mosquises Island. Until 2010, science at the station has resulted in 105 scientific publications, 16 technical reports, 58 thesis and 28 other reports and publications (Molina 2010). However, in 2014 the government revoked the concession to the FCLR (Decree 0270 published in the Official Gazette N. 40.443, June 30, 2014) and passed it over to an organization named FUNDAMAR, which has yet to get started.

Lobster fishing has long been an important fishery in Los Roques. This industry is centred around the village of Gran Roque Island with 1471 inhabitants for year 2011 (Instituto Nacional de Estadística, 2014) and which it produces approximately 40% of the lobster for consumption in Venezuela. About 19.912 kg of lobster are extracted annually during the season by roughly 228 fishermen (Insopesca pers. comm.). In recent years, tourism has replaced fishing as the main economic activity. More than 75 thousand tourists, visit annually (Inparques, 2017), staying in one of the 60 available lodges. Garcia-Melon et al. (2012) studies stakeholder views according to an Analytic Network Process based on questionnaires. They conclude that over the last decades since its inception in 1972 the interaction between the various stakeholders of the park (tourists, inhabitants, authorities, environmentalists, tour operators, etc.) appear to have effectively converged to a common and largely shared vision regarding sustainable development strategies for the future of the Los Roques National Park (Garcia-Melon et al. 2012).

Nature management

Los Roques is managed since 1972 by the National Park Institute (INPARQUES- Official Gazette N° 4.106; Decree N° 276) and Territorio Insular Francisco de Miranda (Official Gazette N° 39.797) is responsible for administrative aspects since 2011.

The management plan makes use of zonation and distinguishes seven management zones. This zoning plan is currently being updated (Taller de Trabajo para la Elaboración del Documento Técnico de la Propuesta de Revision y Actualización del Poru del Parque Nacional Archipiélago Los Roques; Min. Poder Popular para Ecosocialismo y Aguas). The task of nature management falls under the National Parks Institute (INPARQUES), while fishery management is the responsibility of Ministry of Fisheries and Aquaculture, through the Socialist Institute of Fishing and Aquaculture (INSOPESCA) in cooperation with INPARQUES and the National Guard. Up to 2002, INPARQUES has seven park guards and one superintendent based on a small annual budget of about US $30,000. This is only a small portion of the funds available to the AUA (US $418,505 from entrance fees alone) (ParksWatch 2002). The current situation is not well known because of the lack of official information.

Lack of staff and funding has meant that illegal fishing and overfishing has always been a serious problem (ParksWatch 2002). When the lobster season is closed from February through September, queen conch poaching intensifies (Matos 2000). Fishing in restricted zones is a frequent occurrence as is under-reporting of catches (up to 80% under reporting) and the poaching of sea turtles. In 2002 De Los Llanos (2002) found 30% of the nests laid by the four species of sea turtles to have been poached.

Future prospects

Los Roques has a generally good state of environmental conservation, and enjoys a great extent of community support. Major issues that need to be better addressed are the lack of adequate personnel and infrastructure, illegal fishing and pollution. Continued growth, both of the tourist industry and the resident population present major challenges for the future (ParksWatch 2002).

Conclusions

The Los Roques and las Aves oceanic coral reef archipelagos of Venezuela lie in a biogeographically unique area of the Caribbean (Miloslavich et al. 2010) and possess extensive lagoonal seagrass beds mangroves and shallow macroalgae meadows rich with sea life. These areas form part of a biogeographic unity together with Bonaire and Curaçao as part of the Leeward Antilles ridge islands. Both archipelago's are areas of low human impact. While the Aves islands remain uninhabited and are an area of restricted fishing activity, Los Roques, has been a managed park since 1972. While both archipelago's represent similarly rich biodiversity values, Los Roques has been much better documented than Las Aves. Los Roques is a recognized Important Bird Area (IBA) of Venezuela on account of its large seabird breeding colonies (Lentino & Escalans 2009). Notwithstanding year-round habitation by about 1500 people and receiving 75 thousand visitors a year, it has among the lowest levels of human ecological impact in the Caribbean and represents intact and well-connected coastal ecosystems (Elise et al. 2017). Recent assessments show that it also possesses exemplary fish faunas (Elise et al. 2017), that may be considered as a benchmark for overfished coral reef fish faunas throughout the region. In 2012, Los Roques was designated as a shark sanctuary on account of its documented importance as a shark nursery area (Tavares 2008). Local park management enjoys broad community support from the various stakeholders who have a convergent and largely shared vision regarding a sustainable future for the park (Garcia-Melon et al. 2012). Thanks to effective management Los Roques has also successfully maintained its importance to seabird colonies for the last 50 years since the earlies surveys (Bosque et al. 2015). Even though the area has been found to be vulnerable to climate change and how this appears to affect regional oceanographic processes (Villamizar & Cervigon 2017), the current management regime, and the geographic location of these archipelago's which largely safeguard them from most hurricane damage, have been effective in protecting the unique biodiversity and coastal ecosystems of these intact coralline island systems.

In terms of biodiversity and management, the Los Roques Archipelago National Park and the even better-protected Aves islands to the east and towards Bonaire are without question, an excellent partner for a Transboundary World Heritage site nomination. As soon as feasible, this very promising option for a transboundary cooperation should be pursued. In our exploratory contacts, the Venezuelan scientific and NGO communities have shown great interest in pursuing such a course of collaboration. As the waters of the BNMP and the EEZ sector surrounding the island also have already been designated as a shark sanctuary, collaboration with Venezuela on this highly migratory group of endangered fishes also offers interesting possibilities.

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Annex 2: Endemic species of the Bonaire and Curaçao Marine Parks. Principally from Debrot (2006) and with new additions courtesy of Rob van Soest for a total of 123 endemic taxa.

Scientific name	Taxonomic group	Occurrence*	Marine/Terrestrial /Buffer#	Source Reference
Amazona barbadensis rothschildi	Birds	B	t	Voous, 1957, 1983
Butorides striatus curacensis	Birds	B, C	t	Voous, 1957, 1983
Coereba flaveola bonairensis	Birds	B	t	Voous 1957, 1983
Caprimulgus cayenensis insularis	Birds	B, C	t	Voous, 1957, 1983
Dendroica petechia rufopileata	Birds	B, C	t	Voous 1957, 1983
Myiarchus tyrannulus brevipennis	Birds	B, C	t	Voous 1957, 1983
Tiaris bicolor sharpei	Birds	B, C	t	Voous 1957, 1983
Vireo altiloquus bonairensis	Birds	B, C	t	Voous 1957, 1983
Zenaida auriculata vinaceorufa	Birds	B, C	t	Voous 1957, 1983
Brephidium exilis ssp.	Butterflies	B, C	t	Debrot et al. 1999, Miller et al. 2003
Poecilia vandepolli	Fresh- and brackishwater fishes	B, C	m	Poeser 1992
Rivulus marmoratus bonairensis	Fresh- and brackishwater fishes	B, C	m	Hoedeman 1958
Emblemaria culmensis	Marine fishes	B, C	m	Robertson & Cramer (2014)?
Haptoclinus dropi	Marine fishes	B, C	m	Robertson & Cramer (2014)?
Liopropoma santi	Marine fishes	B, C	m	Robertson & Cramer (2014)?
Opistognathus nsp	Marine fishes	B, C	m	Robertson & Cramer (2014)?
Leptonycteris nivalis curasoae	Mammals	B, C	t	Husson 1960b, Petit 1996
Natalus tumidirostris tumiditrostris	Mammals	B, C	t	Husson 1960b, Petit 1996
Davidaster n. sp.	Marine crinoids (Echinodermata)	B, C	m	Meyer and Cornett, in prep.
Nemaster grandis	Marine crinoids (Echinodermata)	B, C	m	Meyer et al. 1978
Bailya marijkae	Marine Gastropods	C	m	Diaz 1995, Jong & Coomans 1988
Calotrophon velero	Marine Gastropods	B, C	m	Diaz 1995, Jong & Coomans 1988
Cerodrillia hannyae	Marine Gastropods	C	m	Jong & Coomans 1988
Chicoreus spectrum	Marine Gastropods	B, C	m	Diaz 1995, Jong & Coomans 1988
Conus attenuatus	Marine Gastropods	C	m	Diaz 1995, Jong & Coomans 1988
Conus aurantius	Marine Gastropods	B, C	m	Jong & Coomans 1988
Conus hieroglyphus	Marine Gastropods	C	m	Jong & Coomans 1988
Crassispira candace	Marine Gastropods	B	m	Jong & Coomans 1988
Crassispira mennoi	Marine Gastropods	C	m	Jong & Coomans 1988
Cypraeolina antillensis	Marine Gastropods	C	m	Diaz 1995, Jong & Coomans 1988
Daphnella louisae	Marine Gastropods	C	m	Jong & Coomans 1988
Decipifus kristenseni	Marine Gastropods	C	m	Diaz 1995, Jong & Coomans 1988
Latirus angulatus	Marine Gastropods	B, C	m	Diaz 1995, Jong & Coomans 1988
Latirus eppi	Marine Gastropods	C	m	Diaz 1995, Jong & Coomans 1988
Murex consuelae	Marine Gastropods	C	m	Diaz 1995, Jong & Coomans 1988
Murexiella macgintyi	Marine Gastropods	C	m	(overcollected, rare) Diaz 1995, Jong & Coomans 1988
Muricopsis huberti	Marine Gastropods	C	m	Diaz 1995, Jong & Coomans 1988
Muricopsis praepauxillus	Marine Gastropods	C	m	Diaz 1995, Jong & Coomans 1988
Persicola cypraeoides	Marine Gastropods	C	m	Diaz 1995, Jong & Coomans 1988
Persicula cordorae	Marine Gastropods	C	m	Diaz, 1995 Jong & Coomans 1988
Persicula muralis	Marine Gastropods	B, C	m	Diaz 1995, Jong & Coomans 1988
Phyllonotus margaritensis	Marine Gastropods	B, C	m	Diaz 1995, Jong & Coomans 1988
Pusiolina veldhoveni	Marine Gastropods	B, C	m	Diaz 1995, Jong & Coomans 1988
Risomurex withrowi	Marine Gastropods	B, C	m	Diaz 1995, Jong & Coomans 1988
Terebra curaçaoensis	Marine Gastropods	C	m	Diaz 1995, Jong & Coomans 1988
Vasum capitellum	Marine Gastropods	B, C	m	Diaz 1995, Jong & Coomans 1988
Agave vivipara	Plants	B, C	t	Proosdij 2001
Cereus repandus	Plants	B, C	t	Proosdij 2001, Hoyos 1985
Maytenus versluysii	Plants	B, C	t	Proosdij 2001, Freitas and Rojer 2000
Melocactus macracanthos	Plants	B, C	t	Proosdij 2001, Thomson 2005, Antesberger, 1990, 1995
Stenocereus griseus	Plants	B, C	t	Proosdij 2001, Hoyos 1985
Garypus bonairiensis	Pseudoscorpions	B	t	Beier 1936, Tooren 1995
Anolis bonairensis	Reptiles	B	t	Wagenaar-Hummelinck 1940a
C. m. ruthveni	Reptiles	B	t	Wagenaar-Hummelinck 1940a
Gonatodes antillensis	Reptiles	B, C	t	Wagenaar-Hummelinck 1940a
Phyllodactylus martini	Reptiles	B, C	t	Wagenaar-Hummelinck 1940a
Diplocentrus hasethi	Scorpions	B, C	t	Wagenaar-Hummelinck, 1940b
Rhopalurus hasethi	Scorpions	B, C	t	Wagenaar-Hummelinck, 1940b
Salmoneus arubae	Shrimps	C	m	Holthuis 1990
Selenops curaçaoe	Spiders	B, C	t	Ayalón García 2001.
Acanthancora coralliophila	Sponges (Porifera)	B, C	m	Van Soest, 1984
Antho (Acarnia) pellita	Sponges (Porifera)	B, C	m	Van Soest, Meesters & Becking, 2014
Asteropus niger	Sponges (Porifera)	B, C	m	Hajdu & van Soest, 1992
Batzella fusca	Sponges (Porifera)	B, C	m	Van Soest, 2009
Calyx magnoculata	Sponges (Porifera)	B, C	m	Van Soest, Meesters & Becking, 2014
Caminus carmabi	Sponges (Porifera)	B, C	m	Van Soest, Meesters & Becking, 2014
Clathria (Microciona) acarnoides	Sponges (Porifera)	B, C	m	Van Soest, Meesters & Becking, 2014
Clathria (Microciona) hymedesmioides	Sponges (Porifera)	B, C	m	Van Soest, 1984
Clathria (Thalysias) collosclera	Sponges (Porifera)	B, C	m	Van Soest, 2009
Clathria (Thalysias) isodictyoides	Sponges (Porifera)	B, C	m	Van Soest, 1984
Crella (Grayella) beglingerae	Sponges (Porifera)	B, C	m	Van Soest, 2009
Dercitus (Halinastra) arubensis	Sponges (Porifera)	B, C	m	Van Soest, Beglinger & de Voogd, 2010
Discodermia adhaerens	Sponges (Porifera)	B, C	m	Van Soest, Meesters & Becking, 2014
Forcepia (Forcepia) minima	Sponges (Porifera)	B, C	m	Van Soest, 2009
Forcepia (Leptolabis) microlabis	Sponges (Porifera)	B, C	m	Van Soest, 2009
Geodia curacaoensis	Sponges (Porifera)	B, C	m	Van Soest, Meesters & Becking, 2014
Hymedesmia (Hymedesmia) agariciicola	Sponges (Porifera)	B, C	m	Van Soest, 1984
Hymedesmia (Hymedesmia) bonairensis	Sponges (Porifera)	B, C	m	Van Soest, 2009
Hymedesmia (Hymedesmia) palmatichelifera	Sponges (Porifera)	B, C	m	Van Soest, 1984
Mycale (Paresperella) vitellina	Sponges (Porifera)	B, C	m	Van Soest, 2009
Neopetrosia dutchi	Sponges (Porifera)	B, C	m	Van Soest, Meesters & Becking, 2014
Neopetrosia eurystomata	Sponges (Porifera)	B, C	m	Van Soest, Meesters & Becking, 2014
Neopetrosia ovata	Sponges (Porifera)	B, C	m	Van Soest, Meesters & Becking, 2014
Plakinastrella stinapa	Sponges (Porifera)	B, C	m	Van Soest, Meesters & Becking, 2014
Strongylacidon poriticola	Sponges (Porifera)	B, C	m	Van Soest, 1984
Strongylacidon unguiferum	Sponges (Porifera)	B, C	m	Van Soest, 2009
Strongylacidon viride	Sponges (Porifera)	B, C	m	Van Soest, 1984
Strongylamma baki	Sponges (Porifera)	B, C	m	Van Soest, 1984
Timea curacaoensis	Sponges (Porifera)	B, C	m	Van Soest, 2009
Xestospongia arenosa	Sponges (Porifera)	B, C	m	Van Soest & de Weerdt, 2001
Xestospongia wiedenmayeri	Sponges (Porifera)	B, C	m	Van Soest, 1980
Curassanthura halma	Subterranean/freshwater isopods, etc.	B, C	t	Kensley 1981, Wagele 1982, Wagele & Brandt 1985
Mesocyclops intermedius	Subterranean/freshwater isopods, etc.	B	t	Pesce 1985
Metacyclops botosaneanui	Subterranean/freshwater isopods, etc.	B	t	Pesce 1985
Psammogammarus caesicolus	Subterranean/freshwater isopods, etc.	B, C	t	Stock 1980, Vonk & Stock 1987
Psammogammarus longidactylus	Subterranean/freshwater isopods, etc.	B	t	Vonk & Stock 1987
Saliweckelia emarginata	Subterranean/freshwater isopods, etc.	B, C	t	Stock 1977b, Vonk & Stock 1987
Saliweckelia holsingeri	Subterranean/freshwater isopods, etc.	B	t	Stock 1977b
Thermocyclops tenuis longifurcatus	Subterranean/freshwater isopods, etc.	B	t	Pesce 1985
Brachypodella raveni	Terrestrial Molluscs	B, C	t	de Jong & Kristensen 1968
Cerion u. uva	Terrestrial Molluscs	B, C	t	de Jong & Kristensen 1968
Cistulops raveni	Terrestrial Molluscs	B, C	t	de Jong & Kristensen 1968
Gastrocopta curacoana	Terrestrial Molluscs	B, C	t	de Jong & Kristensen 1968
Microceramus bonairensis	Terrestrial Molluscs	B, C	t	de Jong & Kristensen 1968
Stoastomps walkeri	Terrestrial Molluscs	B	t	de Jong & Kristensen 1968
Succinea gyrata	Terrestrial Molluscs	B, C	t	de Jong & Kristensen 1968
Tudora aurantia	Terrestrial Molluscs	B	t	de Jong & Kristensen 1968
Tudora maculata	Terrestrial Molluscs	B	t	de Jong & Kristensen 1968

* B: Bonaire; C: Curacao

\# Marine (m)/Terrestrial (t)/Buffer (b)

Appendix 3: Landsverordening 19 Jan 2017

A° 2017 N° 1

PUBLICATIEBLAD

LANDSVERORDENING van de 19de januari 2017 tot wijziging van het Eilandelijk Ontwikkelingsplan Curaçao (A.B. 1995, no. 36) (herziening Oostpunt)

In naam van de Koning!

De Gouverneur van Curaçao,
In overweging genomen hebbende:

dat het Eilandelijk Ontwikkelingsplan Curaçao op 25 augustus 1995 door de eilandsraad van het eilandgebied Curaçao is vastgesteld en afgekondigd;

dat op grond van de Eilandsverordening Ruimtelijke Ontwikkelingsplanning Curaçao voor belanghebbenden de gelegenheid bestond om in beroep te gaan bij de Gouverneur tegen het Eilandelijk Ontwikkelingsplan Curaçao, en het Eilandelijk Ontwikkelingsplan Curaçao ten dele niet in werking kon treden voordat door de Gouverneur in de beroepen was voorzien;

dat bij Landsbesluit van de 6de maart 1997 no.1 no.902/JAZ ten aanzien van het Eilandelijk Ontwikkelingsplan Curaçao in beroep werd beslist dat de eilandsraad een nieuw besluit dient te nemen aangaande de volgende gebiedsclusters: Oostpunt, Popo, Wechi, Jan Kok en omgeving en Siberie/Fontein en omgeving;

dat als gevolg van een juridisch geschil inzake de gronden te Oostpunt tussen de eigenaren van deze gronden, de erven Maal, en het eilandgebied Curaçao, de besluitvorming ter zake is aangehouden;

dat op 25 augustus 2010 tussen de erven Maal en het eilandgebied Curaçao een vaststellingsovereenkomst tot stand is gekomen, waardoor het vorenbedoelde geschil is geëindigd;

dat de partijen bij de bovengenoemde vaststellingsovereenkomst zich hebben verbonden om tot een totaaloplossing te geraken in het kader van de thans door het land Curaçao, als rechtsopvolger van het eilandgebied Curaçao, gewenste economische ontwikkeling op het eiland in het algemeen en een verantwoorde grootschalige ontwikkeling van de gronden te Oostpunt in het bijzonder;

1 - 2 -

dat het wenselijk is dat wordt overgegaan tot de ontwikkeling van de gronden te Oostpunt en dat daarbij in aanmerking wordt genomen het belang van het respecteren van de natuurlijke waarden, de culturele waarden en de bijzondere landschappen van dat gebied opdat er sprake zal zijn van een duurzame ontwikkeling;

dat in verband met het bovenstaande het Eilandelijk Ontwikkelingsplan Curaçao dient te worden herzien, met inachtneming van bovengenoemd Landsbesluit van 6 maart 1997 en met inachtneming van een door externe deskundigen verricht onderzoek naar de gronden te Oostpunt;

Heeft, de Raad van Advies gehoord, met gemeen overleg der Staten, vastgesteld onderstaande landsverordening:

Artikel I
Het Eilandelijk Ontwikkelingsplan Curaçao wordt als volgt gewijzigd:

A. Er wordt een nieuwe bestemmingskaart no. 1 en bestemmingskaart no. 2 voor het gebied Oostpunt ingevoegd, zoals die is opgenomen in de bijlage bij deze landsverordening.

B. Artikel 3 wordt als volgt gewijzigd:

1. Aan artikel 3, tweede lid, wordt een onderdeel toegevoegd, luidende:

l. Voor zover het de gronden te Oostpunt betreft, geldt hierbij dat de ontwikkelingen van deze gronden slechts kunnen plaatsvinden, indien:

a. Passende voorwaarden worden gesteld en passende maatregelen worden getroffen die waarborgen dat sprake is van een daadwerkelijke en effectieve bescherming van het mariene milieu en die waarborgen dat verontreiniging van het kustgebied en het zeewater als gevolg van de bouwactiviteiten of van die activiteiten in de vorm van gebruik na realisatie van de bouwwerkzaamheden wordt voorkomen, zulks in overeenstemming met de eisen die voortvloeien uit regelgeving en internationale verdragen; en

b. Passende maatregelen worden getroffen die waarborgen dat sprake is van daadwerkelijke en effectieve bescherming van natuurwaarden op land, zijnde plant- en diersoorten als bedoeld in de Landsverordening grondslagen natuurbeheer en –bescherming, die zich in het gebied bevinden, zulks ook overigens in overeenstemming met de eisen die voortvloeien uit regelgeving en internationale verdragen.

2. De maatregelen als bedoeld in het eerste lid onderdeel a, moeten onder meer voorkomen dat als gevolg van ontwikkeling meer regen-, storm-, riool-, of andersoortige verontreiniging van het kustgebied en het zeewater plaatsvindt.

3. Er wordt een lid toegevoegd, luidende:

3. Het tweede lid onderdelen j en k zijn niet van toepassing voor de gronden van Oostpunt met de bestemming stedelijk woongebied.

C. Aan artikel 7, tweede lid, onderdeel b, wordt een subonderdeel toegevoegd, luidende:

11. Gronden te Oostpunt

Voor zover het de gronden te Oostpunt betreft, geldt hierbij dat de ontwikkelingen van deze gronden slechts kunnen plaatsvinden, indien:

l. Voor zover het de gronden te Oostpunt betreft, geldt hierbij dat de ontwikkelingen van deze gronden slechts kunnen plaatsvinden, indien:

a. Passende voorwaarden worden gesteld en passende maatregelen worden getroffen die waarborgen dat sprake is van een daadwerkelijke en effectieve bescherming van het mariene milieu en die waarborgen dat verontreiniging van het kustgebied en het zeewater als gevolg van de bouwactiviteiten of van die activiteiten in de vorm van gebruik na realisatie van de bouwwerkzaamheden wordt voorkomen, zulks in overeenstemming met de eisen die voortvloeien uit regelgeving en internationale verdragen; en

b. Passende maatregelen worden getroffen die waarborgen dat sprake is van daadwerkelijke en effectieve bescherming van natuurwaarden op land, zijnde plant- en diersoorten als bedoeld in de Landsverordening grondslagen natuurbeheer en –bescherming, die zich in het gebied bevinden, zulks ook overigens in overeenstemming met de eisen die voortvloeien uit regelgeving en internationale verdragen.

2. De maatregelen als bedoeld in het eerste lid onderdeel a, moeten onder meer voorkomen dat als gevolg van ontwikkeling meer regen-, storm-, riool-, of andersoortige verontreiniging van het kustgebied en het zeewater plaatsvindt.

D. Artikel 9, derde lid, onderdeel e, komt te luiden:

e. Gronden te Oostpunt

Het gebied gesitueerd aan de noordkust van Oostpunt nabij Sint Jorisbaai, met een totale oppervlakte van 46 hectare, zoals aangeduid op de bestemmingskaart no. 1 van het grondgebied Oostpunt, kan worden aangewend ten behoeve van de aanleg van een windmolenpark.

De drie in elkaars nabijheid gelegen gebieden gesitueerd aan de noordkust van Oostpunt met een gezamenlijke totale oppervlakte van 173 hectare, zoals aangeduid op de bestemmingskaart no. 1 van het grondgebied Oostpunt, kunnen worden aangewend ten behoeve van de aanleg van twee golfbanen.

De gebieden gelegen in het midden van de gronden van Oostpunt met een gezamenlijke oppervlakte van 83 hectare, zoals aangeduid op de bestemmingskaart no. 1 van het grondgebied Oostpunt, kunnen worden aangewend ten behoeve van de aanleg van een golfbaan.

Bij het verlenen van aanlegvergunningen en bouwvergunningen worden nadere voorwaarden en eisen gesteld, waaraan de bestemmingen, bedoeld in de eerste ten en met derde volzin, moeten voldoen.

E. Aan artikel 11, tweede lid, onderdeel h, wordt een alinea toegevoegd, luidende:
Oostpunt
Ontwikkeling van de gronden te Oostpunt is slechts toegestaan onder de voorwaarde dat de volgende maatregelen worden getroffen:

l. Voor zover het de gronden te Oostpunt betreft, geldt hierbij dat de ontwikkelingen van deze gronden slechts kunnen plaatsvinden, indien:
a. Passende voorwaarden worden gesteld en passende maatregelen worden getroffen die waarborgen dat sprake is van een daadwerkelijke en effectieve bescherming van het mariene milieu en die waarborgen dat verontreiniging van het kustgebied en het zeewater

als gevolg van de bouwactiviteiten of van die activiteiten in de vorm van gebruik na realisatie van de bouwwerkzaamheden wordt voorkomen, zulks in overeenstemming met de eisen die voortvloeien uit regelgeving en internationale verdragen; en
b. Passende maatregelen worden getroffen die waarborgen dat sprake is van daadwerkelijke en effectieve bescherming van natuurwaarden op land, zijnde plant- en diersoorten als bedoeld in de Landsverordening grondslagen natuurbeheer en –bescherming, die zich in het gebied bevinden, zulks ook overigens in overeenstemming met de eisen die voortvloeien uit regelgeving en internationale verdragen.

2. De maatregelen als bedoeld in het eerste lid onderdeel a, moeten onder meer voorkomen dat als gevolg van ontwikkeling meer regen-, storm-, riool-, of andersoortige verontreiniging van het kustgebied en het zeewater plaatsvindt.

F. Onder verlettering van artikel 12, derde lid, onderdeel c tot artikel 12, derde lid, onderdeel b, vervalt artikel 12, derde lid, onderdeel b.

Artikel II

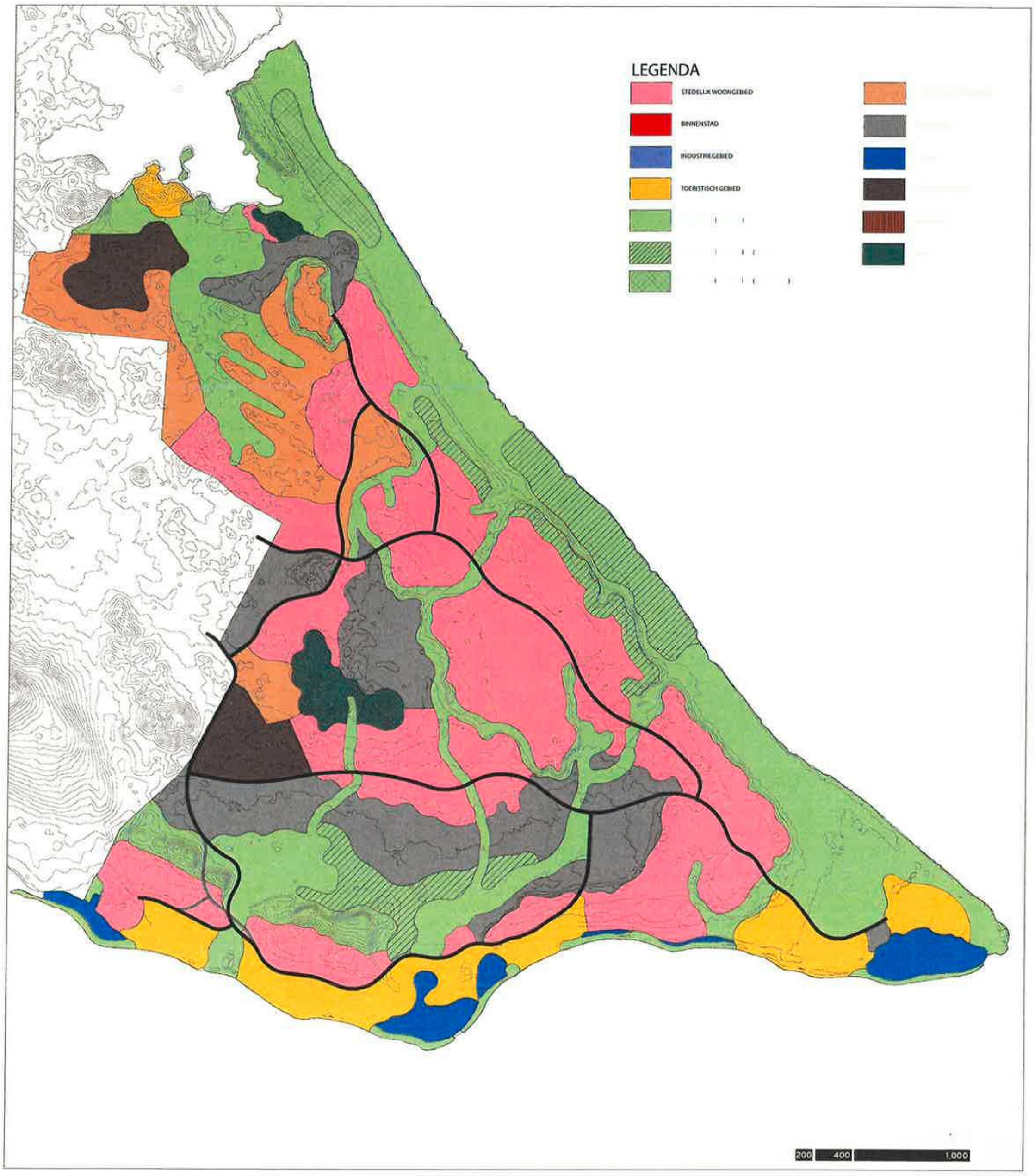
Deze landsverordening treedt in werking op een bij landsbesluit te bepalen tijdstip.

Gegeven te Willemstad, 19 januari 2017
L.A. GEORGE-WOUT

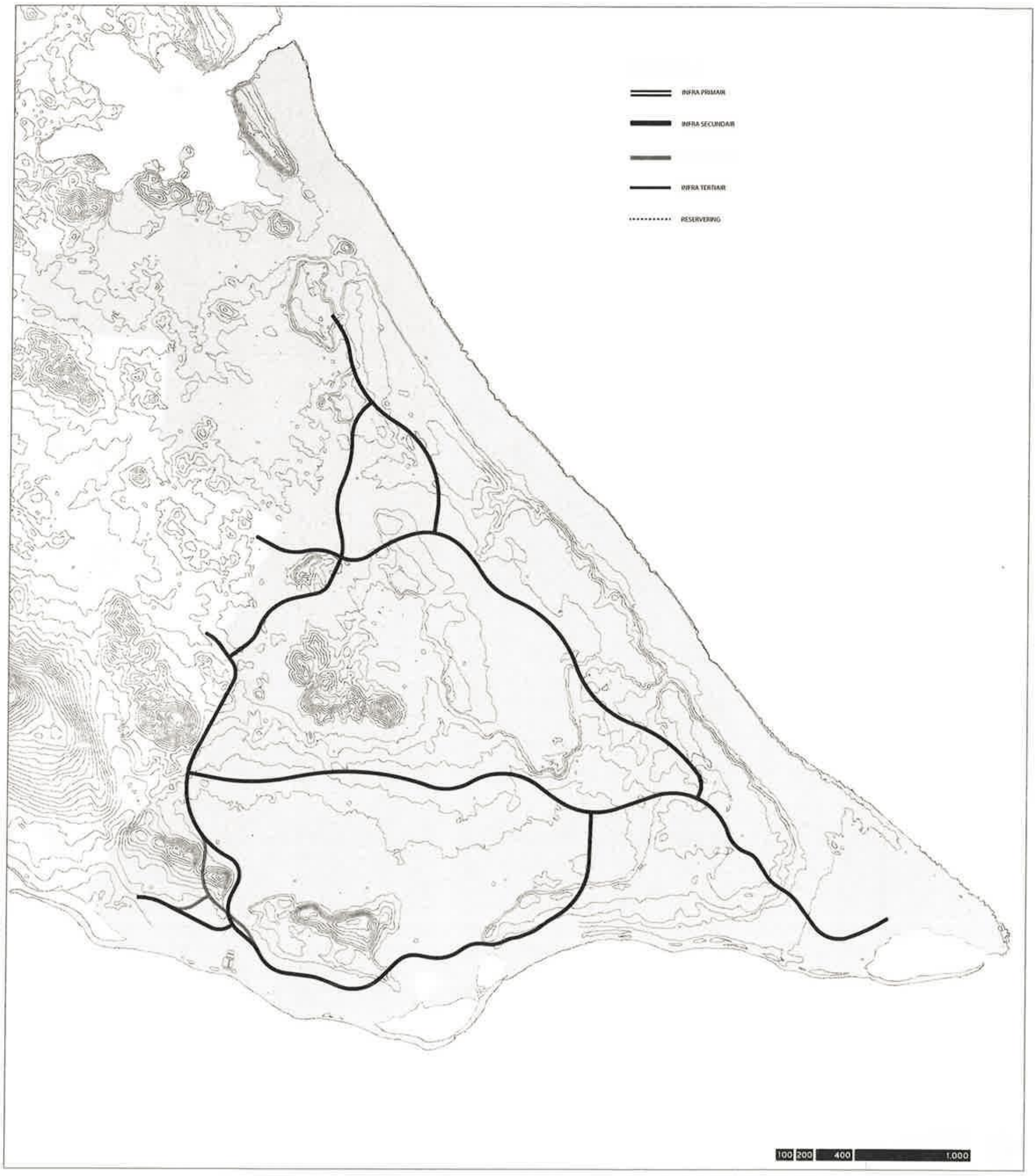
De Minister van Verkeer, Vervoer
en Ruimtelijke Planning,
S.F. CAMELIA-RÖMER

Uitgegeven de 2de februari 2017
De Minister van Algemene Zaken,
H.F. KOEIMAN

Bijlage behorende bij de Landsverordening van de 19de januari 2017 tot wijziging van het Eilandelijk Ontwikkelingsplan Curaçao (A.B. 1995, no. 36) (herziening Oostpunt)


LEGENDA
STEDELIJK WOONGEBIED
BINNENSTAD
INDUSTRIEGEBIED
TOERISTISCH GEBIED
200
400
1.000

Bijlage behorende bij de Landsverordening van de 19de januari 2017 tot wijziging van het Eilandelijk Ontwikkelingsplan Curaçao (A.B. 1995, no. 36) (herziening Oostpunt)



Justification

Report C003/18
Project Numbers: 4318100100

The scientific quality of this report has been peer reviewed by a colleague scientist and a member of the Management Team of Wageningen Marine Research

Approved: Ir René Henkens, researcher

Signature:

Date: 4th of January 2018

Approved: Dr. ir. T.P. Bult
Director

Signature:

Date: 4th of January 2018

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Wageningen Marine Research is the Netherlands research institute established to provide the scientific support that is essential for developing policies and innovation in respect of the marine environment, fishery activities, aquaculture and the maritime sector.

Wageningen University & Research:
is specialised in the domain of healthy food and living environment.

The Wageningen Marine Research vision
‘To explore the potential of marine nature to improve the quality of life’

The Wageningen Marine Research mission
- To conduct research with the aim of acquiring knowledge and offering advice on the sustainable management and use of marine and coastal areas.
- Wageningen Marine Research is an independent, leading scientific research institute

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