PATHWAYS OF UNINTENTIONAL INTRODUCTION AND SPREAD OF 66 INVASIVE ALIEN SPECIES OF UNION CONCERN IN BELGIUM

REPORT 1. IDENTIFICATION AND PRIORITIZATION

2020

Invasive Alien Species
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This report is an update of the 2018 Belgian report on "identification and prioritization of introduction pathways of invasive alien species (IAS) of Union Concern", which considered the 49 species that were on the Union list at that time. This updated report (2020) considers a total of 66 species as 17 species got added to the Union list on August 15th 2019.

This report has been produced by the National Scientific Secretariat on Invasive Alien Species and validated by the National Scientific Council on Invasive Alien Species.

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Several Belgian experts provided valuable feedback on the risk associated with species introductions and pathway categorization for the 17 newly listed species of EU Concern: Filip Verloove (Botanic Garden Meise), Hugo Verreycken (Research Institute for Nature and Forest), Jan Spruyt (vaste plant-kwekerij Spruyt – Van der Jeugd).

2 Executive summary

Article 13 of the *Regulation (EU) No 1143/2014 on the prevention and management of the introduction and spread of invasive alien species* (the 'IAS Regulation') requires Member States to identify and prioritize pathways of unintentional introduction and spread of IAS of Union Concern. This report identifies priority pathways of unintentional introduction in Belgium for the 66 IAS of Union Concern listed to date (2020). Priority pathways are defined in the IAS Regulation as pathways requiring actions by priority because of the volume of the alien species using the pathway or of the potential damage these species can inflict on biodiversity.

First, pathways of introduction and spread were identified for each of the listed species by reviewing pathway information contained in the EU risk assessments using the definitions of the CBD classification framework (CBD, 2014) and the interpretation manual of Harrower *et al.* (2018). The relevance of these pathways was considered for Belgium, based on expert knowledge and review. Second, the prioritization methodology which took into account the species impact, establishment potential and the frequency of introduction via the pathway was used and finetuned. As the results of the prioritization are in line with results of the previous prioritization analysis (NSSIAS, 2018 – report 1), there seems to be no immediate need for a thorough adaptation of the three current actions plans on "introductions of species by private and public ownership", on "introductions through use of freshwater", and "for contamination of sediment transports"). Nevertheless, an update of certain actions in these action plans in order to include the particulars of the newly listed species seems appropriate. Additionally it could be considered to address the pathway "nursery contaminant" which is of importance for several species, including the currently absent but high impact invasive species *Arthurdenyus triangulatus*.

3 SCOPE

The present report is the second Belgian prioritization of pathways of IAS of Union Concern in the framework of Regulation 1143/2014 and accommodates the inclusion of the 17 newly added species on the Union list; it includes the update of species scores of the 1^{st}, 2^{nd} and ^{3rd} list due to the availability of new scientific information. This report has to be interpreted as a working document, which will be updated when new species are added to the list of species of Union Concern, or in the case new knowledge on species and pathways requires an update of the prioritization exercise. The current report presents the analysis and results of the prioritization exercise for all species listed to date (august 2020).

An excel spreadsheet containing all the raw data on species and their pathways used in this report, can be acquired from the National Scientific Secretariat on Invasive Alien Species on request (secretariat@iasregulation.be).

4 BACKGROUND

IAS are organisms that are introduced accidentally or deliberately outside their natural range, and whose introduction has been found to threaten or adversely impact upon biodiversity and ecosystem services (provisioning, regulating, habitat and/or cultural). They are already one of the most important direct drivers of loss of ecosystem service change and biodiversity loss (Brunel et al., 2013) And the incidence and impact of IAS are only expected to increase in the future (E.g. Dudley et al., 2010).

Invasive alien species represent a threat to native plants and animals in Europe and are already causing damage worth billions of euros to the European economy every year. The *Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species* (the 'IAS Regulation') is a response at the European level to the threat posed by IAS. It entered into force on 1 January 2015 and seeks to address the problem of IAS in a comprehensive manner, preventing, minimising and mitigating the adverse effects of IAS on native biodiversity and related ecosystem services. The IAS Regulation is primarily aimed at minimizing the spread of IAS that represent a substantial threat to biodiversity and related ecosystem services in (parts of) Europe. It therefore establishes a list of species of concern to the European Union (the Union List species), for which a suit of measures apply. As new IAS can be introduced continuously into the Union and alien species present are spreading and expanding their range, the list is dynamic and allows for regular updating. Species can be proposed for inclusion on the list at the initiative of Member States or the European Commission.

The IAS Regulation foresees a three-stage hierarchical approach based on 1) prevention, 2) early detection and rapid eradication, and 3) control and/or containment. This approach aims at minimising new introductions and establishment and also covers and management of already established invasive species. It reflects scientific and policy consensus that prevention is generally far more cost-effective and environmentally desirable than post-introduction measures (Leung et al., 2002; Finoff et al., 2007; Kim et al., 2016). Where an IAS has been introduced, early detection and rapid eradication are the most cost-effective ways to prevent establishment and further spread, backed by early warning and information exchange. If eradication is not feasible, control and/or containment measures should be implemented. Here, we address pathway analysis as a component of prevention. The importance of considering pathways is widely acknowledged as a key element of prevention (Wittenberg et al., 2005; Hulme, 2009; McGeogh et al., 2016). At international and European level, several policy measures are already in place tackling pathways via which IAS are introduced, e.g. the Ballast Water Convention, (standards from) the International Plant Protection Convention, the OiE standards (World Organization for Animal Health) and the EU Aquaculture Regulation, Wildlife Trade Regulation. In addition, introduction pathways of IAS are also addressed in the Aichi biodiversity targets of the Convention on Biological Diversity (CBD), under Target 9: "*By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment*". Thus, three actions with regard to pathways are highlighted under Target 9: to identify pathways, to prioritize pathways and to manage pathways. The IAS Regulation reiterates the commitment of the European Union to meet the CBD targets.

The IAS Regulation forbids, transport, breeding, keeping, selling, exchanging and releasing listed species, thereby covering intentional pathways of introduction of IAS. However, a large proportion of IAS are also introduced unintentionally (CBD, 2014), and can be even harder to manage in the new environment than intentionally introduced species (Pysec et al., 2011). Indeed, globally, the most common routes of invasion by vertebrates is escape from containment or deliberate release by irresponsible owners, while most invasive invertebrates arrive as the result of contamination (Hulme, 2008). Plants are most likely to spread due to escape from gardens and parks. Microorganisms, diseases and fungi tend to arrive as contaminants of their hosts. Invasions through transport corridors such as canals, bridges, tunnels and roadsides are important pathways (Brisson et al., 2010; Nunes et al., 2015; Saul et al., 2017) that are often underestimated (Hulme, 2008).

Therefore, according to Article 13 of the IAS Regulation, Member States have to identify and prioritize unintentional introduction pathways for IAS for their specific countries and develop actions to prevent further introductions. More specifically, article 13 requires Member States to: "*carry out a comprehensive analysis of the pathways of unintentional introduction and spread of invasive alien species of Union concern at least in their territory, as well as in their marine waters as defined in point (1) of Article 3 of Directive 2008/56/EC, and identify the pathways which require priority action ('priority pathways') because of the volume of species or of the potential damage caused by the species entering the Union through those pathways.*"

After prioritization, each Member state has to establish and implement (a set of) action plans to address the priority pathways it has identified in their country specific analysis.

5 METHODOLOGY FOR IDENTIFICATION AND PRIORITIZATION OF INTRODUCTION PATHWAYS IN BELGIUM

The process of identification and prioritization of the pathways of introduction for Belgium involved the following steps:

1) Pathway identification: the production of a Belgian inventory of pathways of introduction and spread IAS of Union Concern.
2) Development of a prioritization method.
3) Application of developed method to introduction and spread pathways for IAS of Union Concern.

5.1 SPECIES CONSIDERED

The species covered by this pathway analysis are all 66 species of Union Concern to date (2020): (TABLE 1). These includes the species of Implementing Regulation (EU) No 2016/1141 (37 species), Implementing Regulation (EU) No 2017/1263 (12 species) and Implementing Regulation (EU) No 2019/1262 (17 species).

TABLE 1: LIST OF 66 SPECIES OF CONCERN IN THIS STUDY. IT IS INDICATED WHETHER THE SPECIES IS INCLUDED IN THE IMPLEMENTING REGULATION (EU) NO 2016/1141, IN THE 'IMPLEMENTING REGULATION (EU) NO 2017/1263 OR IN THE IMPLEMENTING REGULATION (EU) NO 2019/1262. "*": THE SPECIES CANNOT ESTABLISH IN BELGIUM UNDER CURRENT CLIMATICAL CONDITIONS.

Scientific name	Common name (Dutch)	Common name (French)	Entry into force
Acacia saligna	Wilgacacia	Mimosa bleuâtre	2019*
Acridotheres tristis	Treurmaina	Martin triste	2019
Ailanthus altissima	Hemelboom	Ailante glanduleux	2019
Alopochen aegyptiacus Linnaeus	Nijlgans	Ouette d'Egypte	2017
Alternanthera philoxeroides (Mart.) Griseb.	Alligatorkruid	Herbe à alligator	2017*
Andropogon virginicus	Amerikaans bezemgras	Barbon de virginie	2019*
Arthurdendyus triangulates	Nieuw-Zeelandse platworm	Ver plat de Nouvelle--Zélande	2019
Asclepias syriaca L.	Zijdeplant	Asclépiade de Syrie	2017
Baccharis halimifolia L	Struikaster	Séneçon en arbre	2016
Cabomba caroliniana Gray	Waterwaaier	Cabomba de Caroline	2016
Callosciurus erythraeus Pallas	Pallas' eekhoorn	Ecureuil de Pallas	2016
Cardiospermum grandiflorum	Ballonrank	Corinde à grandes fleurs	2019*
Cortaderia jubata	Hoog pampasgras	Herbe de la pampa pourpre	2019
Corvus splendens Viellot	Huiskraai	Corbeau familier	2016
Ehrharta calycina	Roze rimpelgras	Ehrharta calycinale	2019*
Eichhornia crassipes (Martius) Solms	Waterhyacint	Jacinthe d'eau	2016*
Elodea nuttallii (Planch.) St. John	Smalle waterpest	Elodée de Nuttall	2017

Eriocheir sinensis H. Milne Edwards	Chinese wolhandkrab	Crabe chinois	2016
Gunnera tinctoria (Molina) Mirbel	Chileense reuzenrabarber	Rhubarbe géante du Chili	2017*
Gymnocoronis spilanthoides	Smalle theeplant	Faux hygrophile	2019
Heracleum mantegazzianum Sommier & Levier	Reuzenberenklauw	Berce du Caucase	2017
Heracleum persicum Fischer	Perzische berenklauw	Berce de Perse	2016
Heracleum sosnowskyi Mandenova	Sosnowsky's berenklauw	Berce de Sosnowski	2016
Herpestes javanicus É. Geoffroy Saint-Hilaire	Indische mangoeste	Mangouste	2016*
Humulus scandens	Oosterse hop	Houblon du japon	2019*
Hydrocotyle ranunculoides L. f.	Grote waternavel	Hydrocotyle fausse renoncule	2016
Impatiens glandulifera Royle	Reuzenbalsemien	Balsamine de l'Himalaya	2017
Lagarosiphon major (Ridley) Moss	Verspreidbladige waterpest	Elodée à feuilles alternes	2016
Lepomis gibbosus	Zonnebaars	Perche soleil	2019
Lespedeza cuneata	Chinese struikklaver	Lespedeza soyeux	2019
Lithobates (Rana) catesbeianus Shaw	Amerikaanse stierkikker	Grenouille taureau	2016
Ludwigia grandiflora (Michx.) Greuter & Burdet	Grote waterteunisbloem	Jussie à grandes fleurs	2016
Ludwigia peploides (Kunth) P.H. Raven	Kleine waterteunisbloem	Jussie rampante	2016
Lygodium japonicum	Japanse klimvaren	Fougère grimpante du japon	2019*
Lysichiton americanus Hultén and St. John	Moerasaronskelk	Faux-arum	2016
Microstegium vimineum (Trin.) A. Camus	Japans steltgras	Herbe à échasses japonaise	2017
Muntiacus reevesi Ogilby	Muntjak	Muntjac de Chine	2016
Myocastor coypus Molina	Beverrat	Ragondin	2016
Myriophyllum aquaticum (Vell.) Verdc.	Parelvederkruid	Myriophylle du Brésil	2016
Myriophyllum heterophyllum Michaux	Ongelijkbladig vederkruid	Myriophylle hétérophylle	2017
Nasua nasua Linnaeus	Rode neusbeer	Coati roux	2016*
Nyctereutes procyonoides Gray	Wasbeerhond	Chien viverrin	2017
Ondatra zibethicus Linnaeus	Muskusrat	Rat musqué	2017
Orconectes limosus Rafinesque	Gevlekte Amerikaanse rivierkreeft	Ecrevisse américaine	2016
Orconectes virilis Hagen	Geknobbelde Amerikaanse rivierkreeft	Ecrevisse à pinces bleues	2016
Oxyura jamaicensis Gmelin	Rosse stekelstaart	Erismature rousse	2016
Pacifastacus leniusculus Dana	Californische rivierkreeft	Ecrevisse signal	2016
Parthenium hysterophorus L.	Schijnambrosia	Fausse chamomille	2016*
Pennisetum setaceum (Forssk.) Chiov.	Lampenpoetsersgras	Herbe aux écouvillons pourpres	2017*
Perccottus glenii Dybowski	Amoergrondel	Goujon de l'Amour	2016

Persicaria perfoliata (L.) H. Gross	Gestekelde duizendknoop	Renouée perfoliée	2016
Plotosus lineatus	Gestreepte koraalmeerval	Poisson-chat rayé	2019*
Procambarus clarkii Girard	Rode Amerikaanse rivierkreeft	Ecrevisse de Louisiane	2016
Procambarus fallax (Hagen, 1870) f. virginalis	Marmerkreeft	Ecrevisse marbrée	2016
Procyon lotor Linnaeus	Wasbeer	Raton laveur	2016
Prosopis juliflora	Mesquite	bayahonde	2019*
Pseudorasbora parva Temminck & Schlegel	Blauwbandgrondel	Goujon de Chine	2016
Pueraria montana (Lour.) Merr. *var. lobata* (Willd.)	Kudzu	Kudzu	2016*
Salvinia molesta	Grote vlotvaren	Salvinie géante	2019*
Sciurus carolinensis Gmelin	Grijze eekhoorn	Ecureuil gris	2016
Sciurus niger Linnaeus	Amerikaanse voseekhoorn	Ecureuil fauve	2016
Tamias sibiricus Laxmann	Siberische grondeekhoorn	Tamia de Sibérie	2016
Threskiornis aethiopicus Latham	Heilige ibis	Ibis sacré	2016
Trachemys scripta Schoepff (incl. subspecies)	Lettersierschildpad	Tortue de Floride	2016
Triadica sebifera	Talgboom	Arbre a suif	2019*
Vespa velutina nigrithorax de Buysson	Aziatische hoornaar	Frelon asiatique	2016

5.2 PATHWAY IDENTIFICATION

5.2.1 PATHWAY CATEGORIZATION

In order to classify pathways, the definitions the CBD classification, Harrower et al. (2018) were used, supplemented with extra information received from the European Commission on the distinction between intentional and unintentional introductions.
In general, there are six principal pathways for IAS (Hulme et al., 2008; CBD 2014; Harrower et al. 2018): 1) release in nature, 2) escape from confinement, 3) transport-contaminant, 4) transport-stowaway, 5) corridor and 6) unaided. For these main pathways, different subcategories are identified (CBD, 2014; FIG 1).
As the regulation demands prioritization of pathways of unintentional introduction and spread, the principal pathway "release in nature", was not retained for analysis since it is an intentional pathway. Release of animals by irresponsible owners or release of plants by inadequate disposal of garden material, was placed under the pathway "escape" after clarification by the European Commission and was retained for analysis.

1) Release in nature refers to the intentional introduction of live alien organisms for the purpose of human use in the natural environment. Examples include release in nature of organisms for biological control, erosion control (and dune stabilization), for fishing or hunting in the wild; landscape "improvement" and introduction of threatened organisms for conservation purposes.
2) Escape refers to the movement of (potentially) invasive alien species from confinement (e.g. in zoos, aquaria, botanic gardens, agriculture, horticulture, aquaculture and mariculture facilities; scientific research or breeding programs) into the natural environment. In this pathway, the organisms were initially purposefully imported or transported to be held in a "captive setting", and then escaped (e.g. escape of live bait from a fishing line). Their presence in the environment is therefore considered accidental. Following clarification by the European Commission (pers. com), this pathway also includes the release of pets or the disposal of plants into the environment.
3) Contaminant refers to the unintentional movement of live organisms as contaminants of a commodity that is intentionally transferred through international trade, development assistance, or emergency relief. This includes pests and diseases of food, seeds, timber and products of agriculture, forestry, and fisheries as well as contaminants of other products such as contaminants of live organisms for aquaculture purposes.
4) Stowaway refers to the moving of live organisms attached to transporting vessels and associated equipment and media. The physical means of transport-stowaway include various conveyances, ballast water and sediments, biofouling of ships, boats, offshore oil and gas platforms and other water vessels, dredging, angling or fishing equipment, civil aviation, sea and air containers.
5) Corridor refers to movement of alien organisms into a new region following the construction of transport infrastructures in whose absence spread would not have been possible. Such trans-biogeographical corridors include international canals (connecting river catchments and seas) and transboundary tunnels linking mountain valleys or oceanic islands.
6) Unaided refers to the secondary natural dispersal of IAS that have been introduced by means of any of the foregoing pathways. Secondary natural dispersal (unaided) takes place after introduction via other pathways through human intervention. Information on the mechanisms of secondary spread of IAS, after their introduction, are relevant to define the best response measures.

FIGURE 1: CBD PATHWAY CATEGORIES AND SUBCATEGORIES, ADAPTED FROM HARROWER ET AL., 2018. "RELEASE IN NATURE" WAS CONSIDERED INTENTIONAL AND NOT RETAINED IN THE CURRENT PATHWAY ANALYSIS, WHEREAS THE OTHER LISTED CATEGORIES AND SUBCATEGORIES WERE CONSIDERED. RELEASE OF PETS OR INADEQUATE DISPOSAL OF PLANTS BY IRRESPONSIBLE OWNERS WAS CONSIDERED UNDER THE "ESCAPE FROM CONFINEMENT PATHWAY".

5.2.2 INVENTORY OF SPECIES' SPECIFIC PATHWAYS

In this study, pathways of introduction of Union List species were retrieved from published sources which are mainly based on available pathway information in 1) the DAISIE and GRISS database (Saul et al., 2017), 2) the CABI compendium (e-ref1), 3) pathway information in the European risk assessments (e-ref2), 4) pathway assessments at larger geographical scales (NOBANIS, 2015) and 5) available pathway analysis performed in other Member States (CLM, 2010; Madsen et al,. 2014;

Ministère du Développement durable et des Infrastructures, Luxemburg, 2016; Rabitsch et al., 2018).
This information was supplemented, adapted and reviewed to assess the relevance of the pathways for the Belgian territory using 1) published information on the pathways (Brunel ,2009; Roy et al., 2013; Gallardo et al., 2016; Adriaens, 2016; Nunes et al., 2015; Carboneras et al., 2017; Saul et al., 2017), 2) online databases and 3) expert review.
Pathways of spread of Union List IAS were equally considered and were analyzed together with the pathways of introduction.

5.3 Pathway prioritization

5.3.1 Identification of species' impacts

Article 13 requires Member States to: *"…identify the pathways which require priority action because of the volume of species or of the potential damage caused by the species entering the Union through those pathways."* To assess the magnitude of impact (damage) of an invasive alien species, we allocated a "risk-score" (from 1-12) to every species as a proxy for species impact. The calculation of these scores was based on the environmental impact protocol "ISEIA" (Invasive Species Environmental Impact Assessment; Branquart et al, 2009; Vanderhoeven et al., 2015). This protocol was developed to classify alien species according to their level of impact in Belgium and allocate alien species to the different hazard categories of the Harmonia information system[1], in an attempt to minimize the use of subjective opinions and to warrant the transparency and repeatability of the assessment process (Daehler *et al*., 2004, Vanderhoeven et al., 2017).
The allocation of scores to individual species is based on semi-quantitive scores for four different elements of impact. It takes into account four criteria, matching the last steps of the invasion process: (i) dispersal potential, (ii) colonization of natural habitats, (iii) adverse ecological impacts on native species, (iv) alteration of ecosystem functions. A score for the four different variables (i-iv) was attributed by experts for each species, based on species information in literature and databases and following the scoring guidelines of the ISEIA prototcol. Although ISEIA scores were already available for 48 of the 66 species of the Union List species (ias.biodiversity.be; prioritization report 1), these scores were validated and adapted where necessary in the light of newly available species information.

The ISEIA protocol was designed to assess species able to establish and adapt to the current climatic conditions in Belgium. Since not all species have the same establishment potential in Belgium, we also included an assessment of the "establishment potential", and used it to weigh variable "dispersal potential" in the formula. To this end, we used a scale from 1 (the species cannot establish in Belgium under current nor future climatic conditions) to 5 (the species is able to establish under current climated conditions). For the species under consideration, the ability of species to adapt to the current climatic conditions in Belgium and to establish in Belgium ranges from 1 (e.g. *Prosopis juliflora*, a (sub)tropical species) to 5 (e.g. *Eriocheir sinensis,* already

[1] http://ias.biodiversity.be (accessed 16/08/2017).

established over 100 years) (TABLE 2). The ecological impact assessment score and the score for establishment potential are both integrated in the pathway prioritization formula. Hence, pathways of introduction for species unable to establish in Belgium are downgraded in the prioritization. The assigned value for the species is based upon expert consultation and literature.

TABLE 2: ASSESSMENT OF ESTABLISHMENT POTENTIAL (1: UNABLE TO ESTABLISH IN BELGIUM UNDER CC AND FC; 2: MARGINALLY ABLE TO ESTABLISH UNDER FC; 3: ABLE TO ESTABLISH UNDER FC 4: MARGINALLY ABLE TO ESTABLISH UNDER CC; 5 ABLE TO ESTABLISH UNDER CC) AND RESULTING ISEIA SCORE IN BELGIUM FOR THE SPECIES CONSIDERED.

Species	Establishment	ISEIA score
Acacia saligna	3	11
Acridotheres tristis	4	7
Ailanthus altissima	5	12
Alopochen aegyptiacus	5	12
Alternanthera philoxeroides	2	10
Andropogon virginicus	2	9
Arthurdendyus triangulatus	5	10
Asclepias syriaca	5	12
Baccharis halimifolia	5	12
Cabomba caroliniana	5	10
Callosciurus erythraeus	5	11
Cardiospermum grandiflorum	3	11
Cordateria jubata	5	12
Corvus splendens	5	7
Ehrharta calycina	2	10
Eichhornia crassipes	1	8
Elodea nuttallii	5	12
Eriocheir sinensis	5	12
Gunnera tinctoria	3	10
Gymnocoronis spilanthoides	4	11
Heracleum mantegazzianum	5	10
Heracleum persicum	4	10
Heracleum sosnowskyi	4	10
Herpestes javanicus	4	9
Humulus scandens	3	10
Hydrocotyle ranunculoides	5	12
Impatiens glandulifera	5	12
Lagarosiphon major	5	12
Lepomis gibbosus	5	9
Lespedeza cuneata	5	11
Lithobates catesbeianus	5	12
Ludwigia grandiflora	5	12
Ludwigia peploides	5	12
Lygodium japonicum	2	9
Lysichiton americanus	5	10
Microstegium vimineum	4	11
Muntiacus reevesi	5	12
Myocastor coypus	5	12

Myriophyllum aquaticum	5	12
Myriophyllum heterophyllum	5	12
Nasua nasua	4	9
Nyctereutes procyonoides	5	9
Ondatra zibethicus	5	12
Orconectes limosus	5	12
Orconectes virilis	5	12
Oxyura jamaicensis	5	10
Pacifastacus leniusculus	5	12
Parthenium hysterophorus	3	6
Pennisetum setaceum	2	9
Perccottus glenii	5	11
Persicaria perfoliata	5	11
Plotosus lineatus	1	7
Procambarus clarkii	5	12
Procambarus fallax forma virginalis	5	12
Procyon lotor	5	11
Prosopis juliflora	1	9
Pseudorasbora parva	5	11
Pueraria montana (var lobata)	3	10
Salvinia molesta	3	11
Sciurus carolinensis	5	11
Sciurus niger	5	9
Tamias sibiricus	5	9
Threskiornis aethiopicus	5	11
Trachemys scripta (incl. subspecies)	2	7
Triadica sebifera	3	11
Vespa velutina nigrithorax	5	12

5.3.2 ASSESSMENT OF THE FREQUENCY OF INTRODUCTION PATHWAYS

Article 13 requires Member States to: *"…identify the pathways which require priority action because of the volume of species or of the potential damage caused by the species entering the Union through those pathways."* The "volume" as set out in the EU IAS Regulation was found to be difficult to assess, as information is scant (see also Adriaens, 2016). Hence, we used a crude assessment of the frequency of introduction of the species with a given pathway as a proxy for volume in the absence of interception data. To this end, we performed an assessment of the frequency of introduction of the species for each introduction pathway identified and allocated them in three categories (TABLE 3). The scores were reviewed by experts. Bearing in mind the absence of quantitative data on pathways in Belgium and the limited information available (e.g. due to a lack of interception data), the assessment of frequency followed a precautionary approach. When the pathway was mentioned in international literature, but its relevance could not be corroborated for Belgium, a score (0.33) was allocated instead of a zero. This way all potential pathways were considered in the analysis. All scores for each species frequency of use in each pathway are available in Annex 1 of the report. For the pathway "escape", we considered the historical popularity of the species in the domestic Belgian trade when allocating a score.

TABLE 3: THREE FREQUENCY-CATEGORIES ARE DISTINGUISHED FOR SCORING SPECIES WITHIN PATHWAYS FOR THEIR FREQUENCIES OF INTRODUCTION FOR BELGIUM.

Frequency	category description	Score
Absent to low (1)	The pathway is infrequently used by the species or even not at all, it is unlikely (but possible) that the pathway is relevant for the species. Very few cases are described in literature. Very few observations are being made of this species in the pathway. E.g. *Cabomba caroliniana* is known to be spread by boating. The few locations in Belgium where the species occurs are isolated ponds without boating activity.	0,33
Medium (2)	The pathway is regularly being used by the species. Several cases are described in literature. Observations of the species in the pathway are regular but not common.	0,66
High (3)	The pathway is commonly being used by the species and represents the main pathway of entry. Most cases in literature are observed in this pathway. Observations of this species in the pathway are common. E.g. *Ambrosia artemisiifolia* is a common seed contaminant in bird food. E.g. Several references in literature describe the high dispersal ability of Asian Hornet, *Vespa velutina*. The pathway "Natural dispersal" will score 1 for this species.	1,00

The pathway frequency category that was allocated to a certain species for a specific pathway, was further complemented with a confidence level (high, medium, low):

- High confidence: evidence on frequency is available.
- Medium confidence: there is limited evidence on frequency available from published information or observations, and the assessment is mainly based on expert judgment.
- Low confidence: there is no direct evidence on frequency available, and the assessment is fully based upon expert judgment.

In case the level of confidence was low, and no decision could be made with regard to the allocation of a species to one of the three categories, allocation is made to the category low. In case some information was available but there was still some doubt remaining on whether a species should be for example in category low or medium, then it was allocated to the category medium.

5.3.3 PATHWAY PRIORITIZATION

Priority pathways are defined by the European IAS regulation (art 13) as "*pathways requiring actions by priority because of the volume of the alien species using it or of the potential damage of these species*".
Prioritization involves 1) the ranking of pathways with the purpose of determining their relative environmental impact (and sometimes socio-economic impact; sensu Blackburn et al., 2014), and as such,

deciding which pathways pose the biggest threat, and 2) and assess which pathways that are manageable and offer a good chance of preventing such threats and decide on the relative priority of actions to mitigate impact of IAS. The current report looks at the first step of prioritization: the prioritization of pathways according to their impact.

To prioritize pathways, we followed two approaches in line with the EU IAS Regulation's requirements:

1) Prioritization based on the number of species: pathways are ranked based on the number of species from the list of 66 species that are introduced through that pathway.

2) Prioritization based on the impact of a species and the frequency of introduction per pathway: pathways are ranked based on a formula that takes into account the number of species in the pathway, the relative ecological impact score (corrected with establishment potential) and the frequency score (as a proxy for volume – see 5.3.2). This formula is defined as follows:

[Pathway priority score] = ∑ spp([establishment potential] * [ISEIA score/10] * [pathway frequency])

By definition, the ISEIA scores for ecological impact of Union List species should be (and are) rather high. While scores can range from 4 to 12, in this dataset, ISEIA scores range between 5 and 12 with a median of 11 and a mean value of 10. Scores were standardized in line with the scoring range for frequency. The confidence level on the frequency score (high – medium – low) was not taken into account in this exercise but can be used as an additional consideration in the decision-making process on which priority pathways to tackle.

We illustrate the application of the formula with the example below (TABLE 4):

-The simple summation of the number of species using the hypothetical pathway would result in a pathway score of 12.

-When only considering the species impact (I), the hypothetical pathway receives a score of 13. This is higher than when solely considering species number, because some species have a high impact (>1).

-When jointly considering species impact and species frequency, the score declines due to the relatively high proportion of species that only have low to medium scores for pathway frequency (>1).

TABLE 4: EXAMPLE TO ILLUSTRATE THE CALCULATION OF THE PRIORITY SCORE OF A HYPOTHETICAL PATHWAY. SPECIES IMPACT (ESTABLISHMENT POTENTIAL * ISEIA/10); FREQUENCY: A PROXY FOR THE VOLUME OF THE SPECIES ON THE PATHWAY: LOW (0,33), MEDIUM (0,66) HIGH (1).

	Species Impact (I)	Frequency (V)	I × V
Species 1	0,9	0,33	0,297
Species 2	1,0	0,66	0,660
Species 3	1,1	1,00	1,100
Species 4	1,2	1,00	1,200
Species 5	0,9	0,33	0,297
Species 6	1,0	0,66	0,660
Species 7	1,2	0,33	0,396
Species 8	1,2	0,33	0,396
Species 9	1,2	0,33	0,396
Species 10	1,0	0,66	0,660
Species 11	1,1	0,33	0,363
Species 12	1,2	0,33	0,396
∑(spp.) = 12	∑(I) = 13		∑(I×V) = 6,821

6 Results

6.1 Pathway identification

A total of 24 (potential) pathways of introduction and spread were identified for the 66 listed species of Union concern, representing the 4 main pathway categories: natural dispersal, escape from confinement, transport stowaway, transport contaminant, (TABLE 5; FIG 2).
Only 1 new pathway was scored as relevant for Belgium in this new species dataset: "forestry" the tree *Prosopis juliflora*. Some pathways were relevant for more than 1/3th of the species in the dataset (escape of pet/aquarium/terrarium species, escape of species from zoos, escape of plant species in other use than horticulture, contaminant of transport of habitat material), whereas others were only relevant for two or even a single species (contaminant of food, transport stowaways in ballast water or containers and escape from confinement in agriculture and forestry, interconnected waterways).
When looking at species groups (aquatic animals, aquatic plants, terrestrial plants, birds, and mammals (FIG 3), some pathways are relevant across groups. For example, natural dispersal and the escape from containment pathway, were represented in all groups. More specifically, the "escape from confinement" subcategories that are represented in current dataset indicate that release/disposal by private owners plays a big role for all groups as well as (historical) escape from zoos, aquaria or botanical gardens – although the latter is mainly important for terrestrial species. Indeed, for birds, mammals and terrestrial plants, these three categories make up the top three ranking. For birds, the only other pathway that was identified is "hitchhikers on ships and boats", for mammals other escape pathways were featured (escape from fur farms and agriculture) as well as hitchhikers on ships boats.
Apart from the "escape pathways" discussed above, the terrestrial plants were also implicated in all categories of contaminant pathways that were identified for Belgium, as well as the stowaway pathways "vehicles", "machinery", "luggage" and "angling and fishing equipment" – probably mainly through contaminant of seeds or vegetative fragments. The aquatic plants are implicated in less pathways than their terrestrial counterparts (e.g. excluded from terrestrial categories such as stowaway on luggage and vehicles). Although many of the other contaminant and stowaway pathways are shared between terrestrial and aquatic plants, their relative importance differs between these taxa. Specifically for aquatic plants, the pathways "hitchhikers on ships/boats" and "angling and fishing equipment" is very prominent.

Vespa velutina and *Arthurdendyus triangulatus* were not included in these species groups since they are the only terrestrial invertebrate and both have a specific dispersal pattern that does not relate with other species.

6.2 PATHWAY PRIORITIZATION

Pathway prioritization based on 1) numbers of species using the pathway or based on 2) the impact of the species using the pathway, were more dissimilar than for the previous prioritization analysis. However, since 1) pathway action plans for the previous species set were chosen on the basis of the ranking via impact, since 2) the subset of 12 most important pathways is similar in identity and since 3) scoring on species impact is more relevant to prevent new introductions and further spread of species in Belgium than simply taking species presence or absence on a pathway into account, we will be discussing the ranking of pathways on impact in the remainder of the document.

"Natural dispersal" ranks number 1 in the pathway ranking (TABLE 5), with a relatively large drop in importance for the subsequent pathways such as escape from confinement. This is not surprising since we not only assessed pathways of introduction but also considered pathways of spread in parallel. In contrast to other pathways, "natural dispersal" is therefore scored for many species under consideration, increasing its importance in the ranking exercise. "Escape or disposal of pets", garden plant and zoo species ranked at number 2, 3 and 5. The pathway contaminant of habitat material ranked 4th. The pathway stowaway on angling/fishing material is ranked at 6th place. The 7th rank – stowaway on machinery - has roughly half the impact/importance as escape of pet/aquarium and terrarium species. Transport contaminant of nursery material and plants is ranked 8th and 10th respectively. Stowaways on ships is ranked 9th. Transport contaminant of animals and plants are ranked 11th and 12th respectively. The pathways showing the lowest priority are "interconnected waterways", "ballast" and "forestry" – each only relevant for one listed species. The species featured in these least important pathways are also implicated in 2 or 3 other pathways.

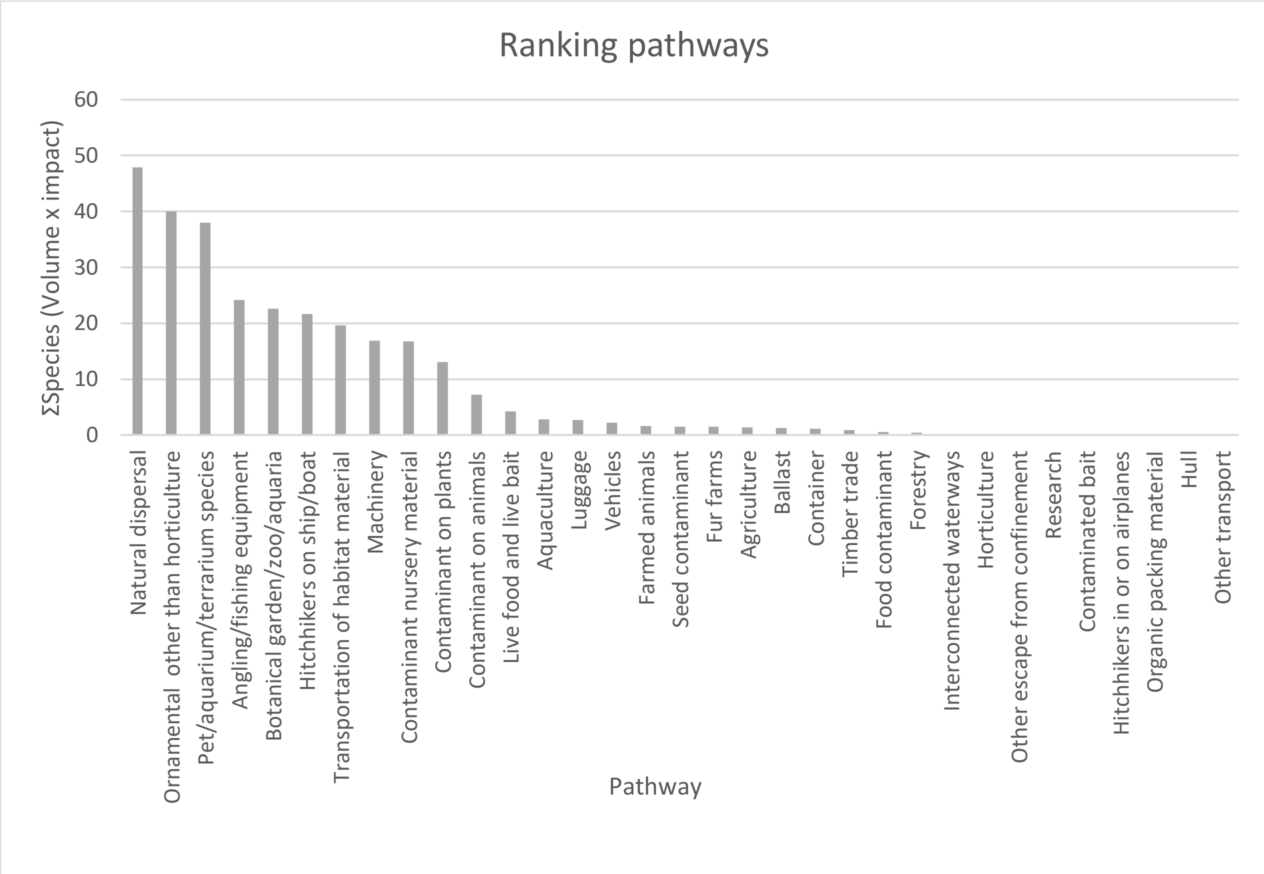
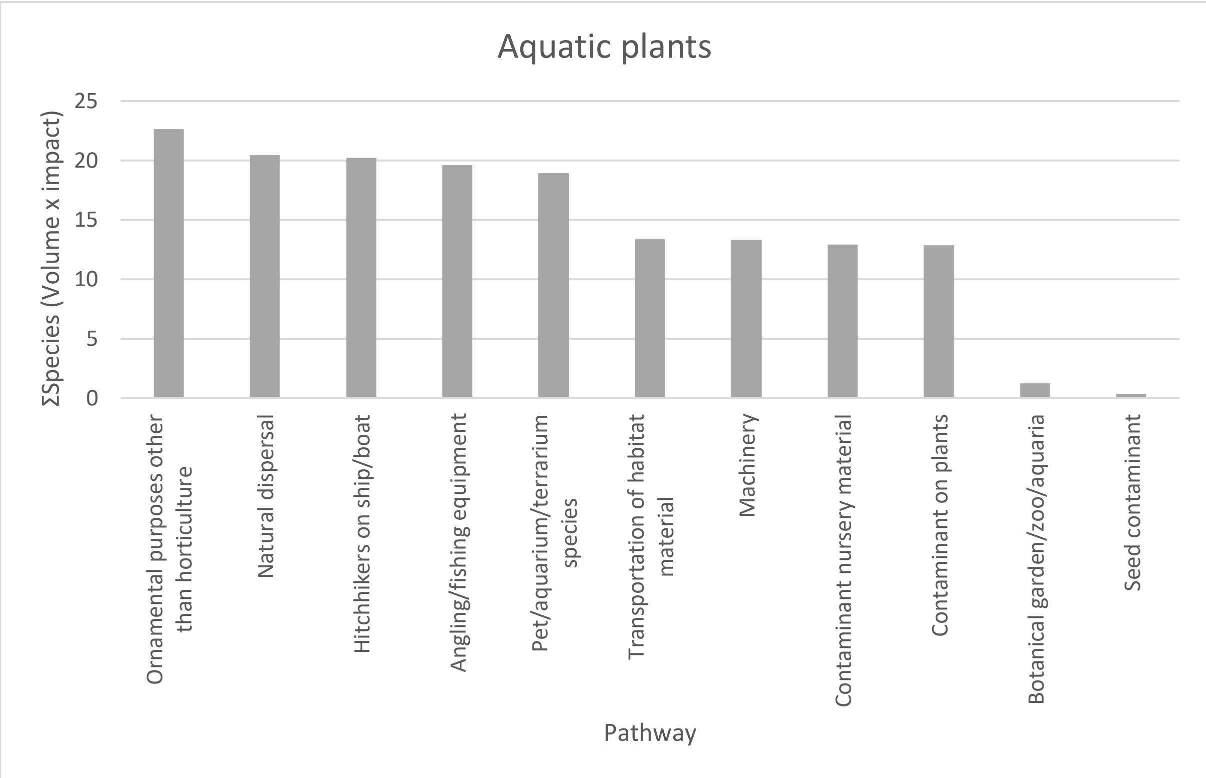


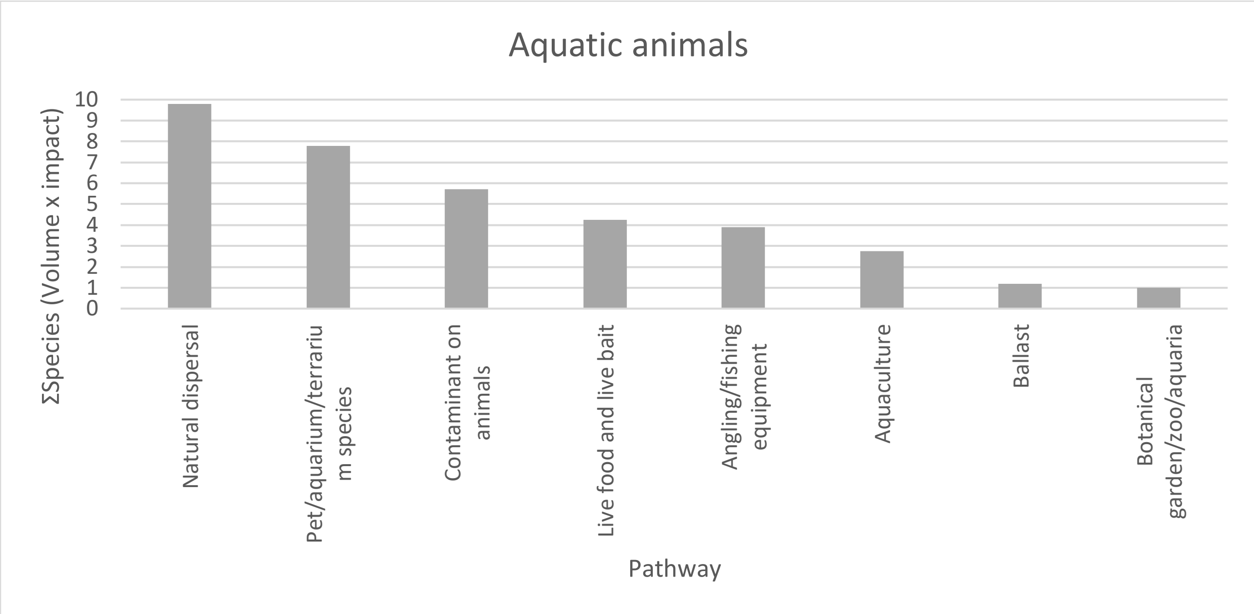
FIGURE 2: PATHWAYS RANKED ACCORDING TO THE CUMULATIVE FACTOR ON IMPACT AND VOLUME (FREQUENCY OF INTRODUCTION FOR THE SPECIES IN A PATHWAY)

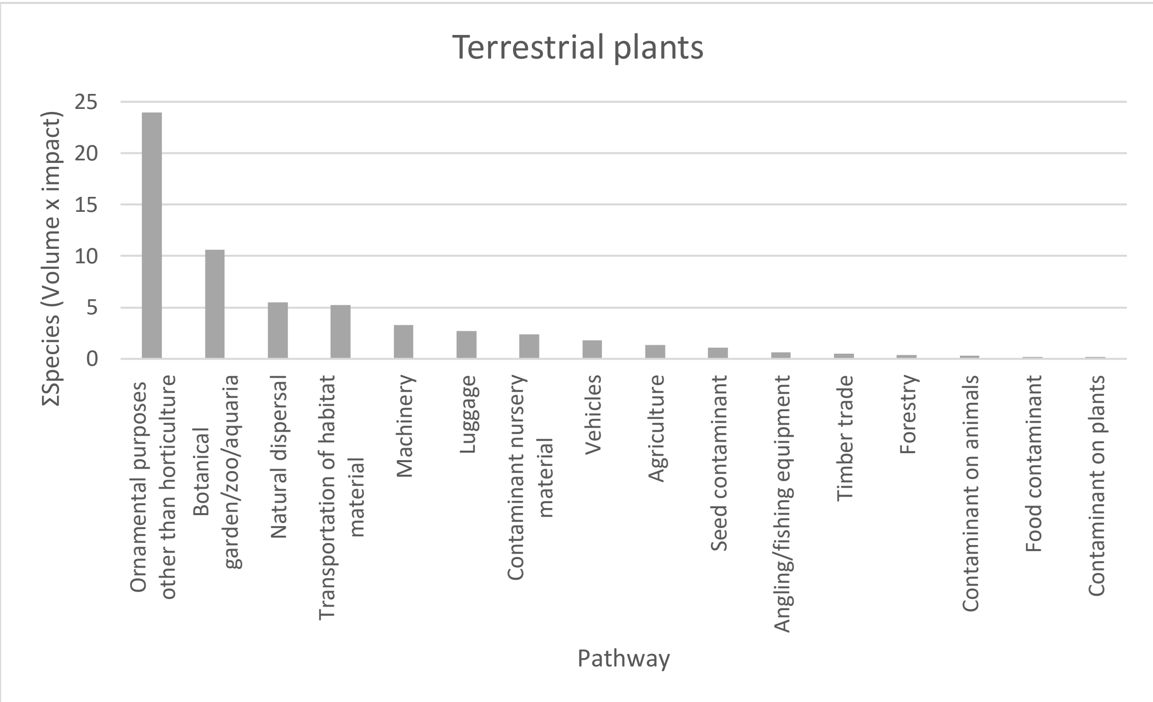
TABLE 5: PATHWAYS RANKED ACCORDING TO THE CUMULATE IMPACTS * VOLUME (FREQUENCY OF INTRODUCTION FOR THE SPECIES IN A PATHWAY) OF THE SPECIES USING THE PATHWAY AND SHOWING THE NUMBER OF SPECIES IN A PATHWAY

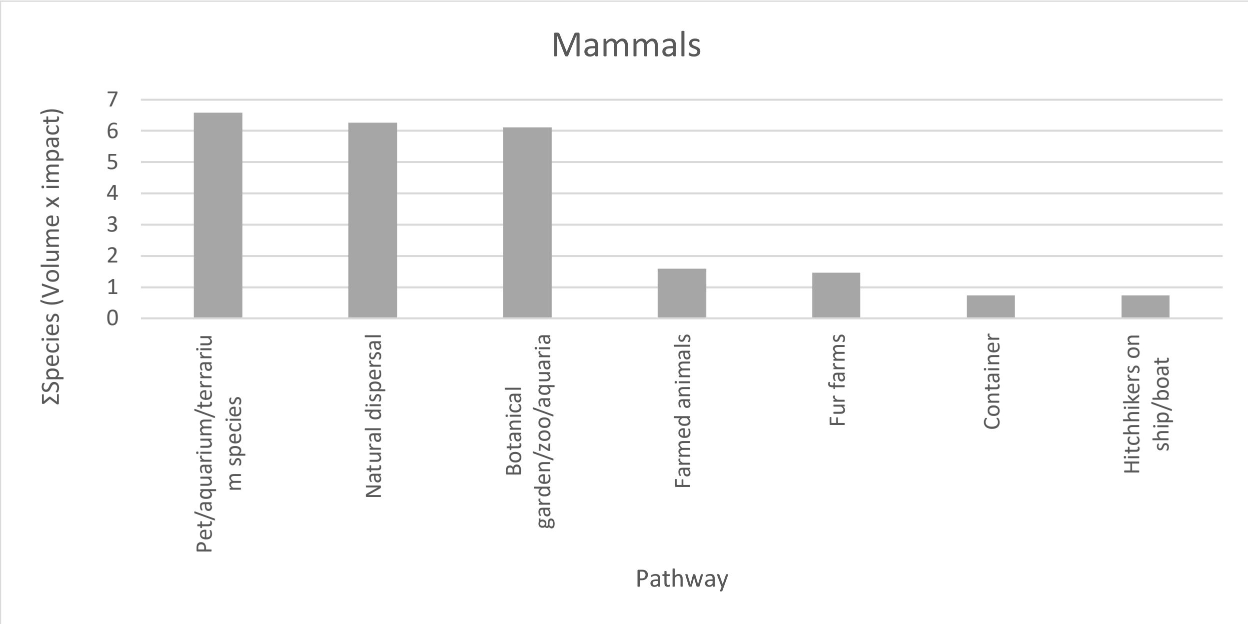
Pathway category	Pathway	No of species	∑Impact x volume
unaided	Natural dispersal	42	47,95264444
Escape from confinement	Ornamental other than horticulture	27	40
Escape from confinement	Pet/aquarium/terrarium species	35	38
Transport stowaway	Angling/fishing equipment	19	24,11869591
Escape from confinement	Botanical garden/zoo/aquaria	22	22,64438754
Transport stowaway	Hitchhikers on ship/boat	12	21,61934595
Transport contaminant	Transportation of habitat material	23	19,65343035
Transport stowaway	Machinery	19	16,89086499
Transport contaminant	Contaminant nursery material	15	16,6993913
Transport contaminant	Contaminant on plants	11	13,04355556
Transport contaminant	Contaminant on animals	10	7,217733333
Escape from confinement	Live food and live bait	8	4,257
Escape from confinement	Aquaculture	5	2,751
Transport stowaway	Luggage	7	2,703991304
Transport stowaway	Vehicles	6	2,1846
Escape from confinement	Farmed animals	3	1,584
corridor	Seed contaminant	4	1,4586

Transport contaminant	Fur farms	4	1,452
Escape from confinement	Agriculture	4	1,349534694
Escape from confinement	Ballast	1	1,2
Transport stowaway	Container	2	1,122
Transport stowaway	Timber trade	3	0,926295652
Transport contaminant	Food contaminant	2	0,5676
Transport contaminant	Forestry	1	0,38372093
Escape from confinement	Interconnected waterways	0	0
Escape from confinement	Horticulture	0	0
Escape from confinement	Other escape from confinement	0	0
Escape from confinement	Research	0	0
Transport contaminant	Contaminated bait	0	0
Transport stowaway	Hitchhikers in or on airplanes	0	0
Transport stowaway	Organic packing material	0	0
Transport stowaway	Hull	0	0
Transport stowaway	Other transport	0	0




Aquatic animals
ΣSpecies (Volume x impact)
10
9
8
7
6
5
4
3
2
1
0
Natural dispersal
Pet/aquarium/terrarium species
Contaminant on animals
Live food and live bait
Angling/fishing equipment
Aquaculture
Ballast
Botanical garden/zoo/aquaria
Pathway


Terrestrial plants
ΣSpecies (Volume x impact)
25
20
15
10
5
0
Ornamental purposes other than horticulture
Botanical garden/zoo/aquaria
Natural dispersal
Transportation of habitat material
Machinery
Luggage
Contaminant nursery material
Vehicles
Agriculture
Seed contaminant
Angling/fishing equipment
Timber trade
Forestry
Contaminant on animals
Food contaminant
Contaminant on plants
Pathway



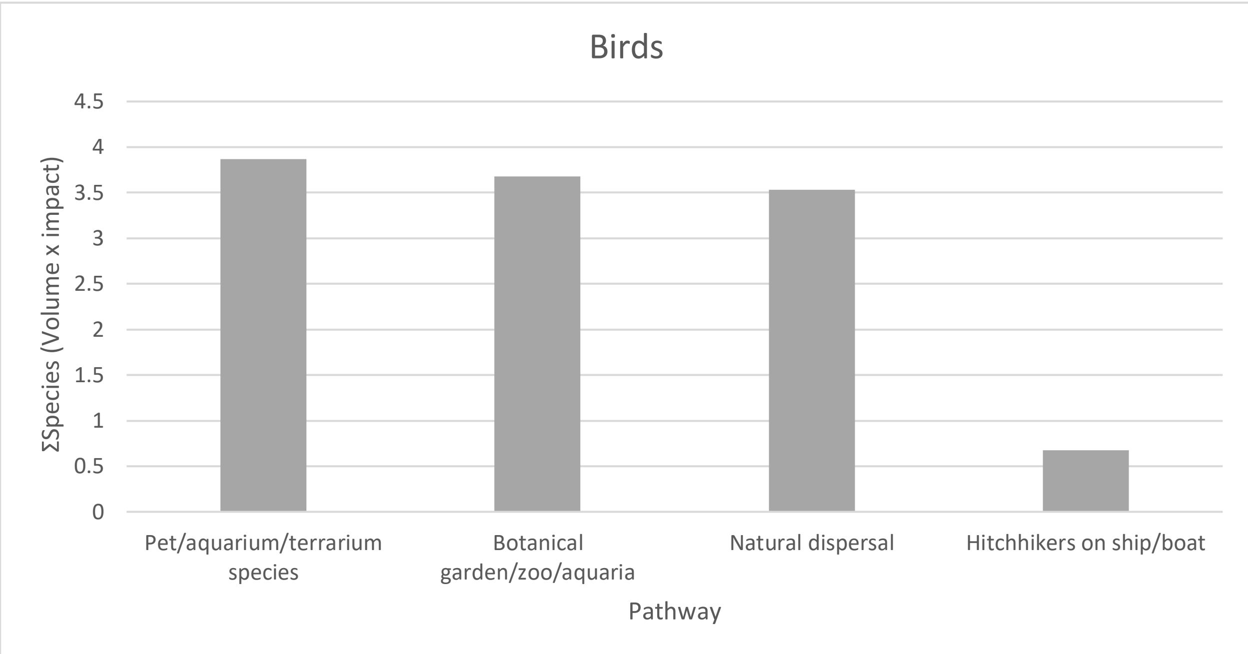


FIGURE 3: PATHWAY RANKING ACCORDING TO ∑IMPACT X VOLUME FOR SPECIES GROUPS: "AQUATIC PLANTS", "AQUATIC ANIMALS", "TERRESTRIAL PLANTS", "MAMMALS", AND "BIRDS"

7 Robustness of results - towards new pathway action plans for Belgium?

Based on the previous prioritization analysis, a political decision was made to retain 9 pathways out of the top 12 for inclusion in 3 pathway action plans in order to prevent unintentional introductions via the selected pathways:

1. Action plan on introductions of pets, garden and pond plants, aquarium plants and animals and terrarium plants and animals from private ownership. This action plan pertains to escape of species of Union Concern that are kept in private possession. Under escape, both dumping and escape is included.
    - Escape: pet, aquarium and terrarium species
    - Escape: ornamental other than horticulture
    - Transport contaminant: contaminant of plants
2. Action plan on introductions through recreational use of freshwater. This action plan pertains to introductions of plants and animals through recreational angling, fish breeding and freshwater boating.
    - Escape: live food and live bait
    - Transport stowaway: angling and fishing
    - Transport stowaway: hitchhiker on ships/boat
    - Transport contaminant: contaminant on animals
3. Action plan for contamination of sediment transports. This action plan pertains to transportation and propagules of plants and animals with sediment and machinery used. Marine sediment transportation is not covered by this action plan.
    - Transport contaminant: transportation of habitat material
    - Transport stowaway: machinery

Although pathway ranks of the current and previous dataset are not identical, they are rather similar: 1) the pathways featured in the top 12 ranking for previous and current dataset are the same, and 2) although the ranking within the top 12 was different for 7 out of those 12 pathways, they only changed one rank on average and never more than two ranks (TABLE 6). Therefore, we conclude that the action plans that are currently developed for the pathways prioritized in the previous analysis are still relevant.

TABLE 6: COMPARISON BETWEEN PATHWAY RANKS AFTER PRIORITIZATION ON IMPACT FOR THE DATASET OF 49 SPECIES AND THE DATASET OF 66 SPECIES.

Ranking	Prioritization 66 species	Prioritization 49 species
1	Natural dispersal	Natural dispersal
2	pet/aquarium/terrarium	pet/aquarium/terrarium
3	Ornamental other than horticulture	Ornamental other than horticulture
4	Transportation of habitat material	Angling/Fishing equipment
5	Botanical garden/zoo/aquarium	Botanical garden/zoo/aquarium
6	Angling/Fishing equipment	Transportation of habitat material
7	Machinery	Hitchhikers on ships/boats
8	Contaminant nursery material	Machinery
9	Hitchhikers on ships/boats	Contaminant nursery material
10	Contaminant on plants	Contaminant on animals
11	Contaminant on animals	Contaminant on plants
12	Live food/live bait	Live food/live bait

Moreover, for 14 out of 17 newly listed species, all pathways that were scored more than 0,33 were covered by the action plans (for an overview of the species in the current Pathway Action plans – see table 7). For two species, pathways that were scored 0,66 or 1 are not included in the action plans: *Lygodium japonicum* and *Arthurdendyus triangulatus* (contaminant nursery material). Out of these two species, only *Arthurdendyus triangulatus* is able to establish (under current and future climatic conditions). Therefore, the pathway "contaminant nursery material" could be taken into consideration when new pathway action plans are being developed. Additionally, some actions might need to be adapted to cover the inclusion of new species in these pathways.

TABLE 7: SPECIES' USE OF THE PATHWAYS OF INTRODUCTION AND SPREAD SELECTED TO BE ADDRESSED THROUGH ACTION PLANS. ACTIONS PLANS: - 1: ACTION PLAN ON INTRODUCTIONS OF PETS, GARDEN AND POND PLANTS, AQUARIUM PLANTS AND ANIMALS AND TERRARIUM PLANTS AND ANIMALS FROM PRIVATE OWNERSHIP - 2: ACTION PLAN ON INTRODUCTIONS THROUGH RECREATIONAL USE OF FRESHWATER - 3: ACTION PLAN FOR CONTAMINATION OF SEDIMENT TRANSPORTS.

	1			2				3	
→ Pathways **↓ Species**	Pet / Aquarium / Terrarium	Ornamental purposes other than horticulture	Contaminant on plants	Angling and fishing	live food and live bait	hitchikers on ship/boats	contaminant on animals	Transportation of habitat material	Machinery
*Acridotheres tristis**	v					(v)			
Alopochen aegyptiacus	v								
*Arthurdenyus triangulatus**								v	(v)
Callosciurus erythraeus	(v)								
Corvus splendens									
Eriocheir sinensis					(v)				
Herpestes javanicus	(v)								
*Lepomis gibbosus**	v			(v)			v		
Lithobates (*Rana*) *catesbeianus*	v						v		
Muntiacus reevesii	v								
Myocastor coypus									
Nasua nasua	v								
Nyctereutes procyonoides	v								
Ondatra zibethicus									
Orconectes limosus	(v)			v	v		v		
Orconectes virilis	v			(v)	(v)		(v)		
Oxyura jamaicensis	v								
Pacifastacus leniusculus	(v)			v	v		v		
Perccottus glenii	(v)				(v)		v		
*Plotosus lineatus**	(v)								

Procambarus cf *fallax*	v			(v)	(v)		(v)		
Procambarus clarkii	v			v	(v)		v		
Procyon lotor	v								
Pseudorasbora parva	v			(v)	v		v		
Sciurus carolinensis	v								
Sciurus niger	v								
Tamias sibiricus	v								
Threskiornis aethiopicus	v								
Trachemys scripta	v								
Vespa velutina nigrithorax								(v)	
Acacia saligna		(v)						(v)	
Ailanthus altissima		v							
Alternanthera philoxeroides	(v)	(v)	(v)	(v)		(v)		(v)	
Andropogon virginicus								(v)	(v)
Asclepias syriaca		v						(v)	
Baccharis halimifolia		v							
Cabomba caroliniana	v	v	(v)	v		v		(v)	(v)
Cardiospermum grandiflorum		(v)							
Cortaderia jubata									(v)
Ehrharta calycina								(v)	
Eichhornia crassipes	v	v							
Elodea nuttallii	v	v	v	v		v		v	v
Gunnera tinctoria		v							
Gymnocoronis spilanthoides	(v)			(v)					(v)
Heracleum mantegazzianum		v						v	
Heracleum persicum								(v)	(v)
Heracleum sosnowskyi								(v)	(v)
Humulus scandens		(v)							
Hydrocotyle ranunculoides	(v)	v	v	v		v		(v)	v
Impatiens glandulifera		v		v				v	(v)
Lagarosiphon major	v	v	v	v		v		v	v
Lespedeza cuneatea		(v)						(v)	
Ludwigia grandiflora	(v)	v	(v)	v		v		v	v
Ludwigia peploides	(v)	v	(v)	v		v		v	v
Lygodium japonicum		(v)							
Lysichiton americanus		v							
Microstegium vimineum									v
Myriophyllum aquaticum	v	v	v	v		v		v	v
Myriophyllum heterophyllum	v	v	v	v		v		v	v
Parthenium hysterophorus			(v)					(v)	(v)
Pennisetum setaceum		(v)					(v)	(v)	(v)
Persicaria perfoliata								(v)	
Proposis juliflora		(v)							
Pueraria montana var. *lobata*		(v)							
Salvinia molesta		v	(v)	(v)					
Triadica sebifera		(v)							

8 ADDRESSING KNOWLEDGE GAPS ON INTRODUCTION PATHWAYS

Current prioritization of pathways of introduction and spread of IAS of union concern lead to the identification of important pathways of introduction and spread of IAS, relevant for Belgium. During the process, some knowledge gaps were identified. Describing and where possible addressing these gaps will aid in a required follow-up work such as future prioritization upon future update of the list of species of EU concern. Some limitations of current analysis are considered below:

- The current analysis is not a full pathway analysis on IAS relevant for Belgium. By definition, the list of species of EU Concern only considers a subset of high impact species. Although including species that are not of Union concern in the pathway prioritization is not an obligation for the EU legislation, it can be of added value. 1) For example, the absence of a strategy for preventing marine invasions is not because it is not an important pathway, but rather an artefact of having only one marine animal on the list. Focusing a prioritization on a larger set of species (e.g. all alien species) would better prevent future invasions and also render the action plans more fit for future list update. A documented register of al exotic species in Belgium is currently being developed by TrIAS project (Desmet P. et al, 2019) and an overview of marine non-inigenous species is given by Vandepitte et al (2012).
- There still is uncertainty about the role of certain pathways of introduction. In the case where no pathway information was available in literature or documents, expert opinion was used to asses pathway relevance in the current analysis. Some considerations can help reducing the need of expert opinion:
    - Data on frequency, number and identity of propagules that are imported, transported or spread through introduction routes are not available for Belgium. For example interception data are currently not fit for purpose. Some numbers on the frequency of certain commodities and goods are available, but more detailed knowledge on the importance of certain routes is needed.
    - Improving and expanding registration and storage of data on inspections and interception on exotic species (to other goods), is needed for an improved analysis of pathways of spread and introduction and the development of policy tools relating to introduction and management of IAS.
- For some species, detailed information on the establishment potential under current and future climate is not available. Additionally, it is difficult to assess the potential impact on ecosystems in Belgium for species that are not established in Europe or in a similar climate. Therefore, revisiting the scores given during previous prioritization analysis when new information is available may change pathway ranking.

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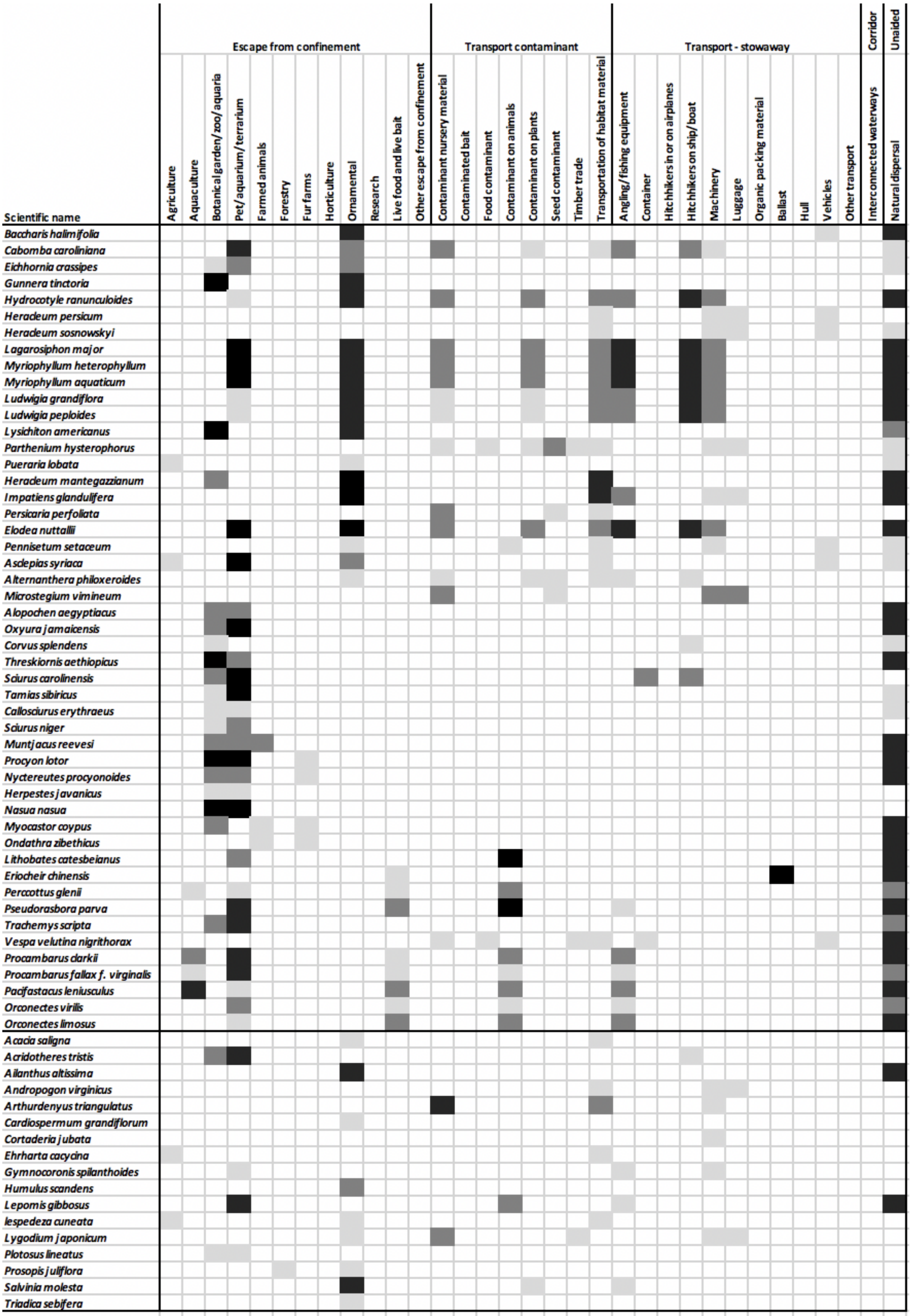
Annex 1

Table presenting frequency-categories (as a proxy for volume) of use of all species in each pathway (light grey: 0,33 / grey: 0,66 / black: 1 / white: 0) – more information on the scores is available in Table 3 ; newly listed species under black line.



Scientific name
Escape from confinement
Agriculture
Aquaculture
Botanical garden/zoo/aquaria
Pet/aquarium/terrarium
Farmed animals
Forestry
Fur farms
Horticulture
Ornamental
Research
Live food and live bait
Other escape from confinement
Transport contaminant
Contaminant nursery material
Contaminated bait
Food contaminant
Contaminant on animals
Contaminant on plants
Seed contaminant
Timber trade
Transportation of habitat material
Transport - stowaway
Angling/fishing equipment
Container
Hitchhikers in or on airplanes
Hitchhikers on ship/boat
Machinery
Luggage
Organic packing material
Ballast
Hull
Vehicles
Other transport
Corridor
Interconnected waterways
Unaided
Natural dispersal
Baccharis halimifolia
Cabomba caroliniana
Eichhornia crassipes
Gunnera tinctoria
Hydrocotyle ranunculoides
Heracleum persicum
Heracleum sosnowskyi
Lagarosiphon major
Myriophyllum heterophyllum
Myriophyllum aquaticum
Ludwigia grandiflora
Ludwigia peploides
Lysichiton americanus
Parthenium hysterophorus
Pueraria lobata
Heracleum mantegazzianum
Impatiens glandulifera
Persicaria perfoliata
Elodea nuttallii
Pennisetum setaceum
Asclepias syriaca
Alternanthera philoxeroides
Microstegium vimineum
Alopochen aegyptiacus
Oxyura jamaicensis
Corvus splendens
Threskiornis aethiopicus
Sciurus carolinensis
Tamias sibiricus
Callosciurus erythraeus
Sciurus niger
Muntjacus reevesi
Procyon lotor
Nyctereutes procyonoides
Herpestes javanicus
Nasua nasua
Myocastor coypus
Ondathra zibethicus
Lithobates catesbeianus
Eriocheir chinensis
Perccottus glenii
Pseudorasbora parva
Trachemys scripta
Vespa velutina nigrithorax
Procambarus clarkii
Procambarus fallax f. virginalis
Pacifastacus leniusculus
Orconectes virilis
Orconectes limosus
Acacia saligna
Acridotheres tristis
Ailanthus altissima
Andropogon virginicus
Arthurdenyus triangulatus
Cardiospermum grandiflorum
Cortaderia jubata
Ehrharta cacycina
Gymnocoronis spilanthoides
Humulus scandens
Lepomis gibbosus
lespedeza cuneata
Lygodium japonicum
Plotosus lineatus
Prosopis juliflora
Salvinia molesta
Triadica sebifera