

ontv. 10 JAN 2017

TECHNICAL REPORT

A study of the natural and cultural values
in 8 ha of land at Playa Grandi, Bonaire, CN

Fernando Simal



Client: Marquise Eco Resort Bonaire

Date: Bonaire, December 12th, 2017



WILDCONSCIENCE B.V.

Wildlife Conservation Science and Education

Directie Ruimte & Ontwikkeling
Openbaar Lichaam Bonaire

Datum: DEC 18 2017

Reg-nr: 2024/2017

Afn. door: *Breuker +* *Reunink* Afd. hoofd: *PM/ma.*

c.c. - DV

WILDCONSCIENCE BV:

- Supports governments and NGOs on nature conservation projects with cutting edge environmental science and educational tools
- Aims to facilitate governments and nature organizations achieve their conservation goals through advanced science and education programs, provided by a highly diverse team of fully committed professionals with outstanding work ethics
- Is a member and founder of the Caribbean Speleological Society – www.caribss.org
- We get it done!

This technical report is financed by Marquise Eco Resort Bonaire. It is a study of the natural and cultural values contained at Playa Grandi and surroundings, on the Island of Bonaire, Caribbean Netherlands. Additionally, the report provides recommendations to preserve these values while carrying out development projects.

Fernando Simal
Co-managing director
Kaya Platina #42
Bonaire
Dutch Caribbean
Tel: +599 701-3400
Email: fernando.simal@wildconscience.com

Jimmy van Rijn
Co-managing director
Marijkeweg, 28 5C 10
6709PG, Wageningen
The Netherlands
+31 642 591756
jimmy.vanrijn@wildconscience.com

© 2015 WILDCONSCIENCE
KVK nr: 8953(0)
BTW nr: 310008190

The Management of WILDCONSCIENCE B.V. is not responsible for resulting damage, as well as for damage resulting from the application of results or research obtained by WILDCONSCIENCE B.V., its clients or any claims related to the application of information found within its research. This report has been made on the request of the client and is wholly the client's property. This report may not be reproduced and/or published partially or in its entirety without the express written consent of the client.

Content

1	Introduction	4
2	Study area and methodology	4
3	Geology.....	5
4	Flora and vegetation	7
5	Fauna	9
6	Playa Grandi in relationship to other important nature areas of Bonaire	11
7	Cultural heritage value	13
8	Agricultural value	13
9	Esthetic and scenic values	13
10	Recommendations for development	14
	References	17

1 Introduction

In relation to the development of a piece of land located at Playa Grandi, Marquise Eco Resort Bonaire, in agreement with the Bonaire Public Entity (Openbaar Lichaam Bonaire), hired WILDCONSCIENCE BV to conduct a study of the natural and cultural values of this area. The survey included data collection and observations of flora and fauna with a special attention to species protected by local legislation and/or international treaties, the presence/absence of caves, potential use of this area as biological corridors and sites of archaeological interest among others. This development aims to develop a 15-units Eco Resort in an area of approximately 8 ha (Fig.1).

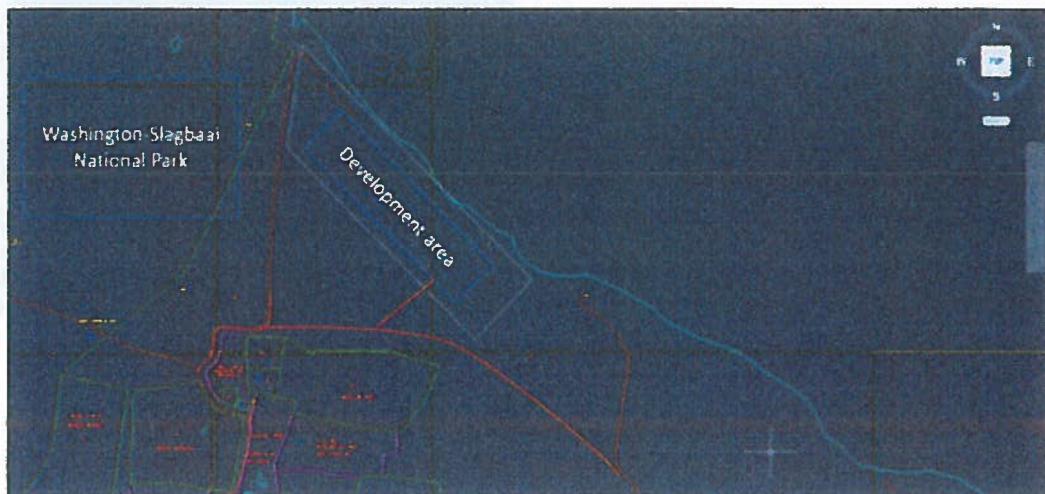


Figure 1. Section of the Cadastral map of Bonaire where the area of Playa Grandi to be developed can be observed.

The study was conducted by WILDCONSCIENCE BV combining fieldwork, anecdotal and literature search with the following objectives:

- 1) Estimate relative abundance of native and exotic species of flora and fauna in the area, highlighting those of special value (e.g. protected by legislation, keystone rare or endangered),
- 2) Find key area habitats for fauna (e.g. nesting, roosting and breeding),
- 3) Find special features of the landscape (e.g. caves, ponds, wells and/or access to freshwater),
- 4) Determine the ecological importance of the area in relation to other important areas for nature conservation on Bonaire (e.g. AICOM's, SICOM's, IBA's and/or Ramsar),
- 5) Find potential cultural heritage values, and,
- 6) Provide recommendations for the development of the project.

In this document, we present the results of our study and recommendations for the potential developments based on these results.

2 Study area and methodology

Playa Grandi is located on the northern windward side of Bonaire, adjacent to the Washington-Slagbaai National Park. On its eastern border, it is surrounded by a seasonally flooded hyper saline lagoon, which narrows into a channel before discharging into the sea. The lagoon collects and retains run-off water from precipitation on its basin area and retains it, avoiding sediment-rich water to flow directly into the sea. Except for unusual heavy precipitation events that overflow the lagoon or large waves caused by storms, the exchange of water between the sea and the lagoon occurs underground.

The plot to be developed lies entirely on limestone and looks in a large portion denuded from vegetation. However, there are many individuals from several species of plants protected by local legislation currently

found in this area, mainly cacti (*Candle cactus* spp. and *Melocactus* spp.). Due to the strong and constant winds with a high salt content that sweep the area, the rest of the vegetation consists mainly of plants with a high tolerance to harsh environments growing very close to the ground (e.g. *Prosopis juliflora*).

From a legal standpoint, the area of study has been designated in the Bonaire Zoning Plan (ROB, 2010) as "Open Landschap". In general, this designation allows for development of projects as long as the natural character of the area is preserved.

Given the size of the plot and in order to account for geographical coverage, we conducted a visual inspection on the entire area and its surroundings in 2 visits during the months of November and December 2017. Instead of using quadrants or transects, we distributed 18 waypoints through the plot of land and walked from point to point on a straight line with the aid of a GPS handheld unit (Fig. 2), taking small detours when the vegetation became impenetrable or to mark special features. We are confident that we achieved plenteous of the area and we did not miss any significant features. During our field work, we recorded the following:

- a) Species richness of plants and relative number of individuals,
- b) Species richness and abundance of reptiles,
- c) Species richness and abundance of birds,
- d) Bird nests,
- e) Special geological features,
- f) Potential sources of contamination.



Figure 2. Satellite image of the study area where we can observe the area explored (blue line polygon), and the distribution of the 18 waypoints for the intended exploring path (white line).

3 Geology

In Figure 3, depicting the Geological and Land Use Map of Bonaire (Pijpers, 1933) we can observe that the area of study appears entirely as part of the Quaternary Limestone formation. Except for the beach area, the area of study forms part of the Lower terrace, which is the youngest of the limestone terraces found on Bonaire, formed approximately 35.000 years B.P. (de Buissonjé 1974). Limestone is rich in sinkholes, shallow depressions, caves and small holes that frequently provide access to ground water for many species of flora

and fauna found on Bonaire. However, we did not find any remarkable features of this type within the boundaries of the plot subject to the study. Considering the fact that our fieldwork consisted of a thoroughly inspection of a relatively small area with good visibility through the vegetation, we are confident that no special karst features of ecological importance, like cave entrances or crevices providing access to fresh ground water are located in this portion of land.

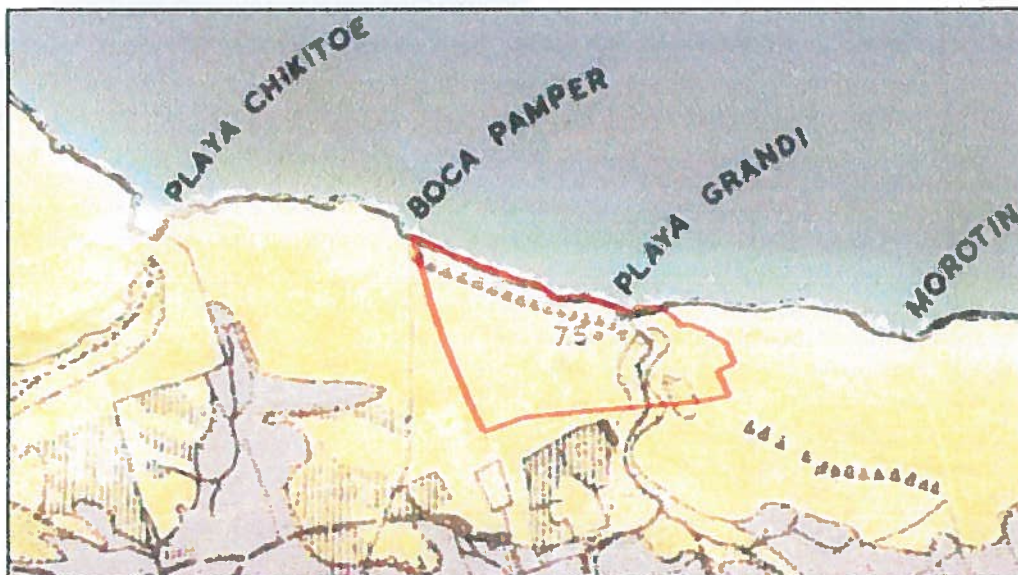


Figure 3. Overlay of the Geological and Land Use Map of Bonaire (Pijpers, 1933), where the area selected for the development of Marquise Eco Resort (red polygon) appears as part of the Quaternary Limestone formation

A geological feature of high relevance found in this portion of land is the channel of the land-locked bay that discharges into the sea at Playa Grandi (Fig. 4). Land-locked bays were created by erosion of valleys where the sea level was about 10 m lower than present. Today, these seasonally flooded lagoons containing hypersaline water are a very important habitat for many species of birds, especially native and migratory aquatic birds. We will cover this topic in more detail on the "Fauna" section of this report.



Figure 4. Satellite image of the lagoon (blue polygon) and the channel inside the surveyed area.

4 Flora and vegetation

In the Landscape Ecological Vegetation Map of Bonaire (de Freitas et al., 2005) our area of study falls under four designations: "TL9=Prosopis-Subpilocereus lower terrace" "TL1=Lithophila-Sesuvium-lower terrace", "B1=Sesuvium-Lithophila beach" and "S2=Sesuvium-salina" (Fig 5). This designation fits in general with our observations on the ground. However, we also observed a high density of the species of candle cacti, *Stenocereus griseus* and some portions of the land also present a very high density of *Melocactus* spp. All three species before mentioned are protected by local legislation and consequently all individuals found in the area should be preserved during the development project if the permit is obtained.

The species of flora above mentioned, together with Mesquite (*Prosopis juliflora*) present the highest relative abundance of plants in the area, consequently dominating the vegetation on the limestone terrace. Due to the harsh conditions on the windward side of the island, Mesquite grows in a bush-like form, next to the ground. As expected, the only exceptions to the dominance of cacti spp. and Mesquite in the area occurs on the shores of the hyper saline lagoon and the beach, which are dominated by Buttonwood (*Conocarpus erectus*) and Sea lavender (*Mallotonia gnaphalodes*) respectively. Buttonwood is also protected by local legislation.

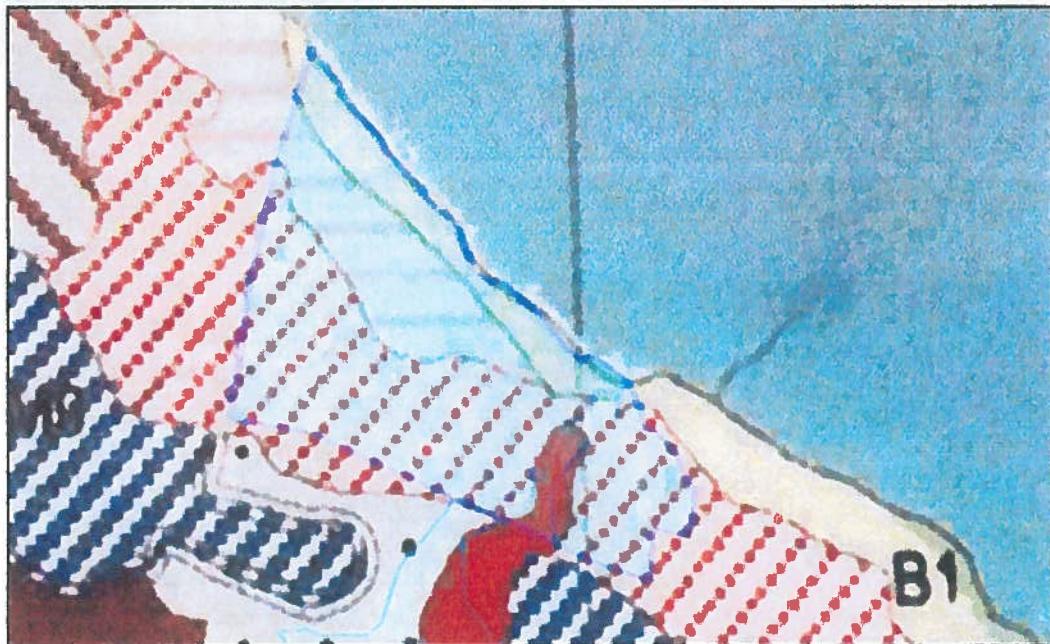


Figure 5. Overlay of the Landscape ecological vegetation map of Bonaire (de Freitas et al., 2005) on a satellite image where the land subject of our study (purple polygon) can be seen on four landscape units: TL9=red diagonal lines, TL1=horizontal grey lines, B1=yellow area and S2=red area

During our field work we also found remarkable the increment in abundance in this area and surroundings of Snakeweed (*Stachytarpheta boldinghii*), known in Papiamentu as "raspa". This species is considered indigenous and interacts ecologically mainly with butterflies and hummingbirds when in bloom. The presence of this plant in the area of study and its surroundings can be considered recent from an ecological perspective. However, it appears that in a very short period is spreading at a very high rate. Additionally, it seems to thrive both on available space but also competing for space with well-established plants (Fig. 6). Consequently, there is potential that it becomes higher in relative abundance than some native species that have been present in the area for a longer period, producing significant changes to the vegetation of the area in the long run, including a decrease in biodiversity. Finally, at least two species of vines considered invasive were observed during our fieldwork.



Figure 6. Two examples of Snakeweed competing with well-established species, on the left image *R. griseus* and *P. juliflora* on the right.

In total, we recorded 18 different species of plants during our fieldwork. On table 1 we present an overview of all the plant species that were found during our data collection. Five of them are legally protected. We did not find any individual trees with the legal criteria of possessing a >65 cm. circumference at a height of 130 cm on the limestone terrace, however we did find a few individuals of Buttonwood meeting this criteria on the shores of the hyper-saline lagoon.

Table 1. Plant species found during this study and their conservation status. *a*=protected under international treaties, *b*= protected under CITES-Appendix II, *c*=protected under local legislation.

Scientific name	Common name	Conservation Status
<i>Agave vivipara</i>	Century plant	
<i>Aloe vera</i>	Aloe	
<i>Bontia daphnoides</i>	Wild Olive	
<i>Casearia tremula</i>	-----	
<i>Conocarpus erectus</i>	Buttonwood	a, b, c
<i>Cereus repandus</i>	Candle cactus	
<i>Crescenta cujete</i>	Calabash	
<i>Croton flavens</i>	Wild sage	
<i>Mallotonia gnaphalodes</i>	Sea Lavender	
<i>Melocatus spp.</i>	Turk's cap	a, b, c
<i>Opuntia spp.</i>	Opuntia	a, b, c,
<i>Prosopis juliflora</i>	Mesquite	
<i>Quadrella odoratissima</i>	Olive tree	
<i>Sesuvium portulacastrum</i>	Shore purslane	
<i>Stachytarpheta boldinghii</i>	Snakeweed	
<i>Stenocereus griseus</i>	Candle cactus	a, b, c
Unidentified grass species (3)	Grass	

5 Fauna

Bats

The absence of caves and/or abandoned human structures frequently used as diurnal roosts by the two species of nectar-feeding bats and the five species of insectivore bats on the island, indicate that this plot of land is not an important roosting area for bats. However, the presence of candle cacti yielding significant amounts fruits and flowers and previous research conducted by the author and colleagues in caves and all habitat-types found on Bonaire, indicate that this area is used as foraging grounds by the two species of nectar-feeding bats (Simal & Lim, in preparation). It is also very likely that some species of small insectivores like the Funnel-eared bat (*Natalus tumidirostris*) and the Little brown bat (*Myotis nesopolus*) use as foraging grounds the shores of the salina, which sustain a small mangrove forest dominated by Buttonwood. On Table 2 we indicate the different bat species found in the habitat-types denominated "Dry Shrub", "Dry forest" and "Mangrove".

Table 2. Presence/absence of bats in all habitat types on Bonaire (Simal and Lim, in preparation) and their conservation status: a=protected under local legislation, b=IUCN Red list-Least concern, c=IUCN Red list-Vulnerable, d=IUCN Red list-Data deficient.

Bonaire Bat species	Mangrove Forest	Dry Forest	Dry Shrub	Cacti Forest	Salinas	Urban	Agriculture
Long-nosed bat (a, c) <i>Leptonycteris curasoae</i>	X	√	X	√	X	X	X
Long-tongued bat (a, d) <i>Glossophaga longirostris</i>	√	√	√	√	√	√	√
Funnel-eared bat (a, b) <i>Natalus tumidirostris</i>	√	√	X	X	X	X	X
Ghost-faced bat (a, b) <i>Mormoops megalophylla</i>	X	√	X	X	X	X	X
Little brown bat (a, b) <i>Myotis nesopolus</i>	√	√	√	X	X	X	√
Free-tailed bat (a, b) <i>Molossus molossus</i>	X	√	X	X	X	√	√
Greater bulldog bat (a, b) <i>Noctilio leporinus</i>	?	?	?	?	?	?	?
Naked-backed bat (a, b) <i>Pteronotus davyi</i>	?	√?	√?	?	?	?	?
White-shouldered bat (a, b) <i>Ametrida centurio</i>	?	?	?	?	?	?	?

Regarding other important bat diurnal, including the most important bat maternity caves, Playa Grandi is located at a distance of approximately 4.7 Km from the closest one (Fig 7). Therefore, if the building permit is granted, we do not foresee any disturbance to any of the bat maternity roosts of the island caused by the construction and post-construction activities of the Eco Resort.

Birds

The author and several colleagues have been conducting terrestrial bird surveys on Bonaire and Klein Bonaire since 2009, using a standard methodology (Distance sampling) in all these studies (Rivera-Milán et al, 2005). In the examined land, we found an average abundance and species richness of native terrestrial birds when compared to other areas of Bonaire with a similar habitat-type. We also encountered during our field work a relative high abundance of foraging Barn swallows (*Hirundo rustica*). This is also a migratory species with a seasonal presence on Bonaire, arriving around October and leaving the island when the spring starts, in March.

As indicated in the Nature and Environment section of Bonaire's Government website (Bonairegov, 2010), the Nature Ordinance protects two of the terrestrial species registered during our observations. In this case, the endemic subspecies Brown-throated parakeet (*Aratinga pertinax xanthogenia*) and the raptor Crested caracara (*Caracara cheriway*).

We recorded a relative small number of nests during our fieldwork and, except for one large individual tree of Buttonwood (*Conocarpus erectus*) where a flock of approximately 8 Bare-eyed pigeons (*Patagioenas corensis*) was found, we did not observe any roosting sites of importance for terrestrial birds inside the study area. Consequently, this plot of land does not appear to be highly important for nesting and/or roosting for the native terrestrial birds of Bonaire.



Figure 7 Distance from Dawari to the closest bat maternity roosts known, approximately 4.7 Km.

Despite of not being entirely within the boundaries of the property, it is essential for this study to emphasize the ecological importance for birds of the salt flat contiguous to the property. As expected, this lagoon served as a habitat for several species of migratory shorebirds of which individuals of Semipalmated sandpiper, Least sandpiper, Stilt sandpipers, Lesser yellowlegs, Greater yellowlegs and Spotted sandpiper were positively identified. Regarding these migratory species, reports from the Canadian Government and also their official webpage "State of Canada's Birds" are announcing since 2012 an alarming population decrease of up to 60% for several of these species (www.stateofcanadasbirds.org 2016, Gratto-Trevor *et al.* 2011). These species breed in Canada and the United States of America but spend the winter in the Caribbean and Latin America. Research indicates that the main threats (e.g. habitat loss, hunting and predation) occur in their wintering grounds. Therefore, ensuring that the habitats they utilize during the winter (e.g. the salt flats of Bonaire) remain undisturbed and safe, has become essential for maintaining viable world populations of these birds. Besides the species before mentioned, a remarkable finding during our fieldwork was a flock of 8 American golden plovers (*Pluvialis dominica*). This is a species of migratory shorebird that can be considered uncommon for Bonaire. Finally, the salt flat is also an important habitat for flamingoes, egrets and herons, including some of special conservation concern like the Reddish egret (*Egretta rufescens*), which was recorded during our surveys in the area.

The full list of observed birds recorded at Playa Grandi is presented below (Table 3), with a total amount of 21 species. However, we are confident that this number is the result of only approximately two hours of data collecting at the site and several other species of commonly found terrestrial and aquatic birds in the island

use the area surveyed for this study as a habitat as well. We will include recommendations for the protection, management and use of these natural resources in the last section of this report.

Table 3. Summary of bird species found during the surveys at Dawari and their conservation status. a= protected under CITES-Appendix II, b=protected under local legislation, c=IUCN Red list-Least concern, d=IUCN Red list - Vulnerable.

Scientific name	Common name	Conservation Status
<i>Actitis macularia</i> *	Spotted sandpiper	
<i>Anas bahamensis</i> *	White-cheeked pintail	
<i>Aratinga pertinax xanthogenia</i>	Brown-throated parakeet	a, b, c
<i>Calidris himantopus</i> *	Stilt sandpiper	
<i>Calidris minutilla</i> *	Least sandpiper	
<i>Calidris pusilla</i> *	Semi-palmated sandpiper	
<i>Chlorostilbon mellisugus</i>	Blue-tailed emerald (hummingbird)	
<i>Coereba flaveola</i>	Bananaquit	c
<i>Columbina passerina</i>	Common ground dove	
<i>Caracara cheriway</i>	Crested caracara	a, b
<i>Elaenia martinica</i>	Caribbean elaenia	
<i>Egretta rufescens</i> *	Reddish egret	
<i>Hirundo rustica</i>	Barn swallow	
<i>Icterus icterus</i>	Troupial	Exotic - invasive
<i>Icterus nigrularis (nest)</i>	Yellow oriole	
<i>Mimus gilvus</i>	Tropical mockingbird	c
<i>Patagioenas corensis</i>	Bare-eyed pigeon	
<i>Pluvialis dominica</i> **	American Golden plover	
<i>Setophaga petechia</i>	Yellow warbler	c
<i>Tringa flavipes</i> *	Lesser yellowlegs	
<i>Tringa melanoleuca</i> *	Greater yellowlegs	

* Aquatic bird species observed in the hyper saline lagoon

** Aquatic bird species found on the limestone terrace

Reptiles

It's very likely that all seven species of reptiles recorded for Bonaire use the area inside the property as a habitat, but only three of these species were directly observed during the surveys, namely the Green iguana (*Iguana iguana*) and our two endemics, the Whiptail lizard (*Cnemidophorus murinus ruthvenii*) and the Tree lizard (*Anolis bonairensis*). The Green iguana is protected both by local legislation and by the CITES international treaty in its Appendix II. All species were found in high densities. The lack of direct observations of the other four species of reptiles is most likely caused by their low densities, their evasive behavior when compared to other areas in the island where they are more used to humans and, in the case of the geckos, because of their nocturnal habits.

6 Playa Grandi in relationship to other important nature areas of Bonaire

The well-known organization BirdLife International recognizes the ecological importance of areas or sites for bird conservation by designating them as IBAs (Important Bird Area) using established criteria. On Bonaire, six of these areas have been designated. The land subject to our study is located between two of these areas, AN009 (Washington-Slagbaai national Park) and AN011 (Fig. 8) and less than 1 Km from their boundaries. Consequently, activities in the area to be developed have a high probability to have a direct impact (negative or positive) on a significant portion of the bird fauna of Bonaire.

The portions adjacent to our study area of the two IBAs above mentioned are well-known nesting grounds for Least terns (*Sternula antillarum*) between the months of April and July (Wells & Wells 2006, Debrot 2009). The last author reported approximately 25 breeding pairs south of Boka Chikitu in 2002. This species is

protected by local legislation and consequently special care should be taken to avoid disturbances to these bordering areas during breeding season.

Similar to the IBAs, one important area and one important site for the conservation of bats have been recognized and officially designated on Bonaire by the Latin American and Caribbean Bat Conservation Network (RELCOM). AICOM and/or SICOM (Important Area or Site for Bat Conservation). A portion of Bonaire's AICOM overlaps with IBA AN011, consequently the land is located adjacent to this nature protection area as well.

The advantages of buffer areas for national parks are well known. The environmental legislation of most countries will not recognize a protected area as a national park unless a buffer area is delineated and special management rules for this area established. The definition of buffer area is: *an area 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.* The planned development will clearly fall inside the buffer area of the Washington-Slagbaai Park. Therefore, the developers should ensure that the planned activities should not jeopardize the process of the official designation of the park as a national park.

Playa Grandi is also adjacent to the Bonaire National Marine Park. Human presence and activities on both the beach and the reef are expected to significantly increase during the construction of the resort and the posterior usage of the facilities. Additionally, changes to the beach may occur in order to make it more appealing for the users of the Eco Resort.

Based on the above stated, we conclude that the execution of this project has a high probability of having a significant impact on one or several important nature areas of Bonaire both in the short and the long term. In fact, recreational activities post-construction of the resort can be considered more important than construction itself, especially if the guidelines for eco lodge construction are respected. It is important for the development of the project to ensure that negative impacts will be minimized while making advantage of the opportunities for positive impact on the environment that the project provides. We will address this and all the previous points of this section in the last chapter of this report, "Recommendations for development".

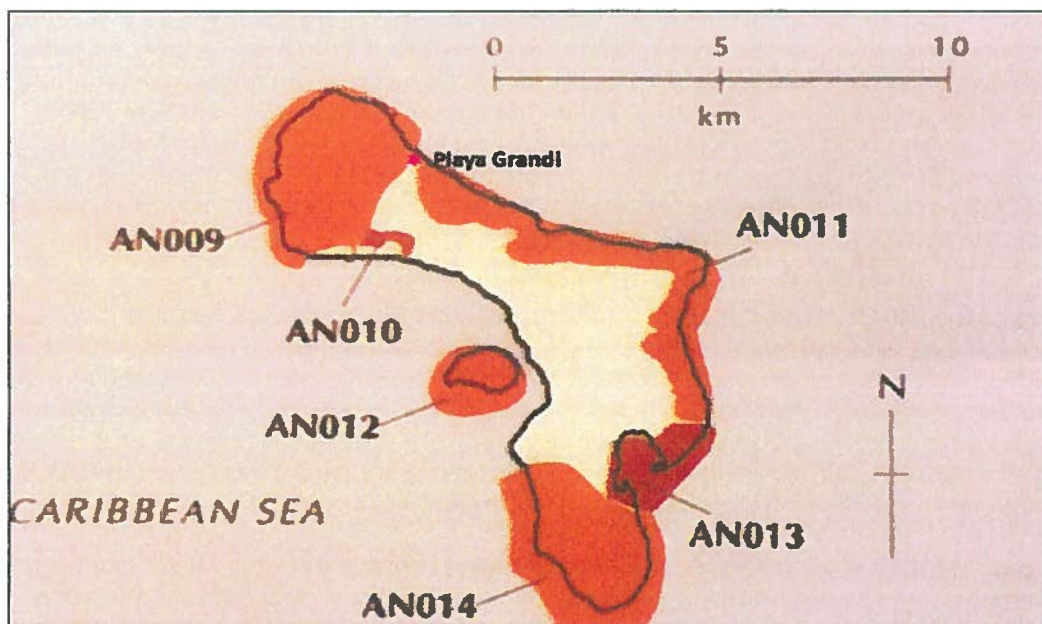


Figure 8. The location of Playa Grandi in relationship to Bonaire's IBAs and other important natural areas.

7 Cultural heritage value

Playa Grandi appears today as another deserted location on the windward side of Bonaire. However, during the colonial and the plantation times until the early 1980's, this beach was a busy site, frequently visited by local people searching for materials and food resources (George Thodé personal observ.). For instance, sand and rocks were commonly mined from this beach while tree trunks were harvested from the mangrove forest and also collected from the driftwood on the beach. Fishing was also an important activity at this location and two fishing boats were kept permanently at Playa Grandi. Historically, the beach contained a much larger volume of sand than today and, consequently, sea turtles used to nest on this location. Another way to obtain fish as a food source, consisted on managing the channel of the lagoon. During difficult times, this channel was open to the sea in order to flood the lagoon, which caused a dramatic increase in abundance of certain species of fish, that, once inside the shallow lagoon, were easier to harvest. Additionally, other useful products drifted on the beach and were collected for different uses (e.g. coconuts for food and production of coconut oil).



Figure 9. The area of Playa Grandi and surroundings in the Werbata Map of Bonaire, dating from 1911.

Despite of all the activity taken place in the past at this location, from the oldest to the newest official maps of Bonaire, like the Werbata map from 1911 (Fig. 9), the Topographic Map of Bonaire, published in 1982 and the Bonaire Zoning Plan Bonaire, (ROB, 2010) the property subject to this study is not highlighted as a site of historic or archaeological interest or suitable for excavations, being the main reasons the dynamic character of the beach and the fact that there is no soil to preserve objects of historic interest over the limestone. Consequently, we do not consider the potential construction of the Eco Resort in this area a threat to important cultural heritage values for the island.

8 Agricultural value

Given its location near the windward shore of the island, where conditions are very harsh and only plants with special adaptations can grow, we do not consider necessary to investigate the agricultural value of this area.

9 Esthetic and scenic values

It is arguable if the scenic and aesthetic values of this area have already been altered in a positive or negative way by the enormous presence of the 12 wind generators in the area. However, if we make the clarification of referring strictly to the *natural scenic values*, there is no much room for discussion that they have been distorted by these human structures. In our opinion, despite of their presence, the natural character of the windward side of Bonaire is still very tangible from Playa Grandi and the effort to maintain it worthwhile.

The esthetic and scenic values of the Playa Grandi are clearly dominated by the impressive view of large waves pounding the limestone cliff on the rugged east coast of the island. Yet, the views towards inland are quite extraordinary as well. From this location, we have a privileged scenic view of the different levels of the limestone terraces of the east coast of Bonaire, but we can also enjoy the scenery created by the hills of volcanic origin towards the north. Additionally, the hypersaline lagoon and its surrounding halophyte vegetation, blend perfectly in this natural rugged landscape. Finally, the vegetation on the limestone terrace, with its special adaptations for surviving on a harsh environment and the fauna associated with it complete the scenic value of the area, giving it its special character. Maintaining this natural character has to be one of the main goals during the development of the area.

10 Recommendations for development

From a natural resources conservation and management perspective, the most relevant fact about this project in Playa Grandi is the immediacy of the location to several of the most important designated natural areas of Bonaire (e.g. BNMP, WSNP, two IBAs and Bonaire's AICOM). Clearly, construction activities as well as posterior recreational activities for the users of the resort, can have a significant impact on the nature contained in these areas. With proper planning and management, the majority of these activities could improve the current habitat situation, hence causing this impact to be positive for the native flora and fauna.

As an instance, the Bonaire terrestrial ecosystem has been degraded by years of overgrazing by introduced large herbivores like feral donkeys, sheep and goats (Coblentz 1980, de Freitas 2005). Within the property subject to our study, this degradation is unmistakable and strong evidence of a sizable abundance of both goats and donkeys roaming the area was found. All the local nature management organizations of the island together with the local government recognize these exotic species as the number one threat to our terrestrial environment. Fortunately, this project presents an opportunity to stop habitat degradation and perhaps reverse it. The first, and perhaps most important feature that creates the opportunity to improve conditions, is the fencing that will come along with the eco lodge. Clearly, this fence will keep large herbivores from accessing the existing vegetation, which provides a chance for the native vegetation to recover. Therefore, irrespective of the materials used, the fencing erected for the project should be sturdy and tall enough to keep out goats, sheep, donkeys and pigs. Additionally, all entrances/exits to the new eco-lodge should be cattle-proofed.

The second opportunity for native habitat improvement comes in the form of landscaping and gardening. This usually means removing a portion of the existing vegetation and planting new plants and trees. Making the right selection of which plants to remove and which plants to use for landscaping, we can greatly improve the native vegetation and, consequently, the terrestrial fauna inhabiting the area on the long term. For this plot of land, given the low species richness of trees and also the low amount of vegetation cover, we recommend to keep all the existing adult and young plants, regardless of being protected by legislation or not, with two exceptions, Cossie (*Vachelia tortuosa*) and Mesquite (*Prosopis juliflora*). Regarding trees and other plants to use for landscaping, we recommend to plant native trees that are well known for thriving on limestone terraces with a lack of soil and also resisting the harsh conditions of the windward side of Bonaire, specially near to the sea, where the salty spray is greater. A few examples of these trees are: Buttonwood (*Conocarpus erectus*), Sea grape (*Coccoloba uvifera*), Braceletwood (*Jacquinia armillaris*), and Wild olive (*Bontia daphnoides*). As we move inland, native species well adapted to dry environments but less resistant to salty environments can be used, for instance Lignum vitae (*Guaiacum* spp.), Olive tree (*Quadrella* spp.), Poisonwood (*Metopium* spp.) and *Coccoloba swartzii*. Increasing the number of individuals of candle cacti and *Melocactus* spp. present in the area is also recommended.

Another important aspect of habitat improvement regarding vegetation is the removal of undesirable exotic invasive species. During our fieldwork, we found two species of these vines and we recommend to eliminate them in the entire area of development and keep control. Despite of not being an exotic plant, the extraordinary increase in abundance of Snakeweed (*Stachytarpheta boldinghii*) in the area during the last

years, especially when competing for space with other native plants, calls for control measurements to be taken. We recommend to allow this plant to grow exclusively in open spaces and remove individuals of this plant that are clearly competing with native plants and monitor the progress of both in a structured way. Conclusively, if the building permit is granted, we strongly recommend the Marquise Eco Resort Project to elaborate a small "Native Vegetation Restoration and Management Plan" that, besides having a clear general goal and objectives, includes the following activities to reach the established goal: a) removal of invasive species, b) planting of new trees, c) watering needs, d) periodical checks on the status of the vegetation (monitoring), and, e) management activities to take depending on monitoring results.

If well managed, the bird life in the area of development and surroundings can be a great recreational and educational opportunity for the users of the Eco resort in the form of bird watching. It is vital, however, that these recreational activities keep disturbance levels to a minimum in order to avoid some species to abandon the area. This applies especially to the aquatic birds in the lagoon adjacent to the resort. For instance, it is essential that these birds have enough quietude to feed during the day. Therefore, avoiding human presence on all areas of the lagoon during the entire day becomes a must. A good practice is to mark walking paths and strategic viewpoints in only one of the two shores of the salina for people to enjoy watching and photographing the birds, but at the same time giving them space to fly to other areas of the salt flat when frightened by the human presence. Combining these paths and strategic viewpoint with the provision of educational information in the form of signs and the availability of binoculars, telescopes and bird identification cards generally ensures the tranquility needed by these birds to remain using this lagoon as a feeding ground. Given the large amount of garbage accumulated on the shores of the lagoon (Fig. 10), we also recommend very strongly a clean-up of the shores of the lagoon before bird watching is promoted on this location.



Figure 10. An example of the amount and type of garbage found on the salina shores.

During the months of April and July, breeding pairs of Least terns (*Sternula antillarum*) have been recorded in the past near Playa Grandi. Both eggs and chicks are currently facing many non-natural threats on Bonaire (e.g. predation by introduced cats and rats, trampling by introduced donkeys and goats and overexposure of eggs to sunlight by human presence). These threats have resulted in a very low nesting success rate for the species. It is possible to improve the situation for these breeding birds, however, this requires professional knowledge and management activities well beyond the scope of an eco-lodge. Additionally, this species is protected by local legislation. Therefore, we recommend for now to solely inform guests about this situation and avoid human presence as much as possible on these nesting areas during the months above mentioned. Yet, the possibility of Marquise Eco Resort in cooperation with a nature organization to support a plan to improve the nesting situation of Least terns in the area and surroundings can be definitely considered.

As previously mentioned, in the Bonaire Zoning Plan (ROB 2010) Playa Grandi falls under the designation of "Open Landschap" (Fig.10). This designation allows certain types of developments while maintaining the natural character of the areas, but several regulations and procedures apply. It is vital for this project to ensure that its main goals and objectives are in concord with these directives. In the same note, Bonaire's legislation recognizes two categories of eco lodge (A and B) being the highest "Type B". This classification is based on the number of suggestions presented on the document that the resort adheres to. "Type B", is given only to eco-lodges adhering to all the suggestions to minimize negative impact on the environment, while for "Type A" adhering only to 50% of them is enough. Given the close proximity of Playa Grandi to several of the most important nature areas we recommend that this project meets all the suggestions and guidelines required for "eco-lodges type B" presented in the Bonaire Zoning Plan (ROB, 2010).



Figure 11. Portion of the ROB map showing Playa Grandi as "Open Landschap" (pink polygon).

Finally, in the information provided by the developer for this project, the only activities mentioned for the beach area are the clean-up of trash, removal of tree trunks and wood and the removal of rocks/boulders that can be used as construction materials. We perceive these activities as beneficial for the beach environment. However other actions that may be requested to carry out on the beach or the intertidal area in the future (e.g. artificially manage the beach by import/moving of sand, creation of physical barriers to retain sand, construction of wave breakers, etc.) will require a complete environmental study from a marine perspective that includes the effects on both the coast and the coral reef.

References

- Bonairegov. 2010. Informatieblad Natuur en Milieu no. 0810 06 N. Eilandgebied Bonaire Dienst Ruimtelijke Ontwikkeling en Beheer Afdeling Milieu- en Natuurbeleid. Gevonden op: <http://www.bonairegov.an/>, laatst bekeken op 14-juli-2015.
- Buckland, S. T., S. J. Marsden, and R. E. Green. 2008. Estimating bird abundance: making methods work: *Bird Conservation International* 81: S91–S108.
- de Buissonjé, P.H., Neogene and Quaternary Geology of Aruba, Curaçao and Bonaire. Uitgaven Natuurwetenschappelijke Studiekring voor Suriname en de Nederlandse Antillen (Utrecht) 78.
- Burnham, K. P., S. T. Buckland, J. L. Laake, D. L. Borchers, T. A. Marques, J. R. B. Bishop, and L. Thomas. 2004. Further topics in distance sampling. Pages 307–392 in S. T. Buckland, D. R. Anderson, K. P. Burnham, J. L. Laake, D. L. Borchers, and L. Thomas, editors. *Advanced distance sampling*. Oxford University Press, New York, New York, USA.
- Cadastral Survey Department, Netherlands Antilles and K.L.M. Aerocarto BV, 1982. Topographic Map of Bonaire. Netherlands Antilles.
- Coblentz, B. 1980. Goat problems in the national parks of the Netherlands Antilles. Department of Fisheries and Wildlife, Oregon State University. Report submitted to the Netherlands Antilles National Parks Foundation and CARMABI, Curaçao.
- Debrot, A. O., Boogerd, C. and Van den Broeck, 2009 Dutch Antilles III: Curaçao and Bonaire. In Bradley P.E. and Norton R.L. eds. *Breeding seabirds of the Caribbean*. Gainesville, Florida: Univ. Florida Press.
- de Freitas, J.A. Nijhof, B.S.J. Rojer, A.C. Debrot, A.O. 2005. Landscape ecological vegetation map of the island of Bonaire (Southern Caribbean). Amsterdam, The Netherlands: Royal Netherlands Academy of Arts and Science.
- de Freitas, J.A. 1996. *De inheemse bomen van de Benedenwindse Eilanden (Curaçao, Bonaire en Aruba)*. Curaçao, Nederlandse Antillen: Stichting CARMABI.
- Gratto-Trevor CL, Morrison RIG, Collins B, Rausch J, Drever M, Johnston VH. 2011. Trends in Canadian shorebirds. *Canadian biodiversity: ecosystem status and trends 2010*. Ottawa: Canadian Councils of Resource Ministers Technical Thematic Report No. 13.
- Petit, S. 1995. The pollinators of two species of columnar cacti in Curaçao, Netherlands Antilles. *Biotropica* 27:538–541.
- Petit, S. 1997. The diet and reproductive schedules of *Leptonycteris curasoae curasoae* and *Glossophaga longirostris elongata* (Chiroptera: Glossophaginae) on Curaçao. *Biotropica* 29:214–223.
- Petit, S. 1996. The status of bats on Curaçao. *Biological Conservation* 77:27–31.
- Pijpers, P.J. 1931. Bonaire. *Leidse Geologische Mededelingen*. Volume 5. Pagina 701-708. Document gevonden op: <http://www.repository.naturalis.nl/document/549298>, laatst bekeken op 14-juli-2015.
- PPRABC. AICOMs and SICOMs in the ABC Islands. Gevonden op: <http://www.pprabc.org>, laatst bekeken op 14-juli-2015.
- Rivera-Milán, F. F., J. A. Collazo, C. Stahala, W. J. Moore, A. Davis, G. Herring, M. Steinkamp, R. Pagliaro, J. L. Thompson, and W. Bracey. 2005. Estimation of density and population size and recommendation for monitoring trends of Bahama parrots on Great Abaco and Great Inagua. *Wildlife Society Bulletin* 33:823–834.

Simal, F., Doest O., Doest, de Lannoy, C., Garcia-Smith, L., de Freitas, Simal, D. Bertuol P., and Nassar J. 2015. Island-island and island-mainland movements of the Curaçaoan long-nosed bat, *Leptonycteris curasoae*. *Journal of Mammalogy*, 96(3):579-590, 2015 DOI: 10.1093/jmammal./jyv063

Smith, S.R. Davaasuren, N. Debrot, A.O. Simal, F. de Freitas, J.A. 2012. Preliminary inventory of key terrestrial nature values of Bonaire. Gevonden op: <http://edepot.wur.nl/200210>, laatst bekeken op 14-juli-2015.

STINAPA Bonaire. a. Protected areas on Bonaire. Gevonden op: <http://www.stinapa.org>, laatst bekeken op 14-juli-2015.

STINAPA Bonaire b. Ramsar sites on Bonaire. Gevonden op: <http://www.bmp.org/ramsar.html>, laatst bekeken op 14-juli-2015.

Thompson, W. L., G. C. White, and C. Gowan. 1998. *Monitoring vertebrate Populations*. Academic Press, Inc., New York, New York, USA.

Tubbs, C.R. & J.W. Blackwood. 1971. Ecological evaluation for planning purposes. *Biol. Conservation* 3(3): 169-172.

Voous, K.H. 1983. *Birds of the Netherlands Antilles*. De Walburg Pers, Zutphen. 327 pp.

Verstappen, H, 2004 *The Werbata maps-2 1906 topographical maps of The Colony of Curaçao*. ©Fotomatiko del Caribe N.V.

Walburg, P., de Bilt, G., Grenoble, S., 1967, *Soil Map of Bonaire and Klein Bonaire*.

Wells, J. Debrot, A.O. Important Bird Areas in the Caribbean – Bonaire. Gevonden op: <http://www.washingtonparkbonaire.org>, laatst bekeken op 14-juli-2015.