



Original research article

A quantitative assessment of the vegetation types on the island of St. Eustatius, Dutch Caribbean



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ABSTRACT

Caribbean dry forests are among the most endangered tropical ecosystems on earth. Several studies exist on their floristic composition and their recovery after natural or man-made disturbances, but little is known on the small Dutch Caribbean islands. In this study, we present quantitative data on plant species richness and abundance on St. Eustatius, one of the smallest islands of the Lesser Antilles. We collected and identified trees, shrubs, lianas and herbs in 11 plots of 25 x 25 m in different vegetation types. We compared their floristic composition and structure to vegetation surveys from roughly the same locations in the 1990s and 1950s. We found substantial differences among our 11 plots: vegetation types varied from evergreen forests to deciduous shrubland and open woodland. The number of tree species ≥ 10 cm DBH ranged between one and 17, and their density between three and 82 per plot. In spite that all plots were subject to grazing by free roaming cattle, canopy height and floristic diversity have increased in the last decades. Invasive species are present in the open vegetation types, but not under (partly) closed canopy. Comparison with the earlier surveys showed that the decline of agriculture and conservation efforts resulted in the regeneration of dry forests between the 1950s and 2015. This process has also been reported from nearby islands and offers good opportunities for the future conservation of Caribbean dry forests.

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1. Introduction

The Caribbean islands are hotspots of biodiversity, harbouring 2.3% of the world's endemic flora on a relatively small surface, with only 11% of the original primary vegetation remaining (Myers et al., 2000). Due to their small size and isolation, islands are particularly vulnerable to anthropogenic processes, resulting in habitat fragmentation, invasive species and extinction of endemic plants (MacArthur and Wilson, 1967; Stachowicz and Tilman, 2005). The climax vegetation on most Caribbean islands is dry forest, one of the most endangered tropical ecosystems on earth (Janzen, 1988). Several studies are available on the recovery of Caribbean dry forests after anthropogenic or natural disturbances, in Guadeloupe (Imbert and Portecop, 2008), Puerto Rico (Brandeis et al., 2009), the Bahamas (Franklin et al., 2015) and the Dominican Republic (Cano and Veloz, 2012; García-Fuentes et al., 2015). Little is known, however, on the composition of dry forests on the Dutch Caribbean islands. Such information is essential for adequate conservation and sustainable management plans. One

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Fig. 1A. Location of St. Eustatius.
Source: Dutch Caribbean Biodiversity Explorer (www.dcbiodata.net).

of the first steps is to produce accurate information on the spatial distribution of habitats and quantitative data on species abundance within different vegetation types (Helmer et al., 2008).

Here we provide quantitative data on plant species richness and abundance on St. Eustatius, with 21 km² one of the smallest islands of the Lesser Antilles (Fig. 1A). St. Eustatius is composed of two volcanic areas separated by lowlands that were once formed by volcanic debris. The northern hills (up to 289 m) are extinct volcanos formed around 500,000 years ago and now extinct. The southern Quill volcano is dormant, 600 m high, with an open, 750 m wide crater at ca. 273 m above sea level. This volcano is less than 50,000 years old, but has not erupted in the last 1600 years (Roobol and Smith, 2004). On the southern side of the Quill, a formation called the White Wall is found, a steep limestone slope that was uplifted due to submarine volcanism in the Holocene (Westermann and Kiel, 1961). Rainfall is quite variable, but averages at an annual 986 mm, with a wet season from August to November and a dry season from December to April. Rainfall is highest on the Quill volcano, while the northern hills receive less precipitation. The average daily temperature is over 30 °C in the warmer months (May to November) and 24 °C in the cooler months (December to April). Relative humidity ranges over the course of the year from a high of 94% to a low of 62% (NOAA, 2015). Due to the heterogenic landscape and climate, the island harbours diverse vegetation types: from xeric shrub land with cacti to seasonal deciduous and evergreen tropical forest (Roobol and Smith, 2004; Helmer et al., 2008; De Freitas et al., 2014).

In 1999, the St. Eustatius Government delegated the St. Eustatius National Parks Foundation (STENAPA) to protect the dry habitats in the northern hills in the Boven National Park and the southern, moister forests in the Quill National Park (Fig. 1B). The island has now 28% of the land under formal protection (Helmer et al., 2008). The lowlands in between the two mountainous protected areas, known locally as the Cultuurvlakte (agricultural plain) and occupying ca. 25% of the island surface, have been intensively used for agriculture, urban development and cattle grazing in the past three hundred years. In the heyday of the plantation economy, some 25,000 people lived on the island. Apart from the Cultuurvlakte, agricultural fields were established in the northern hills, almost up to the rim of the Quill and in the volcano crater itself. The population dropped to just 950 persons in the 1950s following the decline of agriculture and migration of people to Curaçao for paid labour (Palm, 1985). Following the construction of an oil terminal in 1982, now a major employer on the island, the population rose again. The latest figures (CBS, 2013) place the island's current population at to ca. 3900. Due to centuries of anthropogenic disturbance, none of the original lowland forests are left. The Cultuurvlakte suffers from the deleterious effects of invasive species and free roaming cattle, but most of the officially protected vegetation types on the island, also suffer from overgrazing, particularly by goats (Van der Burg et al., 2012).

In 2010, St. Eustatius, Bonaire and Saba became special municipalities of the Kingdom of the Netherlands. A new nature management plan was set up for the period 2013–2017 to create a framework for the protection and sustainable management of biodiversity in the Dutch Caribbean (Ministry of Economic Affairs, 2013). To facilitate scientific research in the region, the Caribbean Netherlands Science Institute (CNSI) was established on St. Eustatius (<http://www.cnsi.nl>). Early 2015, Naturalis Biodiversity Center started its Caribbean programme with a multi-taxon baseline assessment of the terrestrial and marine biodiversity of St. Eustatius. This allows us to reveal how patterns of richness and diversity co-vary within and between taxonomic groups, identify the drivers of these patterns and indicate terrestrial biodiversity hotspots on the island (Wesselingh et al., 2013). Occurrence data will include historic and recent collections, observations and DNA barcoding techniques to identify cryptic species. To serve as a basis for this multi-taxon approach, this paper focuses solely on vegetation and vascular plants.

The first vegetation map of the island was produced by Stoffers (1956) and based on botanical collections made between 1755 and 1953. Stoffers recorded 453 plant species and distinguished 18 different vegetation types, based on plots of different sizes (e.g., 20 × 10 m, 80 × 5 m) in which trees and shrubs over 5 m high were counted and smaller plants visually estimated. Helmer et al. (2008) published land cover and forest formation distributions for St. Kitts, Nevis, St. Eustatius, Grenada and Barbados. Their forest formations were based on cloud-cleared satellite images in stead of on-the-ground vegetation surveys or botanical collections, resulting on broad classifications in rather low resolution for St. Eustatius, as it is rather small compared to the other islands in this study. In 2014, De Freitas et al. (2014) published a landscape ecological vegetation map, based on areal photographs taken in 1991 and field observations from 1999. Based on 84 sample plots,

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