Mountain biking on Aruba’s wild coast

An Environmental Impact Assessment (EIA) of the Aruba MTB trails project proposal

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Wageningen University and research

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Deze milieueffectrapportage (MER) beschrijft de effecten van een voorgesteld MTB-netwerk van 54 km aan de noordwestkust van Aruba, de cumulatieve effecten van andere bezoekersgroepen en een vijftiental maatregelen om de betreffende effecten te mitigeren. Het voorgestelde MTB-netwerk is in theorie een verbetering voor de ecologische omgeving in vergelijking met het huidige MTB-netwerk, hoewel aanvullende maatregelen nodig zijn voordat er over een 'duurzaam' MTB-netwerk kan worden gesproken. Duurzame ontwikkeling kan alleen worden bereikt met een natuur- en bezoekersbeheerplan (inclusief MTB) voor het projectgebied als geheel, passend bij de ambities in het Ruimtelijk Ontwikkelingsplan 2019 van Aruba.

This Environmental Impact Assessment (EIA) describes the impacts of a proposed 54 km MTB-network on the northwest-coast of Aruba, the cumulative impacts of other visitor-groups as well as setting out some fifteen measures to mitigate the impacts concerned. The proposed MTB-network is, in theory, an improvement for the ecological environment if compared to the present MTB-network, though additional measures are needed before speaking about a 'sustainable' MTB-network. Sustainable development can only be achieved with a nature and visitor management plan (including MTB) for the project area as a whole, that matches the ambitions set out in Aruba's Spatial Development Plan 2019.

Keywords: Mountain Biking - MTB, All Terrain Vehicle - ATV, Utility Task (Terrain) Vehicle - UTV, habitat loss and fragmentation, erosion, disturbance, mitigation, management plan, Aruban Burrowing Owl, Shoco, Least Tern, Aruban Rattlesnake.

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Preface

Most Caribbean island ecosystems are fragile. The habitats are relatively small in area, as are the species populations that depend on them. This partly explains why islands are currently the biggest extinction hotspots globally. Aruba is no exception and the sixth National report for the Convention on Biological Diversity describes the worrying status in relation to the conservation of biodiversity in Aruba. This emphasizes the need for responsible use of the island's remaining natural areas, including those outside the protected sites.

All too often questions concerning the visitor-use of natural areas, turn into 'a battle' between nature conservationists and the entrepreneurial group, while their interests are actually more similar than it seems. The majority of visitors request a well-conserved natural scenery for their activities, which also benefits the native species. It's a challenge to highlight these common interests and to strive for the same goal.

From our multiple meetings with stakeholders in November 2019 on Aruba, we noticed that many of them are currently struggling with this challenge. Struggling with the feeling that the native Arubans are losing their island to the tourists, whilst they also want to enjoy it for themselves; but also understanding that they need to use the resource sustainably together. This feeling also concerns the proposed network of MTB trails at Aruba's wild north coast. We hope that this report gives more insight into this matter and that it helps to achieve a more sustainable future for nature and people on Aruba. We thank all people that we have spoken to for sharing their valuable knowledge.

Summary

Het eiland Aruba heeft voor toeristen vooral een 'zon, zee en strand' imago. De Aruba Tourism Authority (A.T.A.) wil het Arubaanse toerismeproduct echter diversifiëren door toeristische niche-markten te ontwikkelen. Een van de mogelijkheden ligt in de ontwikkeling van mountainbiken (MTB), wat wordt beschouwd als een populaire en groeiende sport onder toeristen en de lokale bevolking.

In november 2018 heeft de A.T.A. een voorstel ontvangen van een bedrijf in Colorado (VS) dat MTB-routes aanlegt, getiteld (vertaald): *Aruba MTB Trails; Ontwikkeling van een nichemarkt voor mountainbiken op Arub*a. Het voorstel beoogt het ontwerpen en aanleggen van zo'n 54 km aan geoptimaliseerde MTB-routes.

Hoewel het plan aansluit bij de ambities van A.T.A., vraagt deze zich af of het plan echt zo duurzaam is als gesteld in het voorstel. Voorliggende milieueffectrapportage (MER) beoordeelt dit vraagstuk door de volgende onderzoeksvragen te beantwoorden:

- Wat zijn de effecten van de voorgestelde MTB-routes op de (ecologische) omgeving in het projectgebied?
- Wat zijn de cumulatieve effecten (indicatief) van andere gebruikersgroepen op de (ecologische) omgeving in het projectgebied?
- Welke maatregelen moeten worden genomen om de beoordeelde ecologische effecten te mitigeren of te compenseren?

Deze vragen zijn beantwoord op basis van een grondige literatuurstudie, een veldbezoek in november 2019 (inclusief een quick scan naar de Arubaanse Holenuil) en interviews met lokale belanghebbenden en experts.

Het volgende kan worden geconcludeerd:
Het voorgestelde MTB-netwerk is, in theorie, een verbetering voor de ecologische omgeving in vergelijking met het huidige MTB-netwerk, hoewel aanvullende maatregelen nodig zijn voordat er over een 'duurzaam' MTB-netwerk kan worden gesproken.

De lengte van het huidige MTB-netwerk van meer dan 50 km verschilt niet zoveel van het voorgestelde MTB-netwerk. Het belangrijkste verschil is dat MTB's in de voorgestelde situatie niet meer off-road rijden. Off-road rijden leidt tot het ontstaan van niet-officiële wegen en paden en resulteert in bodemerosie, aantasting en versnippering van leefgebieden, verstoringen van nesten en (dodelijke) botsingen met slangen en grondbroedende vogels, de meest kwetsbare soortengroepen. Sommige van deze effecten konden ook worden waargenomen tijdens een bezoek aan het gebied.

In de voorgestelde situatie zijn er nog steeds soorten die kunnen worden beschouwd als matig tot zeer kwetsbaar voor MTB's. Dit heeft te maken met het feit dat de voorgestelde MTB-routes te dicht langs (potentieel) broedhabitat loopt van de Arubaanse Holenuil en de Amerikaanse Dwergstern. Ook bestaat het risico dat MTB's, vooral in de periode tussen avondschemering en zonsopgang, in botsing komen met slangen (zoals de zeer bedreigde Arubaanse Ratelslang). Dit vereist omleiding van de voorgestelde MTB-paden (ruimtelijke zonering) of sluiting van 'probleem'-paden in ieder geval tijdens de meest kwetsbare maanden (broedseizoen uilen en sterns) of tijd van de dag (tussen schemering en zonsopgang). Deze maatregelen geven onder meer aan dat een padennetwerk binnen het natuurgebied Tierra del Sol, o.a. een bolwerk voor de bedreigde Arubaanse Holenuil, niet realistisch is.

Het gebruik van 'in theorie' in bovenstaande conclusie is opzettelijk, aangezien het duurzaamheids-vraagstuk veel verder gaat dan het MTB-netwerk. De belangrijkste conclusie van deze ecologische effectbeoordeling is dan ook dat:
Duurzame ontwikkeling van de noordwestkust van Aruba alleen kan worden bereikt met een natuur- en bezoekersbeheerplan (inclusief MTB) voor het gebied als geheel, passend bij de ambities in het Ruimtelijk Ontwikkelingsplan Aruba 2019.

De huidige ecologische effecten in het projectgebied zijn aanzienlijk en betreffen verlies en versnippering van habitats, schade aan vegetatie en bodems, verstoring van fauna en in mindere mate ook het verlies van individuen als gevolg van botsingen en vervuiling. Hoewel deze effecten gedeeltelijk kunnen worden toegeschreven aan MTB's, valt dat in het niet vergeleken met de cumulatieve effecten van de vele ATV's en UTV's die het gebied (met name het lagere terras) domineren met hun aantallen, snelheid, geluid, off-road rijden, erosie en stofvorming. De omvang van deze effecten gaat verder dan het projectgebied alleen en heeft niet alleen betrekking op de ecologische draagkracht maar ook op de sociale (lokale gemeenschap) en zelfs psychologische draagkracht (toeristen).

Deze situatie is in tegenspraak met het Ruimtelijk Ontwikkelingsplan Aruba 2019. Dit plan classificeert het projectgebied in twee categorieën: *natuur* (o.a. Tierra del Sol) en *natuur en landschap* met kenmerken als stilte, low-impact recreatie, rijden op daartoe aangewezen (officiële) paden en wegen evenals herstel, instandhouding en ontwikkeling van natuurwaarden. Deze tegenstrijdigheid bevestigt de zelfevaluatie (SWOT-analyse) door het Ministerie van Natuur en Milieu (Min. ROIM, 2018) waarin het "gebrek aan handhaving" voor het behoud van habitats en soorten wordt beschouwd als een van de zwakke punten, terwijl "Geen rekening houden met de draagkracht van Aruba en risico's voor het creëren van een onleefbaar milieu voor de komende generaties" wordt gezien als een bedreiging.

Deze observaties maken duidelijk dat duurzame ontwikkeling van het projectgebied alleen kan worden bereikt met een beheerplan voor natuur en bezoekers voor het projectgebied als geheel.

In dit rapport is een lijst van 15 acties en maatregelen beschreven, die onderdeel kunnen worden van dit beheerplan.

Summary

The island of Aruba predominantly has a 'sun, sea and sand' tourism destination image. The Aruba Tourism Authority (A.T.A.) aims to diversify the Aruban tourism product by developing tourism niche markets. One of the opportunities lies in the development of mountain biking (MTB), which is considered a popular and growing sport amongst tourists and locals.

In November 2018, the A.T.A. received a proposal from an experienced trail building company in Colorado (USA) titled: *Aruba MTB Trails. Developing a niche market for mountain biking in Aruba.* The proposal aims to design and build some 54 km of bike optimized MTB trails.

Although the plan matches with the ambitions of A.T.A., the Authority questions whether the plan is really as sustainable as stated in the proposal. This environmental impact assessment (EIA) assessed this issue by answering following research questions:

- What are the impacts of the proposed MTB-trails on the (ecological) environment in the project area?
- What are the cumulative impacts (indicative) of other user groups on the (ecological) environment in the project area?
- What measures should be implemented to mitigate or compensate any ecological impacts assessed?

These questions were answered based on a thorough literature study, a field visit in November 2019, a field study of the Aruban Burrowing Owl and interviews with local stakeholders and experts.

It could be concluded that:
The proposed MTB-network is, in theory, an improvement for the ecological environment when compared with the present MTB-network, though additional measures are needed before speaking about a 'sustainable' MTB-network.

The length of the present 50+ km MTB-network is not so much different from the proposed MTB-network. The main difference lies in the fact that MTBs are assumed not to ride off-road anymore in the proposed situation. Off-road riding leads to the creation of informal roads and paths and results in soil erosion, habitat degradation and fragmentation, nest disturbances and (fatal) collisions with (ground) breeding birds and snakes, which are the most vulnerable species groups. Some of these impacts were observed while visiting the area.

In the proposed situation there are still species that would show moderate or substantial vulnerability to MTBs. This has to do with the fact that proposed MTB-trails are too close to potential breeding habitat of the Aruban Burrowing Owl and Least Tern as well as the potential for MTBs to collide with snakes between dusk and dawn. This requires rerouting of the proposed MTB-trails (spatial zoning) or closure of 'problem' trails at least during the most vulnerable months (breeding season owls and terns) or time of day (between dusk and dawn). These measures indicate, among others, that a trail network within the Tierra del Sol nature area, which is a stronghold for the endangered Aruban Burrowing Owl, is not realistic.

Our use of 'in theory' in the conclusion above is intentional, as the sustainability-issue goes much further than the MTB-network. The main conclusion of this ecological impact assessment is therefore that:
Sustainable development of Aruba's wild north coast, can only be achieved with a nature and visitor management plan (including MTB) for the area as a whole, that matches with the ambitions in Aruba's Spatial Development plan 2019.

Present ecological impacts in the project area are substantial and concern habitat loss and fragmentation, damage to vegetation and soils, disturbance of fauna and to a lesser extent also the loss of individuals due to collision and pollution. Though these impacts can partly be attributed to

MTBs, it is nothing when compared to the cumulative impacts of the multiple ATVs and UTVs which dominate the area (especially the lower terrace) with their numbers, speed, noise, off-road driving, erosion and dust creation. The scope of these impacts goes beyond the project area and does not only relate to the ecological carrying capacity but also to the social (local community) and even psychological carrying capacity (tourists).

This situation is contradictory to the Aruba Spatial Development Plan 2019. This plan classifies the project area in two categories nature (e.g. Tierra del Sol) and nature and landscape with characteristics like silence, low-impact visitor-use, driving on formal paths and roads as well as restoration, conservation and development of natural values. This contradiction confirms the self-evaluation by the Ministry of Nature and Environment (Min. ROIM, 2018) in which the lack of law enforcement for the conservation of nature is regarded as one of the weaknesses, while not taking into account the ecological carrying capacity of Aruba risks the creation of an unlivable environment for generations to come. These observations make clear that sustainable development of the project area can only be achieved with a nature and visitor management plan for the project area as a whole.

A list of 15 actions and measures is included in this report, which it is recommended should be integrated within the nature- and visitor management plan.

1 Introduction

1.1 Lead

The island of Aruba predominantly has a 'sun, sea and sand' tourism destination image. The Aruba Tourism Authority (A.T.A.) aims to diversify the Aruban tourism product by developing tourism niche markets. One of the opportunities lies in the development of mountain biking (MTB), which is considered a popular and growing sport amongst tourists and locals.

In November 2018, the A.T.A. received a proposal from an experienced trail building company in Colorado (USA) titled: *Aruba MTB Trails. Developing a niche market for mountain biking in Aruba.* The proposal aims to design and build some 54 km of bike optimized MTB trails (see Figure 1 for an overview of the proposed trails network).

Although the plan matches with the ambitions of A.T.A., the Authority questions whether the plan is really as sustainable as stated in the proposal. This environmental impact assessment (EIA) aims to assess this issue by answering following research questions:

- What are the impacts of the proposed MTB-trails on the (ecological) environment in the project area?
- What are the cumulative impacts (indicative) of other user groups on the (ecological) environment in the project area?
- What measures should be implemented to mitigate or compensate any ecological impacts assessed?

1.2 Definition project area

Figure 1 shows the proposed MTB-trails at the northwest coast of Aruba. The 54 km of bike trails are situated in an area slightly longer than 10 km (between Tierra del Sol and the Natural Bridge) and an average 1 km wide, and cover the lower terrace and a large part of the adjacent hills. The 'project area' is defined as the area between the coastline and the outer trails, including a 100 m disturbance zone as the influence of MTBs goes beyond the trails themselves. This area covers 1032 ha.

1.3 Project realisation

This report has been based on a desk study, (local) expert knowledge, field visits to the project area and a rapid field assessment of the presence of the Aruban Burrowing Owl.

The project began with a mission to Aruba between 11-15 November 2019. Due to lack of freely available literature, data on ecology and visitor use of the project area itself, we had to rely to a large extent on expert knowledge. For that, interviews were held with representatives from the Aruba Tourism Association (A.T.A.), the Department of Nature and Environment (DNM), the department for Infrastructure Management and Planning (DIP), the Department of Public Works (DOW), National Park Arikok, the Aruba Cycling Federation, the Mountain bike Committee, Tribike, Aruba One Happy Bike Island Foundation, The University of Aruba, tour agents and local bird specialists.

Several field visits were made to the project area to assess the ecological conditions, visitor-use and potential impacts. A rapid field assessment of the Aruban Burrowing Owl was carried out during the same period, which is the species breeding period, to assess the species status in the project area.

The desk study concerned the gathering and analysis of available data and information concerning environmental legislation and policies that apply to the project area and scientific knowledge concerning the impacts of visitor-use on the environment.

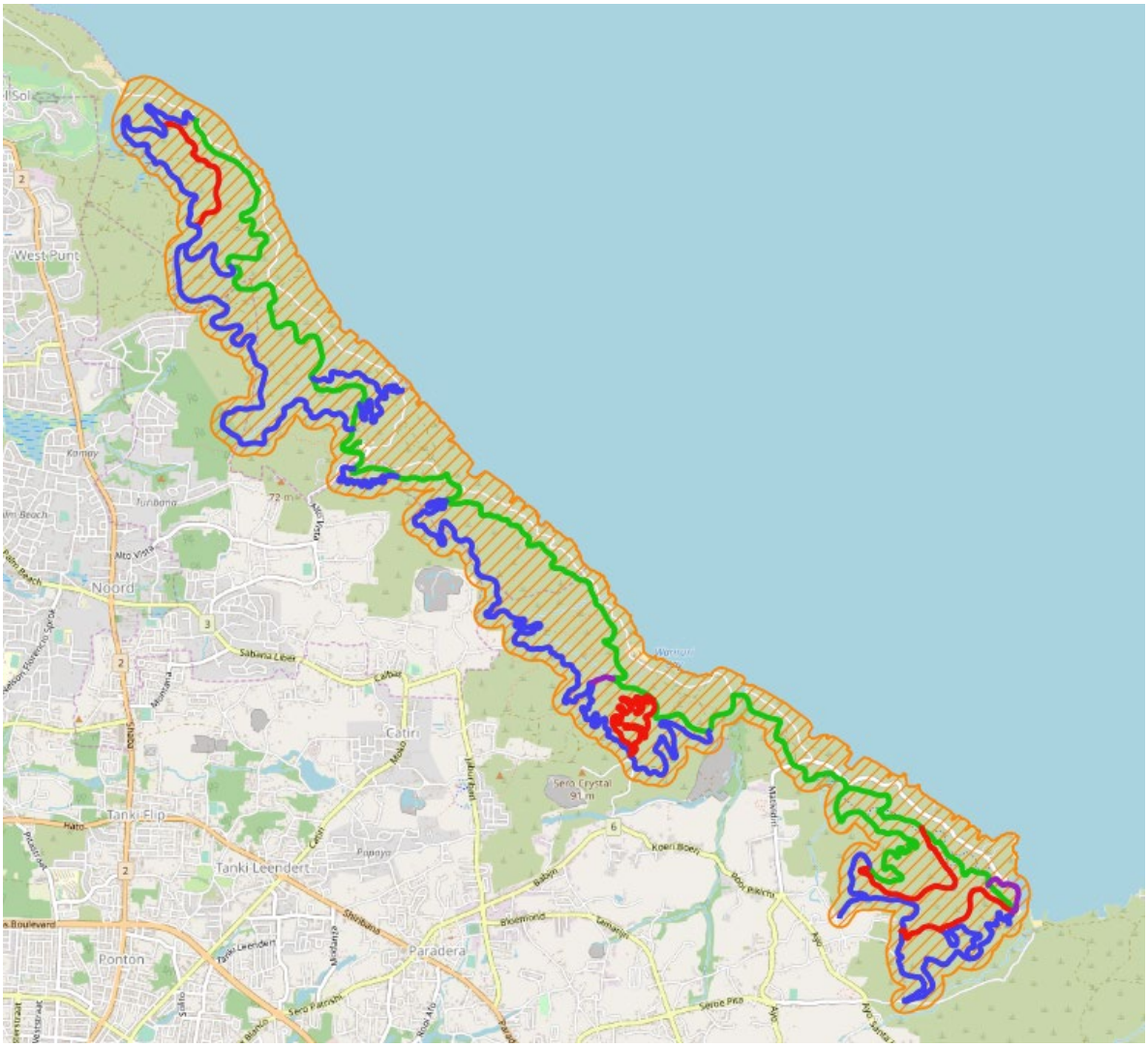

Figure 1 *The (shaded) 1032 ha project area with the proposed MTB trails network on the north west coast of Aruba), with 19 km beginner (green), 27 km intermediate (blue) and 9 km advanced trails (red) (source: proposal Aruba MTB Trails. Developing a niche market for mountain biking in Aruba).*

2 Environmental legislation and policies

2.1 The Aruba Spatial Development Plan 2019

The Aruba Spatial Development Plan 2019 shows what is planned for Aruba's 'wild north coast'. The proposed MTB-network has been overlaid onto this map (fig 2) and shows that it overlaps with the categories 'nature area' (dark green) and 'nature and landscape' (light green). The nature area concerns the IBA Tierra del Sol in the north of the project area. The policy for the conservation and visitor-use in these two categories are very much the same (Table 1), and are both characterized by key-words like 'ecological preservation, restoration and development, low-impact use on paths and roads only, restriction of noise, light and dust production.

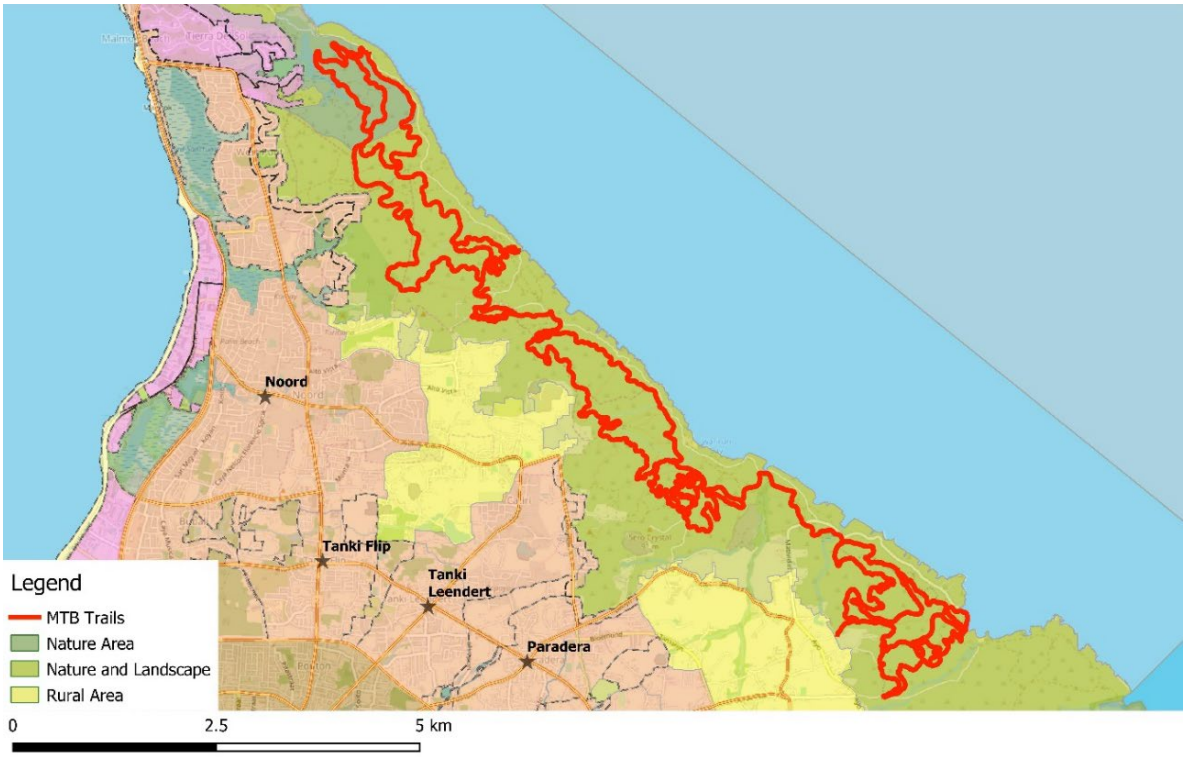

Figure 2 *Spatial Development Plan Aruba 2019, specifically focusing on the project area. The trails would overlap with the categories 'nature area' (dark green) and 'nature and landscape' (light green).*

Table 1 *Policy of the spatial categories within the Spatial Development Plan 2019 that apply to the project area (Min. ROIM).*

Functions	Nature area	Nature and landscape
Conservation:		
• Preservation, restoration and development of existing ecological (or natural), archaeological, landscape, cultural-historical and geological values;	X	X
• Silence area.	X	X
Visitor-use:		
• Daily visitor-use with low impact on the environment.	X	X
• Visitor-use is limited to walking, cycling, horse riding, driving motorized vehicles on paths and roads designated for this purpose by the manager.	X	X
Conflicting visitor-use:		
• Visitor-use outside roads and paths designated for this purpose by the manager.	X	X
• Other forms of daily recreational use than those mentioned that are a disturbance to the environment due to their noise, light or dust production and other emissions.	X	X

2.2 The SPAW Protocol of the Cartagena Convention

The Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Region (WCR) is the only legally binding regional environmental treaty for the Region. The Convention, referred to as the Cartagena Convention, presently has 23 (out of 28 possible) States that are Contracting Parties. The Convention and its Protocols constitute a legal commitment by these countries to protect, and manage their common coastal and marine resources individually, jointly and in a sustainable manner. The Cartagena Convention and its Protocols enhance not only protection but also development, as specifically noted in its provisions.

The SPAW Protocol was signed on 18 January 1990 and ratified by the Kingdom of the Netherlands on 2 March 1992. The annexes to the protocol have a list of agreed species that should receive certain conservation measures. Parties shall ensure total protection and recovery of fauna species listed in Annex II of the protocol by prohibiting:

- the taking, possession or killing (including, to the extent possible, the incidental taking, possession or killing) or commercial trade in such species, their eggs, parts or products;
- to the extent possible, the disturbance of such species, particularly during periods of breeding, incubation, estivation or migration, as well as other periods of biological stress.

Annex III of the protocol contains the agreed list of species of marine and coastal flora and fauna that may be utilized on a rational and sustainable basis and that require the protection measures indicated in Article 11(1)(c) of the protocol.

2.3 The National Decree on the protection of indigenous flora and fauna 2017

The National Decree on the protection of native flora and fauna (Landsbesluit bescherming inheemse flora en fauna; Min. DNM, 2017) came into force on 15 August 2017. It implements Articles 4, first and second paragraph, and 26, first paragraph, of the Nature Conservation Regulation (Natuurbeschermingsverordening; AB 1995 no. 2). The National Decree aims to protect 55 flora species and 69 fauna species whose survival is threatened in Aruba or for which sustainable presence is deemed desirable. The National Decree is a law that clearly states that it is illegal to kill and / or damage flora and fauna that are protected by the National Decree. Annex 1 gives the full list of flora and fauna species under article 1 and 2 of this National Decree.

3 Visitor use project area

3.1 Present visitor use

Official data on the visitor use of the project area, the visitor types, their numbers and distribution during the day and the season are not available. An impression however was obtained during the field visits in November 2019.

Visitor concentrations can be found at the Bushiribana Gold Smelter ruins and at the Natural Bridge. The main visitor-types observed were motorized vehicles, especially ATV (all-terrain vehicle) and UTV (utility task vehicle), and to a lesser extent horseback riders and mountain bikers. Although the area is suitable for hiking, there were no hikers observed during the field visits.

Motorized vehicles
No data are available on the number of motorized vehicles in the project area. It is obvious however that their numbers are high. The lower terrace is the domain of ATVs, UTVs and to a lesser extent also trucks and jeeps (Fig. 3). These user groups are visible and audible throughout the period of the day, often in groups and many were observed to drive at high speed (approx. > 40 km/hr).

Figure 3 *Trucks, UTVs and ATVs observed in the project area on 12-11-2019 (Photos by René Henkens).*

Horseback riding

Several horse riding schools offer horse rides for tourists. Official data on the number of horseback riders in the project area and their distribution during the day and the seasons are not available. Horse riding groups were visible throughout the day. They can be found all along the project area but mainly in the hills, which is relatively less crowded if compared to the lower terrace (Fig. 4).

Figure 4 *Horseback riders in the hills of the project area on 12-11-2019 (Photo by René Henkens).*

Mountain biking

Official data on the length of the mountain bike trails network and the number of mountain bikers on Aruba are not available. Nevertheless, the island has been said to have some 350 kilometers[1] of mountain bike routes. The north coast is regarded as most challenging for mountain biking. Several marked trails already exist in the project area ranging from easy (green), intermediate (blue), and advanced (red) to trails (black) for expert mountain bikers (see Fig. 5). Presently marked MTB-trails already cover some 50 km length. The proposed 54 km MTB-network is therefore not a new phenomenon in the project area.

[1] Source: https://www.beautiful-aruba.nl/activiteiten/fietsen-mountainbiken.php

Figure 5 *Panel at the Bushiribana Gold Smelter ruins (top left) and the Alto Vista chapel (top right) indicating green, blue, red and black marked mountain bike trails (pictures below) that currently exist in the project area at the northwest coast of Aruba (Photos by René Henkens).*

Several tour operators and bike shops rent mountain bikes to tourists, while mountain biking is also a popular leisure activity among local residents. One of the bigger tour operators on Aruba, an enthusiastic mountain biker himself, explained that their efforts in the past to promote mountain biking to tourists had never paid off. It remains speculative why it failed but the sun-sea-sand image of Aruba, the relatively limited trail length as well as the heat during day-time were assumed to make Aruba less attractive as a MTB-destination.

3.2 The proposed Aruba MTB-network

In November 2018, the A.T.A. received a proposal from an experienced trail building company in Colorado (USA) titled: *Aruba MTB Trails. Developing a niche market for mountain biking in Aruba.* The long-term goal of this proposal is "*to replace the existing, eroding trail system (estimated at 50km) created by users and livestock overtime, with a 54 km world-class sustainable trail system with trails for all ages and abilities*" (see Figure 1 for an overview of the proposed trails network).

The trail builders aim to adhere to the International Mountain Bicycling Association (IMBA) recommendations (guidelines) for MBA Flow Country Trails industry standards/guidelines. Besides that they also aim to adhere to other guidelines, like IMBA's Guide to Freeriding Solutions, the Whistler Trail Standards and Design Principles and Guidelines for Aerial Features and Dirt Jumps & Other Freestyle Bicycle Facilities. The trail builders evaluated the present Aruba MTB-trails system as fun but not sustainable, especially because of the many informal trails (due to lack of proper directional signage) and the signs of erosion of formal and informal trails. Box 1 gives an impression of the proposed MTB-network and associated activities aimed to make it sustainable.

Box 1. Characteristics of the MTB trail network as described in the trail builders proposal

The MTB trail builders:

- aim to build a 53.95 km MTB trails network of which 19.19 km for beginners, 27.15 km for intermediate cyclists and 7.61 km for advanced cyclists.
- aim to implement a trail maintenance program which is essential in keeping the visitor experience consistent and which minimizes risks (like falling) for the users.
- aim to develop the trails with a local crew in three years' time and realize on the job training in trail development and maintenance. The local crew should consist of 4-8 interns from the Aruban government working alongside the trail crews for three seasons. These interns would be trained in natural resource management, trail construction and reclamation, which would essentially turn them into Aruba's professional trail crew.
- recognize that additional research and consultation would be needed to minimize environmental impacts and also that cooperation with biologists and archaeologists would be needed during the construction phase.
- emphasize that no materials (or seeds from exotic plants) will be imported for the construction of the trails.
- recommend a trail of minimum 1 meter wide due to the expected volumes of use, specific type of use, presence of horned plants, and potential velocities of riders.
- emphasize that their team's number one goal is to keep water off the trail and people on the trail! For that they will utilize earthen features like rollers and jumps at strategic locations to minimize the time water is flowing across the trail.
- may require the use of barrow pits in relatively flat zones to generate soil to raise the existing tread above the surrounding terrain. This will enhance drainage and sustainability over time.
- will identify areas of highly erosive soils and areas of soil with high sand content and minimize grades when routing trails across such soils. They aim to specify appropriate measures to minimize the effects of these conditions in areas where this is possible.
- aim to avoid construction activities when soils are wet or muddy.

4 Biodiversity values project area

Inventories of the biodiversity values of the project area are not available, although some publications report on species like the Aruban Burrowing Owl (Oirschot, 1999) and the Aruban Rattle Snake (Reinert at al., 2002, 2008). However, the field visits in November 2019 provided a good impression about the existing habitats in the project area. Based on the presence of these habitats it can be argued which species could use the project area for functions like foraging and/or reproduction.

In paragraph 4.1 we describe the habitats encountered, while in paragraph 4.2 we list the species that may be observed here. We limit ourselves to the threatened species as listed in the National Decree Flora and Fauna (Annex I, Min. DNM, 2017).

4.1 Habitats

The natural environment of terrestrial Aruba is characterized by xeric-adapted (dry-adapted) shrubs, cacti and woodland. Although the island is the most arid of the former Netherlands Antilles, its less porous soils favour the persistence of standing water (van Buurt 2006).

Figure 6 *Habitats in the project area with: (tertiary) bare limestone in the lower terrace (top left), which is potential breeding habitat for the Least Tern (Sterna dougalii); a pool (top right) which serves as reproduction habitat for the Colombian four-eyed frog (Pleurodema brachyops); the blooms and fruits of cacti (bottom left) with Prickly pear (Opuntia wentiana; in front), the candelabra-formed pillar cactus Breba (Cereus repandus; background left) bearing fruits and the pillar cactus Cadushi (Stenocereus griseus; background right) are a critical resource for bats, birds and other animals; thorned scrub (bottom right, with Valchellia tortuosa and Prosopis juliflora) with sandy patches that may serve as nesting habitat for the Shoco (Athene cunicularia arubensis) (Photos by René Henkens).*

Figure 6 gives an impression of the diversity of habitats that can be found in the project area, like: bare limestone shores, which is potential breeding habitat for terns, especially the Least Tern (*Sterna dougalii*); pools which serve as reproduction habitat for the Colombian Four-eyed Frog (*Pleurodema brachyops*); blooms and fruits of cacti which are a critical resource for bats, birds and other animals; and sandy patches that may serve as nesting habitat for the Aruban Burrowing Owl or Shoco (*Athene cunicularia*). The pictures in Figure 6 were taken mid November 2019. This is in the middle of the rainy season - running roughly between October and mid-December- which provided the project area with a relatively 'greenish' look.

The nature area Tierra del Sol lies in the north of the project area. This area encompasses an approximately 2 ha natural Salina (salt water lake) within a golf course. It comprises an area of open water which flows naturally to the sea, and is surrounded by desert scrub habitat. The Salina dries out periodically either naturally or through re-directed surface water flow. This Salina is an official IBA or Important Bird Area (BirdLife International, 2008).

4.2 Species

Table 2 lists the threatened faunal species (based on the list in the National Decree Flora and Fauna; Min. DNM, 2017) for which the project area may function as a breeding and/or feeding habitat.

Table 2 *Threatened species of Aruba (source: National Decree on the protection of native flora and fauna) for which the project area forms reproduction and/or foraging habitat.*

Species name			Reproducing	Foraging	Nat. Decree Flora & Fauna	SPAW Annex	IUCN Red List	Island Endemic
Scientific	**English**	**Local**						
Glossophaga longirostris	Leaf Nosed Bat	Raton di anochi		X	X		LC	
Leptonycteris curasoae	Curaçaoan Longnosed Bat	Raton di anochi		X	X		VU	
Pteronotus davyi	Lesser Naked-backed bat	R. di anochi lomba sunu		X	X		LC	
Polyborus plancus	Southern Crested Caracara	Warawara	X	X	X		LC	
Buteo albicaudatus	White-tailed Hawk	Falki		X	X		LC	
Falco peregrinus	Peregrine Falcon	Falki peregrino		X	X	II	LC	
Athene cunicularia arubensis	Aruban Burrowing Owl	Shoco	X	X	X		EN[2]	X
Sternula antillarum	Least Tern	Sternchi Chikito	X		X	II	LC	
Eupsittula pertinax arubensis	Brown-throated Parakeet	Prikichi	X	X	X		EN[3]	X
Amazona barbadensis	Yellow-shouldered Amazon	Lora			X	II	VU	
Colinus cristatus	Crested Bobwhite	Patrishi	X	X	X		LC	
Columba squamosa	Scaly-naped Pigeon	Paloma di baranca		X	X		LC	
Chlorostilbon mellisugus	Blue-tailes Emerald	Blenchi	X	X	X		LC	
Chrysolampis mosquitus	Ruby-topaz Hummingbird	Blenchi dornasol	X	X	X		LC	
Crotalus unicolor	Aruban Rattlesnake	Cascabel	X	X	X		CR	X
Leptodira bakeri	Cat-eyed Snake	Santanero	X	X	X		LC	
Iguana	Common Green Iguana	Yuana	X	X	X	III	LC	
Anolis lineatus	Striped Anole		X	X	X		LC	
Pleurodema brachyops	Colombian Four-eyed Frog	Dori, dori mako	X	X	X		LC	

Flora species listed on the National Decree are also found here, such as the nocturnal pillar cacti Cadushi (*Stenocereus griseus)* and Breba (*Cereus repandus)*, of which many specimens can be found

[2] IUCN ranks the species *Athene cunicularia* as Least Concern (LC). However, the subspecies *Athene cunicularia arubensis* is endemic to Aruba, numbers only some 200 pairs and is declining, which justifies its status as Endangered (EN).

[3] IUCN ranks the species *Eupsittula pertinax* as Least Concern (LC). However, the subspecies *Eupsittula pertinax arubensis* is endemic to Aruba and its population is considered small and declining, which justifies its status as Endangered (EN).

in the project area. These pillar cacti and their associated pollinator bats play a crucial role in the ecology of Aruba. Leaf Nosed Bat (*Glossophaga longirostris*) and Curaçaoan Longnosed Bat (*Leptonycteris curasoae*) are dependent on nectar and are the only animal species that can pollinate these cacti (Nassar et al., 2003). The cacti flowers and fruits form a very important food source for the fauna of Aruba during the dry period.

The cacti also serve as nesting habitat. Species like the Southern Crested Caracara (*Polyborus plancus*) may breed on its branches, while species like the Brown-throated Parakeet (*Aratinga pertinax arubensis)* may breed here in nesting holes.

The Colombian Four-eyed Frog (*Pleurodema brachyops)* probably uses the pools for reproduction, while the Cat-eyed Snake (*Leptodira bakeri)* may prey on this species (Mijares-Urrutia et al., 1995).

The salina Tierra del Sol is significant for the Near Threatened Caribbean Coot *Fulica caribaea*. Up to 170 birds have been recorded here (Birdlife International, 2008). The wetland supports a wide range of waterbirds including White-cheeked Pintail *Anas bahamensis* (up to 95 birds), nesting and roosting herons and egrets (over 300 birds in the roost), and roosting terns. Hundreds of shorebirds visit the site during migration. The surrounding shrubland is important for a number of species, including Bare-eyed Pigeon *Patagioenas corensis* —Aruba's only Northern South America biome-restricted species (Birdlife International, 2008). Apart from the Salina, the Tierra del Sol nature area has also become a stronghold for the conservation of the Aruban Burrowing Owl (see Section 4.3).

Some more information will be provided below on the Burrowing Owl, Least Terns and the Aruban Rattle snake, for which some data in the project area are available.

4.3 Aruban Burrowing Owl *(Athene cunicularia arubensis)*

The Aruban Burrowing Owl (*Athene cunicularia arubensis*), known locally as Shoco, is an endemic sub-species of burrowing owl that occurs only on Aruba. They get their name from their unusual habit of nesting underground, whether in artificial or self-made burrows. When the breeding season is over, the owls continue to use the borrows to rest during the day. Unlike most owl species, Burrowing Owls are often active during the day, although they hunt for food at night. This means that conservation efforts can not only be attributed to the nesting season between late October – late May, but it needs protection throughout the day and year (spatial zoning measures rather than temporary zoning measures).

The Shoco's population has greatly diminished in the last few decades and is now endangered, with estimates of less than 200 pairs remaining[4]. Threats include urbanisation, disturbance, and invasive species like the Boa constrictor but also plant species like the Acacia thorn which has a negative impact on the species' preferred habitat through closing over the favoured grasslands and creating a dense thorn scrub layer. This partly explains why most of the nesting-burrows found in the project area by van Oirschot (1999) were currently not occupied anymore.

Figure 7 shows the (concept for the) first Spatial Development Plan with Regulations for Aruba (ROPV 2019). It shows among others 'Proposed Shoco Area' by Aruba Birdlife Conservation (ABC). The underlying aspect here is to establish 'anchor points' of habitat for Shoco's in the landscape. These anchor points reflect the predominant methods in conservation biology for species, rather than trying to protect/enhance the species everywhere. These anchor points become source populations and owls produced within these areas can disperse to adjoining blocks. The Tierra del Sol golf course and nature area should also be considered an anchor point for the Shoco. 20 years ago this area already showed the highest density of the species on Aruba (van Oirschot, 1999). Over a period of the past two years, 22 artificial burrows have been placed at safe locations on and around Tierra del Sol, which is the result of a partnership between Aruba Birdlife Conservation, National Park Aruba, the Gobal Owl Project and the Tierra del Sol golf course owner.

[4] Source: https://www.dcnanature.org/aruban-burrowing-owl-7/

4.4 Least Tern *(Sterna antillarum)*

Figure 7 shows the (concept for the) first Spatial Development Plan with Regulations for Aruba (ROPV 2019). It shows that the shores of the project area are marked as 'Proposed Terns Area' by Aruba Birdlife Conservation (ABC). These shores are barren, sparsely vegetated gravelly substrates (Fig. 6), which form an important nesting area, especially for the Least Tern (*Sterna antillarum*).

The national population of Least Terns was assessed at 480 birds in 2008. Some 3-53% of these could be attributed to the San Nicolas Bay Reef Islands, an Important Bird Area (Birdlife International, 2008), while the species was not attributed to any of the other IBA reef islands. Although exact data are not available, this means that the shores of the northwest coast (project area) and the northeast coast of Aruba form an important nesting area for approximately half or more of the national Aruban population.

The species moves around between nesting locations, depending on the nesting success in previous seasons (which explains the large 3-53% range mentioned above). Nesting attempts may fail due to predation (whether natural predators, or cats and rats) or human disturbance (e.g. recreation). The species is known to attempt a second clutch (Boyd, 1983) and is even known to re-nest as quickly as four days after the loss of eggs (Massey and Fancher, 1989), which results in a prolonged nesting season that runs from late March until late July on Aruba.

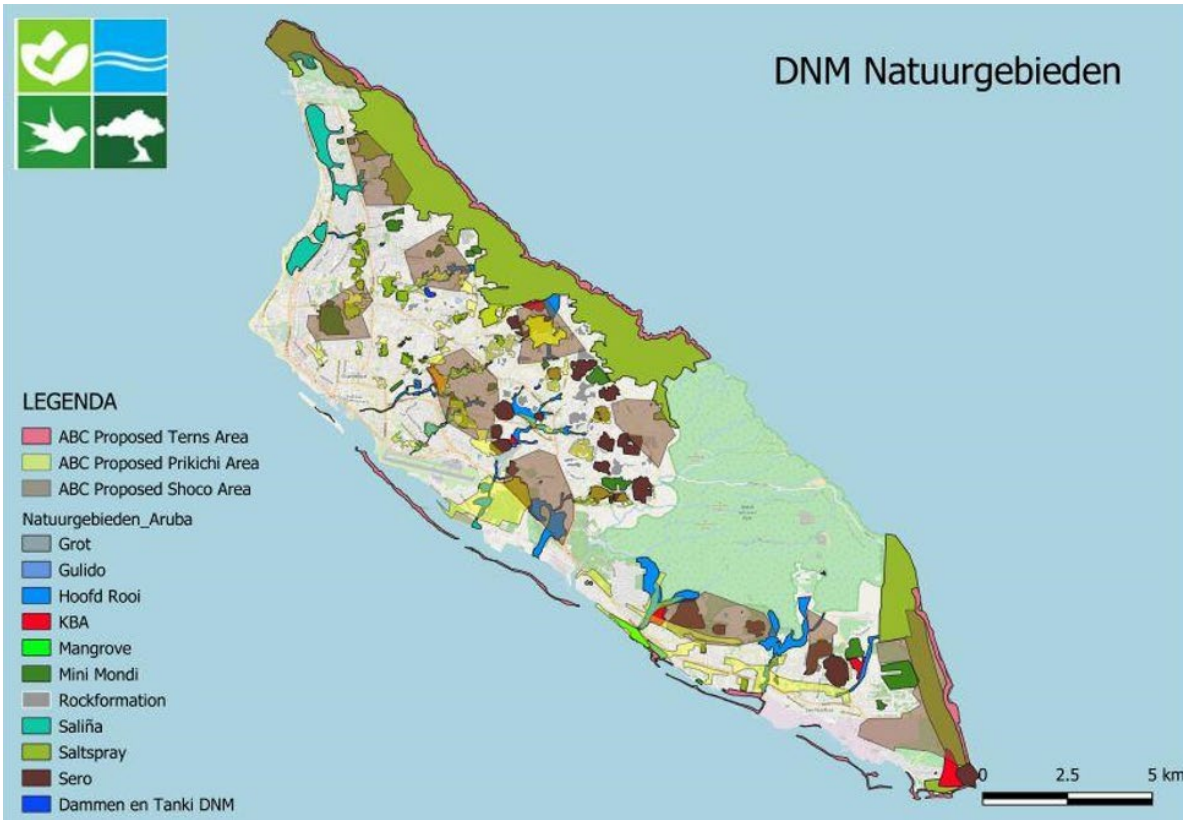

Figure 7 *Concept for the first Spatial Development Plan with Regulations for Aruba (ROPV 2019) drafted by the Directorate of Nature and Environment*[5] *(DNM Aruba).*

[5] https://www.overheid.aw/news/news_47033/item/from-october-1-2019-the-spatial-development-plan-with-regulations-2019-will-be-available-for-inspection_45856.html

4.5 Aruban Rattlesnake *(Crotalus durissus unicolor)*

The Aruban Rattle Snake (*Crotalus durissus unicolor*) or Cascabel is an island endemic. The species feeds on small rodents, birds and lizards. Nocturnal during the warmer months, Aruban Rattle Snakes are active in early morning and late afternoon during the rest of the year.

Reinert et al. (2002) have recorded, as part of a long-term field study, the locations of Aruban Rattle Snakes between 1988 and 2001. It was concluded that the species was distributed across 76 km² of Aruba (Fig. 8). Within this area, the snakes were observed from approximately sea level (2.0 m) to the 189 meter top of Jamanota, Aruba's highest mountain. The diabase mountains and terraced limestone plateau in the central and eastern portion of the range seem to harbor the highest density of Rattle Snakes. Some 50% of the species habitat is covered by the Arikok National park (Reinert et al., 2008), which means that the other 50% is relatively unprotected. The eastern tip of the MTB project area covers some 2% of the species habitat.

The species has been assessed as Critically Endangered on the IUCN Red List (Van Buurt, 2006). The number of adult snakes was estimated to be potentially as low as 225 in 1995 (Reinert et al., 1995), while the annual mortality of adult snakes is no less than 55.1% (Reinert et al., 2008). Van Buurt (2006) suggested a slight recovery of the species numbers due to protection measures like the designation of the Arikok National Park, but its status remains worrying.

Reinert et al. (2008) assessed causes of mortality and assessed that 50% of Cascabel mortality could be reduced or eliminated. The snakes do not avoid roads, are slow-moving and often stop moving if approached by a vehicle. This behaviour results in 8.3% of traffic-related mortality. Among others Reinert et al. (2008) suggest closing roads after sunset and before sunrise.

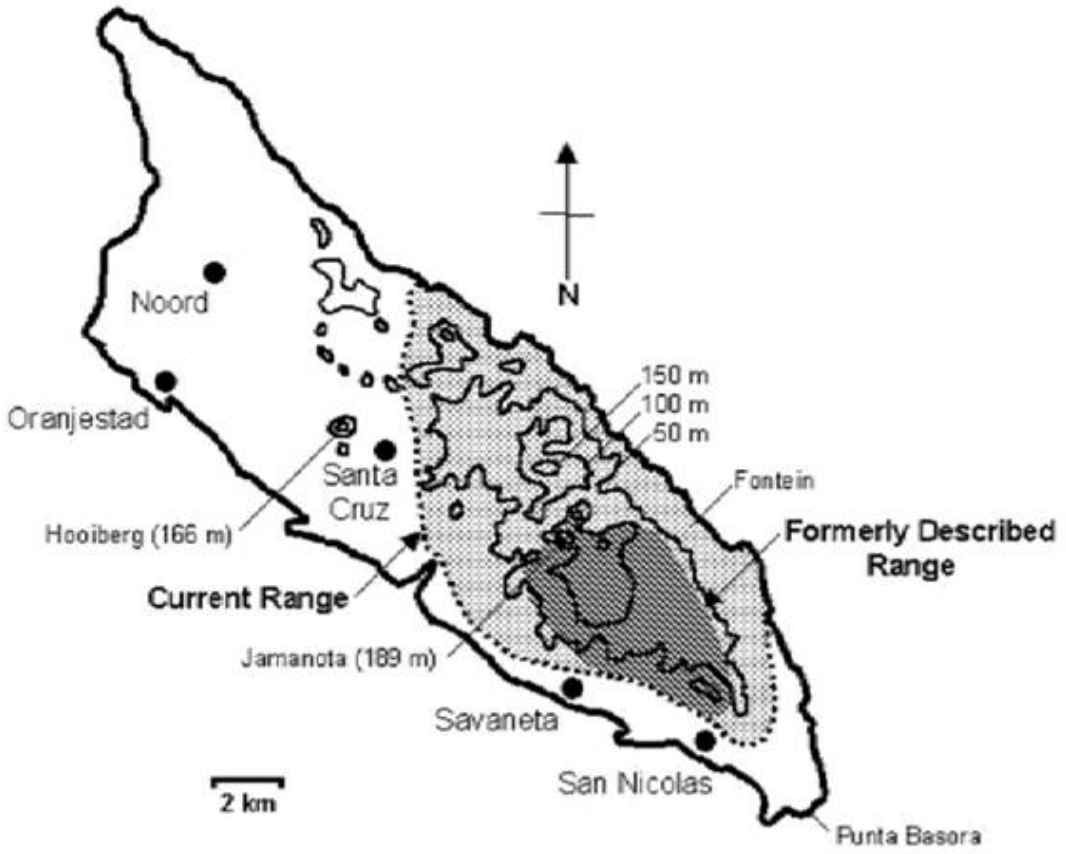

Figure 8 *Former and current geographic distribution of the Aruban Rattlesnake (Crotalus unicolor). The former range was redrawn from a map published by the Caribbean Conservation Association (1980). Topographic contour lines represent 50, 100, and 150 m (Reinert et al., 2002).*

5 Environmental impacts

The ecological impacts of mountain biking and other visitor-types can be categorized in five groups (Henkens et al., 2012):

1. Habitat loss and fragmentation due to the planned construction of visitor infrastructures like trails and facilities.
2. Damage to vegetation and soils mainly due to off-road behaviour which among others results in soil erosion.
3. Disturbance of fauna due to the presence and behaviour of visitors with or without their dogs, horses, vehicles etc.
4. Direct population changes due to loss of individuals, whether unintended (e.g. collision) or intended (e.g. killing).
5. Pollution due to solid waste disposal or pollutants such as nutrients and sunscreen.

The impacts of mountain biking alone could be relatively minor but in combination with the impacts from other visitor-types it may result in significant environmental impacts. In natural resource management this is referred to as cumulation of impacts (Canter and Ross, 2010). The five ecological impacts will therefore not only be described in relation to mountain biking (both present and proposed situation), but also in relation to other visitor-types in the project area, especially motorized vehicles like ATV and UTV.

The focus of this chapter lies on the impacts in relation to the ecological carrying capacity of the project area, though at the end of this chapter some observations will also refer to the impacts in relation to the social and psychological carrying capacities (in reference to Ceballos-Lascurain, 1996).

5.1 Habitat loss and fragmentation

This section describes the habitat loss and fragmentation due to formal infrastructure that has been planned to accommodate visitors in the project area. (See Section 5.2 for informal infrastructures).

5.1.1 Mountain biking

Present situation
The project area covers 1032 ha (see Section 1.2). The present formal MTB trail-network is approximately 0.5 m wide and some 50 km long (see panels in Figure 5). Based on these figures the present marked MTB-network covers some 2.5 hectares, which is roughly 0.25% of the project area. Though the habitat loss and fragmentation caused by formal trails is relatively limited, the real situation with the many informal trails is much different (see Section 5.2).

Proposed situation
The proposed marked trail network measures 54 km of minimum 1 m wide. This means that the total proposed marked trail network would cover some 5.4 hectares, which is 0.5% of the total project area. This is double the amount of habitat loss compared to the present situation.

5.1.2 Cumulative impacts other user-groups

Formal roads, mainly dirt roads, for motorized vehicles run for approximately 10 km along the coast between Tierra del Sol and the Natural Bridge. There are also formal roads perpendicular to this coastal road, which run down from the hills like the roads near Alto Vista Chapel, the Bushiribana Ruins and the Natural Bridge. Official data on formal roads were not available, but an assessment through Google Earth revealed that these roads would roughly cover 16 km in length and 5 m width. Based on these figures and including parking places this would cover some 10 hectares or 1% of the project area.

5.2 Damage to vegetation and soil

5.2.1 Mountain biking

Present situation
Besides marked trails (see Section 5.1), there are also plenty of unmarked trails, often created by free-roaming livestock. These informal tracks are -probably unintentionally- used by visitors, for instance driving MTB's, and together with the lack of proper directional signage of the marked trails this is confusing. It is obvious that the total length and use of trails in the project area by MTB's is significantly greater than the marked trails only. The present situation with many informal trails can be regarded unsustainable, as it leads to loss of vegetation cover and consequently erosion. It also leads to further fragmentation of the habitat and, because of the 'crisscross' nature of the paths and the fact that they are never very far from each other, leads to a situation where hardly any relatively undisturbed areas are left for wildlife (see Section 5.3).

Proposed situation
The proposed situation assumes the realization of well-designed and maintained MTB-trails. Several studies have indicated that this would minimize off-road behavior (Newsome et al, 2016; Higgins and Yalden, 1997). It would result in less habitat loss and a less fragmented landscape. It is however recommended to block and additionally restore/replant the informal roads, in order to make sure that these trails are closed-off for further visitor-use.

5.2.2 Cumulative impacts other user-groups

The damage to vegetation and soil by MTB's is relatively trivial when compared to the impacts from motorized vehicles (ATVs, UTVs, jeeps, trucks etc.). Formal roads, especially in the lower terrace, are hardly recognizable anymore as they have grown very wide all along the approx. 10 km length of the project area (Figure 9 and 10). An estimated 10 - 20 m width of these ATV/UTV-tracks is not an exaggeration. This is similar to a direct habitat loss between 100 – 200 hectares (10-20% of the total project area) due to these tracks only. It is clear that the cumulative impacts from motorized vehicles cannot be ignored when describing the impacts of MTB's.

Figure 9 *The impacts of motorized vehicles like ATV and UTV in the project area is substantial. The eroded bare soil is estimated to cover roughly 100 – 200 hectares (Photos by René Henkens).*

This damage to vegetation and soil has a much broader impact than can be observed at first sight. Reduction of the biological soil crust in the project area should be considered a top concern. It reduces nitrogen fixing organisms that are the dominant source of nitrogen in arid ecosystems (Belnap, 2002; Ouren et al., 2007). This negatively affects plant performance as nitrogen (besides water) is the element most limiting plant growth in desert environments (Romney et al. 1978).

The loss of vegetation and biological soil crust increases water and wind erosion rates (Iverson et al. 1981; Webb 1982). Rainwater flows often result in the creation of erosion gullies (Fig. 9). This is responsible for increases in soil loss (Foltz et al., 2007) and increased sediment deposition in the water (Meadows et al., 2008). The negative impacts it has on marine habitats like coral reefs, seagrass beds and mangrove forests are well-documented and should not be underestimated.

The motorized vehicles abrade and pulverize the bare soils which leads to wind erosion and fugitive dust migration (Lovich and Bainbridge, 1999). In addition, it leads to soil compaction which affects vegetation development and soil fauna. The dust accumulates on the vegetation (or the marine environment) which disrupts photosynthetic and respiration processes and decreases plant reproduction and survival (Ouren et al. 2007). This favors the undesirable introduction of invasive species (Greenberg et al., 1997). Natural recovery from the impacts of ATV/UTV use to pre-disturbance conditions can take generations (BHA, 2011).

Figure 10 *Google Earth Image from 30-11-2018 illustrating the bare soil and multiple formal and informal tracks around the Bushiribana Ruins.*

5.3 Disturbance of fauna

Disturbance of fauna can be defined as a change in the behaviour of fauna due to the presence of humans, and ranges from becoming more alert to actual flight behaviour. Disturbance is mainly an issue in relation to birds and mammals. They can perceive the presence of humans from a far distance, sometimes even hundreds of meters. Other fauna groups have less developed senses, which generally results in a disturbance distance of just a few meters or less (Henkens et al., 2012).

Vulnerability to disturbance depends on the sensitivity of the species and the visitor type. Many species can to a certain extent habituate to the presence of visitors, as long as the visitor behaviour is predictable and non-dangerous. Staying on formal trails can therefore be regarded a very important measure to minimize disturbance of fauna. Least disturbing visitors are often the ones that don't look like humans. Horse riders are often able to approach wildlife at short distances (Henkens et al., 2012).

Disturbance is not per definition problematic. The vulnerability of a species is dependent on three determining factors (Henkens et al., 2012):

- Chances of interaction: there may be no chance of interaction if visitors and a species have different activity patterns;
- Sensitivity of the species concerned: some species are more shy than others, which also depends on the activity exposed (e.g. breeding or foraging);
- Ability to recover from disturbance: some species quickly return to their pre-disturbance behaviour or start a second nest, while others won't.

Many studies (Henkens et al., 2012; Pouwels et al., 2017; Taylor et al., 2003) argue that birds, especially ground nesting birds are particularly sensitive to visitor disturbance. The main ground nesting birds of concern in the project area are Least Tern and the Aruban Burrowing Owl. The Roseate tern may also be found breeding along the coastline, while the project area might as well be home to the Crested Bobwhite if not almost extirpated on Aruba (Peterson and Peterson-Bredle, 2016). The White-tailed Nightjar is another ground breeder (between February and June; Ferraro, 2015), although not listed on the National Decree for the protection of Flora and Fauna.

The Flight Initiation Distance (FID), a measure of an animal's tolerance to human disturbance and a descriptor of its fear of humans, is increasingly employed for conservation purposes (Carrete et al., 2016; Weston et al., 2012). For both, breeding Aruban Burrowing Owls and breeding Least Terns (two of the most vulnerable species) FIDs of 100 m have been suggested for conservation purposes.

- Aruban Burrowing Owl: FIDs greatly vary among individuals, ranging from 3.5 to 130 m (Carreta and Tella, 2017);
- Least Tern: Rogers & Smith (1995) found a FID between 22-88 m (average 58 m) for breeding Least Tern. They recommended a bufferzone of at least 100 m around breeding Least Terns.

For the project area we interpreted this as that MTB-trails should at least run 100 m from 'ABC proposed Shoco Area' and 'ABC proposed Tern Area'.

5.3.1 Mountain biking

Present situation

As described above (Section 5.1 and Section 5.2), the present situation not only concerns 50 km of official marked trails, but also a substantial length of unofficial unmarked trails. The exact length is not known, but it's obvious that relatively undisturbed areas are scarce under the present total (un)official MTB trails network. Figure 11 as described under the *proposed situation* below (without unofficial unmarked trails) may be illustrative in this sense.

Proposed situation

Figure 11 shows an overlap of the DNM Nature EHS map with the proposed trails and 100 m of potentially disturbed area to each side of the MTB-trails. The many green coloured areas in this figure show that large parts of the project area remain relatively undisturbed from MTBs in the proposed situation (as long as unofficial trails can be prevented).

However, Figure 11 also shows that ecological bottlenecks still occur. Some parts of the proposed trails are not only too close but even cut through the ABC Proposed Terns Area (at 10 locations) and Shoco Area; (these bottlenecks are highlighted in yellow in Figure 11). Besides that, nature area Tierra Del Sol overlaps for almost 53%, while the Salina (especially important during the spring and autumn migration periods, respectively early March/late May and mid-August/late October) lies also largely within the disturbance zone (Fig. 12). This requires temporary closure (temporary zoning during the breeding/migration seasons) or rerouting of parts of the trail (spatial zoning).

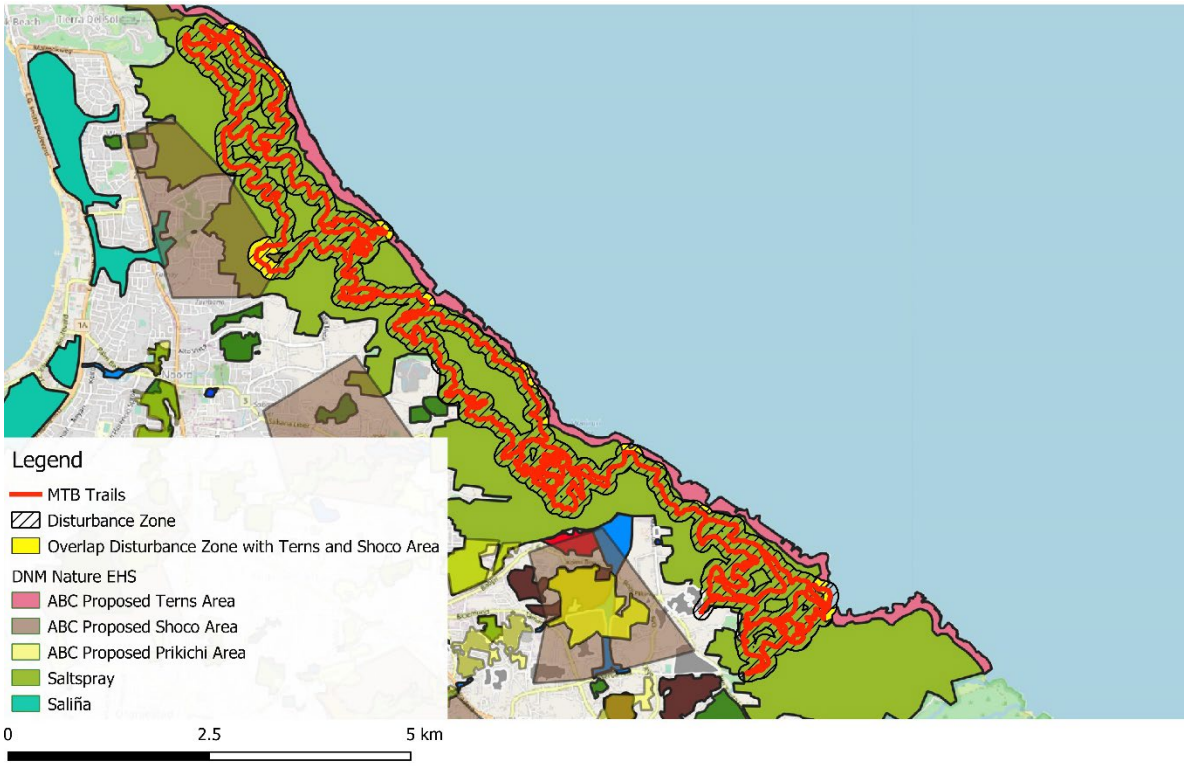

Figure 11 *Overlap of disturbance zone with the map of DNM Nature EHS, showing (yellow) overlap with ABC Proposed Terns Area (10X) and Shoco Area (1x; Aruban Burrowing Owl), which requires temporary closure (zoning in time) or rerouting of part of the trail (spatial zoning).*

Figure 12 *Overlap of the disturbance zone with the map in the Aruba Spatial Development Plan 2019 shows 53% overlap with Nature Area Tierra del Sol. Note that the trails adjacent to the Salina will cause disturbance during the spring and autumn migration periods, which requires temporary closure (zoning in time) or rerouting of part of the trail (spatial zoning). (A bird hide at the Salina would support the observation of migratory birds.)*

5.3.2 Cumulative impacts other user-groups

It is obvious that the cumulative disturbance impacts of ATVs and UTVs are generally much larger than the MTBs, especially for the tern's breeding habitat. Measures to avoid disturbance by MTBs only make sense in combination with measures to mitigate the impacts of motorized vehicles.

5.4 Direct population changes

Direct population changes concern the loss of individuals within a population. This can happen during the construction phase of tourist infrastructures. It may also happen following that phase, when recreational activities are undertaken.

5.4.1 Mountain biking

Present situation
Distinction should be made between cycling on the road and off-road. Off-road cycling during the breeding season can destroy nests of ground nesting birds like Least Terns, Burrowing Owls or the Crested Bobwhite. Ground dwelling species like reptiles are also vulnerable to collision, as this is one of the vertebrate groups most affected by roads (Andrews et al., 2008), also tertiary roads (Heigl et al., 2017) and even cycle paths (Walpot and Verver, 2011; Spitzen-Van der Sluis et al., 2007). The most susceptible reptiles are snakes (Andrews and Gibbons, 2008), especially desert snakes. This may be due to their adaptation to open land cover types which may explain their lack of road avoidance behavior (Brehme et al., 2013). Some even seek out roads to thermoregulate (Andrews et al., 2008). Brehme et al. (2018) ranked herpetofauna species for their susceptibility to road mortality and fragmentation and found that the larger Colubridae snakes (the Cat-eyed Snake of Aruba belongs to the same family) and Crotalus snakes (the Aruban Rattle Snake belongs to the same genus) were ranked among the highest risk from negative road effects. The risk of collision is highest during the species active period between dusk and dawn. MTB trails should be closed in that period, especially trails within the habitat of the critically endangered Aruban Rattlesnake.

Proposed situation
The construction of the 1 m wide trails may cause the loss of threatened plant species that are listed on the national decree for the protection of indigenous flora and fauna (Min. DNM, 2017). This should be prevented by having an ecologist/botanist accompanying the construction phase.

The risk for collision with fauna is quite similar as described above under 'present situation'.

GIS-analysis revealed that no less than 15.5 km or 29% of the total length of proposed MTB-trails is located in Rattlesnake habitat (Fig. 13). These trails cover roughly 150 ha or 2% of the species total territory. Due to its critically endangered status, it is recommended that the trails should be closed between dusk and dawn (zoning in time) to avoid any fatal collisions during its most vulnerable period.

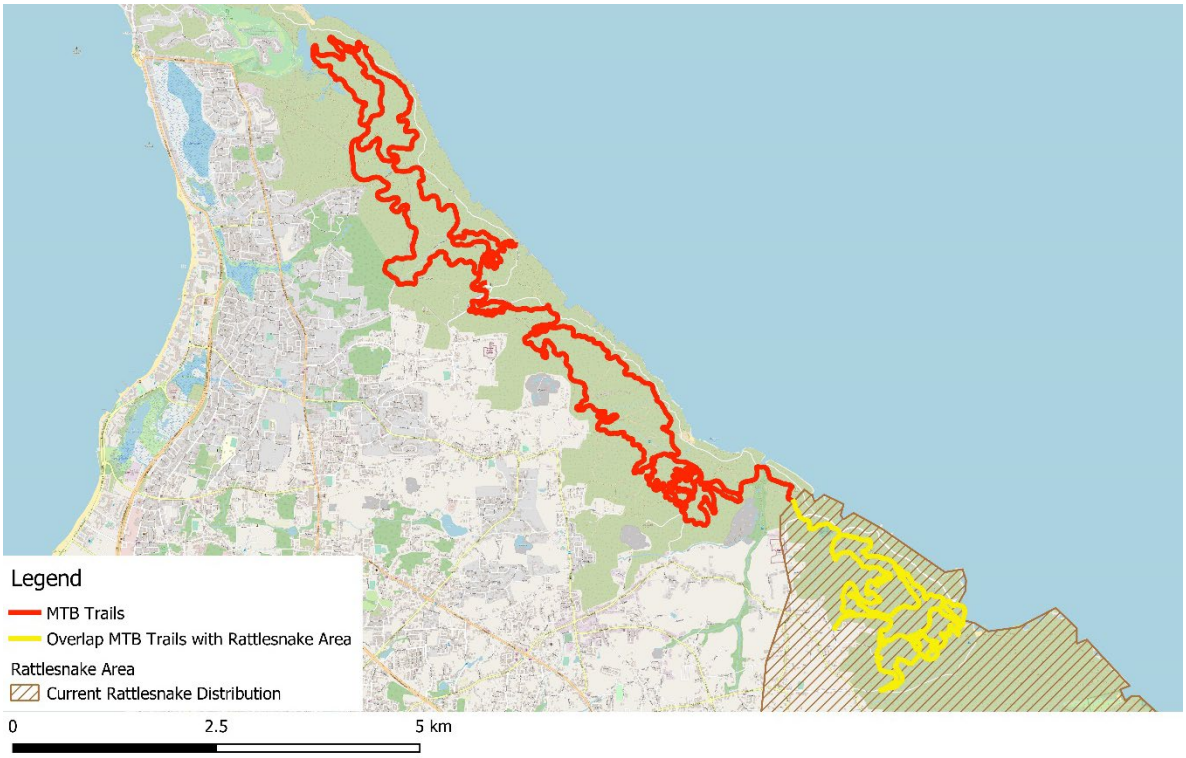

Figure 13 *Illustration of the overlay of 15.5 km proposed MTB-trails (yellow trails) with Aruban Rattlesnake habitat (faded area). This reveals potential interaction between MTB and Rattlesnakes in approx. 150 ha or 2% of its total area of distribution. Due to its critically endangered status it is recommended that a mitigation measure be implemented through the closure of the trails between dusk and dawn.*

5.4.2 Cumulative impacts other user groups

Off-road driving, whether on horseback or in a motorized vehicle should be avoided at all times to prevent collision with plants, nests or individual animals. Illustrative are the two dead Burrowing Owls that were found near their burrow at Spanish Lagoon in November 2016 (Fig. 14). ATV track tires betrayed the perpetrator. Bird species that are low flying, ground dwelling and/or relatively heavy relative to their wing size are highly susceptible to road mortality (van der Ree et al., 2015), such as Burrowing Owls and the Crested Bobwhite. This susceptibility increases with the speed of the vehicle. The observed high speed driving of many of the motorized vehicles in the project area is therefore a concern. Not only for wildlife but also for safety reasons.

Figure 14 *Two dead Burrowing Owls near their burrow which - based on the tire tracks- have probably died in collision with an ATV (Photo by Lawrence Jones-Walters, Spanish Lagoon, Aruba, 25-11-2016).*

5.5 Pollution

Although the impacts of solid waste should not be underestimated (many species are for instance known to ingest marine debris (Kühn & van Franeker, 2020)), pollution seems to be less of an issue in the project area if compared to the other impacts described above. Some 'trash hotspots' can be observed like the bottles in Figure 15. The lens effect of these bottles may cause a bush fire (Donahue, 2017), but trash like this usually affects aesthetic values more than biodiversity values. It signals the lack of management action in the project area.

Figure 15 *A trash hotspot in the project area impacts the aesthetic values of the project area, but may also cause a bush fire.*

5.6 Overview impacts MTB on ecological environment

Table 3 *Relative vulnerability to MTB for threatened species of Aruba (source: National Decree on the protection of native flora and fauna) that may use the project area for reproduction and/or foraging. Relative vulnerability to MTB: green = very limited; orange = moderate; red = substantial. The most vulnerable months are highlighted blue/greyish.*

Species name	Specific vulnerability (if any) in time and place													Relative vulnerability to MTB	
	Month														
Scientific/English/Local	1	2	3	4	5	6	7	8	9	10	11	12	Place/time of day	Present situation	Proposed situation
Glossophaga longirostris Leaf Nosed Bat													Caves/between dawn and dusk	Hardly interaction	Hardly interaction
Leptonycteris curasoae Curaçaoan Longnosed Bat													Caves/between dawn and dusk	Hardly interaction	Hardly interaction
Pteronotus davyi Lesser Naked-backed bat													Caves/between dawn and dusk	Hardly interaction	Hardly interaction
Polyborus plancus Southern Crested Caracara[6]													Nest in cactus or tree	Nest disturbance	Nest disturbance
Buteo albicaudatus White-tailed Hawk													Nest in shrub near pond	Formerly breeding	Formerly breeding
Falco peregrinus Peregrine Falcon[7]													Only non-breeding	Hardly interaction	Hardly interaction
Athene cunicularia arubensis[8] Aruban Burrowing Owl													Ground nest	Nest disturbance, Collision nest/specimen	Nest disturbance
Sternula antillarum Least Tern													Ground nest	Nest disturbance, Collision nest/specimen	Nest disturbance
Aratinga pertinax arubensis Brown-throated Parakeet[9]													Roosting sites/ between dusk and dawn; Nest in cavity tree/cacti.	Disturbance at roosting sites between dusk and dawn	Disturbance at roosting sites between dusk and dawn
Amazona barbadensis Yellow-shouldered Amazon[10]													Roosting sites/ between dusk and dawn; Nest in cavity tree/cacti.	Disturbance at roosting sites between dusk and dawn; currently extinct on Aruba	Disturbance at roosting sites between dusk and dawn; currently extinct on Aruba
Colinus cristatus Crested Bobwhite[11]													Ground nests	Damage nest habitat, Nest disturbance, collision.	Nest disturbance
Columba squamosa Scaly-naped Pigeon													Nest in trees	Nest disturbance	Nest disturbance
Chlorostilbon mellisugus Blue-tailed Emerald[12]													Nest in shrub, bush or tree	Nest disturbance	Nest disturbance
Chrysolampis mosquitus Ruby-topaz Hummingbird[13]													Nest in shrub, bush or tree	Nest disturbance	Nest disturbance
Crotalus unicolor Aruban Rattlesnake													Activity period between dusk and dawn	Risk of collision between dusk and dawn	Risk of collision between dusk and dawn
Leptodira bakeri Cat-eyed Snake													Activity period between dusk and dawn	Risk of collision between dusk and dawn	Risk of collision between dusk and dawn
Iguana iguana Common Green Iguana													Nest/tunnel with eggs below surface	Hardly interaction with MTB	Hardly interaction with MTB
Anolis lineatus Striped Anole													Nest with eggs	Hardly interaction with MTB	Hardly interaction with MTB
Pleurodema brachyops Colombian Four-eyed Frog													Reproduction pond	Hardly interaction with MTB	Hardly interaction with MTB

[6] Source: Rivera-Rodriguez and Rodriguez-Estrella, 1998
[7] https://www.birdscaribbean.org/2015/05/featured-bird-peregrine-falcon/
[8] The Burrowing Owl of Aruba is probably an endemic subspecies.
[9] http://www.oiseaux-birds.com/card-brown-throated-parakeet.html
[10] http://www.echobonaire.org/parrots/bonaires-parrot/
[11] Source: Sandoval (2011).
[12] https://sta.uwi.edu/fst/lifesciences/sites/default/files/lifesciences/documents/ogatt/Chlorostilbon_mellisugus%20-%20Blue-tailed%20Emerald.pdf
[13] https://www.beautyofbirds.com/rubytopazhummingbird.html

This section summarizes the assumed impacts of MTBs on the natural values of the project area in the present and the proposed situation, based on underlying assumptions:

- The intensity of MTB-use of the proposed trails will not grow 'out of control', unlike the situation with the current number of ATV and UTV;
- The MTBs will indeed stay on the formal trails and will not ride off-road;
- The present substantial cumulative impacts of ATV and UTV will be controlled and managed. The impacts of MTBs are generally minor if compared to the cumulative impacts of ATV and UTV. It does not make sense to create a sustainable MTB-trail network, if nothing will be done about the substantial impacts of the numerous ATVs and UTVs.

Table 3 again gives the list of threatened species (Min. DNM, 2017) for which the project area forms potential habitat, as well as their most vulnerable months, time of day and locations. It illustrates that (ground) breeding birds are considered most vulnerable to MTBs due to impacts of nest disturbance and/or collision with nests or individual animals. Collision with snakes, especially between dusk and dawn, is also considered a concern, especially for the critically endangered endemic Aruban Rattlesnake.

The proposed situation looks better when compared to the present situation. This has mainly got to do with the assumption that MTBs will not ride off-road anymore, if compared to the present situation.

Off-road riding leads to informal roads and paths and results in soil erosion, habitat degradation and fragmentation, nest disturbances and collisions.

Also in the proposed situation there are still species that have moderate or substantial vulnerability to MTBs. This has to do with the fact that proposed MTB-trails are too close to potential breeding habitat of the Aruban Burrowing Owl and Least Tern and MTBs may collide with snakes between dusk and dawn. This requires rerouting of the proposed MTB-trails (spatial zoning) or closure of 'problem' trails during the most vulnerable months (breeding season terns) or time of day (between dusk and dawn). These measures indicate, among others, that a trail network within the Tierra del Sol nature area, which is a stronghold for the Aruban Burrowing Owl, is not very realistic, as the species can be found near its burrow year round and throughout the day.

Some form of nest disturbance may still occur in the proposed situation, however if MTBs stay on the trails and pose no threat, this nest disturbance will express itself as a higher alertness, rather than flight behaviour.

Some species are currently extinct from the project area, like breeding White-tailed Hawk (*Buteo albicaudatus),* Yellow-shouldered Amazon *(Amazona barbadensis;* which is extinct on entire Aruba) and the Crested Bobwhite *(Colinus cristatus),* which has been said to be on the brink of extinction in Aruba (Peterson and Peterson-Bredle, 2016). Sustainable habitat management however is the first step to achieve their return.

5.7 Observations regarding social and psychological carrying capacities

The stakeholder interviews made clear that there is generally no objection against an improvement of the MTB trails in the project area. Especially as this would improve the opportunities for MTB riding by the local residents. Many interviewees however did raise substantial concerns regarding the present and increasing numbers of ATVs/UTVs on the island.

It is obvious that this visitor-type exceeds the project area's ecological carrying capacity, when considering the previously described habitat loss, disturbance, erosion, noise, velocity, numbers and dust that is associated with ATVs/UTVs. The negative impacts are however not only restricted to the ecological environment. Several interviewees stressed the lack of support for the increasing number of

ATVs/UTVs among the local community and that tensions are building up (Fig. 16). This illustrates that the social carrying capacity for these vehicles may also be exceeded.

Besides that, the ATVs/UTVs also negatively impact other visitor-groups in the project area. It not only decreases the aesthetic value of the 'wild north coast', but it also brings safety issues. For instance it was observed on more than one occasion that ATVs/UTVs drive very close to groups of horseback riders and sometimes even chase the horses away.

Visitor-groups with different velocity characteristics usually have their own trails (e.g. hiking, cycling, horse riding trails) to prevent clashes like these. The ATVs/UTVs in the project area however, often drive off road and take any trail. This brings safety risks which seem insufficiently addressed. Websites like Tripadvisor give frequent reports of accidents with ATVs/UTVs on Aruba and highlight the lack of proper medical care in emergency situations. This also illustrates that the psychological carrying capacity may already have been exceeded.

It is obvious that present impacts of ATVs/UTVs not only transcend the ecological carrying capacity of the project area (and probably beyond that), but it also has a substantial impact on the social and psychological carrying capacities. This situation is unsustainable and urgent action is needed in order to safeguard the appreciation of the Aruba tourism product.

Figure 16 *Illustrations of the impact of ATV/UTV on other tourists and local residents: MTB cycling on a road in the project area, eroded by ATV/UTV (top left); a group of ATV driving into a horseback riding group in the project area (top right); local residents expressing their aversion towards ATVs/UTVs (bottom left and right) (Photos by René Henkens).*

6 Conclusions and recommendations

6.1 Main conclusions

The proposed MTB-network is, in theory, an improvement for the ecological environment when compared to the present MTB-network, although additional measures are needed before a 'sustainable' MTB-network can be achieved.
The length of the present MTB-network is not so very different from the proposed MTB-network. The main difference lies in the fact that MTBs are assumed not to ride off-road anymore in the proposed situation. Off-road riding leads to informal roads and paths and results in soil erosion, habitat degradation and fragmentation, nest disturbances and (fatal) collisions.

In the proposed situation there are still species that are moderately or substantially affected by MTBs. This has to do with the fact that proposed MTB-trails are too close to potential breeding habitat of the Aruban Burrowing Owl and Least Tern as well as that MTBs may collide with snakes between dusk and dawn. This requires rerouting of the proposed MTB-trails (spatial zoning) or closure of 'problem' trails during the most vulnerable months (breeding season owls and terns) or time of day (between dusk and dawn). These measures indicate, among others, that a trail network within the Tierra del Sol nature area, which is a stronghold for the Aruban Burrowing Owl, is not realistic.

Table 4 lists 15 actions and measures that should be taken to sustainably manage the project area and mitigate the ecological impacts of MTBs (and other visitor types). These are described in more detail below.

Sustainable development of *Aruba's wild north coast*, can only be achieved with a nature and visitor management plan (including MTB) for the area as a whole, that matches with the ambitions in Aruba's Spatial Development plan 2019.
Present ecological impacts in the project area are substantial and concern habitat loss and fragmentation, damage to vegetation and soils, disturbance of fauna and to a lesser extent also the loss of individual animals and pollution. Though these impacts can partly be attributed to MTBs, it is trivial when compared to the cumulative impacts of the multiple ATVs and UTVs which dominate the area (especially the lower terrace) with their numbers, speed, noise, off-road driving, erosion and dust creation. The scope of the impacts goes beyond the project area and does not only relate to the ecological environment but also to the social (local community) and even psychological environment (tourists).

This situation is in contradiction to the Aruba Spatial Development Plan 2019. This plan classifies the project area as *nature* and *nature and landscape* with characteristics like silence, low-impact visitor-use, driving on formal paths and roads and restoration, conservation and development of natural values. This contradiction confirms the self-evaluation by the Ministry of Nature and Environment (Min. ROIM, 2018) in which the *lack of law enforcement* for the conservation of nature is regarded as one of the weaknesses, while *not taking into account the ecological carrying capacity of Aruba risks the creation of an unlivable environment for generations to come*. These observations make clear that sustainable development of the project area can only be achieved with a nature and visitor management plan for the project area as a whole.

This plan should also include an inventory and monitoring plan, to overcome the substantial lack of data. The goal of a biodiversity inventory is to reveal the present state of nature, particularly the condition of habitats and the presence of threatened species from the National Decree for the protection of flora and fauna. A periodic monitoring (e.g. annually or once every 5 years) is aimed to reveal any positive or negative trends that might require management action.

6.2 Mitigation measures

The measures regarding the MTB-network as described below should be integrated within the management plan.

Spatial and temporary zoning measures are needed to protect species listed on the National Decree for the protection of flora and fauna
The proposed MTB network may be considered an improvement compared to the present situation in relation to the aim of avoiding soil erosion. Some rerouting of trails is also however needed to avoid areas that are important for threatened wildlife, like burrows of the Shoco which are occupied year round.

Temporary closure of trails refers to periods during the day or season. MTB-trails should be closed between sunset and sunrise as this is the active period for many threatened species. It not only avoids disturbance of fauna but also avoids collisions with species like the Aruban Rattlesnake. Some MTB-trails should be closed at least during critical periods (or rerouted), like the bird migration periods (spring migration early March/end of May; autumn migration mid-August/late October) and the breeding season of the Least Tern (between late March/late July), in order to avoid unnecessary disturbance. Awareness raising is important and often proves effective in raising sufficient support for such measures.

Considering the fact that the bird migration and breeding periods, as mentioned above, last several months (the Shoco even uses its nesting burrow year round), it's recommended to choose for spatial zoning instead of temporary zoning. This means rerouting of those parts of the proposed trails that currently overlap with key-areas for migratory birds (Salina - see Figure 12) and breeding Least Terns and Shoco (see Figure 11). The exact rerouting requests tailor made support in the field from an experienced ecologist.

Visitor regulation and guidance measures are needed to minimize environmental impacts
MTB-trails should be formally closed for other visitor types (signage: MTB only!). Not only to avoid erosion of MTB-trails (for instance due to ATV/UTV or horseback riding) but also to avoid collisions between visitors (due to differences in velocity). The MTB-trails must be properly marked and preferably rock-bordered, to minimize off-road riding. Awareness raising at strategic locations (e.g. starting point of the MTB-trails) is necessary to inform users about the rules and regulations (signage: Stay on the trail!), but its enforcement in the field is equally important.

Supervision during construction of MTB-trails and maintenance measures
The construction, if any, of the proposed MTB-trail network should be supervised by an experienced field ecologist to avoid damage or loss of threatened plant species or important habitats (e.g. nesting burrows for Shoco). These formal MTB-trails should be physically closed (e.g. by stones, poles) for other users, like motorized vehicles and horseback riders (Fig. 17).

Trails should measure a *maximum* 1 m width and not the proposed minimum 1 m width, as it remains questionable whether 'high volumes' of MTBs can be expected in the proposed situation.

The formal MTB-trails must be maintained as this stimulates its users to stay on the trail and prevents them from riding off-road. Elimination of all informal trails through blocking, restoration and/or replanting with indigenous plants is one of the most crucial steps in the ecological restoration of the project area, as it prevents habitat loss, fragmentation, disturbance, collisions etc. (Fig. 17). Creation of new informal trails should be avoided, among others by planting of indigenous (thorny) shrub or rock-borders at strategic locations along the formal MTB-trails.

Table 4 *Summary of 15 actions and measures that should be taken to sustainably manage the project area and mitigate the (five) ecological impacts of MTBs (and other visitor types).*

	Measures aimed to mitigate the ecological impacts of MTB and other visitor-types	Habitat loss	Damage to vegetation and soil	Disturbance of fauna	Direct population changes	Pollution
	Nature and visitor management plan					
1	Thorough biodiversity inventory aimed at assessing the current state of nature within the project area e.g. the condition of habitats and presence of species that are listed on the National Decree for the protection of flora and fauna (Landsbesluit AB 2017 no. 48).	+	+	+	+	+
2	Development of a nature and visitor management plan for the project area as a whole, aimed at managing visitor impacts (e.g. ATV/UTV) and increasing the ecological carrying capacity and consequently the resilience of the project area for potential threats like visitor impacts.	+	+	+	+	+
3	Biodiversity monitoring plan to assess any trends in biodiversity and threats that require management action.	+	+	+	+	+
	Spatial and temporary zoning measures					
4	Spatial zoning e.g. rerouting of MTB-trails on ecological bottleneck locations (e.g. erosion-sensitive locations, important breeding and migration areas). Reconsider trails at Tierra del Sol nature area.			+		
5	Temporary zoning e.g. formal closure of MTB-trails between sunset and sunrise			+	+	
	Visitor regulation and guidance measures					
6	Formal access ban for undesirable visitor transport types on MTB-trails, like motorized vehicles and horses		+			
7	Awareness raising at strategic locations (e.g. starting point of the MTB-trail) to inform and explain about rules and regulations	+	+	+	+	+
8	Proper signaling of marked trails to prevent visitors from getting lost and cycling off-road			+		
9	Enforcement of regulations by an investigating officer or rangers		+	+	+	+
10	Bird hide at the Salina to support the observation of (migratory) birds			+		
	Construction and maintenance measures					
11	Support from an experienced field ecologist during construction works aimed to prevent damage/loss of threatened species (e.g. plants) or important habitat (e.g. nesting burrows for Shoco)	+			+	
12	Maintenance of formal MTB-trails aimed to stimulate visitors to stay on the trail	+	+	+	+	
13	Elimination of informal trails through blocking, restoration and/or replanting with indigenous plants	+	+	+	+	
14	Planting of indigenous (thorny) shrub along trails and/or rock-bordered trails to prevent visitors from going off-road	+	+	+	+	
15	Physical closure of MTB-trails (e.g. stones, poles) for undesirable visitor transport types, like motorized vehicles and horses.		+			

Figure 17 *Simple closure of a small trail for motorized vehicles proved to work well in the project area.*

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Annex 1 Species National Decree F&F

Species of Article 1 and 2 of the National Decree for the protection of indigenous Flora and Fauna.

Artikel 1

Op grond van artikel 4, eerste lid, van de Natuurbeschermingsverordening (AB 1995 no. 2) worden aangewezen:

a. van de flora:

1. Familie: Corallinaceae
2. Soort: *Agave arubensis* - Cuco di Indjan
3. Soort: *Agave rutenniae/rutteniae*
4. Soort: *Brassavola nodosa* - Orkidia di mondi
5. Soort: *Bromelia humilis* - Teco
6. Soort: *Bursera simaruba* - Palisia Cora
7. Soort: *Cakile lanceolata*
8. Soort: *Capparis flexueosa* - Stoki / Mosterd
9. Soort: *Capparis indica / quadrella indica* - Huliba macho
10. Soort: *Castela erecta*
11. Soort: *Celtis iguanaea* - Beishi di Yuana
12. Soort: *Ceratosanthes palmata* - Batata di zumbi
13. Soort: *Cissampelos pareira* - Rais of Yerba di Pataka
14. Soort: *Clusia rosea*
15. Soort: *Condalia henriquezii*
16. Soort: *Convulvus nodiflorus / jacquemontia nodiflorus*
17. Soort: *Crataeva tapia* - Giron
18. Soort: *Cynanchum boldinghii* - Mari di Palu
19. Soort: *Datura stramonium* - Yerba Stinki
20. Soort: *Erythrina velutina*
21. Soort: *Ficus brittonii* - Mahawa
22. Soort: *Geoffroea spinosa* - Taki
23. Soort: *Guaiacum sanctum*
24. Soort: *Guapira fragrans*
25. Soort: *Halodule wrightii*
26. Soort: *Halophila baillonis*
27. Soort: *Halophila decipiens*
28. Soort: *Halophila engelmannii*
29. Soort: *Ipomea incarnata*
30. Soort: *Krugiodendron ferreum* - Wayakito
31. Soort: *Manihot carthaginensis*
32. Soort: *Maytenus sieberiana* - Palo di Colebra
33. Soort: *Maytenus tetragona*
34. Soort: *Metopium brownei* - Manzalinja macho / Mansaniya bobo
35. Soort: *Morisonia americana* - Bushicuri
36. Soort: *Myrmecophila humboldtii / Schomburgkia humboldtii* - Banana shimaron
37. Soort: *Paspalum curassavicum*
38. Soort: *Pereskia guamacho* - Azufro

39. Soort: *Pithecellobium platylobum*
40. Soort: *Pluchea carolinensis*
41. Soort: *Ruppia maritima*
42. Soort: *Salicornia perennis* - Zeekraal
43. Soort: *Schoepfia schreberi* - Mata Combles
44. Soort: *Serjania curassavica* - Behuco
45. Soort: *Spondias mombin*
46. Soort: *Syringodium filiforme*
47. Soort: *Tournefortia volubilis*
48. Soort: *Trixis inula*

b. van de fauna:
1. Klasse: Anthozoa
2. Klasse: Hydrocorallina
3. Order: Cetacea - Dolfijnen en Walvissen
4. Soort: *Amazona barbadensis* - Lora / Yellow-shouldered amazon
5. Soort: *Anolis lineatus* – Toteki
6. Soort: *Aratinga pertinax arubensis* – Prikichi
7. Soort: *Athene cunicularia arubensis* - Shoco
8. Soort: *Buteo albicaudatus* - Falc / Falki / witstaartbuizerd
9. Soort: *Caretta caretta* - Cawama / Loggerhead turtle
10. Soort: *Chelonia mydas* - Tortuga Blanco / Green turtle
11. Soort: *Colinus cristatus* - Patrishi
12. Soort: *Columba squamosa* - Blauduif / Paloma di baranca
13. Soort: *Conus curassaviensis*
14. Soort: *Conus hieroglyphus*
15. Soort: *Conus wendrosi*
16. Soort: *Crotalus durissus unicolor* - Cascabel
17. Soort: *Dermochelys coriacea* - Drikil / Leatherback turtle
18. Soort: *Epinephelus itajara* - Djukfes / jewfish / Goliath grouper
19. Soort: *Epinephelus striatus* - Jakupepu / Jacupeper / Nassau grouper
20. Soort: *Eretmochelys imbricata* - Caret / Hawksbill turtle
21. Soort: *Falco peregrinus* - Falki peregrino / Slechtvalk / Peregrine falcon
22. Soort: *Iguana iguana* - Yuana
23. Soort: *Lepidochelys kempii* - Kemp's Ridley turtle
24. Soort: *Lepidochelys olivacea* - Olive Ridley turtle
25. Soort: *Leptodira bakeri* - Santanero / Cat-eyed snake
26. Soort: *Manta birostris* - Manta / Manta ray
27. Soort: *Melongena melongena* - Caribbean Crown conch
28. Soort: *Oreaster reticulatus* - Strea di lama / Red cushion sea star / the West Indian sea star
29. Soort: *Panulirus argus* - Kreft / Caribbean Spiny Lobster
30. Soort: *Pelecanus occidentalis* - Rogans
31. Soort: *Phoenicopterus ruber* - Flamingo
32. Soort: *Pleurodema brachyops* - Dori
33. Soort: *Poecilia vandepolli* - Molly / Machuri

34. Soort: *Polyborus plancus / Caracara plancus* - Warawara
35. Soort: *Pristis pectinata* - Zaagvis / Sawfish
36. Soort: *Pterodroma hasitata* - Black-capped petrel
37. Soort: *Pteronotus davyi* - Raton di anochi lomba sunu
38. Soort: *Sphyrna lewini* - Tribon Martieu / Scalloped Hammerhead
39. Soort: *Sphyrna mokarran* - Tribon Martieu / Great Hammerhead
40. Soort: *Sterna antillarum* - Sternchi Chikito / Least Tern
41. Soort: *Sterna dougallii* - Sternchi Pecho Roos / Roseate Tern
42. Soort: *Strombus costatus* - Calco / Milk conch
43. Soort: *Strombus gallus* - Calco / Rooster conch / Rooster-tail conch
44. Soort: *Strombus gigas* - Calco / Queen conch
45. Soort: *Strombus pugilis* - Calco / Fighting conch (West Indian)
46. Soort: *Strombus raninus* - Calco / Hawk-wing conch
47. Soort: *Sylvilagus floridanus nigronuchalis* - Conew / Conenchi
48. Soort: *Thunnus thynnus* - Buni / Tuna / Atlantic bluefin tuna

Artikel 2

Op grond van artikel 4, tweede lid, onderdeel a, van de Natuurbeschermingsverordening worden aangewezen:

a. van de flora:
   1. Soort: *Acanthocereus tetragonus* - Cushicuri / Cadushi di colebra
   2. Soort: *Avicennia germinans* - Mangel Preto / Black Mangrove
   3. Soort: *Bursera karsteniana*
   4. Soort: *Bursera tomentosa*
   5. Soort: *Canavalia rosea* - Boonchi di lama
   6. Soort: *Cereus repandus* - Cadushi / Breba
   7. Soort: *Conocarpus erectus* - Fofoti
   8. Soort: *Guapira pacurero* - Macubari
   9. Soort: *Haematoxylum brasiletto* - Mata di Brasil / Brasil / Brasia / Kampeshi
   10. Soort: *Laguncularia racemosa* - Mangel Shimaron / Mangel Cora / Mangel Blanco
   11. Soort: *Melocactus macracantus* - Bushi
   12. Soort: *Melocactus stramineus* - Bushi
   13. Soort: *Melocactus X Bozsingianus* - Bushi
   14. Soort: *Opuntia caracassana* - Tuna
   15. Soort: *Opuntia curassavica* - Sumpina di colebra / Tuna di colebra
   16. Soort: *Pilosocereus lanuginosus / Cephalocereus lanuginosus* - Cadushi pushi / Breba di pushi
   17. Soort: *Rhizophora mangle* - Mangel Tam / Mangel / Red Mangrove
   18. Soort: *Sesuvium portulacastrum*
   19. Soort: *Stenocereus griseus*
   20. Soort: *Strumpfia maritima*
   21. Soort: *Thalassia testudinum*

b. van de fauna:
   1. Familie: Scaridae - Gutu / Papegaaiachtige vissen / Parrotfishes
   2. Soort: *Chlorostilbon mellisugus* - Blenchi / Blue-tailes emerald
   3. Soort: *Chrysolampis mosquitus* - Blenchi dornasol / Ruby-topaz hummingbird
   4. Soort: *Diadema antillarum* - Bushi / Long-spined black sea urchin
   5. Soort: *Glossophaga longirostris* - Raton di anochi / Leaf nosed bat
   6. Soort: *Leptonycteris curasoae* - Raton di anochi / Curaçaoan Long-nosed Bat
   7. Soort: *Phyllodactylus julieni* - Pega pega / House Gecko

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