

# English translation of major sections of Part B

## **Taking Stock of the Terrestrial Environment of the Isle of Aruba**

Jasper van Belle

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Final research paper by Jasper van Belle

Coaching:

Dr.A.J. Schilstra, IVEM

Drs.K. Bettels, Groningen

University of Groningen

IVEM Center for Energy and Environmental Studies

Nijenborgh 4

9737 AG Groningen

Tel. 050 - 3634614

Fax. 050 - 3637168



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## 1. Introduction

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This is a report on a survey of the Flora and Fauna of the isle of Aruba. Most of the data presented here is obtained from the literature. The data is supplemented with knowledge from local specialists and some observations from the author.

The original report is written in Dutch. For the convenience of those who do not master Dutch the chapters 1, 2, 3, 6, 7 and 8 are here partly translated in English.

### ***Aruba in a Nut Shell***

#### **Location and Climate**

The isle of Aruba is situated at 12°26' North Latitude and 16°55' Western Longitude, about 30 km from the north-west coast of Venezuela, South-America (see Map 1). Aruba is the most western island from the Lesser Antilles of the Caribbean region. The island is 32 km long and has a width of maximally 8 km, and has a surface area of about 190 km<sup>2</sup> (from various sources).



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Map 1: The Location of Aruba within the Region of South and Middle America, and the Caribbean Area.

Aruba is situated in the so called 'Intertropical Convergence Zone', resulting in a semi-arid climate. This climate is characterised by a rather constant average temperature: the average year temperature is about 28 °C. The coldest month (January) has an average temperature of

about 26.5 °C, while the warmest month (September) has an average temperature around 29 °C<sup>1</sup>.

The annual precipitation is about 400 mm per year, whereof 60% rains down in the months October to January. The annual evaporation is around 1590 mm per year<sup>1</sup>. So Aruba has a substantial shortage of rain. On top of this is the rainfall very variable, both per year and over the island. This can be concluded from the table of meteorological data over the period 1956-1972 (Finkel & Finkel, 1975).

## History

Aruba is probably inhabited from about 4000 BC. These earliest inhabitants, Indians from the main land South America, are likely to have visited the island during regular food gathering expeditions. From about 600 AD Indians settled permanently on the island. These permanent inhabitants introduced agriculture in Aruba. While Aruba was permanently inhabited the population probably fluctuated with the seasons.

Around 1500 AD Aruba is discovered by a Spanish sailor (Alonso de Ojedo or Amerigo Vespucci). The Spanish found no precious metals or pearls on Aruba so that the island was placed on the list of 'Islas inútiles' (unusable islands). After that, in 1515, almost the total population was deported to Hispaniola. On the plantations in Hispaniola was a severe shortage of workers (read: slaves). As Indians kept coming from the main land to Aruba the indigenous population was not exterminated. The land was used in the Spanish time mainly for grazing and breeding of cattle (Schut, ' 95). Also wood was produced, especially *Haematoxylon brasiletto* (Brasil wood) and *Guaiacum sanctum* (Terpstra, ' 48).

From 1636 the Dutch West-Indische Compagnie ruled over the island and used it mainly for cattle, for food production for the main island Curaçao. Also for military purposes horses were bred. Again wood was produced, the same species as mentioned above. Under Dutch rule it was not allowed for European descendent people to settle on the island as this would limit the free grazing of cattle (Schut, ' 95).

In the beginning of the 19<sup>th</sup> century Aruba is ruled by successively Venezuelan, Dutch, English, and from 1816 again Dutch government. In 1824 gold is discovered near Rooi Fluit and Rooi Daimari. Until 1916 gold is being produced on Aruba (Schut, ' 95).

Around 1840 *Aloe vera* is introduced on Aruba. The plant thrives so that Aloe culture is becoming more and more important for Aruba. In the beginning of the 20<sup>th</sup> century Aloe plantations occupy a 6000 hectares, about 1/3 of the island. After the second world-war the Aloe culture declines. One reason is that industrial demand is reduced by the development of synthetic substitutes, another reason for the decline is that more and more people are finding work at the refinery at San Nicolas (van Schaik, ' 94). This refinery, opened in 1927, had such a demand for labour that immigration from mostly English speaking Caribbean islands started to develop (Schut, ' 95).

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<sup>1</sup> These data are averaged over the period from 1956 to 1988, and collected by the Meteorological Institute Airport Queen Beatrix, Oranjestad, Aruba (Van Schaik, 1994).

From the 1950's employment at the refinery dropped. In a reaction to this the government tried to compensate by developing the tourism trade. When in 1985 the refinery was finally closed tourism was strongly stimulated by the government (Schut, ' 95). This policy resulted in an increase of visitors from 100.000 (stay-over visitors) in 1975 (Finkel & Finkel, ' 75) to 683.300 visitors (stay-over visitors) in 1999 (Centrale Bank van Aruba, 2000).

In 1986 Aruba is granted the long wished for "Status Aparte", which made it an independent country within the Dutch Kingdom.

In 1990 the refinery is re-opened in a more modest size; where in 1999 520 people were employed (Centrale Bank van Aruba, 2000).

### **Population**

The population of Aruba has almost doubled since 1960. The 1960 consensus counted 53.199 people, while the 1991 consensus reported 66.687 people (Eelens, ' 94). In 1999 95.201 people were official inhabitants of Aruba (Centrale Bank van Aruba, 2000). Informal sources however told the author that Aruba has a substantial illegal population. Their number is estimated from about 10.000 to about ca. 40.000 persons. Assuming the lowest estimation the total population is at least 105.000.

The population has grown especially fast in the last decade. Such a strong increase puts a great strain on spatial development. For example, the number of permits for new houses increased from 988 in 1998 to 1098 in 1998 and 1180 in 1999 (Centrale Bank van Aruba, 2000).



### ***The Problem***

The size of Aruba's population is increasing fast. This rapid growth means an increase in the use of space. Economically the growing population is strongly dependant on tourism. Tourists come to Aruba because of the fine weather, the beautiful beaches and the casino's. But also because of the landscape above and under sea level.

In order to keep the above water landscape attractive in these times of increased pressure on space use, a method must be found to assess the natural values of the various areas. With this method an argued case can be made to build or not to build houses or roads on a given area.

The first step towards such a system of assessing natural values consists of making an inventory of the landscape: what can be found, biotic and a-biotic, and what are the variations thereof? The next step is assigning values to the various components of the landscape, how do the areas contribute to the biodiversity of Aruba?

This report deals with the first step.

### ***The Questions***

In the time available for this research not all plants and animals could be dealt with. This report therefor is restricted to those organisms that deserve attention because of their national or international vulnerability. In this report these organisms will be called "focus plants" and "focus animals" (Dutch: aandachtsoorten). These terms are used by V. Schaik & Petrocchi ('98); they define "focus species" as kinds of animals and plants that satisfy one or more of the following criteria:

1. Species with low numbers on Aruba or the region, or threatened species.
2. Species who's local, regional or global existence is threatened by habitat disturbance, habitat fragmentation or disappearance of the habitat. This is especially the case for coastal ecosystems.
3. Species threatened now or possibly in the future by the (international) trade. Here the CITES treaty is important. Indigenous species on the CITES list are included in this report.
4. Species unique on regional or mondial level, including indigenous species.

Unless indicated otherwise the concept "focus species" is used here somewhat differently. The occurrence of a species on the CITES list is not considered, nor the expected future development of the population or the regional occurrence. Only the past and the present situation is considered.

On the other hand, attention is given to the authenticity of species: did they arrive (presumably) on Aruba without human interference. Does the species reproduce on the island? If so, it is assumed to be part of the Aruba ecosystem.

Having formulated the concept like this, the research questions can be stated as follows:

- What are the focus species of Aruba?
- How many individuals or pairs are there?
- How did the populations develop?
- Where do they occur?

To select the focus species from the complete list of flora and fauna of Aruba the following questions have to be answered.:

- For which (sub)species is Aruba the natural habitat?
- Which from these (sub)species do reproduce on Aruba?
- Which from these (sub)species have a limited habitat? Or, as a local population, decline in numbers or habitat size? Or are (very) rare on Aruba or the world?

In order to be able to indicate where the focus species are present or could be present the Aruban landscape will have to be divided in units of landscape type. To arrive at such a system of types the following questions are put:

- What areas are not too heavily used as to preclude natural values?
- What level of human disturbance is present?
- How dense is the local vegetation?
- How can these areas be typified?

With these questions in mind the variation in the landscape and nature are divided into a manageable number of landscape types.

#### ***Flora***

The Flora of Aruba has been investigated reasonably well, and quite a lot of information has become available. A.H. van Schaik and L.M. Petrocci have in 1998 combined the known information and have created a list of focus species (*sensu* V. Schaik & Petrocchi) of Aruba's flora. The information from Van Schaik & Petrocci is supplemented with information from other sources and from the author's own observations.

This preselection is then further reduced and limited to species that are locally rare, locally diminishing in numbers and species with internationally very restricted habitats. When available, information is presented on the international distribution, development of population size, the number of plants on Aruba and where these can be found, including (miscellaneous) relevant information.

#### ***Fauna***

##### **Birds**

As a point of departure the list from K.H. Voous (1983) is used. Species clearly introduced by humans are then excluded, as are the species that do not breed on Aruba on a regular basis.

Furthermore the list is reduced by excluding birds that did not breed normally on Aruba before the Bubali wetland area came into being in 1974. The sweet water Bubali wetlands are the result of (partially purified) waste water from nearby hotels.

Also species that have an extensive habitat and that do not seem to have been reduced in numbers (on Aruba) are deleted from the list. Of the remaining species on the list the following information is presented: where do the birds occur, has the range increased, decreased or remained stable, both internationally and on Aruba; and other information available (f.e. specific threats) is added.

##### **Mammals**

The list of focus species for mammals is based on "Basisrapport zoogdierkundig onderzoek" from J.P. Bekker (1996). Excluded are species that have been introduced, that have an extensive range internationally and have a stable or increasing population on Aruba and those species that are quite common.

Of the remaining species on the list the following information is presented: where do these mammals occur, has the range increased, decreased or remained stable, both internationally and on Aruba; and other information available (f.e. specific threats) is added.

## **Reptiles & Amphibians**

The list of reptiles and amphibians is based on the list of Van Buurt (in press). Species that have been introduced, or are suspected by Van Buurt to have been introduced are removed from the list.

Of the remaining species on the list the following information is presented: where do the species occur, has the range increased, decreased or remained stable, both internationally and on Aruba; other information available (f.e. specific threats) is added.

## ***Landscape types***

The classification of landscape types used is based on a map of the vegetation of Aruba prepared by J. de Freitas from the Caribbean Marine Biological Institute (CARMABI) for the Directorate LVV Aruba. De Freitas focuses on areas that are according to his view little disturbed. These areas, mainly the north-coast and the Parke Nacional Arikok, are compared with a soil chart from a report by Sogreah & Grontmij (1968). This results in a system of soil types. Next, based upon photographs from an aerial survey, the rate of ground cover by the vegetation is estimated and coded into 6 categories. More information on this can be found in a report on the charting of vegetation on Curaçao, de Freitas is one of the co-authors of this report (Beers *et al*, '97).

For the current research the 6 categories were reduced to 2: low and moderate. Low corresponds to category 0 (= bare) to moderate in de Freitas' system. Moderate corresponds with the categories moderate to coarse. De soil type system is also simplified and consists of three types: limestone underground, tonalite-batholite underground and Aruba Lava Formation underground.

The part from Aruba not covered by de Freitas' charts is divided in areas densely built and less densely built. The former area is thus classified on the basis of photo interpretations by Van Oirschot (1999) to be covered by more than 70% built area. These areas are not considered to be refugia for species of interest. Summing up, using the proportion of built area as criterion, Aruba is divided in three parts: little disturbed (charted by de Freitas), moderately disturbed, and severely disturbed (>70%).

The moderately disturbed area is again divided according to soil type, following the simplified system of de Freitas. Then the vegetation cover is estimated in order to be comparable with De Freitas.

**Flora**

Current knowledge of the Aruban flora is restricted to trees, shrubs and succulents. Little is known about herbs and grasses, these are not considered in this report..

The complete list of the findings of the literature search is put into two tables, see the addenda 1 and 2. For a more complete list see the new edition of Arnoldo's Pocket Flora, reworked by A. van Proosdij (at the moment of writing in press).

Below only the vulnerable species are considered, divided into three categories (see Table II). The first category consists of species rare in number or distribution on Aruba. The second category consists of species that are currently diminishing in number or distribution. The third category are those species internationally very rare. Some species may be found in more than one category, indicating a very high level of vulnerability.

<b>Categories of vulnerability used in this report</b>	
Category I	Species rare on Aruba and/or limited in number or distribution area.
Category II	Species with a decreasing population and/or distribution area.
Category III	Species with an internationally very restricted distribution.

Table I: The three categories of vulnerability used in this report. The precise dividing lines between the categories may vary between groups of organisms, and are discussed below.

*Category I*

The first category consists of those species with at most 50 individuals on Aruba, or species that can only be found at one or two places in the wild, the international occurrence is not considered. Also the species classified by Van Schaik & Petrocchi ('98) as "rare" or "very rare" are placed in this category. The species from this category are listed in Table III.

<b>Categories of vulnerability according to Van der Perk ('97)</b>	
Very rare	less than 20 individuals in the wild
Rare	20 to 50 individuals in the wild
Limited	50 to 100 individuals in the wild

Table II: The categories of vulnerability according to Van der Perk ('97).

The categories from Van der Perk ('97) are listed in Table II; more information can be found in Van der Perk ('97), pp. 7 – 8.

For several species the vitality of known individual plants is indicated, taken from Van der Perk ('97), where more information can be found on pp. 26 – 28. In brief Van der Perk describes his vitality classification as:

- Vital: “An individual of a species with a stable good health, independent of its age.”
- Moderately Vital: “An ailing individual of a species still capable of reproduction ...”
- Not Vital: “An individual deteriorated to the extent that total destruction is imminent or that no viable seeds can be produced any longer.”

[Not translated

<b>Rare and very rare plants on Aruba</b>		
<u>Species</u>	<u>Details</u>	<u>Occurrence on Aruba</u>

Tabel III: Rare and very rare plants on Aruba ]

The number of individuals of *Crossopetalum rhacoma* on Aruba is not clear. As can be found in Table III, about 30 individuals are known in nature reserves and an additional number along the coast. How many is not known. Maybe further research will place *Crossopetalum rhacoma* just outside the range defined for Table III.

The number of *Rauvolvia viridis* is unknown, the only information obtained refers to “a couple of individuals”. Most probably this means less than 50 individuals, hence the classification as rare. However, *Rauvolvia viridis* could be “very rare” or “limited” in reality.

*Brassavola nodosa* en *Bromelia humilis* can only be found on one place on Aruba, on the number of individuals no information could be found.

*Pilocarpus goudotianus* is also only present on one place, but rather abundantly. This species is considered locally not rare.

Concluding, Aruba knows 18 very rare species (and 1 sub-specie), 12 rare species, 1 locally abundant species and 2 very restricted species. From one species (*Guapira fragans*) it is not clear whether it has disappeared from Aruba.

### *Category II*

The second category of vulnerable species of the Aruban flora concerns species that are reduced in number and distribution since 1900, In the Appendices 1 and 2 the complete collection of data from the literature is collected. A first analysis from Appendix 1 shows that for the majority of the focus species nothing is known about the development of the populations in time, see the column “Trend”. Table IV presents an overview of the species that are demonstrably reduced, however this table is very probably very incomplete.

The group of presumably reduced species consists of species that are thus qualified on indirect evidence of various kinds. *Agave vivipara* for example was a rather common species whose habitat was largely destroyed by building and infrastructure activities. *Guaiacum sanctum* has been logged for local use and export. *Pilocarpus goudotianus* has presumably largely been used for the improvement of alcoholic beverages. This formerly everyday use has led to an occurrence of this species now on only a single plot. Also *Tournefortia gnaphalodes* has suffered a reduction in numbers and habitat since it was common on the western coast, an area that has now largely been occupied by hotels.

[Not translated

<b>Plant species reducing in population size on Aruba</b>	
<u>Species</u>	<u>Where found</u>

Table IV

]

### *Category III*

The third category of rare species consists of internationally very restricted species, i.e. northern Venezuela and the island along its coast, including Aruba, Bonaire and Curaçao.

The species with the smallest international habitat is *Lantana arubensis*, an endemic species for Aruba. It is also the only species whose distribution on Aruba is unknown.

[Not translated

<b>Plant species on Aruba with an internationally very restricted occurrence.</b>		
<u>Species</u>	<u>International distribution</u>	<u>Occurrence on Aruba</u>

Table V.

]

The international distribution of the above species is well known, in contrast to *Agave arubensis*, *Agave cocui* en *Stachytarpheta boldinghii*. Of these species it has been found that they do not occur on Bonaire and Curacao, on the occurrence outside this area no information has been found.

## **Fauna**

### **Birds**

For the complete list of species found on Aruba see Appendix 3, put together by the Projectbureau Arikok. The Appendices 4 and 5 all information on birds collected in the present investigation is collected.

In this section only those species are discussed that are demonstrably vulnerable. They are divided into three categories. The first category deals with birds which are rare on Aruba. The second category concerns species that have been reduced in number or habitat area on Aruba. The third category then concerns birds with a restricted distribution internationally.

#### *Categorie I*

[Not translated ]

### **Mammals**

The total number of mammals living in the wild in Aruba is 13. Of these 9 are indigenous, that is 9 species have colonised Aruba without (recent) human help.

[Not translated ]

### **Reptiles and Amphibians**

Aruba currently houses 3 amphibian species: two frogs and one toad, and 14 reptilian species i.e. 5 gecko species, 2 iguanas, 5 lizards and 2 snakes (Van Buurt, in press). Very recently governmental co-workers have found several individuals of *Boa constrictor*, a species that requires a much moister environment than Aruba offers. Both young and older individuals were found implying that this species may multiply in the wild in Aruba. Maybe *B. constrictor* has to be considered a native species as well.

[Not translated ]

### **Landscape types**

The data to divide Aruba in ecotypes or ecosystems are largely lacking. In order to come to a subdivision of different areas a system based upon landscape features is chosen. In this manner Aruba is divided in landscape types or units, as defined by Zonneveld ('95). Zonneveld ('95) defines a type as: "A land unit is a tract of land that is ecologically relatively homogenous at the scale level concerned". This definition, actually a description, is based on rather vague and arbitrary boundaries found in the landscape. Distinctive elements are soil type, level of disruptive human interference and vegetation.

### **Geology**

Firstly the geology of Aruba is considered. The Aruba territory is dry with a rather high concentration of iron and aluminium. The Soil Conservation Service van de US Department of Agriculture in its global system of soil classification has classified the Aruban soil as

# Simplified Geologic Map of ARUBA Plate 4

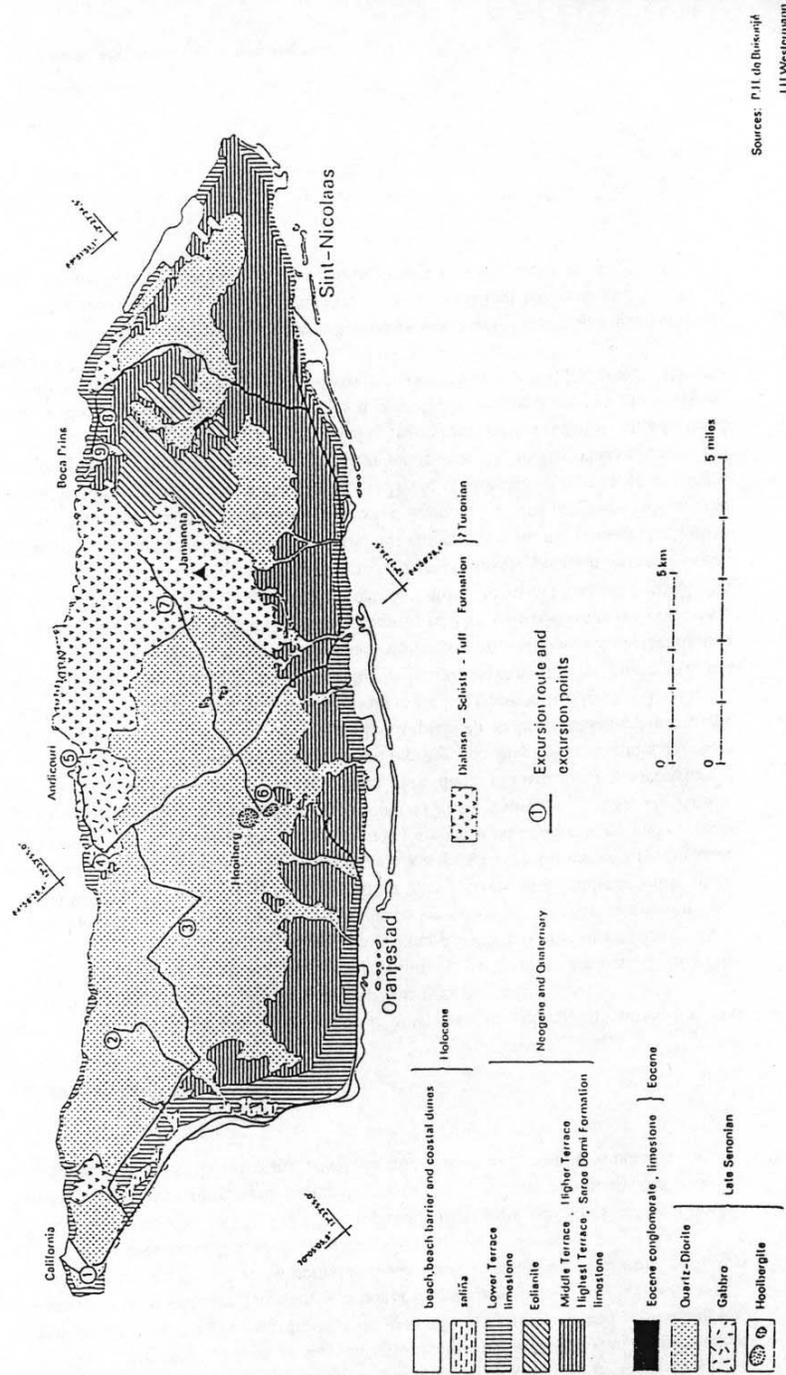


Chart 2: Geological map of Aruba. Rock types are grouped under Holocene, Neogene and Quaternary are Chalk Rocks, Quartz-Diorite and Gabbro are the Tonalite-Batholite rocks, while Diabase-Schists-Tuff this report are called Aruba Lava Formation.

“aridisols undifferentiated – with ustalfs” (Miller & Donahue, ‘95). See Chart 2 for more details (Beets, ‘96).

Geologically Aruba is divided into three main categories: Tonaliet-Batholiet-formation, Aruba Lava Formation and Chalk formation. On these three geological substrates various landscaped have developed.

[Not translated ]

### **Disturbances**

The second landscape characteristic is the level of disturbance. Disturbance is here considered to be the interruption of natural developments due to human interference. Three levels are discerned: severely disturbed, moderately disturbed and little disturbed. In a strict sense the whole of Aruba is seriously disturbed since the arrival of Europeans in 1500. The completely forested island is turned into a semi-desert with here and there patches of vegetation. This disturbance is taken as the starting point.

[Not translated ]

### **Vegetation Cover**

De Freitas (CARMABI) is developing a vegetation map of Aruba using the so-called “landscape guided method”, as developed by the International Institute for Aerospace Survey and Earth Sciences (ITC). In principle this method tries to determine the variation in types of vegetation and its boundaries on the basis of (aerial) photographs. For more details see Zonneveld (1979), Van Gils *et al.* (1985).

[Not translated ]

### **Relief**

In “Erosie op Aruba” (Geelhoed, ‘97) a map is presented where Aruba is divided in classes on the basis of relief. The only map available for this research was not clear enough to be useful.

### **Total**

In total the various classifications result in 36 classes, see Table XII. 12 of these are not considered as they are severely disturbed. The 24 classes are reduced to 14 as the relief classification is not taken into consideration, see the paragraph on relief above. The resulting analysis of landscape types is available from A.J. Schilstra, IVEM, Rijksuniversiteit Groningen.

[Not translated ]

In this report three categories of vulnerable species are discerned: locally rare (in numbers and area), species diminishing in numbers or habitat, and species with a very restricted distribution internationally.

### **Flora**

47 plant species are found to belong to one or more of the above categories, the so called focus species of the Aruban flora. Numbers, trends and distribution are given in the Tables III, IV and V. To the three categories belong:

- 6 species locally rare (in number and habitat): *Brassavola nodosa*, *Bromelia humilis*, *Tillandsia recurvata*, *Tillandsia utriculata*, *Guaiacum sanctum*, and *Pilocarpus goudotianus*.
- 2 species with a locally and internationally very restricted distribution: *Ficus brittonii* and *Maytenus tetragonus*.
- Of 2 species the number and habitat are diminishing, and are internationally restricted: *Agava vivipara* and *Melocactus macracanthus*.
- 27 are locally rare, see Table III. Note, this table also includes species mentioned above
- 4 species are rare and declining in number, see Table IV.
- 6 species have a very restricted habitat internationally, see Table V. This table also includes some species mentioned above.

The exact location of the above species is not always known. From 36 species indications are available, sometimes rather general, like “on tonalite hills”. 10 times limestone was mentioned, and 17 times “roois” (small canyons leading to the coast, most of the time dry). Especially the Mahawa, Barbacoa, Taki, Kochi, Awa Marga, Calbas, Lamunchi, Prins and Thomas roois are mentioned. This indicates that especially the roois in and next to limestone areas harbour vulnerable (focus) species.

### **Fauna**

#### **Birds**

In this report 27 vulnerable bird species are discerned, the so called focus species. The available data are collected in the Tables VI to VIII.

The categories are defined as:

- 2 species are locally rare, locally decreasing in number and have an internationally limited distribution: *Inters nigrogularis curasoënsis* and *Vireo altiloquus bonairensis*.
- 2 species are locally rare and locally decreasing in number: *Amazona barbadensis barbadensis* and *Columba squamosa*, both species are now extinct on Aruba.
- 2 species are locally rare and have a limited distribution internationally: *Dendroica petechia rufopileata* and *Myiarchus tyrannulus brevipennis*.
- 2 species are locally diminishing in number and have an internationally restricted distribution: *Aratinga pertinax arubensis* and *Athene cunicularia arubensis*, both are endemic subspecies.
- 6 species are locally rare, see Table VI.
- 6 species are locally reducing in number, see Table VII.
- 7 species have a limited international distribution, see Table VIII.



Data on the above species are also rare. When available they deal with the Ago-reef (sea birds) and the Arikok-Yamanota region. The present author has the strong impression that the presence of vulnerable focus species is positively correlated with the density of the vegetation.

### **Mammals**

Aruba has 9 indigenous mammals. 7 of these are bats. All indigenous mammals of Aruba are focus species, see the Tables IX and X for numeric data. Two levels of vulnerability are discerned, where rarity and the decreasing in numbers are taken together:

- 1 bat specie is extinct *Peropteryx macrotis*.
- 3 bat species are seriously threatened and very restricted internationally: *Natalus tumidirostris tumidirostris*, *Mormoops megalophylla intermedia* and *Leptonycteris curasoae*.
- 1 bat is seriously threatened: *Pteronotus davyi davyi*.
- 1 bat is threatened and internationally restricted: *Glossophaga longirostris elongata*.
- 1 bat is threatened: *Molossus molossus*.
- 1 rodent is vulnerable and has a restricted international distribution: *Calomys hummelincki*.
- 1 rodent is not quite safe and internationally restricted: *Sylvilagus floridanus nigronuchalis*.

For bats both feeding and sleeping areas and nurseries are important. Each species has its own requirements, depending among others, on the diet. (*Glossophaga longirostris elongata* and *Leptonycteris curasoae*) are important for fruit and pollen eaters.

For *Calomys hummelincki* the narrow, rugged and vegetated strip along the NE-coast is important.

### **Reptilians and Amphibians**

Aruba has 1 indigenous amphibian, the Aruban frog (*Pleurodema brachiops*). In this study no information about its distribution has been found. Until more is known this species should be considered a focus species.

Aruba has 11 indigenous reptiles of which 7 have a very restricted international distribution: *Gonatodes albogularis albogularis*, *Phyllodactylus julieni*, *Anolis lineatus*, *Cnemidophorus arubensis*, *Tretioscincus bifasciatus*, *Leptodeira annulata bakeri* and *Crotalus durissus unicolor*. *P. julieni*, *C. arubensis* and *C. d. unicolor* can only be found on Aruba, and so are endemic species. *Crotalus durissus unicolor*. *C. d. unicolor* is the subject of an active protection and research program.

The above 7 species have a limited international distribution, of the others little is known. So all 11 reptiles should be considered to be focus species.

### **Landscape type**

For this research the map of Aruba is divided into 26 classes, based on the soil type, the level of disturbance, the level of vegetation and the relief.

Next to these 26 classes a number of additional landscape types are discerned; the “rooien” (gullies), the dunes, the salinías and the mangroves. Especially the mangroves and the rooien next to chalk areas are important.



### ***In general***

This research initially used the concept “focus species”, though used slightly different from the concept as defined by V. Schaik & Petrocchi (‘97). During this research in practice the meaning has moved away from its original meaning, as a result of the local situation. This might cause some misunderstanding that could have been avoided by using a different term. For example the term “vulnerable species”.

This report combines the findings from very different sources, with different levels of reliability. Scientific reports have been studied, like Bekker (1996) and Geelhoed (1997), but also publications that have, at face value, the level for high school use, see Petrocchi (1997). Also now and then data have been used from people with hands on experience in the field, not based on scientific research. For example, the decline and rise of the Aruban burrowing owl (shoco, *Athene cunicularia arubensis*) in the 80’s and 90’s are obtained from field experience of Mr. R. de Kort.

The reader should also keep in mind that this report is written by a biologist grown up in the Netherlands. Nature there is not comparable with that from Aruba. This may enhance objectivity on the one hand, but also forces to come to conclusions in a very short time. Too short maybe for some interpretations.

### ***Per item***

No information has been found for any of the species regarding the minimal population size required to have a genetic stable situation. This information is however very much connected to the concept of what constitutes a “rare” species. If the minimal size is unknown it also cannot be concluded when a species is approaching the danger zone.

### **Flora**

The available information on Aruban flora is restricted to trees, shrubs and succulents. Little is known about grasses and herbs. These grasses and herbs could however play an important role for the germinating of seeds by creating a suitable substrate, shadow and shelter and thereby slowing down evaporation. The microclimate would be favourable for germinating and root formation.

In the first part of this report on the flora not only species are indicated that are considered “rare” or “very rare” by various authors, but also species that can only be found on one or two places on Aruba. This is a rather subjective criterion not based on extensive field research but on ad hoc knowledge. When more field work is done on the less central parts of the island more places can be found.

Not much is known about the trends in time of the Aruban flora. This is mainly due to the fact that most floristic knowledge is obtained in the ‘90’s of last century. The vulnerability category II is probably an underestimation: the number of plant species that are reducing in number and area of habitat is probably higher than indicated in this report.

The criterion for vulnerability category III is arbitrarily chosen, and not based on verifiable research.

## **Fauna**

### *Birds*

Most data used in this research are from the work of Voous, from 1983. So these data are at least 17 years old so that the presented information could very well be outdated. In a small number of cases this has indeed been found. For example the American oyster-catcher (*Kibra kokolishi*, *Haematopus palliatus*). Voous writes: “probably breeds on Aruba”, Van Halewijn (1989) mentions a single case.

On trends in population sizes little is known. In 60% of the better known species no information on trends is available. The estimated 12 species in the vulnerability category II is probably an underestimate. Also the exact location for breeding of many birds is not known.

### *Mammals*

For mammals the vulnerability categories I and II have been put together, as this was the classification of the most important information source, Bekker (1996). His classification is based on “presence” and trends. What he actually means by “presence” has not been found.

The criterion for category II, internationally very restricted species, is also arbitrarily chosen.

### *Reptiles and Amphibians*

It is known what reptilian and amphibian species occur on Aruba, and what their international distribution is. Very little is known outside this, like how rare a species is, whether the population is declining, increasing or remains stable.

## **Landscape types**

### *Geology*

It must be mentioned first that relief is not included in the current analysis of landscape types. This is due to the fact that the only map available has become unreadable.

The second point concerns the geological map included in this report. This map is based on data from Buisonjé and Westermann, and who have is taken it from Schut (1995). Where Schut has obtained this map is unknown, he provides no reference. Probably the map comes from a publication from Buisonjé, or from a report from Grontmij & Sogreah from 1968.

The landscape is divided into three types of soil. The water retaining capacity of the three types is not known, nor the mineral availability determining the soil fertility for plants. So, while these aspects are very important for plant growth they did not play a role in dividing the island into landscape or soil types.

### *Disturbance*

Disturbance is classified into three categories, namely “severely disturbed”, “moderately disturbed” and “little disturbed”. The last category does however point to areas that are severely disturbed by human interference in former times. They are first denuded and then overgrazed. The classification therefore is rather relative. The boundaries between the first two categories are rather rough, and may misclassify certain areas.

*Vegetation cover*

The estimation of vegetation cover in the little disturbed parts is based on a reworking of estimations by De Freitas. The vegetation cover of the moderately disturbed is estimated by the present author, in analogy to De Freitas' method. However, due to the fact that the data are from two different authors and the interpretation of aerial photographs is somewhat subjective leads probably to variations in classification.

It should also be kept in mind that the classification is based on the density of the vegetation, and not on its composition of species.



## **7. Suggestions for further research**

**Part B page 52**

For a better understanding of the Aruban ecosystems hiatus in the knowledge have to be filled in. A number of points for future research are highlighted below.

For an assessment of the various rare species it has to be investigated what the minimum population is for genetic stability.

If the presence of grasses and herbs influences the germinating success of trees and shrubs, the prevalence of grasses and shrubs should be investigated further.

The total of Aruba, with perhaps the exclusion of the severely disturbed parts, should be researched floristically. At least the species in the vulnerability category I to III. A monitoring system should be set up to assess the fate of the various populations.

The vulnerability categories I to III for birds should be investigated further. Here also a monitoring system should be developed to monitor population changes in time.

Knowledge of mammals is reasonable complete. However, the data are several years old. In order to keep track of developments a monitoring system should be set up.

Data on reptiles and amphibians is scanty. An qualitative and quantitative inventory as well as a monitoring system for changes in time should be developed.

Next to nothing is known about Aruban insects. They could however play an important role in the ecosystems, for example as prey for bats, birds, reptiles and the Aruban frog. They could also be important as pollinators. It is therefore important to obtain at least a general view of the presence and distribution of insects, their distribution and ecological function.

Landscape and soil types should be investigated in relation to their waterstoring capabilities and nutritional properties. The classification of types in 3 categories should be critically reviewed.

Finally, but also very importantly, the work of J. De Freitas at CARMABI should be completed.



## **8. Thanks**

**Part B page 53**

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