Key Elements Towards a Joint Invasive Alien Species Strategy for the Dutch Caribbean

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Photo description cover page:
Left image: Lionfish, *Pterois miles/volitans*, a top invasive predator in many coral reef environments. *Courtesy of M.J.A Vemeij*.
Center image: Giant African landsnail*, Achatina fulica*, a recent (2013) accidental introduction to St. Eustatius. *Courtesy of R. Hensen*.
Right image: *Pedilanthus tithymaloides*, a recent invader of Boven area on St Eustatius *W. Joost van der Burg*.

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Summary

Recent inventories have documented no less than 211 exotic alien species in the wild for the Dutch Caribbean. These amount to no less than 27 introduced marine species, 65 introduced terrestrial plants, 72 introduced terrestrial and freshwater animals and 47 introduced agricultural pests and diseases. A list of these species, pests and diseases are found in resp. Debrot *et al*. (2011), Van der Burg *et al*. 2012, and Van Buurt and Debrot (2012, 2011). The rate of introductions and establishment of invasive alien species (IAS) worldwide has grown rapidly as a result of increasing globalisation. Invasive species cause major ecological effects (decimating native flora or fauna populations) as well as economic losses to these islands, across sectors such as agriculture (diseases, weeds and vectors), fisheries (fish diseases and the lionfish), industry (rodents and termites), tourism (roadside weedy species) and public health (mosquitos). Recently in Curaçao the kissing bug *Triatoma infestans* was found; this is a vector for Chagas disease. It almost certainly came in with palm leaves imported from South America to be used as roof covering for recreational beach "palapa's".

Several countries in the Caribbean have developed a strategy to address the invasive species problem already, such as Jamaica (Townsend 2009), the Bahamas (BEST Commission 2003) and St. Lucia (Andrew and John 2010, Chase 2011). Islands are particularly at risk because of a number of factors: their small size, resulting in small vulnerable plant and animal populations, a relatively large border which is difficult to control, a small human population lacking the necessary expertise and resources to take adequate measures. For islands, the sea acts as a strong natural barrier for natural transport of terrestrial flora and fauna, however human activities helped in overcoming this barrier. The issue of feral animals, especially roaming cattle, donkeys, goats create similar problems everywhere: they have a devastating effect on tree and shrub regeneration, which greatly degrades the natural vegetation, with severe soil degradation as a result. This shifts the competitive advantage to hardy exotics and creates runoff of nutrients and silt into the sea, where algal growth and silt deposition are damaging the coral. The new nature policy plan for the Caribbean Netherlands assigns a high priority to the invasive species problem (MinEZ 2013), which worldwide is considered second only to habitat destruction as a long-term threat to biodiversity (Kaiser 1999, Mooney 2001).

While acknowledging a focus on the Caribbean Netherlands in specific (Bonaire, Saba, St. Eustatius) this report sets the first key steps in developing a common frame of reference for the whole of the Dutch Caribbean (i.e. including the islands of Aruba, Curacao and St. Maarten). These islands share historical and cultural ties, partly similar climates, scarce expertise, and experience most IAS as a common problem. The magnitude and severity of the problem is evident and necessitates a joint strategy into which action at insular level can be embedded for maximum efficiency and synergy: a common Invasive Alien Species Strategy (IASS).

The main action points for implementation are:

1. Develop and adopt guiding legal lists for action: **Black lists, Alert lists and Watch lists**, enumerating the species for which border control is essential or for which control and management actions would be required. A **special task group** should be made responsible for keeping these lists up to date.

2. Install **effective border controls**. To prevent is better than to cure: the costs of controlling or eliminating invasives once established can be very costly. For this reason and because of the earlier indicated special vulnerability of the island ecosystems, it is strongly recommended to prevent the entrance of (more) invasives.

3. Establish **Invasive Species Management Teams**. For the coordination of data collection, evaluation and the initiation of actions, a special team is required. This ISMT team shall have its own facilities and budget.

4. Define **responsibilities and mandates**. Ultimate responsibility for IAS control lies with the island governments. This means that policies regarding IAS will be determined by the government.

However, to be effective and efficient the ISMT (see 9.) needs full mandate to act within the limits of their own budget.

5. Require **quarantine documents**. Phytosanitary certificates and animal health certificates will be required for all imports.

6. Enforcement. Staff must be trained and instructed how to perform border controls. They must obtain **sufficient mandate and means** to confiscate and dispose of prohibited goods.

7. Develop **action plans**. A plan of action needs to be ready, describing the successive steps and decisions that have to be made for key threat species at all stages of the invasion process.

8. Arrange **access to properties**. When an alien species is invasive and needs to be eliminated, it is important that regulations allow the exterminators access to all properties, private and public alike.

9. Assure **public support**. Large scale programs for extermination and control, especially of animals, needs extensive public support. Volunteers may prove essential to assure enough 'eyes' and manpower.

10. Make **rapid surveys**. In order to decide whether a complete eradication is needed or that monitoring and restricting the distribution (mitigation) is the best or only option, a survey of the extent of the problem must be assessed by experts.

11. **Rapid response**. Usually a rapid action can localise the problem to a restricted area or eliminate the first individuals effectively so that no further costs have to be made.

12. Make **risk assessments** before introducing natural enemies. In case species are already present in vast numbers, biological control is often a last resort. This usually means introducing a natural enemy from the area of origin of the species. This means introducing another alien species, which may become a pest in itself. Expert consultation and small-scale experimenting is usually needed before the potential natural enemies can be safely released.

13. Create an **information system**. A team of experts managing a computer database is needed. This ISMT team needs to develop a system for easy reporting of new discoveries of alien species, for maintaining and updating information on key threats. The information system supports policy, action and research at all levels of the invasion process.

14. Create **a platform for cooperation**. In order to develop the system further, a national as well as an island platform is needed for participation of all relevant stakeholders. These platforms will develop recommendations for the ISMT and the island governments, and may also act as support group for the ISMT.

Contents

Terms of Reference

The arrival of exotic species to native communities is a large and increasingly more frequent problem world-wide, including the Caribbean (Williams and Sinderman 1992; Williams *et al*. 2001; Kairo *et al*. 2003; Lopez and Krauss 2006). While many introduced species are unsuccessful, some new arrivals become extremely abundant and widespread and can negatively impact native flora and fauna. Such introduced species are often referred to as "invasive alien species" (IAS). IAS presently 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). Island ecosystems are especially vulnerable to biological invasions and often also happen to possess unique concentrations of biodiversity. This is also the case with the islands of the Dutch Caribbean which all lie within a global hotspot for biodiversity (Myers *et al*. 2000; Mittermeier *et al*. 1999).

Since 2010, when the former island state known as the Netherlands Antilles was disbanded and the islands of Bonaire, Saba and St. Eustatius acceded to the Netherlands, the ultimate responsibility for nature management on these islands has lain with the Ministry of Economic Affairs, the Netherlands. As one of the premier threats to biodiversity, early on this ministry identified the problem of IAS as a core area of focus for policy development for its three Caribbean islands and the surrounding maritime EEZ zone. In the current nature policy plan (2013-2017) for the Caribbean Netherlands, invasive species are identified as the highest threats to biodiversity for both marine and terrestrial nature (MinEZ 2013).

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 call 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.

Consequently, in 2011 the Ministry of Economic Affairs commissioned IMARES to review the IAS problem for the Dutch Caribbean. That work resulted in four reports, jointly documenting no less than 211 introduced alien species for the Dutch Caribbean which are present in the natural environment. As IAS are often costly to combat, but at the same time overlap between the islands was large, development of a joint approach based on a shared awareness was a key recommendation and formed the basis for the Ministry to commission this study.

Our report represents the combined input of 38 island organizations and 62 individuals, based on meetings (25 organizations and 44 persons spoken with) and questionnaires (an additional 13 organizations and 18 persons spoken with). The island organizations and individuals represented diverse sectors that have to do with IAS in one way or other, either as importers of biological material, in policy development, in enforcement and control or in nature management.

This report was edited by Sarah Smith, Joost van der Burg, Dolfi Debrot, John de Freitas and Gerard van Buurt (in order of text contributed). Project leader: Dolfi Debrot. Additional input was provided by:

Aruba - Veterinary Clinics Aruba, Directorate of Infrastructure and Environment - Inspection of Public Health and Environment, Aruba Port Authorities, Aruba Marine Park Foundation, Directorate of Shipping Aruba and Fantastic Gardens Aruba.

Bonaire – Bonaire Hotel and Tourism Association (BONHATA), Human Environment and Transport Inspectorate – Shipping (I&M), Echo, STINAPA, Wayaká Advies BV, Ministry EZ Agriculture & Fisheries, Dutch Caribbean Nature Alliance (DCNA) and DROB.

Curacao – Vivian's Nursery, CARMABI, Ministry of Health, Environment and Nature, Veterinary practice Doest, Executive department of Veterinary Affairs.

Saba – Saba Conservation Foundation, Island Government, Agriculture Station, Mosquito Control Unit, Saba Airport, Customs, Saba Foundation for Prevention of Cruelty to Animals, Saba Port Authority, Saba Public Health Department.

St. Eustatius – St. Eustatius National Parks, Department of Agriculture, St. Eustatius Harbour Service, St. Eustatius Health Department.

St. Maarten – St. Maarten Nature Foundation, Landscape West Indies, Ministry of Public Health, Social Development and Labour for the Government of Sint Maarten, Ministry of Public Housing, Spatial Planning, Environment and Infrastructure (VROMI).

1 Introduction

The ever-increasing international traffic of persons and goods has resulted in the arrival of a whole range of species in Caribbean Netherlands (CN). These would never have reached the islands by natural processes alone: they have profited from this increased mobility. Insects are transported in suitcases, marine species are transported in ballast water, terrestrial plants and animals are escaping from cultivation and captivity. The majority of these species are not sufficiently adapted to the new environments to survive, let alone produce offspring. But some are. For years such species may remain unnoticed whilst adapting to the new environment. This is the so-called 'lag phase'. But when circumstances are right they may proliferate exponentially because they occupy a 'niche' that was more or less empty or that belonged to a less-competitive native species. Often these new arrivals have the advantage of absence of natural enemies. It takes time for predators to adapt to the newly arrived species and in the meantime the then invasive species can proliferate freely (out)competing the local species, endangering them with extinction. Examples of such species are the Lionfish (*Pterois volitans/miles*), the small Asian mongoose (*Herpestes javanicus*) and Rubber vine (*Cryptostegia grandiflora*).

Apart from ecological impacts, also economic losses may be considerable. Direct losses may occur if a species invades areas rendering them useless for e.g. horticulture. Examples are Purple nutsedge (*Cyperus esculentus*) or Corallita (*Antigonon leptopus*) that may invade vegetable gardens (Figures 1 and 2). The Lionfish (*Pterois volitans/miles;* figure 4) preys on fish larvae and outcompeting local fish, negatively impacting commercial fish stocks (Albins and Hixon 2008), while the *Boa constrictor* (figure 3) feeds on native birds and lizards (Quick *et al*. 2005). Another example are insects or pests that ruin trees (e.g. the Red palm weevil). In many cases the costs are significant: costs for control and management may become huge if action is delayed for too long. For example, the eradication of the Giant African land snail in Florida has cost an estimated 1 million US dollars (USDA 2013). The annual costs of IAS control in the Netherlands is estimated to cost about 1.3 billion euros (van der Weijden *et al*. 2005). This relates to the costs of musk rat control, and control and eradication of invasive water plants. Special cases are introductions that may affect human and animal health, such as dengue fever and the mosquitos that are transmitting the disease.

Figure 1. A lot for sale on Saba overgrown with Corallita (W.J. van der Burg).

Figure 2. A vegetable field on St. Eustatius infested with Nutsedge (W.J. van der Burg).

The costs of control grow exponentially with the growth of the invasive populations. Therefore, it is of utmost importance to try to prevent the introductions altogether. This means control at the borders, and these are also not without costs. Developing a system of monitoring, early detection, control and management requires knowledge about the species in and around CN as well as capacity to take measures in the field or sea.

Recent years have shown an exponential increase in introductions world-wide and the same can be concluded for the Caribbean Netherlands. Consequently unless action is taken, the situation and consequences will only become worse. As pathways for accidental and/or intentional introduction of potentially harmful alien species continue to develop, a proactive instead of a merely reactive approach is essential.

A proactive strategy towards IAS (Townsend 2009) will be based on:

a) Prevention – to limit the number of IAS that enter the country's borders
b) Early detection and eradication – to detect, track down and eliminate potential threats before they can establish themselves
c) Control and management of species already established - to minimize impact
d) Rehabilitation - of areas rendered useless by invasive species
e) Public awareness - as public attitudes towards trafficking with live biological materials is the main source of the problem.

Figure 3. A Boa constrictor on Aruba (G. van Buurt).

This will require establishment of human and material capacity to implement measures promptly as well as the legal framework to authorize and mandate actions (such as confiscations, and eradication measures). Aside from a special team (an Invasive Species Management Team) effective implementation will require capacity training in relevant sectors such as agriculture, landscaping, fisheries, nature conservation, customs, police, and judiciary bodies.

Elsewhere, it is often the case that key departments with environmental mandates do not have the programs or capacity they need, while others with good programs do not have the legal mandate or sufficient capacity to do the work (Townsend 2009). Such mismatch needs to be avoided.

The ability to tap into a wide range of taxonomic expertise is essential to allow species to be accurately identified. Therefore, cooperation with external institutes and experts needs to be established to allow rapid identification of potential threats. At present, efforts are made by the United States Department of Agriculture (USDA) to establish a network for the entire Caribbean for plant pests through the installation of the Caribbean Plant Health Directors Forum (CPHD). The network, known as the Caribbean Pest Diagnostic Network (CPDN) (www.caribpest.org), intends to provide a collaboration and communication tool to share information on plant pests.

1.1 Dutch Caribbean

This project was carried out as follow-up to four recent reports that provide an overview of exotic and invasive species in the Dutch Caribbean (Debrot *et al*. 2011; Van Buurt and Debrot 2011, Van der Burg *et al*. 2012, Van Buurt and Debrot 2012). The main findings and recommendations of those reviews can be summarized as follows:

1.1.1 Marine invasives

Twenty-seven (27) (known or suspected) marine exotic species for one or more islands of the Dutch Caribbean, of which some are also invasive. The marine communities of the Dutch Caribbean have suffered major changes based on a handful of marine exotic and/or invasive species, particularly in the special case of (opportunistic) pathogens. The arrival of a marine exotic species is possible through a variety of pathways. Former identified pathways include; lifting along with ballast water (Buddo *et al*. 2003) or ship hulls (commercial or recreational, Sammarco *et al*. 2010; Willette *et al*. in press; Mantelatto and Garcia 2001), hull fouling and accidental introduction from aquaculture or the aquarium trade (Sammarco *et al*. 2010; Morris *et al*. 2008). As eradication and control have proven difficult for marine exotics, management practices should especially focus on preventing the arrival of these species. Harbours are often areas where marine exotic species establish themselves first. While the primary introduction of exotic species is by definition related to human activities, once introduced, natural dispersion by means of ocean currents may also contribute to the spread of such species. An example of an invasive marine species is the seagrass, *Halophila stipulacea* (figure 5).

Figure 4. The Lionfish, a top introduced predator in many coral reef environments (M.J.A Vermeij).

Figure 5. Chokingly-dense growth of the invasive seagrass, Halophila stipulacea, 9 m depth, San Nicolas Bay, Aruba, June 2013 (B. Boekhoudt).

1.1.2 Terrestrial exotic plants

Sixty-five (65) naturalised and (potentially) invasive alien plant species. The Coral vine (*Antigonon leptopus*), the Rubber vine (*Cryptostegia grandiflora*), the Neem tree (*Azadirachta indica*) and 'Donna grass' (*Botriochloa pertusa*) appear to be the four main problematic species. To control the introduction of and the proliferation of invasive species the key recommendations of Van der Burg *et al*. (2012) were:

- the development of Black, Watch and Grey lists
- public awareness
- funding for staff to control pathways of introduction,
- development of management plans for specific species to stop further spreading,
- research on control, and
- proper legislation.

1.1.3 Terrestrial and freshwater exotic animals and pests

The list of terrestrial and freshwater exotic introductions amounts to 61 invasive animal species (12 exotic mammals, 16 birds, 13 reptiles, 5 amphibians, 2 freshwater fishes, 3 insects, 2 molluscs and 8 exotic earthworms), as well as some 47 exotic pests, diseases, parasites and pathogens. Some of the most deleterious animal introductions have been mammals such as goats, the mongoose, the cat and the black rat (Van Buurt and Debrot 2012). In case of terrestrial and freshwater invasive species, prevention is also preferred compared to control or eradication.

Important pathways are container transported goods, international trade in pets and trade in ornamental plants. In most cases, invasive terrestrial species are so wide-spread, firmly established or even kept as livestock, that eradication may no longer be possible. Urgent control of these species in sensitive areas will therefore be essential. Several introduced mammals and reptiles are currently still present in relatively small populations, making eradication still very feasible (Van Buurt and Debrot 2012). Van Buurt and Debrot (2012) identified the following actions necessary for successful action against invasive species on the Dutch Caribbean islands:

- control of goats
- control of introduced predators
- eradication of several small populations of exotic mammal predators and reptiles before their proper establishment
- eradication of introduced species from small satellite island (which serve as seabird breeding habitat), and
- prevent further introductions.

In addition two key action points which are urgently needed are the development of the existing legislation en the empowerment of invasive species management teams (ISMT's) for action. It is important that these initiatives be firmly imbedded in a policy framework.

2 Objectives and approach

The Dutch Ministry of Economic Affairs (EZ) requested IMARES and PRI to develop an Invasive Alien Species Strategy for the Caribbean Netherlands. Using the four studies (mentioned in section 1.) as a baseline starting point, the objectives of this study were to jointly with island partners discuss priorities, constraints and key needs and develop a main list of action points to promote and guide the implementation of a proactive strategy towards IAS in the Dutch Caribbean. This project consisted of the following 4 objectives:

a) Dissemination of the above-mentioned review reports so that partners have access to the current state of affairs with respect to invasive species.
b) Development and distribution of an IAS-questionnaire (Appendix 1) to gain insight into institutional the perception on the IAS problem, the priority species considered, the participants actual or potential contribution to addressing IAS, and the priority problem areas in mitigating the IAS problem. This questionnaire was mailed in April and May 2013 to actual (and potential partners) on all six Dutch Caribbean Islands (Bonaire, Aruba, Curacao, St. Maarten, Saba and St. Eustatius). The organizations the questionnaire was sent to (137 in total) included governmental bodies, veterinary practices, customs, tourism authorities, waste management authorities, police, nurseries, food importers, animal trade, research institutes and shipping companies (Appendix 2). In total, 24 organizations responded.
c) Island meetings held with key institutions and organizations in the Caribbean Netherlands to discuss the initial survey findings and identify priorities in developing a joint approach. These meetings took place from the 18th of June to 2nd July 2013. In total 44 individuals were spoken with involving a total of 25 organizations (Appendix 3). Eleven of these organizations also filled in a questionnaire.
d) After receiving last input in (September) a joint strategy document was drafted for consultation. This draft was sent out for final comments and review to the Ministry of EZ and island partners in beginning December 2013 and finalized based on the received input at the end of December 2013.

2.1 Acknowledgements

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3 Results

3.1 Survey

In total 137 island organizations were sent questionnaires and reminders, and 24 questionnaires were returned with responses (Table 1, Appendix 2). Bonaire showed the highest response rate, 8 out of 22 (36%), whereas the more populous islands of Aruba, Curacao and St. Maarten showed uniformly low responses rates (combined: 14 out of 111 = 13%).

Table 1. Number of questionnaires sent and received per island.

Island	**Questionnaires sent**	**Questionnaires received**	**Percent (%) return**
Aruba	48	6	13
Bonaire	22	8	36
Curacao	42	5	12
Saba	2	1	50
St. Eustatius	2	1	50
St. Maarten	21	3	14
Overall	137	24	18

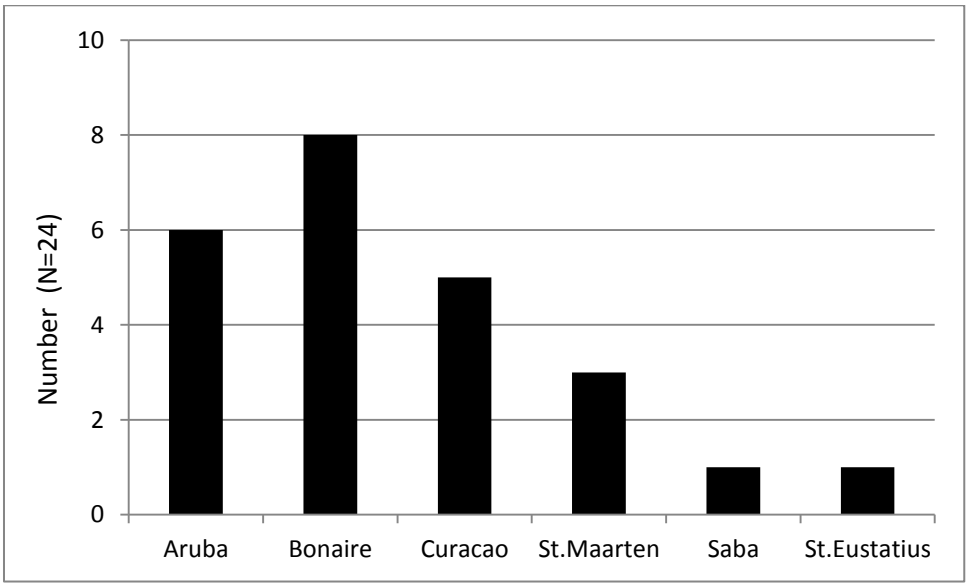


Figure 6. The number of questionnaires returned per Caribbean island.

The results of the survey as represented in different figures are found in Appendix 4. In the present section a short description is given of the general outcome of the inquiry. The questionnaire first focused on the organizations themselves (sector, organizational program), secondly enquired about their views on priorities concerning the IAS problem and thirdly enquired about the capacity and needs of the organization in order to contribute to the fight against invasive alien species.

The majority of the participants belonged to the categories Governmental (42%) and Nature Organizations (40%). The remaining participants belonged to the categories Agriculture, Farmer, Tourism and Individual Citizens. Most of the participants rated the importance of the IAS-problem in their organizational program as high (50%). The next highest category scored invasive as "more than average" importance (25%). Even so, they proclaimed that the subject deserves (a bit (17%) and much (83%)) more attention.

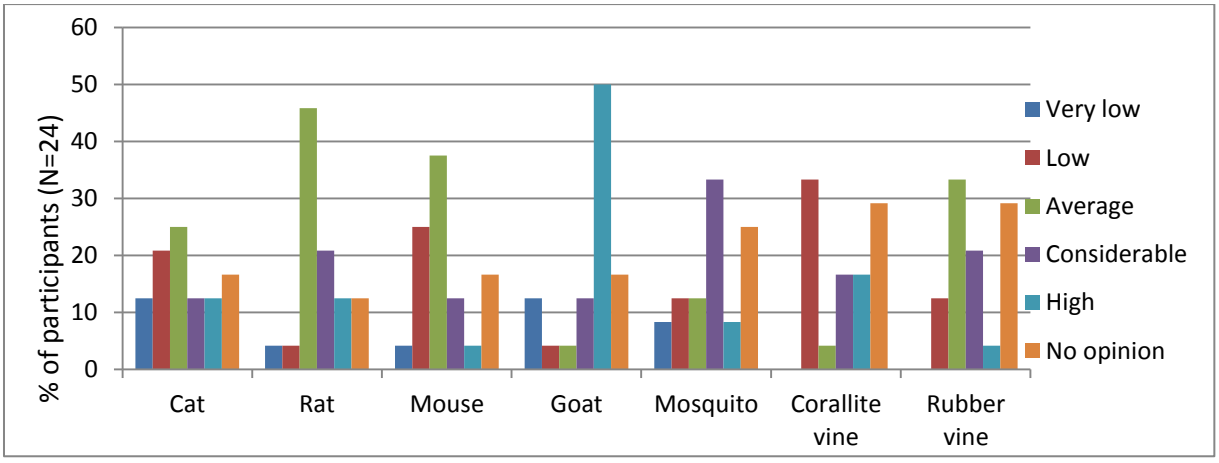
The response from organizations not directly concerned with nature management, such as shipping companies, fisheries or pest control companies was limited. For an overview of the contacted organizations see Appendix 2. As the IAS problem has been an issue on the islands for some years now, the authors do not think that the awareness of the problem is lacking. It is possible that the necessary more detailed knowledge needed to answer the questionnaire, may not be readily available within the organizations not directly concerned with nature management. The participants that did answer the questionnaire indicated that the IAS-problem was being taken serious within their organizational program.

The top 3 of most impacting invasive alien species in the Caribbean were considered to be the Lionfish (29%), goats (22%) and the Red palm weevil (9%). The Lionfish preys on fish larvae without having a natural predator that in turn preys on it. As a result, the Lionfish outcompetes local fish and may negatively affect commercial fisheries. Goats often roam free on the islands grazing, thereby endangering native plant species and indirectly causing erosion problems. The Red palm weevil causes a lot of damage to various species of palm trees.

Due to their presence in the top 3, it can be expected that the Lionfish (67%) and the Goat (50%) scored high in their present ecological impact on the Caribbean islands (figures 7), as perceived by the surveyed organizations. The invasive species Cat (figure 8), Rat, Mouse and Rubber vine are considered to have an average ecological impact. Whereas, the Pink mealy bug, the Agave weevil, the Whistling frog and the Shiny cowbird seem to be lesser known invasive alien species as the 'No opinion' option was often chosen. The Mosquito is considered to have a considerable ecological impact and the Corallita vine an average impact on the islands.

In addition, participants also mentioned Donkey (6x), Boa constrictor (3x), (wild) Pig (4x), Sheep (once), *Tecoma stans* (Kelki hel, 1x), *Pedilanthus sp.* (Milkbush, 1x) and Neem tree (1x) as invasive alien species of primary concern. *Tecoma stans* and *Pedilanthus sp.* were rated to have an average ecological impact, while the Donkey, Boa, Pigs, Sheep and Neem tree would have a considerable to high ecological impact according to the respondents.

Goats, Lionfish and the Red palm weevil are predominantly seen as the most impacting invasive alien species.



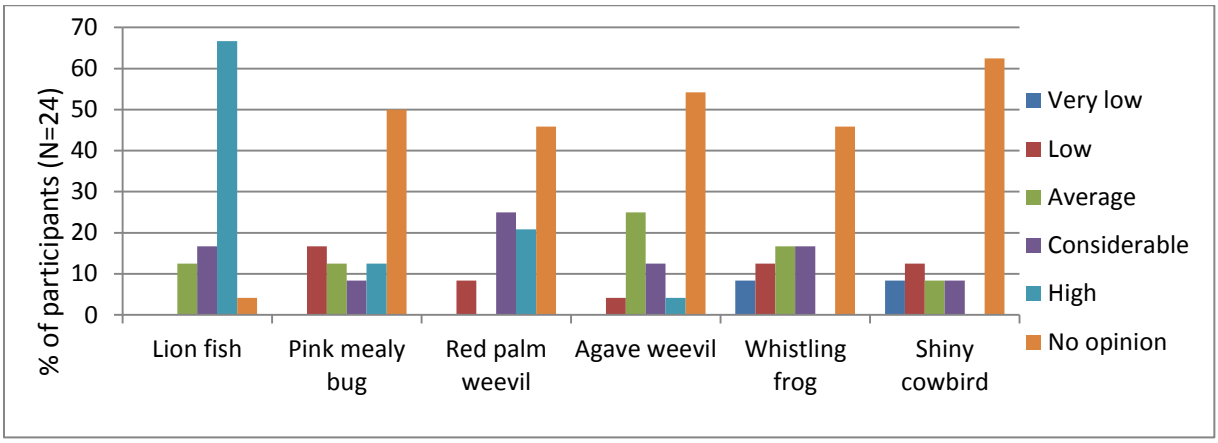


Figure 7. The different invasive alien species ranked according to their present ecological impact on the Caribbean islands according to the questionnaires participants (N=24).

The participants were also asked to rank the different invasive alien species according to economic impact on the island to the best of their knowledge. Ranking the ecological impact of an invasive alien species on the islands seemed to be a more difficult task, as the majority of the participants checked the "No opinion" option for most species. However, the Goat and the Lionfish are predominantly ranked "High" on their economic impact on the islands. The Mosquito (29%) and the Red palm weevil (21%) are next in line and ranked as having a "Considerable" economic impact.

Figure 8. Feral cat about to kill and remove a Red-billed Tropicbird, Phaethon aethereus, fledgling from its nest burrow, Saba, December 2013 (M. Terpstra).

When asked which invasive alien species could be successfully controlled, an even larger number of participants checked the "No opinion" box. However, the potential to control Cats and Goats were predominantly ranked as "High", while the Lionfish was predominantly ranked "Average"/"Considerable". The potential to control Rats and Mice was ranked as "Considerable".

The participants were asked to rank, from very low to high, known invasive alien species not yet found on the island according to their priority to be kept off the island. Most of the listed options for invasive alien species were ranked as a high priority to keep off the island. A large part of the participants also checked the 'No opinion' option.

Based on the high number of participants that checked the 'No opinion' option, our results suggest that respondents feel unsure about the potential dangers that these species represent for the islands. As the remainder of the participants predominantly ranked the different species as high, our results suggest that the respondents would support keeping all new potential invasive species from entering the islands. Participants also mentioned the Screwworm and the Giant African land snail as potential invasive species to be reckoned with.

The majority of the participating organizations (88%) stated to be willing to contribute to the fight against invasive species. This was predominantly by providing people (39%, e.g. staff, hunters, trappers, bee keepers, shooters), equipment (20%, e.g. pig traps, sprayer, hunting dogs), facilities and vehicles (each 17%, e.g. office and storage space, truck) and toxins (5%).

Other options included: communication, know-how, policy, feedback, raising awareness and PR. All organizations indicated that they currently contribute to addressing the IAS problem, predominantly through creating awareness (20%), through policy development (19%), eradication and control and research (both 16%). Man-hours involved per year were mostly around <300 / 300-500 (resp. 42% and 25%) and occasionally > 1000 (17%), while the financial resources that represented these activities were considered to be below the 1000 USD (67%) and occasionally between 1000 – 10.000 USD or 10.000 – 100.000 USD (resp. 17% and 4%).

Even though the willingness to contribute is clearly large, there are major constraints in terms of budget and time/availability of personnel for operations and research.

The top 3 areas in which respondents experienced problems when combating invasive species were: 1) Awareness (22%), 2) Policy (16%) and 3) Enforcement (16%), followed by Capacity and Finance (each 13%). According to the participants the top 5 priority problem areas that need to be overcome for a successful mitigation of the IAS-problem are:

1. Political attention (26%)
2. Awareness (24%)
3. Embedding into legal framework/ Enforcement (20%)
4. Capacity (14%)
5. Lack of IAS knowledge (13%)

The majority of the participants recommended that regulations should focus on all areas of approach mentioned (57% All of the above: Knowledge, Prevention, Eradication Control, Restoration of native species). The options in declining order were Prevention (18%), Eradication (9%), Control (8%) and Knowledge (6%).

Respondents concluded that awareness and basic knowledge under the public, political attention and enforcement (through legal framework) were the areas most urgently needed to start successfully addressing the IAS-problem. In addition, the participants stressed the need for regulations to prevent invasive alien species entering the Dutch Caribbean.

Fifty-two percent (52%) of the organizations were interested in capacity training. The areas of interest for capacity training ranged from prevention (23%), knowledge (20%), eradication (20%), control (15%) and restoration of native species (15%). Alternative organizational structure was another field of interest mentioned. The need for an IAS database was less clear (52% yes and 43% maybe), however the required information within the database ranged from information on prevention (20%), alert species (15%), present IAS species (14%), eradication (11%), control (12%), pathways of introduction (9%), legislation (9%) and restoration of native species (8%).

The majority of the organization indicated that the extent to which they communicate with surrounding countries concerning the invasive alien species problem is low (50%) to medium (27%).

The wish for a database and capacity training was average. It seems that the majority of the participants give priority to action and implementation rather than inventories.

3.2 Synthesis of the Caribbean Netherlands island discussions

In total five islands were visited and 44 people were spoken with, representing 25 organizations. The IAS problem is shared between the Dutch Islands and there is considerable overlap in many aspects of this problem. A synthesis is limited to the three Caribbean Netherlands islands (i.e. Saba, Statia and Bonaire).

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 main focus to limiting and containing the IAS problem.

The two biggest bottlenecks to implementation were the almost total lack of useful legislation, and lack of capacity. The exception is where it concerns species of public health concern, particularly the yellow-fever mosquito and rats. The current teams for these species are considered adequate in terms of capacity and resources (by those involved) but additional training and certification are welcomed.

The needs for implementation in terms of legislation, capacity and the most pressing practical needs are highlighted separately per island. To address the IAS issue more broadly, the consensus was that new legislation needs to be developed to be consistent with other existing legislation, and additional island-teams of 3-5 individuals are minimally needed.

3.3 Island overviews

3.3.1 Statia

The number of potentially deleterious invasive species continues to grow. The most disturbing recent introduction is the Giant African Snail (figure 9). 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.

Figure 9. Giant African land snail on St Maarten.

Point of entry

For invasive species in general, parties agree that prevention at the point of entry is most effective. The key focus should be directed to prevention of entry, for those species not already present on a given island. Awareness of potential problems and willingness to cooperate are high but the required legislation, capacity and practical tools all remain totally lacking. The legal basis for any action by Customs to prevent entry of species that have the customary health papers is completely absent. Customs needs legislation, identification sheets and experts on call and can then easily keep an eye out for invasives and collaborate to write police reports. There is a need for better legislation to prevent new introductions, for training to identify new threats during inspections and screening.

Specific needs:

Legislation:

- Full legislation needed to require self-reporting of importation, and to provide authority for impoundment, confiscation, quarantine and destruction.

Capacity:

- Minimally one dedicated customs officer.
- Training.

Practical:

- Quarantine capability needed for the port.
- Identification sheets for customs.
- Network of experts on call.

Rapid Response

There is no legislation or organized personnel capacity for rapid response of any kind. LVV has one staff level personnel member funded by the Ministry of EZ that is part time dedicated to invasive species issues. Minimally one dedicated staff member is needed to coordinate implementation. Aside from some shotguns and fencing materials of LVV, spears (used for lionfish) and cat traps of STENAPA, there is no supply of tools with which to trap, kill catch or eradicate any invasive species. STENAPA is active in combating and assessing impacts of invasive species but is very limited in personnel capacity and does most if not all projects in conjunction with outside support by visiting scientists. It is willing to head and coordinate rapid response efforts on selected species when needed, as well as to serve as experts for species confirmation for suspected shipments.

Specific needs:

Legislation:

- Full legislation needed to outlaw species and provide authority for impoundment, confiscation, quarantine and destruction.

Capacity:

- Minimally one fully-dedicated officer.
- Training.

Practical:

- Standard tool kits to be developed for main target species.

Control and mitigation

Four Statia island organizations are currently active in combating established invasive species. These are the Agriculture Department, STENAPA, the Public Health Department and the Animal Shelter. The only directly funded program (3? persons fulltime) is the control of species of direct public health impact, namely the mosquito *Aedes aegypti* and rats. The housefly is sometimes a problem that is addressed using poisoned baits.

On Statia, rats appear much less a problem than on Saba. This is likely due to less feral fruit trees being present, due to alternation in the use of rodenticide (which prevents the build-up of resistance) and due to landfill practices that reduce night-time food availability. Cats are also much less of a problem than on Saba because the Animal Shelter does not release unwanted pets into the wild as was common practice until recently on Saba. Mosquitos may be more of a problem on Statia than Saba because gardens often have more refuse that collects water. Sanitary conditions that breed roaches and flies also appear to be more of a problem on Statia than on Saba.

STENAPA devotes some attention to the Lionfish while the Animal Shelter helps combat the overpopulation of pets by neutering pets for a fee. The Agriculture Department currently has several persons part-time dedicated to reducing and controlling feral livestock. Work is underway to facilitate livestock reductions as well as studies in cooperation with IMARES to evaluate herd size structure and distribution and the effects of livestock grazing on vegetation development.

Specific needs:

Legislation:

- Full legislation needed to provide authority for impoundment, exclusion, confiscation, quarantine and destruction.

Capacity:

- Minimally one dedicated officer to coordinate control and mitigation (towards species other than mosquitoes and rats).
- The inspectors ask for training and police authority to better do their work.

Practical:

- A study is needed to assess and compare the costs and benefits of roaming livestock to facilitate well-informed decision-making.
- Study needed to assess feral grazer population size as this defines magnitude of the problem and the magnitude of the required effort to contain the problem.
- Standard tool kits to be developed for main target species.

3.3.2 Bonaire

Even though nature and environment are the pillar upon which the economy of Bonaire largely rests, the Nature and Environment Division of the Bonaire Government is allotted only one quarter of a percent of the annual island government budget. This is way too little considering the importance of the sector. A larger proportion of the more than 120 million guilders spent annually must be allotted to the sector. Only with more capacity is it possible to deliver the sustained effort that is necessary to address the invasive species problem.

Point of Entry

While customs recognizes the problem, and is ready to cooperate it must be better equipped, in terms of legal status, training, information resources (folders and sheets) and tools of the trade. The islands need their own inspections, particularly concerning ornamentals, pets and agricultural products which form the main entry pathways for new invasive species, with a short list of acceptable (useful) species and defining all "other" species as "black listed" and undesired. Customs do not have enough resources (manpower, equipment and time) to do all their current duties, and would need additional resources to effectively address this matter.

Specific needs:

Legislation:

- Full legislation needed to require self-reporting of importation, and to provide authority for impoundment, confiscation, quarantine and destruction.

Capacity:

- Minimally one dedicated customs officer.
- Training.

Practical:

- Identification sheets for customs.
- Network of experts on call.

Rapid response

Parties consider it optimal on island level to have a single team to decide and coordinate effort on three major levels of the invasion process. Decision-making criteria to act or not to act on any particular species will be a) actual or potential impact of the species and b) likely effectiveness of the effort. It will be important to score some early successes as encouragement to all, including volunteers. An example of a recent success is the Lionfish.

A removal program was initiated based on volunteers using spear guns immediately after the first Lionfish was sighted (2009) on Bonaire. Results showed that Lionfish biomass in fished locations was 2.76-fold lower than in unfished areas on Bonaire and 4.14-fold lower than on unfished areas on Curacao (De Léon *et al*. 2013). Preliminary results on Little Cayman showed 70 percent more native fish in areas where Lionfish were culled compared to areas where Lionfish were not culled. Examples of potential successes waiting to be executed are several species of plants on Klein Bonaire.

Specific needs:

Legislation:

- Full legislation needed to outlaw (more) species and provide authority for impoundment, confiscation, quarantine and destruction.

Capacity:

- Minimally two fully-dedicated officers.
- Training.

Practical:

- Standard tool kits to be developed for main target species.

<u>Control and mitigation</u>

Control efforts are currently carried out by three organizations on Bonaire. These are the Department of Public Health and Welfare, STINAPA and Echo. The first organization largely limits its effort towards *Aedes aegypti* mosquito abatement. STINAPA coordinates a public program addressing the Lionfish and goat removals from the Washington Slagbaai National Park. Echo is active in the control of feral pigs and, to a much lesser extent, bees. No other species are actively targeted for control.

The goat is the worst invasive and urgent action is needed. The best conditions to address goats on Bonaire are inside the Slagbaai plantation. While conditions have improved, STINAPA still lacks the capacity to address the situation. Building on experience in Curacao and applying approaches and techniques successfully used there, it should be possible to turn around the situation in Slagbaai within a few years. Building from such a success and with additional studies that deliver convincing arguments, the nature sector of Bonaire will be in a stronger, more convincing position to address the problem at island level.

Figure 10. Feral livestock grazing on tree-cactus bark in the Washington-Slagbaai National Park, Bonaire, threatens a key food source for native fauna and flora (A.O. Debrot).

To deal effectively with the terrestrial exotic invasive problem on the BES islands a small teams (in the case of Bonaire, at least 5 people) should be created and funded initially for several years to evaluate effectiveness.

Specific needs:

Legislation:

- Full legislation needed to provide authority for impoundment, exclusion, confiscation, quarantine and destruction.

Capacity:

- Minimally two dedicated officers to coordinate control and mitigate (towards species other than mosquitoes and rats).
- The inspectors ask for training and police authority to do their work better.

Practical:

- Network of experts and volunteers that can be mobilized to support rapid action.
- A study is needed to assess and compare the costs and benefits of roaming livestock to facilitate well-informed decision-making.
- Action plans to be developed and implemented towards key deleterious grazing species (such as the goat, pig and donkey.

3.3.3 Saba

The number of potentially deleterious invasive species continues to grow. The most disturbing recent development is the establishment and spread of introduced Guinea pigs and rabbits at The Level.

Point of entry

Parties agree that prevention at the point of entry is most effective. The key focus should be directed to prevention of entry. Awareness of potential problems and willingness to cooperate are high but the required legislation, capacity and practical tools all remain totally lacking. There is no legal basis for any action by Customs to prevent entry of species that have the customary health papers. Customs needs legislation, identification sheets and experts on call and can then easily keep an eye out for invasives and collaborate to write police reports.

Specific needs:

Legislation:

- Full legislation needed to require self-reporting of importation, and to provide authority for impoundment, confiscation, quarantine and destruction.

Capacity:

- Minimally one dedicated customs officer.
- Training.

Practical:

- Quarantine capability needed for the ports.
- Livestock trailer for humane transport of imported cattle and goats.
- Identification sheets for customs.
- Network of experts on call.

Rapid Response

There is no legislation or organized personnel capacity for rapid response of any kind. Minimally one dedicated staff member is needed to coordinate implementation. Aside from some spears (used for lionfish) and cat traps of the SFPCA, there is no supply of tools with which to trap, kill catch or eradicate any invasive species. Guinea pigs and rabbits are a potential major problem but are still easy to contain as both species are still limited in distribution and numbers, and easy to capture as they are still relatively tame. Both species are very appropriate for rapid response.

Specific needs:

Legislation:

- Full legislation needed to outlaw species and provide authority for impoundment, confiscation, quarantine and destruction.

Capacity:

- Minimally one dedicated officer.
- Training.

Practical:

- Network of experts and volunteers that can be mobilized for rapid action.

Control and mitigation

Three Saba island organizations are currently active in combating established invasive species. These are the SCF the SFPCA and the Agricultural Station. The only funded program (5 persons fulltime) is the control of species of direct public health impact, namely rats and the mosquito *Aedes aegypti*. SCF devotes some attention to the Lionfish while the SFPCA helps combat the overpopulation of pets by neutering and euthanizing unwanted pets. SFPCA does not support abandonment of pets into the feral state. The Agricultural Station has several persons fulltime dedicated to abatement of established species of public health concern. All programs rely heavily on participation of the local community and volunteers. Most support from the community is obtained for the species that cause hinder (rats and mosquitoes). For pets there is some legislation requiring registration but this is not being enforced.

On Saba, rats appear much more of a problem than on neighbouring Statia. This is likely due to a number of factors such as the much larger abundance of feral fruit trees being present, due to the decades-long use of the identical rodenticide (instead of alternation like on Statia which prevents build-up of resistance) and due to landfill practices that allow night-time food availability to cats and rats (unlike on Statia). Cats are also (still) much more of a problem than on Statia because of the (recently discontinued) practice of releasing unwanted pets into the wild which has never been common practice on Statia.

Specific needs:

Legislation:

- Full legislation needed to provide authority for impoundment, exclusion, confiscation, quarantine and destruction.

Capacity:

- Minimally one dedicated officer to coordinate control and mitigation (towards species other than rats and mosquitoes).
- Training.

Practical:

- Network of experts and volunteers that can be mobilized to support rapid action.
- A solution to the shortage of guppies is important for the Agriculture Station.
- An evaluation of rat resistance to brodifacoum should be conducted for the Agriculture Station.
- New cat traps for the SFPCA.
- Possibilities for control should be studied and evaluated (e.g. bringing the endangered native tortoise back to help control the invasive snail).
- The island landfill needs a varmint-proof night vault for garbage to eliminate food availability to rats and abandoned cats.
- Action plans to be developed and implemented towards key deleterious grazing species (such as the cat and rat.

4 Invasive alien species strategy for Caribbean Netherlands

4.1 Implement prevention

4.1.1 Lists of prohibited and restricted species

The scale of the IAS problem in Caribbean Netherlands means that priorities need to be sharply set. Black lists, grey lists, watch lists, alert lists have been developed elsewhere in the world, but the criteria for compiling these lists vary among authors.

Develop lists of invasives.
Black lists, Alert lists, and Watch lists need to be developed, officially recognised and maintained.

Shine *et al*. (2000) and Wittenberg and Cock (2001) suggest to prioritize species according to three categories: black list species, white list species and grey list species. Black list species are those known to be problematic and risky and need to be dealt with. White list species are those proven not to be problematic and grey list species are the large number of species for which the information available is insufficient.

EEA (2010) indicates the need for further refinement within the general black category of problem species so as to facilitate a rapid assessment and response. Within the black "problem" list category they propose distinguishing: "black list" species for which risk assessment has shown they are a proven risk to the environment, health or economy; "watch list" species which have a high likelihood of being problematic and therefore need to be monitored; "alert list species" that are both a proven risk and also have a high probability of introduction.

- **Black "problem" list species** **Problematic and risky**
  - Black list — Proven risk to the environment, health or economy
  - Watch list — High likelihood of being problematic, monitoring needed.
  - Alert list — Proven risk, high probability of introduction.
- **White list species** — **Not problematic**
- **Grey list species** — **Insufficient information available**

We recommend following EEA and distinguish between Black, Watch, and Alert lists:

Lists Task Group
A special task group should be made responsible for keeping the lists up-to-date.

Black lists contain species that are already present and are creating harm to the environment (reduce biodiversity), health or economy: these have to be eradicated and are prohibited to import;

Watch lists contain species that are already present and have shown invasive behaviour elsewhere. These have to be closely monitored.

Alert lists contain species that are not yet present but are known invasives elsewhere, in similar climates and are likely to arrive. They are prohibited to import. Species that are likely to arrive may be determined by observing their previous distribution pattern in the vicinity and with knowledge on the pathways they use. Appendix 5 shows a decision key to determine the appropriate listing.

In order to prevent the arrival of new invasive species in Caribbean Netherlands, it is necessary to make an inventory of those invasive species already found in other parts of the Caribbean or in surrounding countries. This requires active interchange of information via an insular knowledge network.

With knowledge on their pathways of introduction, it is possible to estimate the chances of their actual arrival and to determine which measures should be taken to prevent that. The Caribbean Invasive Species Working Group (CISWG) in cooperation with the United States Department of Agriculture (USDA) established a report on the pathways of plant pest movement into and within the entire Greater Caribbean Region (Meissner *et al*. 2009). It provides necessary information in preventing the introduction and further spread of exotic pests. Debrot *et al*. (2011) constructed a marine alert list of marine and cryptogenic species recorded from nearby waters (i.e. <300 km or at an up-current location from an island) of the Dutch Caribbean. The alert list shows the species that can be expected to arrive in the near future. Similar lists were made for agricultural and animal pests, diseases and vectors (Van Buurt & Debrot 2012), as well as for plants (Van der Burg *et al*. 2012).

Because of the different climatic nature of the Leeward Islands as compared to the Windward Islands, two sets of lists have been developed, with the latter also taking account of the more humid forest species. These are presented in Appendices 6 and 7. To provide a legal basis for enforcement at the points of entry, the lists must officially be adopted and published (see also paragraph 'Public awareness' below).

Carry out strict border control
Most IAS are being introduced by individuals through the regular ports of entry like airports and harbours.

Facilities
Facilities are needed to collect and dispose of confiscated materials.

Regular updates and re-evaluation of such lists should be a task assigned to a specific task group, e.g. Invasive Species Management Teams (ISMT's, section 3.2). Appendix 10 shows a preliminary Black, Alert and Watch Lists for non-native animal species in the Dutch Caribbean.

4.1.2 Border control

According to Waugh (2009) about 66% of invasive plant species in the Caribbean are linked to horticulture as the main pathway while about 23% are linked to agriculture. Meissner *et al*. (2009) further point out that plant quarantine material transfers within and from the Caribbean nations is very high compared to levels typical of the Northern European countries studied.

St. Eustatius airport customs practices 100% control on both exports and imports focussing on materials of natural or historical value. Self-reporting of unprocessed biological materials and fresh foods is a low cost and simple method to increase effectiveness of border control. In the Dutch Caribbean, at present only Aruba, Curacao and St. Maarten practice any form of self-reporting but this is currently almost only dedicated to tourism-related information (e.g. Appendix 8). Only St. Maarten requires visitors to self-report the transportation of animals, plants and perishables. Since 2010 all forms of reporting have been discontinued on all three Caribbean Netherlands islands for tourism marketing purposes.

Enforcement
Staff must be trained and instructed how to perform border controls effectively.

4.1.3 Restrictions and prohibitions

In case plants or animals are found at border control it must be made clear to the carrier that (s)he is required to carry the necessary permits for import (see quarantine). In case of animals all imports shall be prohibited, unless specifically granted through an import permit. Permits can only be granted for species not present on a Black, Watch or Alert list.

Plants may be imported unless present on the Black list or Alert list. For species on the Watch lists, exemptions may be made if the authorities are convinced that the species will remain under close management and can be effectively contained.

The distinction between plants and animals is due to the fact that plants are more easily contained: they do not move, there is usually no ownership and there are no ethical issues.

Therefore, certain plants on the Watch list may be imported for ornamental purposes or agricultural production. This may differ per island: some species are behaving invasively on one island but not on the other: Rubber vine (*Cryptostegia grandiflora*) is especially problematic on Bonaire, while Coral vine (*Antigonon leptopus*) is so on St. Eustatius (Van der Burg *et al*. 2012). Dedicated lists per island would therefore be needed. For efficiency reasons, and because not yet enough is known about the behaviour of species on the various islands, we propose separate lists for the Windward and Leeward Dutch Caribbean Islands. These are presented in appendices 5 to 6.

4.1.4 Quarantine and treatment

Prevention by border control is potentially very cost effective. Live import and import of plants and potentially infested or infected materials should be better regulated. Apart from invasive, plants are potentially harmful to the environment, as they may also carry diseases which can be detrimental to crops. In addition, the soil in which plants are transported can be a vehicle for plant pests. It is believed that the invasive African snail has entered the territory (Van Buurt and Debrot 2012): eggs may have lain hidden in or on the potting soil of imported plants.

Adopt an action plan
The consecutive steps for control and management need to be described, including responsibilities.

Many other organisms may be transported through soil. Apart from snail eggs, it is normally impossible for customs officers to identify these: they may be harmful fungi, insects, nematodes, etc. Clearly diseased plants may be stopped at the border effectively. A phytosanitary certificate from the place or origin shall be required at all times.

The ultimate tool to prevent unwanted introductions is a form of quarantine, where plants or animals are kept in a carefully guarded environment before release. This however requires investment in facilities, expertise and management costs. This does not seem a realistic possibility.

Some transports are known vectors of harmful insects and pose an extra risk: ships containers, cargoes of wood and bamboo, wooden crates, etc. These may harbour mosquitoes, beetles, spiders, snakes, rats, mice. Species not known in the territory or established pests. Such material shall be disinfected at the point of shipment (with a document confirming this) or disinfected at the point of entry.

4.1.5 Public awareness

Create public awareness
Make people aware of the dangers of introducing IAS and the costs of control.

A successful implementation of legal measures and prohibitions can only work if: 1. the public is made aware of the new regulations; and 2. people understand and appreciate the background and accept the logical consequences. Restrictions alone will not work and may be perceived as outside interference or undue bureaucracy.

Moreover, in case a species is not prohibited but needs to be contained within certain numerical or geographic limits, i.e. Watch list species, then the cooperation of the population is essential. Campaigns may be necessary to control the plants or animals, and then many volunteers may be necessary. Access to private properties may be needed to eradicate pockets of possible re-infestation, so people should willingly cooperate and give access to their property or do the removal themselves.

Regulate access to properties
Control officers must get the legal right to control pests and diseases when they harm the general safety.

In the case of prohibited species that pose a danger to the environment, pose human or animal health risks, or may harm agriculture or horticulture, regulations must guarantee access to private properties by official control people.

From the returned questionnaires for the survey discussed in 2.1. one could

get the impression that, with exception to a few governmental and nature organizations, for the majority of the organizations in the Caribbean the IAS problem is not a priority. This means that more emphasis must be given to information on the subject, to both civil society organizations as well as to the general public. This includes information meetings, newspaper articles, radio and television items, special school activities, etc. Because of its relevance to island communities, information about invasive species shall be part of the normal curriculum in all types of education.

Awareness should not only be island specific but preferably Caribbean wide. More international communication and collaborations in keeping IAS in check is necessary, as the IAS problem does not stop at borders, in particular for marine exotics. A joint effort is needed in obtaining a larger awareness on the islands, benefitting more islands than the Dutch Caribbean.

4.2 Implement early detection and eradication

4.2.1 Early warning system

An Early warning system is necessary to detect newly arrived alien species on the islands, so that swift action can be taken to prevent the establishment of a possibly new IAS. Essential is that the early warning system is open and inviting people to submit their observations (e.g. like www.waarnemingen.nl in the Netherlands) and is constantly monitored by experts. These will then validate the first observations by going to the indicated locations.

A special team should be available for a rapid response action. For marine species already loose and dispersed in the marine environment, rapid action is likely not appropriate. However, in the case of accidental release of mariculture or aquarium species, rapid action may certainly be possible. Van der Burg & Lotz (2012) have developed a flow chart for the Belgian-Netherlands area which describes the successive steps in the decision process. For the Caribbean Netherlands this would translate as follows:

- After an initial observation by an individual who reports this to the invasives action team,
- a specialist verifies the signalling.
- In case of a species from the Black list (species with a proven risk to the environment, health or economy), a team of controllers will take immediate action to remove the species and put it under control (animal) or destroy the specimen (plant).

Note. In case of an animal it depends on ethics and the public sentiment whether the animal can be killed or that it shall remain under care (mosquitoes vs. vertebrates). See Public awareness below.

- In case of a species from the Watch list, the location(s) will be visited at regular intervals to see whether the species starts to reproduce and proliferate (plants). In case of animals just observing will normally lead to proliferation. Thus, a certain level of control has to be adopted (see 3.3).
- After appropriate action, it will always be necessary to monitor the situation on site for a number of years: propagules (seeds) may have germinated, animals may have escaped.

Assure public support
Large-scale eradications can only be effective with general support.

Throughout this process it must be clear who is responsible for what: who are the experts available for field verification, who are carrying out rapid assessments, who decide on extermination, who can allocate budget for this, who are the ones to carry out the action, who can do the monitoring, who is responsible for information to the public. Such issues are to be laid down in an **action plan**, so that at the time of entry of an IAS, this should be no issue of discussion and that immediate action can be taken.

4.2.2 Public awareness

The general public generally oppose the extermination of animals, especially of vertebrates. Culling without public consent may create serious opposition, not only to the event itself but also to the entire process of invasives control. It is therefore opportune to discuss these issues beforehand. An example is the discussion in the Netherlands on the annual culling of 100,000 geese: only after long debate, conviction that something really needs to be done, after agreeing on the most animal-friendly way of killing, and after finding alternative destinations for the animals (animal feed, geese meat in restaurants), the actions could start. This example has several parallels with the case of goats and other feral grazers on the Caribbean islands.

Make rapid surveys
If possible make a rapid assessments to quantify the problem.

4.2.3 Rapid assessment

Risk assessment for species that could potentially be introduced is an essential tool for setting priorities. Several risk assessment tools have been developed and may be applicable to the situation in the Dutch Caribbean. One example developed and used in screening plant imports into Australia is referred to as a "weed risk-assessment" (WRA) system and has recently been modified and applied successfully to the IAS problem in other Pacific Island systems (Daehler *et al*. 2004). The screening system allows for the identification of likely invasive pests before they are introduced (intentionally). The likeliness of a species to be potentially invasive is based on the factors such as a history of invasiveness elsewhere; intrinsic life-history traits such as persistence, reproduction and dispersal attributes, and suitable climate or environmental conditions in the new site of introduction (Rejmánek 2000). The screening system used by Daehler *et al*. (2004) consists of the modified Australian and New Zealand WRA system (49 questions on factors that contribute to the likelihood of becoming a pest) plus a second screening (decision tree, figure 11), based on trends identified from empirical literature on weeds and natural-area invaders, to reduce the number of species that are ranked for further evaluation (Daehler *et al*. 2004).

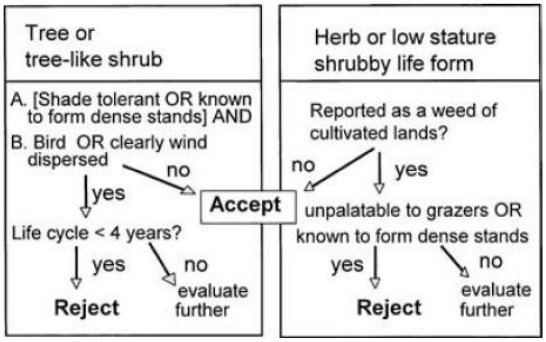


Figure 11. The decision tree used for the second screening of harmful plant species by Daehler et al. (2004) 'Reject' indicates a predicted pest, and 'accept' indicates a likely nonpest.

Often time and resources are limited, while a decision on a possible rapid action is urgent. Then rapid assessments may be a useful tool. Campbell *et al.* (2007) describe rapid survey methods used to assess the marine invasive problem. Ashton *et al.* (2006) demonstrate the usefulness of a rapid assessment approach focusing on a limited number of species and the most important sites. This provides essential quantitative information and will enable a fact-based evaluation of the situation. Such a baseline field assessment is urgently needed both on land and in the sea. At a later stage, tailor-made monitoring programs for the various invasive species are needed.

Establish Invasive Species Management Teams (ISMT's)
A team with a mandate to collect, and evaluate information and to initiate control and management actions.

Hayes and Silwa (2003) describe a method of risk analysis to determine the risk that the same or similar exotics could arrive in future. They developed a so-called "next pest list". For that they suggest the following criteria:

- species has been reported in a shipping vector or has a ship-mediated invasion history;
- the vector still exists;
- the species is responsible for economic or environmental harm; and,
- it is exotic to (a region) or present in (a region) but subject to official control.

By accurately predicting the "next pest" it may be possible to anticipate its arrival and take preventive measures. However, for most species, too little is known about their ecology to know what measures might actually be effective.

4.2.4 Rapid response

Rapid response
Early action is necessary before the situation literally grows out of hand.

Some pests, diseases and invasive species can be eliminated at an early stage, before they are able to establish themselves, if rapid action is taken. An example of a successful rapid response campaign was that of the campaign against the screw-worm fly on Aruba, October 2004, with the assistance of the Mexican-American Commission for the eradication of the screwworm and the USDA-ARS (United States Department of Agriculture- Agricultural Research Services).

The task to quickly respond to the first detection of potential IAS should lie with 'biosecurity units' or Invasive Species Management Teams (ISMT's). The latter having the same tasks as the Team Invasieve Exoten in the Netherlands, with its own personnel and budget. The ISMT's would have the following responsibilities:

- Regular update and re-evaluate of Black lists, Alert lists and Watch lists 3.4;
- Initiate rapid assessments;
- Develop contingency plans to combat diseases and IAS that are on these lists;
- Initiate and coordinate control and management actions;
- Monitor the effects of eradication actions;
- Maintain close contact with all Kingdom island partners, stakeholders, regional organizations (FAO, CABI and USDA/Aphis), local commercial pest control companies, local and regional companies supplying chemicals to combat species (insecticides, acaricides, fungicides, herbicides, mollucides etc.);

Define responsibilities and mandates
Staff must have the necessary backup from superiors and legislation.

So far only Curaçao and Aruba have long had plans to develop a biosecurity unit, which have not yet been realized. Clearly, such a unit is needed for the Caribbean Netherlands. In order for ISMT's to be a success, additional and supportive legislation is necessary to allow for the establishment of such (a) unit(s) and for effective enforcement.

4.3 Implement control and management

The saying 'to prevent is better than to cure' is certainly true for the IAS problem. Prevention is often more cost-effective than eradication or containment of arrived invasive species. However, for those IAS already present actions need to be taken in order to mitigate their proliferation and negative impact on their surroundings. Several options exist to control or completely eliminate (eradicate) IAS.

Quarantine
Phytosanitary certificates or health certificates shall be required for all imports.

4.3.1 Methods of control

Manual or mechanical (e.g. bulldozers for invasive plants) removal as control methods are often easier to apply to plant species than animal species. Manually removing animal species is problematic due to their mobility. The combination of manual and mechanical removal is also applied to plant species (e.g. Floating pennywort (Van der Burg & Lotz 2012)): the best method proved to be mechanical removal of the plants early in the year including part of the soil if possible and manual removal of any new shoot including its roots. Applying this method with water plants rooted in the bottom however, is extremely difficult because one cannot normally drain whole ponds or lakes (e.g. Parrot feather, *Myriophyllum aquaticum* ref.).

Manual removal of animal species relates to trapping or hunting; spearing Lion fish, trapping mongoose, bio constrictors, cats or goats, netting bullfrogs (*Rana catesbeiana*) and their larvae etc. Using nets to catch bullfrogs (*Rana catesbeiana*) and their larvae has only limited effect. In the case of infested ponds, the only way seems to be the complete draining of the ponds and removal of all the animals (Van der Burg & Lotz 2012).

Make risk assessments before introducing natural enemies ***Introduction of alien predators and parasites may put indigenous species at risk.***

Chemical control is another option. However, chemical control is only an option for land plants and insects. Applying chemicals to water is very undesirable. The effects on other life in the water is unknown and cannot be contained. Many substances can be used either to spray onto land plants directly or on stubs and regrowth after mechanical removal. The latter method seems the most appropriate for Corallita (figure 12, Ernst & Ketner 2007) and most trees and shrubs.

Biological control relates to the use of (predatory) insects or diseases such as fungi to control the growth of invasive plant species. Predatory insects were successfully used in controlling floating water plants such as Giant salvinia (*Salvinia molesta*) in many tropical countries (CSIRO 2011) and Water hyacinth (*Eichhornia crassipes*) on Lake Victoria (E. Africa). The introduction of natural enemies from the area of origin however, has to be done only after careful study: the intended predator may prefer the local plants over the invasive, aggravating the problem (Mo *et al.* 2000). When available, the use of native predators already present is to be preferred. A good example, is the introduction of the small Asian mongoose (*Herpestes javanicus*) on several Caribbean islands; initially to decimate the rat population on the island, the mongoose nearly decimated reptile populations native to these islands. Despite this risk the use of predatory insects to control Rubber vine (*Cryptostegia grandiflora*) in Australia has been successful (Mo *et al*. 2000). Likewise, the use of diseases such as fungi has been quite successful in decimating populations of Rubber vine (*Cryptostegia grandiflora*), also in Australia (Tomley & Evans 2007). A well-known example of the introduction of a disease to control animals is the introduction of myxomatosis to control rabbits in various parts of the World.

Several control and management methods can be employed to address IAS. These include mechanical, chemical, biological methods of control as well as habitat management and integrated pest management approaches which combine two or more of these approaches. Integrated approaches can often be quite productive. Our review of species provides some options that can be applied but in general and with few exceptions effective methods still need to be developed for the most problematic species (see appendix 13).

Before one can decide on a method to control a (potentially) invasive alien species, it is necessary to make a risk assessment to avoid putting the cart before the horse. The Code of Conduct for the Import and Release of Exotic Biological Control Agents (FAO 1996) has been adopted as an international standard for phytosanitary measures under the IPPC and aims to facilitate the safe import, export and release of such agents.

Figure 12. Rubber vine overgrowing the vegetation on Bonaire (W.J. van der Burg)

4.3.2 Legislation

The existing legal framework to prevent the introduction of invasive species and pests and plant diseases and to combat them once they have been introduced is critically insufficient

Create an information system ***A system to collect, store, and evaluate data on alien species must be established and maintained***

(Debrot *et al*. 2011). A similar conclusion can be made from the survey results. For instance, the Ordinance for Importation of Small Animals into the Caribbean Netherlands (Besluit Invoer Kleine Dieren BES) cannot prevent the disastrous importation of even a mongoose into the BES islands so long that there is a valid health certificate (Appendix 9, *in Dutch*). Participants of the survey considered 'embedding into legal framework' one of the top 3 priority problem areas that needed to be overcome for a successful mitigation of the IAS problem. A major problem is that the existing legislation often does not enable governments to confiscate and destroy imported plants and animals. Such legislation does exist for veterinary products which could transmit diseases (Van Buurt & Debrot 2012). Additionally, legislation regulating the importation of and trafficking with aquaculture and aquarium species is also necessary. Appendices 11 and resp. lists international legislation and initiatives and national legal and institutional framework.

4.4 Information system

An information system needs to be developed (e.g. EEA 2010) which provides:

a) species databases,
b) identification tools,
c) risk assessment tools,
d) registers of experts,
e) documentation of best management options.

Many countries are in the process of developing systems for prevention, early detection, control and management of invasives. Such a system is as of yet still absent in CN. Central in such a system is one organization responsible for collecting and storing the data and providing this information to authorities that are responsible for containment and action. In the Netherlands the 'Team Invasive Exoten' performs this task. It coordinates the collection of information, which for a large part are provided by NGO's and professionals, and translate this in policy recommendations. This is often based on a Risk Assessment, but sometimes the time to make such an assessment is not available and immediate action is necessary. The responsible ministry will then instruct provinces and communities to take action and in some cases, when human or animal health is concerned, may provide funding. If necessary, such as in the case of potential economic damage or the possibility of serious diseases in crops, animals or humans, the NVWA (Nederlandse Voedsel- en Warenautoriteit) takes over and coordinates on a national scale.

For the Dutch Caribbean priorities need to be set for species requiring control and management and species requiring eradication. The need for control or eradication is determined by the impact of the species and the prospects for measures actually sorting an effect. In other words, even if a species has a large effect but if prospects for control are poor, the species is assigned a low priority for action. On the other hand even species for which the presumed impact is low, the priority for action may be high because the chances for successful eradication or control are good. For many species, too little is known to provide such judgement calls.

4.4.1 Monitoring invasives

Monitoring is an expensive endeavour and priorities must be sharply set. For many species that have already established themselves, and for which the sense of conducting action is questionable, monitoring is discouraged. Monitoring of IAS should certainly focus to a large extent on the borders of the nation and the islands to prevent introduction of new agents. However, in the case of eradication of invasive plants or animals, monitoring the effect to be sure that no escapes have happened, may be necessary for some years.

5 Recommendations for the Caribbean Netherlands

Based on the four studies on invasive species in the Caribbean providing a preliminary overview of the exotic species found on the islands, the questionnaire survey, the island meetings and the final consultation with the islands partners the following IAS Strategy recommendations were determined:

1. Develop and adopt guiding legal lists for action: **Black lists, Alert lists and Watch lists**, enumerating the species for which border control is essential or for which control and management actions would be required. A **special task group** should be made responsible for keeping these lists up to date.
2. Install **effective border controls**. To prevent is better than to cure: the costs of controlling or eliminating invasives once established can be very costly. For this reason and because of the earlier indicated special vulnerability of the island ecosystems, it is strongly recommended to prevent the entrance of (more) invasives.
3. Establish **Invasive Species Management Teams**. For the coordination of data collection, evaluation and the initiation of actions, a special team is required. This ISMT team shall have its own facilities and budget.
4. Define **responsibilities and mandates**. Ultimate responsibility for IAS control lies with the island governments. This means that policies regarding IAS will be determined by the government. However, to be effective and efficient the ISMT (see 9.) need full mandate to act within the limits of their own budget.
5. Require **quarantine documents**. Phytosanitary certificates and animal health certificates will be required for all imports.
6. Enforcement. Staff must be trained and instructed how to perform border controls. They must obtain **sufficient mandate and means** to confiscate and dispose of prohibited goods.
7. Develop **action plans**. A plan of action needs to be ready describing the successive steps and decisions that have to be made for key threat species at all stages of the invasion process.
8. Arrange **access to properties**. When an alien species is invasive and needs to be eliminated, it is important that regulations allow the exterminators access to all properties, private and public alike.
9. Assure **public support**. Large scale programs for extermination and control, especially of animals, needs extensive public support. Volunteers may prove essential to assure enough 'eyes' and manpower.
10. Make **rapid surveys**. In order to decide whether a complete eradication is needed or that monitoring and restricting the distribution (mitigation) is the best or only option, a survey of the extent of the problem must be assessed by experts.
11. **Rapid response**. Usually a rapid action can localise the problem to a restricted area or eliminate the first individuals effectively so that no further costs have to be made.
12. Make **risk assessments** before introducing natural enemies. In case species are already present in vast numbers, biological control is often a last resort. This usually means introducing a natural enemy from the area of origin of the species. This means introducing another alien species, which may become a pest in itself. Expert consultation and small-scale experimenting is usually needed before the potential natural enemies can be safely released.
13. Create an **information system**. A team of experts managing a computer database is needed. This ISMT team needs to develop a system for easy reporting of new discoveries of alien species, for maintaining and updating information on key threats. The information system supports policy, action and research at all levels of the invasion process.
14. Create **a platform for cooperation**. In order to develop the system further, a national as well as an island platform is needed for participation of all relevant stakeholders. These platforms will develop recommendations for the ISMT and the island governments, and may also act as support group for the ISMT.

6 Glossary of Terms

Alert List	a list of species that are not yet present but are known invasives elsewhere, in similar climates and are likely to arrive.
Alien	not normally part of the natural flora or fauna (and introduced intentionally or unintentionally by man or man-related activities). Synonym of exotic.
Black List	a list of species that are already present and are creating harm to the environment (reduce biodiversity), health or economy.
Established	a species that occurs 'in the wild' and is able to reproduce.
Exotic	a species introduced by human intervention outside its native distribution range
In the wild	outside the control of cultivation and husbandry.
Invasive	behaving aggressively and spreading at a high rate, replacing native species, competing on resources or significantly changing the environment.
Naturalised	a species that has adapted itself (physiologically or through habitat use) to the new environment without significantly harming or replacing native species.
Non-indigenous	a species that is not part of the natural indigenous fauna or flora.
Prevention	to keep the chance that exotic species are introduced as low as possible.
Red List	the IUCN Red List of Threatened Species™: an internationally agreed list of endangered species that need special protection.
Watch List	a list of species that are already present and have shown invasive behaviour elsewhere.

7 Abbreviations and Acronyms

CABI	Centre of Agricultural Bioscience International
CARDI	Caribbean Agricultural Research and Development Institute
CARICOM	Caribbean Community (and Common Market)
CBD	Convention on Biological Diversity
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement (French Agricultural Research Centre for International Development).
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CN	Caribbean Netherlands
CPDN	Caribbean Pest Diagnostic Network
FAO	Food and Agricultural Organization of the United Nations
IICA	Inter American Institute for Co-operation on Agriculture
IMO	International Maritime Organization
IPPC	International Plant Protection Convention
IUCN	International Union for the Conservation of Nature
PAHO	Pan American Health Organisation
UF	University of Florida
USDA-APHIS	US Department of Agriculture Plant Health Inspection Services
UWI	University of the West Indies
WTO	World Trade Organization

8 Quality Assurance

IMARES utilises an ISO 9001:2008 certified quality management system (certificate number: 124296-2012-AQ-NLD-RvA). This certificate is valid until 15 December 2015. The organization has been certified since 27 February 2001. The certification was issued by DNV Certification B.V. Furthermore, the chemical laboratory of the Fish Division has NEN-EN-ISO/IEC 17025:2005 accreditation for test laboratories with number L097. This accreditation is valid until 1th of April 2017 and was first issued on 27 March 1997. Accreditation was granted by the Council for Accreditation.

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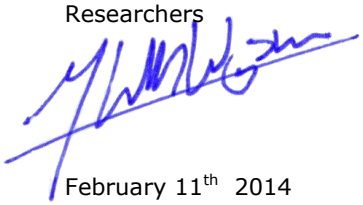
10 Justification

Report number IMARE C020/14 – Report number PRI 550
Project Number: 430.870.1025

The scientific quality of this report has been peer reviewed by a colleague scientist and the head of the department of IMARES.

Approved: Dr.ir. Jeroen Wijsman
Researchers

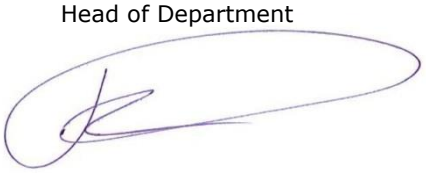
Signature:



Date: February 11th 2014

Approved: F.C. Groenendijk, MSc.
Head of Department

Signature:



Date: February 11th 2014

Appendix 1. IAS Questionnaire

Dutch Caribbean Invasive Alien Species (IAS) Preparedness and Priority Rapid Assessment Questionnaire.

Dear Sir/Madam,

To establish a baseline towards our joint development of an Invasive Alien Species (IAS) strategy, we would like to ask you to answer the following multiple-choice questions. There are 19 questions to answer. Room for comments is available on the last page. Thank you for your cooperation.

Name: .....
Organization and function: .....
Date: .....
Country/Island: .....

1. What kind of organization do you represent?

☐ Governmental organization
☐ Nature organization
☐ Coastguard
☐ Customs
☐ Agriculture
☐ Animal trader
☐ Farmer
☐ None. But as a citizen of .....

2. How important do you score the IAS-problem in your current organizational program? *(please circle)*

very low – low – average – more than average – high – no opinion

3. According to you, does the IAS-problem deserve more, the same or less attention? *(please circle)*

much less – a bit less – the same – a bit more – much more – no opinion

4. Which invasive alien species do you consider are presently the most impacting invasive alien species according to your organization and sectoral interests?

Please mark the 3 most impacting from 1 to 3 in declining importance.

☐ Cat
☐ Rats
☐ Mice
☐ Goats
☐ Yellow fever mosquito
☐ Corallita vine
☐ Rubber vine
☐ Lion fish
☐ Pink mealybug
☐ Red palm weevil
☐ Agave weevil
☐ Whistling frog
☐ Shiny cowbird
☐ Other: .....

5. To your best knowledge, rank the following invasive species according to present <u>ecological</u> impact on your island: *(please circle)*

Cat	very low – low – average – considerable – high – no opinion
Rat	very low – low – average – considerable – high – no opinion
Mouse	very low – low – average – considerable – high – no opinion
Goat	very low – low – average – considerable – high – no opinion
Mosquito	very low – low – average – considerable – high – no opinion
Corallita Vine	very low – low – average – considerable – high – no opinion
Rubber vine	very low – low – average – considerable – high – no opinion
Lion fish	very low – low – average – considerable – high – no opinion

Pink mealybug	very low – low – average – considerable – high – no opinion
Red palm weevil	very low – low – average – considerable – high – no opinion
Agave weevil	very low – low – average – considerable – high – no opinion
Whistling frog	very low – low – average – considerable – high – no opinion
Shiny cowbird	very low – low – average – considerable – high – no opinion
Other:.....	very low – low – average – considerable – high – no opinion

6. To your best knowledge, rank the following invasive species, according to economic impact for your island: *(please circle)*

Cat	very low – low – average – considerable – high – no opinion
Rat	very low – low – average – considerable – high – no opinion
Mouse	very low – low – average – considerable – high – no opinion
Goat	very low – low – average – considerable – high – no opinion
Mosquito	very low – low – average – considerable – high – no opinion
Corallita Vine	very low – low – average – considerable – high – no opinion
Rubber vine	very low – low – average – considerable – high – no opinion
Lion fish	very low – low – average – considerable – high – no opinion
Pink mealybug	very low – low – average – considerable – high – no opinion
Red palm weevil	very low – low – average – considerable – high – no opinion
Agave weevil	very low – low – average – considerable – high – no opinion
Whistling frog	very low – low – average – considerable – high – no opinion
Shiny cowbird	very low – low – average – considerable – high – no opinion
Other:.....	very low – low – average – considerable – high – no opinion

7. To your best knowledge, rank the following invasive species according to the potential for successful control on your island: *(please circle)*

Cat	very low – low – average – considerable – high – no opinion
Rat	very low – low – average – considerable – high – no opinion
Mouse	very low – low – average – considerable – high – no opinion
Goat	very low – low – average – considerable – high – no opinion
Mosquito	very low – low – average – considerable – high – no opinion
Corallita Vine	very low – low – average – considerable – high – no opinion
Rubber vine	very low – low – average – considerable – high – no opinion
Lion fish	very low – low – average – considerable – high – no opinion
Pink mealybug	very low – low – average – considerable – high – no opinion
Red palm weevil	very low – low – average – considerable – high – no opinion
Agave weevil	very low – low – average – considerable – high – no opinion
Whistling frog	very low – low – average – considerable – high – no opinion
Shiny cowbird	very low – low – average – considerable – high – no opinion
Other:.....	very low – low – average – considerable – high – no opinion

8. To your best knowledge, rank the following invasive species according to their priority to keep off your island: *(please circle)*

Giant landsnail	very low – low – average – considerable – high – no opinion
Agave weevil	very low – low – average – considerable – high – no opinion
Florida palm weevil	very low – low – average – considerable – high – no opinion
Mango seed weevil	very low – low – average – considerable – high – no opinion
Killer bee	very low – low – average – considerable – high – no opinion
Cactus mealybug	very low – low – average – considerable – high – no opinion
Red fire ant	very low – low – average – considerable – high – no opinion
African fruitfly	very low – low – average – considerable – high – no opinion
Tiger mosquito	very low – low – average – considerable – high – no opinion
Tropical bont tick	very low – low – average – considerable – high – no opinion
Lyme disease	very low – low – average – considerable – high – no opinion
Other:.....	very low – low – average – considerable – high – no opinion

9. Is your organization willing to contribute to the fight against invasive species?
☐ Y ☐ N ☐ Maybe

10. What is the available capacity in your organization to contribute to the fight against invasive species? *Please circle the relevant options and give a short description of your choice (e.g. number of people/vehicles, which vehicles/equipment/toxins in particular, etc.)*
☐ People
☐ Facilities
☐ Vehicles
☐ Equipment
☐ Toxins
☐ Other: .....

Comments: .....

11. What is the current role of your organization in this process?
☐ None.
If so please explain the reason why not? .....
☐ Awareness (e.g. education)
☐ Research
☐ International networking
☐ Policy development
☐ Enforcement
☐ Eradication and control (e.g. monitoring)
☐ Restoration of native species
☐ Other: .....

12. How many man-hours/year do these activities involve?
☐ < 300
☐ 300 – 500
☐ 500 – 700
☐ 700 – 1000
☐ > 1000

13. How much are the financial resources that these activities represent (per month)?
☐ < 1000 USD
☐ 1000 - 10.000 USD
☐ 10.000 – 100.000 USD
☐ > 100.000 USD

14. In which field do the main problems arise according to your organization, when it comes to combating invasive species?
Please mark the 3 most important from 1 to 3 in declining importance.
☐ Awareness
☐ Policy
☐ Enforcement
☐ Capacity (e.g. people, equipment)
☐ Eradication and control (e.g. monitoring)
☐ Finance
☐ Knowledge
☐ Other: .....

15. What are the priority problem areas that still need to be overcome?
Please prioritise the following areas from 1 (very high) to 5 (very low).
☐ Awareness
☐ Political attention
☐ Embedding into legal framework / Enforcement
☐ Lack of IAS knowledge
☐ Capacity
☐ Other: .....

16. In your opinion, which area(s) of approach should the regulations focus on?
☐ Knowledge
☐ Prevention
☐ Eradication
☐ Control
☐ Restoration of native species
☐ All of the above
☐ Other: .....

17a. Would your organization be interested in receiving 'capacity trainings'?
☐ Y ☐ N ☐ Maybe

17b. If so, in what areas?

☐ Knowledge
☐ Prevention
☐ Eradication
☐ Control
☐ Restoration of native species
☐ Other: .....

18a. Would an IAS information system and database be welcome?
☐ Y ☐ N ☐ Maybe

18b. If so, what kind of information would your organization most want to obtain? Information on:
☐ Alert species
☐ Present IAS species
☐ Pathways of introduction
☐ Prevention
☐ Eradication
☐ Control
☐ Restoration of native species
☐ Legislation
☐ Other: .....

19. To what extent does you organization presently communicate with the surrounding countries concerning invasive alien species?
☐ None
☐ Low
☐ Medium
☐ More than average
☐ High
☐ No opinion or don't know

Thank you for your cooperation!
There is room for comments below.

Additional comments:

Appendix 2. Contacted Organizations

Bonaire

Category	Organisation	Contact person	Position
Ministry EZ	RCN	Paul Hoetjes	Policy Advisor Nature
Ministry I&M	RCN	Wil van Delft	I&M representative
Veterinary and quarantine dept.	Veterinary Nikiboko	Jan v/d Laarakker	vet
Fish dept	RCN	Pieter van Baren	Policy Advisor Agriculture and Fisheries
Customs, border immigration authorities	Harbour	-	-
Customs, border immigration authorities	Airport	-	Team Fysiek Toezicht
Customs, border immigration authorities	Coastguard	-	-
Port and marina authorities	RCN	Raul Quilotte	Chief Inspector Netherlands Shipping Inspectorate
Port and marina authorities	Harbourmaster	Rob Sint Jago	Harbourmaster
Tourism authorities	Tourism Corporation Bonaire	-	-
Tourism authorities	Bonaire Hotel and Tourism Association	Irene Dingjan	-
Nature management authorities	BNMP	Ramon de Leon	Marine park manager
Waste management authorities	Selibon	Rudsel Leito	-
Agriculturalists	Kriabon	Agnes Joosten	-
Nurseries and landscapers	Green Label	-	-
Nurseries and landscapers	Captain Don's Island Grower	-	-
Nurseries and landscapers	Fontein nursery of native, rare species	Sam Williams	Founder Echo Foundation
Nurseries and landscapers	Kibrahacha NV	Jan Jaap van Almenkerk en Maarten Schuit	
Food importers	Van Den Tweel Foodgroup/Bonaire Food Group	-	-
Food importers	Warehouse NV	-	-
Animal and pet trade	Boomerang Huis & Tuin	-	-
Research institutes	CIEE	Rita Peachey	Director
Research institutes	STINAPA	Fernando Simal	Lead scientist
Shipping Companies	Rocargo	http://www.rocargo.com/contact_us.html	
Shipping Companies	Don Andres NV	-	-

St. Maarten

Category	Organisation	Contact person	Position
Government bodies	Government	Claire Hooft Graafland	Senior policy advisor Nature and Environment

Government bodies	Ministery VROMI	J.B. (Hans) Sellink MPM	Head of the VROMI policy department
Dienst Gezondheid en Hygiene	Directie Volksgezondheid	Fleur Hermanides	-
Veterinary and quarantine dept.	Veterinary Service & LVV	Mervyn Butcher	Vet
Veterinary and quarantine dept.	St. Maarten Veterinary Clinics	Gary Swanston	-
Veterinary and quarantine dept.	Animal Hospital	Glen Romney	Vet
Customs, border immigration authorities	Princess Juliana International Airport	-	-
Customs, border immigration authorities	Coastguard - CGDG Steunpunt SXM	Commanding Officer Eddy Kirindongo	-
Port and marina authorities	INTERMAR Shipping & Port Agency	Bob van der Mark	General Manager
Port and marina authorities	St. Maarten Harbour Group of Companies	Mark Mingo	Managing Director
Tourism authorities	St. Maarten Tourism Board	-	-
Nature management authorities	Nature Foundation	Tadzio Bervoets	Manager
Nature management authorities	Simpson Bay Lagoon Authority Corporation	-	-
Nature management authorities	Environmental Protection in the Caribbean (EPIC)	Rueben Thompson	-
Waste management authorities	Dartam	-	-
Nurseries and landscapers	Landscape West Indies	Gilles Cauvi, Richard Lucas	-
Pest Control	Terminix	-	-
Pest Control	ADVANCED TERMITE AND PEST CONTROL	-	-
Animal and pet trade	Caribbean Puppies & More	-	-
Shipping Companies	SEL Maduro and Sons	H.L. Chance	Managing director
Shipping Companies	Saga Transport Limited	-	-

Curacao

Category	**Organisation**	**Contactperson**	**Position**
Government bodies	Department of Shipping & Maritime Affairs (SINA)	-	-
Government bodies	Veterinary Service	Dhr. A. Dwarkasing	Vet
Government bodies	Directie Landbouw, Veeteelt en Visserij	Dhr. K. Heidweiler	-
Government bodies	Milieudienst	Administration	-
Dienst Gezondheid en Hygiene	Inspectie Volksgezondheid	-	-
Veterinary and quarantine dept.	Veterinary Practise Doest	Odette Doest	Vet

Veterinary and quarantine dept.	Animal Care Center	Dolf van der Glessen	Vet
Veterinary and quarantine dept.	Klinika Veterinaria Parera	-	Vet
Veterinary and quarantine dept.	Dierenarts Vinck	-	Vet
Customs, border immigration authorities	Curacao Ports Authority	Marlon La Roche	Harbour Master
Customs, border immigration authorities	Customs & Immigration	Headoffice	-
Customs, border immigration authorities	Curacao Airport Partner N.V.	Martin Kattestaart	Manager Security
Customs, border immigration authorities	Coastguard	-	-
Tourism authorities	Curacao Toeristen Bureau	-	-
Nature management authorities	CARMABI	John de Freitas	Head department Advice & Consultancy
Waste management authorities	Selikor N.V.	-	-
Waste management authorities	Samander & Co	-	-
Waste management authorities	Mits Curacao N.V.	-	-
Waste management authorities	Sea- Harbortransport Curacao	-	-
Police	Administratie	-	-
Agriculturalists	Marco's Farm (fish)	Marco	-
Agriculturalists	Finca del Sol	Lori Kooyman-Sanchez	-
Agriculturalists	Aloe vera plantation Curacao	-	-
Agriculturalists	Curacao Ostrich Farm	-	-
Nurseries and landscapers	Aria Gardens	-	-
Nurseries and landscapers	Exotische Tuinen N.V.	-	-
Nurseries and landscapers	Hoekstra Landscapers	Remco Hoekstra	-
Nurseries and landscapers	Jardineria Hernandez	-	-
Nurseries and landscapers	Vivian`s Nursery	-	-
Pest Control	Professional Pest Control N.V.	-	-
Pest Control	Termite Curacao.com	-	-
Pest Control	Truly Nolen Pest Control	Christopher Bloem	-
Pest Control	Dal Pest Control	-	-
Animal and pet trade	Aquarian Fish shop	-	-
Animal and pet trade	Get-a-pet Boutique	-	-
Animal and pet trade	Pet Care N.V.	-	-
Animal and pet trade	Veeris Importers & Pet Center	-	-
Shipping Companies	Admiral Shipping Agency N.V.	-	-
Shipping Companies	Dammers Shipagencies INC.	-	-
Shipping Companies	S.E.L. Maduro & Sons (Curacao) Inc.	-	-

Shipping Companies	Rocargo Service N.V.	-	-
Shipping Companies	Quality Shipping & Agencies N.V.	-	-

Saba

Category	Organisation	Contact person	Position
Customs, border immigration authorities	Port Authority	Travis Johnson	Harbourmaster
Nature management authorities	Saba Conservation Foundation	Kai Wulf	Manager

St. Eustatius

Category	Organisation	Contact person	Position
Customs, border immigration authorities	Port Authority	Austin van Heijningen	Harbourmaster
Nature management authorities	St. Eustatius National Park	Hannah Madden	Manager

Aruba

Category	Organisation	Contactperson	Position
Government bodies	Directie Scheepvaart	-	Harbourmaster
Government bodies	Veterinaire Dienst	Pieter Barendsen	Vet
Government bodies	Directie Landbouw, Veeteelt en Visserij	Facundo Franken	-
Government bodies	Directie Infrastructuur en Planning	-	-
Government bodies	Directie Natuur en Milieu	-	-
Dienst Gezondheid en Hygiene	Directie Volksgezondheid	-	-
Veterinary and quarantine dept.	Veterinaire Klinieken Aruba	Eric de Cuba	Vet
Veterinary and quarantine dept.	Contreras Veterniary Services NV	-	Vet
Veterinary and quarantine dept.	Animal Care Clinic	-	-
Fisheries	Fundacion Centro di Pesca Hadicurari	-	-
Customs, border immigration authorities	Servicio di Aduana	-	-
Customs, border immigration authorities	Aruba Airport Authority N.V.	-	-
Customs, border immigration authorities	Coastguard	-	-
Port and marina authorities	ARUBA PORTS AUTHORITY N.V.	-	-
Port and marina authorities	Inspectie Beveiliging Scheep- en Luchtvaart	-	-
Tourism authorities	Aruba Tourism Authority	-	-
Nature management authorities	Fundacion Parke Nacional Arikok	Diego Marquez	Director

Nature management authorities	Aruba Marine Park	-	-
Nature management authorities	Boa Constrictor Task Force	Diego Marquez	Chairman
Waste management authorities	Serlimar	-	-
Agriculturalists	Aruba Aloe Balm N.V.	-	-
Agriculturalists	IslandFresh	-	-
Agriculturalists	Nos Cunucu - The Land Farm	-	-
Agriculturalists	Aruba Ostrich Farm	-	-
Agriculturalists	Hunt's Farm	-	-
Agriculturalists	Kwong Sai Hua Natural Farm	-	-
Agriculturalists	Salinja Farm	-	-
Agriculturalists	Su Kee Natural Farm	-	-
Nurseries and landscapers	Botanica Oro Y Plata	-	-
Nurseries and landscapers	Fantastic Gardens Aruba	-	-
Nurseries and landscapers	Perfect Landscaping NV	-	-
Fishermen	Quality Aruba Fisheries	-	-
Fishermen	S.L. Aruba Fisheries Trading N.V.	-	-
Pest Control	Caribbean Pest Solution	-	-
Pest Control	Dal Pest Control	-	-
Pest Control	Krozendijk Pest Management & Supplies	-	-
Pest Control	Professional Pest Control	-	-
Shipping Companies	Wevco Supplies and Services NV	-	-
Shipping Companies	VR Shipping (Aruba) NV	-	-
Shipping Companies	Swa So Import & Export	-	-
Shipping Companies	S.E.L. Maduro & Sons	-	-
Shipping Companies	Roos Sea Services	-	-
Shipping Companies	Rocargo Services Aruba NV	-	-
Shipping Companies	Nautilus Shipping	-	-
Shipping Companies	Global Marine Services	-	-
Shipping Companies	Dutch Antilles Maritime Agencies (Aruba) N.V.	-	-
Shipping Companies	ARMADA Port Agency	-	-
Shipping Companies	Ace Cargo Service	-	-

Appendix 3. Key organizations and persons involved in Island meetings (June - July 2013).

Island	Contactperson	Position
St. Eustatius		
Department of Agriculture	Roberto Hensen	Head of the department
STENAPA	Steve Pointek	Director
Dienst Zeehaven St. Eustatius	Austin van Heijningen	Head of the department
St. Eustatius Health Department	Bernadine Woodley	Health Inspector
	Ingrid Houtman	Health Inspector
	Rodey Vlijtig	Vector control
Saba		
Saba Conservation Foundation	Kai Wulf	Director
	Brooke Rodgers	Conservation scientist
	James Johnson	
	Jelle van der Velde	
	Mike Charma	Board member
Island Government	Menno van der Velde	Island Secretary
Agriculture Station	Michael Hassel	Head
	Julio Levenstone	
Mosquito Control Unit	Jerry Hassel	Interim head
Saba Airport	Vincent Hassell	Director
Customs	Theo Hartelveld	Chief officer
	Yanick Cicilia	
Saba Foundation for prevention of cruelty to animals	Yvette Peterson	Director
Saba Port Authority	Travis Johnson	Director
Saba Public Health Department	Dr. Gijs Koot	Director
Bonaire		
Public Health (GGD), Directie Samenleving en Zorg (OLB)	J. van Slobbe	Head of the department
Handhaving Samenleving en Zorg, Directie toezicht en handhaving (OLB)*	G. van Arneman	Head of the department
LVV	R. Emers	Head
STINAPA	P. Bertuol	Wildlife Biologist
	E. Beukenboom	Director
	R. de Leon	Marine Park Manager
	Fernando Simal	Manager
DCNA	N. Miller	
	Paul Westerbeek	
Department of spatial planning and development	P. Montanus	Policy advisor environment and nature

	F. van Slobbe	
RCN, Ministry EZ	G. Schutjes	Senior Policy Official
Customs	C. Vrolijk	Adjunct Head
Curacao		
CARMABI	G. van Buurt	
	John de Freitas	
Directie Gezondheid Milieu en Natuur	Gisette Seferina	Medical entomologist
	Faisal Dilrosun	Agricultural expert
Executive department of Veterinary Affairs Curacao	Arnold Dwarkasing	Head of the department
Aruba		
Directorate of Agriculture, Husbandry and Fisheries (LVV)*	Nathalie Maduro	Head of the department
	Facundo Franken	Staff member
Aruba Marine Park foundation	Byron Boekhoudt	Manager
Directorate of Nature and Environment (DNM)	Gisbert Boekhoudt	Staff member
	Robert Kock	Head department research and monitoring

* In total, 25 organizations were involved during the island meetings. OLB and LVV are mentioned twice in the list above.

Appendix 4. Detailed IAS survey results for the Dutch Caribbean

In April and May 2013 IAS-questionnaires were sent to six Caribbean Islands (Bonaire, Aruba, Curacao, St. Maarten, Saba and St. Eustatius). The organizations included governmental bodies, veterinary practices, customs, tourism authorities, waste management authorities, police, nurseries, food importers, animal trade, research institutes and shipping companies.

The questionnaire (Appendix 1) enquired on the perception on the IAS problem, the priority species considered, the participants contribution to the fight against IAS, and the priority problem areas in mitigating the IAS problem.

The results of the questionnaires were lumped together to obtain a general idea of how the IAS problem is perceived in the (Dutch) Caribbean. Aruba, Curacao and St. Maarten were approached as these islands also share in the IAS problem.

In addition, meetings were held with key institutions and organizations in the Caribbean Netherlands from the 18th of June to 2nd July 2013.

The IAS problem on the Dutch Caribbean islands has been a subject of research for some years now. In 2011 and 2012, 4 studies were performed on the status of the IAS-problem on the Dutch Islands, concerning marine species (Debrot *et al.* 2011), terrestrial and freshwater species (Van Buurt & Debrot 2012a, plant species (Van der Burg *et al.* 2012) and agricultural pests, plant and animal diseases and vectors (Van Buurt & Debrot 2012b).

It is based on these four studies, the results of the questionnaires and the meetings held on the Dutch islands that the present IAS strategy is developed.

Bonaire
IAS-questionnaires were sent to 24 organizations (see Appendix) on Bonaire through email (18) or letter (9). Emails were sent on 11 April 2013 and letters on 12th April 2013. Two letters returned as undelivered due to an incomplete address. On the 31st April 2013 a reminder was sent per email. In September 2013 another reminder was sent to those organizations that had not yet replied. In total, 22 organizations should have received the IAS-questionnaire. We received back 8 IAS-questionnaires.

Saba
On Saba 2 organizations were sent questionnaires of which 1 questionnaire was returned.

St. Eustatius
On St. Eustatius 2 organizations were asked to fill questionnaires of which 1 questionnaire returned.

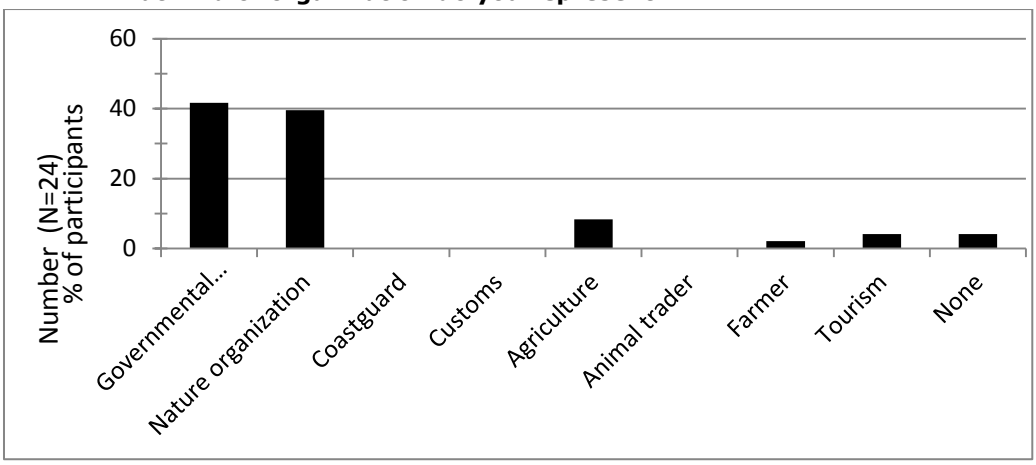
Aruba
Fourty-eight organizations on Aruba were sent an IAS-questionnaire through email (31) or letter (17). Emails were sent on 17 May 2013 and letters on 21st May 2013. Six questionnaires were returned.

Curacao
For Curacao, IAS-questionnaires were sent to 44 organizations through email (29) or letter (15). Emails were sent on 17 May 2013 and letters on 21st May 2013. Of the 15 letters sent 2 returned as undelivered due to an incomplete address. As a result 42 organizations should have received the IAS-questionnaire. Five IAS-questionnaires were returned.

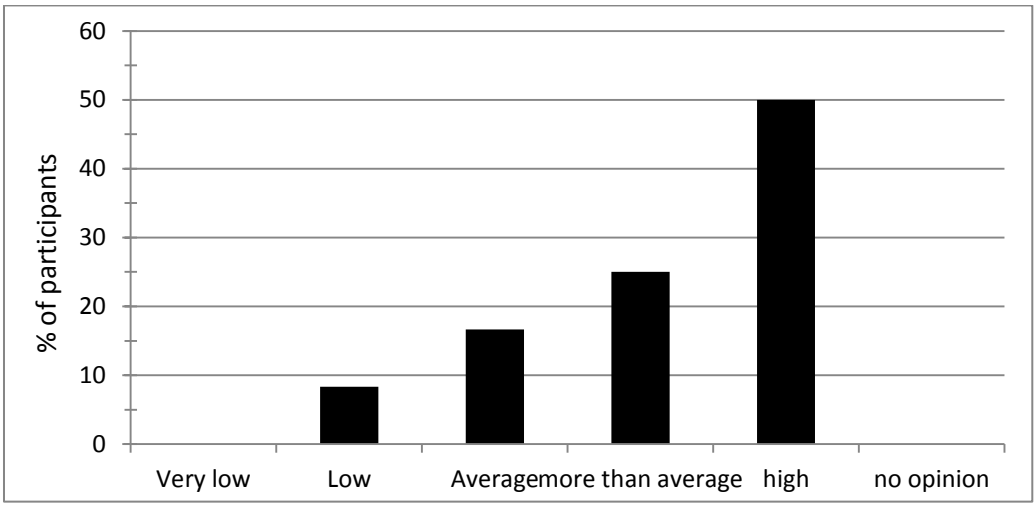
St. Martin
Twenty-one organizations on St. Maarten were sent an IAS-questionnaire. Seven by letter (21 May 2013) and 13 by email (17 May 2013). Three IAS-questionnaires were returned.

Survey results

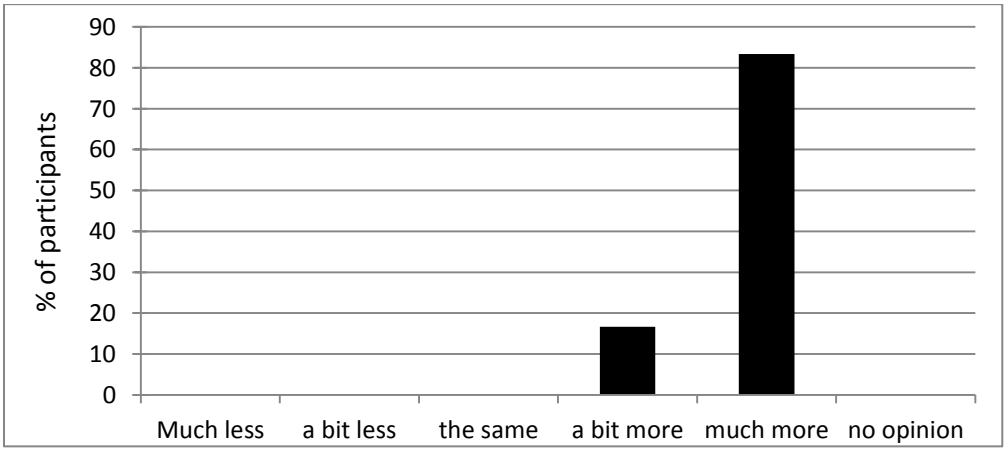
1. What kind of organization do you represent?



2. How important do you score the IAS-problem in your current organizational program?



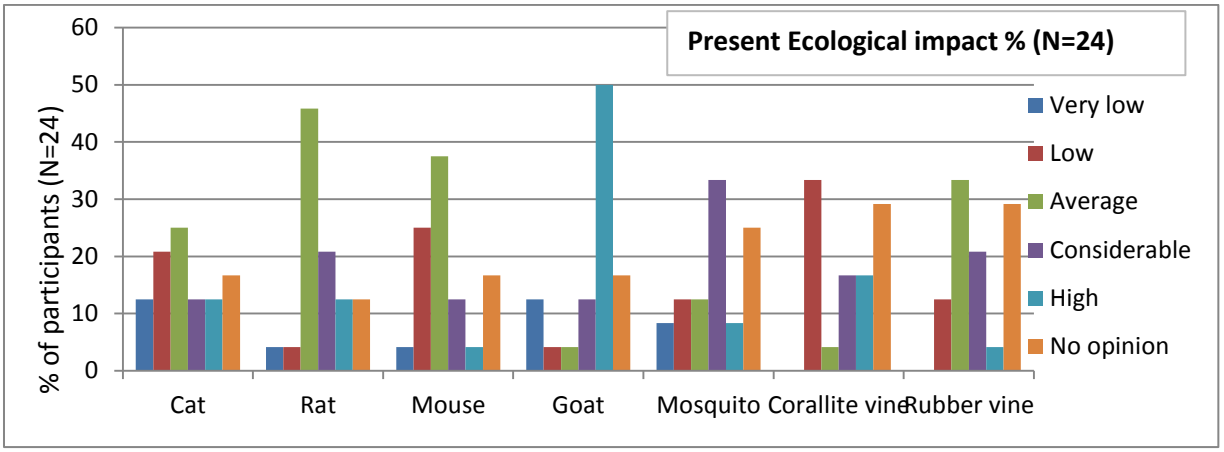
3. According to you, does the IAS-problem deserve more, the same or less attention?

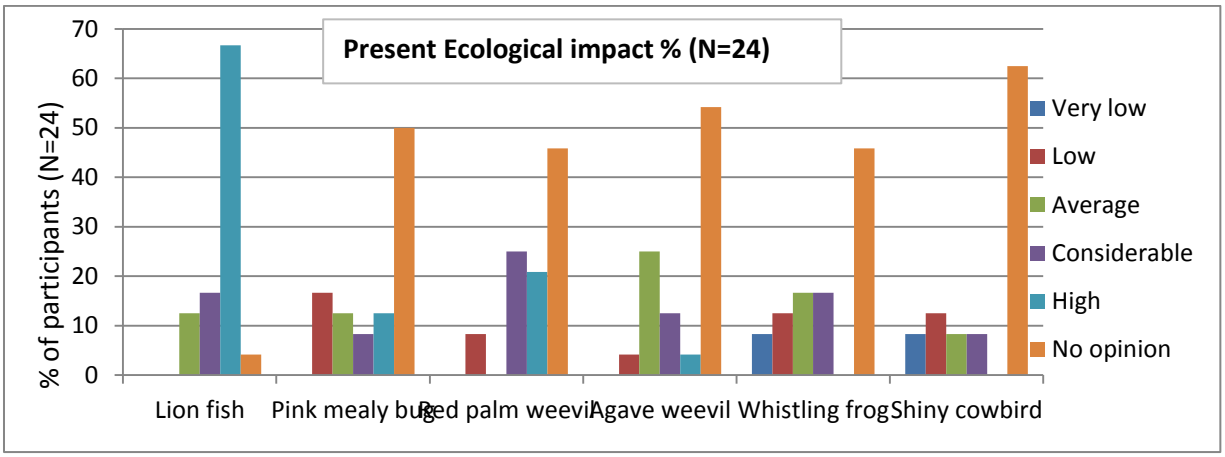


4. Which invasive alien species do you consider are presently the most impacting invasive alien species according to your organization and sectoral interests?

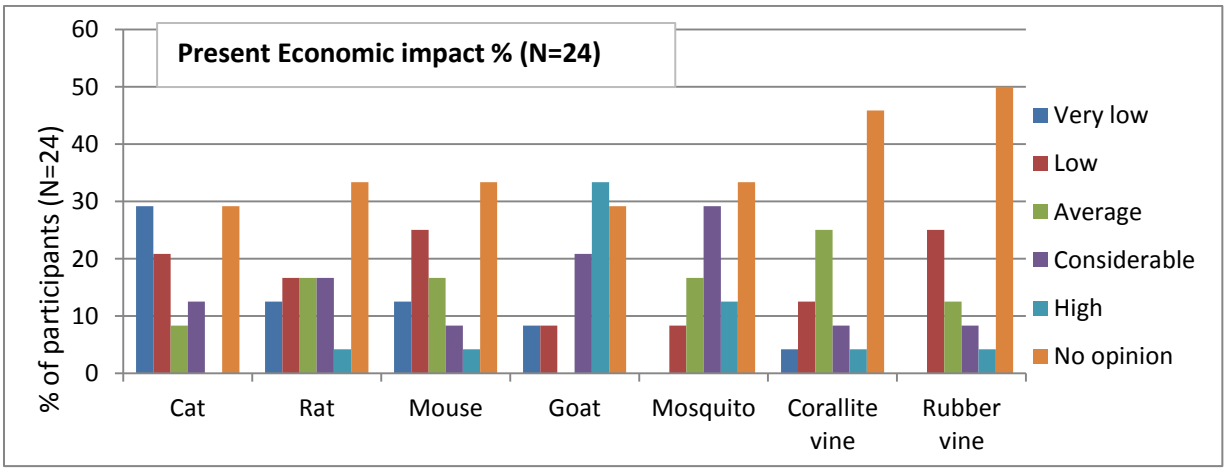
1. Lion fish (29%)
2. Goat (22%)
3. Red palm weevil (9%)

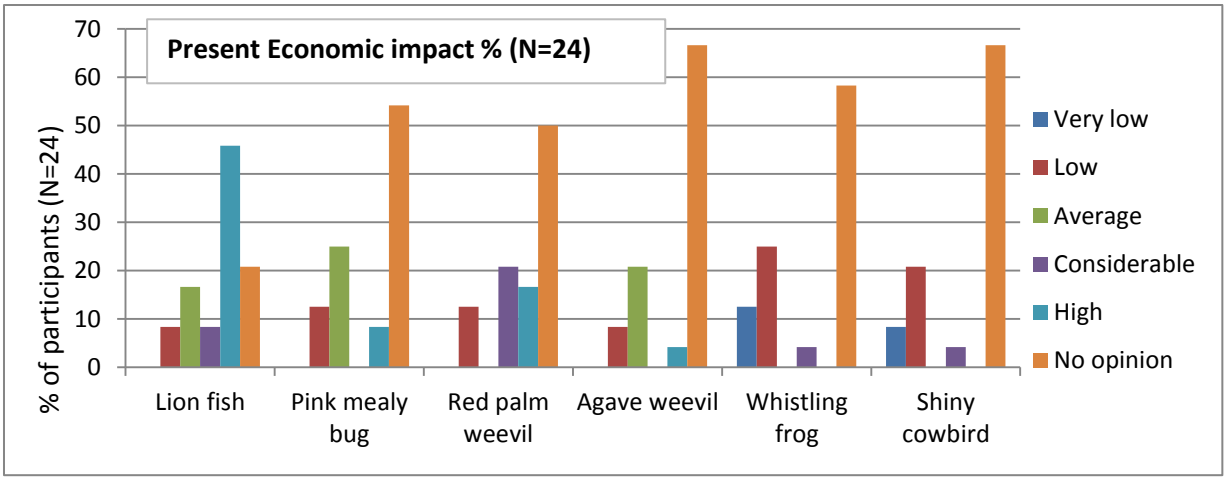
5. To your best knowledge, rank the following invasive species according to present ecological impact on your island.



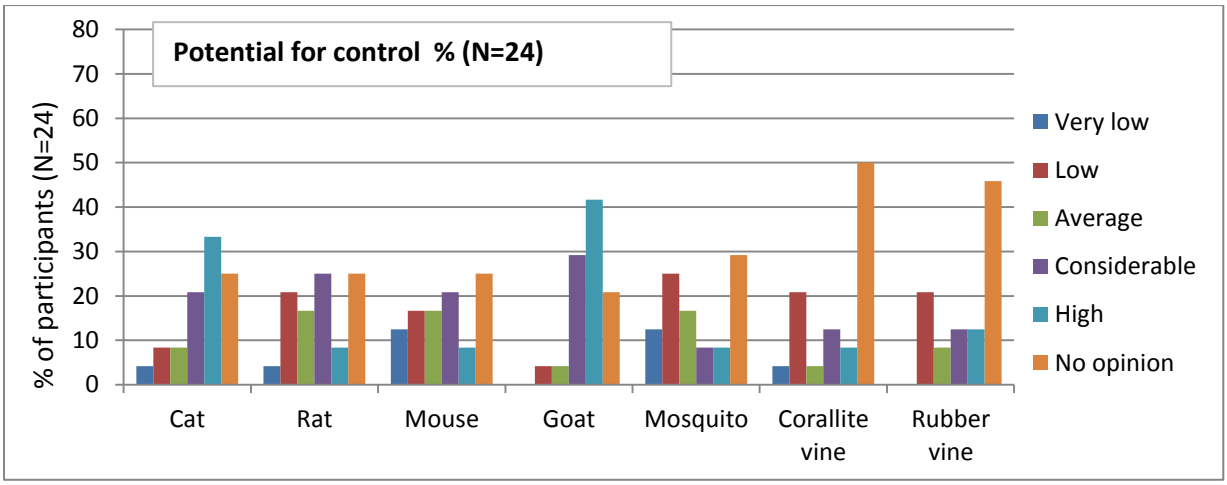


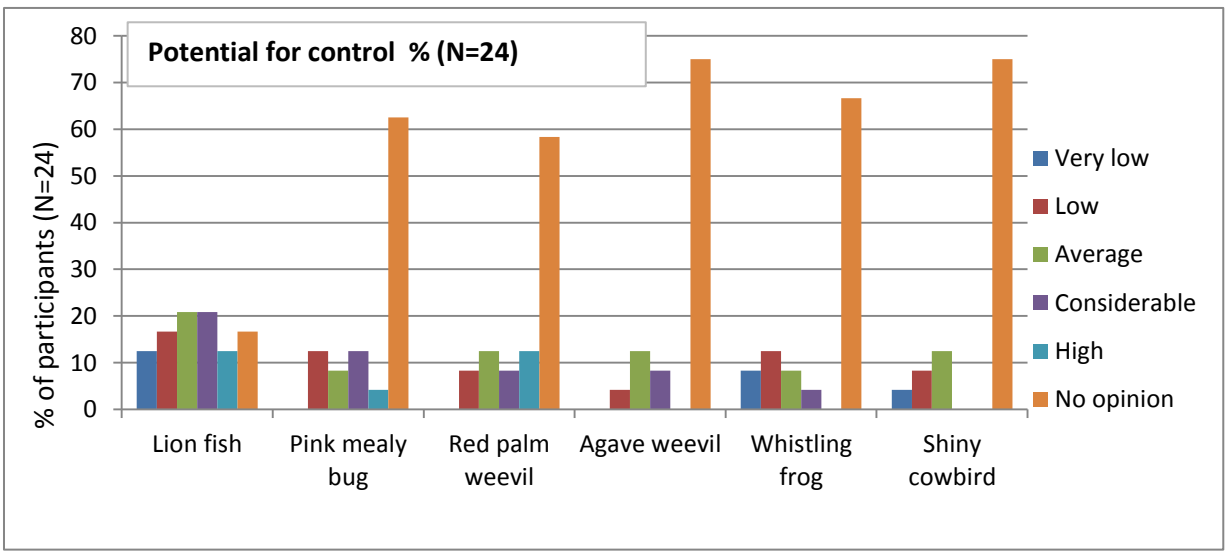
6. To your best knowledge, rank the following invasive species, according to economic impact for your island.



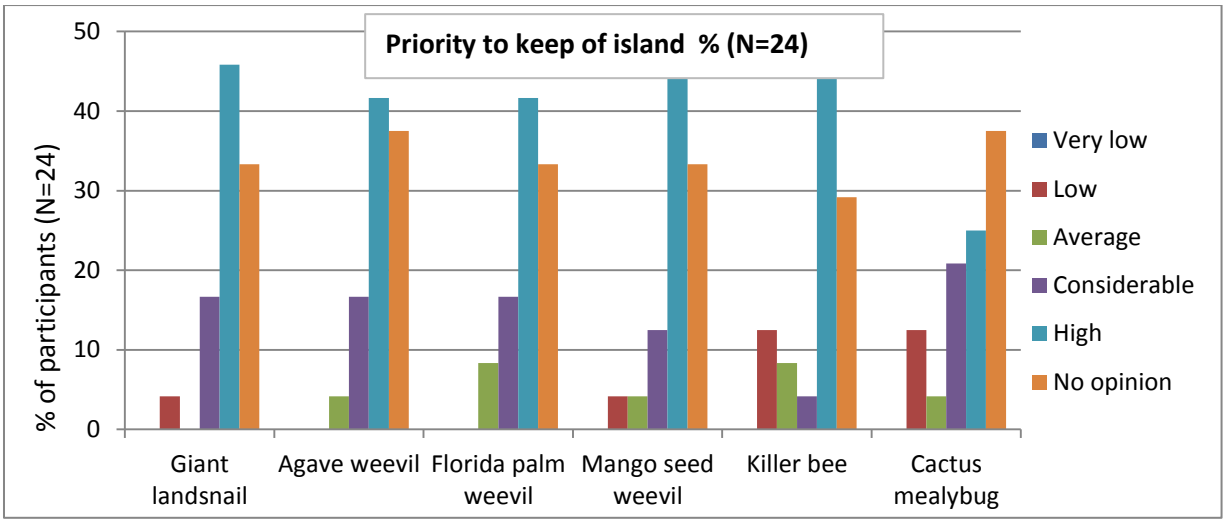


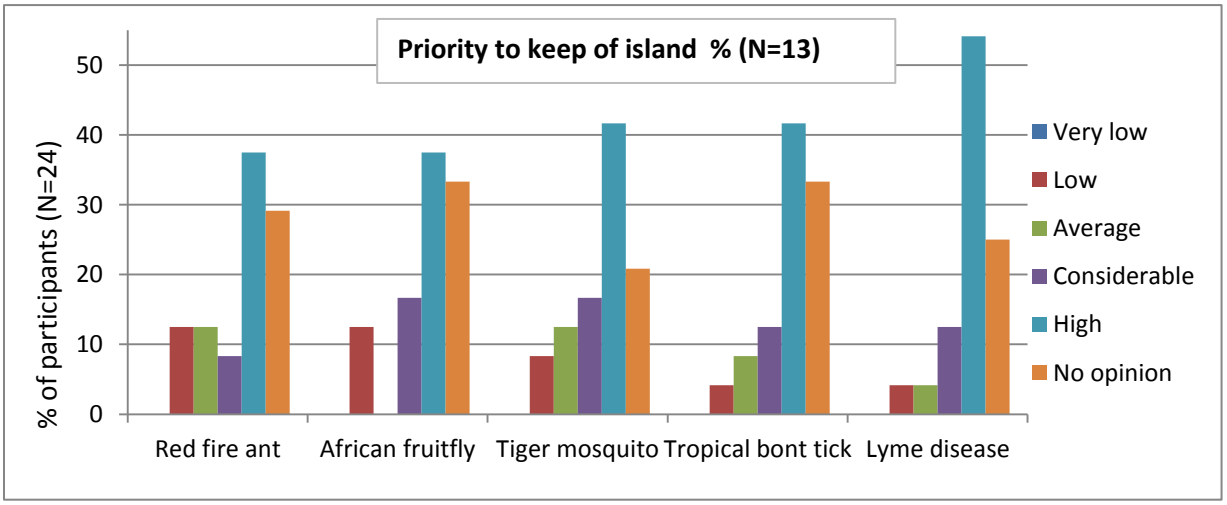
7. To your best knowledge, rank the following invasive species according to the potential for successful control on your island.



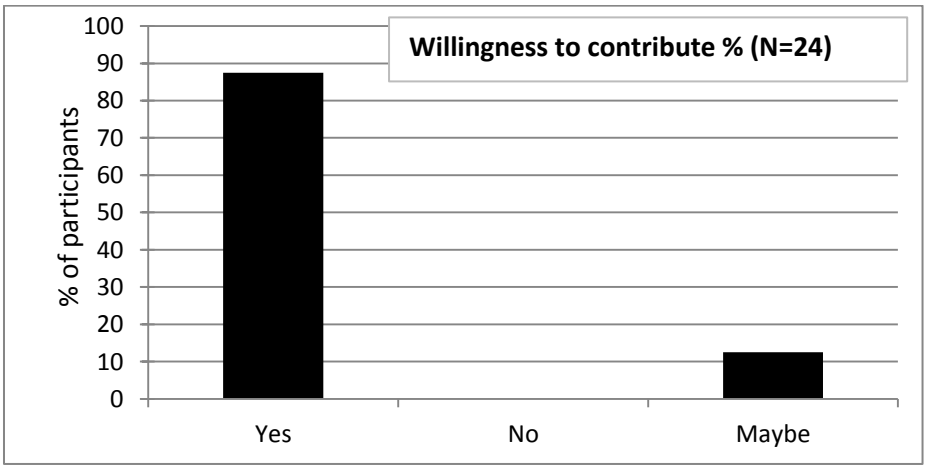


8. To your best knowledge, rank the following invasive species according to their priority to keep off your island.

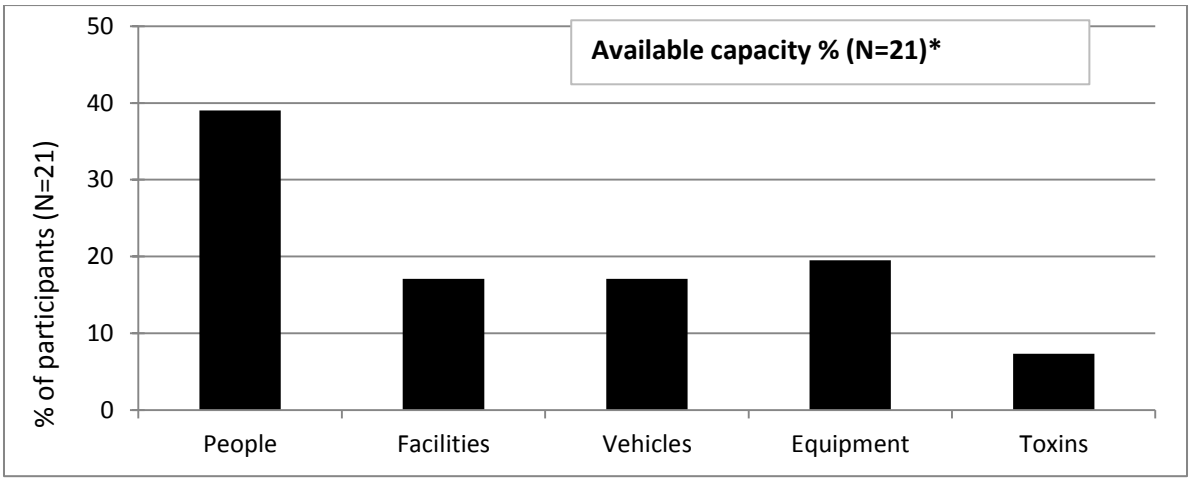




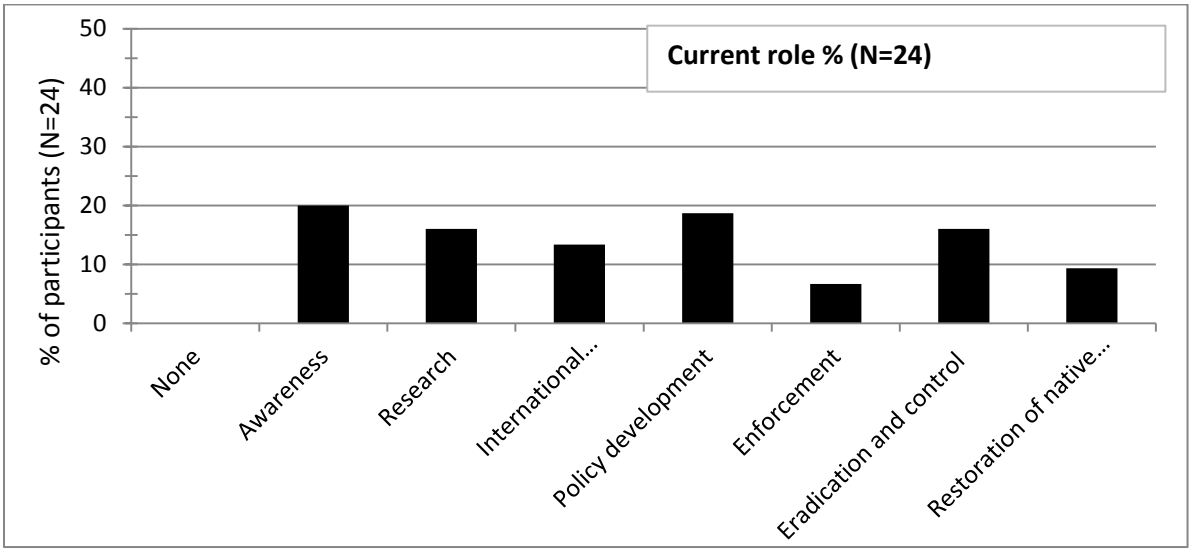
9. Is your organization willing to contribute to the fight against invasive species?



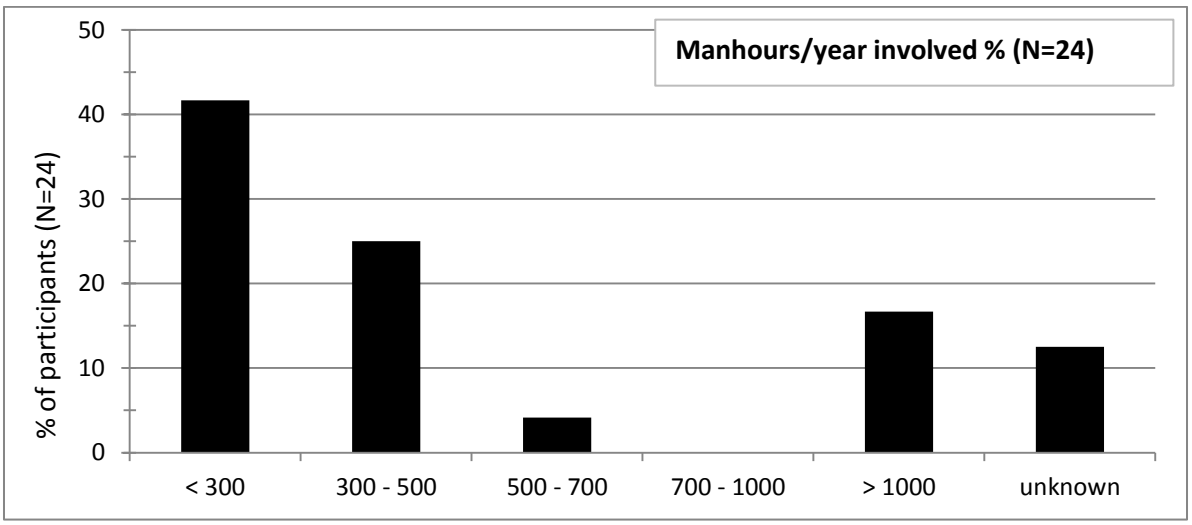
10. What is the available capacity in your organization to contribute to the fight against invasive species? ** Three participants did not answer this question.*



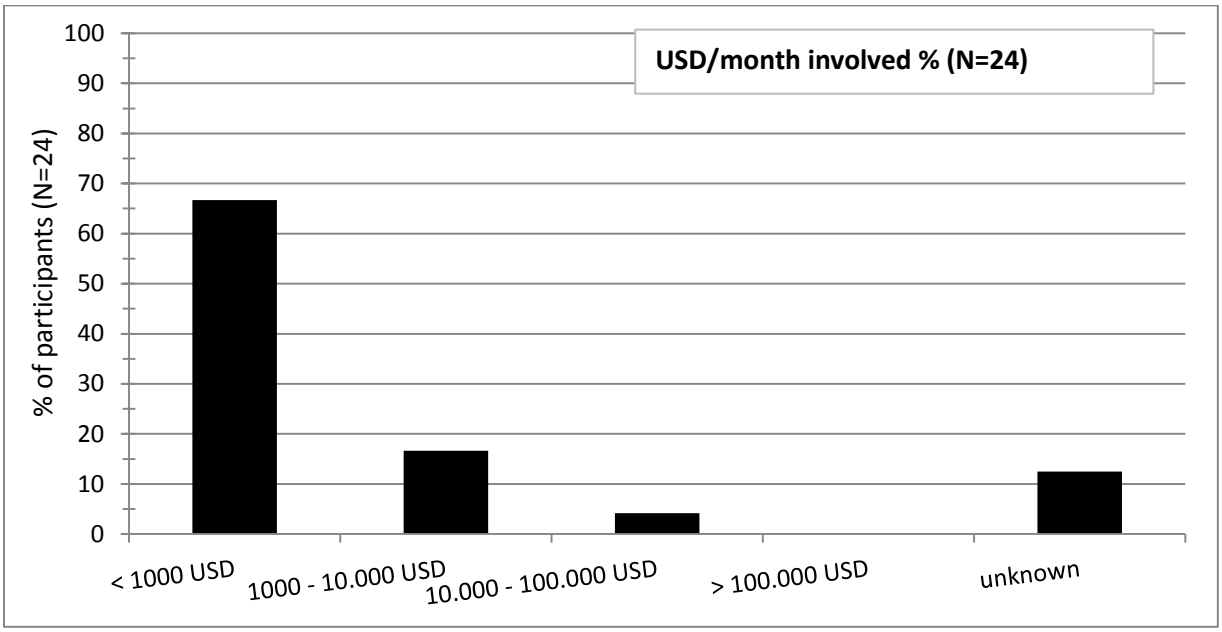
11. What is the current role of your organization in this process?



12. How many man-hours/year do these activities involve?



13. How much are the financial resources that these activities represent (per month)?



14. In which field do the main problems arise according to your organization, when it comes to combating invasive species?

1. Awareness (22%)
2. Policy (16%)
3. Enforcement (16%)

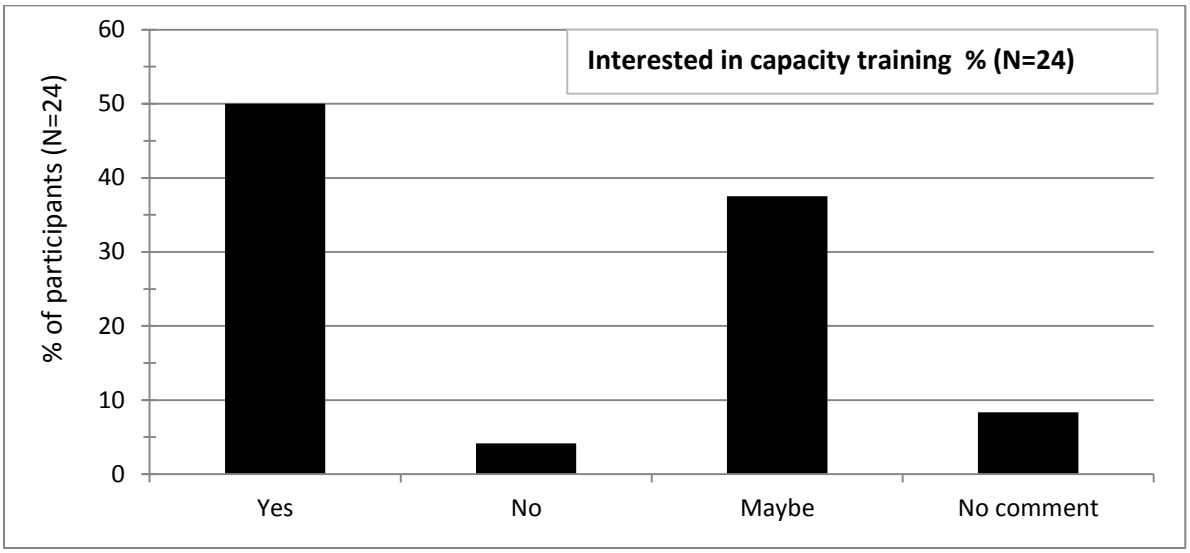
15. What are the priority problem areas that still need to be overcome?

1. Political attention (26%)
2. Awareness (24%)
3. Embedding into legal framework/ Enforcement (20%)
4. Capacity (14%)
5. Lack of IAS knowledge (13%)

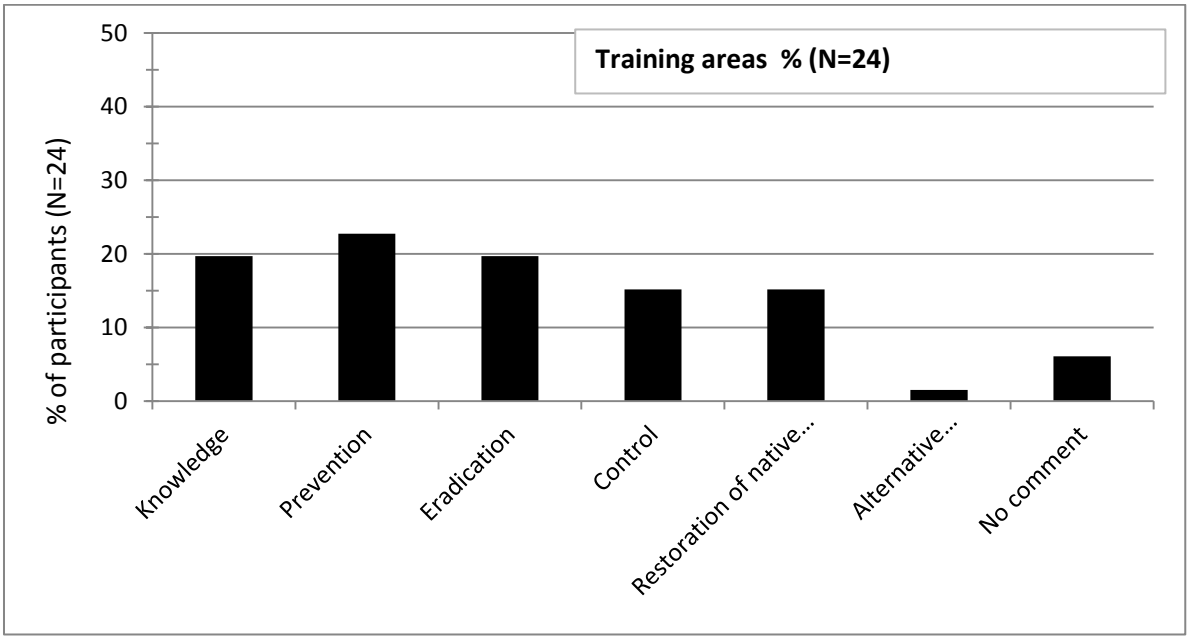
16. In your opinion, which area(s) of approach should the regulations focus on?

1. All of the above (57%, Knowledge, Prevention, Eradication Control, Restoration of native species)
2. Prevention (18%)
3. Eradication (9%)
4. Control (8%)
5. Knowledge (6%)

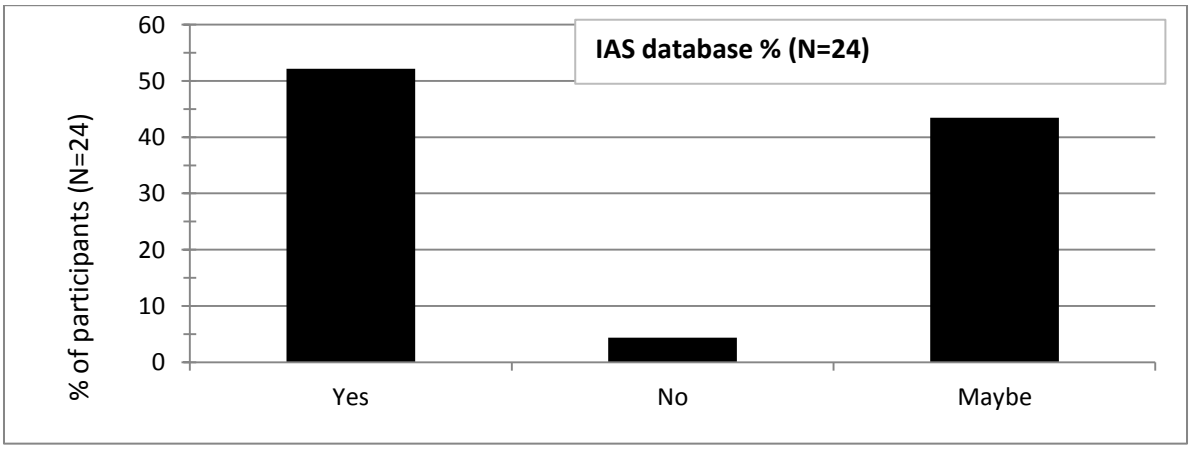
17a. Would your organization be interested in receiving 'capacity trainings'?



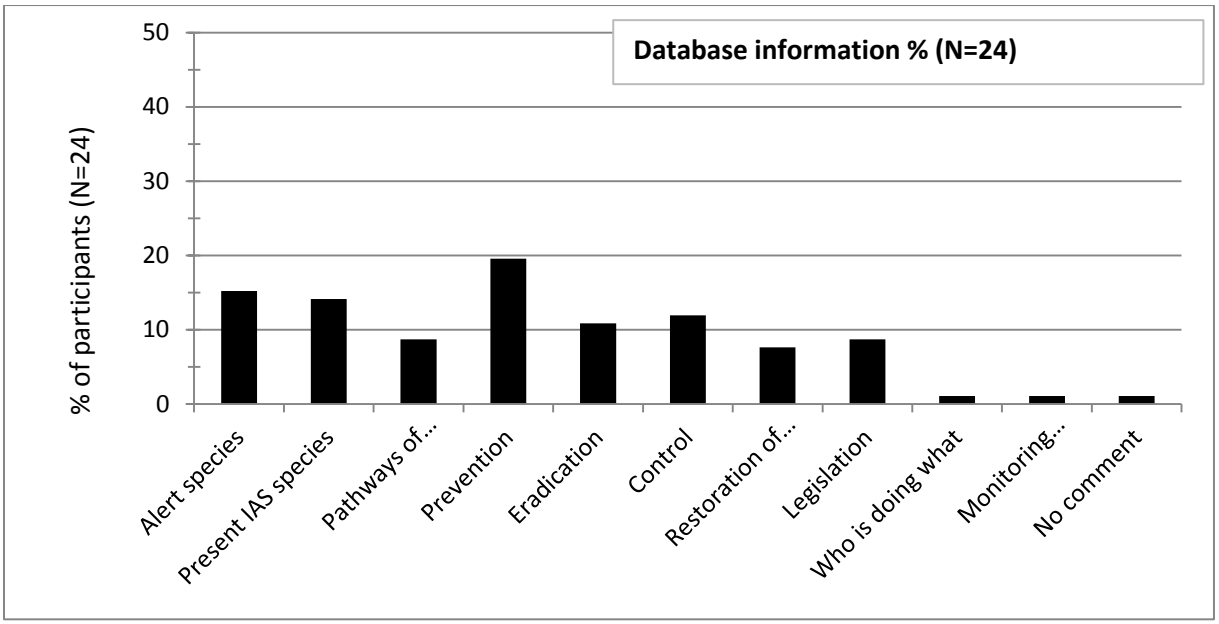
17b. If so, in what areas?



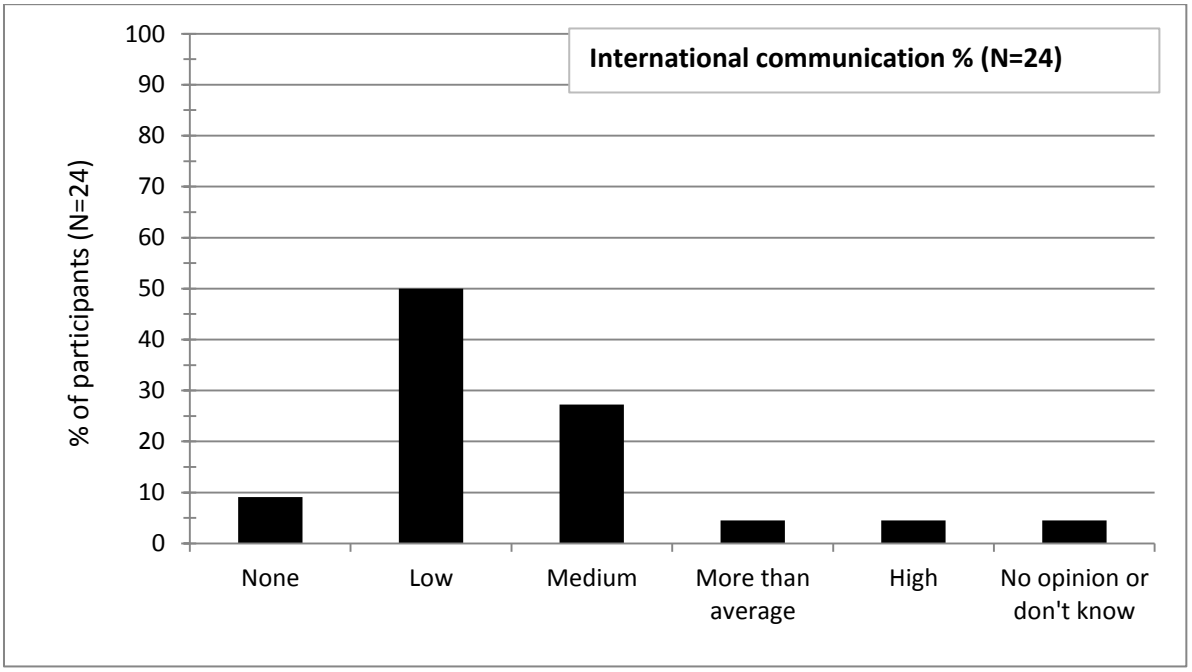
18a. Would an IAS information system and database be welcome?



18b. If so, what kind of information would your organization most want to obtain? Information on:



19. To what extent does you organization presently communicate with the surrounding countries concerning invasive alien species?



Appendix 5. Decision key to determine the need for listing and action

This key may be used to determine whether a particular species needs to be listed, and hence requires action, or can be ignored. It is based on Van der Burg & Lotz (2011) and Weber *et al*. (2005).

BL = Black list: present, shall be avoided and needs immediate action if present

WL = Watch List: present, potentially invasive and problematic, needs close monitoring

AL = Alert List: not yet present, proven risk, must be prevented from introduction

NL = No listing, no action required

1 The species is not present yet, but is known to behave invasively in areas with a similar climate and it is likely to become introduced if no measures are taken ..... **AL**

1* The species is present already **2**

2 The (alien) species is known to behave invasively in areas with a similar climate **4**

2* The (alien) species is known to behave invasively in areas with a (slightly) different climate **3**

3 The species behaves invasively on own territory, with large populations that seem to compete with local species **4**

3* The species does not show invasive behaviour. ..... **NL**

4 The species poses an important health hazard for man or animal, like allergenic or poisonous properties ..... **BL**

4* The species does not pose important health hazards **5**

5 The species is present in valuable or vulnerable habitats **7**

5* The species is mainly present in human-associated habitats that are not particularly valuable from the point of nature conservation **6**

6 The species causes considerable economic losses ..... **BL**

6* The species causes little economic loss ..... **WL**

7 It is known that this species can outcompete local species or change the environment in such a way that local species are affected **8**

7* The species has no direct or indirect negative effect on other species ..... **WL**

8 The species indeed has an impact as described under 6 ..... **9**

8* That type of damage has not been observed yet, but is not unlikely ..... **WL**

9 The species is spreading rapidly locally or over larger distances **10**

9* The species is not spreading rapidly, the area is getting smaller or is insufficiently known ..... **WL**

10 The species is present in 1-5 restricted populations **11**

10* The species is present in more than 5 populations ..... **BL**

11 The species is difficult to control[1] and needs immediate action ..... **BL**

11* It is not necessary to act immediately ..... **WL**

[1] Plants are difficult to control or need immediate action if the species has a short life cycle (annual vs. perennial), make lots of seeds that remain viable for a long time, have seeds that can spread rapidly via water or air, the plants are difficult to remove completely.

[1] Animals are difficult to control when they have a short life cycle, have a large offspring, are difficult to control without harming other animals (like invasive insects), are very mobile, cannot be caught in an animal-friendly way.

Appendix 6. Preliminary Plant Black, Alert and Watch Lists for the Leeward Islands

(NB based on Van der Burg *et al*. 2012: the most obvious invasive plant species.)

Preliminary Black List for the Leeward Islands (A) B (C)

This list concerns those species already present that must be eradicated (if realistic) and be stopped from further entering. (Between brackets the island(s) where the species is not yet present).

Balanites aegyptica (A)

Ficus microcarpa (A, B)

Jasminum fluminense (A)

Kalanchoe pinnata + spp. (A, B, C)

Scaevola taccada (A)

Schinus therebinthifolius (A, B)

Preliminary Alert List for the Leeward Islands (A) B (C)

This list concerns known invasive species not yet present that must be stopped from entering. (Between brackets the islands that do not yet have these species in nature and should be especially vigilant). All grass species (exceptions for agricultural purposes may be made based on a risk assessment and special import permit required).

Agave sisalana (A, B)

Balanites aegyptica (A)

Caesalpinia bonduc (A, B, C)

Euphorbia tithymaloides (A, B)

Ficus microphylla (A, B)

Indigofera tinctoria (A)

Luffa aegytiaca (A, B)

Melaleuca quinquenervia (A)

Oeceoclades maculata (A, B)

Sansevieria (A, B, C)

Preliminary Watch List for the Leeward Islands (A) B (C)

This list concerns those species already present on the islands mentioned between brackets but must be contained.

Albizia lebbeck (A, B, C)

Antigonon leptopus (A, B, C)

Azadirachta indica (A, B, C)

Balanites aegyptica (B, C)

Cryptostegia grandiflora (A, B, C)

Cyperus rotundus (A, B, C)

Euphorbia tithymaloides (A, B)

Ficus microcarpa (C)

Indigofera tinctoria (B, C)

Jasminum fluminense (B, C)

Kalanchoe daigremontiana (A, B, C)

Lawsonia inermis (A, B, C)

Leucaena leucocephala (A, B, C)

Luffa aegytiaca (C)

Megathyrsus maximus (C)

Melaleuca quinquenervia (B, C)

Moringa oleifera (A, B, C)

Oeceoclades maculata (C)

Scaevola taccada (B, C)

Schinus therebinthifolius (C)

Tabebuia heterophylla (A, B, C)

Tecoma stans (A, B, C)

Ziziphus spina-christi (A, B, C)

Appendix 7. Preliminary Plant Black, Alert and Watch Lists for the Windward Islands

Preliminary Black List for SA, SE (SM)

This list concerns those species already present that must be eradicated (if realistic) and be stopped from further entering. (Between brackets the island(s) where the species is not yet present).

Antigonon leptopus ()

Azadirachta indica (SE, SM)

Bambusa vulgaris ()

Cyperus rotundus (SE)

Oeceoclades maculata (SA, SE)

Tithonia diversifolia (SA)

Preliminary Alert List for the Windward Islands SA, SE (SM)

This list concerns the known invasive species not yet present that must be stopped from entering. (Between brackets the islands that do not yet have these species and/or should be especially vigilant). All grass species (exceptions for agricultural purposes may be made based on a risk assessment and special import permit required).

All fern species (SA, SE, SM)

Azadirachta indica (SA)

Bambusa vulgaris (SE, SM)

Cyperus rotundus (SA, SM)

Epipremnum aureum (SM)

Euphorbia all spp. (SA, SE, SM)

Indigofera tinctoria (SE)

Kalanchoe all spp. (SA, SE, SM)

Melaleuca quinquenervia (SA, SM)

Oeceoclades maculata (SM)

Philodendron giganteum (SM)

Senna bicapsularis (SM)

Senna italica (SA, SE)

Syngonium podophyllum (SE, SM)

Tabebuia heterophylla (SM)

Tithonia diversifolia (SE, SM)

Preliminary Watch List for SA, SE (SM)

This list concerns those species already present on the islands mentioned between brackets but must be contained.

Azadirachta indica (SE, SM)

Bambusa vulgaris (SA)

Cryptostegia grandiflora (SA, SE, SM)

Epipremnum aureum (SA, SE)

Euphorbia tithymaloides (SE)

Indigofera tinctoria (SA, SM)

Jasminum fluminense (SA, SE, SM)

Kalanchoe daigremontiana (SA)

Kalanchoe pinnata (SA, SE, SM)

Lawsonia inermis (SA, SE, SM)

Leucaena leucocephala (SA, SE, SM)

Melaleuca quinquenervia (SE)

Nephrolepis spp. (SA)

Philodendron giganteum (SA, SE)

Psidium guajava (SA, SE, SM)

Pteris spp. (SA, SE)

Ricinus communis (SA, SE, SM)

Sansevieria spp. (SA, SE, SM)

Senna bicapsularis (SA, SE)

Senna italica (SM)

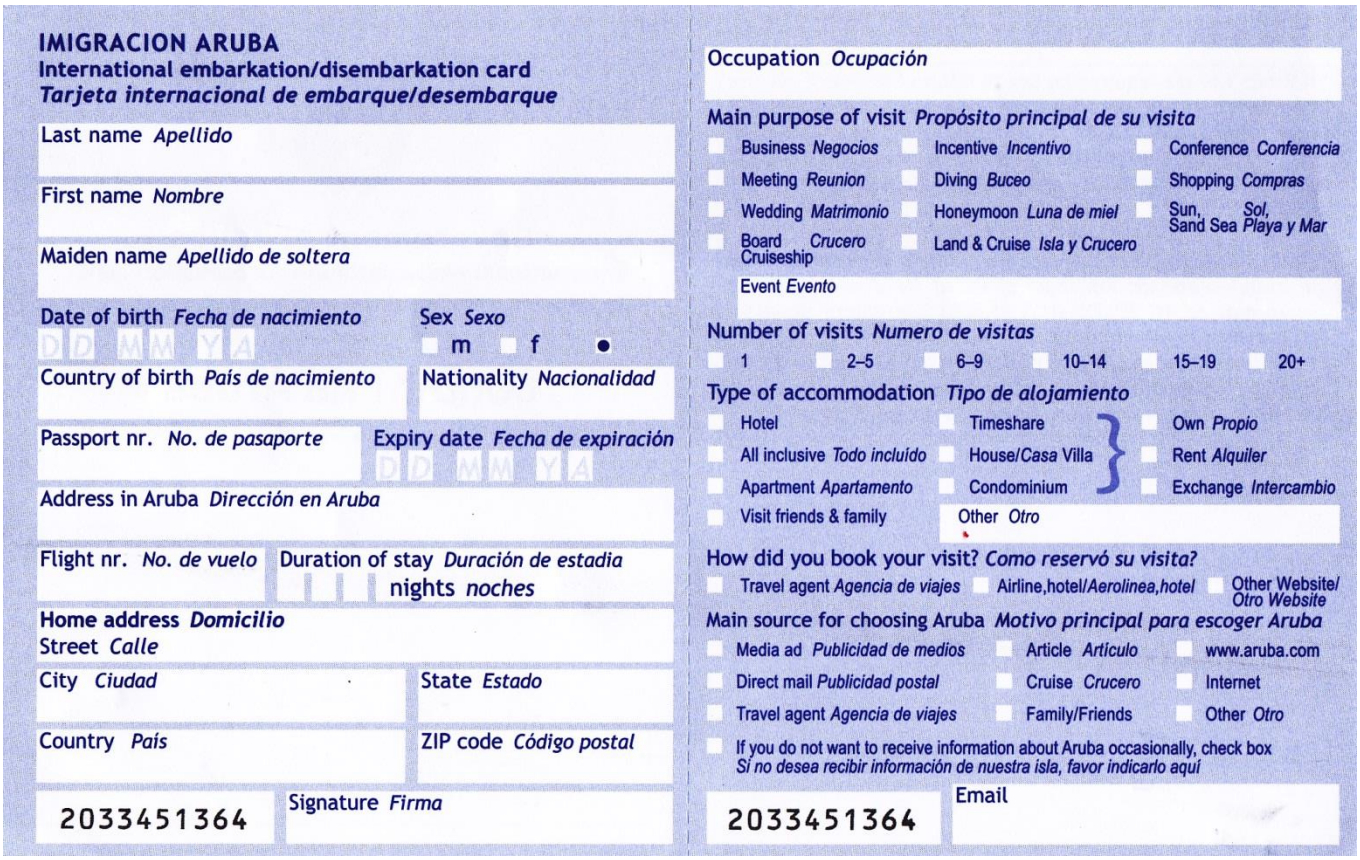
Syngonium podophyllum (SA)

Tabebuia heterophylla (SE)

Tecoma stans (SA, SE, SM)

Tithonia diversifolia (SA, SM)

Appendix 8. Self-reporting border control Aruba,



IMIGRACION ARUBA
International embarkation/disembarkation card
Tarjeta internacional de embarque/desembarque

Last name *Apellido*

First name *Nombre*

Maiden name *Apellido de soltera*

Date of birth *Fecha de nacimiento* D D M M Y Y

Sex *Sexo* m f

Country of birth *País de nacimiento*

Nationality *Nacionalidad*

Passport nr. *No. de pasaporte*

Expiry date *Fecha de expiración* D D M M Y Y

Address in Aruba *Dirección en Aruba*

Flight nr. *No. de vuelo*

Duration of stay *Duración de estadia* nights *noches*

Home address *Domicilio*
Street *Calle*

City *Ciudad*

State *Estado*

Country *País*

ZIP code *Código postal*

2033451364

Signature *Firma*

Occupation *Ocupación*

Main purpose of visit *Propósito principal de su visita*

- Business *Negocios*
- Incentive *Incentivo*
- Conference *Conferencia*
- Meeting *Reunion*
- Diving *Buceo*
- Shopping *Compras*
- Wedding *Matrimonio*
- Honeymoon *Luna de miel*
- Sun, Sand Sea *Sol, Playa y Mar*
- Board Cruiseship *Crucero*
- Land & Cruise *Isla y Crucero*

Event *Evento*

Number of visits *Numero de visitas*

1 2–5 6–9 10–14 15–19 20+

Type of accommodation *Tipo de alojamiento*

- Hotel
- Timeshare
- Own *Propio*
- All inclusive *Todo incluído*
- House/*Casa* Villa
- Rent *Alquiler*
- Apartment *Apartamento*
- Condominium
- Exchange *Intercambio*
- Visit friends & family
- Other *Otro*

How did you book your visit? *Como reservó su visita?*

Travel agent *Agencia de viajes* Airline,hotel/*Aerolinea,hotel* Other Website/ *Otro Website*

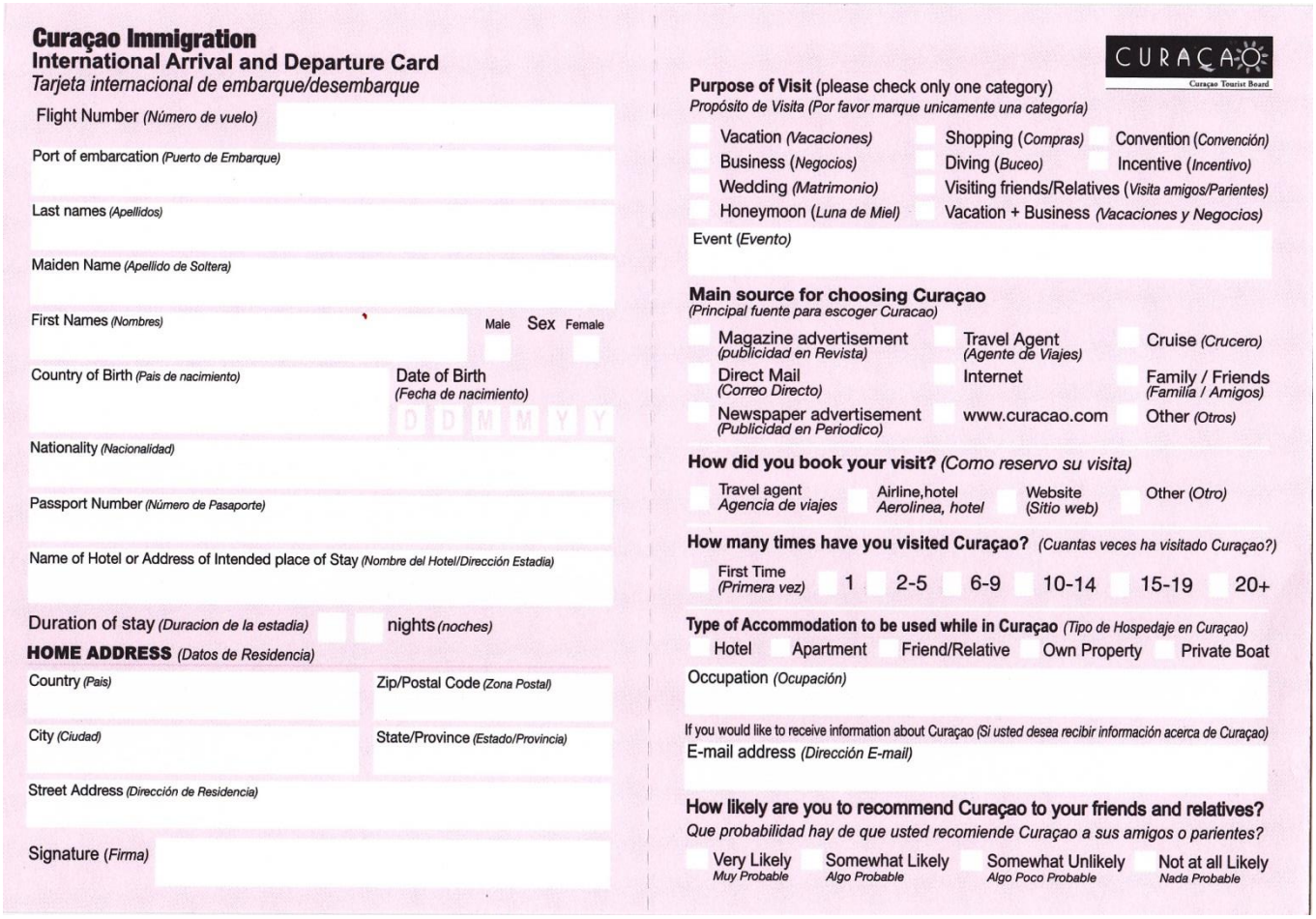
Main source for choosing Aruba *Motivo principal para escoger Aruba*

- Media ad *Publicidad de medios*
- Article *Articulo*
- www.aruba.com
- Direct mail *Publicidad postal*
- Cruise *Crucero*
- Internet
- Travel agent *Agencia de viajes*
- Family/Friends
- Other *Otro*

If you do not want to receive information about Aruba occasionally, check box
Si no desea recibir información de nuestra isla, favor indicarlo aquí

2033451364

Email



Curaçao Immigration
International Arrival and Departure Card
Tarjeta internacional de embarque/desembarque

Flight Number *(Número de vuelo)*

Port of embarcation *(Puerto de Embarque)*

Last names *(Apellidos)*

Maiden Name *(Apellido de Soltera)*

First Names *(Nombres)*

Sex Male Female

Country of Birth *(Pais de nacimiento)*

Date of Birth *(Fecha de nacimiento)* D D M M Y Y

Nationality *(Nacionalidad)*

Passport Number *(Número de Pasaporte)*

Name of Hotel or Address of Intended place of Stay *(Nombre del Hotel/Dirección Estadia)*

Duration of stay *(Duracion de la estadia)* nights *(noches)*

HOME ADDRESS *(Datos de Residencia)*

Country *(Pais)*

Zip/Postal Code *(Zona Postal)*

City *(Ciudad)*

State/Province *(Estado/Provincia)*

Street Address *(Dirección de Residencia)*

Signature *(Firma)*

CURAÇAO
Curaçao Tourist Board

Purpose of Visit (please check only one category)
Propósito de Visita (Por favor marque unicamente una categoría)

- Vacation *(Vacaciones)*
- Shopping *(Compras)*
- Convention *(Convención)*
- Business *(Negocios)*
- Diving *(Buceo)*
- Incentive *(Incentivo)*
- Wedding *(Matrimonio)*
- Visiting friends/Relatives *(Visita amigos/Parientes)*
- Honeymoon *(Luna de Miel)*
- Vacation + Business *(Vacaciones y Negocios)*

Event *(Evento)*

Main source for choosing Curaçao
(Principal fuente para escoger Curacao)

- Magazine advertisement *(publicidad en Revista)*
- Travel Agent *(Agente de Viajes)*
- Cruise *(Crucero)*
- Direct Mail *(Correo Directo)*
- Internet
- Family / Friends *(Familia / Amigos)*
- Newspaper advertisement *(Publicidad en Periodico)*
- www.curacao.com
- Other *(Otros)*

How did you book your visit? *(Como reservo su visita)*

Travel agent *Agencia de viajes* Airline,hotel *Aerolinea, hotel* Website *(Sitio web)* Other *(Otro)*

How many times have you visited Curaçao? *(Cuantas veces ha visitado Curaçao?)*

First Time *(Primera vez)* 1 2-5 6-9 10-14 15-19 20+

Type of Accommodation to be used while in Curaçao *(Tipo de Hospedaje en Curaçao)*

Hotel Apartment Friend/Relative Own Property Private Boat

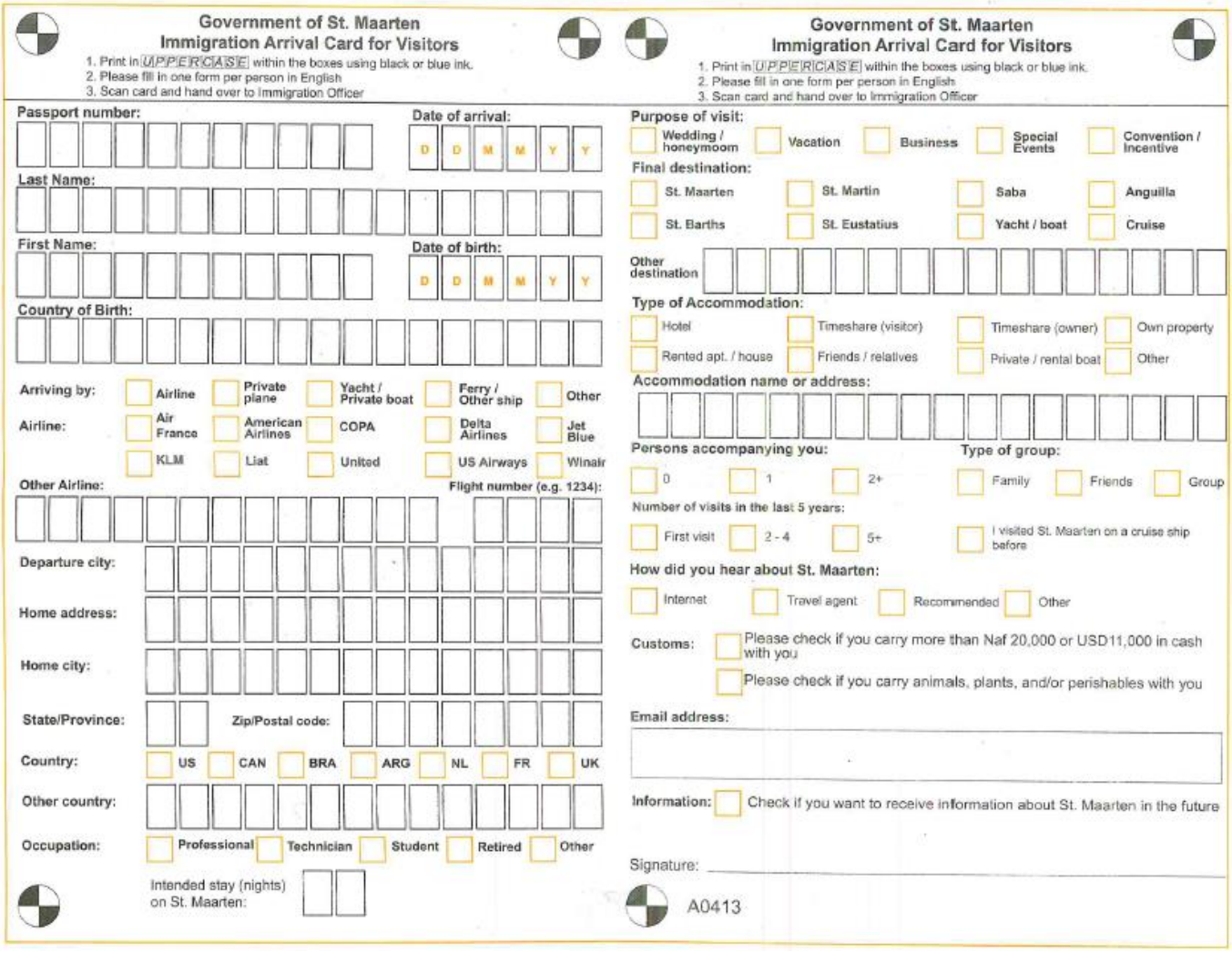
Occupation *(Ocupación)*

If you would like to receive information about Curaçao *(Si usted desea recibir información acerca de Curaçao)*
E-mail address *(Dirección E-mail)*

How likely are you to recommend Curaçao to your friends and relatives?
Que probabilidad hay de que usted recomiende Curaçao a sus amigos o parientes?

Very Likely *Muy Probable* Somewhat Likely *Algo Probable* Somewhat Unlikely *Algo Poco Probable* Not at all Likely *Nada Probable*

Curacao and St. Maarten



Government of St. Maarten
Immigration Arrival Card for Visitors

1. Print in UPPERCASE within the boxes using black or blue ink.
2. Please fill in one form per person in English
3. Scan card and hand over to Immigration Officer

Passport number:

Date of arrival: D D M M Y Y

Last Name:

First Name:

Date of birth: D D M M Y Y

Country of Birth:

Arriving by: Airline | Private plane | Yacht / Private boat | Ferry / Other ship | Other

Airline: Air France | American Airlines | COPA | Delta Airlines | Jet Blue | KLM | Liat | United | US Airways | Winair

Other Airline:

Flight number (e.g. 1234):

Departure city:

Home address:

Home city:

State/Province:

Zip/Postal code:

Country: US | CAN | BRA | ARG | NL | FR | UK

Other country:

Occupation: Professional | Technician | Student | Retired | Other

Intended stay (nights) on St. Maarten:

Government of St. Maarten
Immigration Arrival Card for Visitors

1. Print in UPPERCASE within the boxes using black or blue ink.
2. Please fill in one form per person in English
3. Scan card and hand over to Immigration Officer

Purpose of visit: Wedding / honeymoon | Vacation | Business | Special Events | Convention / Incentive

Final destination: St. Maarten | St. Martin | Saba | Anguilla | St. Barths | St. Eustatius | Yacht / boat | Cruise

Other destination

Type of Accommodation: Hotel | Timeshare (visitor) | Timeshare (owner) | Own property | Rented apt. / house | Friends / relatives | Private / rental boat | Other

Accommodation name or address:

Persons accompanying you: 0 | 1 | 2+

Type of group: Family | Friends | Group

Number of visits in the last 5 years: First visit | 2 - 4 | 5+ | I visited St. Maarten on a cruise ship before

How did you hear about St. Maarten: Internet | Travel agent | Recommended | Other

Customs: Please check if you carry more than Naf 20,000 or USD11,000 in cash with you

Please check if you carry animals, plants, and/or perishables with you

Email address:

Information: Check if you want to receive information about St. Maarten in the future

Signature:

A0413

Appendix 9. Besluit invoer kleine dieren BES

(Tekst geldend op: 29-11-2013)

Besluit invoer kleine dieren BES

Artikel 1

1. Onder kleine dieren wordt in dit besluit verstaan de tot de hierna genoemde biologische indeling behorende dieren:

a. de hond (canis domesticus)
b. de kat (felis domestica)
c. de familie der hondachtige
d. de familie der katachtige
e. de familie der hyena-achtige
f. de familie der marterachtigen
g. de familie der beren
h. de familie der haasachtige
i. de familie der halfhoevige
j. de familie der eekhoornachtige
k. de familie der muisachtige
l. de orde der apen
m. de orde der vleermuizen.

2. Bij ministeriële regeling kan dit besluit geheel of gedeeltelijk van toepassing worden verklaard op andere kleine dieren.

Artikel 2

1. Het is verboden kleine dieren in de openbare lichamen Bonaire, Sint Eustatius of Saba in te voeren zonder een geldige gezondheidsverklaring.

2. Een geldig bewijs van vaccinatie tegen rabiës is bovendien vereist voor het invoeren of doorvoeren van de onder a., b. en e. van artikel 1 genoemde diersoorten.

3. Een geldig bewijs van vaccinatie tegen rabiës kan vereist worden voor het invoeren of doorvoeren van de onder c., d., f., g., h., i., j., k., l. en m. genoemde diersoorten.

4. Bij ministeriële regeling kunnen andere voorschriften worden gegeven waaraan bij de invoer of doorvoer van de in artikel 1 genoemde diersoorten moet worden voldaan.

Artikel 3

1. Indien niet aan de in of krachtens artikel 2 gestelde voorwaarden is voldaan, moet het betrokken dier onmiddellijk in quarantaine worden gesteld. In dat geval is de vervoerder die het dier heeft aangebracht, verplicht dit per eerstvolgende gelegenheid terug of door te voeren.

2. De kosten van onderhoud en verpleging van het dier komen gedurende de quarantainetijd ten laste van de vervoerder die het dier heeft aangebracht, en kunnen op het schip of luchtvaartuig worden verhaald.

3. Na het eindigen van de quarantainetijd kan het dier worden afgemaakt.

4. Slechts in zeer bijzondere gevallen, zulks ter beoordeling van Onze Minister of de door deze aan te wijzen deskundige, kan verlenging worden toegestaan van de quarantainetijd.

Artikel 4

1. Doorvoer van de in artikel 1 genoemde dieren zonder het in de leden 2 en 3 van artikel 2 vereiste bewijs van vaccinatie is geoorloofd, indien de dieren gedurende hun verblijf in de openbare lichamen Bonaire, Sint Eustatius of Saba in quarantaine worden gesteld en per eerstvolgende gelegenheid worden doorgevoerd.

2. De leden 2, 3 en 4 van het vorig artikel zijn ten deze toepasselijk, behoudens dat de maximum quarantainetijd zes weken bedraagt.

Artikel 5

Van het in of krachtens artikel 2 bepaalde en van het bepaalde in artikel 4 kunnen geheel of gedeeltelijk worden vrijgesteld, zulks ter beoordeling van Onze Minister of de door deze aan te wijzen deskundige, die dieren, welke nodig zijn voor wetenschappelijke en exhibitionistische doeleinden.

Artikel 6

Indien geen geldig bewijs van vaccinatie tegen rabiës aanwezig is, kan Onze Minister of de door deze aan te wijzen deskundige, hierbij geleid door maatstaven aangegeven door wetenschap en praktijk, het dier doen vaccineren op kosten van de vervoerder.
In een dergelijk geval vindt, tenzij Onze Minister zulks wel noodzakelijk acht, het bepaalde in artikel 3, lid 1, tweede zin, geen toepassing, ook indien niet is voldaan aan de overige door of krachtens artikel 2 gestelde voorwaarden.

Artikel 7

1. In afwijking van artikel 2, eerste lid, is de invoer in en de doorvoer door de openbare lichamen

Bonaire, Sint Eustatius of Saba van apen, honden en katten alsmede hondachtigen en katachtigen afkomstig uit één der landen van het vasteland van Zuid- en Midden-Amerika met uitzondering van Suriname verboden.

2. Het in het eerste lid bedoelde verbod geldt niet ingeval het betreft de invoer van de huisdieren van iemand die zich metterwoon in de openbare lichamen Bonaire, Sint Eustatius of Saba vestigt en die deze dieren reeds vier maanden of meer in zijn bezit heeft.

Artikel 8

Dit besluit berust op artikel 18.2.2 van de Invoeringswet openbare lichamen Bonaire, Sint Eustatius en Saba.

Artikel 9

Vervallen

Artikel 10

Dit besluit wordt aangehaald als: Besluit invoer kleine dieren BES

Appendix 10. Preliminary Black, Alert and Watch Lists for Non-Native Animal species in the Dutch Caribbean

Preliminary Black List for the Leeward and Windward Islands (A, B, C, SA, SE, SM)

This list concerns those species already present that must be eradicated (if realistic) and be stopped from further entering. Between brackets the island(s) where the species is known to be present.

Mammals

Wild boar	*Sus scrofa* (A, B, C, SE)
Mongoose	*Herpestes auropunctatus* (SM)

Reptiles

Boa constrictor	*Boa constrictor (A)*
Green Iguana	*Iguana iguana* (SM**)**

Amphibians

Cane Toad	*Rhinella marinus* (A)

Fish

Lionfish	*Pterois volitans/miles* (A, B, C, SA, SE, SM)*

Molluscs

Giant African Land Snail	*Achatina fulica* (A, SE, SM)

Plant diseases, vectors, parasites

Red Palm Weevil	*Rhynchophorus ferrogineus* (A, C)
Cactus Moth	*Cactoblastics cactorum* (SA, SE)

Animal diseases, vectors, parasites

Yellow fever mosquito	*Aedes aegypti* (A, B, C, SA, SE, SM)

Preliminary Alert List for the Leeward and Windward Dutch Islands (A, B, C, SA, SE, SM)

This list concerns known invasive species not yet present or present as native species but for which further introduction of non-native genes must be prevented. This list is compiled based on the experiences in other Caribbean countries, existing trade patterns and taking into account which species could survive in an arid climate.

Reptiles

Green Iguana	*Iguana iguana*

Amphibian

Cane Toad	*Rhinella marinus*

Molluscs

Giant African Land Snail	*Achatina fulica*
Giant Ghana Snail	*Achatina achatina*

Giant West African Snail	*Achatina marginata*
Nigerian Land Snail	*Limicolaria aurora*

Animal diseases, vectors, parasites

Red Palm Weevil	*Rhynchophorus ferrogineus*
Cactus Moth	*Cactoblastics cactorum* (SE)
Common Lime Butterfly	*Papilio demoleus*

Beetles and Weevils

Asian ambrosia beetle	*Xyleborus glabratus*
Palmetto weevil	*Rhynchophorus cruentatus*
Agave weevil	*Scyphophorus acupunctatus*
Mango Seed weevil	*Stemochaetus mangiferae*

Mealybugs

South American Cactus mealybug	*Hypogoecoccus pungens*

Bees, Termites and Ants

Africanized honey bee	*Apis mellifera scutellata*
Formosan subterranean termite	*Coptotermes formosanus*
Red fire ant	*Solenops invicta*

Flies and mosquitos

African fruit fly	*Bactrocera invadens*
New World screw-worm fly	*Cochliomyia hominivorax*
Asian Tiger mosquito	*Aedes albopictus*

Butterflies

South American tomato pinworm	*Tuta absoluta*

Ticks and mites

Red palm mite	*Raoiella indica*
Tropical bont tick	*Amblyomma variegatum*

Nematodes

Red ring nematode	*Bursaphelechus cocophilus*

Barnacles

Striped Barnacle	*Balanus amphitrite**

Malacostraca

Variegate Shore Crab	*Geograpsus lividus**
Retiring Hairy Crab	*Pilumnus spinohirsutus**

Red algae
*Kappaphycus alvarezii**

Preliminary Watch List for the Leeward and Windward Islands (A, B, C, SA, SE, SM)

This list concerns those species already present on the islands mentioned between brackets but which must be contained and controlled. This list includes those species that at present are mainly present in human-associated habitats that are not particularly valuable from the point of nature conservation, but which even so may be a potential hazard for natural habitats.

Mammals

Cat	*Felix domesticus* (C, B, SA)
Goat	*Capra hircus* (A, B, SA, SE)
Donkey	*Equus asinus* (A, C, B, SE)

Birds

Shiny cowbird	*Moluthrus bonariensis* (A, C)

Molluscs

Cuban Brown Snail	*Zachrysia provisoria* (C, SA, SM)

Fish

Red Tilapia	*Oreochromis mossambica* (A, B, C, SM)

Animal diseases, vectors, parasites

Varroamite	*Varroa destructor* (A, C)

Plant diseases, vectors, parasites

White fly	*Bemisia tabaci* (C)
Black Citrus aphid	*Toxoptera citricida* (C, SE)
Sweet potato weevil	*Cylas formicarius* (C, SE, SM)
Common Lime Butterfly	*Papilio demoleus* (SE)
Palm thrips	*Thrips palmi* (C)
Cuban Laurel thrips	*Gynaikothrips ficorum* (C)
Citrus miner	*Phyllocnistis citrella* (A, B, C)
Pink/H Ibiscus mealy bug	*Macconellicoccus hirsutus* (A, C)
Papaya Mealy big	*Paracoccus marginatus* (C)
White partridge pea bug	*Crypticerya genistae* (C)
Spittle bug	*Aenolamia varia* (C)
Citrus hindu mite	*Schizotetranychus hindustanicus* (A, B, C)
Coconut scale	*Aspidiotus destructor* (C)
Longhorn beetle	*Mionochroma vittatum* (C)

Tabebuia plague	*Thrips sp*.? (SA)

Fungi

Sorghum ergot	*Claviceps africana* (C)
Fusarium of palms ()	-
-	*Ganoderma zonatum* (C)
-	Gliocladium of palms (C)

Mycoplasma Like Organisms
Lethal yellowing of palms (LY-disease) (SM)

Papaya Bunchy Top (MLO) (C)

Papaya Ringspot Virus (PRSV-P) (C)

Seagrass

Halophila seagrass	*Halophila stipulacea* (A, B, C, SE, SM)*

Crustose coralline
Ramicrusta sp. (B)*

* For marine species already loose and dispersed in the marine environment, actions will potentially be difficult.

Appendix 11. International legislation and initiatives

Shine *et al*. (2000) provides an extensive overview of the existing International regime concerning Alien Invasive Species. In the present section a few international legislations and initiatives important for the Caribbean are highlighted.

The **Convention on Biological Diversity (CBD)** is an international legally binding treaty for the conservation and sustainable use of biological diversity. Its existence was initiated by the United Nations Environment Programme (UNEP) and entered into force on 29 December 1993. The Convention's three main objectives are the conservation of biodiversity, the sustainable use of the components of biological biodiversity and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources. The Netherlands are party to the Convention since 12 June 1994. The countries that join the Convention (193 parties) are obliged to implement its provisions. Invasive species are considered main direct drivers of biodiversity loss. Parties of the Convention are required 'to prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species' (Article 8h). Other provisions of the Convention that should guide Parties include Article 11 (use of incentives as well as conventional regulatory approaches); Article 12 (promotion of research and training regarding conservation and sustainable use of biodiversity); and Article 13 (promotion of public education and awareness) (Shine, *et al*., 2000).

The **Global Invasive Species Programme (GISP)** is an international partnership which was founded in 1997. The programme focused on conserving biodiversity and sustaining human livelihoods by minimising the spread and impact of invasive alien species through prevention, eradication and management. It attempted to bring new approaches and commitment to the invasive species problem (Shine *et al*., 2000). The programme was closed down on 31st March 2011 and remaining activities were undertaken by CABI (a not-for-profit international organization that improves livelihood by solving problems in agriculture and the environment) (BGCI).

The **Globallast Programme** is a four year programme (2000-2004, implemented and executed by IMO, GEF and UNDP) assisting developing countries to implement effective measures to control the introduction of foreign marine species, in particular through ships' ballast water.

The **Caribbean Invasive Species Working Group (CISWG)** comprises of several Caribbean related organizations: CABI, CARDI, CARICOM Secretariat, CIRAD, FAO, IICA, PAHO, USDA-APHIS, UF and UWI. The working group develops strategies to prevent the introduction of alien invasive species and strategies to manage invasive species already present. The working group developed a Caribbean Regional Invasive Species Intervention Strategy (CRISIS) with agricultural pests as its main focus. At present the threat of invasive species for fisheries have not yet been considered.

The **IMO Ballast Water Convention**, adopted in 2004, is an internationally binding legal instrument on the control and management of ships' ballast water and sediments. By establishing standards and procedures for the management and control the spread of harmful aquatic organisms is prevented.

The **World Trade Organization (WTO)** provides in the negotiation of trade relations between member governments. WTO established multiple agreements to which the different member countries have committed to. One such agreement is the Sanitary and Phytosanitary Agreement, an agreement on how governments can apply food safety and animal and plant health measures (SPS measures). Some invasive alien species, such as diseases, are spread through trade of e.g. livestock and plants.

The **IPPC (International Plant Protection Convention, FAO)** is an international agreement on plant health (178 signatories, including the Netherlands), enforced on 3 April 1952. The agreement aims to protect cultivated and wild plants by preventing the introduction and spread of pests. Core activities include; governance, setting standards, exchange of information, settling disputes, capacity building and reviewing the global status of plant protection.

Appendix 12. National legal and institutional framework

Van der Burg & Lotz 2012 provide a summary of the legal and institutional framework of the Netherlands.

Policy in the Netherlands

Policy and regulations concerning invasive species are determined by the national government. In the Convention on Biological Diversity (CBD) Article 8h calls on its members 'to prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species'. In 2007, the Ministry of Agriculture, Nature and Food Quality (Ministerie van Landbouw, Natuurbeheer en Voedselkwaliteit, LNV, presently the Ministry of Economic Affairs, EZ) published the "Beleidsnota Invasieve Exoten" (Policy on invasive species). The policy describes when certain measures against invasive species should be taken and who has the responsibility to do so. Provinces, land managers and regional governmental bodies may determine for themselves how to combat invasive species in their area of responsibility.

Dutch policy focuses predominantly on the prevention and elimination in an early stage when dealing with invasive species to prevent damage to ecosystems. The policy notes that prevention, early detection and elimination are the responsibility of the government, while invasive species management (*i.e.* managing populations of invasives that are or cannot be eliminated completely) is a responsibility of land managers such as owners of forests, natural parks, and water boards.
The 'Beleidsnota Invasieve Exoten' (Policy Note on Invasive Exotics) recognises that invasive species can cause problems for public health, economy and security. The Ministry of Economic Affairs, the Ministry of Infrastructure and Environment and the Ministry of Health, Welfare and Sport work together with local authorities to mitigate the effects of invasive species. It is important to tune invasive species policy to the policy concerning the protection of agri- and horticultural crops and cattle, in order to make optimal use of the available expertise and facilities.

Since 1 Januari 2009 the 'Team Invasieve Exoten', TIE, has been created as part of the Dutch Food and Consumer Product Safety Authority (NVWA) and contributes to the implementation of national policy on invasive species. TIE predominantly focusses on invasive species that cause damage to the natural environment, but also to possible negative effects on public health, economy and security. Main activities of TIE include:

- Advisor for the Ministry of Economic Affairs
- Carry out or to have carried out risk assessments and monitoring
- Communication of risks to individuals, land managers, water boards and businesses.

The team strives for an optimal cooperation on international level.

Rijkswaterstaat (part of the Dutch Ministry of Infrastructure and the Environment) is working on an invasive species policy concerning coastal waters, in particular the Wadden Sea. In addition, the policy 'Beleidslijn Verplaatsing Schelpdieren' (Policy regarding the relocating of shellfish) has been drafted. Imports of shellfish harbours the danger of involuntarily introducing unwanted exotic species. Permits are necessary under the Natuurbeschermingswet (Nature Conservancy Act, 1998) when seeding shellfish like mussels and oysters. The new policy gives a clear overview of the different conditions necessary for allowing the relocation and cultivation of mussel seed, in such a way that Natura 2000 conservation objectives (like the Wadden Sea and the Eastern Scheldt) are met.

Provincial policy
Each province in the Netherlands has a 'Faunabeheereenheid' (Fauna management unit, FBE). These FBE's are responsible for the management of species and the mitigation of damage. Each FBE develops a fauna management plan, which describes the FBE tasks and objectives. Invasive species management is part of these fauna management plans.

Policy of Dutch Water boards and Land managers
Some Water boards and managers of natural park and forests develop joint management plans and policies, because of common problems with invasive species in their waters or on their terrain.

Regulation in the Netherlands

The intended new Wet Natuur (Nature Act) will replace three former nature conservation acts: the Flora- and Fauna Act, the Nature Conservation Act (1998) and the Forest act (1961). This new Nature Act will take into account the devolution agreement between Government and provinces (September 2011). Meaning, that provinces will be responsible for the elimination of invasive species, as designated by the Minister of Economic Affairs.

Flora and Fauna Act
Article 14 of the Flora- en Faunawet (Flora and Fauna Act) prohibits the introduction of indigenous and exotic species in the wild, with exception of a few fish species. Article 14 also prohibits the use of biological control. However, exemption possibilities are provided. It is forbidden to plant in the wild those flora species as designated by the 'Algemene Maatregel van Bestuur' (AMvB). Article 14 also prohibits the possession, trade and transport of plants and animals, as designated by the AMvB.

At present, the Water pennywort (*Hydrocotyle ranunculoides*) is forbidden to plant in the wild and together with the Reeves's muntjac (*Muntiacus reevesi*) it is forbidden to possess, trade or transport these two exotic species. Possession or trade in the three squirrel species; the Eastern grey squirrel (*Sciurus carolinensis*), the Pallas's squirrel (*Callosciurus erythraeus*) and the Fox squirrel (*Sciurus niger*) are both forbidden. This ban on possession applies since 1 juli 2012 (DR-loket 2012).

Article 67.1 of the Flora and Fauna Act allows Gedeputeerde Staten (Governments of provinces, GS) to decide to limit the populations of protected indigenous animals, other animals or feral animals as indicated by Ministerial Decree.
Appendix 1 of the 'Regeling Beheer en Schadebestrijding Dieren' (Regulation of management and damage control by animals, 2012) indicates the species to which this applies. Included are: the Coypu, the Muskrat, the Raccoon and the Ruddy Duck. GS of provinces can indicate persons and categories of persons (including water boards) and charge them with the control of these species, even without the consent of owners and users. The actual control can only be done using the control methods and compounds indicated for each species.

Nature Conservation Act (1998)
The Natuurbeschermingswet (Nature Conservation Act, 1998) allocates the Natura 2000 areas, the protected natural monuments and wetlands. Protected species are found in the species database of the Ministry of Economic Affairs. Invasive species can jeopardize the conservation objectives of Natura 2000 sites.

Fisheries Act
Article 17 of the Visserijwet (Fisheries Act) prohibits the release of fish and shellfish species in waterways without a permit, other than those designated. The species concerned are found in the 'Regeling aanwijzing vissen, schaal- en schelpdieren' (Regulation designated fish and shellfish).

Plant Health Act
Based on the Plantenziektenwet (Plant Health Act) measures can be taken to control organisms that can damage plants or plant products (crops) and to prevent the further spread of these species. In addition, this act implements the phytosanitary regulations of the EU.

Appendix 13. Preliminary inventory of plant control and management methods.

			S/M/L	Y/N	S/M/L			
Scientific name	**Environment, effect**	**Main mode of dispersal ***	**Potential impact**	**Listed in the Global Inavasive Species database (GISD 2012)**	**Possibility for complete eradication**	**Eradication/ Management**	**Conventional Biological Control & Pathology**	**References**
Agave sisalana Perrine	Sandy soils, it can outcompete native species	Profuse production of bulbils	S	Y	L	Uprooting all plants; herbicide on regrowth? Uprooting all plants feasible. Limited invasive potential and few patches present.		GISD 2012
Albizia lebbeck (L.) Benth.	Anywhere	Profuse production of seed	M	Y	M	Seedlings and saplings pulled out by hand or dug out. Cut trees and treat the stumps with herbicide		Weber 2003
Aloe vera (L.) Burm.f.	Rocky shores, dry land	Seed	M	N	S	Uprooting all plants		
Antigonon leptopus Hook. et Arn.	Dry to moist wasteland	Seeds floating on water; trailing stems, proliferous rhizome and tuber formation; nursery trade	L	Y	S	Mechanical removal of above-ground parts; treating stumps with systemic herbicide; regular repetitions. Removal from gardens. Spread into well developed vegetation is limited. Spread can be prevented by preventing ground disturbance.		Ernst & Ketner 2007; Burke and DiTomasso 2011; PIER 2012

Asystasia gangetica (L.) T.Anderson	Dry habitats, low elevation,, roadsides, disturbed habitats, recent clearings	Propelled seeds; trailing stems; this species can be highly invasive and can smother any vegetation	L	Y	S	Manual removal and herbicides		PIER 2012
Azadirachta indica A.Juss.	Anywhere	Profuse fruit production; distribution via seeds in bird and bat droppings	M	N	M	Removal of all trees and pulling of seedlings; treatment of the stumps with herbicide: it will otherwise quickly grow back or sucker from the roots. The trees tolerate coppicing very well. One should prevent it from flowering. Plant widespread in central and eastern Curacao. Removal of all trees and seedlings. This is still feasible for Bonaire where few trees are found and for the Knip plantation in western Curacao. Eradication also still feasible for Saba and St. Eustatius.		Csurshes 2008; PIER 2012; Schmidt and Jøker 2000
Balanites aegyptiaca (L.) Delile	Anywhere	Seeds in droppings of mammals	M?	N	L	Removal of all trees and seedlings. This is still feasible for Bonaire where few trees are found and for the Knip plantation in western Curacao. Plant widespread in central and eastern Curacao.		Burtt and Salisbury 1929
Bambusa vulgaris Schrad. ex J.C.Wendl.	Lowland humid habitats, water courses	Vegetatively by man, (broken-off) tillers (no seeds)	M	Y	M	Continued cutting will eventually exhaust most root stocks; herbicide treatment of stumps and regrowth		Cruzado et al. 1961; GISD 2012; PIER 2012

Bothriochloa ischaemum (L.) Keng	Adapted to a well-drained sandy soils (not deep sands), loams and clays. Has some salt tolerance.	Seeds by wind, water, animal fur	M?	N	S			Cook et al. 2005
Bothriochloa pertusa (L.) A.Camus	Native savannah, shrubland and riparian biotas	Seeds by wind; strong rhizome formation; allelopathic properties	L	Y	S	Intensive turf management (see main text); mechanical or chemical removal of the grass and planting with shade trees or permanent agriculture; replanting suggested with native seedlings of *Tabebuia heterophylla, Cordia rickseckeri, Conocarpus erectus, Bursera simaruba* and taller shrubs, which will prevent this shade-intolerant grass to re-establish	Main diseases in cultivation are rust caused by *Puccinia duthiae* and ergot caused by *Claviceps pusilla*. A smut caused by *Sporisorium* sp., and other fungal diseases caused by *Balansia sclerotica*, *Claviceps purpurea*, *Physoderma bothriochloae*, *Puccinia cesatii*, *P. erythroaeensis*, *P. pusilla*, *Sphacelotheca tenuis*, *Ustilago bothrioch-loae*, and *Uromyces andropogonis-annulati* have also been reported on *B. pertusa. Moderately* susceptible to attack by army worm (*Spodoptera* spp.) and other	Cook et al. 2005; McNair and Lombard 2004.

							lepidopterous larvae.	
Caesalpina bonduc (L.) Roxb.	Wasteland	Trailing stems; seeds; seeds are buoyant (drift seeds)	L	N	M	Removal of all vegetation and seedlings (persistent seeds will be all around for several years). Burning of patches may be feasible on saba and St. Eustatius.		Cook et al. 2005; McNair and Lombard 2004; Markland 2012
Calotropis procera (Aiton) W.T.Aiton	Wasteland, sea shore	Long-range wind dispersal of the very light seeds which are present almost all year round	M	N	B	Usually present with few individuals that are easy to remove; may incidentally form uniform stands, especially in disturbed lands; a dense pasture sward prevents invasion. Deep taproots withstand almost any treatment. Chemical control appears to be no realistic option.	Co-evolved fungal pathogens: *Ascochyta tripolitana* Sacc. and Trotter, *Gloeosporium calotropidis* Pat. and Har., *Napicladium calotropidis* Morstatt, *Phoma calotropidis* Speg.	Barreto et al. 1999; Ellison & Barreto 2004; Crothers and Newbound 1998
Catharanthus roseus (L.) G.Don	Dry land	Seeds by ants, wind, water	M	N	M			BioNET-EAFRINET 2012
Chenopodium murale L.	Arable fields, roadsides	Ants?, worms? Seeds remain viable for over a century	S	N	S	Manual removal is easy; many herbicides are effective	No biological agents are known for effective control despite many natural enemies have been reported including species of fungi, viruses, nematodes and insects.	Halvorson and Guertin 2003; Holm et al. 1997; ISC 2012
Clitoria ternatea L.	Shrubby vegetation	Vegetatively by trailing stems; most probably	S	N	S	Manual removal		

		also with seeds						
Cordia sebestena L.	Anywhere and moist to arid; tolerates alkaline soils and salt spray	Seeds	S	N	L	Cutting trees and uprooting seedlings from wild habitat on Klein Bonaire and Curacao is feasible.		Gilman and Watson 2012
Cryptostegia grandiflora (Roxb.) R.Br.	Shrubby vegetation, esp. along water courses	Wind dispersal of the very light seeds	L	Y	M	Cutting vines, removal of fruits, application of herbicide on stubs. Prospects for eradication best on Klein Bonaire, Saba and St. Eustatius	Australia introduced natural enemies, like a leaf-feeding moth, *Euclasta whalleyi* Popescu-Gorj and Constantinescu (= *Euclasta gigantalis* Viette) and a rust fungus *Maravalia cryptostegiae* (Cummins) Ono. These seem to have been relatively successful. In the early stages the moth was found to defoliate large patches of vine, but the last few years this effect became less in part due to its parasitisation by a native wasp. Rubber vine rust, which was released between 1995 and 1997, has had a significant impact. It was	McFadyen & Harvey 1990; Mo et al. 2000; Starr et al. 2003; QNRME 2004; ISC 2012

							observed to affect leaves but also the damaged stumps after clearing, hampering them to grow out.	
Cyperus rotundus L.	Arable fields	Profuse production of tubers; transported with root crops (potatoes), flower bulbs (Gladiolus) and ground nuts; via movement of soil; farm machinery.	L	Y	S	Once established it is very difficult to eradicate. The most effective herbicide is glyphosate. It is taken up by actively growing shoots and translocated to the tubers. There is no regrowth until 2-4 weeks after treatment. Tuber populations can be reduced by 95% with multiple in-crop applications or by single applications at the beginning of 4 consecutive seasons within 2 years.	Purple nutsedge is taxonomically isolated from all crop plants of importance making it an ideal target for biocontrol. Experimenst with insect natural enemies had little success. Repeated applications of the mycoherbicide Dactylaria higginsii provided 90% control. Promising fungal pathogens are: Entyloma cyperi, Phytophthora cyperi-rotundati, Puccinia conclusa, P. philippinensis.	Barreto and Evans 1995; ISC 2012; Charles, 1997; Darkwa et al., 1999; Evans 1987; Evans 1991; Julien and Griffiths 1998; Kadir et al. 2000
Delonix regia (Bojer) Raf.	Anywhere	Seeds, seeds in animal droppings; seeds remain dormant on the ground for several years;	S	N	L	Cutting trees, herbicide application on stumps, uprooting seedlings		ISC 2012; Briones-Salas et al. 2006

		mice and other small rodents were observed as important agents for moving the fruits and seeds.						
Echinochloa colona (L.) Link	Waste places, rice fields, ditches, requires a moist habitat	Seeds via water, birds, sowing seed	?	N	S	It can be controlled by most herbicides, but resistance to single-compound herbicides is common. Mixtures are therefore used.	The fungus *Exserohilum monoceras* (*Setosphaeria m.*) can control seedlings. Mixtures of fungal pathogens were producing superior control than when they were applied alone.	ISC 2012; Eusebio and Watson 2000; Zhang and Watson 1997
Eleusine indica (L.) Gaertn.	Roadsides, waste places, fields, ditches, requires a moist habitat	Seeds with wind, water, fur of small animals (?)	S	N	S	It can be controlled by most herbicides, but resistance is becoming increasingly important.	For classical biocontrol, potential organisms include the smut fungus *Melanopsichium eleusinis*, the nematode *Heterodera delvii*, and certain cecidomyiid gall midges (*Contarinia* sp.) but further study is needed. Fungi which might be developed as mycoherbicides	ISC 2012; Figliola et al. 1988; Wapshere 1990

							include *Bipolaris [Cochliobolus] setariae* and *Pyricularia [Magnaporthe] grisea* but no active programme of development of these has yet been reported.	
Epipremnum aureum (Linden & André) G.S.Bunting (syn.: *E. pinnatum* (L.) Engl.)	Moist forest	Escapes from garden dumpings	S	Y	S	Cutting the stems at the base and herbicide treatment of the stumps and regrowth.		Wagner et al. 1999; FLEPPC 2007; GISD 2012; PIER 2012;
Eragrostis ciliaris (L.) R.Br.	Salt tolerant; coastal area, along shores and beaches	Seeds blown by the wind, attached to animal fur	?	N	S	Herbicides		PIER 2012
Euphorbia tithymaloides L. (syn.: *Pedilanthus tithymaloides* (L.) Poit.)	Dry land, often growing in shrubs protected from goats(?) ; escapes from gardens	Seeds transported by ants; escaping from garden waste	S	N	L	Manual removal; goats may eat it (and distribute the seeds?); Manual removal of local patches likely to be sucessful on Curacao. On St. Eustatius it is too widespread for realistic eradication.		Lengyel et al. 2010
Ficus microcarpa L.f.	On trees, buildings	Ants, birds, gardens	?	Y	L	*Ficus microcarpa* is particularly susceptible to triclopyr herbicides, if applied as a basal or stump treatment. Small plants can be removed by hand, though they have a tendency to resprout. Plants growing on structures and as epiphytes should be treated when young, to prevent damage	Several pests have been reported that could be looked at for biological control potential including various ants which were seen carrying off pollinator wasps from *Ficus* fruits,	Nadel et al. 1992; Starr et al. 2003; GISD 2012

						to the host structure or the eventual strangling of the host tree. Redispersal from garden sources likely.	Hymenoptera and mites that may be parasites of the pollinator wasps, and staphylinids which were seen entering Ficus fruits and eating the pollinator wasps.	
Gossypium spp.	Roadsides, (rocky) sea shores. Salt and drought tolerant.	Probably carried by rodents, ants(?); seeds with lint float and are salt tolerant	S	N	M	Cutting shrubs, herbicide application on stumps, uprooting seedlings.	Important pests are the caterpillars of *Helicoverpa armigera*, the two-spotted spider mite *Tetranychus urticae*, the bean spider mite (*T. ludeni*) and strawberry spider mite (*T. lambi*).	Pyke & Brown 1996; Shaw 2000; Anon. 2002; Francis 2009
Indigofera tinctoria L.	Wasteland, abandoned fields	Long-lived seed	S	N	L	Cutting shrubs, herbicide application on stumps, uprooting seedlings		
Jasminum fluminense Vell.	Forest edges	Seeds dispersed by birds and raccoons, with dense plots of seedlings often seen arising from raccoon droppings.	L	N	S	Young plants can be pulled up by hand. Older plants should be cut at the ground level and the stumps treated with herbicide. Follow-up treatments will probably be required.		Francis 2009

Kalanchoe daigremontiana Raym.-Hamet & H. Perrier (syn. : *Bryophyllum diagremontianum* (Raym.-Hamet & H. Perrier) A.Berger	Gardens, waste places	Vegetatively with plantlets from the leaves; is autogamous and produces seeds profusely; through garden waste	S	N	M	Manual removal from gardens, between rocks and walls. Effectiveness of herbicides unknown		Herrera and Nassar 2009; PIER 2012
Kalanchoe pinnata (Lam.) Pers. (syn.: Bryophyllum pinnatum (Lam.) Oken)	Gardens	Small plants from the margins of leaves	S	Y	M	Manual removal including the roots or chemical treatment. Dropped leaves and plantlets must be removed carefully. Herbicide application proved much more cost-effective than manual removal. Several herbicides are reported to be effective.		ISC 2012; Sparkes et al. 2002; Soria et al. 2002; GISD 2012; PIER 2012
Lawsonia inermis L.	Wasteland, abandoned fields	Birds feed on fruits and probably disperse the seeds	S	N	G	Cutting shrubs, herbicide application on stumps, uprooting of seedlings		Orwa et al. 2009
Leucaena leucocephala (Lam.) de Wit	Anywhere on disturbed land. It is not known to invade undisturbed closed forest habitats	Self-fertile , some outcrossing, pollinated by a wide range of generalist insects including large and small bees.	L	Y	S	Cutting trees in nature areas, herbicide application on stumps, uprooting seedlings. Once established, it is difficult to eradicate. It resprouts vigorously after cutting. Stumps need to be treated with diesel or other chemicals. The soil seed bank can remain viable for at least 10-20 years after seed dispersal	A bruchid beetle seed predator, *Acanthoscelides macrophthalmus* has been deliberately introduced and released in South Africa as a biocontrol agent and the same insect has been	GISD 2012; ISC 2012; Neser 1994; Weber 2003; Henderson 2001

		Flowering and seeding continually thoughout the year as long as moisture permits combined with self-fertility promotes abundant pod and seed set.					accidentally introduced to Australia. The accidental spread of the psyllid insect defoliator *Heteropsylla cubana* in the mid 1980s can cause cyclical defoliation, but does not kill trees and the psyllid appears to have been brought under control by a number of generalist local (and in some cases introduced) psyllid predators and parasites.	
Luffa aegyptiaca Mill. (syn.: *Luffa cylindrica* M.Roem.)	Rich soils, waste places?		S	N	L	Pulling out plants and seedlings.		PIER 2012
Mangifera indica L.	Planted anywhere in moist tropical areas		S	N	L	Cutting trees in nature areas, herbicide application on stumps, uprooting seedlings		PIER 2012
Megathyrsus maximus (Jacq.) B.K.Simon & S.W.L.Jacobs (syn.: *Panicum maximum* Jacq.; *Urochloa maxima* (Jacq.) R.D.Webster)	Open pastures and disturbed areas. Moist well-drained soils. *M. maximus* forms dense stands and can suppress or displace local plants on fertile	Seeds profusely. Seeds of low germination or empty. Seeds are dispersed by wind and water and can	M	Y	S	Pulling out or herbicide; plant dierapidly under close grazing	*Drechslera gigantea, Exserohilum rostratum*, and *E. longirostratum* were highly effective in controlling *M. maximus*. A 'cocktail' of these fungi, applied	ISC 2012; GISD 2012; Chandramohan et al. 1999, 2001; Motooka et al. 2002

	soils in pastures. As *M. maximus* can survive fires, it can dominate the ground after a fire.	survive long periods of drought.					in an emulsion was the most effective treatment compared to each pathogen alone.	
Melaleuca quinquenervia (Cav.) S.T.Blake	Anywhere, from dry to flooded land and tolerant to fire. Unmanaged weedy stands may have tree densities of 7000-20,000 stems/ha, thus crowding out native vegetation and wildlife habitats	Seeds are dispersed by wind, possibly also by floating on water. Seeds are not long-lived.	L	Y	L	Cutting trees, herbicide application on stumps, hand pulling of seedlings	Two bio-control agents, the Australian melaleuca snout weevil *(Oxyops vitiosa*) and the Australian melaleuca psyllid *(Boreioglycaspis melaleucae*), have been approved by the USDA for use against *Melaleuca* and have been released in the field. Research has been conducted on at least six other potential bio-control agents, including leaf, stem tip, and flower bud feeders.	GISD 2012; PIER 2012; Burrows & Balciunas 1997; Laroche 1999; Flores 2002; Wineriter et al. 2003; Gioeli and Neal 2004
Melinis repens (Willd.) Zizka (syn.: *Rhynchelytrum repens* (Willd.) C.E.Hubb.)	Disturbed areas, fallow land, roadsides	Seeds (florets) are adapted for long-range wind dispersal.	L	N	S	Typically natal grass reseeds and resprouts vigorously following fire and quickly invades disturbed areas. In several areas in south Florida, natal grass has invaded scrub habitat following fire. Mowing will not provide control. Several herbicides have proven to be effective.	There are no known biological control agents for natal grass. It can be affected by mycorrhizal fungi which may play a role in promoting or repelling invasion.	Langeland et al. 2008; FloraBase 2012

Moringa oleifera L.	Very drought tolerant, no strict soil requirements; tolerates soil pH between 5 and 9; salt tolerant; re-shoots vigorously after damage and older plants usually develop a swollen underground rootstock	Planting of stem cuttings, planting by seeds	S	N	L	Removal of all trees and pulling of seedlings; treatment of the stump with herbicide: it will otherwise quickly grow back. One should prevent it from flowering. The trees tolerate coppicing very well: in this way the leaves can still be used. The tree is not very agressive. Seedlings develop close to the mother tree. Seed longevity is limited to about 2 years.		Navie and Csurhes 2010
Nephrolepis hirsutula (G.Forst.) C.Presl (syn.: *N. multiflora* F.M.Jarrett)	Disturbed land, roadsides, between rocks	Spores are dispersed long-range during tropical rain storms.	L	N	S	Foliar application of herbicides and manual removal		Lellinger 2002; FLEPPC 2007; Hadden et al. 2010
Oeceoclades maculata (Lindl.) Lindl.	In the shade among leaf litter of dry natural forests	Self-fertilising flowers result in millions of tiny seeds blown everywhere.	M	Y	S	Manual removal. Difficult to find in natural environments (leaf litter, shade).		Cohen and Ackerman 2009; ISC 2012
Pennisetum ciliare (L.) Link. (syn.: *Cenchrus ciliaris* L.)	Arable fields, dry land, disturbed areas, sandy soils, well-drained soils	Seeds via fur of animals, clothes of humans, wind, water; introduced as pasture grass	L	Y	S	Drought, fire and grazing resistant. Repeated tilling can be successful; mechanical removal is possible on small isolated patches but generally no option because of regrowth from the roots. Burning or flooding are not effective. Chemical control is quite possible.	The species has no serious pest problems except for a fungal blight caused by the fungus *Magnaporthe grisea*. Since it reproduces by apomixis there is very little genetic diversity in its stands.	Cook et al. 2005; GISD 2012

							Therefore, strains that are resistent to *M. grisea* are not likely to develop naturally (but cultivars resistant to all known strains exist). Other fungal species causing damage are *Fusarium oxysporum, Bipolaris* sp., and *Claviceps* sp	
Pennisetum purpureum	Various soil types, preferrably deep and well-drained. Very drought tolerant. Recovers well after fire	Dense tillering, forms rhizomes, plants up to 4 m high (forms 'reed jungles'). Seeds, if produced, are transported by animal fur, wind.	M?	N	S	Work in Florida is investigating the use of the pathogenic fungi, Drechslera and. Exserohilum, to control P. purpureum .	Many fungal diseases reported, the most common being leaf spots caused by Helminthosporium sacchari (syn. Bipolaris sacchari), Helminthosporium ocellum and Pyricularia grisea. Some varieties are resistant. Also attacked by the bacterium, Pectobacterium carotovorum, other diseases including Pseudo- Fiji Disease, chlorotic streak, a disease of sugarcane, and leaf mottle virus, and by nematodes (Aphelenchus	Cook et al. 2005; FLEPPC 2007; PIER 2012

							avenae, Meloidogyne incognita acrita, M. javanica and Pratylenchus brachyurus). Work in Florida is investigating the use of the pathogenic fungi, Drechslera and. Exserohilum,	
Philodendron giganteum Schott	Tropical moist forest		L	N	S	Cutting the stems at the base and herbicide treatment of the stumps and regrowth.		Van 't Hof 2010
Psidium guajava L.	Grows almost anywhere and invades disturbed land; moderately salt tolerant; full sun to half shade; reprouts easily after damage and can sucker from the roots.	The seeds are dispersed by birds, rats, fruit bats and pigs	S	Y	L	Cutting results in regrowth with multiple stems. In the Galapagos, burning, manual cutting and even bulldozing have resulted in exacerbated invasion. Regeneration from underground parts by suckering limits the effectiveness of manual control. Goats and sheep can be used for control, as they graze leaves and strip the bark. Goats have been successfully used in Hawai'i. Guava is very sensitive to a number of herbicides.	Goats and sheep can be used for control, as they graze leaves and strip the bark. Goats have been successfully used in Hawai'i.	Smith 1998; Cronk and Fuller 1995, 2001; Anon. 2007; GISD 2012; Weber 2003
Pteris spp.	Terrestrial or epilithic	Spores and rhizoids. Spores are dispersed long-range during tropical rain	S	N	S	No known effective methods. Regrowth form the rhizoids. Minimise spore formation and transport. Chemical control with foliar application of herbicide.	There is limited research on biological control	Langeland et al. 2008; CAIP 2012a

		storms; short-range via air, clothing,equipment, animal fir, water.						
Ricinus communis L.	Roadsides, wasteland		M	Y	M	Early successional species. Disappears in absence of ground disturbance. Manual removal of shrubs and seedlings, treatment of stumps with systemic herbicide. Repeated cultivation. Fire.	-	Motooka et al. 2003; Weber 2003; GISD 2012; ISC 2012
Sansevieria spp.	Dry land, sea shore	Mainly by rhizomes; occasionally by seeds? The dense stands form an almost soilless mat of intertwined stolons. Every piece that is left will result in a new plant	L	Y	S	Foliar application of herbicides. Plants often take six to twelve months to die and follow-up applications are necessary. Dense populations may require initial physical removal.		Gordon et al. 2008; Langeland et al. 2003, 2012; CAIP 2012b; GISD 2012.
Scaevola taccada (Gaertn.) Roxb. (syn.: *Scaevola sericea* Vahl)	Sea shore	Fruits are bouyant; nursery trade	M?	Y	M	Manual removal of shrubs and seedlings; re-sprouting occurs from remains of roots and cuttings; herbicide treatment of stumps; repeated for some years, especially in tidal zone and mangrove.		GISD 2012; Randall and Marinelli 1996

Schinus terebinthifolia Raddi	Anywhere, prefers wet habitats and fairly tolerant to shade, high salinity, flooding, and fire.	Fruits are consumed by birds and mammals; root suckers; high seed germination rate; seedlings are shade tolerant. The tree has allelopathic properties.	L	Y	S	Removal of possible seedlings. Seed longevity is reportedly up to 5 months only. Chemical control with a number of herbicides was effective elsewhere. Resprouting occurs from roots after removal of trees. Uprooting the few trees that are present on Klein Curacaco, Saba, Statia.	A variety of biological control agents have been investigated or released for control, none of which seems to have been very effective. The most important include the Brazilian pepper thrips (*Pseudophilothrips ichini*), the Brazilian pepper leafroller (*Episimus utilis*), the Brazilian pepper sawfly (*Heteroperreyia hubrichi*), torymid wasp *Megastigmus transvaalensis*, and a variety of fungal pathogens. *M. transvaalensis* attacks the drupes or seeds and damages them so they do not germinate and represents a potential biological control. The fungi *Sphaeropsis tumefaciens, Rhizoctonia solani* and *Chrondostereum purpureum* are all	Cuda et al. 2006, 2012; Cronk and Fuller 1995; Ferriter and Clark 1997; Randall 2003; Donelly et al. 2008; GISD 2012; ISC 2012

							known to infect *S. terebinthifolius* in different capacities and may also prove to be useful biological controls.	
Senna bicapsularis (L.) Roxb.	Road sides	Long-lived seed	M	N	S	Naturalised: eradication is no longer possible. Management by cutting shrubs and careful disposal of the debris.		Swarbrick 1997; PIER 2012;
Senna italica Mill.	Distrurbed land, road sides, rocky and gravelly soils	Long-lived seed		N	S	Naturalised: eradication is no longer possible. Management by cutting shrubs and careful disposal of the debris.		
Syngonium podophyllum Scott	Moist, well-drained, fertile soils and shady conditions.	Via trailing stems and pieces of stem. Starting from garden clippings.	L	Y	L	May be removed by hand pulling or mechanical removal. It is difficult to eradicate and may reproduce from small root and plant fragments. All vegetation must be removed to achieve eradication and multiple treatments are usually required. Hand pulling is typically only effective on isolated plants and small infestations. Discarded plant materials should be bagged and properly disposed. Gloves should be worn as sap can be irritating to sensitive individuals.		Space and Flynn 2001; Morgan et al. 2004; Morgan and Overholt 2005; DEEDI 2010; GISD 2012; PIER 2012

Tabebuia heterophylla (DC.) Britton	Dry, coastal woodlands and secondary forests. It grows on any soil type and will adapt to poor or degraded soils. It can form monotypic stands.	Countless winged seeds floating in the wind	M	Y	L	Cutting trees, herbicide application on stumps, uprooting seedlings. Cutting the few trees invading Klein Bonaire is feasible.	In the natural forest, pathogens do not appear to be of any consequence. However, branches of city and roadside trees are often deformed into a witches' broom appearance, apparently by a virus possibly transmitted by the leaf hopper *Protalebra tabebuiae*. The insect also defoliates the tree or causes the leaves to turn yellow and fall prematurely. A similar disease on a closely related species, *Tabebuia pentaphylla*, was observed on trees grown for cacao shade on the Paria peninsula of Venezuela. Because of the numerous problems with pathogens, some authorities have recommended that closely related members of the same	Weaver 1990; GISD 2012

							genus be used as substitutes in ornamental plantings. A dieback disease was observed in 3 percent of potted trees in a nursery in Puerto Rico and was attributed to *Botryodiplodia* spp. Transplants from a nearby wooded area were infested by a shoot borer, probably *Pachymorphus subductellus.*	
Tecoma stans (L.) Juss. ex Kunth	Dry and disturbed areas such as roadsides but it can also be found in relatively undisturbed forests. It can develop dense, almost monospecific thickets and restrict the regeneration of native species.	Countless winged seeds floating in the wind. Re-introductions via gardens.	L	Y	S	Cutting shrubs and trees with herbicide application on stumps. Seedlings can be hand-pulled. Resprouting from cut roots can cause rapid reinfestation unless the remaining roots are burnt after drying. Follow-up control to remove the regrowth is necessary for at least a year after initial control. Rehabilitation of disturbed lands and keeping a vigourous ground cover afterwards is essential.	Host specificity tests on two rust fungus species, *Prospodium transformans* and *P. appendiculatum* from Mexico are in progress in South Africa. *P. appendiculatum* is already present in Brazil and Argentina but is not contributing much to the suppression of populations. A raceme-feeding membracid and the pyralid pod-feeding	Kranz and Passini 1996a, 1996b, 1997; GISD 2012; ISC 2012; PIER 2012

							moth *Clydenopteron sp.* are to be introduced into quarantine in South Africa for possible biological control .	
Tithonia diversifolia (Hemsl.) A.Gray	Herbaceous stoloniferous perennial along roadsides and disturbed areas. It can form 2-3 m high dense monotypic bushes.	Seeds carried by animals (?)	L	Y	L	Cutting shrubs and herbicide application of stumps. Careful disposal of the debris.		Varnham 2006; PIER 2012
Urochloa mutica (Forssk.) T.Q.Nguyen (syn.: *Panicum purpurascens* Raddi)	Wet fields, ditches and gullies. Can grow to 2 m high,	Mainly by seeds. It forms dense monotypic stands by layering of trailing stems and overgrowing shrubs and native vegetation.	L	Y	L	No known effective methods		GISD 2012; PIER 2012
Ziziphus mauritiana Lam.	Roadsides, abandoned farmland, dry river beds	Cultivated	S	Y	L	Cutting shrubs and trees with herbicide application on stumps, uprooting of seedlings. Vigorous regrowth from roots and stumps as well as after fire.		Grice 1996, 1997, 1998; Grice et al 1999; Weber 2003; ISC 2012; PIER 2012

Ziziphus spina-christi (L.) Desf.	Roadsides, abandoned farmland	Cultivated	S	N	L	Cutting shrubs and trees with herbicide application on stumps; uprooting of seedlings		