

Alien species on Dutch Wadden Sea islands

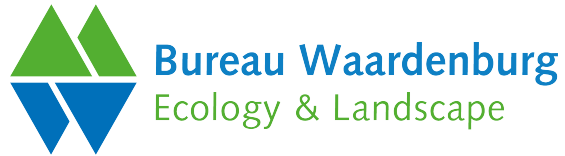
Occurrence in the period 2015-2020 and
ecological risks



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Bureau Waardenburg
Ecologie & Landschap



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Preface

Invasive alien species can have negative impacts on native species and ecosystems, but also can have adverse effects on public health, safety and economy. These impacts can be more substantial on islands compared to the mainland due to the lower but more unique biodiversity and smaller population sizes of native species. In addition, predators are often lacking on islands due to the isolation and island populations are usually vulnerable to introduced native or alien predators.

Since 1999, the Trilateral Wadden Sea Cooperation between Denmark, Germany and the Netherlands has periodically produced the Wadden Sea Quality Status Reports describing and evaluating the current ecological status of the Wadden Sea, including the Wadden Sea islands. In 2015, as part of this inventory, the Office for Risk Assessment and Research (BuRO) of the Netherlands Food and Product Safety Authority (NVWA) has commissioned an overview of the distribution and abundance of alien species on the Wadden Sea islands in the period 2004 – 2014 (Lensink *et al.*, 2015). This report also evaluated the ecological risks of a selection of alien species for native species and ecosystems, especially those protected under the European Bird and Habitat Directives. In 2021 BuRO has commissioned Bureau Waardenburg to update the occurrence of alien species on the Wadden Sea islands for the period 2015-2020 and to provide a risk analysis for additional newly established species.

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C. Heunks and D. Emond provided comments on previous versions of this manuscript. Rob Lensink carried out an extra check on the report and ISEIA impact assessments. The authors thank everyone who has contributed to this report.



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Summary

Background

Since 1999, the Trilateral Wadden Sea Cooperation has periodically produced the Wadden Sea Quality Status Report describing the ecological status of the international Wadden Sea and Wadden Sea islands. In 2015, the Office for Risk Assessment and Research (BuRO) of the Netherlands Food and Product Safety Authority (NVWA) has commissioned as part of this inventory, an overview of the distribution and abundance of alien species on the Wadden Sea islands in the period 2004 – 2014 and risk assessments of a selection of alien species (Lensink *et al.*, 2015)¹. In 2021, the BuRO has commissioned Bureau Waardenburg to update the occurrence of alien species on the Wadden Sea islands for the period 2015-2020 and to provide a risk assessment for a selection of newly established species.

Number of alien species

The number of alien species on the Wadden Sea islands increased in recent years. In the period 2005-2020 610 alien species were observed on the Wadden Sea islands: 407 in the period 2005-2014 and 518 in the period 2015-2020. If the agricultural pests (most fungi and insects) are excluded, there are 170 newly observed alien species compared to the 2005-2014 time period.

Establishment status

The total number of species observed on the Wadden Sea islands includes all NSR-status categories (2a-d and 2) and varies between unknown (2) and a minimum of 100 years of establishment (2d). The category of species which are established at least 100 years is well represented by 122 species out of a total of 176 species in this category in the Netherlands as a whole (69%). The relative proportions in the other categories are very similar to the national level.

Pathways

Plants were the most frequently observed alien species taxonomic group (74%), followed by the fungi (7,4%), bird (7,2%) and insects (5,6%). The risk assessments suggests that horticulture, the trade and cultivation of garden plants is an important pathway of alien species to the Wadden islands. The pet trade is probably the most important pathway for fishes (6 species), amphibians (1 species) and reptiles (one species with 3 subspecies). Most bird species (44 species) probably reach the islands by secondary dispersal, because of their large dispersal capacity. Most fungi reach the islands probably also by secondary dispersal, as most species reproduce and disperse with spores.

Observed species of EU-concern

The total list of observed alien species in both study periods includes 15 invasive alien species of EU-concern and three subspecies of the Pond Slider (11 in 2005-2014, 13 in 2015-2020). There were three additions of invasive alien species in the 2015-2020 study period (Raccoon Dog, American Skunk-cabbage, Various-leaved Milfoil) and two (sub)species were only observed in the first period (Pumpkinseed, Red-eared pond



slider). The observations of sacred ibises and ruddy ducks (both periods) referred to wandering individuals. The observation of a Raccoon Dog on Ameland (2015) was a dead animal washed ashore on the beach.

Expected species of EU-concern

Based on the fact that all alien species of EU-concern observed on the Wadden Sea islands have established populations on the mainland (Article 19a or 19b), it is expected that all other species with large, established populations might colonise one or more Wadden Sea islands in the near future. These species (9) are indicated in Appendix III.

Habitats at risk

For the alien species not included in Lensink *et al.* (2015) it was evaluated in which terrestrial Natura 2000 habitats they potentially can occur or settle based on literature information. 38 species, including all fungi (mainly plant rust species) and insects and several plant species were considered as not likely to settle in natural habitats. These species include mainly agricultural pests, several garden plants and their natural enemies (plant rusts, phytophagous insects) and several insect species living indoors. The Natura 2000-habitats dry dunes and wooded dunes have the highest risk of new alien species settlements, followed by humid dune slacks and open water. Salt marshes have a low risk of alien species settlements, which is probably related to the salt stress in this habitat.

Risk assessment

75 species (out of the 296 species not included in Lensink *et al.*, 2015) were selected for a risk assessment, including 56 plant species, 11 bird species, 4 mollusc species, 3 fish species and one mammal species. 16 Medium to high impact species (ISEIA-score higher than 8) were identified, which included eleven plant species (Billard's bridewort, five species of cotoneaster, False Spirea, Field Burrweed, Oregon grape, Himalayan blackberry, Rhododendron), 2 bird species (least Canada goose, ring-necked parakeet), one mollusc species (Chinese pond mussel) and 2 fish species (Prussian carp, round goby).



Nederlandse samenvatting

Achtergrond

De Trilateral Wadden Sea Cooperation publiceert sinds 1999 periodiek het Wadden Sea Quality Status Report dat de ecologische toestand beschrijft van de internationale Waddenzee en Waddeneilanden. In 2015 heeft het Bureau Risicobeoordeling & Onderzoek van de Nederlandse Voedsel- en Warenautoriteit (NVWA) opdracht gegeven een overzicht op te stellen van de verspreiding en aantallen van exoten op de Waddeneilanden in de periode 2004-2014 en een risicobeoordeling van een selectie van soorten (Lensink *et al.*, 2015). In 2021, heeft het BuRO Bureau Waardenburg opdracht verleend om een update te maken van het overzicht van het voorkomen van exoten op de Waddeneilanden in de periode 2015-2020 en risicobeoordelingen uit te voeren voor een selectie van nieuw gevestigde exoten.

Aantal exoten

Het aantal exoten op de Waddeneilanden is recentelijk toegenomen. In de periode 2005-2020 zijn 610 soorten exoten waargenomen: 407 in de periode 2005-2014 en 518 in de periode 2015-2020. 170 exoten werden in de periode 2015-2020 nieuw waargenomen. Hierbij zijn plaagorganismen voor de landbouw (vooral schimmels en insecten) buiten beschouwing gelaten.

Vestigingstatus

Het totale aantal soorten exoten dat is waargenomen op de Waddeneilanden omvatten alle categorieën van de vestigingsstatus zoals aangegeven in het Nederlands Soortenregister (2a-d, 2). Deze codes geven aan of de exoot gevestigd is en reproduceert en sinds wanneer. De categorie van soorten die zich tenminste 100 jaar in Nederland voortplanten (categorie 2d) is goed vertegenwoordigd door 122 soorten van de 176 soorten in totaal in deze categorie. De relatieve aantallen van de andere categorieën zijn vergelijkbaar met aantallen op landelijk niveau.

Pathways

Planten vormden het grootste aandeel van waargenomen exoten (74%), gevolgd door de Fungi (plantenroesten, korstmossen, paddenstoelen; 7,4%), vogels (7,2%) en insecten (5,6%). Uit de risicobeoordelingen blijkt dat horticultuur, de handel en kweek van tuinplanten, waarschijnlijk een belangrijke pathway is van exoten naar de Waddeneilanden. De handel in huisdieren is mogelijk de belangrijkste pathway voor vissen (6 soorten), amfibieën (1 soort) en reptielen (1 soort met 3 ondersoorten). De meeste vogelxoten (44 soorten) bereiken de eilanden waarschijnlijk vliegend vanaf de vaste wal (secundaire dispersie). De meeste schimmels bereiken de eilanden vermoedelijk door verspreiding met sporen vanaf het vasteland.

Waargenomen Unielijst soorten

In de gehele waarnemingsperiode (2005-2020) werden 15 soorten invasieve exoten (en 3 ondersoorten van de lettersierschildpad) waargenomen die op de Unielijst zijn geplaatst (11 in 2005-2014, 13 in 2015-2020). In de meest recente onderzoeksperiode (2015-2020) zijn



drie nieuwe invasieve exoten waargenomen (wasbeerhond, moeraslantaarn en ongelijkbladig vederkruid) en twee (onder)soorten (zonnebaars, roodwangschildpad) werden alleen in de eerste periode waargenomen. De waarnemingen van heilige ibissen en rosse stekelstaart (beide perioden) betroffen zwervende individuen. Van de wasbeerhond werd een dood dier gevonden dat was aangespoeld op het strand (2015).

Verwachte Unielijst soorten

Alle invasieve exoten die op de Waddeneilanden zijn waargenomen hebben gevestigde populaties op het vasteland (Artikel 19a en 19b soorten). Op basis hiervan wordt verwacht dat de Unielijst soorten die zich mogelijk in de toekomst vestigen vooral zullen behoren tot de groep Unielijstsoorten met gevestigde populaties op het vasteland. Deze negen soorten zijn aangegeven in Appendix III.

Habitats met risico op vestiging van exoten

Voor de soorten exoten die niet zijn opgenomen in Lensink *et al.* (2015) is op basis van literatuurgegevens bepaald in welke terrestrische Natura 2000 habitats ze potentieel kunnen voorkomen of vestigen. Van 38 soorten, waaronder alle Fungi (voornamelijk plantenroesten), insecten en een aantal plantensoorten, werd verondersteld dat de kans laag is dat deze zich in natuurlijke habitats zullen vestigen. Dit betreft exoten die landbouwschade veroorzaken (landbouwplaagdieren), een aantal soorten tuinplanten en hun natuurlijke vijanden (plantenroesten, fytofage insecten) en een aantal soorten insecten die in uitsluitend in huizen voorkomen. De Natura 2000 habitats droge duinen en duinbossen hebben het hoogste risico op vestiging van exoten, gevolgd door vochtige duinvalleien en open water. Kwelders hebben een laag risico op de vestiging van exoten, wat vermoedelijk gerelateerd is aan zoutstress in dit habitat.

Risicobeoordelingen

In totaal 75 soorten werden geselecteerd voor een risicobeoordeling, waaronder 56 plantensoorten, 11 vogelsoorten, vier weekdieren, drie vissoorten en een zoogdier. 16 middel tot hoog-risico soorten (ISEIA-score hoger dan 8) werden geïdentificeerd, waaronder elf plantensoorten (theeboompje x Douglasspirea, vijf soorten Cotoneaster, naalddaadbloem, mahonie, dijkviltbraam, Pontische rhododendron, Sorbaria), twee vogelsoorten (kleinste Canadese gans, halsbandparkiet), een soort weekdier (Chinese vijvermossel) en twee vissoorten (giebel, zwartbekgrondel).



1 Introduction

1.1 Background

1.1.1 Invasive alien species on islands

Invasive alien species are non-native species which are introduced by human activities and after establishment have negative impacts on native species and ecosystems. These species can also have adverse effects on public health, safety and economy. The ecological impacts can be more substantial on islands compared to the mainland due to the generally lower but more unique biodiversity and smaller population sizes of native species. In addition, predators are often lacking on islands due to the isolation which makes island populations vulnerable to introduced native or alien predators.

1.1.2 Alien species on Dutch Wadden Sea islands

Since 1999, the Trilateral Wadden Sea Cooperation between Denmark, Germany and the Netherlands has periodically produced the Wadden Sea Quality Status Reports describing and evaluating the current ecological status of the Dutch Wadden Sea, including the Wadden Sea islands. In 2015, as part of this inventory, the Office for Risk Assessment and Research (BuRO) of the Netherlands Food and Product Safety Authority has commissioned an overview of the distribution and abundance of alien species on the Wadden Sea islands in the period 2005 – 2014 (Lensink *et al.*, 2015). This report also evaluated the ecological risks of a selection of alien species for native species and ecosystems, especially those protected under the European Bird and Habitat Directives. The Wadden Sea Board adopted on 14 March 2019 the Management and Action Plan for Alien species, which aims to give an overview of the obligations in international law and EU legislation regarding the Wadden Sea Area and proposals, where feasible, for appropriate trilateral actions (WG-AS & Gittenberger, 2019).

1.1.3 Occurrence and ecological risks 2005-2014

Lensink *et al.* (2015) were the first to analyse the presence of alien species on the Dutch Wadden Sea islands. This resulted in approximately 360 observed alien species for the period 2005-2014 based on data from various monitoring programmes. In Lensink *et al.* (2015) the ISEIA-protocol was applied to 110 species. For these species the main vector(s) or pathways for the Wadden Sea islands were given as well. 47 alien species were found to have a potentially moderate (ISEIA score 9-10) or high (ISEIA score 11-12) ecological impact.

This study found that the number of alien species on each island correlated with the land surface area (total and Natura 2000 habitat, separately, in hectares), number of inhabitants, number of overnight-stays and number of habitats. Larger islands usually have more inhabitants, more tourists and more habitats. It is, therefore, expected that more alien



species will be introduced on larger islands and will have a higher risk of establishment, as the presence of suitable habitat is also more likely (Lensink *et al.* (2015).

1.2 Objectives of this study

BuRO has commissioned Bureau Waardenburg to update the study of Lensink *et al.* (2015) and to make an inventory of the occurrence of alien species on the Dutch Wadden Sea islands for the period 2015-2020 and to provide a risk analysis for additional, newly established species. The results will contribute to the Wadden Sea Quality Status Report and the Management Action Plan Alien Species.

This study has two major objectives:

- To prepare a list of all alien species observed on the Dutch Wadden Sea islands in the period 2015-2020. For each species is indicated if it has been observed for the first time or has been previously observed in the period 2005-2014.
- To make a short risk assessment of all alien species, which are new compared to the list of Lensink *et al.*, (2015) and are a potential threat to native biodiversity and ecosystems or might become a threat in the near future.

An alien species is defined as a non-native species that is actively or passively introduced in the Netherlands by human activities. The alien species in this study can reach the Wadden Sea islands by two general pathways: direct introduction by human activities or by secondary natural dispersal from established populations on the mainland. Species only occurring in the marine environment (below the high tide water mark) are excluded from this study except for species living in salt marshes. In case of doubt on the exclusive appearance in marine or brackish environments, the species are included in the list.

The focus is on alien species which are a potential threat to habitats and species designated as part of the Natura 2000-areas on the Wadden Sea islands. The establishment status, (is it established in the Netherlands and if so, how long?), is given for each species. Alien species threatening only agriculture, safety or human and animal health are excluded from the risk assessments. (More information on these species can be found on the NVWA website)^{1, 2}.

Two other groups of species are identified in addition to the alien species list on the Wadden Sea islands: (1) alien species of EU-concern which are present on the mainland in the Netherlands but which could colonise the Wadden Sea islands in the near future; (2) native mammalian predators, which naturally do not occur on the Wadden Sea islands and have been intendedly or unintendedly introduced to the Wadden Sea islands and potentially threaten protected species.

¹ <https://www.nvwa.nl/onderwerpen/muggen-knutten-en-teken>

² <https://www.nvwa.nl/onderwerpen/plantenziekten-en-plagen/risico-analyses-plantenziekten-en--plagen>



2 Materials and methods

2.1 Study area

The Dutch part of the international Wadden Sea is about 600 km² in size. From west to east the barrier islands Texel, Vlieland, Terschelling, Ameland, Schiermonnikoog, Rottumeroog and Rottumerplaat are situated between the Wadden Sea and the North Sea, Griend is situated in the Wadden Sea (Table 2.1; Figure 2.1). The first five islands are inhabited, the latter three are uninhabited. Between the islands five sand banks with primordial dune formations (Razende Bol, Richel, Engelsmanplaat, 't Rif, Simonszand) are included in this study.

For this study a Wadden Sea island is defined as an area surrounded by sea and situated above the level of average high water ('www. Rws.nl; Table 2.1, Figure 2.1).

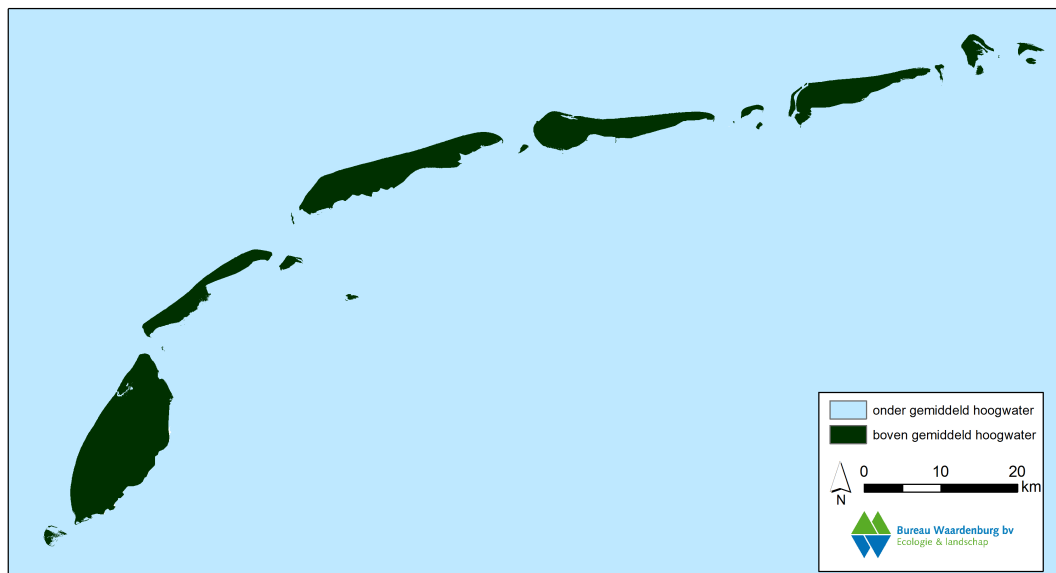


Figure 2.1 The Dutch Wadden Sea islands: five large inhabited islands, three small uninhabited islands and five sandbanks; in black the land above mean high tide.



Table 2.1 Inhabited islands (5), uninhabited islands (3) and sandbanks (s; 5) in the Wadden Sea area, the surface area land (ha), number of inhabitants (Wikipedia) and Natura 2000 dune habitats. Salt marshes are part of the of N2000 area Wadden Sea (in total 272.449 ha, the beaches are part of the N2000 area North Sea coastal zone (144.475 ha). The islands Rottumerplaat and Griend are guarded during summer both by two wardens.*

Island	Surface area land (ha) 2021	# Inhabitants (2014)	Natura 2000 dune habitats
Texel	16.200	13.641	4.615
Vlieland	3.915	1.113	1.535
Terschelling	8.526	4.721	5.017
Ameland	5.911	3.591	2.012
Schiermonnikoog	4.050	942	1.024
Rottumeroog	250	0	
Rottumerplaat	782	2	
Griend	100	2	
Razende Bol	400	0	
Richel	100	0	
Engelsmanplaat	90	0	
't Rif	70	0	
Simonszand	60	0	
Dutch Wadden Sea			272.449
North Sea coastal zone			144.475

The five major islands all have the same geomorphological structure. Large beaches occur along the North Sea coast and are included in the Natura 2000 area North Sea coastal zone. Large dune formations along or behind the beach shelter the islands from the North Sea. All these dune areas are separate Natura 2000 areas and managed by private (NGO's) or governmental nature management organisation. The landward side of the islands (except Vlieland) consists of areas surrounded by dikes and used for mostly agricultural purposes (polders at or slightly above sea level), which are not included in the Natura 2000 areas. The eastern parts of the islands (and sometimes the western parts as well) consist of well-vegetated salt marshes, which gradually slope into higher dunes; these salt marshes are included in the Natura 2000 area Wadden Sea and mainly managed by NGO's as well.

Most of the North Sea coastal zone, the Wadden Sea and the islands are protected under the Dutch 'Nature Conservation Law' (Wet Natuurbescherming), except for the polder areas and villages. In this law the European Bird and Habitat Directives are implemented.



2.2 Species database

The inventory of alien species on the Dutch Wadden Sea islands, which will provide input for the Wadden Sea Quality Status Report and the Management Action Plan Alien Species, therefore, a species database was constructed. The methods how the information for this database was acquired are described in the following paragraphs. The database is an excel-file which accompanies this report and is made available to the BuRO-NVWA.

2.2.1 Species list set-up

Naturalis (<https://www.nederlandsesoorten.nl/exoten>) provides a list of species, including alien species, observed in the Netherlands, also known as the Netherlands Species Register (NSR). The NSR is continually updated to include also alien species that have been newly observed in the Netherlands. The list gives information on the scientific name, Dutch name, taxonomic order or family, and establishment status of species in the Netherlands. The establishment status is the history and status (established or not) of its occurrence in the Netherlands since the first observation according to the criteria of the NSR. The criteria for the different status establishment status categories are as follows:

Code	Establishment status	Specification
2a	Alien; at least 100 years with reproduction:	Introduced by human activities and after introduction at least a 100 years reproduction and forming a self-sustaining population
2b	Alien; between 10 and 100 years with reproduction:	Introduced by human activities and after introduction 10-100 years reproduction and forming a self-sustaining population
2c	2c Alien; less than 10 years with reproduction:	Introduced by human activities and after introduction less than 10 years reproduction and forming a self-sustaining population
2d	2d Alien; incidental import:	Introduced by human activities so far no reproduction noticed
2	Alien (not defined):	Introduced by human activities, status yet unknown

2.2.2 Collection distribution data

Dutch National Database Flora and Fauna (NDFF)

For the collection of distribution data of alien species on the Dutch Wadden Sea islands, the NDFF database has been consulted. The query to extract this data of alien species includes the abovementioned status categories (2, 2a-d) as used in the NSR.

In the Netherlands, biodiversity data are usually sampled on a 1x1 km square resolution (following the grid of the Amersfoort-coordinates) or 5x5 km squares. It was decided to use the 1x1 km grid resolution. Of each observation the 1x1 km-square is selected in which the centre of the observation (line, plane or other) falls. For each species only the number of 1x1 km squares where it has been observed is given as a semi-quantitative measure. In



this approach overrepresentation by repeated observations of the same individuals is prevented.

Our approach, using the NDFF-database and the list of alien species in the NSR, is more straightforward and standardised than the method of Lensink *et al.* (2015), who consulted various databases with a list of alien species that was assembled from several sources. Therefore, we applied our method also to the first time period of 2005-2014 to ensure comparability between the two time periods and to determine the changes in species composition.

2.2.3 Metainformation

The metainformation of the database is presented in Appendix I. Included are the scientific name, Dutch name, English name, taxonomic group, observation history, establishment status and presence of “alien species passport” in the NSR. In addition, the suitability of the designated habitats of the Natura 2000 areas for the establishment of alien species is indicated and the number of 1x1 km squares is given for each island and for each time period. The overall distribution of alien species is summarized by (1) the number of islands where the species is observed for the two time periods separately, (2) the change between the two time periods, (3) the total number of 1x1 km squares where the alien species is observed and (4) the change in 1x1 km squares between the two time periods.

2.3 Additional information

Requests for observations additional to NDFF were sent to the nature and water management organisations on the Wadden Sea islands: State Forestry Service (Staatsbosbeheer; Texel, Vlieland, Terschelling, Ameland), Natuurmonumenten (Texel, Schiermonnikoog) and It Fryske Gea (Ameland), Wetterskip Fryslân (all Frisian Wadden Sea islands, Vlieland, Terschelling, Ameland, Schiermonnikoog), Hoogheemraadschap Hollands Noorderkwartier (Texel; see also Table A.1).

2.4 Risk assessment

2.4.1 Species selection

The potentially invasive species that required a risk assessment were selected from the list of alien species not included in Lensink *et al.* (2015) in a stepwise procedure. In this procedure the following groups were excluded *a priori*: (1) all species of EU-concern and (2) all Fungi (including plant rusts, lichens and mushrooms). The first group includes species that are considered as high impact species for most EU-member states and detailed risk analyses are available (www.nvwa.nl for the Netherlands). The Fungi are excluded because most species are highly species-specific plant rusts, which disperse widely by producing spores and for which no management options are available in natural habitats. The latter argument also applies to most of the alien insect species, which are either agricultural pests or occur mainly within houses.



Three sources of information were used to select alien species for a risk assessment: the alien species information in the NSR (soortenregister.nl; “exotenpaspoort”), the European Network on Invasive Alien Species (NOBANIS) website (NOBANIS.org), and the information on Norwegian alien species in Gederaas *et al.*, 2012 and the Norwegian Biodiversity Information Centre (2018) website.

An “exotenpaspoort” (alien species passport) is currently available for approximately half of the alien species in the list. It contains information, such as date of first introduction or observation, pathway, invasiveness and potential impact. Alien species of which a potential impact on biodiversity (and the Natura 2000 goals in particular) is indicated in the “alien species passport”, were selected for a risk assessment with the ISEIA-protocol. The Netherlands are included in the regional NOBANIS-maps and the invasiveness is indicated for most species. The Norwegian sources (Gederaas *et al.*, 2012 and NBIC-website) include risk analyses for all alien species observed after 1800 (Norwegian Biodiversity Information Centre, 2018). Although the climate match between the Netherlands and Norway mainly applies to Southern Norway, the completeness and easy access makes it a useful source of information. The term “invasive” in these sources was interpreted conservatively, as the potential impact was often not specified. This implies that the outcome of the impact assessment could indicate that there is no impact.

An alien species was included for a risk assessment if the “exotenpaspoort” indicated the species as established, invasive and with potential impact. If no “exotenpaspoort” information was available the other sources (NOBANIS, Gederaas *et al.*, 2012) were consulted. Alien species labelled as established in surrounding countries with similar climate and having actual or potential impact on biodiversity were included for a risk assessment.

The risk assessments were performed by the first author. Rob Lensink carried out an independent check.

2.4.2 Risk assessment with ISEIA

The invasive species environmental impact assessment protocol or ISEIA-protocol, was developed in Belgium (Branquart, 2009). One of the requirements for the application of the ISEIA-protocol is that the alien species have established populations in Western Europe. This requirement is fulfilled by the abovementioned selection procedure. The ISEIA-protocol assesses four aspects of the ecology and ecological impact of alien species (Table 2.2; dispersal potential, colonisation of natural habitats, impact on native species and impact on ecosystems), which are summarized by the sum of the scores on these four elements. If data are deficient then there is no score. The total score is used to distinguish high impact species (score 11-12), medium impact species (score 9-10) and low impact species (score 4-8). The information on the four aspects is gathered from scientific literature and published risk assessments. These include the NSR-website (soortenregister.nl; “exotenpaspoort”), the European Network on Invasive Alien Species (NOBANIS) website (NOBANIS.org), the information on Norwegian alien species in Gederaas *et al.*, 2012 and



the Norwegian Biodiversity Information Centre (2018) website, the invasive Species Compendium (CABI, 2022), and risk assessments on the NWWA-website¹. Additional information was also gathered from the NDFF-website *Verspreidings-atlas.nl*, where information is available on ecology and impact of alien species.

Table 2.2. Summary of the ISEIA-protocol (Branquart, 2009).

Aspect	Score	Impact
Dispersion potential	1, 2 or 3	low, medium or high
Colonisation of natural habitats	1, 2 or 3	low, medium or high
Impact on native species	1, 2 or 3	low, medium or high
Impact on ecosystems	1, 2 or 3	low, medium or high

List	Sum
High impact species	ISEIA index = 11-12
Moderate impact species	ISEIA index = 9-10
Low impact species	ISEIA index = 4-8

¹ <https://www.nvwa.nl/onderwerpen/invasieve-exoten/risicobeoordelingen-soorten>



3 Results

3.1 Updated list of alien species 2015-2020

610 alien species were observed on the Dutch Wadden Sea islands in the entire observation period of 2005-2020: 407 were observed in the period 2005-2014 and, 518 in the period 2015-2020. 203 species were added to the list in the period 2015-2020, 92 species were only observed in the period 2005-2014. If the agricultural pests (most fungi and insects) are excluded, there are 170 newly observed alien species compared to the 2005-2014 time period.

3.2 Number of alien species

3.2.1 Taxonomic groups

Plants were the most observed alien species on the Wadden Sea islands (74%), followed by the fungi (7,4%), birds (7,2 %) and insects (5,6%; Table 3.1). The relative frequencies of the taxonomic groups did not differ much between the two time periods and between the species only observed in either first or second time period (Table 3.1).

Table 3.1. Number of alien species of different taxonomic groups observed on the Wadden Sea islands in both study periods (2005-2020).

Taxonomic group	#species	%	2005-2014	%	2015-2020	%	Lost	%	New	%
Plants	453	74,3	302	74,2	394	76,1	59	64,1	151	74,4
Fungi	45	7,4	31	7,6	35	6,8	10	10,9	14	6,9
Molluscs	6	1,0	4	1,0	6	1,2	0	0,0	2	1,0
Arachnids	4	0,7	3	0,7	4	0,8	0	0,0	1	0,5
Mites	1	0,2	0	0,0	1	0,2	0	0,0	1	0,5
Insects	34	5,6	15	3,7	30	5,8	4	4,3	19	9,4
Arthropods	4	0,7	2	0,5	3	0,6	1	1,1	2	1,0
Fishes	7	1,1	5	1,2	4	0,8	3	3,3	2	1,0
Amphibians	1	0,2	1	0,2	1	0,2	0	0,0	0	0,0
Reptiles	4	0,7	4	1,0	1	0,2	3	3,3	0	0,0
Birds	44	7,2	34	8,4	34	6,6	10	10,9	10	4,9
Mammals	7	1,1	6	1,5	5	1,0	2	2,2	1	0,5
Totals	610		407		518		92		203	



3.2.2 Establishment status

To date, 3.167 alien species have been observed in the Netherlands and described in the NL Soortenregister (May 2022; Table 3.2). Approximately fifty percent of these species are relatively new and have not been established yet in the Netherlands (categories 2d and 2, 1.609 species), the other half has been found reproducing in the Netherlands (categories 2a, 2b, 2c).

The total number of species observed on the Wadden Sea islands includes all NSR-status categories (2a-d and 2; Table 3.2). The category of species with at least 100 years reproduction is well represented by 122 species out of 176 species in this category in the Netherlands (69%). The relative proportions in the other categories are very similar to the national level (Table 3.3 – 3.4).

Table 3.2. Total number of alien species observed for each establishment status in the Netherlands (2022) and Wadden Sea islands in the period 2005-2020 and the percentage of species of each establishment status category which occurs on the Wadden Sea islands (%).

Code	NSR-Status	# alien species total NL 2022	# alien species WS islands 2005-2020	% of category
2a	Alien; at least 100 years with reproduction:	176	122	69
2b	Alien; between 10 and 100 years with reproduction:	806	170	21
2c	2c Alien; less than 10 years with reproduction:	576	103	18
2d	2d Alien; incidental import:	1.459	208	14
2	Alien (not defined):	150	7	5
Total		3.167	610	



Table 3.3. Total number of alien species observed for each establishment status in the Netherlands (2022) and Wadden Sea islands in the periods 2005-2014 and 2015-2020 with relative frequency of establishment status (%).

Code	NSR-status	# alien species total NL 2022	% total NL 2022	# alien species WS islands 2005-2014	% WS islands 2005-2014	# alien species WS islands 2015-2020	% WS islands 2015-2020
2a	Alien; at least 100 years with reproduction:	176	6	107	26	108	21
2b	Alien; between 10 and 100 years with reproduction:	806	25	114	28	152	29
2c	2c Alien; less than 10 years with reproduction:	576	18	54	13	88	17
2d	2d Alien; incidental import:	1.459	46	131	32	164	32
2	Alien (not defined):	150	5	1	0	6	1
Total		3.167		407		518	

Table 3.4. Total number of alien species observed for each establishment status in the Netherlands (2022) compared to the number of alien species only observed in 2005-2014 or 2015-2020 for each establishment status and relative frequency of establishment status (%).

Code	NSR-status	# alien species total NL 2022	% total NL 2022	Lost species	% lost species	New species	% new species
2a	Alien; at least 100 years with reproduction:	176	6	14	15	15	7
2b	Alien; between 10 and 100 years with reproduction:	806	25	18	20	56	28
2c	2c Alien; less than 10 years with reproduction:	576	18	15	16	49	24
2d	2d Alien; incidental import:	1.459	46	44	48	77	38
2	Alien (not defined):	150	5	1	1	6	3
Total		3.167		92		203	



3.3 Invasive alien species of EU-concern

3.3.1 Observed species of EU-concern

The total list of observed alien species in both study periods includes 14 invasive alien species of EU-concern and three subspecies of the pond slider (11 in 2005-2014, 13 in 2015-2020; Table 3.5). There were three additions of invasive alien species in the 2015-2020 study period (Raccoon Dog, American Skunk-cabbage, Various-leaved Water-millfoil) and two (sub)species were only observed in the first period (Pumpkinseed, Red-eared Pond Slider; Table 3.5). The observations of sacred ibises and Ruddy Ducks (both periods) referred to wandering individuals. The observation of a Raccoon Dog on Ameland (2015-2020) was a dead animal washed ashore on the beach. All observed species of EU-concern have relatively large, established populations on the mainland (Lensink *et al.*, 2015) and fall under Article 19 of EU Regulation 1143/2014 (Appendix III).

3.3.2 Expected species of EU-concern

Which alien species of EU-concern would be expected to colonise one or more Wadden Sea islands in the near future? Because all alien species of EU-concern observed on the Wadden Sea islands have established populations on the mainland (Lensink *et al.*, 2015) and fall under Article 19a (locally established populations or 19b widespread established populations, Appendix III), it is expected that all other species with large, established populations on the mainland might colonise one or more Wadden Sea islands in the near future. These nine species are indicated in Appendix III.

Table 3.5. Number of 1x1 km squares where invasive alien species of EU-concern were observed on the five largest Wadden Sea islands in the periods 2005-2014 and 2015-2020, with the number of islands (#islands) and number of 1x1 km squares (#km total). Included in Lensink et al. (2015): 0=no, 1=yes.



Species name	Group	Lensink et al. 2015		Texel		Terschelling		Ameland		Schiermonnikoog		Vlieland		# islands		#km total	
		Status		2005-2014	2015-2020	2005-2014	2015-2020	2005-2014	2015-2020	2005-2014	2015-2020	2005-2014	2015-2020	2005-2014	2015-2020	2005-2014	2015-2020
<i>Procambarus virginalis</i> Marbled Crayfish	Arthropods	0	2b									1	1	1	1	1	1
<i>Threskiornis aethiopicus</i> Sacred Ibis	Birds	0	2d		6					2				1	1	2	6
<i>Nyctereutes procyonoides</i> Raccoon Dog	Mammals	0	2c						1					0	1	0	1
<i>Oxyura jamaicensis</i> Ruddy duck	Birds	0	2b	12	1					2	1	2		3	2	16	2
<i>Lysichiton americanus</i> American Skunk-cabbage	Plants	0	2b		1									0	1	0	1
<i>Myriophyllum heterophyllum</i> Various-leaved Water-millfoil	Plants	0	2b		1									0	1	0	1
<i>Trachemys scripta</i> Pond Slider	Reptiles	0	2d		1	1	1	1						2	2	2	2
<i>Trachemys scripta scripta</i> Yellow-bellied Pond Slider	Reptiles	0	2d			1								1	0	1	0
<i>Trachemys scripta troostii</i> Cumberland Pond Slider	Reptiles	0	2d			1								1	0	1	0
<i>Alopochen aegyptiaca</i> Egyptian Goose	Birds	1	2b	173	186	63	86	48	52	23	40	29	40	9	11	348	427
<i>Heracleum mantegazzianum</i> Giant Hogweed	Plants	1	2a	12	30	19	13	5	4	2	4	2	2	5	5	40	53
<i>Impatiens glandulifera</i> Indian Balsam	Plants	1	2a	2	6	8	6		1	3	1		1	3	5	13	15
<i>Ailanthus altissima</i> Tree-of-Heaven	Plants	1	2b		1	2	1							1	2	2	2
<i>Elodea nuttallii</i> Nuttall's Waterweed	Plants	1	2b	6	9	5	5	1	1	1	1			4	4	13	16
<i>Lepomis gibbosus</i> Pumpkinseed	Fishes	1	2a			2				1				2	0	3	0
<i>Myriophyllum aquaticum</i> Parrot Feather	Plants	1	2b	1	2					1				2	1	2	2
<i>Trachemys scripta elegans</i> Red-eared Pond Slider	Reptiles	1	2d	1		1								2	0	2	0



3.4 Habitats at risk

In total 25 different terrestrial habitat types (including H2190A – humid dune slacks with open water) occur in the Natura 2000-areas on the Wadden Sea islands (Appendix II; Lensink *et al.*, 2015). For all 296 alien species which are not included in Lensink *et al.* (2015) it was evaluated in which habitat they potentially can occur or settle, based on information in the NSR, Verspreidingsatlas.nl, NOBANIS.org, and CABI (2022). 258 (out of 296 not included in Lensink *et al.*, 2015) alien species were linked to specific terrestrial Natura 2000 habitats. 38 species, including all fungi (mainly rust species) and insects and several plant species are not likely to settle in natural habitats. These include mainly agricultural pests, several garden plants and their natural enemies (rusts, insects) and some organisms living indoors. The dry dunes and wooded dunes have the highest risk of new alien species settlements (Table 3.6), followed by humid dune slacks and open water. Salt marshes have a low risk of alien species settlements, which is probably related to the salt stress.

Table 3.6. Natura 2000 habitats at risk for establishments of alien species observed for the first time in the period 2015-2020. The different habitat types and subtypes are aggregated in five general habitats: salt marsh, dry dunes, wooded dunes, humid dune slacks and open water.

Habitat	Habitat (sub)types	# Alien species
Salt marsh	H1310A,B, H1320, H1330A,B	5
Dry dunes (incl grey dunes)	H2110, H2120, H2130A,B,C, H2140A,B, H2150 – H2170	97
Wooded dunes	H2180A,B,C	80
Humid dune slacks	H2190A,B,C,D	43
Open water	H2190A	33

3.5 Native mammals with potential impact

In total 39 native and 8 alien mammal species occur in the Netherlands. Due to the isolation of the Wadden Sea islands only 18 of the 39 native mammal species occur on the Wadden Sea islands. The island populations of species which are unlikely to colonise the islands (e.g. hedgehog, small mammals) possibly date back to the time that these islands were still connected to the mainland. No alien mammal species have recently been observed alive on the Wadden Sea islands, except for a raccoon dog found dead on the beach of Ameland. This implies that new occurrences of mammal species are likely linked to active or passive introduction events. Many ground breeding species on the Wadden Sea islands are vulnerable to ground predators. In addition, Natura 2000 habitats may be vulnerable to grazing by deer and wild boar. These species with potential negative impact are included in Table 3.7. Stoat occurs only on the largest island, Texel. European hedgehog is found on all large islands, but is lacking on Griend, Rottumeroog and Rottumerplaat. As these islands are very important for ground nesting seabirds, an accidental introduction of hedgehog might have a large impact. Several native mammal species with potential



ecological impact were observed in the period 2015-2020: pine marten on Texel and Vlieland, stoat on Texel, stone marten on Texel, Ameland and Rottumerplaat, red fox on Texel, Schiermonnikoog and Rottumerplaat, and weasel on Vlieland, Ameland and Schiermonnikoog (Table 3.7). These observations include also dead animals washed ashore on the beach.

Table 3.7. Native mammals with potential negative impact (predation, grazing) on conservation goals on Wadden Sea islands observed in the period 2015-2020 (number of 1x1 km squares with observations).

Dutch name	English name	Scientific name	Texel	Vlieland	Terschelling	Ameland	Schiermonnikoog	Rottumeroog	Rottumerplaat	Griend
Boommarter	Pine marten	<i>Martes martes</i>	1	1	0	0	0	0	0	0
Bunzing	European polecat	<i>Mustela putorius</i>	0	0	0	0	0	0	0	0
Damhert	European fallow deer	<i>Dama dama</i>	0	0	0	0	0	0	0	0
Edelhert	Red deer	<i>Cervus elaphus</i>	0	0	0	0	0	0	0	0
Egel	European hedgehog	<i>Erinaceus europaeus</i>	114	19	49	18	17	0	0	0
Hermelijn	Stoat	<i>Mustela erminea</i>	10	0	0	0	0	0	0	0
Steenmarter	Stone marten	<i>Martes foina</i>	1	0	0	1	0	1	0	0
Vos	Red fox	<i>Vulpes vulpes</i>	1	0	0	0	1	0	1	0
Wezel	Weasel	<i>Mustela nivalis</i>	0	1	0	1	1	0	0	0
Wild zwijn	Wild boar	<i>Sus scrofa</i>	0	0	0	0	0	0	0	0



4 Risk assessment

The species selection for the risk assessment with ISEIA was based on information in the Dutch species register (Soortenregister.nl), the NOBANIS (www.nobanis.org) and CABI (www.cabi.org) websites and Gederaas *et al.* (2012). Out of 296 new alien species not included in Lensink *et al.* (2015), 75 were selected for a risk assessment, including 56 plant species, 11 bird species, 4 mollusc species, 3 fish species and one mammal species. In total 16 medium to high-risk species (score higher than 8) were identified, which included ten plant species (Billard's bridewort, five species of cotoneaster, False Spirea, Field Burrweed, Oregon grape, Himalayan blackberry, Rhododendron), 2 bird species (Least Canada goose, Ring-necked Parakeet), one mollusc species (Chinese pond mussel), and 2 fish species (Prussian carp, Round Goby). The scores of the ISEIA-risk assessment are presented in Tables 4.1a-c.

A summary of the main characteristics is given in the next paragraphs for the analysed species. The summaries of the analysed plant species are limited to species with a ISEIA-score higher than 6. For each species is given: the scientific name, Dutch name, English name, region of native origin, characteristics, possible pathway, distribution in the Netherlands (for birds information was taken from the SOVON-website, www.SOVON.nl in August 2022), potential establishment in Natura 2000 areas on the Wadden Sea islands (yes, no or possibly), possible impact on species and habitats (low=impact unlikely), the ISEIA-score and references.

Table 4.1a. ISEIA-risk assessment scores of alien bird species observed on the Wadden Sea islands.

Scientific name	Group	NSR Status	Origin	Dispersal potential	Colonisation natural habitats	Impact on native species	Impact on ecosystems	total score
<i>Branta hutchinsii minima</i>	Birds	2b	North America	2	3	3	3	11
<i>Psittacula krameri</i>	Birds	2b	Indian subcontinent & Africa	3	3	2	1	9
<i>Aix galericulata</i>	Birds	2b	East Asia	3	3	1	1	8
<i>Cygnus atratus</i>	Birds	2b	Australia	3	2	1	1	7
<i>Cygnus melancoryphus</i>	Birds	2d	South America	3	2	1	1	7
<i>Phoenicopterus chilensis</i>	Birds	2d	South America	2	1	1	2	6
<i>Tadorna cana</i>	Birds	2d	Southern Africa	1	1	2	1	5
<i>Tadorna tadornoides</i>	Birds	2d	Australia	1	1	2	1	5
<i>Cyanochen cyanoptera</i>	Birds	2d	Ethopia	1	1	1	1	4
<i>Numida meleagris</i>	Birds	2d	Africa	1	1	1	1	4
<i>Serinus canaria</i>	Birds	2d	Canary Islands	1	1	1	1	4



Table 4.1b. ISEIA-risk assessment scores of alien plant species on the Wadden Sea islands. Only the species with scores >6 have been included.

Scientific name	Group	NSR Status	Origin	Dispersal potential	Colonisation natural habitats	Impact on native species	Impact on ecosystems	total score
<i>Cotoneaster bullatus</i>	Plants	2c	China	3	3	3	2	11
<i>Cotoneaster dielsianus</i>	Plants	2b	China	3	3	3	2	11
<i>Cotoneaster divaricatus</i>	Plants	2c	China	3	3	3	2	11
<i>Cotoneaster salicifolius</i>	Plants	2d	China	3	3	3	2	11
<i>Rhododendron ponticum</i>	Plants	2a	S Europe	2	3	3	3	11
<i>Cotoneaster franchetii</i>	Plants	2d	China	2	3	3	2	11
<i>Rubus armeniacus</i>	Plants	2c	Caucasus	3	3	2	2	10
<i>Berberis aquifolium</i>	Plants	2b	North America	2	3	2	2	9
<i>Soliva sessilis</i>	Plants	2c	South America	3	3	2	1	9
<i>Sorbaria sorbifolia</i>	Plants	2d	Asia	3	2	1	2	9
<i>Spiraea x billardii</i>	Plants	2d	North America	3	2	2	2	9
<i>Lonicera acuminata</i>	Plants	2d	East Asia	2	2	2	2	8
<i>Persicaria amplexicaulis</i>	Plants	2d	Himalaya	2	2	2	2	8
<i>Tellima grandiflora</i>	Plants	2d	North America	3	2	2	1	8
<i>Allium triquetrum</i>	Plants	2b	Mediterranean	2	3	1	1	7
<i>Echinops sphaerocephalus</i>	Plants	2c	S Europe	2	3	1	1	7
<i>Prunus laurocerasus</i>	Plants	2d	S Europe	3	2	1	1	7
<i>Pseudosasa japonica</i>	Plants	2c	Japan	3	2	1	1	7
<i>Viola x wittrockiana</i>	Plants	2	Europe	3	2	1	1	7



Table 4.1c. ISEIA-risk assessment scores of other alien species groups observed on the Wadden Sea islands.

Scientific name	Group	NSR Status	Origin	Dispersal potential	Colonisation natural habitats	Impact on native species	Impact on ecosystems	Total score
<i>Sinanodonta woodiana</i>	Molluscs	2c	China	3	3	3	3	12
<i>Carassius gibelio</i>	Fishes	2a	Cryptogenic (Asia)	3	3	3	2	11
<i>Neogobius melanostomus</i>	Fishes	2b	Ponto-Caspian Region	2	3	3	3	11
<i>Arion vulgaris</i>	Molluscs	2b	S Europe	3	2	2	1	8
<i>Tamiasciurus hudsonicus</i>	Mammals	2	North America	1	3	3	1	8
<i>Deroceras invadens</i>	Molluscs	2c	Italy	3	2	2	1	8
<i>Coregonus albula</i>	Fishes	2d	Baltic & N. Europe	1	1	1	1	4
<i>Lehmannia valentiana</i>	Molluscs	2c	Iberian Peninsula	1	1	1	1	4

4.1 Birds

4.1.1 *Aix galericulata*

Mandarijneend, Mandarin Duck

Origin: East Asia

Characteristics: Small, colourful duck. Male in breeding plumage with pink bill, purple breast with stripes, elongated orange neck feathers and elongated inner wing feathers. Females nondescript brown. Breeds in tree holes in forests and bushes along ponds and lakes.

Pathway(s): Escapes from waterbird collections, ornamental trade and secondary dispersal.

Distribution: Introduced in many European countries. Netherlands: 300-400 breeding pairs, 600-1.200 individuals in the winter period (SOVON, 2022).

Natura 2000: Yes.

Impact: Possible impact on species breeding in tree holes, but unlikely as no bird species breeding in big tree holes along wetlands (similar to Common Goldeneye) occur in the Netherlands, including Wadden Sea islands.

ISEIA-score: 8

References: van Kleunen (2014); Madge & Burn (1988).



4.1.2 *Branta hutchinsii minima*

Kleinste Canadese gans, least Canada goose

- Origin: North America, coastal Alaska.
- Characters: Similar to Canada goose, *Branta canadensis*, but much smaller and darker. Dark brown body plumage, black neck and head with large, white chin patch. Breeds in native range on open, coastal tundra in Alaska.
- Pathway: Escapes from waterbird collections, ornamental trade and secondary dispersal.
- Distribution: Introduced in many European countries. Netherlands: 460-770 breeding pairs (2013-2015) 1.500-2.000 individuals in the winter period (2013-2015; SOVON, 2022).
- Natura 2000: Yes.
- Impact: High, guano-trophication of wet dune slacks, grazing of wet dune vegetation.
- ISEIA-score: 11
- References: Lemaire & Wiersma (2011); Madge & Burn (1988).

4.1.3 *Cyanochen cyanoptera*

Blauwvleugelgans, Blue-winged Goose

- Origin: Ethiopia
- Characters: Goose-like duck, the size of a shelduck or Egyptian goose. Grey-brown, with pale blue forewing, mainly visible in flight. Occurs naturally only in the Ethiopian highlands along rivers, freshwater lakes and marshes. It feeds on grassland and is adapted to the cold, mountainous climate.
- Pathway: Escapes from waterbird collections and ornamental trade.
- Distribution: Netherlands 1-2 individuals year-round.
- Natura 2000: Possibly.
- Impact: Not known, but unlikely, adapted to mountainous habitats.
- ISEIA-score: 4.
- References: Madge & Burn (1988).

4.1.4 *Cygnus atratus*

Zwarte Zwaan, Black Swan

- Origin: Australia
- Characters: Size as mute swan, completely black except for white wing feathers. Forages on water plants by “upending”, but also grazes on grasslands along ditches and canals. Breeds throughout the year along lakes and rivers.
- Pathway: Escapes from waterbird collections, ornamental trade and secondary dispersal.



Distribution: Introduced in many European countries. Netherlands: 40-60 breeding pairs in all provinces, 110-200 in the winter period (SOVON, 2022).
Natura 2000: Yes.
Impact: Low, foraging mainly in agricultural areas with possibly some agricultural damage.
ISEIA-score: 7.
References: Beemster & Klop (2013)

4.1.5 *Cygnus melancoryphus*

Zwarthalszwaan, Black-necked Swan

Origin: South America.
Characters: Unmistakable, white swan with black neck and head and large, red knob at base of the bill. Slightly smaller than mute swan. Feeds shallow water by submerging head and dabbling.
Pathway: Escapes from waterbird collections, ornamental trade and secondary dispersal.
Distribution: Netherlands: 1-5 year-round (SOVON, 2022).
Natura 2000: Yes.
Impact: Low, similar to black swan.
ISEIA-score: 7.
References: Lensink *et al.* (2013); Madge & Burn (1988).

4.1.6 *Numida meleagris*

Helmparelhoen, Helmeted Guineafowl

Origin: Africa.
Characters: Size as domestic chicken, plumage slate grey with fine, white spots; naked and blue-red head with conspicuous horny ridge on top of head. Occurs in open grassland, savanna, dry lands and cultivated lands.
Pathway: Escapes from (water)bird collections, ornamental trade and secondary dispersal.
Distribution: Netherlands: 1-10 year-round (SOVON, 2022).
Natura 2000: No.
Impact: Low, few suitable habitats, dry grasslands and savanna, available.
ISEIA-score: 4.
References: Maclean (1985).



4.1.7 *Phoenicopterus chilensis*

Chileense flamingo, Chilean Flamingo

- Origin: South America
- Characters: Large wading birds with extremely long neck and legs and curved bills, which are adapted to filter feeding. Similar to European flamingo, but with dark pink leg joints.
- Pathway: Escapes from waterbird collections, ornamental trade and secondary dispersal.
- Distribution: Netherlands: 35-45 in the winter period (SOVON, 2022) originating from one breeding colony in Germany.
- Natura 2000: Yes.
- Impact: Low. Competition with native birds is unlikely, due to their highly specialized feeding method. Guanotrophication by breeding colonies may occur in oligotrophic ponds.
- ISEIA-score: 6.
- References: Treep (1998).

4.1.8 *Psittacula krameri*

Halsbandparkiet, Ring-necked Parakeet

- Origin: Africa and West Asia.
- Characters: Ring-necked Parakeet is a common, medium-sized (c 40 cm) bird with a bright green plumage, pink collar, long pointed tail and large red bill. Lives in a variety of forested habitats such as secondary forest, riparian woodland, mangroves, savanna grasslands, open farmlands with scattered trees and parks and gardens in urban areas. Mainly due to its popularity as a cage bird, it has succeeded in establishing feral populations almost worldwide, but especially in Europe. Several populations are growing exponentially, but the rate of spatial spread is rather slow (Van Kleunen *et al.*, 2010).
- Pathway: Pet trade and secondary dispersal by flight from mainland populations.
- Distribution: Introduced in most European countries. Netherlands: 2.000-2.300 breeding pairs, 10.000-12.000 in the winter period (SOVON, 2022).
- Natura 2000: Yes.
- Impact: Medium. In Europe, is known to compete for nesting cavities with native hole-nesting birds and possibly also bats. In its natural range is known to cause considerable agricultural damage.
- ISEIA-score: 9.
- References: Van Kleunen *et al.* (2010); CABI Invasive Species Compendium.



4.1.9 *Serinus canaria*

Kanarie, Canary

- Origin: Canary Islands.
- Characters: Small, finch-like birds, similar to, but larger than the native serin (*Serinus serinus*), with grey, streaked upperparts, pale yellow face, olive-yellow rump and pinkish bill. Common bird on the Canary Islands, Azores and Madeira and frequents edges of cultivated land, gardens, orchards, laurel forest and open woodland.
- Pathway: Escapes from bird collections, ornamental trade.
- Distribution: Netherlands: 0-5 individuals year- round. Winter is critical period.
- Natura 2000: No.
- Impact: Low, suitable habitats areas are either cultivated areas or not available (laurel forest).
- ISEIA-score: 4.
- References: Clement, Harris & Davis (1993).

4.1.10 *Tadorna cana*

Kaapse casarca, South African Shelduck

- Origin: Southern Africa.
- Characters: A grey-headed, rusty-orange shelduck; males with ash-grey head and breast, females has slate-grey head with white facial patches. Breeds along small, shallow freshwater and brackish lakes in open landscapes.
- Pathway: Escapes from waterbird collections, ornamental trade.
- Distribution: Netherlands: 1-5 individuals year- round (SOVON, 2022).
- Natura 2000: Yes.
- Impact: Low, combination of suitable breeding and foraging habitat may be scarce; competition with native shelducks is unlikely. Hybridisation with native species may occur (Johnsgard, 1960).
- ISEIA-score: 5.
- References: Madge & Burn (1988).

4.1.11 *Tadorna tadornoides*

Australische bergeend, Australian Shelduck

- Origin: Australia.
- Characters: Large (size of a shelduck), blackish ducks with a rufous-chestnut breast with white wing coverts and narrow white collar. Females with additional white eye ring. In native range breeds in freshwater marshes, brackish and freshwater lakes, preferably with scattered trees. Forages on grasslands, lake shores and stubble fields.



Pathway: Escapes from waterbird collections, ornamental trade.
Distribution: Netherlands: 0-1 individuals year-round (SOVON, 2022).
Natura 2000: Yes.
Impact: Low, combination of suitable breeding and foraging habitat may be scarce; competition with native shelducks is unlikely. Hybridisation with native species may occur (Johnsgard, 1960).
ISEIA-score: 5.
References: Madge & Burn (1988).

4.2 Plants

4.2.1 *Allium triquetrum*

Driekantig look, Three-cornered leek

Origin: Mediterranean.
Characters: Three-cornered leek is a bulbous, flowering plant (17-60 cm) with characteristic concavely triangular stems with an umbel inflorescence of 4-19 white flowers with a green line. Seed dispersal by ants (myrmecochory). It grows in grasslands, forests, in shrubs, under hedges, along river shores and road sides.
Pathway: Horticulture and secondary dispersal by garden waste from gardens to natural habitats.
Distribution: Limited to the western part of the Netherlands, with only one established population near Heemskerk.
Natura 2000: Yes.
Impact: Low, limited dispersal capacity by myrmecochory (seeds dispersed by ants).
ISEIA-score: 7.
References: Verspreidingsatlas.nl.

4.2.2 *Berberis aquifolium*

Mahonie, Oregon Grape

Origin: North America.
Characters: Oregon grape is a self-fertile, evergreen perennial shrub growing to 2 m by 1.5 m. Leaves are alternate, compound, leathery and glossy. Flowers are bright yellow, insect pollinated, and honey-scented in terminal racemes. The blue berries appear from August to October and may remain on the plant until winter. The grape-like berries ripen from August to September and are eaten by birds.
Pathway: Horticulture and secondary dispersal of seeds by birds, which eat the berries, to natural habitats.
Distribution: Introduced in many countries, including most European countries.



Natura 2000: Yes.
Impact: Medium. Clonal growth, seedling recruitment and increased genetic diversity make Oregon grape an aggressive invader. Oregon grape populations usually consist of distinct patches formed by one or more genets, but the shrub occasionally covers the entire understorey. As a result it can out-compete native species due to its successful reproductive strategy, that is colonization of available space due to repeated recruitment of seedlings.
ISEIA-score: 9.
References: CABI (2022).

4.2.3 *Cotoneaster bullatus*

Rimpelige/Grote boogcotoneaster, Hollyberry cotoneaster

Origin: China.
Characters: An evergreen shrub, up to 4 m height with large, rounded leaves (6-9 cm) and 5-15 white flowers. Occurs in disturbed habitats mainly in cities and along forest edges, wooded dunes and conifer forests.
Pathway: Horticulture and secondary dispersal to natural habitats. The berries are dark red and eaten by birds, which disperse the seeds.
Distribution: Introduced in several European countries. Netherlands: established, occurs widespread, but relatively rare in all provinces.
Natura 2000: Yes, including dune habitats.
Impact: High. Competition with native species by forming dense thickets.
ISEIA-score: 11.
References: Boer (2014); Verspreidingsatlas.nl.

4.2.4 *Cotoneaster dielsianus*

Diels' Cotoneaster, Diels' Cotoneaster

Origin: China.
Characters: An evergreen shrub, up to 2 m height with small, rounded leaves (2-3 cm) and 3-7 white flowers. Plants can also reproduce from node-rooting fragments and are self-layering, so plants can also spread vegetatively. Occurs in disturbed habitats mainly in cities and along forest edges, wooded dunes and conifer forests.
Pathway: Horticulture and secondary dispersal to natural habitats. The berries are red and eaten by birds, which disperse the seeds.
Distribution: Introduced in several European countries. Netherlands: established, occurs widespread, but relatively rare in all provinces.
Natura 2000: Yes, including dune habitats.
Impact: High. Competition with native species by forming dense thickets.
ISEIA-score: 11.
References: Boer (2014); Verspreidingsatlas.nl.



4.2.5 *Cotoneaster divaricatus*

Cotoneaster divaricatus, *Cotoneaster divaricatus*

- Origin: China.
- Characters: An evergreen shrub, up to 2 m height with small, rounded leaves (0,7-2,5 cm) and 2-4 white flowers. Occurs in disturbed habitats mainly in cities and along forest edges, wooded dunes and conifer forests.
- Pathway: Horticulture and secondary dispersal to natural habitats. The berries are red and eaten by birds, which disperse the seeds.
- Distribution: Introduced in several European countries. Netherlands: established, occurs widespread, but relatively rare in all provinces.
- Natura 2000: Yes, including dune habitats.
- Impact: High. Competition with native species by forming dense thickets.
- ISEIA-score: 11.
- References: Boer (2014); Verspreidingsatlas.nl.

4.2.6 *Cotoneaster franchetii*

Franchet's cotoneaster, *Franchet's cotoneaster*

- Origin: China.
- Characters: Evergreen shrub, grows up to 3 m. Dark green leaves 2-3 cm, small pink to purple flowers and orange-red berries. Occurs in forested areas, including dunes and pine forest.
- Pathway: Horticulture and secondary dispersal from gardens to natural habitats by birds, which eat the berries and disperse the seeds. .
- Distribution: Introduced in several European countries. Rare and not established in the Netherlands.
- Natura 2000: Yes, including dune habitats.
- Impact: High. Forms dense thickets with negative impact on native flora.
- ISEIA-score: 11.
- References: Boer (2014); Verspreidingsatlas.nl.

4.2.7 *Cotoneaster salicifolius*

Wilgbladige cotoneaster, *Willowleaf Cotoneaster*

- Origin: China.
- Characters: An evergreen shrub, up to 5 m height with large, elongated leaves (6-9 cm) and more than 20 white flowers. The berries are red and eaten by birds, which disperse the seeds.
- Pathway: Horticulture and secondary dispersal to natural habitats.
- Distribution: Introduced in several European countries. Netherlands: established, occurs widespread, but relatively rare in all provinces.
- Natura 2000: Yes, including dune habitats.



Impact: Competition with native species by forming dense thickets.
ISEIA-score: 11.
References: Boer (2014); Verspreidingsatlas.nl.

4.2.8 *Echinops sphaerocephalus*

Beklierde kogeldistel, Glandular globe-thistle

Origin: Southern Europe.
Characters: Glandular globe-thistle is a woolly perennial herbaceous plant (50-100 cm). The erect branches are grey and hairy with large, sharply toothed and pointed green leaves. The leaves have sticky hairs above and are white woolly below. Grows in open, sunny and rocky habitats, with grassland, herbaceous vegetation and shrubs.
Pathway: Horticulture and secondary dispersal by garden waste to natural habitats.
Distribution: Rare in the Netherlands with established populations along the large rivers.
Natura 2000: Yes.
Impact: Low, preferred habitat scarce, competition with native species unlikely.
ISEIA-score: 7.
References: Verspreidingsatlas.nl.

4.2.9 *Lonicera acuminata*

Geurige Kamperfoelie, Henry's Honeysuckle

Origin: Japan.
Characters: Evergreen, fast-growing lignifying vine, up to several meters high, with reddish to purple flowers similar to honeysuckle *Lonicera*. Berries are blue-black.
Pathway: Horticulture and secondary dispersal to natural habitats by birds, which eat the berries and disperse the seeds.
Distribution: Introduced in several European countries. Netherlands: established in all provinces in various forested areas and parks usually near urban areas.
Natura 2000: Yes.
Impact: Medium. Potentially invasive in forest and along rivers.
ISEIA-score: 8.
References: Soortenregister.nl

4.2.10 *Persicaria amplexicaulis*

Doorgroeide duizendknoop, Mountain Fleece

Origin: Himalaya.
Characters: Perennial herb, with large and broad leaves and red to purple flowers. Reproduces only vegetatively by rhizomes.
Pathway: Horticulture and secondary dispersal by garden waste to natural habitats.



Distribution: Introduced in several European countries and established in England and Ireland. Netherlands: established and widespread in all provinces.
Natura 2000: Yes.
Impact: Low, no competition with native species reported.
ISEIA-score: 8.
References: Verspreidingsatlas.nl.

4.2.11 *Prunus laurocerasus*

Laurierkers Cherry Laurel

Origin: South-eastern Europe.
Characters: Large, evergreen shrub (usually up to 6-8 m) with large, shiny leaves, pinkish flower clusters and black berries.
Pathway: Horticulture and secondary dispersal to natural habitats by birds, which eat the berries and disperse the seeds.
Distribution: Introduced in several European countries. Netherlands: recently possibly established in relation to climate change; widespread in all provinces.
Natura 2000: Yes.
Impact: Low, no competition with native species reported.
ISEIA-score: 7.
References: Verspreidingsatlas.nl.

4.2.12 *Pseudosasa japonica*

Japanese bamboo, Metake Bamboo

Origin: Japan.
Characters: Metake Bamboo is a flowering plant of the Poaceae, the grass family, with thick golden-yellow stems growing in thickets up to 4-6 m. Reproduces by rhizomes.
Pathway: Horticulture and secondary dispersal by garden waste and garden soils to natural habitats.
Distribution: Netherlands: not established and but occurs widespread in all provinces.
Natura 2000: Yes.
Impact: Low, no competition with native species reported.
ISEIA-score: 7.
References: Verspreidingsatlas.nl.

4.2.13 *Rubus armeniacus*

Dijkviltbraam, Himalayan Blackberry

Origin: Armenia.
Characters: Himalayan blackberry is a perennial shrub, which can reach 6-12 m horizontally and 3 m vertically. Leaves are toothed and typically



compounded with five leaflets. Leaf blades are 3-12 cm long, ovate to orbicular and dark green in colour. Flowers are white to rose in groups of three to 20 in terminal panicles. The fruit are less than 2 cm aggregates of black, shiny, roundish drupelets. Himalayan blackberry can reproduce both vegetatively and by the production of seed.

- Pathway: Agriculture and secondary dispersal to natural habitats by birds which eat the berries and disperse the seeds.
- Distribution: It was introduced outside of its native range as a cultivated crop and dispersed into natural areas in many temperate areas around the world including most European countries.
- Natura 2000: Yes.
- Impact: Medium. This species is highly invasive and can form impenetrable thickets which have a negative impact on native flora and fauna. In addition to this, it has been reported as highly invasive in Central Europe and has been identified as one of the most problematic invasive plants Sweden.
- ISEIA-score: 10.
- References: CABI, 2022.

4.2.14 *Soliva sessilis*

Naaldzaadbloem, Field Burrweed

- Origin: South America.
- Characters: Field Burrweed is a herbaceous, low-growing winter annual that germinates during the wet period in Mediterranean climate areas and grows throughout the winter when the weather is warm enough. Flowering occurs from March to July after which the plants wither and dry up, leaving the sharply pointed seeds sitting upright in the head where they can easily attach to any passing shoe or to tent floors. The flowers of *S. sessilis* are small and inconspicuous. The seeds of *S. sessilis* are sharply pointed with wings and/or barbs of various shapes.
- Pathway: International trade and transports, recreation, camp-sites. The seeds can cling to fabric such as tent floors and be transported long distances. In local areas, it may be moved on the soles of shoes, particularly soft-soled shoes commonly worn around the beach and when camping.
- Distribution: Netherlands: mainly limited to coastal camping sites.
- Natura 2000: Yes.
- Impact: Medium. Field Burrweed spreads readily in areas with poor soils. Once established, the plant forms dense carpets that suppress most other lawn species and can out-compete rare species. It is considered one of the most hated turf weeds in New Zealand because it can make barefoot walking very painful. It is low-growing and escapes the blades of most mowers. It has developed a resistance to synthetic auxin herbicides of the carboxylic acid family.
- ISEIA-score: 9.
- References: CABI (2022).



4.2.15 *Sorbaria sorbifolia*

Sorbaria, False Spirea

- Origin: Asia.
- Characters: Large perennial herb (up to 2 m) with pinneate leaves and large, white flower clusters.
- Pathway: Horticulture and secondary dispersal by garden waste and soils from gardens to natural habitats.
- Distribution: Netherlands: widespread and found in all provinces, but not established.
- Natura 2000: Yes.
- Impact: Medium, competition with native species reported (Veselkev *et al.*, 2020).
- ISEIA-score: 9.
- References: Verspreidingsatlas.nl.

4.2.16 *Spiraea x billardii*

Theeboompje x Douglasspirea, Billard's Bridewort

- Origin: Hybrid, North America.
- Characters: Shrub which grows up to 2 m, with white to reddish flowers. Spreads vegetatively by fast growing rhizomes.
- Pathway: Horticulture and garden discards and soils into natural habitats.
- Distribution: Introduced in many European countries. Widespread in the Netherlands in particular the eastern part on higher grounds.
- Natura 2000: Yes.
- Impact: Medium. Forms dense thickets with negative impact on native flora.
- ISEIA-score: 9.
- References: Verspreidingsatlas.nl.

4.2.17 *Tellima grandiflora*

Franjekelk, Bigflower Tellima

- Origin: North America
- Characters: Bigflower tellima is an herbaceous perennial plant (height up to 0,3 m) with small greenish white to purple flowers. In the native range occurs in moist forest. Produces numerous small seeds and can form dense patches in non-native range.
- Pathway: Horticulture and secondary dispersal by garden waste and garden soils to natural habitats.
- Distribution: Introduced in several European countries. Netherlands: established and widespread in all provinces.
- Natura 2000: Yes.
- Impact: Low to medium impact by competition.
- ISEIA-score: 8.
- References: Verspreidingsatlas.nl; Verloove, 2022.



4.2.18 *Viola x wittrockiana*

Tuinvioltje, Garden pansy

- Origin: Hybrid, Europe.
Characters: Large-flowered, annual herb with a wide range of flower colours. Found mainly in disturbed, ruderal areas such as fallow areas, road verges and urban areas.
Pathway: Horticulture and secondary dispersal by garden waste and garden soils to natural habitats.
Distribution: Widespread in all provinces, in particular in dune areas, but not established.
Natura 2000: Yes.
Impact: Low reproductive potential, hybrid.
ISEIA-score: 7.
References: Verspreidingsatlas.nl.

4.3 Other groups

Molluscs

4.3.1 *Ambigolimax valentianus (Lehmannia valentiana)*

Spaanse aardslak, Iberian Slug

- Origin: Iberian Peninsula
Characters: The Iberian slug is a small slug of up to 7 cm. Colour varies from yellowish grey, flesh or pale pink purple with darker colour bands.
Pathway: Transport of garden plants, plant materials, crops and soil, and by transport equipment (containers, pellets).
Distribution: Introduced in most European countries and other continents. Netherlands: established and widespread in all provinces.
Natura 2000: No.
Impact: Low, limited occurrence in natural habitats.
ISEIA-score: 4.
References: Verspreidingsatlas.nl; NOBANIS.

4.3.2 *Arion vulgaris*

Spaanse wegslak, Spanish Slug

- Origin: Southern Europe.
Characters: Spanish slugs are very similar to the “dusky arions” (*Arion fuscus* and *A. subfuscus*) and have a variable body colour, including yellowish, greyish, chocolate, reddish, and brownish and are similar to . Adults are normally unbanded, colour of the upper surface a uniform yellowish-brown, brown,



reddish-brown or dark brown, rarely black. Juveniles have dark lateral bands with paler bands on the sides above and below these – distinguishing them from juvenile *A. rufus* and juvenile and adult *A. subfuscus*. Spanish slugs occur mainly in disturbed, antropogenic habitats and is most frequent in agricultural and horticultural habitats with permanent, dense vegetation, such as grassland, fallows and gardens (compost heaps). In low numbers, it is present in most agricultural and horticultural land and increasingly in natural habitats.

- Pathway: Transport of garden plants, plant materials, crops and soil, and by transport equipment (containers, pellets).
- Distribution: Introduced in most European countries. Netherlands: established and widespread in all provinces.
- Natura 2000: Yes, but low numbers.
- Impact: Medium. Hybridizes with most large slugs native to western Europe. Mainly economic impact in agricultural and horticultural habitats.
- ISEIA-score: 8.
- References: Soes & de Winter (2011); CABI (2022).

4.3.3 *Deroceras invadens*

Zwervende akkerslak, Tramp Slug

- Origin: Italy
- Characters: The Tramp slug is a small, agile, slug species with a reputation for pugnacity towards other slugs. Size range is 25-35 mm. The body colour is variable. In north-west Europe two forms predominate. The most common is mid grey and translucent with lighter mantle.
- Pathway: Transport of garden plants, plant materials, crops and soil, and by transport equipment (containers, pellets).
- Distribution: Introduced in most European countries and other continents. Netherlands: established and widespread in all provinces.
- Natura 2000: Yes, but low numbers.
- Impact: Medium. Aggressive competitor may have negative impact on native slugs in natural habitats.
- ISEIA-score: 8.
- References: CABI (2022); Verspreidingsatlas.nl.

4.3.4 *Sinanodonta woodiana*

Chinese vijvermossel, Chinese Pond Mussel

- Origin: temperate and tropical Asia (China)
- Characters: *S. woodiana* is a large freshwater mussel species, which grows up to a length of 12-26 cm and a maximal height of 12 cm. This mussel is found in a variety of habitat such as ponds, oxbow lakes and canals, in particular heavily modified and artificial habitats and is tolerant to high siltation rates.



It prefers substrates of silt and clay, turbid conditions with relatively high water temperatures (30-33° C) and is found in either standing or slow-flowing water. It has a Unionid life cycle and produces thousands of glochidia, parasitic larvae which attach to a variety of fish species. The reproductive rate is higher compared to native Unionidae and the glochidia can parasitize a larger number of host fish species.

Pathway: Live fish transports for angling or ornamental purposes (e.g., common carp).

Distribution: Introduced in most European countries, North and South America and Asia, outside the native range.

Natura 2000: Yes

Impact: High. Potential competition with native Unionidae, because the reproductive potential is higher (more larvae) and more host fish species are utilized by the glochidia.

ISEIA-score: 12.

References: US Fish & Wildlife Service (2021); Łabęcka *et al.* (2018).

Fishes

4.3.5 *Carassius gibelio*

Gibel, Prussian carp

Origin: cryptogenic, possibly Asia

Characters: Prussian carp resembles wild goldfish and Crucian carp: a relatively high and laterally compressed body with a long, dorsal fin. It differs from these species in having a silver to grey brown colour (bronze or golden brown in wild goldfish and Crucian carp) and concave or straight dorsal fin (convex in Crucian carp). The scales are large, numbering 29 to 33 on the lateral line. The mouth is terminal and has no barbels. Prussian carp can grow to a length of 50 cm. It occurs in freshwater habitats including ponds, lakes and rivers with submerged vegetation

Pathway: Introduced in Europe, including the Netherlands, centuries ago together with common carp and goldfish.

Distribution: Widespread in Europe and the Netherlands.

Natura 2000: Yes.

Impact: High. Prussian carp can hybridize with Crucian carp, which is a threatened species in the Netherlands. Competition with native species has been reported in Europe.

ISEIA-score: 11.

References: Schiphouwer *et al.* (2014).



4.3.6 *Coregonus albula*

Kleine marene, Vendace

- Origin: Baltic, N. Europe
- Characters: The vendace is a small, salmonid fish species with a bluish green back, a white belly and silvery flanks that grows up to 20 to 23 cm. The vendace has grey fins which become darker towards their margins. Like all Salmonidae the vendace has a second dorsal fin. Vendace eyes are large and their superior mouth is relatively small. It grows up to 20-23 cm and has a maximum lifespan of approximately 10 years.
The vendace is a pelagic species that prefers clean, cold and oxygen-rich waters. It is most abundant in large deep lakes, but also has anadromous populations and populations in the Baltic Sea.
- Pathway: Introduction for commercial fisheries in Scandinavia. Secondary dispersal from other populations in the Netherlands.
- Distribution: The vendace has frequently been introduced in lakes and reservoirs in northern and central Germany and Poland. After introduction to Finnish headwaters the vendace invaded the Pasvik river system in Norway and Russia. Netherlands: one observation in the Wadden Sea (Texel), one observation in Lake IJssel (IJsselmeer).
- Natura 2000: Yes.
- Impact: Low. A negative impact on native fish communities has been reported in the Pasvik river. This river flows through an arctic climate zone and similar impact is unlikely in the Netherlands.
- ISEIA-score: 4.
- References: Schiphouwer *et al.* (2014).

4.3.7 *Neogobius melanostomus*

Round Goby, Zwartbekgrondel

- Origin: Ponto-Caspian Region
- Characters: Round gobies are small, greyish fish with large eyes and a black spot on the first dorsal fin. The pelvic fins are fused to form a suction cup. Round gobies grow up to 10-25 cm and have a maximum life span of 4 years. Male round gobies are larger than females and adult male round gobies become dark black during the spawning season. Occurs in fresh and brackish water, prefers hard substrates like armour rock along lakes and rivers, but also occurs on soft substrates.
- Pathway: Passive transport of eggs with ballast water.
- Distribution: Introduced in several European countries and North America. Netherlands: established and widespread in all provinces in ponds, lakes and rivers.
- Natura 2000: Yes.
- Impact: High. Competition with native fish species.
- ISEIA-score: 11.



References: Spikmans *et al.* (2010).

Mammals

4.3.8 *Tamiasciurus hudsonicus*

Amerikaanse rode eekhoorn, American red squirrel

Origin: North America.

Characters: American red squirrels are slightly smaller (total length 28-35 cm) than European red squirrels (total length 30-40 cm). Both species have a reddish fur with a white venter (underbelly) and reddish plumes to the ears. American red squirrels can be distinguished by the larger, white eye-ring and more greyish colour. Prefers pine forest but is also found in mixed and deciduous forest. Highly territorial, aggressive and strong competitor.

Pathway: Pet trade.

Distribution: Relatively rare in the trade. Netherlands: not established, a few observations in several provinces.

Natura 2000: Yes.

Impact: High. Competition with native squirrels is likely. American red squirrels can also be affected by a squirrel pox virus (Himsworth *et al.*, 2009), of which the effect on European red squirrel is unknown.

ISEIA-score: 8.

References: Dijkstra & Dekker (2008); Himsworth *et al.* (2009).



5 Conclusions and recommendations

5.1 Conclusions

Number of alien species

The number of alien species on the Wadden Sea islands increased in recent years. In the period 2005-2020 610 alien species were observed on the Wadden Sea islands: 407 in the period 2005-2014 and 518 in the period 2015-2020. 203 were added to the list in the period 2015-2020, 92 species were only observed in the first period. If the agricultural pests (most fungi and insects) are excluded there were 170 newly observed alien species compared to the 2005-2014 time period. Plants were the most observed alien species on the Wadden Sea islands (74%), followed by the fungi (7,4%), birds (7,2 %) and insects (5,6%).

Establishment status

The total number of species observed on the Wadden Sea islands includes all National Species Register establishment status categories (2a-d and 2). The category of species with at least 100 years reproduction is well represented by 122 species out of 176 species in this category in the Netherlands (69%). The relative proportions in the other categories are very similar to the national level (Table 3.3 – 3.4). This is expected as species which are already present in the Netherlands for over 100 years are usually widespread on the mainland and have much more time and opportunities to colonise the islands.

Observed species of EU-concern

The total list of observed alien species in both study periods includes 15 invasive alien species of EU-concern and three subspecies of the pond slider. There were three additions of invasive alien species in the 2015-2020 study period (Raccoon Dog, American Skunk-cabbage, Various-leaved Milfoil) and two species were only observed in the first period. The observations of Sacred Ibises and Ruddy Ducks referred to wandering individuals. The observation of a raccoon dog on Ameland was a dead animal washed ashore on the beach.

Expected species of EU-concern

Based on the fact that all alien species of EU-concern observed on the Wadden Sea islands have established populations on the mainland (Article 19a or 19b), it is expected that all other species with large, established populations might colonise one or more Wadden Sea islands in the near future. These nine species are indicated in Appendix III.

Habitats at risk

The dry dunes and wooded dunes have the highest risk of new alien species settlements, followed by humid dune slacks and open water. Salt marshes have a low risk of alien species settlements, which is probably related to the salt stress.

257 alien species (out of 296 not included in the study of Lensink *et al.*, 2015) were assessed if they could occur in specific terrestrial Natura 2000 habitats and indicated as such in the database. 38 species, including all fungi (mainly plant rust species) and insects and several plant species were considered as not likely to settle in natural habitats. These



species include mainly agricultural pests, several garden plants and their natural enemies (plant rusts, phytofagous insects) and several insect species living indoors.

Risk assessments

Out of 296 new alien species which were new to the analysis of Lensink *et al.* (2015), in total 75 species were selected for risk assessment, including 56 plant species, 11 bird species, 4 mollusc species, 3 fish species and one mammal species. 16 High risk species (score higher than 8) were identified, which included eleven plant species (Billard's bridewort, five species of Cotoneaster, False Spirea, Field Burrweed, Oregon Grape, Himalayan Blackberry, Rhododendron), 2 bird species (Least Canada goose, Ring-necked Parakeet), one mollusc species (Chinese Pond Mussel) and 2 fish species (Prussian Carp, Round Goby).

5.2 Discussion

Plants were the most observed alien species taxonomic group. The risk assessments suggests that horticulture, the trade and cultivation of garden plants is an important pathway of alien species to the Wadden islands. The pet trade is probably the most important pathway for fishes (6 species), amphibians (1 species) and reptiles (one species with 3 subspecies). Most bird species (44 species) probably reach the islands by secondary dispersal, because of their large dispersal capacity. Most fungi reach the islands probably also by secondary dispersal, as most species reproduce and disperse with spores.

Although 170 new alien species (excluding most agricultural pest species) were observed on the Wadden Sea islands in the period 2015-2020, only a small number of high-risk species (18) were identified. One of these, Field Burrweed, deserves more attention as it not only might threaten dune vegetations but also produces seeds with sharp needles which can be a nuisance for (bare footed) tourists on camp sites.

5.3 Recommendations

- It is recommended to give invasive alien species reporting a higher priority in the regular monitoring programmes, with a focus on high impact invasive species which are new or not established, including the species list of EU-concern and additional provincial priority species (provinces of Fryslân and Noord-Holland).
- Pet shops and garden centres on the Wadden Sea islands are possible pathways for invasive alien species. It is recommended to include these sites in the surveillance for invasive alien species of EU-concern and provincial priority species.



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Appendix I Metainformation alien species database

First row	Second Row with Autofilter	Explanation
	Scientific name	As in the Netherlands Species Register & NDFF
	Dutch name	As in the Netherlands Species Register & NDFF
	English name	As in the Netherlands Species Register
	Group	Taxonomic group
	Lensink 2015	Alien species mentioned in Lensink et al. 2015: 0=no; 1=yes
	NSR-status	Establishment status in Netherlands Species Register
	Exoten-paspoort	Alien species passport in NSR: 0= not present, 1=present
H1310-1330	Salt marsh	Natura 2000-habitats where alien species can occur: 1=suitable
H2110-2170	Dry dunes	Natura 2000-habitats where alien species can occur: 1=suitable
H2180	Wooded dunes	Natura 2000-habitats where alien species can occur: 1=suitable
H2190	Humid dunes	Natura 2000-habitats where alien species can occur: 1=suitable
H2190A	Open water	Natura 2000-habitats where alien species can occur: 1=suitable
Texel	2005-2014	Island, period, #1x1km-squares of observations
Texel	2015-2020	Island, period, #1x1km-squares of observations
Terschelling	2005-2014	Island, period, #1x1km-squares of observations
Terschelling	2015-2020	Island, period, #1x1km-squares of observations
Ameland	2005-2014	Island, period, #1x1km-squares of observations
Ameland	2015-2020	Island, period, #1x1km-squares of observations
Schiermonnikoog	2005-2014	Island, period, #1x1km-squares of observations
Schiermonnikoog	2015-2020	Island, period, #1x1km-squares of observations
Vlieland	2005-2014	Island, period, #1x1km-squares of observations
Vlieland	2015-2020	Island, period, #1x1km-squares of observations
Rottumeroog	2005-2014	Island, period, #1x1km-squares of observations
Rottumeroog	2015-2020	Island, period, #1x1km-squares of observations
Rottumerplaat	2005-2014	Island, period, #1x1km-squares of observations
Rottumerplaat	2015-2020	Island, period, #1x1km-squares of observations
Engelsmanplaat	2005-2014	Island, period, #1x1km-squares of observations
Engelsmanplaat	2015-2020	Island, period, #1x1km-squares of observations
Griend	2005-2014	Island, period, #1x1km-squares of observations
Griend	2015-2020	Island, period, #1x1km-squares of observations
Het Rif	2005-2014	Island, period, #1x1km-squares of observations
Het Rif	2015-2020	Island, period, #1x1km-squares of observations
Richel	2005-2014	Island, period, #1x1km-squares of observations
Richel	2015-2020	Island, period, #1x1km-squares of observations
Zuiderduintjes	2005-2014	Island, period, #1x1km-squares of observations
Zuiderduintjes	2015-2020	Island, period, #1x1km-squares of observations
#eilanden	2005-2014	Number of island where alien species is observed
#eilanden	2015-2020	Number of island where alien species is observed
Change # islands		Change in number of island where alien species is observed
#km total	2005-2014	#1x1 km squares with alien species observations in time period
#km total	2015-2020	Number of km squares with alien species observations in time period
Change #km squares		Change in #1x1 km squares where alien species is observed in period
List of EU-concern		Invasive alien species of EU-concern, 1=included in list
Agricultural pest species		1=yes, 0=no



Appendix II Natura 2000-areas on Wadden Sea islands

Natura 2000 areas

In the Netherlands, the European Bird and Habitat Directives are implemented in the Nature conservation act by the designation of protected areas. Currently, 164 Natura 2000-areas are designated in the Netherlands. For each area a list of habitats and species is available and included in the Natura 2000 Nature Conservation goals. For each island in the Wadden Sea (five main islands; Table A1)) several Natura 2000 areas have been designated for specific species and habitats. The smaller islands (e.g. Rottumeroog, Rottummerplaat) and major sandbanks are part of Natura 2000 area Wadden Sea. The beaches of the islands are part of the Natura 2000 area Noordzeekustzone (North Sea Coastal Zone; Tables A.1 – 6).

The occurrences of alien species on the Wadden Sea Islands have been linked to one or more designated habitat type. Most of the habitat types which are at risk for the establishment of alien species are located in the Natura 2000 areas. A smaller number of alien species occur in disturbed habitats which are mainly found outside Natura 2000 areas such as eutrophic and hypertrophic waters, roadsides, urban areas and agricultural.

Table A.1 Overview Natura 2000 areas in the study area, surface area protected and management organisations of the protected area.

#	Natura 2000 area	Area (ha)	RWS	SBB	PP	NM	IFG	GI	LNH	Mdef	Mfin
1	Waddenzee	272.449	x	x		x	x	x	x	x	
2	Duinen & Lage Land Texel	4.615	x	x	x	x				x	
3	Duinen Vlieland	1.535	x	x	x						
4	Duinen Terschelling	5.017	x	x	x						
5	Duinen Ameland	2.012	x	x	x		x				x
6	Duinen Schiermonnikoog	1.024	x		x	x					
7	Noordzeekustzone	123.134	x	x		x					

Rijkswaterstaat	RWS
Staatsbosbeheer	SBB
Private Property	PP
Natuurmonumenten	NM
It Fryske Gea	IFG
Groninger Landschap	GL
Landschap Noord-Holland	LNH
Ministerie van Defensie	Mdef
Ministerie van Financiën	Mfin



Protected Species

Parts of the European Bird and Habitat Directives are implemented in the Dutch law under the Nature conservation act covering the protection of species. Plants form the largest taxonomic group in these lists. Since most protected species are rare and mostly confined to highly protected areas or specific environmental condition, the majority occurs in Natura 2000 areas. For these reasons, no special attention was paid to protected species in relation to the abundance of invasive alien species.

Table A.2 Overview of habitat types in the assignments of the Wadden Sea islands (in English).

	Noordzeekustzone	Duinen & Lage Land Texel	Duinen Vlieland	Duinen Terschelling	Duinen Ameland	Duinen Schiermonnikoog	Waddenzee	number of assignments
H1110A Sandbanks which are slightly covered by sea water all the time (tidal zone)							1	1
H1110B Sandbanks which are slightly covered by sea water all the time (North Sea)	1							1
H1140A Mudflats and sandflats not covered by seawater at low tide (tidal zone)							1	1
H1140B Mudflats and sandflats not covered by seawater at low tide (North Sea)	1							1
H1310A Salicornia and other annuals colonizing mud and sand (<i>Salicornia</i>)	1	1	1	1			1	5
H1310B Salicornia and other annuals colonizing mud and sand (<i>Sagina maritima</i>)	1	1		1			1	4
H1320 Spartina swards (<i>Spartinion maritimae</i>)							1	1
H1330A Atlantic salt meadows (<i>Glauco-Puccinellietalia maritimae</i>) (tidal zone)	1	1	1	1			1	5
H1330B Atlantic salt meadows (<i>Glauco-Puccinellietalia maritimae</i>) (inland)	1						1	2
H2110 Embryonic shifting dunes	1	1		1			1	4
H2120 Shifting dunes along the shoreline with <i>Ammophila arenaria</i> ('white dunes')	1	1	1	1	1	1	1	6
H2130A Fixed coastal dunes with herbaceous vegetation ('grey dunes') (calcerous)	1				1	1	1	3
H2130B Fixed coastal dunes with herbaceous vegetation ('grey dunes') (decalcified)	1	1	1	1	1	1	1	6
H2130C Fixed coastal dunes with herbaceous vegetation ('grey dunes') (heather)	1		1	1	1	1	1	4
H2140A Decalcified fixed dunes with <i>Empetrum nigrum</i> (humid)	1	1	1	1	1			4
H2140B Decalcified fixed dunes with <i>Empetrum nigrum</i> (dry)	1	1	1	1	1	1	1	5
H2150 Atlantic decalcified fixed dunes (<i>Calluno-Ulicetea</i>)	1	1	1	1	1			4
H2160 Dunes with <i>Hippophaë rhamnoides</i>	1	1	1	1	1	1	1	6
H2170 Dunes with <i>Salix repens ssp. argentea</i> (<i>Salicion arenariae</i>)	1	1	1	1	1	1	1	5
H2180A Wooded dunes of the Atlantic, Continental and Boreal region (dry)	1	1	1	1	1	1	1	4
H2180B Wooded dunes of the Atlantic, Continental and Boreal region (humid)			1	1	1	1	1	3
H2180C Wooded dunes of the Atlantic, Continental and Boreal region (inside)						1	1	1
H2190A Humid dune slacks (open water)	1	1	1	1	1	1	1	5
H2190B Humid dune slacks (calcerous)	1	1	1	1	1	1	1	7
H2190C Humid dune slacks (decalcified)	1	1	1	1	1	1	1	5
H2190D Humid dune slacks (high marsh plants)	1	1	1	1	1	1	1	5
H6230 Species-rich <i>Nardus</i> grasslands,				1	1			2
H6410 <i>Molinia</i> meadows on calcareous, peaty or clayey-silt-laden soils (<i>Molinion caeruleae</i>)						1	1	1
H7210 Calcareous fens with <i>Cladium mariscus</i> and species of the <i>Caricion davallianae</i>	1							1
total	7	20	15	19	14	15	12	



Table A.3 Overview of habitat directive species in the Natura 2000 areas of the Wadden Sea islands.

			Noordzeekustzone	Duinen & Lage Land Texel	Duinen Vlieland	Duinen Terschelling	Duinen Ameland	Duinen Schiermonnikoog	Waddenzee	aantal aanwijzingen
H1014	Narrow-mouthed whorl snail	Nauwe korfslak							1	1
H1095	Sea Lamprey	Zeeprik	1						1	2
H1099	River Lamprey	Rivierprik	1						1	2
H1103	Fint	Fint	1						1	2
H1340	Tundra Vole	*Noordse woelmuis		1						1
H1351	Porpoise	Bruinvis	1							1
H1364	Grey Seal	Grijze zeehond	1						1	2
H1365	Harbour Seal	Gewone zeehond	1						1	2
H1831	Floating Water-Plantain	Drijvende waterweegbree				1				1

Table A.4 Overview of breeding bird species in the Natura 2000 areas of the Wadden Sea islands and their breeding habitats.

			Noordzeekustzone	Duinen & Lage Land Texel	Duinen Vlieland	Duinen Terschelling	Duinen Ameland	Duinen Schiermonnikoog	Waddenzee	aantal aanwijzingen	breeding site
A004	Little grebe	Dodaars				1				1	marsh
A017	Cormorant	Aalscholver			1					1	ground, trees
A021	Bittern	Roerdomp	1				1	1		3	marsh
A034	Spoonbill	Lepelaar	1	1				1		3	ground, shrub
A063	Eider	Eider	1	1			1	1	1	5	ground
A081	Marsh Harrier	Bruine Kiekendief	1	1	1	1	1	1		6	ground
A082	Blue Harrier	Blauwe Kiekendief	1	1	1	1	1	1		6	ground
A119	Crake	Porseleinhoen			1		1			2	marsh
A132	Oocet	Kluut		1					1	2	ground
A137	Ringed Plover	Bontbekplevier	1	1		1			1	4	ground
A138	Sandplover	Strandplevier	1			1			1	3	ground
A183	Lesser Black-backed Gull	Kleine Mantelmeeuw		1	1				1	3	ground
A191	Sandwich Tern	Grote stern							1	1	ground
A193	Common tern	Visdief							1	1	ground
A194	Arctic Tern	Noordse Stern							1	1	ground
A195	Little Tern	Dwergstern	1	1		1			1	4	ground
A222	Short-eared Owl	Velduil		1		1	1	1	1	5	ground
A275	Winchat	Paapje				1				2	shrub
A276	Stonechat	Roodborsttapuit		1						1	shrub
A277	Wheatear	Tapuit	1	1	1	1	1			5	ground
A295	Sedge warbler	Rietzanger			1	1				2	marsh
A338	Red-backer Shrike	Grauwe Klauwier				1				1	shrub
			3	12	8	10	9	7	13		



Table A.5 Overview of non-breeding bird species in the Natura 2000 areas of the Wadden Sea islands and their use of high tide roosts.

<i>EU-nr</i>	<i>English</i>	<i>Dutch</i>	Noordzeekustzone	Duinen & Lage Land Texel	Duinen Vlieland	Duinen Terschelling	Duinen Ameland	Duinen Schiermonnikoog	Waddenzee	aantal aanwijzingen	use of high tide roost
A001	Red-throated Loon	Roodkeelduiker	1							1	
A002	Black-throated Loon	Parelduiker	1							1	
A005	Crested Grebe	Fuut							1	1	
A017	Cormorant	Aalscholver	1		1				1	3	
A034	Spoonbill	Lepelaar			1					2	
A037	Bewick's Swan	Kleine Zwaan							1	1	
A039b	Bean Goose	Toendrarietgans							1	1	
A043	Greylag Goose	Grauwe Gans							1	1	
A045	Barnacle Goose	Brandgans							1	1	
A046	Brent Goose	Rotgans							1	1	
A048	Shelduck	Bergeend	1						1	2	1
A050	Wigeon	Smient							1	1	
A051	Gadwall	Krakeend							1	1	
A052	Teal	Wintertaling							1	1	1
A053	Mallard	Wilde eend							1	1	1
A054	Pintail	Pijlstaart			1				1	2	1
A056	Shoveler	Slobeend			1				1	2	
A062	Scaup	Toppereend	1						1	2	
A063	Eider	Eider	1						1	2	
A065	Scoter	Zwarte zee-eend	1							1	
A067	Goldeneye	Brilduiker							1	1	
A069	Red-Breasted Merganser	Middelste Zaagbek							1	1	
A070	Goosander	Grote Zaagbek							1	1	
A103	Peregrine	Slechtvalk							1	1	
A130	Oystercatcher	Scholekster	1						1	2	1
A132	Avocet	Kluut	1		1				1	3	1
A137	Ringed Plover	Bontbekplevier	1						1	2	1
A140	Golden Plover	Goudplevier							1	1	
A141	Greu Plover	Zilverplevier	1						1	2	1
A142	Lapwing	Kievit							1	1	
A143	Knot	Kanoet	1						1	2	1
A144	Sanderling	Drieteenstrandloper	1						1	2	1
A147	Curlew Sadpiper	Krombekstrandloper							1	1	1
A149	Dunlin	Bonte strandloper	1						1	2	1
A156	Godwit	Grutto							1	1	
A157	Bar-tailed Godwit	Rosse grutto	1						1	2	1
A160	Curlew	Wulp	1						1	2	1
A161	Spotted Redshank	Zwarte ruiter							1	1	1
A162	Redshank	Tureluur			1				1	2	1
A164	Greenshank	Groenpootruiter							1	1	1
A169	Turnstone	Steenloper	1						1	2	1
A177	Little Gull	Dwergmeeuw	1							1	
A197	Black Tern	Zwarte Stern							1	1	
	<i>total species</i>	<i>totaal soorten</i>	18	0	6	0	0	0	39		18



Appendix III Invasive alien species of EU-concern

The EU-regulation 1143/2014 differentiates the management of invasive alien species according to the establishment stage and spread of the population. Species which were not yet established in a EU-member state when the EU-regulation became effective (3 August 2016) are assigned to Article 17 of the Regulation, which aims for complete removal of new populations. If these invasive alien species are observed then the province has the responsibility to take action to remove or manage these species. Established species fall under Article 19 of the Regulation, which aims in addition to elimination for locally established population or management of widespread populations.

The “Masterplan elimination and management of invasive alien species of EU-concern”¹ was published in 2017 by the Dutch government together with private nature management organisations. This plan fulfills the implementation of the EU-regulation 1143/2014 in the Netherlands. It describes the responsibilities of governmental institutes and organisations and subdivides the species falling under Article 19 of the regulation. Invasive alien species with a limited distribution and for which elimination is still feasible are assigned to Article 19a. Widespread invasive alien species, for which only management applies, fall under Article 19b. The Masterplan specifies for each listed species of EU-concern the level of ambition (elimination, management or acceptance) together with possible management actions.

Observed and expected invasive alien species of EU-concern on the Dutch Wadden Sea islands² with relevant article based on the Masterplan Invasieve Exoten¹. For the 37 species listed on 3 August 2016 and included in the Masterplan the article is indicated in bold, for the other species the relevant article is based on expert judgement and information on the distribution in the Netherlands.

¹ Focusgroep Beheer. 2017. Masterplan uitroeiing en beheersing Unielijstsoorten, Den Haag

² List of Invasive Alien Species of Union Concern – Environment – European Commission (Europa.eu) https://ec.europa.eu/environment/nature/invasivealien/list/index_en.htm

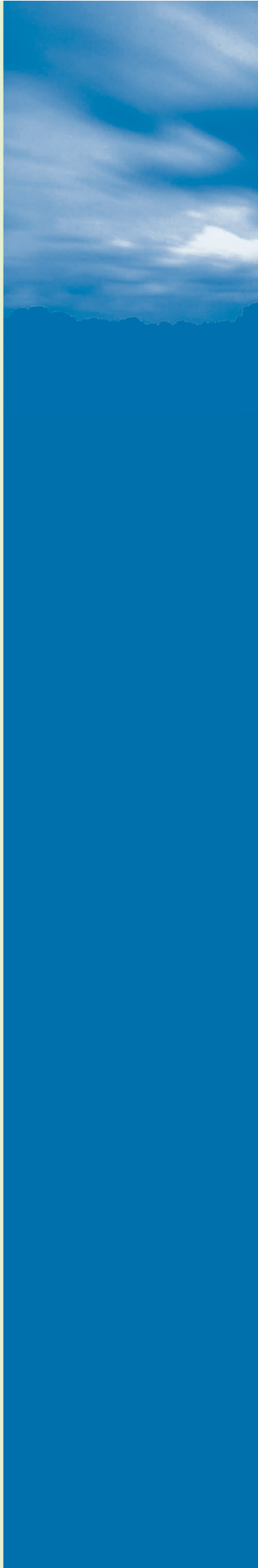


Dutch name	Scientific name	Article EU-list	Observed	Expected
Amerikaans bezemgras	<i>Andropogon virginicus</i>	17		
Ballonrank	<i>Cardiospermum grandiflorum</i>	17		
Chinese struikklaver	<i>Lespedeza cuneata</i>	17		
Fraai lampenpoetsersgras	<i>Pennisetum setaceum</i>	17		
Gestekelde duizendknoop	<i>Persicaria perfoliata</i>	17		
Gewone gunnera	<i>Gunnera tinctoria</i>	17		
Hoog pampagras	<i>Cortaderia jubata</i>	17		
Japans steltgras	<i>Microstegium vimineum</i>	17		
Japanse klimvaren	<i>Lygodium japonicum</i>	17		
Kudzu	<i>Pueraria montana var. lobata</i>	17		
Mesquite	<i>Prosopis juliflora</i>	17		
Oosterse hop	<i>Humulus scandens</i>	17		
Perzische berenklaauw	<i>Heracleum persicum</i>	17		
Roze rimpelgras	<i>Ehrharta calycina</i>	17		
Schijnambrosia	<i>Parthenium hysterophorus</i>	17		
Sosnowsky's berenklaauw	<i>Heracleum sosnowskyi</i>	17		
Struikaster	<i>Baccharis halimifolia</i>	17		
Talgboom	<i>Triadica sebifera</i>	17		
Wilgacacia	<i>Acacia saligna</i>	17		
Alligatorkruid	<i>Alternanthera philoxeroides</i>	17		
Grote vlotvaren	<i>Salvinia molesta</i>	17		
Smalle theeplant	<i>Gymnocoronis spilanthoides</i>	17		
Aziatische hoornaar	<i>Vespa velutina</i>	17		
Nieuw-Zeelandse landplatworm	<i>Arthurdendyus triangulatus</i>	17		Yes
Amerikaanse stierkikker	<i>Lithobates catesbeianus</i>	17		
Amoergrondel	<i>Percottus glenii</i>	17		
Gestreepte koraalmeerval	<i>Plotosus lineatus</i>	17		
Heilige ibis	<i>Threskiornis aethiopicus</i>	17	Yes	
Treurmaina	<i>Acridotheres tristis</i>	17		
Amerikaanse voseekhoorn	<i>Sciurus niger</i>	17		
Grijze eekhoorn	<i>Sciurus carolinensis</i>	17		
Indische mangoeste	<i>Herpestes javanicus</i>	17		
Rode neusbeer	<i>Nasua nasua</i>	17		
Wasbeer	<i>Procyon lotor</i>	17		



Dutch name	Scientific name	Article EU-list	Observed	Expected
Hemelboom	<i>Ailanthus altissima</i>	19a	Yes	
Reuzenbalsemien	<i>Impatiens glandulifera</i>	19a	Yes	
Zijdeplant	<i>Asclepias syriaca</i>	19a		Yes
Kleine waterteunisbloem	<i>Ludwigia peploides</i>	19a		Yes
Moeraslantaarn	<i>Lysichiton americanus</i>	19a	Yes	
Waterhyacint	<i>Eichhornia crassipes</i>	19a		Yes
Huiskraai	<i>Corvus splendens</i>	19a		
Rosse stekelstaart	<i>Oxyura jamaicensis</i>	19a	Yes	
Beverrat	<i>Myocastor coypus</i>	19a		
Muntjak	<i>Muntiacus reevesi</i>	19a		
Pallas' eekhoorn	<i>Callosciurus erythraeus</i>	19a		
Wasbeerhond	<i>Nyctereutes procyonoides</i>	19a	Yes	

Dutch name	Scientific name	Article EU-list	Observed	Expected
Reuzenberenklauw	<i>Heracleum mantegazzianum</i>	19b	Yes	
Grote waternavel	<i>Hydrocotyle ranunculoides</i>	19b		Yes
Ongelijkbladig vederkruid	<i>Myriophyllum heterophyllum</i>	19b	Yes	
Parelvederkruid	<i>Myriophyllum aquaticum</i>	19b	Yes	
Smalle waterpest	<i>Elodea nuttallii</i>	19b	Yes	
Verspreidbladige waterpest	<i>Lagarosiphon major</i>	19b		Yes
Waterteunisbloem	<i>Ludwigia grandiflora</i>	19b		Yes
Waterwaaier	<i>Cabomba caroliniana</i>	19b		Yes
Californische rivierkreeft	<i>Pacifastacus leniusculus</i>	19b		
Chinese wolhandkrab	<i>Eriocheir sinensis</i>	19b		Yes
Geknobbelde Amerikaanse rivierkreeft	<i>Orconectus virilis</i>	19b		
Gevlekte Amerikaanse rivierkreeft	<i>Orconectus limosus</i>	19b		
Marmerkreeft	<i>Procambarus fallax f. virginialis</i>	19b	Yes	
Rode Amerikaanse rivierkreeft	<i>Procambarus clarkii</i>	19b		
Blauwband	<i>Pseudorasbora parva</i>	19b		
Zonnebaars	<i>Lepomis gibbosus</i>	19	Yes	
Geelbuikschildpad	<i>Trachemys scripta scripta</i>	19b	Yes	
Geelwangschildpad	<i>Trachemys scripta troostii</i>	19b	Yes	
Lettersierschildpad	<i>Trachemys scripta</i>	19b	Yes	
Roodwangschildpad	<i>Trachemys scripta elegans</i>	19b	Yes	
Nijlgans	<i>Alopochen aegyptiacus</i>	19b	Yes	
Muskusrat	<i>Ondatra zibethicus</i>	19b		
Siberische grondeekhoorn	<i>Tamias sibiricus</i>	19		



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