Management of Biological Invasions (2015) Volume 6, Issue 2: 197–208
doi: http://dx.doi.org/10.3391/mbi.2015.6.2.10

Open Access

Special Issue: Alien species related information systems and information management

Information Management

A science-based approach to tackle invasive alien species in Belgium – the role of the ISEIA protocol and the Harmonia information system as decision support tools

Sonia Vanderhoeven[1,2]*, Tim Adriaens[3], Bram D'hondt[3], Hans Van Gossum[4,5], Maurits Vandegehuchte[5], Hugo Verreycken[3], Julien Cigar[1] and Etienne Branquart[2]

[1]*Belgian Biodiversity Platform – Walloon Research Department for Nature and Agricultural Areas (DEMNA), Service Public de Wallonie, Avenue Maréchal Juin, 23 B-5030 Gembloux, Belgium; Belgian Science Policy Office, Avenue Louise, 231 B-1050 Brussels, Belgium*
[2]*Invasive Species Unit, Département de l'Etude du Milieu Naturel et Agricole (DEMNA), Service Public de Wallonie, Avenue Maréchal Juin, 23 B-5030 Gembloux, Belgium*
[3]*Research Institute for Nature and Forest (INBO), Department of Management and Sustainable Use, Kliniekstraat 25, B-1070 Brussels, Belgium*
[4]*ARCADIS Belgium, Posthofbrug, 12 B-2600 Antwerp – Berchem, Belgium*
[5]*Agency for Nature and Forest, Koning Albert II-laan, 20 B-1000 Brussel, Belgium*

E-mail: s.vanderhoeven@biodiversity.be (SV), tim.adriaens@inbo.be (TA), bram.dhondt@inbo.be (BD), h.vangossum@arcadisbelgium.be (HV), maurits.vandegehuchte@lne.vlaanderen.be (MV), hugo.verreycken@inbo.be (HV), j.cigar@biodiversity.be (JC), etienne.branquart@spw.wallonie.be (EB)

**Corresponding author*

Received: 31 October 2014 / Accepted: 11 May 2015 / Published online: 28 May 2015

Handling editor: Helen Roy

Abstract

A coherent response to biological invasions involves science-based, up-to-date prioritization tools alongside information transfer to relevant authorities and stakeholders. Here, we describe how the collaboration between scientists and policy makers in Belgium has allowed the development of decision support tools regarding invasive alien species. We present the environmental impact assessment protocol ISEIA and comment on its applications. Furthermore, we describe and provide metadata for the information system Harmonia which was developed to disseminate this information to a diverse audience. Using several examples of initiatives addressing the threat of invasive alien species in Belgium, we show how these tools have been instrumental in strengthening capacity of the scientific community, authorities and stakeholders in Belgium on addressing the invasive alien species issue.

Key words: risk assessment, decision making, prioritization

Introduction

Like many disciplines in biodiversity conservation, invasion biology is expected to help answering environmental questions raised by decision makers and managers. However, for the time being, there appears to be a mismatch between the focus of invasion science and the information needs that managers of biological invasions currently have. Also, it has been shown that research results are still poorly disseminated to the people that need them, *i.e.* policy makers, decision makers or managers (Matzek et al. 2014). Indeed, apart from being based on credible information, decision processes also need to be efficiently communicated towards stakeholders and the general public (Brunel 2014). Therefore, filling this gap not only requires an increase of the amount of useful information produced by the scientific community, but also to reshape the way knowledge is exchanged and used in practice (Young et al. 2014). These requirements can be met through the development of effective information systems and decision support tools (Genovesi and Shine 2004; Katsanevakis et al. 2013).

The current Belgian dynamics with respect to tackling biological invasions were initiated at the initiative of the Belgian scientific community in

2006 by claiming the necessity to develop risk analysis procedures for evaluating the potential risks from Invasive Alien Species (IAS) in Belgium (Belgian Forum on Invasive species 2006). Decision makers were asked to act coherently on the reduction of IAS negative impacts, but developing a coherent national initiative was not straightforward. This was especially true for Belgium, a federal state composed of communities and regions, each of which having their own legal competences. As a result, considerable coordination and coherence was needed to ensure the efficiency of initiatives that were taken.

The Belgian Biodiversity Platform is an initiative of the Belgian Science Policy Office that works in collaboration with the regions and communities to provide services to the entire Belgian community engaged in biodiversity research and policy. The Platform coordinates the 'Belgian Forum on Invasive Species' (BFIS), an informal structure involving about 120 people, including scientists (50%), policy makers (20%) and other stakeholders (30%). Its aim is to encourage interdisciplinary cooperation, information exchange and dissemination in support development of measures dedicated to the prevention and the mitigation of the impacts of invasive alien species.

A major tool developed through this forum is Harmonia, an information system on alien species. It provides species fact sheets, risk assessment protocols but also includes the results of quick environmental impact assessments for a selection of about 100 terrestrial and freshwater alien species in Belgium so far. Impacts and risks are assessed through dedicated protocols that enable the digestion of scientific information into a risk classification. The results from the species assessments are disseminated through the Harmonia information system in an easily comprehensible message to environmental policy makers and managers by means of a list system comprising a black list, a watch list, a white list and an alert list of alien species in Belgium.

In this article, we describe how the collaboration between scientists and policy makers in Belgium has allowed the development of a national information system on invasive species named Harmonia in support of decision making. We provide an overview of the different components of this system and the information it contains. Furthermore, we highlight some important initiatives showing the use of the information from the Harmonia system with respect to a more coherent approach to managing biological invasions in Belgium.

ISEIA and black listing

The Invasive Species Environmental Impact Assessment (ISEIA) protocol (Branquart 2007) represents one of the first generic protocols dedicated to invasive species prioritization in Europe (Essl et al. 2011). This tool quantifies potential spread and environmental impacts of alien species in Belgium. Driven by environmental policy at the time of development, its focus is on the possible adverse impacts on biodiversity and ecosystem processes (Appendix 1). ISEIA allows for categorizing alien species on the basis of a standardized methodology irrespective of their taxonomic affiliation. The rationale behind its construction was to minimize the use of subjective opinions and to make the process of assessing and listing of species transparent, reliable and repeatable (cf. Burgman 2004; McGeoch et al. 2012). Like many other prioritization tools (e.g. Randall et al. 2008; Brunel et al. 2010; Essl et al. 2011), the ISEIA approach is based on environmental impact data documented in peer-reviewed publications and scientific reports from the impact assessment area and neighbouring areas, rather than species life histories. It is therefore not a predictive protocol but rather a prioritization tool. Invasion histories elsewhere are generally good predictors of impacts (Williamson 1996). Hence, if species already caused impacts on native species and ecosystems in neighbouring regions and countries with similar environmental conditions, it was assumed they were likely to do the same in Belgium. The reference area taken into consideration for the assessment includes the European regions with eco-climatic conditions comparable to Belgium i.e. areas included within the Atlantic and the continental biogeographic regions in Europe. As Belgium has a maritime temperate climate (Köppen-Geiger climate type Cfb (Peel et al. 2007)), the reference area largely covers the Netherlands, Luxembourg, and large parts of Germany, France and Great Britain.

An assessment is made by scoring four criteria that match the post-establishment phases of the invasion process (Richardson et al. 2000): 1) the potential for spread, 2) the colonization of natural habitats, 3) adverse ecological impacts on native species and 4) adverse ecological impacts on ecosystems. Equal weight is assigned to each of the four criteria and a three-point scale is used for criteria scoring: low (or unlikely), medium (or likely) and high. In line with the precautionary principle of the Convention of Biological Diversity (UNEP 1992), the scoring follows a maximum

Table 1. Members of the expert panel for each taxonomic group.

Taxonomic group	Expert panel members - affiliation at the time of the assessment
Vascular plants	**Etienne Branquart** - Belgian Biodiversity Platform, **Iris Stiers** - Vrije Universiteit Brussel, **Ludwig Triest -** Vrije Universiteit Brussel, **Sonia Vanderhoeven** - Université de Liège, **Wouter Van Landuyt-** Research Institute for Nature and Forestry (INBO), **Fabienne Van Rossum** - National Botanic Garden, **Filip Verloove** - National Botanic Garden
Amphibians	**Etienne Branquart** - Belgian Biodiversity Platform, **Joachim Mergeay** - KU Leuven, **Gérald Louette** - Research Institute for Nature and Forestry (INBO),**Youri Martin** - Université Catholique de Louvain, **Christiane Percsy** - Université Libre de Bruxelles
Fishes	**Dieter Anseeuw** - KU Leuven, **Etienne Branquart** - Belgian Biodiversity Platform, **François Lieffrig** - CER Groupe, **Gérald Louette** -Research Institute for Nature and Forestry (INBO), **Jean-Claude Micha** - Facultés Universitaires Notre Dame de la Paix, **Denis Parkinson** -Natagora, **Hugo Verreycken** - Research Institute for Nature and Forestry (INBO)
Birds	**Anny Anselin** - Research Institute for Nature and Forestry (INBO), **Etienne Branquart** - Belgian Biodiversity Platform, **Koen Devos** - Research Institute for Nature and Forestry (INBO), **Jean-Yves Paquet** - Natagora, **Diederik Strubbe** - Universiteit Antwerpen, **Didier Vangeluwe** - Royal Belgian Institute for Natural Sciences, **Anne Weiserbs** - Natagora
Mammals	**Etienne Branquart** - Belgian Biodiversity Platform, **Margo D'haes** - Universiteit Antwerpen, **Alain Licoppe** - Walloon Research Department for Nature and Agricultural Areas (DEMNA), **Grégory Motte** Walloon Research Department for Nature and Agricultural Areas (DEMNA), **Vinciane Schockert** - Université de Liège, **Jan Stuyck** - Research Institute for Nature and Forestry (INBO)
Insects	**Etienne Branquart** - Belgian Biodiversity Platform, **Tim Adriaens -** Research Institute for Nature and Forestry (INBO), **Patrick De Clercq** – UGhent, **Jean-Claude Grégoire** – Université Libre de Bruxelles

likelihood approach, with the highest score determining the final score of the two impact modules (species impact, ecosystem impact). The global ISEIA score is then calculated as the sum of the scores of the four criteria. Minimum and maximum global scores therefore are 4 and 12, respectively. When nothing can be said about the parameter due to data deficiency, no score is calculated. See Branquart (2007) and Appendix 1 for additional explanation on the criteria, including definitions and examples.

ISEIA was used by the Belgium Forum on Invasive Species for a nation-wide impact assessment. First, a pre-screening of alien species established in Western Europe was made with special reference to alien species that were suspected to cause adverse ecological impacts on biodiversity and/or ecosystem functioning and/or had recently expanded their geographic range. Species assessments were conducted through five expert panels dealing with either vascular plants, fishes, amphibians, birds or mammals from 2007 to 2009. Each group consisted of three to six scientists from different research institutes and universities in Belgium (Table 1) with strong expertise on the invasion biology, the invasive species biological characteristics and distribution and/or on invasive environmental impacts. Assessments were individual based, as they were first performed by each expert independently. The scores were then compared and discussed in panel meetings in order to reach a consensus score. It is worth noting that all experts having performed the ISEIA species assessments have done so without remuneration so far.

Based on the resulting scores, species were listed according to the methodology described hereafter, and included in the Harmonia information system. The list scheme encompasses three different list categories that are in line with the recommendations of the European strategy on Invasive Alien Species in 2003 (Genovesi and Shine 2004). These categories refer to the severity of impact on the environment ranging from no negative impact (white list), suspected negative impact (watch list) and confirmed negative impact (black list). A fourth list (alert list) was added for species that do not occur in Belgium yet. The assignment of an alien species to one of those categories was based upon the scores following the ISEIA assessment and their invasion stage in the country (Figure 1).

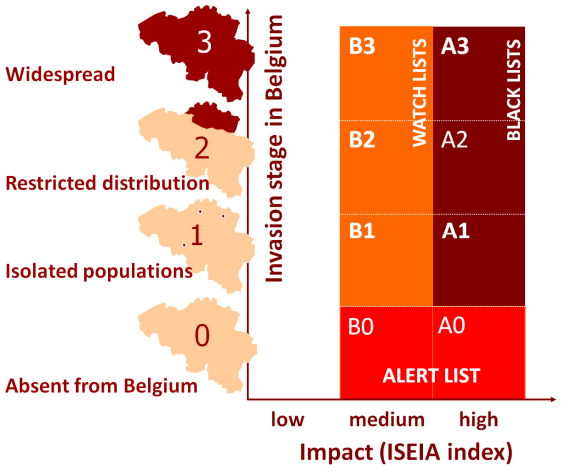

Figure 1. List system proposed to identify non-native species of most concern and mitigation actions in Belgium.

Species with ISEIA scores from 4 to 8 were ascribed to the white list 'C' (low impact species). Those with scores from 9 to 10 were ascribed to the 'B' watch list (medium impact species). High impact species (scoring 11 and 12) were ascribed to the black list 'A' if they were already present in Belgium, or the alert list, if not yet naturalised in Belgium. A further categorization is based on their current invasion stage in Belgium, from 0 (not yet naturalised or present in Belgium), to 1 (isolated populations), 2 (restricted distribution) and 3 (widespread).

The underlying rationale was for the system to be dynamic by adding or removing species, or by moving them between different lists. Such modifications may be necessary as scientific knowledge on the species progresses, or as species distributions change. For example, the raccoon dog *Nyctereutes procyonoides* (Grey, 1834), was downgraded from black to watch list. Recent publications demonstrated that impact by predation was lower than previously assumed as it behaves as a scavenger rather than a predator (Kauhala et al. 2011). On the other hand, round goby *Neogobius melanostomus* (Pallas, 1814), was moved from the alert to the black list as the species was first observed in Belgium in 2010 (Verreycken et al. 2011) and has spread since then to most canals and to the rivers Scheldt and Meuse (Verreycken 2013).

The Harmonia information system

The development of information systems and decision support tools is expected to facilitate effective and efficient exchange of information both within the scientific community, as well as between the scientific, policy and management arena (Genovesi and Shine 2004; Katsanevakis et al. 2013).

The potential target audience covered by the Harmonia system is composed of scientists seeking detailed references, decision makers developing science-based policy and managers wanting to prioritize. This audience has been enlarged to the general public looking for information, and key stakeholders playing a possible role in the introduction of species (e.g. horticulture, aquaculture).

So far, the Harmonia information system only comprises species that have been assessed with the ISEIA protocol by experts from BFIS. It does not serve as a complete inventory of (invasive) alien species in Belgium. The list also comprises species that have not yet established in the country (alert list). Hence, this register can neither be used to infer statistics nor to provide indication of the number of invasions in the Belgian territory.

The list of species is supplemented with the information fields shown in Table 2. As much as possible, information entered in the database is based on available peer-reviewed publications but also grey literature and online databases.

For the moment, 101 species have been assessed: 67 vascular plants, 1 arthropod, 2 amphibians, 9 fishes, 8 birds and 14 mammals. Thirty five species are fully or partly freshwater species and 66 are terrestrial. No marine or brackish species have been assessed so far. The assessments demonstrated 6 species with low environmental impact after assessment, 44 with medium impact and 51 species with high impact (Appendix 2).

From a technical perspective, the Harmonia system is written in the Python programming language, using the Pylons framework (van Rossum and Drake 2001). Data are stored in a relational PostgreSQL database. SQLAlchemy (Python SQL toolkit and Object Relational Mapper) was used to facilitate queries.

The annual number of unique visitors has increased significantly from 4.000 to over 18.000 since its launch (Figure 2). As unique visitors are recorded through IP addresses, these figures should not be considered as absolute values but rather crude indicators of website usage.

Table 2. List of fields used in the Harmonia system.

Fields	Description
Scientific name	
Common names	English – French - Dutch
Taxonomic Groups	
Family	
Origin	
Introduction pathway	accidental/agriculture/horticulture/pets and domestic animals/aqua-mariculture/aquaria and ponds/biological control/forestry/fur farming/game and fish stocking
ISEIA score	From 4 to 12
Habitat type	Brackwish / Freshwater / Marine / Terrestrial
Year of first observation into the wild	
Invasiveness	Textual description
Distribution range	Absent / Isolated / Restricted / Widespread
Harmonia list category	A0 / A1 / A2 / A3 / B0 / B1 / B2 / B3
Reproduction in the wild	Yes / No
Dispersal potential	Low / Medium / High
Risk to invaded high conservation value natural habitats	Low / Medium / High
Distribution per Belgian biogeographic distric (Maritime; Flandrian; Kempen; Brabant; Meuse; Ardenne; Lorraine)	Absent in the district / Isolated populations (1-5 localities per district) / Widespread (> 5 localities per district)
Endangered Natura2000 habitats	EUR27 categories (European Commission 2007)
Endangered areas[1]	Maritime; Flandrian; Kempen; Brabant; Meuse; Ardenne; Lorraine
Impact on species through predation or herbivory	Low / Medium / High
Impact on species through competition	Low / Medium / High
Impact on species through disease transmission	Low / Medium / High
Impact on species through genetic effect	Low / Medium / High
Impact on ecosystem through nutrient cycling	Low / Medium / High
Impact on ecosystem through physical alteration	Low / Medium / High
Impact on ecosystem through natural succession	Low / Medium / High
Impact on ecosystem through food web alteration	Low / Medium / High
Impact	Textual description
Pictures	Pictures and credits
Authors of the assessment	
Date of publication	
Date of last update	
References	Link to web portals, scientific publications and grey literature

[1]Biogeographic areas made of Natura2000 habitats that are likely to be invaded by the species.

The use of the ISEIA protocol and the Harmonia information system for policy actions

The ISEIA protocol and the Harmonia system have been instrumental tools for the development of several initiatives within Belgium and other European countries, some of which are described hereafter.

The Belgian code of conduct on ornamental plant species

Voluntary codes of conducts are used to encourage risk awareness and induce behavioural change among stakeholders involved in sectors that are linked to the import and trade of alien species. In some cases, the aim of such codes is the voluntary

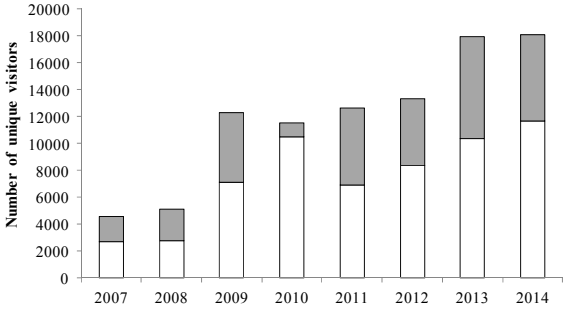

Figure 2. Evolution of the number of unique visitors from 2007, date of establishment of the Harmonia information system to 2014 (2014 visitors are extrapolated from the 13549 visitors between January and September 2014).Visitors in Belgium are shown in white, visitors out of Belgium in grey.

removal of target species from trade (Dehnen-Schmutz and Touza 2008). The LIFE+ programme from the European Commission co-financed an "Information and communication" project, called AlterIAS (Alternatives to Invasive Alien Species), which aimed at raising awareness of horticulture professionals and gardeners on plant invasions (Halford et al. 2014). The project was launched in 2010 with a total budget of 1 010 804 Euros for four years.

A major outcome of the project was the establishment of a code of conduct prepared in consultation with representatives from the sector. The code was established based on the lists of invasive plants included in the Harmonia information system. Based on the results of an economic value assessment of the species and a survey on the perception and knowledge of different IAS by the sector (Vanderhoeven et al. 2011; Halford et al. 2011), a step by step consultation process was undertaken with the sector. During this process, a facilitator of BFIS and invasion biologists were present to answer any question regarding the impacts of the species of concern.

The consultation resulted in the drafting of two lists. The 'consensus list' consisted of species for which subscribers to the code of conduct voluntarily accepted restriction of use (sale or planting ban). This list represented 44% of the total number of plants (n = 28) included in the black list of the Harmonia system (categories A1, A2, A3). Restriction of use was accepted by the sector for highly invasive plants of low or medium economic value (Vanderhoeven et al. 2011; Halford et al. 2011). The remaining 56% consisted of species of high economic importance such as *Rhododendron ponticum* L. or *Rosa rugosa* Thunb. They are included in a 'communication list' for which the professional sector agreed to communicate the potential risk to their customers in order to limit their use near habitats of high conservation value. So far, 511 horticulture professionals, 498 gardeners and 53 organizations have endorsed the AlterIAS code of conduct. In 2013, at the end of the project, a final survey was performed. It showed a significant behavioural change and an improvement of the knowledge and understanding of the horticulture professionals on the issue of invasive alien plants in Belgium. There is unfortunately no data available on the economic value of the species at the national level. It is however worth noting that 8% of horticulture professionals considered the code having a negative impact on their activities (Halford et al. 2014).

An early warning and rapid response system

Waiting to tackle the problem after damage becomes evident is not a cost-efficient option with respect to biological invasions (Wittenberg and Cock 2001; Simberloff et al. 2013). Therefore, rapid detection of emerging harmful IAS is essential. Until recently, Belgium had no dedicated portal for reporting observations of such species, despite the high political priority and ongoing current (inter)national initiatives. In 2011, a pilot project on early warning for invasive species was launched in cooperation between all Belgian regions. For some notorious IAS, the Flemish Agency for Nature and Forest (ANB), the Research Institute for Nature and Forestry (INBO), the Research Department for Nature and Agricultural Areas (DEMNA), and the non-governmental organisations Natuurpunt and Natagora, launched an early warning system (EWS) through the popular online recording platforms http://www.waarnemingen.be and http://www.observations.be, the Belgian domains of observation.org. Although ISEIA served as a basis, the criteria for inclusion of a species in the early warning project were broader than the impact assessment and involved a consensus process among the different regions in Belgium. While A0 and A1 species were considered a priority for detection, the list included a mixture of alert list (A0, B0), watch list (B1, B2), black list (A1, A2, A3) and non-evaluated species. Thus, the list also included established species in Belgium. These were often of regional importance for early warning. For example, raccoon *Procyon lotor* (L., 1758), widely established in Wallonia and therefore classified A2 in Belgium, was added to the list because there is still no evidence of establishment in the Flemish region (Van den Berge 2008). Other species were added because of ongoing response mechanisms in one of the Belgian regions so the system could serve as an additional data source. A few other non-evaluated high profile species were added based on expert knowledge such as Asian hornet *Vespa velutina nigrothorax* Du Buysson, 1905 and Indian house crow *Corvus splendens* Vieillot, 1817. The system is dynamic and allows for setting regional priorities and the inclusion of additional species. The EWS allows reporting of sightings, consulting fact sheets and setting up of user-driven automated e-mail alerts in daily or weekly digests and tailored per thematic group or management area. The aim of the pilot phase (March-November 2012) was to examine how the system would work (which species are reported, potential reporting bias, data quality).

Apart from testing the reporting tool, the project had several spin-offs. In the longer run, it aims to mobilize volunteers for monitoring IAS, to provide information and raise awareness amongst field workers and the public and to streamline the process from reporting to management intervention. The ultimate goal is to build an early warning system for IAS that connects with federal initiatives and anticipates developments of a trans-European system (Katsanevakis et al. 2012; Katsanevakis et al. 2013). The pilot phase yielded 6335 geo-referenced occurrences of early warning species, including also some alert list species.

The data from this EWS is being used for various rapid response as well as longer term control projects in Belgium. These include the ongoing eradication of ruddy duck *Oxyura jamaicensis* (Gmelin, 1789) (Robertson et al. 2015), which uses observations of the species and the alert system to implement an action plan and report back to the Bern Convention about progress in this field. In 2014, rapid response was organised for American mink *Mustela vison* Schreber, 1777 in Flanders and fox squirrel *Sciurus niger* L., 1758 in Wallonia (Adriaens et al. 2015). Similarly, the system is used to tackle an incursion of the Reeves's muntjac *Muntiacus reevesi* (Ogilby, 1839) in Flanders as an additional data source on top of observations reported by hunters and government officials. The regional management services responsible for the control of invasive aquatic plants (mostly the floating pennywort *Hydrocotyle ranunculoides* (L.f.), the parrot's feather *Myriophyllum aquaticum* (Vell.) Verdc. and the water primrose *Ludwigia grandiflora* (Michx.) Greuter and Burdet use the data collected through the EWS as an important addition to their own. Furthermore, data and alerts on the American bullfrog *Lithobates catesbeianus* (Shaw, 1802) occurrences were used to support ongoing eradication and control actions as well as research activities (Devisscher et al. 2012; Devisscher et al. 2013; Louette et al. 2012; Louette et al. 2014). With regards to the early warning requirements set out in the EU regulation (European Commission 2014), future work will include harmonizing the species list in the Belgian regions.

Detailed pest risk analyses in light of trade restrictions

Interestingly, both regulatory tools and voluntary codes of conduct were established based on the Harmonia species listing. As a general principle, strong prohibition measures and priority species for early warning should be linked to detrimental species that are still poorly established in the country (A0 and A1 categories) while more widespread organisms should be accompanied by less restrictive measures, such as an obligation or incentive to provide information to customers.

When considering trade restrictions to reduce the risk of introduction and spread of an alien organism, full and comprehensive risk analysis, including risk assessment, risk management and risk communication is required. It must be demonstrated that the proposed measures are adequate and efficient to reduce the risk and that they are not a trade-barrier in disguise (Shine et al. 2010). The risk analysis should prevent introduction through any pathway and should therefore provide scientific justification about the necessity, proportionality, non-discrimination, efficiency and cost-effectiveness of proposed management measures (WTO 1995; Baker et al. 2008; Shine et al. 2010; Shrader et al. 2010).

Detailed risk analysis reports were prepared in 2013 for a selection of alien species, mostly allocated to the A0 and A1 lists in the Harmonia system (Table 2). Additionally, detailed risk analysis was performed for *Sciurus niger* L., 1758 (Baiwy et al. 2013d) and *Procambarus clarkii* (Girard, 1852) (Delsinne et al. 2013) which had not been previously assessed with ISEIA.

Scirus niger was selected because of its recent inclusion in the Annex B of the EU wildlife trade regulation (European Commission 2012). *Procambarus clarkii* was considered for full PRA because of observed emergence in Belgium and its negative impact in several freshwaters systems in Europe (Gherardi 2007). In Flanders, Boets et al. (2012) ranked *P. clarkii* as an A1 species following the ISEIA protocol.

The Pest Risk Analysis (PRA) reports are accessible through the Harmonia information system. The general process of drafting, reviewing and approving the risk analysis for selected invasive alien species in Belgium was attended by a steering committee, chaired by the Federal Public Service Health, Food chain safety and Environment. The documents have been subject to a peer review process, mostly involving national experts. The risk analysis followed a simplified scheme that was drafted in line with the recommendations provided by the International Plant Protection Convention (FAO 2004). It separates the assessment of entry, establishment, spread and impacts, and also addresses risk management.

These risk analyses serve as advisory scientific documents in support of decision making: they

do not determine government policy, nor do they have a legal status. They may however serve as a formalized scientific document to propose species inclusion within the list of IAS of Union or Member State concern according to the new EU Regulation (European Commission 2014).

Use of the ISEIA protocol and the Harmonia system

The ISEIA protocol and Harmonia information system have been widely used in Belgium and neighbouring countries for horizon scanning (Parrott et al. 2009; Gallardo et al. 2013), prioritization and risk assessment exercises (Hurel 2011; Gyimesi and Lensink 2010; van de Koppel et al. 2012; Boets et al. 2012; Verbrugge et al. 2012; Roy et al. 2014a; Ries et al. 2013; Schiphouwer et al. 2014). The information from the Harmonia system has been used in global information systems such as GISD (GISD 2012) and the Global Register of Introduced and Invasive Species (GRIIS) currently under development, but also regional systems such as NOBANIS (NOBANIS 2009) and DAISIE (DAISIE 2009).

Perspectives

The ISEIA protocol is one of the first national standardized environmental impact assessment tools that has been developed for alien species in Europe (Verbrugge et al. 2010). The Harmonia system and ISEIA protocol have answered demands of Belgian scientists, policy makers and managers who needed to use or refer to scientific information on IAS in Belgium during the past decade. Nonetheless, considering developments in international collaboration, legislation, and the scientific field of risk analysis (Kumschick and Richardson 2013), the system is now requiring new developments.

Enlarging the scope: the Harmonia$^+$ protocol

During the past few years, several issues were found to be insufficiently covered by the ISEIA protocol. Firstly, it did not incorporate invasion stages like introduction and establishment (Blackburn et al. 2011; Leung et al. 2012). Secondly, it only addressed environmental impacts, neglecting impacts on human health, economic activities and infrastructure (European Environment Agency 2012). Thirdly, it did not allow for the inclusion of confidence levels, while dealing with uncertainty is inherent in performing risk analyses (Leung et al. 2012). Lastly, it did not provide opportunities for incorporating the role of parasites and pathogens in biological invasions. Indeed, the infections they cause often form a key driver for invasion success (Dunn and Perkins 2012).

We therefore constructed a new protocol that addresses these issues, through a project-based collaboration among eight scientific institutes from different fields (D'hondt et al. 2015). The *Harmonia*$^+$ protocol brings together 30 questions that cover the complete invasion process and refer to multiple kinds of impacts. The protocol allows for quantitative output on stage-specific and general risks, by converting answers into summary statistics. In parallel, we constructed a protocol for the risk assessment of pathogens and parasites, called *Pandora*. Its results are compatible with the *Harmonia*$^+$ protocol, and thus allow for integrated risk assessments of pathogens and their alien hosts. All details are described by D'hondt et al. (2015). The protocols are accessible as online questionnaires, for which registered users have advanced possibilities of modifying forms and sharing assessments.

The Harmonia system in the future: reporting species occurrence

Accurate and detailed information on species occurrences is needed to ensure efficient prevention, early detection and rapid response, as well as to evaluate management measures (Katsanevakis et al. 2012). However, data availability has been recognized as a challenging issue, particularly when subsequent integration into regional or global systems is needed (Hulme and Weser 2011).

The Harmonia information system was designed to address the specific Belgian needs of science and policy at a time when they both were at their beginning of addressing biological invasions. Eight years later, our knowledge has evolved and it is now time to develop a real system to report on species occurrence. An instrumental example in this respect is Great Britain's Non Native Species Information Portal that dynamically links its species register to the National Biodiversity Network (Roy et al. 2014b). Likewise, the Harmonia system could live link real-time information on species distributions from various data sources. To make this happen, issues of database interoperability, data standards and licensing will have to be addressed at regional, Belgian and international levels.

Further developing and updating the Harmonia system as a versatile communication hub represents a challenge, particularly because a large part of the content is related to the notion of risk.

Sustainability and funding

Either in response to, or proactively to the establishment of legislative instruments, obligations and commitments under European and international frameworks, many IAS information systems have emerged in recent years. In 2012, the European Commission and the Joint Research Centre launched EASIN, the European Alien Species Information Network, aiming to facilitate exploration of existing information systems and assist the implementation of European policies on IAS (Katsanevakis et al. 2012; 2015).

It is however necessary to stress the basic role of national information systems, networks of local experts, and managers of invasive species. They provide the detailed data and knowledge that feeds into the bigger pictures. It is of utmost importance to sustain and financially support such national initiatives and expert networks without which there would not be any supply of information, knowledge or expertise (Katsanevakis et al. 2013).

So far, the scientific expertise that has allowed the assessment of the 101 species in the Harmonia system by application of the ISEIA protocol and consensus building in expert panels, was offered by scientists willing to build upon a tool under development and contributing to solve a major environmental issue. However, with an increasing number of species to be screened, a legal basis for risk assessment (European Commission 2014) as well as an increased frequency of screening, risk assessment may become a more permanent and repetitive task of the experts involved. To retain expert involvement in the risk screening process might involve an approach of remuneration of their work and a continuous investment in building sustainable partnerships e.g. through the drafting of working agreements between parties. This will increase the need for coordination of IAS activities in Belgium.

Now that we have a new EU regulation, it would seem logical, as advocated by Hulme and Weser (2011), to centralize data capture and interpretation rather than to encourage multiple independent country-based initiatives. This could avoid redundancy and increase efficiency in the current financial reality of limited resources. Furthermore, article 11 of the European regulation (European Commission 2014) invites Member States to increase regional collaboration in order to tackle species that might be of concern to several countries in the same bioregion. Meanwhile, an informal collaboration has been initiated for the last four years with the Netherlands, Northern France, Luxembourg and western Germany (Baden-Württemberg, Rheinland-Pfalz). The aim of this current platform is to strive for synergies by applying common risk analysis schemes, sharing expertise and exchange best practices.

Despite these efforts we are convinced that an effective support is needed to create data capturing tools and to encourage professionals in the field to share their observations (Groom et al. 2015). This is particularly important for a time-dependent issue such as IAS where rapid reporting and response is an important part of the solution. Moreover, at smaller scales, analyses will always be needed within countries to support national and regional decision making in defining the most appropriate management measures in response to specific biological invasions, particularly for the restoration of invaded habitats and in general for acting against invasive species of Member States concern.

Conclusion

Experiences from the past decade in Belgium have shown intensive collaboration between science and policy in the field of IAS management for which both the ISEIA protocol and the Harmonia system have provided incentive and momentum. The development of the new Harmonia$^+$ protocol and further improvements to the Belgian information system Harmonia are needed to answer the challenge of implementing the new EU regulation on IAS in Belgium.

Acknowledgements

The Belgian information system on invasive alien species (Harmonia) and Belgian risk assessment protocols (ISEIA and Harmonia$^+$) are funded by the Belgian Science Policy Office. We wish to thank Natuurpunt and Natagora for their cooperation on early warning in Belgium. We are grateful to the experts of the BFIS who provided their input in the ISEIA expert panels and the colleagues in the different Belgian administrations for their willingness to collaborate, in particular Olivier Beck (Brussels Environment) and Maud Istasse (Federal Public Service Health, Food chain safety and Environment). We thank Dr Quentin Groom for an English language check and two anonymous reviewers for their helpful comments and suggestions to improve the manuscript.

References

Adriaens T, Huysentruyt F, Stuyck J, Van Den Berge K, Vandegehuchte M, Casaer J (2015) Surveillance voor invasieve exoten: samen op de uitkijk. *Zoogdier* 26(1): 17–19

Baiwy E, Schockert V (2013) Risk analysis of the fox squirrel, *Scirus niger* - Risk analysis report of non-native organisms in Belgium. Cellule interdépartementale sur les Espèces invasives (CiEi), DGO3, SPW/Editions, 37 pp, http://ias.biodiversity.be/species/risk (Accessed 25 February 2015)

Baker R, Black R, Copp G, Haysom K, Hulme P, Thomas M, Brown A, Brown M, Cannon R, Ellis J, Ellis M, Ferris E, Glaves P, Gozlan RE, Holt J, Howe L, Knight JD, MacLeod A, Moore NP, Mumford JD, Murphy ST, Parrot D, Sansford CE, Smith GC, St-Hilaire S, Ward N (2008) The UK risk assessment scheme for all non-native species. In: Rabitsch W, Essel F, Klingenstein F (eds), Biological Invasions – From Ecology to Conservation. *Neobiota* 7: 46–57

Belgian Forum on Invasive species (2006) Recommendations by the scientific community to the 'SOS invasions !' Open conference (Brussels, 10th of March 2006). http://ias.biodiversity.be/meetings/200603_sos_invasions/doc/SOS_Invasions_docs_-_Recommendations_en.pdf (Accessed 11 March 2015)

Blackburn TM, Pysek P, Bacher S, Carlton JT, Duncan RP, Jarošik V, Wilson JRU, Richardson DM (2011) A proposed unified framework for biological invasions. *Trends in Ecology & Evolution* 26: 333–339, http://dx.doi.org/10.1016/j.tree.2011.03.023

Boets P, Lock K, Adriaens T, Mouton A, Goethals PLM (2012) Distribution of crayfish (Decapoda, Astacoidea) in Flanders (Belgium): an update. *Belgian Journal of Zoology* 142: 86–92

Branquart E (2007) Guidelines for environmental impact assessment and list classification of non-native organisms in Belgium, version 2.1. http://ias.biodiversity.be (Accessed 11 March 2015)

Brunel S, Branquart E, Fried G, Van Valkenburg J, Brundu G, Starfinger U, Buholzer S, Uludag A, Joseffson M, Baker R (2010) The EPPO prioritization process for invasive alien plants. *EPPO Bulletin* 40: 407–422, http://dx.doi.org/10.1111/j.1365-2338.2010.02423.x

Brunel S (2014) How to communicate on pests and invasive alien plants? Conclusions of the EPPO/CoE/IUCN-ISSG/DGA/UC/ESAC Workshop. *EPPO Bulletin* 44: 205–211, http://dx.doi.org/10.1111/epp.12110

Burgman (2004) Expert frailties in conservation risk assessment and listing decisions. In Hutchings P, Lunney D, Dickman (eds), Threatened species legislation: Is it just an act? Royal Zoological Society of South Wales, Sydney, Australia, pp 20–29

D'hondt B, Vanderhoeven S, Roelandt S, Mayer F, Versteirt V, Adriaens T, Ducheyne E, San Martin G, Grégoire JC, Stiers I, Quoilin S, Branquart E (2015) *Harmonia*$^+$ and *Pandora*$^+$: risk screening tools for potentially invasive plants, animals and their pathogens. *Biological Invasions* 17: 1869–1883, http://dx.doi.org/10.1007/s10530-015-0843-1

DAISIE (2009) European Invasive Alien Species Gateway. http://www.europe-aliens.org

Dehnen-Schmutz K, Touza J (2008) Plant invasions and ornamental horticulture: pathway, propagule pressure and the legal framework. *Floriculture, ornamental and plant biotechnology* 5: 15–21

Delsinne T, Lafontaine R-M, Beudels RC, Robert H (2013) Risk analysis of the Louisiana Crayfish *Procambarus clarkii* (Girard, 1852) - Risk analysis report of non-native organisms in Belgium from the Royal Belgian Institute of Natural Sciences for the Federal Public Service Health, Food chain safety and Environment. http://ias.biodiversity.be/species/risk (Accessed 25 February 2015)

Devisscher S, Adriaens T, De Vocht A, Descamps S, Hoogewijs M, Jooris R, van Delft J, Louette G (2012) Beheer van de stierkikker in Vlaanderen en Nederland. Instituut voor Natuur- en Bosonderzoek 2012 (52), Brussels, Belgium, 209 pp

Devisscher S, Adriaens T, Jooris R, Louette G, Casaer J (2013) Opvolging van Amerikaanse stierkikker *Lithobates catesbeianus* in de provincie Antwerpen - Onderzoeksopdracht in het kader van post-Invexo Actieplan stierkikker. Rapporten van het Instituut voor Natuur- en Bosonderzoek 2013 (711500). Instituut voor Natuur- en Bosonderzoek, Brussel, Belgium, 92 pp

Dunn A, Perkins S (2012) Invasions and infections. *Functional Ecology* 26: 1234–1237, http://dx.doi.org/10.1111/1365-2435.12022

Essl F, Nehring S, Klingenstein F, Milasowzky N, Nowack C, Rabitsch W (2011) Review of risk assessment systems of IAS in Europe and introducing the German–Austrian Black List Information System (GABLIS). *Journal for Nature Conservation* 19: 339–350, http://dx.doi.org/10.1016/j.jnc.2011.08.005

European Commission (2007) Interpretation manual of European Union habitats. European Commission – DG Environment, Brussels, Belgium, 142 pp

European Commission (2012) Commission regulation (EU) No 101/2012 of 6 February 2012 amending Council Regulation (EC) No 338/97 on the protection of species of wild fauna and flora by regulating trade therein. *Official Journal of the European Union* L 39/133

European Commission (2014) Commission regulation (EU) No 1143/2014 of the 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species. *Official Journal of the European Union* L 317/35

European Environment Agency (2012) The impacts of invasive alien species in Europe – European Environment Agency Technical report No 16/2012. EEA, Copenhagen, Denmark

FAO [Food and Agriculture Organization] (2004) International Plant Protection Convention – New revised text approved by Resolution 12/97 of the 29th Session of the FAO Conference in November 1997 - Declaration

Gallardo B, Zieritz A, Aldridge DC (2013) Targeting and prioritisation for INS in the RINSE project area. Cambridge Environmental Consulting. Report commissioned by the Interreg 2Seas RINSE

Genovesi P, Shine C (2004) European strategy on invasive alien species. *Nature and Environment*, nr. 137. Council of Europe publishing, Strasbourg, France, 452 pp

Gherardi F (2007) Understanding the impacts of invasive crayfish in Europe: how to make the best of a bad situation? In: Gherardi F, Holdich DM (eds), Crayfish in Europe as alien species – How to make the best of a bad situation. AA Balkema Rotterdam, The Netherlands, pp 271–279

GISD (2012) Global Invasive Species Database. http://www.issg.org/database

Groom Q, Desmet P, Vanderhoeven S, Adriaens T (2015) The importance of open data for invasive alien species research, policy and management. *Management of Biological Invasions* 6: 119–125, http://dx.doi.org/10.3391/mbi.2015.6.2.02

Gyimesi A, Lensink R (2010) Risk analysis of the Egyptian goose in the Netherlands. Bureau Waardenburg bv, Nijmegen and Delft, The Netherlands

Halford M, Heemers L, Mathys C, Vanderhoeven S, Mahy G (2011) Socio-Economic survey on invasive plants and ornamental horticulture in Belgium. Final Report. University of Liège Gembloux Agro Bio-Tech, Gembloux, Belgium, 29 pp

Halford M, Heemers L, van Wesemael D, Mathys C, Wallens S, Branquart E, Vanderhoeven S, Monty A, Mahy G (2014) The voluntary code of conduct on invasive alien plants in Belgium: results and lessons learned from the AlterIAS Life+ project. *EPPO Bulletin* 44: 212–222, http://dx.doi.org/10.1111/epp.12111

Hulme P, Weser C (2011) Mixed messages from multiple information sources on invasive species: a case of too much of a good thing? *Diversity and Distributions* 17: 1152–1160, http://dx.doi.org/10.1111/j.1472-4642.2011.00800.x

Hurel (2011) Les espèces exotiques envahissantes animales du Nord-Est de la France: inventaire, évaluation, hiérarchisation et plans d'action. Rapport de stage Master Environnement et Aménagement, Université Paul Verlaine, Metz, France

Katsanevakis S, Bogucarskis K, Gatto F, Vandekerkove J, Deriu I, Cardoso AC (2012) Building the European Alien Species Information Network (EASIN): a novel approach for the exploration of distributed alien species data. *BioInvasions Records* 1: 235–245, http://dx.doi.org/10.3391/bir.2012.1.4.01

Katsanevakis S, Genovesi P, Gaiji S, Nyegaard Hvid H, Roy HE, Nunes AL, Aguado S, Bogucarskis K, Debusscher B, Deriu I, Harrower C, Josefsson M, Lucy F, Merchini A, Richards G., Trichova T, Vanderhoeven S, Zenetos A, Cardoso AC (2013) Implementing the European policies for alien species: networking, science, and partnership in a complex environment. *Management of Biological Invasions* 4: 3–6, http://dx.doi.org/10.3391/mbi.2013.4.1.02

Katsanevakis S, Deriu I, D'Amico F, Nunes AL, Pelaez Sanchez S, Crocetta F, Arianoutsou M, Bazos I, Christopoulou A, Curto G, Delipetrou P, Kokkoris Y, Panov V, Rabitsch W, Roques A, Scalera R, Shirley SM, Tricarico E, Vannini A, Zenetos A, Zervou S, Zikos A, Cardoso AC (2015) European Alien Species Information Network (EASIN): supporting European policies and scientific research. *Management of Biological Invasions* 6: 115–118, http://dx.doi.org/10.3391/mbi.2015.6.2.01

Kauhala K, Kowalczyk R (2011) Invasion of the racoon dog *Nyctereutes procyonoides* in Europe: History of colonization; features behind its success, and threats to native fauna. *Current Zoology* 57: 584–598

Kumschick S, Richardson D (2013) Species-based risk assessments for biological invasions: advances and challenges. *Diversity and Distributions* 19: 1095–1105, http://dx.doi.org/10.1111/ddi.12110

Leung B, Roura-Pascual N, Bacher S, Heikkila J, Brotons L, Burgman MA, Dehnen-Schutz K, Essel F, Hulme PE, Richardson DM, Sol D, Vilá M (2012) TEASIng apart alien species risk assessments: a framework for best practices. *Ecol. Letters* 15: 1475–1493, http://dx.doi.org/10.1111/ele.12003

Louette G, Devisscher S, Adriaens T (2012) Control of invasive American bullfrog *Lithobates catesbeianus* in small shallow water bodies. *Froglog, newsletter of the IUCN/SSC Amphibian Specialist Group* 20: 2

Louette G, Devisscher S, Adriaens T (2014) Combating adult invasive American bullfrog *Lithobates catesbeianus*. *European Journal of Wildlife Research* 60: 703–706, http://dx.doi.org/10.1007/s10344-014-0829-9

Matzek V, Covino J, Funk J, Saunders M (2014) Closing the knowing-doing gap in invasive plant management: accessibility and interdisciplinarity of scientific research. *Conservation Letters* 7: 208–215, http://dx.doi.org/10.1111/conl.12042

McGeoch M, Spear D, Kleynhans EJ, Marais E (2012) Uncertainty in invasive alien species listing. *Ecological Applications* 22: 959–971, http://dx.doi.org/10.1890/11-1252.1

NOBANIS (2009) European Network on Invasive Alien Species, gateway to information on invasive alien species in North and Central Europe, http://www.nobanis.org

Parrott D, Roy S, Baker R, Cannon R, Eyre D, Hill M, Wagner M, Preston C, Roy H, Beckmann B, Copp G, Edmonds N, Ellis J, Laing I (2009) Horizon Scanning for new Invasive non-native species in England. Central Science Laboratory, York, UK

Peel MC, Finlayson BL, McMahon TA (2007) Updated world map of the Köppen-Geiger climate classification. *Hydrology and Earth System Sciences* 11: 1663–1644, http://dx.doi.org/10.5194/hess-11-1633-2007

Randall JM, Morse LE, Benton N, Hiebert R, Lu S, Killeffer T (2008) The Invasive Species Assessment Protocol: A Tool for Creating Regional and National Lists of Invasive Nonnative Plants that Negatively Impact Biodiversity. *Invasive Plant Science and Management* 1: 36–49, http://dx.doi.org/10.1614/IPSM-07-020.1

Richardson DM, Pysek P, Rejmanek M, Barbour MG, Dane Panetta F, West CJ (2000) Naturalization and invasion of alien plants: concepts and definitions. *Diversity & Distributions* 6: 93, http://dx.doi.org/10.1046/j.1472-4642.2000.00083.x

Ries C, Krippel Y, Pfeiffenschneider M, Schneider S (2013) Environmental impact assessment and black, watch and alert list classification after the ISEIA protocol of non-native vascular plant species in Luxembourg. *Bulletin de la Société des Naturalistes luxembourgeois* 114: 15–21

Robertson P, Adriaens T, Caizergues A, Cranswick PA, Devos K, Gutiérrez-Expósito C, Henderson I, Hughes B, Mill AC, Smith GC (2015) Towards the European eradication of the North American ruddy duck. *Biological Invasions* 17: 9–12, http://dx.doi.org/10.1007/s10530-014-0704-3

Roy HE, Peyton J, Aldridge DC, Bantock T, Blackburn TM, Britton R, Clark P, Cook E, Dehnen-Schmutz K, Dines T, Dobson M, Edwards F, Harrower C, Harvey MC, Minchin D, Noble DG, Parrott D, Pocock MJO, Preston CD, Roy S, Salisbury A, Schönrogge K, Sewell J, Shaw RH Stebbing P, Stewart AJA, Walker KJ (2014a) Horizon scanning for invasive alien species with the potential to threaten biodiversity in Great Britain. *Global Change Biology* 20: 3859–3871, http://dx.doi.org/10.1111/gcb.12603

Roy HA, Preston CD, Harrower C, Rorke SL, Noble D, Sewell J, Walker K, Marchant J, Seeley B, Bishop J, Jukes A, Musgrove A, Pearman D, Booy O (2014b) *Biological Invasions* 16: 2495–2505, http://dx.doi.org/10.1007/s10530-014-0687-0

Schiphouwer ME, van Kessel N, Matthews J,. Leuven RSEW, van de Koppel S, Kranenbarg J, Haenen OLM, Lenders HJR, Nagelkerke LAJ, van der Velde G, Crombaghs BHJM, Zollinger R (2014) Risk analysis of exotic fish species included in the Dutch Fisheries Act and their hybrids. Nederlands Expertise Centrum Exoten (NEC-E), Nijmegen, The Netherlands

Shine C, Kettunen M, Genovesi P, Essel F, Gollash S, Rabitsch W, Scalera R, Starfinger U, ten Brink P (2010) Assessment to support continued development of the EU Strategy to combat invasive alien species. Final Report for the European Commission. Institute for the European Environmental Policy (IEEP), Brussels, Belgium, 297 pp

Shrader G, MacLeod A, Mittinty M, Brunel S, Kaminski K, Kehlenbeck H, Petter F, Baker R (2010) Enhancement of pest risk analysis techniques. *EPPO Bulletin* 40: 107–120, http://dx.doi.org/10.1111/j.1365-2338.2009.02360.x

Simberloff D, Martin J-L, Genovesi P, Maris V, Wardle DA, Aronson J, Courchamps F, Galil B, García-Berthou E, Pascal M, Pyšek P, Sousa R, Tabacchi E, Vilá M (2013) Impacts of biological invasions: what's what and the way forward. *Trends in Ecology & Evolution* 28: 58–66, http://dx.doi.org/10.1016/j.tree.2012.07.013

UNEP [United Nations Environment Programme] (1992) Convention of Biological Diversity. United Nations Environment Programme, Nairobi, Kenya

van de Koppel S, van Kessel N, Crombaghs BHJM, Getreuer W, Lenders HJR (2012) Risk analysis of the Asp viper (*Vipera aspis*) in the Netherlands. Natuurbalans-Limes Divergens BV, ReptielenZoo SERPO, Radboud University, Nijmegen and Delft, The Netherlands

Van Den Berge K (2008) Carnivore exoten in Vlaanderen. *Zoogdier* 19(2): 6–9

van Rossum G, Drake FL (2001) Python Reference Manual, PythonLabs, Virginia, USA, http://www.python.org (Accessed on 25 March 2015)

Vanderhoven S, Piqueray J; Halford M, Nulens G, Vincke J, Mahy G (2011) Perception and understanding of invasive alien species issues by nature conservation and horticulture professionals in Belgium. *Environmental Management* 47: 425–442, http://dx.doi.org/10.1007/s00267-011-9621-8

Verbrugge LNH, Leuven RSEW, van der Velde G (2010) Evaluation of international risk assessment protocols for exotic species. Radboud University, Nijmegen, The Netherlands

Verbrugge LN, van der Velde G, Hendriks AJ, Verreycken H, Leuven RSEW (2012) Risk classifications of aquatic non-native species: application of contemporary European assessment protocols in different biogeographical settings. *Aquatic Invasions* 7: 49–58, http://dx.doi.org/10.3391/ai.2012. 7.1.006

Verreycken H, Breine JJ, Snoeks J, Belpaire C (2011) First record of the round goby, *Neogobius melanostomus* (Actinopterygii: Perciformes: Gobiidae) in Belgium. *Acta Ichthyologica et Piscatoria* 41:137–140, http://dx.doi.org/10.3750/AIP2011.41.2.11

Verreycken H (2013) Risk analysis of the round goby, *Neogobius melanostomus*, risk analysis report of non-native organisms in Belgium. Rapporten van het Instituut voor Natuur- en Bosonderzoek 2013 (INBO.R.2013.42). Instituut voor Natuur- en Bosonderzoek, Brussels, Belgium. http://ias.biodiversity.be/species/risk (Accessed on 25 March 2015)

Williamson M (1996) Biological invasions. Population and community biology series. London, UK, pp 1–244

Wittenberg R, Cock MJW (2001) Invasive alien species. How to address one of the greatest threats to biodiversity: A toolkit of best prevention and management practices. CAB International, Wallingford, Oxon, UK, 228 pp, http://dx.doi.org/10.1079/9780851995694.0000

WTO [World Trade Organization] (1995) The WTO agreement on the application of sanitary and phytosanitary measures (SPS agreement)

Young JC, Waylen KA, Sarkki S, Albon S, Bainbridge I, Balian E, Davidson J, Edwards D, Fairley R, Margerison C, McCrecken D, Owen R, Quine CP, Stewart-Ropper C, Thompson D, Tinch R, Van den Hove S, Watt A (2014) Improving the science-policy dialogue to meet the challenges of biodiversity conservation: having conversations rather than talking at one-another. *Biodiversity and Conservation* 23: 387–404, http://dx.doi.org/10.1007/s10531-013-0607-0

Supplementary material

The following supplementary material is available for this article:

Appendix 1. The ISEIA protocol: scoring system.

Appendix 2. List of species of high and medium impact listed in the Harmonia information system.

This material is available as part of online article from:
http://www.reabic.net/journals/mbi/2015/Supplements/MBI_2015_Vanderhoeven_etal_Supplement.xls