Environmental impact assessment and black, watch and alert list classification after the ISEIA Protocol of non-native vascular plant species in Luxembourg

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Abstract. The environmental impact of 55 invasive alien vascular plants in Luxembourg has been assessed through the Belgian ISEIA Protocol. 9 species of high ecological impact have been assigned to a black list, while 10 species of medium impact have been added to a watch list; 8 species not yet present in Luxembourg have been assigned to an alert list. The remaining 28 taxa of low ecological impact have not been included in any list.

Keywords. Risk assessment, ISEIA Protocol, biological invasions, invasive alien species, neophytes, plant invasions, vascular plants, Luxembourg.

1. Introduction

Approximately 5800 species are considered alien plants in Europe, of which around 2900 are of extra-European origin. Amongst the latter, 1800 species are currently naturalized, a number that is estimated to increase by 6 species every year (Lambdon et al. 2008). In Belgium, 1969 non-native vascular plant taxa have been recorded since 1800, regardless of their degree of naturalisation; but only a negligible part of the naturalised species is considered to be invasive and/or noxious (Verloove 2006). In Luxembourg, Colling (2005) included 118 established alien taxa to the latest checklist of vascular plants. Reliable knowledge concerning non established alien species remains quite patchy.

The problems caused by non-native or alien species are not new and since the 1980s the contracting parties - by ratifying the Convention on the Conservation of European Wildlife and Natural Habitats (also known as Bern Convention) - have to strictly control the introduction of non-native species (Conseil de l'Europe 1979). But the extent of non-native species is going on unimpaired. Officially, Luxembourg lists 7 vascular plant species as invasive and problematic in its National Plan for Nature Conservation (Luxembourg Government 2007): *Ambrosia artemisiifolia*, *Fallopia japonica*, *Fallopia sachalinensis*, *Helianthus tuberosus*, *Heracleum mantegazzianum*, *Impatiens glandulifera* and *Senecio inaequidens*.

Invasive alien species (IAS) are affecting numerous natural habitats and constitute a threat to fragile ecosystems. Biological invasions are one of the main drivers of biodiversity loss, but they also cause high economic costs, mainly in agriculture, forestry and fisheries and, in some cases, constitute a serious prejudice to human health. These costs are estimated to be at least EUR 12 billion per year in Europe alone (EEA 2012). Target 5 of the EU biodiversity strategy for 2020 states: "By 2020, Invasive Alien Species

and their pathways are identified and prioritised, priority species are controlled or eradicated, and pathways are managed to prevent the introduction and establishment of new IAS." (European Commission 2011). Even if international standards are about to be elaborated (Brunel et al. 2010), the risk assessment is mainly made on national levels.

Risk assessments are efficient tools to enable decision makers to develop legislation, policy and management strategies, but detailed risk assessment methods for IAS are quite labour-intensive and there is a wide range of scientific approaches. For the different black and watch lists the assessment criteria can be more or less extensive, occasionally including economic impacts and/or health related aspects (Genovesi & Scalera 2007, Essl et al. 2008, 2011). One of the approaches that enables an expert group to evaluate the potential risk of the different species in a reasonable amount of time is the Invasive Species Environmental Impact Assessment (ISEIA) elaborated by the Belgian Forum on Invasive Species (BFIS) (Branquart 2009). This approach, commonly known as the ISEIA Protocol, has been applied to invasive alien vascular plants in Luxembourg in the frame of the present study.

2. Methods

In 2012, the consultancy firm EFOR-ERSA was contracted by the department of Ecology of the National Natural History Museum in Luxembourg (NNHM) to establish a list of all the neophytes present in Luxembourg and/or occurring and creating problems in at least one of the three adjacent countries. The result was a list of 65 plant species. The nomenclature of the vascular plants follows Lambinon & Verloove (2012).

As far as available, the following information has been gathered for the assessment process:

a) General information: scientific name, family, synonyms, common name, French name, German name, group, origin, habitat, introduction.

b) Invasiveness: reproduction in the wild, dispersion potential, dispersion by seeds and/or vegetatively, places where the species is already invasive, additional information on invasiveness.

c) Situation in Luxembourg: first documented observation in the wild, observations in the Recorder database of the NNHM, distribution maps, invasion stage, spatial distribution, establishment potential in Luxembourg.

d) Impacts: impacts on species, competition, disease transmission, genetic effects, impacts on ecosystems, physical alteration, natural succession, impacts on public health, economic impacts, additional information on impacts.

e) Data sources and references.

A botanical expert group, convened on initiative of the department of Ecology of the NNHM, was invited to evaluate this draft list in compliance with the ISEIA Protocol (Branquart 2009). The expert group attended 4 half-day meetings: 7.11.2012, 13.12.2012, 24.01.2013, 7.02.2013. The following persons attended the expert group: Sandra Cellina, Guy Colling, Thierry Helminger, Pierre Kirsch, Yves Krippel, Emmanuel Kunsch, Jim Meisch, Jacques Mersch, Georges Moes, Manou Pfeiffenschneider, Christian Ries, Simone Schneider, Corinne Steinbach, Marc Thiel and Tania Walisch.

The environmental impact of non-native species is assessed in a standard, objective and transparent way through a simplified protocol which consists of four sections matching the last steps of the invasion process, i.e. the potential for spreading and colonising natural habitats as well as the adverse impacts on native species and ecosystems:

a) dispersion potential / invasiveness: potential of an organism to spread in the environment by natural means and/or by human assistance;

b) colonisation of high conservation value habitats: potential of a species to colonise habitats with high conservation value (irrespective of its dispersal capacities), based on habitat preference information from native and invaded areas;

c) adverse impacts on native species: potential of a species to cause species replacements through different mechanisms;

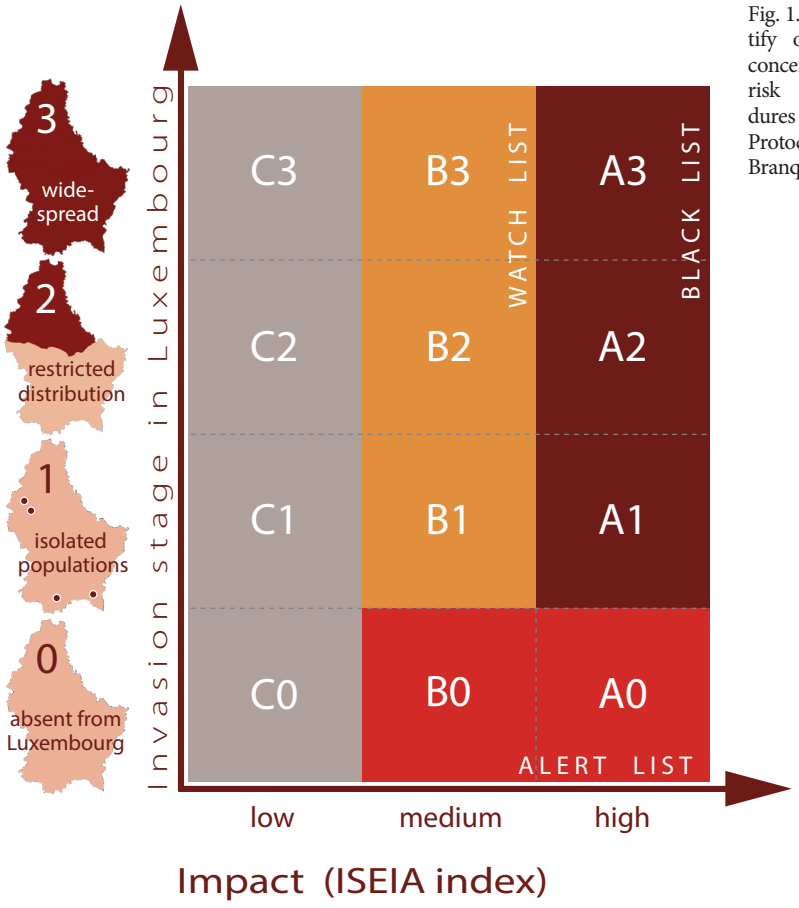

Fig. 1. List system to identify organisms of most concern in the frame of risk assessment procedures using the ISEIA Protocol (adapted after Branquart 2009: 1).

d) alteration of ecosystem function: potential of a species to alter native ecosystem processes and structures in ways that significantly decrease native species ability to survive and reproduce.

Scores for each section are based on organisms' history of impact in neighbouring areas together with their ecological profiles according to the following scale: low risk (1), medium risk (2), high risk (3). When data is insufficient, the following alternative scale is used: unlikely (1), likely (2), deficient data (0).

The sum of the 4 scores allows assigning the species to one of the following categories:

4-8 = C (no list attribution)
9-10 = B (watch list)
11-12 = A (black list)

Potential watch or black list species not occurring in Luxembourg are assigned to the alert list.

The combination with the present-day spatial distribution of the species produces the ISEIA index of a precise species as can be seen in Fig. 1.

During the assessment process, 10 species - with no or little ecological impact in the adjacent regions, no documentation in both literature and databases for Luxembourg and no occurrence confirmed by a member of the expert group - have been excluded. These 10 taxa are: *Cyperus eragrostis*, *Echinocystis lobata*, *Elaeagnus angustifolia*, *Fraxinus pennsylvanica*, *Ludwigia grandiflora*, *Ludwigia peploides*, *Lysichiton americanus*, *Persicaria wallichii*, *Rhododendron ponticum* and *Spiraea tomentosa*.

Table 1. Risk assessment of 55 non-native vascular plant taxa for Luxembourg. Column "Evaluation": 1st score = dispersion potential or invasiveness; 2nd = colonization of high conservation value habitats; 3rd = adverse impact on native species; 4th = alteration of ecosystem functions. ISEIA index: A = high impact; B = medium impact; C = low impact; 0 = absent from Luxembourg; 1 = isolated populations; 2 = restricted distribution; 3 = widespread.

Species	Family	Evaluation	Spatial distribution	ISEIA index
Acer negundo	Aceraceae	1+1+1+1=4	isolated	C1
Ailanthus altissima	Simaroubaceae	1+1+1+1=4	isolated	C1
Ambrosia artemisiifolia	Asteraceae	2+1+2+1=6	isolated	C1
Amelanchier lamarckii	Malaceae	1+2+2+1=6	isolated	C1
Aster lanceolatus	Asteraceae	2+2+2+1=7	isolated	C1
Aster novi-belgii	Asteraceae	1+1+1+1=4	isolated	C1
Azolla filiculoides	Azollaceae	2+2+2+2=8	isolated	C1
Bidens frondosa	Asteraceae	2+2+2+1=7	restricted	C2
Buddleja davidii	Buddlejaceae	2+2+2+2=8	restricted	C2
Bunias orientalis	Brassicaceae	1+2+1+1=5	isolated	C1
Claytonia perfoliata	Portulacaceae	1+1+1+1=4	isolated	C1
Conyza canadensis	Asteraceae	3+2+2+1=8	widespread	C3
Cornus sericea	Cornaceae	1+1+1+1=4	isolated	C1
Cotoneaster horizontalis	Malaceae	1+2+2+2=7	isolated	C1
Crassula helmsii	Crassulaceae	2+3+2+3=10	absent	B0
Duchesnea indica	Rosaceae	2+1+2+1=6	isolated	C1
Egeria densa	Hydrocharitaceae	2+3+3+3=11	absent	A0
Elodea canadensis	Hydrocharitaceae	3+3+3+3=12	widespread	A3
Elodea nuttallii	Hydrocharitaceae	3+3+3+3=12	isolated	A3
Epilobium ciliatum	Onagraceae	3+3+2+1=9	widespread	B3
Epimedium alpinum	Berberidaceae	1+1+1+1=4	isolated	C1
Erigeron annuus	Asteraceae	2+2+1+1=6	isolated	C1
Fallopia ×bohemica	Polygonaceae	2+2+3+3=10	isolated	B1
Fallopia japonica	Polygonaceae	3+3+3+3=12	widespread	A3
Fallopia sachalinensis	Polygonaceae	2+2+3+3=10	isolated	B1
Helianthus tuberosus	Asteraceae	2+3+2+2=9	restricted	B2
Heracleum mantegazzianum	Apiaceae	3+3+2+3=11	widespread	A3
Hydrocotyle ranunculoides	Apiaceae	2+3+3+3=11	absent	A0
Impatiens glandulifera	Balsaminaceae	3+3+2+3=11	widespread	A3
Impatiens parviflora	Balsaminaceae	3+2+1+1=7	widespread	C3
Lagarosiphon major	Hydrocharitaceae	2+3+3+3=11	absent	A0
Lemna minuta	Lemnaceae	2+3+2+3=10	absent	B0
Lupinus polyphyllus	Fabaceae	1+2+2+2=7	isolated	C1
Mahonia aquifolium	Berberidaceae	3+2+2+2=9	isolated	B1
Mimulus guttatus	Scrophulariaceae	1+2+1+1=5	isolated	C1
Myriophyllum aquaticum	Haloragaceae	2+2+3+3=10	isolated	B1
Myriophyllum heterophyllum	Haloragaceae	2+3+2+3=10	absent	B0
Parthenocissus spp.	Vitaceae	1+1+1+1=4	isolated	C1
Pinus nigra	Pinaceae	2+3+3+3=11	isolated	A1
Populus ×canadensis	Salicaceae	2+2+2+1=7	widespread	C3
Prunus laurocerasus	Rosaceae	2+2+0+1=5	isolated	C1
Prunus serotina	Rosaceae	2+2+3+3=10	isolated	B1
Quercus rubra	Fagaceae	1+1+1+1=4	isolated	C1
Rhus typhina	Anacardiaceae	2+2+3+3=10	isolated	B1

Robinia pseudoacacia	Fabaceae	2+3+3+3=11	widespread	A3
Rosa rugosa	Rosaceae	1+1+1+1=4	isolated	C1
Rudbeckia laciniata	Asteraceae	2+2+2+2=8	isolated	C1
Senecio inaequidens	Asteraceae	3+2+2+3=10	restricted	B2
Solidago canadensis	Asteraceae	3+2+3+3=11	restricted	A2
Solidago gigantea	Asteraceae	3+2+3+3=11	restricted	A2
Spiraea alba	Rosaceae	1+1+3+2=7	isolated	C1
Spiraea ×billardii	Rosaceae	2+2+3+2=9	absent	B0
Spiraea douglasii	Rosaceae	2+2+3+2=9	absent	B0
Spirodela polyrhiza	Lemnaceae	2+3+3+1=9	widespread	B3
Syringa vulgaris	Oleaceae	1+2+2+2=7	isolated	C1

3. Results

The results of the assessment of the 55 non-native species are presented in table 1. While 28 taxa are considered of low ecological impact and are consequently not included in any list (C), 9 species are regarded as being of high ecological impact and are assigned to the black list: *Elodea canadensis* (A3), *Elodea nuttallii* (A3), *Fallopia japonica* (A3), *Heracleum mantegazzianum* (A3), *Impatiens glandulifera* (A3), *Pinus nigra* (A1), *Robinia pseudoacacia* (A3), *Solidago canadensis* (A2) and *Solidago gigantea* (A2).

The watch list includes 10 taxa of medium impact: *Epilobium ciliatum* (B3), *Fallopia ×bohemica* (B1), *Fallopia sachalinensis* (B1), *Helianthus tuberosus* (B2), *Mahonia aquifolium* (B1), *Myriophyllum aquaticum* (B1), *Prunus serotina* (B1), *Rhus typhina* (B1), *Senecio inaequidens* (B2) and *Spirodela polyrhiza* (B3).

The following 8 species are not yet present in Luxembourg, but cause already - at least locally - major problems in neighbouring areas; they have been assigned to the alert list: *Crassula helmsii* (B0), *Egeria densa* (A0), *Hydrocotyle ranunculoides* (A0), *Lagarosiphon major* (A0), *Lemna minuta* (B0), *Myriophyllum heterophyllum* (B0), *Spiraea ×billardii* (B0), *Spiraea douglasii* (B0).

4. Discussion

The assessment was made by strictly applying the ISEIA-Protocol and did not take into consideration economic impacts and health related aspects. In some countries, e.g. in Switzerland, health related aspects are a major criterion in the assessment process (Weber et al. 2005). Some of the species, i.e. *Heracleum mantegazzianum* and *Ambrosia artemisiifolia* can cause prejudices to human health, and the latter species might have been assigned to the watch list or the black list if the assessment criteria would have been different.

While the applied method appears effective to assess a range of taxa, highlighting pretty well the most problematic invasive alien species in a given region, we have to keep in mind that we often deal with patchy knowledge which needs to be regularly updated on a broader data basis. The evaluation of the impact of invasive species on the environment remains valid only for a limited period of time. On the one hand the knowledge about the actual distribution of a species and its effects on other species or ecosystems is often very low, on the other hand changes can occur quite rapidly. It is therefore essential to continuously update such lists (Kowarik 2010: 398). This underlines the need for initial inventories for new alien species and regular updates of former inventories (e.g. Pfeiffenschneider 2007, Welter et al. 2008, Glesener et al. 2009, Thommes 2009, Krippel & Richarz 2013).

Furthermore, follow-up work like the monitoring of river banks of major rivers of Luxembourg annually implemented since 2010 (Gräser 2010, 2011, 2012) should not only be continued, but should be extended to other habitat types with a high potential for the establishment of

IAS, e.g. for the Luxembourg railway network, which is being investigated in 2013, or roadsides.

Only such accurate and up to date data will enable the competent authorities on a national and regional level to prioritize, elaborate and implement management plans for specific IAS, which will be particularly relevant in the light of upcoming EU regulations like the Commission proposal for EU legislation to address invasive alien species and protect biodiversity: "The proposal seeks to address the problem of invasive alien species in a comprehensive manner so as to protect native biodiversity and ecosystem services, as well as to minimize and mitigate the human health or economic impacts that these species can have. The proposal is for three types of interventions; prevention, early warning and rapid response, and management. A list of invasive alien species of Union concern will be drawn up with Member States using risk assessments and scientific evidence." (European Commission 2013).

Recent observations of IAS in Luxembourg and its bordering regions, particularly concerning those species listed in both watch and alert lists, should be made publicly available as soon as possible, e.g. in the Recorder database of the Luxembourg National Museum for Natural History (Colling et al. 2007) and in the biennial publication of the floristic news entitled "Notes floristiques" in the present Bulletin series (e.g. Krippel & Colling 2012).

This first risk assessment based on the ISEIA Protocol in Luxembourg having been completed for vascular plants, the remaining neophyta, the neozoa and the neomyceta still need to be assessed in subsequent studies.

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