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# 27 Invasive Species: Major Threat to Caribbean Netherlands Biodiversity

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## Status

Not all introductions of exotic species will ultimately result in biological establishment or invasive tendencies but do carry that risk. Assessment of risks is complicated; assessment of invasions is somewhat easier after a non-native species has been present for a shorter or longer period and risks differ greatly depending on the species. However, once invasion takes place and becomes evident typically any action to reverse the problem is too late and the ecology of the area invaded will likely forever be impacted. Therefore, in this assessment of the invasive species problem we use exotic species as the barometer for the invasive alien species (IAS) problem.

A first assessment of invasive alien species (IAS) within the Dutch Caribbean was performed in 2011, which indicated the presence of 211 exotic, non-native species across different invasion stages. These included 27 marine, 65 terrestrial plant, and 72 terrestrial animal species as well as 47 introduced pests and diseases. Lists of these species, pests and diseases are found in respectively Debrot et al. (2011), van der Burg et al. (2012), and van Buurt and Debrot (2012; 2011). Even without an exhaustive review, we here now report an additional 710 new island occurrences of (potentially invasive) exotic taxa which have been documented from nature on one or more of the six Dutch Caribbean islands (Bonaire, Saba, St. Eustatius) since the 2011 inventory. These new island occurrences amount to for example, 40 records of exotic reptiles, 54 records of exotic snails, 10 records of non-native land flatworms, 448 records of exotic weedy plants, and 100 records of exotic insects (Table 1).

The NEPP for the Caribbean Netherlands assigns a high priority to the invasive species problem (Min. LNV et al., 2020), which worldwide is considered second only to habitat destruction as a long-term threat to biodiversity (Kaiser, 1999; Mooney and Hobbs, 2001).

**Table 1.** Number of newly identified non-native species among the Dutch Caribbean islands. (see Appendix 3 for full listing).

Species group	New records of exotic species
<b>Mammals</b>	6
<b>Fish</b>	8
<b>Birds</b>	12
<b>Amphibians</b>	4
<b>Reptiles</b>	40
<b>Mollusca</b>	53
<b>Flatworms</b>	10
<b>Earthworms</b>	1
<b>Insects</b>	100
<b>Animal diseases, vectors and parasites</b>	10
<b>Plant diseases, vectors and parasites</b>	15

Species group	New records of exotic species
<b>Other invertebrates</b>	7
<b>Fungi</b>	0
<b>MLO's (Mycoplasma Like Organisms)</b>	0
<b>Plants</b>	445
<b>Total</b>	<b>710</b>

## Characteristics/Knowledge

The ever-increasing international traffic of persons and cargo has facilitated non-native species introduction throughout the Caribbean, including the islands of the Caribbean Netherlands. Insects are transported in suitcases, marine species are transported in ballast water, soil fauna hitchhikes with plant imports, and terrestrial plants and animals are escaping from cultivation, captivity, and particularly from cargo with construction materials, consumer goods, and plant imports. Although most translocated species cannot adapt to the new environment or do not survive long enough for reproduction, some can. These often remain unnoticed for years whilst adapting to the new environment; the so-called 'lag phase'. Once circumstances are right, they may proliferate exponentially because they occupy a 'niche' that was often empty or that belonged to a less-competitive native species. Establishing arrivals commonly proliferate due to the absence of natural enemies. During the time that native predators need to adapt, the new arrival can proliferate freely and outcompete local species, endangering them with extirpation or extinction. Examples of such species are the Lionfish (*Pterois volitans/miles*) that negatively affects all reefs of the Caribbean Netherlands and impacts fishery production by preying on fish larvae and outcompeting local fish (Albins and Hixon, 2008), the Common Green Iguana (*Iguana iguana*) that threatens the critically endangered Lesser Antillean Iguana (*I. delicatissima*) on St. Eustatius and the Saba Green Iguana on Saba, and the Madagascan Rubber Vine (*Cryptostegia grandiflora* and *C. madagascarensis*) that have no native natural enemies and are a problem to the vegetation on all three islands.

The arrival of non-native species within native communities is a large and ever-growing problem world-wide, including the Caribbean (Williams and Sinderman, 1992; Williams et al., 2001; Kairo et al., 2003; Lopez and Krauss, 2006). IAS cause major economic losses worldwide (Pimentel et al., 2005) and rank amongst the most important drivers of local and global reductions in biodiversity (World Conservation Monitoring Centre, 1992; Vitousek et al., 1996, 1997; Mooney and Hobbs, 2000; Butchart et al., 2010). Island ecosystems are especially vulnerable to biological invasions and often possess unique assemblies of endemic biodiversity, including the islands of the Dutch Caribbean which all lie within a global hotspot for biodiversity (Mittermeier et al., 1999; Myers et al., 2000). Islands are particularly at risk because of several factors: 1) their small size, resulting in vulnerable plant and animal populations; 2) relatively high numbers of endemic species which have evolved without the ecological pressures found on larger landmasses, often experiencing naturally lower levels of predation and competition, for example; 3) a relatively large border zone in relation to surface area which can be difficult to control; 4) small local economy, resulting in high amounts of imported cargo and goods; 5) a small human population lacking the "economies of scale" necessary to support the institutions, expertise and resources needed to effectively implement and take adequate measures.

The Netherlands is signatory to several international treaties and conventions which accord special emphasis to invasive species. These are the **Convention on Biological Diversity (CBD)** which in Article 8h calls on its members 'to prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species', the 2004 **IMO Ballast Water Convention** and the **Ballast Water Management Convention (BWM)** which the Netherlands ratified in 2010, and finally the **International Plant Protection Convention (IPPC)**, which principally aims to protect cultivated and wild plants by preventing the introduction and spread of pests. In 2014 strict new norms were implemented throughout Europe, including the Netherlands, to forbid importation of dangerous or risky exotic species. These international treaties call for an active IAS program, also within the Caribbean part of the Kingdom. However, until now any form of structural joint IAS management

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remains wanting. Several countries in the Caribbean have developed a strategy to address their invasive species problem, such as Jamaica (Townsend, 2009), the Bahamas (BEST Commission, 2003) and St. Lucia (Andrew and John, 2010; Chase et al., 2011). These may serve as examples for the Caribbean Netherlands on how to implement their own strategy to address this urgent issue.

Brown and Daigneault (2014) review economic impacts for case studies of invasive species in the Caribbean. Special cases are introductions that may affect human and animal health, such as disease-transmitting mosquito species. The costs of control grow exponentially with the growth of the invasive populations. For example, whilst over 5 million US dollars have been spent within a harvest management program to reduce invasive green iguanas on Grand Cayman, continuous removal and financial aid will be necessary to prevent population regrowth (Rivera-Milan and Haakonsson, 2020). Therefore, it is of utmost importance to try to prevent the introductions altogether or halt them at an early stage. This means strict biosecurity control at both import and export. Developing a system of monitoring, early detection, and control and management, requires knowledge about the species present in the region as well as legal authority and institutional capacity to take decisive action on land or at sea.

## Ecological Aspects

### **Negative effects:**

Invasive species cause major ecological effects (decimating native flora or fauna populations) as well as economic losses, across sectors such as agriculture (diseases, weeds, vectors, and animal pests), fisheries (fish diseases, the Lionfish, smothering coral and sponge species), industry (rodents and termites), tourism (roadside weedy species) and public health (mosquitos and introduced parasites). Ecological effects are numerous and often multiple per IAS; e.g., direct predation, (out)competition for food or complete niche space, hybridization, overgrowing, and spill-over of parasites, bacteria and diseases. Unfortunately, negative effects are often not immediately noticeable and often a species will persist at low and seemingly unharmed densities for years before becoming a major problem. Therefore, altogether prevention (or as next-best early detection and eradication) is preferable to letting a species of high risk come in persist and spread before doing an assessment of what to do.

### **Maximum allowed population density:**

In principle, even the smallest presence of a non-native species is to be avoided as it alters the native community composition and somehow affects the ecological processes even though it may not yet be clear how or to what extent. For instance, at the lowest level of impact, the introduction of non-native plant species can take place gradually over time and ultimately change native forests into “novel” forests dominated by non-native species (Lugo et al., 2020). It is especially tropical island forests that are vulnerable to developing into novel forests (“fauna- en floravervalsing” in Dutch). While such novel forests (or novel animal communities e.g., Raymond-Léonard et al., 2018) may be able to fulfil many of the ecosystem processes and functions of the original communities and not always represent a “total environmental loss”, preventing establishment of exotic species at the preference of native species should always be the priority but is not always possible. This is particularly the case when incursions have not been halted at the national border or when eradication is unsuccessful at an early stage. In such cases, a form of tolerance may be the only option substantiated with or without using a local ongoing control program. Ongoing control is often a costly management measure, so strong prioritization is essential. A choice needs to be made between which species to control, where to do so, to what density, and to know whether the efforts actually have the desired effect.

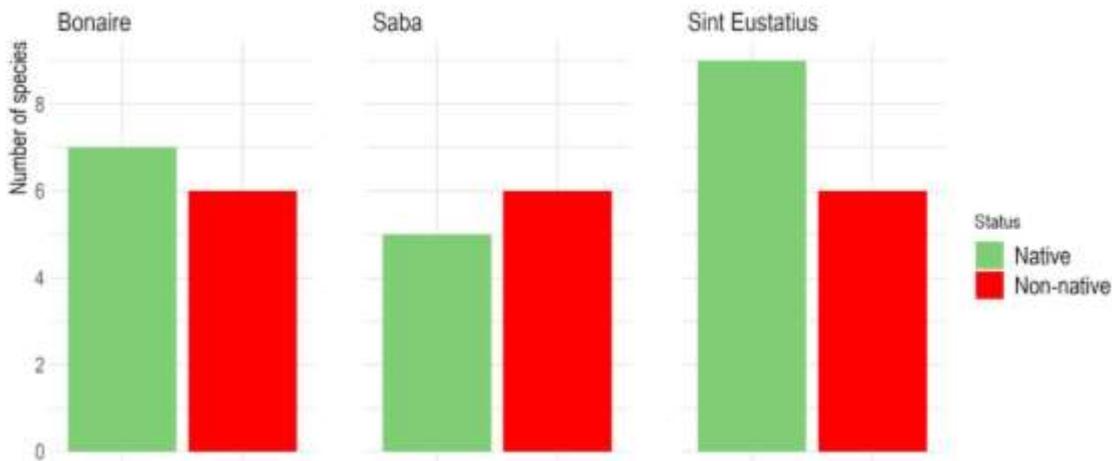
## Important IAS and Recent Developments

### **Recent developments within the Caribbean Netherlands:**

Since the last IAS survey and the 2017 State of Nature (Debrot et al., 2018), even more potential damaging introductions have occurred and new data on historical introductions have become available. Our newest inventory adds an additional 714 new island occurrences of potentially invasive exotic taxa which have been documented on one or more of all six Dutch Caribbean islands, (not only

the three Caribbean Netherlands islands; Bonaire, Saba, St. Eustatius) since the 2011 inventory (Debrot et al., 2011; van Buurt and Debrot, 2011, 2012; van der Burg et al., 2012). It lies beyond the scope of this report to discuss in detail all newly reported exotic species, the risks they may represent and what, if anything, can be done about them.

However, especially alarming is the high number of new established reptile populations among the BES islands (including Green Iguana, geckos, and tegulets; Figure 1), guinea pigs and rabbits that have become established on Saba, as well as the presence of the New Guinean Flatworm on both Bonaire and Saba. Similarly alarming is the large number of non-native plant species that have escaped and naturalized from gardens and agricultural areas as well as were brought in unintentionally by residents and tourists (Figure 2). More than half of the flood of exotic species entering the wild in the Dutch Caribbean are plants, for which there is no phytosanitary legislation or control.

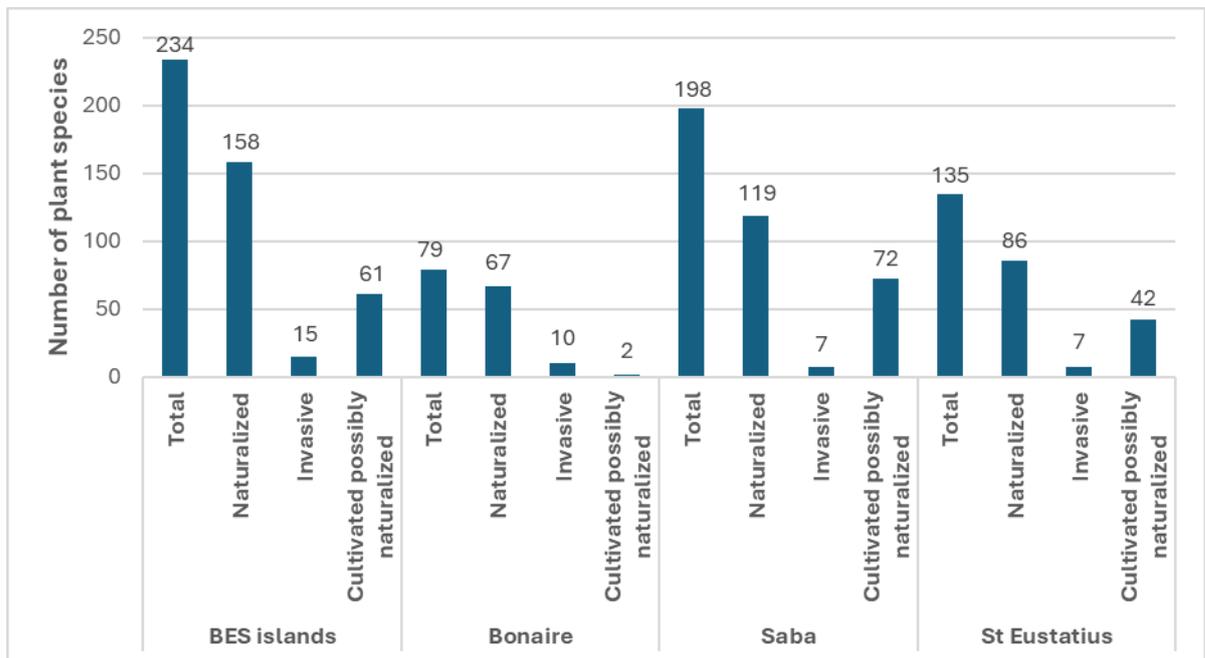


**Figure 1.** Overview of the number of native and non-native species of herpetofauna on the BES islands recorded by 2024.

Recently, further complexity to the ongoing incursions of Green Iguana from St. Maarten to both Saba and St. Eustatius have been identified. Genetic analyses have demonstrated that non-native ectoparasitic mites have been introduced to both populations, where these can spill-over to native iguanas (van den Burg et al., in prep). This was equally found for the tick *Ornithodoros puertoricensis*, which has been identified on Saba and St. Eustatius in 2023 and 2024 (van den Burg and Debrot, 2025). Alarmingly, *O. puertoricensis* is a known carrier of tick-borne diseases and has been found elsewhere on a variety of other hosts like rats, goats, cats, and humans (Endris et al., 1991; Paternina et al., 2009). Furthermore, a preliminary microbiome analysis of native and non-native iguanas on Saba suggests that non-native iguanas have introduced several invasive and potentially harmful bacteria, which are known to be able to transfer to other native reptiles (Hellebuyck et al., 2017). Additionally, there are numerous species present on other Caribbean islands, as well as the main regional hub of IAS, Florida (e.g. Witt, 2024), which have not (yet) reached the BES islands. Recent sightings of at least two reptile species (*Agama picticauda* and *Phelsuma laticauda*) from several Caribbean islands have led to major concern among regional stakeholders (van den Burg et al., 2024a; De Jesús VillaNueva et al., in prep.). Also worrisome are several species of *Anolis* which have already become established on St. Maarten (Dewynter et al., 2022).

While structural measures against the growing flood of introductions of known or potential invasive species are the greatest single priority (Smith et al., 2014), the need to be able to take effective measures against invasive species once present is also crucial. Therefore, in recent years Wageningen University and Research and its island partners have conducted several studies or field pilot interventions directed towards either:

- a) species that have long been present and known to be highly deleterious (like goats, cats, and Lionfish) or
- b) “newly”-arrived species of peak risk to native biodiversity and human health (e.g., non-native Green Iguana, the Giant African Land Snail and the New Guinea Flatworm).
- c) exotic plants- discussed separately below.



**Figure 2.** Overview of the number of non-native plant species recorded in the wild on the BES islands recorded by 2024.

### A) Long present

**Goats:** Uncontrolled feral grazing by goats is likely the most serious and longstanding invasive species problem with wide-sweeping ecological consequences for both terrestrial and marine ecosystems and is therefore discussed elsewhere in a separate chapter in this collection.

**Cats:** Feral cats are believed to be directly responsible for some 26% of global species extinctions due to invasive mammalian predators since AD 1500, and today they are the primary existential threat to no less than 367 species worldwide (Medina et al., 2011; Doherty et al., 2016). They have long been present on the islands of the Dutch Caribbean and their impact is likely to be massive but also almost impossible to retrace. They can be very abundant on especially Bonaire where they might well be a factor contributing to the local absence of small endemic terrestrial mammals (the endangered Curaçao Vesper mouse and the Curaçao cottontail) and/or ground-nesting birds like the Crested bobwhite, *Colinus cristatus*, such as are (still) found on neighbouring Curaçao and Aruba.

Feral cats are a demonstrated serious threat to nesting Red-billed Tropicbirds (*Phaethon aethereus*) on Saba, where they became problematic after local animal advocates started dumping unwanted cats into the wild instead of humanely euthanizing them (Debrot et al., 2014). For each cat “saved” by abandoning it in the outdoors, excess predation pressure is put on multiple other species who frequently have no evolved defences to mammalian predators (Figure 2). Therefore, Debrot et al. (2022b) have urged animal advocates to take a more species-inclusive perspective on animal welfare that includes the consideration of collateral animal suffering. Others have argued that culling cats may be a bad idea as they would be the only possibility to contain rats that also prey on small nesting seabirds, their chicks and eggs. For the Red-billed Tropicbird however, which are a fairly large and aggressive bird largely able to fend off rats, nest success only became a problem when cats started being abandoned. In the case of Saba, data has further shown that cats (which are terrestrial predators) are most abundant in the lower drier and more barren parts of Saba, while rats (which are

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mainly arboreal) prefer the lush vegetation higher up the slopes of the island (Debrot et al., 2014). This means that due to such “habitat partitioning” in the Saba situation, cats can never serve to control rats.

In addition, studies elsewhere have shown that even in areas where feral cats and rats co-exist, cats tend to be very inefficient predators of rats, preferring other species which are easier and less dangerous to catch, such as birds and lizards. The perception that rat populations decreased after cat introductions was due to rats’ avoidance behaviour towards cats also becoming apparent to human observers (Parsons et al., 2018).

Other recent work on the Dutch Caribbean island of Klein Curaçao, an island formerly populated with both cats and rats, shows the positive effect that cat removal can have even when rats are not removed. Within a decade (from 2009 to 2021), cat removal resulted in the number of seabirds breeding on the island increasing from a single breeding species with maximally 140 pairs to nine breeding species with upwards of 430 pairs annually (Debrot et al., 2023a). Removal or culling programs for mammals like cats (but also goats and donkeys) often evoke strong emotional sentiments with the public, whereby public opinion then may have major impacts on the continuity and effectiveness of such programs. Therefore, such programs require careful preparation to properly educate and inform the public on why it is so important to remove such invasive mammals. Work by P. Bertuol on Bonaire has further shown how a single stray cat can wipe out a colony of more than 30 breeding pairs of terns in a single night (video on file). So, while removing cats from seabird breeding areas and conservation areas on Saba and other islands is challenging, it is feasible and will give measurable positive results in terms of higher seabird nesting success quite directly (Terpstra et al., 2015; Debrot et al., 2022b). In this whole, rats should also not be forgotten as they can also greatly depress seabird breeding success (as on Klein Curaçao; Debrot et al., 2023a) but rats are a totally different challenge in terms of control or eradication due to the increased difficulty in locating them and their much higher reproductive potential.



**Figure 2.** A feral house cat just moments before killing and removing an almost-fledged Saba Red-billed Tropicbird chick from its nest.

**Lionfish:** *Pterois volitans/miles*, or Lionfish for short, have been present in the tropical Western Atlantic for more than 30 years and have widely spread throughout the region. While a massive amount of research has been devoted to the Lionfish question and major grassroots efforts have been made in terms of trying to control outbreaks locally, the ultimate conservation effectiveness of all this effort can now be highly questioned for two reasons: research has shown that the largest Lionfish populations are located at depths well below the maximum safe diving depth at which they can be

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removed by spearing, and studies from various areas such as the Gulf of Mexico, the Bahamas and the Saba Bank (e.g., Debrot et al., 2023b) have shown large population crashes. This suggests that the species likely has peaked and is now stabilizing in the region at lower and more sustainable densities due to emergent biological controls. So while research initially included some exploratory fishing using different trap designs to potentially develop Lionfish as an alternative for the Saba trap fisheries (de Graaf et al., 2017), after the population crash on the Saba Bank (Debrot et al., 2023b) and plummeting trap catches, these efforts were abandoned as being of unlikely practical conservation value.

**Halophila seagrass:** Another marine species that is similarly beyond “the point of no return” is the invasive seagrass *Halophila stipulacea*, well-established in the Caribbean region since around 2002. The species has widely spread, also invading original seagrass habitat massively throughout the Dutch Caribbean (Willette et al., 2014). Even though it greatly reduces the fish nursery habitat of seagrass beds (Becking et al., 2014) and is of lower nutritional value to sea turtles than the native Turtle Grass (*Thalassia testudinum*) which it is replacing (Christianen et al., 2018), there is likely little that can fruitfully be undertaken against this species at a scale at which it really makes a difference. Setting priorities in research and intervention efforts have never been more acute than now.

## B. “Newly arrived”

**Green Iguana:** The Green Iguana, *Iguana iguana*, is a species that has become popular as a pet and has been and is being traded worldwide (CITES, 2024). Therefore, feral populations have been establishing themselves in tropical regions around the world where they create serious conservation problems (van den Burg et al., 2020; Knapp et al., 2021). This is particularly the case in the Caribbean where they not only compete with but also interbreed with the native iguanas (e.g. Vuillaume et al., 2015). Interbreeding is particularly problematic as the resulting gene swamping means that the native population genome is gradually overtaken by the invading *Iguana iguana* genome. As a result, all iguana populations of the Lesser Antilles are under threat and *Iguana delicatissima* has lost more than 91% of its former range due to hybridization with invasive Green Iguanas (van den Burg et al., 2023). In response to the relatively recent discoveries of invasive iguanas on St. Eustatius and Saba, the Netherlands Ministry of LNV financed research on rapid response removal campaigns which remain ongoing on both islands. The results demonstrate that early removal of invasive iguanas is feasible (Debrot et al., 2022a) and further methods are being developed to also be able to swiftly field-identify hybrid and introgressed iguanas for culling (van den Burg et al., 2023, 2024b), so that iguana invasions can be halted while still possible at an early stage.

**Giant African Land Snail:** The Giant African Land Snail, *Lissachatina fulica*, has been introduced to the Dutch Caribbean islands in recent years. The most recent island on which its presence has been found is Bonaire (van Leeuwen et al., 2023, in prep.), while on St. Eustatius it was first detected in 2013 (Debrot et al., 2016). Its impact on native vegetation and agriculture can be serious, which makes it one of the most significant agricultural pest species in tropical areas (Rauth and Barker, 2002). The snails are also a potential risk to human health because they can be the host of the nematodes *Angiostrongylus cantonensis* and *A. costaricensis*, which can both cause serious diseases in humans (meningoencephalitis and/or eosinophilic meningitis respectively abdominal angiostrongylosis). And third, the snail can carry the bacterium *Aeromonas hydrophila* (Chester) Stanier, 1943, that has caused a variety of bacterial infections (bacterioses) in humans (Smith, 2005; CABI, 2018). Its initial introduction to the region was probably based on its potential value as a food or pet species but its further spread is likely largely due to it hitching rides in shipments of ornamental plants. The species is abundant on Sint Maarten, which is the main port for goods transported to Saba and Sint Eustatius. On Sint Eustatius, trials to contain and eradicate the species were conducted fairly early in the process when it was almost only found on a few streets in a single neighbourhood (Debrot et al., 2016). While the results of the trials were very promising, the local agricultural authorities have since found it impossible to sustain the eradication effort. Consequently, more than 10 years after its introduction, it has spread across the island and eradication may no longer be possible. On Bonaire in 2023, its distribution was still limited to 2-3 small areas (Van Leeuwen, 2024; Van Leeuwen et al., in prep), suggesting that eradication might still be possible before it spreads more widely. An

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assessment of the current situation on Bonaire, followed by a more thorough and systematic approach to control or eradicate the snail from Bonaire is highly recommended.

**New Guinean Flatworm:** The New Guinean Flatworm (*Platydemus manokwari*) was only discovered on Bonaire in 2023 (De Waart and Van Leeuwen, 2024; De Waart et al., in prep). The species is notorious as a predator of land snails and is responsible for wiping out whole endemic land snail communities on islands in the tropical Pacific and in Florida (Suguiura, 2010; Lopez et al., 2022). Its presence on Bonaire threatens the rich native land snail fauna of the island, which includes nine regional endemic species, of which eight are restricted to Bonaire. Thanks to emergency funding provided by the Netherlands Ministry of LNV, a rapid response assessment was conducted in 2024 to determine the current distribution and what if any measures can be taken to halt further spread or accomplish eradication. The species already appears to be present on Saba at moist higher elevations where its potential impact can even be expected to be worse than on Bonaire which is a much drier island. However, since the first record on Saba, no study has yet been performed to assess its status and distribution there. Equal to the Giant African Land Snail, the New Guinean Flatworm can be a host of *A. cantonensis*, which can cause diseases that can lead to blindness and death in rare cases (Smith, 2005; Thunnissen et al., 2020). Whilst the species is not known to occur on St. Eustatius, no land-flatworm study has been performed there.

### C. Exotic terrestrial plants

Exotic plants are entering and establishing themselves in nature at an ever increasing rate and amount to more than half of the 714 new island records for invasive species recorded since the 2011 and 2012 inventories. For centuries, many plant species have been cultivated on the Dutch Caribbean islands. Most of these do not survive outside the garden environment where competition from native plant and animal species is largely absent. Several however have spread into surrounding areas and once established managed to invade natural areas. Some have become a true pest, outcompeting native species by covering entire areas, smothering all other plants species present. The most illustrative example is Coralita or Mexican bellcreeper (*Antigonon leptopus*) that is currently covering some 15% of St. Eustatius' land surface. The list of exotic plant species that have been recorded (far) outside gardens is long (see Figure 2 for numbers) and can increase even further considering the even larger number of species that is currently cultivated in gardens. Additionally, the number of pantropical weeds is huge and globalisation facilitates transport of plant material on a massive scale. Import of plant propagules occurs via several pathways. Most important is the largely uncontrolled import of ornamental plants as seeds, cuttings, bare-rooted plants or in containers for horticultural purposes. In addition, via bulk import of fodder for cattle and soil for building activities pantropical weeds are imported. Finally, the unintended transport of seeds, spores and vegetative parts by humans, both residents and tourists enables exotic weeds to arrive on the islands. In appendix 3 a all non-native plant species are listed that have been documented to occur outside gardens. For Bonaire, the 2012 edition of the Flora (van Proosdij, 2012), as well as additional plant records present in the CACTUS database (Janssen et al., 2023) have been used. For Saba and St Eustatius, the recently published checklists (Axelrod 2017 & 2021), as well as additional plant records present in the CACTUS database (Janssen et al., 2023) have been used. In total, 234 exotic vascular plant species are recorded for the BES islands. Occurrence on Aruba, Curaçao and St Maarten is provided too for reasons of comparison, although data on St Maarten are particularly sparse. Often, a species is cultivated on one island but has become naturalized on another island. For several species listed in Axelrod (2017, 2021) as occurring outside gardens the actual distribution remains unclear as often the number of observations is very small. Viewing the long list of non-native species and the ongoing establishment of additional exotic species, strict phytosanitary regulations are urgently needed in addition to a much more in-depth inventory of the IAS currently present.

**Other species:** While an expansive review of all exotic species is beyond the scope of this report, on all three islands the number of potentially invasive species continues to grow. On Bonaire, feral cats continue to exact a high toll in the tern nesting colonies but remain unaddressed as does the continued spread of the invasive Neem Tree, *Azadirachta indica*. While the Neem Tree invasion is far advanced and likely little meaningfully can be done about its further spread, combatting cats at tern nesting colonies should yield large and easily measurable results in terms of enhanced nesting success

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for several tern and other shorebirds (see results of Terpstra et al., 2015 and Debrot et al., 2023a). Bonaire has long been of high international importance as a nesting island for several tern species and protection of this international importance deserves a high priority (Debrot et al., 2009). For St. Eustatius, two of the most ecologically impactful recent introductions are the Giant African Snail and continuous Green Iguana incursions (van den Burg et al., 2018; Debrot et al., 2022a). The most economically damaging recent introduction so far is the Lethal-yellowing virus that has killed a large fraction (maybe 30%) of the coconut trees. Especially troubling is the recent prediction of future coverage by Coralita across the island (Huisman et al., 2021) as well as the continued rapid spread of the invasive Neem Tree into the forested protected areas of the Northern Hills (A. Debrot, pers. Obs.). The recent discovery of the Agave Weevil (*Scyphophorus* spp.) adds additional pressure to the island's dry-adapted flora, already decimated by the Cactus Moth *Cactoblastis cactorum*. For Saba, the growing number of invasive reptiles is especially noticeable (van den Burg et al., 2021; van den Burg and Debrot, 2024). The most disturbing recent development is the establishment and spread of introduced Guinea pigs and rabbits at The Level, and Green Iguanas both at the harbour area and in Windward Side (van den Burg et al., 2023). These species can likely still be eradicated if rapid action programs are implemented. Feral cats also pose a serious threat to nesting seabirds, especially in the lower areas of the island. At higher elevations, rats are very abundant in the rainforest, where they presumably have a significant impact on the reptile and avifauna species, and likely on multiple plant species, several of which are already locally threatened. There is no recent report on the spread of Coralita on Saba, which is well established and likely continues to expand into gullies where disturbance by torrents during the rainy season is high. However, on Saba the spread of Coralita has been and remains much less than on St. Eustatius mainly due to the much lower extent of anthropogenic vegetation disturbance.

## Assessment of National Status

### Recent developments:

#### **Assessment of distribution:** Unfavourable-bad

Overall, distributions of establishing IAS continue to increase in the absence of structural financial aid for eradication/management programs. However, very little knowledge about the distribution of the identified exotic species is present. The distribution per IAS per island is often highly dependent on its establishment state, mode of introduction and time since first incursion. For example, some species appear initially only present around the port of entry, like *Hemidactylus frenatus* on Saba (van den Burg and Debrot, 2024), whilst non-native Green Iguanas on Saba have additionally been reported from Windward Side (van den Burg et al., 2023), and another non-native reptile for Saba, *Gymnophthalmus underwoodi*, was able to spread across the entire island in only 5 years' time (van den Burg et al., 2021). Whilst the Giant African Land Sail is limited to few locations on Bonaire, on St. Eustatius it has spread much wider from its initial limited range. IAS that have long been established generally occurs across the islands, such as cats and rats. The Caribbean Netherlands are surrounded by island nations that likewise have very poor to non-existent IAS intervention plans. Given the extent of inter-island travel and trade within the Caribbean Netherlands, between the Caribbean Netherlands and the rest of the Caribbean, which include the three other islands of the Dutch Caribbean, the risks of further introductions, be it intentional or unintentional, are very high.

#### **Assessment of population:** Unfavourable-inadequate (variable depending on the species)

Apart from some conducted inventories and surveys on the occurrence of feral cats on Saba (Debrot et al., 2014), the Lionfish on Bonaire (White, 2011; De Leon et al., 2013), and the African Giant Land Snail on St. Eustatius (Debrot et al., 2016), there is no data available on IAS densities from the BES islands.

#### **Assessment of impact** Unfavourable-bad

The magnitude of impact varies per IAS, with some species seemingly having no immediate and clearly observable effect; although adequate impact studies are rare. However, numerous IAS present on the BES islands have an immediate and sometimes disastrous impact on native species and ecosystems. These include feral cats, Coralita, and recently arrived non-native green iguanas and the New Guinea Flatworm.

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**Assessment of management intervention:** Unfavourable-bad

There is no structural management strategy and associated financial backing for addressing the IAS issue in the Caribbean Netherlands islands. Some temporary projects have seen reactive financial aid from the ministry, often when new problematic arrivals have recently appeared, but frequently these 'new arrivals' will have been present unnoticed for some time, making their control more difficult. Harmful species list of high-risk species to watch out for, similar as are known for the mainland EU, are urgently needed. Biosecurity intervention should be prioritised by all relevant ministries and local governments.

**Assessment of future prospects:** Unfavourable-bad

If no measures are implemented, the invasion process will continue to accelerate, with all its consequences. This is especially problematic given several planned major infrastructural projects that will require a large quantity of imported materials, e.g., the planned harbour on Saba at Black Rocks. If no rigorous measures are implemented, the many unique and endangered species of the islands will increasingly be at risk of extinction, ecological functioning will be profoundly compromised, and native flora and fauna will gradually be replaced by entirely artificial nature, "novel tropical forests" (sensu Lugo, 2009; Lugo et al., 2020).

**Table 2.** Summary overview of the threat status of invasive alien species to biodiversity of the Caribbean Netherlands in terms of different criteria.

Aspect invasive species	2024
Distribution	Unfavourable-bad
Population	Unfavourable-inadequate
Impacts	Unfavourable-bad
Future prospects	Unfavourable-bad
<b>Overall Assessment of Threat Status</b>	<b>Unfavourable-bad</b>

## Comparison to the 2018 State of Nature Report

Overall, the situation with respect to invasive species and the risks they present has significantly worsened since the 2018 State of Nature report. No less than 714 new island occurrences of non-native species can be reported since the 2011 and 2012 inventories (Debrot et al. 2011; van Buurt and Debrot 2011; 2012; van der Burg et al., 2012; Smith et al., 2014). This is an average of no less than 54 species per year. However, the current rate of increase is certainly higher because the process is exponential which means that the "average" always underestimates the present status.

## Recommendations for National Conservation Objectives

**National protection targets:**

Implementation of a proactive strategy towards IAS (Townsend, 2009) should be based on:

- a) Prevention – to limit the number of incursions and IAS that enter each island's borders: develop infrastructure and measures to minimize incursion risk of non-native species
- b) Early detection and eradication – to detect, track down and eliminate potential threats before their establishment and subsequent spread: develop monitoring programs and awareness with harbour personnel.
- c) Inventory of IAS present in cultivated areas and in natural areas. Particularly for plant species, the list of known IAS present on the BES islands is far from complete, hampering effective detection and eradication as well as raising public awareness.
- d) Control and management of species already established - to minimize impact: create structural financial program.

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- e) Rehabilitation - of areas rendered useless by invasive species: promote ecological restoration and reforestation.
  - f) Public awareness - proper public awareness towards travel with live biological materials, the risks with importation of materials from abroad and towards early detection and eradication are essential and have already proven of utmost value in St. Eustatius efforts for control (e.g., Debrot et al., 2016; 2022a).

**Protection-sub targets:**

- Prevent new introductions by
  - o Creating Alert and Watch lists for invasive species, as well as White lists
  - o Make IAS an integral part of infrastructural planning (especially for new harbours)
- Eradicate or manage the most damaging established species

**Most important threats and management implications:**

The introduction of new IAS that form a threat to nature, healthcare and the economy is proceeding at an accelerated pace.

- There are several urgent problem species (e.g., exotic predators and iguanas) for which pilot projects demonstrate that eradication or control are practical and financially feasible. In addition to prevention of new introductions, these species should be preferred for targeted intervention.
- The economic costs of IAS evidently become enormous but have not yet been made transparent. Making these costs visible will provide a significant argument for a more proactive stance by governments and nature managers and is therefore also recommended by us as a top priority.
- Because the IAS problem is so extensive and involves so many partners and stakeholders, the development of broader policy frameworks is necessary within which individual legislation needs to be elaborated for the different jurisdictions. This could involve the establishment of so-called Invasive Species Management Teams (ISMTs). A common vision, a so-called Invasive Species Strategy (and Action Plan) (ISSAP), has already been largely developed for the islands.
- From the meetings held on the Dutch islands the consensus is that the IAS problem should be addressed via a three-tiered approach (a) prevention, b) rapid response and c) control and mitigation). Parties agree that prevention of entry should be the focus with which to limit and contain the IAS problem.

The two biggest bottlenecks to implementation are the almost total lack of useful legislation, and lack of capacity. The exception is where it concerns a few species of public health concern, such as the yellow-fever mosquito and rats which do some capacity and some funding, often as part of regional WHO (World Health Organization) programs.

## Data Quality and Completeness

Apart from a few studies (see above), there is no data available on IAS densities from the Caribbean Netherlands. This is the same for many other aspects such as distribution, but often also the impact on native species. Monitoring is an expensive endeavour, and priorities must be sharply set. For many species that have already established themselves, and for which the meaningfulness of conducting action is questionable, monitoring is discouraged. Monitoring of IAS should certainly focus largely on the borders of the islands (importation harbours) to prevent introduction of new agents. As well as during the period of first discovery after any new introduction. However, for successful eradication of invasive plants or animals, monitoring may be necessary for several years during and after eradication efforts to be sure that no invasive individuals have been overlooked. For future major infrastructural projects (new Saba harbour), especially those that require large quantities of imported construction materials, we recommend the budgetary inclusion of strict biosecurity measures and species monitoring during the project.

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## Appendix 3. Update of exotic (and possibly) invasive species documented in the wild in the Dutch Caribbean islands, as recorded since last Wageningen UR inventory (2011) (the list of plants is most complete for Bonaire, Saba and St. Eustatius but outdated for Curaçao, Aruba and St. Maarten)

Definition: Invasive species are non-indigenous species (or exotic species) introduced by historic human actions, whose introduction causes, or is likely to cause, economic or environmental harm or harm to human health (US government definition)

Colour legend for the 'island' columns:

Pr	Present non-native population
Oc	Occasionally reported
Uc	Unclear
In	Indigenous
Po	Potential non-native species
Px	Previous non-native population present

Column: **habitat** has options: Marine, Land; Freshwater.

Column: **date** means date/year first recorded for a species (if known)

The following species groups are present in the table below (listed here in order of occurrence):

**Mammals; Fish; Birds; Amphibians; Reptilia; Mollusca; Flatworms; Earthworms (Annelida); Insects; Animal disease vectors parasites; Plant disease vectors parasites; Other mites and ticks; Fungi; MLO (Mycoplasma Like Organisms); Plants.**

Species/species group	common name	habitat	date	Aruba	Bonaire	Curacao	Saba	St Eustatius	St Maarten
<b>Mammals</b>									
<i>Rattus rattus</i>	black rat	Land		Pr	Pr	Pr	Pr	Pr	Pr
<i>Rattus norvegicus</i>	brown rat	Land		Pr	Pr	Pr			
<i>Canis familiaris</i>	dog	Land		Pr	Pr	Pr	Pr	Pr	Pr
<i>Mus musculus</i>	house mouse	Land		Pr	Pr	Pr	Pr	Pr	Pr
<i>Sus scrofa</i>	pig	Land			Pr	Pr	Pr	Pr	
<i>Ovis aries</i>	sheep	Land		Uc	Pr			Pr	
<i>Felix domesticus</i>	cat	Land		Pr	Pr	Pr	Pr	Pr	Pr
<i>Capra hircus</i>	goat	Land		Pr	Pr	Uc	Pr	Pr	Pr
<i>Herpestes auropunctatus</i>	mongoose	Land				Po		Po	Pr
<i>Equus assinus</i>	wild ass	Land		Pr	Pr	Pr	Pr	Pr	
<i>Chlorocebus pygerythrus</i>	vervet monkey	Land					Po	Po	Pr
<i>Procyon minor</i>	raccoon	Land					Po	Po	Pr
<i>Bos sp.</i>	cow	Land						Pr	
<i>Cavia porcellus</i>	guinea pig	Land					Pr		
<i>Oryctolagus cuniculus domesticus</i>	rabbit	Land					Pr		
<b>Fish</b>									
<i>Poecilia reticulata</i>	guppy	Freshwater		Pr	Pr	Pr	Po	Po	Po
<i>Oreochromis mossambica</i>	Mozambique tilapia	Freshwater		Pr	Pr	Pr			Pr
<i>Pterois volitans</i>	red lionfish	Marine		Pr	Pr	Pr	Pr	Pr	Pr
<i>Pterois miles</i>	common lionfish	Marine		Uc	Px	Uc		Pr	

Species/species group	common name	habitat	date	Aruba	Bonaire	Curacao	Saba	St Eustatius	St Maarten
<b>Birds</b>									
<i>Icterus icterus</i>	Venezuelan Troupial			In	Pr	In			
<i>Streptopelia decaocto</i>	Eurasian dove						Pr	Pr	Pr
<i>Passer domesticus</i>	house sparrow			Pr	Pr	Pr	Pr	Pr	Pr
<i>Gallus gallus</i>	Jungle fowl						Pr	Pr	Pr
<i>Sicalis flaveola</i>	saffron finch			Pr	Pr	Pr			
<i>Corvus splendens</i>	house crow					PX			
<i>Quiscalus lugubris</i>	Caribbean grackle			Pr	Pr	Pr			Pr
<i>Quiscalus mexicanus</i>	Boatbilled grackle			In		Uc		Oc	
<i>Bubulcus ibis</i>	cattle egret			Pr	Pr	Pr	Pr	Pr	Pr
<i>Molothrus bonariensis</i>	shiny cowbird			Pr		Pr		Pr	
<i>Ploceus cucullatus</i>	village weaver-bird					Pr			
<i>Eupsittula pertinax</i>	West-Indian parakeet			In	In	In	Pr		
<i>Columba livia</i>	rock dove			Pr	Pr	Pr	Pr	Pr	Pr
<i>Amazona ochrocephala</i>	Yellow-crowned amazon					Pr			
<i>Psittacula krameri</i>	rose-ringed parakeet					Pr			
<i>Estrilda troglodytes</i>	Black-rumped waxbill					PX			
<i>Patagioenas corensis</i>	Bare-eyed Pigeon			In	In	In			Pr
<b>Amphibians</b>									
<i>Eleutherodactylus johnstonei</i>	Johnstone's frog			Pr	Pr	Pr			

Species/species group	common name	habitat	date	Aruba	Bonaire	Curacao	Saba	St Eustatius	St Maarten
<i>Eleutherodactylus martinicensis</i>	Martinique Robber Frog								Pr
<i>Eleutherodactylus planirostris</i>	Greenhouse Frog								Pr
<i>Osteopilus septentrionalis</i>	Cuban tree frog				Pr	Pr	Po	Po	Pr
<i>Bufo marinus</i>	Cane Toad, Marine toad			Pr		Po			
<i>Pleurodema brachyops</i>	dori			In	Pr	Pr			Pr
<b>Reptilia</b>									
<i>Anolis carolinensis</i>	North American Green Anole	Land							Pr
<i>Anolis cristatellus</i>	Puerto Rican Crested Anole	Land		Pr					Pr
<i>Anolis gingivinus</i>	Anguilla Bank Anole	Land		Pr					In
<i>Anolis porcatius</i>	Cuban Green Anole	Land		Pr					
<i>Anolis sagrei</i>	Cuban brown anole	Land		Uc					Pr
<i>Boa constrictor constrictor</i>	Boa	Land		Pr		Po			Oc
<i>Boiga irregularis</i>	Brown tree snake	Land				Po			
<i>Cnemidophorus arenivagus</i>	Rainbow Whiptail	Land		Pr					
<i>Diadophis punctatus</i>	Ringneck Snake	Land				Uc			
<i>Elaphe guttata</i>	Corn snake	Land				Po			
<i>Epictia albifrons</i>	Wagler's Blind Snake	Land			Uc				
<i>Gekko gekko</i>	Tokay gecko	Land				Pr			
<i>Gonatodes albogularis</i>	White-throated Clawed Gecko	Land		Px		Oc			

Species/species group	common name	habitat	date	Aruba	Bonaire	Curacao	Saba	St Eustatius	St Maarten
<i>Gonatodes antillensis</i>	Venezuelan Coastal Clawed Gecko	Land		Px	In	In			
<i>Gonatodes vittatus</i>	Striped Clawed Gecko	Land		Pr		Oc			
<i>Gymnophthalmus underwoodi</i>	Underwood's Spectaded Tegu	Land					Pr	Pr	Pr
<i>Hemidactylus frenatus</i>	Common House Gecko	Land		Pr	Pr	Pr	Pr	Pr	Pr
<i>Hemidactylus mabouia</i>	African House Gecko	Land		Pr	Pr	Pr	Pr	Pr	Pr
<i>Iguana iguana</i>	Green Iguana	Land		In	In	In	Pr	Oc	Pr
<i>Iguana melanoderma</i>	Melanistic Lesser Antilles Iguana	Land					In		Pr
<i>Ramphotyphlops braminus</i>	Brahminy Blindsnake	Land		Pr		Pr	Pr	Pr	Pr
<i>Lepidodactylus lugubris</i>	Mourning Gecko	Land			Pr	Pr			Pr
<i>Liotyphlops albirostris</i>	Whitenose Blind Snake	Land		Uc		In			
<i>Micrurus fulvius</i>	Eastern Coral Snake	Land				Uc			
<i>Pantherophis guttatus</i>	Eastern Corn Snake	Land				Oc			Uc
<i>Pseudemys floridana</i>	Coastal plain scooter	Land		Uc					
<i>Storeria dekayi</i>	Florida Brown Snake	Land				Oc			
<i>Thamnophis cyrtopsis</i>		Land				Uc			
<i>Thamnophis cyrtopsis subsp. ocellatus</i>		Land				Uc			
<i>Trachemys scripta</i>	Common slider	Freshwater		Pr		Uc		Oc	Oc
<i>Anolis sabanus</i>	Saban Anole	Land					In	Oc	
<i>Epicrates cenchria</i>	Rainbow Boa	Land							Oc

Species/species group	common name	habitat	date	Aruba	Bonaire	Curacao	Saba	St Eustatius	St Maarten
<i>Python curtus</i> -group	Blood Python	Land							Oc
<i>Python regius</i>	Ball Python	Land							Oc
<b>Mollusca</b>									
<i>Allopeas gracile</i>	Graceful Awnsnail, Traveling Tramp	Land		Uc	Oc	Uc	Oc	Pr	Pr
<i>Archachatina marginata</i>	Giant West African Snail, Banana Rasp Snail	Land	Not yet	Po	Po	Po	Po	Po	Po
<i>Bulimulus guadalupensis</i>	West Indian Bulimulus	Land		Po	Po	Pr	Pr	Pr	Pr
<i>Cryptelasmus canteroiana cienfuegosensis</i>		Land				Oc	Oc		
<i>Gulella bicolor</i>	Two-tone Gulella, Toothed Gulella, Carrot snail	Land			Oc				Oc
<i>Hawaiiia minuscula</i>		Land			Oc				
<i>Leptinaria unilamellata</i>		Land				Oc			Oc
<i>Limicolaria aurora</i>	Nigerian land snail	Land	Not yet	Po	Po	Po	Po	Po	Po
<i>Lissachatina fulica</i>	Giant African snail, African Giant Snail	Land		Po	Pr	Pr	Po	Pr	Pr
<i>Melanoides tuberculata</i>	Red Rimmed Melania	Land		Po	Pr	Uc	Po	Po	Pr
<i>Naria turdus</i>		Marine		Pr	Pr	Pr	Po	Po	Pr
<i>Neosubulina gloynii</i>		Land				In			Oc
<i>Opeas hannense</i>	Dwarf Awnsnail	Land				Oc	Pr	Pr	Oc
<i>Pallifera sp.</i>	Mantleslugs	Land					Po	Po	Pr
<i>Paropeas achatinaceum</i>	Indonesian Awnsnail	Land		Po	Pr	Po			
<i>Physella acuta</i>	Acute Bladder Snail	Freshwater		Po	Pr	Po	Po	Po	Pr

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<i>Planorbella duryi</i>	Seminole Ram's-horn, American ram's horn snail, Florida's Ram's-horn, Miniature ramshorn snail	Freshwater		Po	Pr	Pr		Oc	
<i>Polygyra cereolus</i>	Southern Flatcoil	Land		Po	Pr	Pr			Pr
<i>Praticolella griseola</i>	Vagrant Scrubsnail, Central American Scrubsnail	Land			Oc				Oc
<i>Sagdidae</i>		Land							Oc
<i>Streptartemon glaber</i>		Land			Oc		In		In
<i>Subulina octona</i>	Miniature Awlsnail, Glossy Subulina, Wandering Awlsnail, Subulina Snail	Land		Po	Oc	Pr	Pr	Pr	Pr
<i>Succinea concordialis</i>	Spotted Ambersnail	Land			Oc				
<i>Tomostele musaecola</i>		Land		Uc			Pr	Po	Pr
<i>Veronicellidae</i>	Leatherleaf Slugs	Land		Po	Oc	Po	Oc	Po	Pr
<i>Zachrysia provisoria</i>	Cuban Brown Snail, Cuban garden snail	Land	2000 <	Po	Oc	Pr	Pr	Po	Pr
<b>Flatworms</b>									
<i>Bipalium vagum</i>		Land	2014				Oc	Oc	Oc
<i>Geoplanidae indet</i>		Land	2023	Po	Oc	Oc	Oc	Po	Po
<i>Platydemus manokwari</i>	New Guinean flatworm	Land	2020	Po	Oc	Oc	Oc	Po	Oc
<b>Earthworms (Annelida)</b>									
<i>Pontoscolex corethrurus</i>						Px			Px

Species/species group	common name	habitat	date	Aruba	Bonaire	Curacao	Saba	St Eustatius	St Maarten
<i>Dichogaster affinis</i>				Px		Px			
<i>Dichogaster bolau</i>				Px	Px	Px			
<i>Dichogaster modighlianii</i>						Px	Px		
<i>Dichogaster saliens</i>								Px	
<i>Polypheretima elongata</i>					Px				
<i>Pontodrilus litoralis</i>				Px	Px	Px	Px		
<i>Eudrilus eugeniae</i>							Px		Px
<i>Ficopomatus miamensis</i>						Pr			
<b>Insects</b>									
<i>Aedes aegyptii</i>	yellow fever mosquito			Pr	Pr	Pr	Pr	Pr	Pr
<i>Aedes albopictus</i>	Asian Tiger mosquito			Po	Po	Po	Po	Po	Po
<i>Aeneolamia reducta</i>			1986			Pr			
<i>Anoplolepis gracilipes</i>	Crazy ant			Po	Po	Po			
<i>Apis mellifera</i>	European Honey Bee			Pr	Pr	Pr	Pr	Pr	Pr
<i>Apis mellifera scutellata</i>	Africanized honey bee			Po	Po	Po	Po	Po	Po
<i>Bactrocera invadens</i>	African fruit fly								
<i>Blatella germanica</i>	german cockroach								
<i>Cardiocondyla emeryi</i>	Emery's Sneaking Ant			Pr	Uc	Pr			Uc
<i>Cardiocondyla mauritanica</i>	Moorish Sneaking Ant				Pr	Pr	Uc		
<i>Carpophilus sp.</i>						Uc			
<i>Caryedon gonagra</i>				Pr		Oc			
<i>Cercyon nigriceps</i>							Pr		

Species/species group	common name	habitat	date	Aruba	Bonaire	Curacao	Saba	St Eustatius	St Maarten
<i>Chalepides barbatus</i>									Pr
<i>Coelophora inaequalis</i>							Uc	Uc	
<i>Coptotermes formosanus</i>	Formosan subterranean termite			Po	Po	Po			
<i>Crocothemis servilia</i>	Crimson darter dragonfly	E/SE Asia							
<i>Cryptolaemus montrouzieri</i>									Uc
<i>Cryptotermes brevis</i>						Pr			
<i>Curelius japonicus</i>							Uc	Uc	
<i>Digitonthophagus gazella</i>	Gazelle Scarab			Uc				Oc	Oc
<i>Hemianax ephippiger</i>	Vagrant Emperor Dragonfly			Uc		PX			
<i>Hybosorus illigeri</i>								Uc	
<i>Hypothenemus hampei</i>				Oc		Uc			
<i>Hypothenemus obscurus</i>						Uc	Pr		
<i>Kallima paralekta</i>	Indian Leafwing								Oc
<i>Labarrus lividus</i>							Uc	Uc	
<i>Leptostylopsis argentatus</i>						Oc			Uc
<i>Monoanus concinnulus</i>							Uc	Oc	
<i>Monomorium floricola</i>	Flower ant	Trop. Asia	<1937	Pr	Uc	Pr	Pr		Pr
<i>Necrobia rufipes</i>	Red-legged Ham Beetle					Uc		Pr	Uc
<i>Nialaphodius nigrita</i>							Uc	Oc	
<i>Palorus cerylonoides</i>								Uc	
<i>Papilio demoleus</i>	Lime Swallowtail						Pr	Pr	Pr
<i>Paratrechina longicornis</i>	Longhorn crazy ant			Pr	Pr	Pr	Pr		Pr

Species/species group	common name	habitat	date	Aruba	Bonaire	Curacao	Saba	St Eustatius	St Maarten
<i>Paratrechina pubens</i>	Hairy crazy ant			Po	Po	Po	Po	Po	Po
<i>Pectinophora gossypiella</i>	Pink Bollworm								Uc
<i>Periplaneta americana</i>	American Cockroach			Pr	Pr	Pr	Pr	Pr	Pr
<i>Periplaneta australasiae</i>	Australian Cockroach								Uc
<i>Pheidole megacephala</i>	African-Big headed Ant			Pr		Pr	Pr		
<i>Plagiolepis alluaudi</i>	Alluaud's Little Yellow Ant								Oc
<i>Planuncus tingitanus</i>						Uc			
<i>Pseudoazya trinitatis</i>								Uc	Uc
<i>Rhynchophorus ferrugineus</i>				Uc		Oc	Uc		
<i>Rhyparobia maderae</i>					Uc				
<i>Scymnus coccivora</i>								Oc	
<i>Scyphophorus cf. acupunctatus</i>						Uc			
<i>Solenopsis geminata</i>	Tropical fire ant	Trop. S. America, West Indies	<1936	In	In	In	Pr	Pr	Pr
<i>Solenopsis invicta</i>	South American Fire ant			Pr					Uc
<i>Strumigenys emmae</i>	Emma's Dacetine Ant			Pr	Uc	Pr			
<i>Strumigenys membranifera</i>	Membraniferous Dacetine Ant				Uc				Uc
<i>Supella longipalpa</i>					Uc				
<i>Tapajosa spinata</i>	Sharpshooter leafhopper					Pr			
<i>Tapinoma melanocephalum</i>	ghost ant	old world tropics	<1994	Pr	Pr	Pr	Pr		Pr
<i>Technomyrmex difficilis</i>									

Species/species group	common name	habitat	date	Aruba	Bonaire	Curacao	Saba	St Eustatius	St Maarten
<i>Tetramorium bicarinatum</i>	penny ant,	SE Asia	<2007	Pr					
<i>Tetramorium caldarium</i>						Pr			
<i>Tetramorium lanuginosum</i>	wooly ant	Trop. Asia	<2004	Pr		Pr			
<i>Tetramorium simillimum</i>				Pr		Pr			
<i>Trachyscelis aphodioides</i>								Oc	Uc
<i>Trichobaris bridwelli</i>								Oc	
<i>Trichomyrmex destructor</i>	destroyer ant	old world	<1999	Pr	Pr	Pr			Pr
<i>Typhaea stercorea</i>	Hairy fungus beetle							Pr	
<i>Ulomoides ocularis</i>									Uc
<i>Vespula squamosa</i>	yellow jacket wasp	N America		Po	Po	Po			
<i>Wasmannia auropunctata</i>	Little fire ant	Neotropics	<1972			Pr	Pr		Pr
<b>Animal disease vectors parasites</b>									
<i>Amblyomma variegatum</i>							Po	Po	Po
<i>Cochliomyia hominivorax</i>	New World screw-worm fly			Po	Po	Po			
<i>Ixodes</i>	Lyme disease tiks								
<i>Ornithodoros puertoricensis</i>							Pr	Pr	Pr
<i>Varroa destructor</i>	varroa mite		1996	Pr	Pr	Pr	Pr	Pr	Pr
<i>Geckobiella stamii</i>							Pr	Pr	Pr
<b>Plant disease vectors parasites</b>									

Species/species group	common name	habitat	date	Aruba	Bonaire	Curacao	Saba	St Eustatius	St Maarten
<i>Scyphophorus acupunctatus</i>	Agave weevil			Po	Po	Po		Pr	
<i>Cactoblastis cactorum</i>	Opuntia cactus moth			Po	Po	Po	Uc	Pr	Po
<i>Bemisia tabaci</i>	white fly		1989	Po	Po	Pr			
<i>Toxoptera citricida</i>	Black Citrus aphid, Brown Citrus aphid		1989	Po	Po	Uc		Pr	
<i>Cylas formicarius</i>	sweet potato weevil		1990	Po	Po	Pr		Pr	Pr
<i>Thrips palmi</i>	palm thrips		1994	Po	Po	Pr			
<i>Gynaikothrips ficorum</i>	Cuban Laurel Thrips		1996	Po	Po	Pr			
<i>Phyllocnistis citrella</i>	Citrus miner		1996	Pr	Pr	Pr			
<i>Macconellicoccus hirsutus</i>	Pink/Hibiscus Mealy bug		1997	Pr	Po	Pr			
<i>Paracoccus marginatus</i>	Papaya Mealy bug		2002			Pr			
<i>Rhynchophorus ferrogineus</i>	Red palm weevil		2008	Pr		Pr			
<i>Crypticerya genistae</i>	White partridge pea bug		2009			Pr			
<i>Aenolamia varia</i>	spittle bug		1986			Pr			
<i>Aspidiotus destructor</i>	Coconut scale			Pr	Pr	Pr			Pr
<i>Mionochroma vittatum</i>	longhorn beetle					Pr			
<i>Thrips sp.</i>	Tabebuia plague						Uc	Uc	
<b>Other mites and ticks</b>									
<i>Raoiella indica</i>	red palm mite			Po	Po	Po			
<i>Schizotetranychus hindustanicus</i>	Citrus hindu mite		2000	Pr	Pr	Pr			

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<b>Fungi</b>									
<i>Claviceps africana</i>	sorghum erot		2003			Pr			
<i>Fusarium of Palms</i>			2005-2010						
<i>Ganoderma zonatum</i>	Ganoderma butt rot of palms					Oc			
<i>Gliocladium of palms</i>			2005-2010			Pr			
<b>MLO's (Mycoplasma Like Organisms)</b>									
<i>Lethal Yellowing of Palms (LYdisease)</i>				Po	Po	Po			
<i>Papaya Bunchy Top (MLO)</i>			early 1960	Po	Po	Pr			
<i>Papaya Ringspot Virus (PRSV-P)</i>			2002	Po	Po	Pr			
<b>Plants</b>									
<i>Abelmoschus moschatus</i>		Land					Pr		
<i>Abrus precatorius</i>		Land			Uc	Pr	Pr	Pr	Pr
<i>Abutilon hirtum</i>		Land		Pr	Pr	Pr	Uc		
<i>Abutilon indicum</i>		Land					Uc	Pr	Uc
<i>Acalypha indica</i>		Land					Pr		Uc

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<i>Acalypha wilkesiana</i>		Land					Pr		
<i>Adonidia merrillii</i>		Land					Uc		
<i>Agave karatto</i>		Land		Pr	Pr	Pr	In	In	
<i>Agave sisalana</i>		Land			Uc	Pr	Uc	Pr	Uc
<i>Ageratina adenophora</i>		Land						Pr	
<i>Albizia lebbbeck</i>		Land		Pr	Pr	Pr	Uc	Uc	Uc
<i>Allamanda carthartica</i>		Land					Pr		
<i>Aloe vera</i>		Land		Pr	Pr	Pr	Pr	Pr	
<i>Alpinia purpurata</i>		Land					Uc		
<i>Alysicarpus vaginalis</i>		Land				Pr	Pr	Pr	Pr
<i>Amblovenatum opulentum</i>		Land					Pr	Pr	
<i>Anacardium occidentale</i>		Land					Pr	Pr	Uc
<i>Antigonon leptopus</i>		Land		Pr	Pr	Pr	Pr	Pr	Pr
<i>Aristolochia elegans</i>		Land					Pr		Uc
<i>Artocarpus altilis</i>		Land					Pr	Uc	
<i>Asparagus aethiopicus</i>		Land					Pr		
<i>Asparagus setaceus</i>		Land					Pr	Pr	
<i>Asystatia gangetica</i>		Land					Pr	Pr	Pr
<i>Azadirachta indica</i>		Land		Pr	Pr	Pr	Pr	Pr	Pr
<i>Balanites aegyptica</i>		Land				Pr			
<i>Bambusa multiplex</i>		Land					Uc		
<i>Bambusa vulgaris</i>		Land					Uc	Uc	

Species/species group	common name	habitat	date	Aruba	Bonaire	Curacao	Saba	St Eustatius	St Maarten
<i>Barleria cristata</i>		Land					Pr		
<i>Bauhinia monandra</i>		Land					Uc	Uc	
<i>Bergia capensis</i>		Land		Pr	Pr				
<i>Bixa orellana</i>		Land					Pr		
<i>Boerhavia diffusa</i>		Land		Pr	Pr	Pr	Pr	Pr	
<i>Bothriochloa ischaemum</i>		Land		Uc	Pr	Pr			
<i>Bothriochloa pertusa</i>		Land		Pr	Pr	Pr	Pr	Pr	Pr
<i>Brassica juncea</i>		Land					Pr	Pr	
<i>Breynia disticha</i>		Land					Uc		
<i>Brugmansia x candida</i>		Land					Uc		
<i>Caesalpinia pulcherrima</i>		Land					Uc	Uc	
<i>Cajanus cajan</i>		Land					Pr	Uc	
<i>Callisia fragrans</i>		Land					Uc		
<i>Calotropis procera</i>		Land		Pr	Pr	Pr	Pr	Pr	Pr
<i>Canna indica</i>		Land					Uc	Uc	
<i>Capsicum frutescens</i>		Land					Uc	Uc	
<i>Cardamine flexuosa</i>		Land					Pr		
<i>Casuarina equisetifolia</i>		Land					Uc	Uc	
<i>Catharanthus roseus</i>		Land		Pr	Pr	Pr	Pr	Pr	Pr
<i>Cenchrus ciliaris</i>		Land		Pr	Pr	Pr			
<i>Cenchrus purpureus</i>		Land					Pr		Uc
<i>Cenchrus setaceus</i>		Land					Pr		

Species/species group	common name	habitat	date	Aruba	Bonaire	Curacao	Saba	St Eustatius	St Maarten
<i>Centratherum punctatum</i>		Land					Pr	Pr	
<i>Chamaecrista absus</i>		Land		Pr	Pr	Pr			
<i>Christella dentata</i>		Land			Pr		Pr	Uc	
<i>Citrus x aurantiifolia</i>		Land					Uc		
<i>Citrus x aurantium</i>		Land					Uc	Uc	
<i>Citrus x jambhiri</i>		Land					Uc		
<i>Cleome rutidosperma</i>		Land					Pr		
<i>Clitoria ternatea</i>		Land		Pr	Pr	Pr	Pr	Pr	
<i>Cnidoscolus aconitifolius</i>		Land					Pr		
<i>Codiaeum variegatum</i>		Land					Pr	Uc	
<i>Coffea arabica</i>		Land					Uc	Uc	
<i>Combretum indicum</i>		Land					Uc		
<i>Commelina benghalensis</i>		Land		Pr	Pr	Pr	Pr	Pr	
<i>Conyza canadensis</i>		Land					Pr	Pr	
<i>Cordia obliqua</i>		Land					Uc		Uc
<i>Cordia sebestena</i>		Land		Pr	Pr			Uc	Uc
<i>Coriandrum sativum</i>		Land					Uc		
<i>Corynandra viscosa</i>		Land		Pr	Pr	Pr	Pr	Pr	Pr
<i>Cosmos sulphureus</i>		Land					Uc	Uc	
<i>Crinum bulbispermum</i>		Land						Uc	
<i>Crotalaria pallida</i>		Land						Pr	
<i>Crotalaria retusa</i>		Land		Pr	Pr	Pr	Pr	Pr	

Species/species group	common name	habitat	date	Aruba	Bonaire	Curacao	Saba	St Eustatius	St Maarten
<i>Crotalaria spectabilis</i>		Land					Pr		
<i>Crotalaria verrucosa</i>		Land					Pr	Pr	Uc
<i>Cryptostegia grandiflora</i>		Land		Pr	Pr	Pr			
<i>Cryptostegia madagascariensis</i>		Land					Pr	Pr	
<i>Cucumis anguria</i>		Land		Pr	Pr	Pr	Uc	Pr	
<i>Cucumis dipsaceus</i>		Land		Pr	Pr	Pr	Pr	Pr	
<i>Cucumis melo var dudaim</i>		Land			Pr	Pr			
<i>Cucurbita pepo</i>		Land					Uc		
<i>Cyanthillium cinereum</i>		Land		Pr	Pr	Pr	Pr	Pr	
<i>Cynodon dactylon</i>		Land		Pr	Pr	Pr	Pr	Pr	Pr
<i>Cyperus croceus</i>		Land						Pr	
<i>Cyperus involucratus</i>		Land					Pr		
<i>Cyperus pelophilus</i>		Land		Pr	Pr	Pr			
<i>Cyperus rotundus</i>		Land		Pr	Pr	Pr	Pr	Pr	Pr
<i>Dactyloctenium aegyptium</i>		Land		Pr	Pr	Pr	Pr	Pr	Pr
<i>Delonix regia</i>		Land					Uc	Uc	Uc
<i>Digitaria bicornis</i>		Land		Pr	Pr	Pr	Pr	Pr	
<i>Digitaria longiflora</i>		Land						Pr	
<i>Digitaria setigera</i>		Land					Pr	Pr	
<i>Echinochloa colona</i>		Land		Pr	Pr	Pr	Uc		
<i>Eleusine indica</i>		Land		Pr	Pr	Pr	Pr	Pr	Pr
<i>Eleutherine bulbosa</i>		Land					Pr	Uc	

Species/species group	common name	habitat	date	Aruba	Bonaire	Curacao	Saba	St Eustatius	St Maarten
<i>Emilia sonchifolia</i>		Land					Pr	Pr	Pr
<i>Epipremnum aureum</i>		Land					Pr		
<i>Eragrostis ciliaris</i>		Land		Pr	Pr	Pr	Pr	Pr	Pr
<i>Eragrostis pilosa</i>		Land		Pr	Pr	Pr			
<i>Eragrostis tenella</i>		Land		Pr	Pr	Pr	Pr	Pr	
<i>Erigeron karvinskianus</i>		Land					Pr		
<i>Erythrina variegata</i>		Land					Uc		
<i>Eucharis amazonica</i>		Land						Pr	
<i>Eugenia uniflora</i>		Land					Pr	Pr	
<i>Euphorbia lactea</i>		Land			Pr	Pr		Pr	
<i>Euphorbia tirucalli</i>		Land			Pr	Uc		Pr	Uc
<i>Ficus benjamina</i>		Land					Uc		
<i>Foeniculum vulgare</i>		Land					Uc		
<i>Gliricidia sepium</i>		Land					Pr	Pr	
<i>Grona triflora</i>		Land			Pr	Pr	Pr	Pr	
<i>Gynandropsis gynandra</i>		Land		Pr	Pr	Pr	Pr	Pr	
<i>Haematoxylum campechianum</i>		Land					Uc	Pr	
<i>Halophila stipulacea</i>		Sea		Pr	Pr	Pr	Uc	Pr	Pr
<i>Heliconia latispatha</i>		Land					Uc		
<i>Heliconia psittacorum</i>		Land					Uc		
<i>Hibiscus rosa-sinensis</i>		Land					Uc		
<i>Hibiscus schizopetalus</i>		Land					Uc		Uc

Species/species group	common name	habitat	date	Aruba	Bonaire	Curacao	Saba	St Eustatius	St Maarten
<i>Hippeastrum puniceum</i>		Land						Pr	Uc
<i>Hymenocallis caribaea</i>		Land						Pr	Uc
<i>Impatiens balsamina</i>		Land					Uc	Uc	
<i>Impatiens walleriana</i>		Land					Uc		
<i>Indigofera tinctoria</i>		Land			Pr	Pr		Pr	Pr
<i>Jasminum fluminense</i>		Land			Pr	Pr	Pr	Pr	Pr
<i>Jatropha curcas</i>		Land					Pr	Uc	Uc
<i>Justicia betonica</i>		Land					Pr		
<i>Kalanchoe laxiflora</i>		Land					Uc		
<i>Kalanchoe pinnata</i>		Land		Pr			Pr		
<i>Kalanchoe x houghtonii</i>		Land		Pr	Pr	Pr	Pr	Pr	
<i>Lablab purpureus</i>		Land					Pr	Uc	
<i>Lantana x strigocamara</i>		Land		Pr	Pr	Pr	Pr	Pr	
<i>Launaea intybacea</i>		Land		Pr	Pr	Pr	Pr	Pr	Pr
<i>Lawsonia inermis</i>		Land		Pr		Pr	Uc		
<i>Leonotis nepetifolia</i>		Land			Pr	Pr	Pr	Pr	
<i>Leonurus japonicus</i>		Land					Pr	Uc	
<i>Lepidium virginicum</i>		Land					Pr	Pr	Pr
<i>Leucaena leucocephala</i>		Land		Pr	Pr	Pr	Pr	Pr	Pr
<i>Livistona chinensis</i>		Land					Uc		
<i>Lonicera japonica</i>		Land					Uc		
<i>Mangifera indica</i>		Land					Uc	Uc	Uc

Species/species group	common name	habitat	date	Aruba	Bonaire	Curacao	Saba	St Eustatius	St Maarten
<i>Manihot carthagenensis</i>		Land		In	In	In		Pr	
<i>Manihot esculenta</i>		Land					Pr		
<i>Maurandya scandens</i>		Land					Uc		
<i>Megathyrsus maximus</i>		Land		Pr	Pr	Pr	Pr	Pr	Pr
<i>Melia azedarach</i>		Land					Uc	Pr	Uc
<i>Melinis repens</i>		Land		Pr	Pr	Pr	Pr	Pr	
<i>Microsorium grossum</i>		Land					Pr		
<i>Mimosa pigra</i>		Land					Pr		
<i>Mirabilis jalapa</i>		Land					Pr	Uc	
<i>Momordica charantia</i>		Land		Pr		Pr	Pr	Pr	Pr
<i>Morinda citrifolia</i>		Land			Pr	Pr	Uc	Pr	Uc
<i>Moringa oleifera</i>		Land			Pr	Pr	Pr	Uc	
<i>Muntinga calabura</i>		Land				Pr			
<i>Murraya paniculata</i>		Land					Uc	Uc	
<i>Neonotonia wightii</i>		Land						Pr	
<i>Nephrolepis brownii</i>		Land		Pr	Pr		Pr	Pr	
<i>Nerium oleander</i>		Land					Pr	Pr	
<i>Nicotiana tabacum</i>		Land		Pr	Pr	Pr	Pr	Pr	
<i>Ocimum africanum</i>		Land			Pr	Pr			
<i>Ocimum gratissimum</i>		Land		Pr	Pr	Pr			
<i>Oeceoclades maculata</i>		Land				Pr	Pr	Pr	
<i>Oldenlandia corymbosa</i>		Land		Pr	Pr	Pr	Pr	Pr	Pr

Species/species group	common name	habitat	date	Aruba	Bonaire	Curacao	Saba	St Eustatius	St Maarten
<i>Opuntia ficus-indica</i>		Land				Uc	Uc	Uc	
<i>Parkinsonia aculeata</i>		Land		Pr	Pr	Pr		Uc	
<i>Passiflora edulis</i>		Land					Uc	Uc	
<i>Pentas lanceolata</i>		Land					Uc		
<i>Pereskia grandifolia</i>		Land					Uc		
<i>Persea americana</i>		Land					Pr	Pr	
<i>Phyllanthus acidus</i>		Land					Uc	Uc	
<i>Phyllanthus urinaria</i>		Land					Pr		
<i>Plantago major</i>		Land					Pr		
<i>Plectranthus amboinicus</i>		Land					Pr	Pr	
<i>Plumbago auriculata</i>		Land					Uc		Uc
<i>Plumbago zeylanica</i>		Land		Pr	Pr	Pr	Pr	Pr	
<i>Pontederia crassipes</i>		Freshwater		Pr	Pr	Pr			Uc
<i>Pseudogynoxys chenopodioides</i>		Land					Pr		
<i>Pteris vittata</i>		Land			Pr	Pr	Pr	Pr	
<i>Rhipidocladum racemiflorum</i>		Land					Uc		
<i>Rhynchosia minima</i>		Land		Pr	Pr	Pr	Pr	Uc	Pr
<i>Ricinus communis</i>		Land		Pr	Pr	Pr	Pr	Pr	Pr
<i>Rubus rosifolius</i>		Land					Pr		
<i>Saccharum spontaneum</i>		Land					Uc		
<i>Salvinia molesta</i>		Freshwater		Pr	Pr				
<i>Samanea saman</i>		Land					Uc	Uc	

Species/species group	common name	habitat	date	Aruba	Bonaire	Curacao	Saba	St Eustatius	St Maarten
<i>Sansevieria hyacinthoides</i>		Land			Pr		Pr	Pr	
<i>Sansevieria trifasciata</i>		Land					Uc		
<i>Scaevola taccada</i>		Land		Pr	Pr	Pr		Pr	Pr
<i>Schefflera actinophylla</i>		Land					Uc	Uc	Uc
<i>Schinus terebinthifolia</i>		Land				Pr	Pr	Pr	
<i>Sechium edule</i>		Land					Pr		
<i>Selenicereus grandiflorus</i>		Land					Uc	Uc	
<i>Selenicereus undatus</i>		Land					Uc		
<i>Senna alata</i>		Land					Uc	Uc	Uc
<i>Senna italica</i>		Land		Pr	Pr	Pr			
<i>Sesbania bispinosa</i>		Land		Pr	Pr	Pr			Uc
<i>Sonchus oleraceus</i>		Land					Pr	Pr	
<i>Sorghum bicolor</i>		Land					Uc	Uc	
<i>Sorghum halepense</i>		Land					Uc		
<i>Spathiphyllum wallisii</i>		Land						Pr	
<i>Spathodea campanulata</i>		Land					Uc	Uc	Uc
<i>Spathoglottis plicata</i>		Land					Pr		
<i>Swietenia mahagoni</i>		Land					Pr	Uc	
<i>Syngonium podophyllum</i>		Land					Pr		Uc
<i>Syzygium jambos</i>		Land					Pr		
<i>Tabebuia caraiba</i>		Land				Pr			
<i>Tabebuia heterophylla</i>		Land			Pr	Pr	In	In	In

Species/species group	common name	habitat	date	Aruba	Bonaire	Curacao	Saba	St Eustatius	St Maarten
<i>Tamarindus indica</i>		Land		Pr	Pr	Pr	Pr	Pr	Pr
<i>Tarenaya hassleriana</i>		Land					Pr		
<i>Tecoma stans</i>		Land		Pr	Pr	Pr	Pr	Pr	Pr
<i>Tecomaria capensis</i>		Land					Pr		
<i>Terminalia catappa</i>		Land			Pr	Pr	Uc	Uc	Uc
<i>Theobroma cacao</i>		Land					Uc	Uc	
<i>Thespesia populnea</i>		Land		Pr	Pr	Pr	Pr	Pr	Pr
<i>Thevetia peruviana</i>		Land					Uc		
<i>Thunbergia alata</i>		Land					Pr		
<i>Thunbergia fragrans</i>		Land					Pr	Pr	
<i>Thunbergia grandiflora</i>		Land					Pr		
<i>Thymophylla tenuiloba</i>		Land		Pr		Pr	Pr		
<i>Tithonia diversifolia</i>		Land					Pr		
<i>Tradescantia zebrina</i>		Land					Pr		
<i>Tragus berteronianus</i>		Land		Pr	Pr	Pr	Pr	Pr	Pr
<i>Tridax procumbens</i>		Land		In	In	In	Pr	Pr	Pr
<i>Triphasia trifolia</i>		Land				Pr	Pr	Pr	Pr
<i>Triumfetta rhomboidea</i>		Land					Pr	Pr	
<i>Turnera subulata</i>		Land				Pr	Pr		
<i>Urena lobata</i>		Land					Pr		
<i>Urochloa distachya</i>		Land					Pr	Pr	
<i>Urochloa mutica</i>		Land		Pr	Pr	Pr	Uc	Pr	

Species/species group	common name	habitat	date	Aruba	Bonaire	Curacao	Saba	St Eustatius	St Maarten
<i>Urochloa reptans</i>		Land		Pr	Pr	Pr			
<i>Vigna luteola</i>		Land					Pr		
<i>Washingtonia robusta</i>		Land		Pr	Pr	Pr			Uc
<i>Xanthosoma sagittifolium</i>		Land					Pr	Uc	
<i>Xanthosoma violaceum</i>		Land					Pr		
<i>Youngia japonica</i>		Land					Pr		
<i>Yucca guatemalensis</i>		Land					Uc		
<i>Zingiber officinale</i>		Land					Uc		
<i>Zinnia elegans</i>		Land					Uc		
<i>Ziziphus mauritiana</i>		Land					Pr	Pr	Uc
<i>Ziziphus spina-christi</i>		Land		Pr	Pr	Pr			
<i>Zoysia matrella</i>		Land					Pr	Pr	Pr

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*State of Nature Report for the Caribbean Netherlands, 2024: a second 6-year assessment of the Conservation State, threats and management implications for habitats and species in the Caribbean Netherlands.* Wageningen Marine Research Wageningen UR (University & Research centre), Wageningen Marine Research report C001/25. 399 pp.

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Photo cover: An extreme example from St. Eustatius of how uncontrolled livestock husbandry can overgraze vulnerable slopes to the point at which even infrastructure at the top of the cliff comes in danger from erosion.

Photo: J. Hazenbosch

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