Environmental impact assessment and black, watch and alert list classification after the ISEIA Protocol of vertebrates in Luxembourg

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Abstract. The environmental impact of 25 invasive alien vertebrate species in Luxembourg has been assessed in accordance with the Belgian ISEIA Protocol. 3 species of high ecological impact have been assigned to a black list: the fish bighead goby (*Neogobius kessleri)* and round goby (*N. melanostomus*), and the bird Canada Goose (*Branta canadensis*). 5 species of medium impact have been added to a watch list: the bird Egyptian Goose (*Alopochen aegyptiacus*), the mammals North American beaver (*Castor canadensis*), fallow deer (*Dama dama*) and muskrat (*Ondatra zibethicus*), and the fish Zander (*Sander lucioperca*). 2 species not yet present in Luxembourg have been assigned to an alert list: the amphibian American bullfrog (*Rana catesbeiana*) and the mammal American mink (*Mustela vison*). The remaining 15 taxa of low ecological impact have not been included in any list.

Keywords. Risk assessment, ISEIA Protocol, biological invasions, invasive alien species, neobiota, neozoa, vertebrata, vertebrates, Luxembourg.

1. Introduction

More than 12'000 alien species have been documented by DAISIE (Delivering Alien Invasive Species Inventory for Europe), a three year research project funded by the European Union that provides new knowledge on biological invasions in Europe (Anonymous 2014). The DAISIE database names 265 fish, 37 amphibians, 73 reptiles, 175 birds and 117 mammals that are considered an invasive alien in at least one European country or region. Reliable knowledge concerning alien species in Luxembourg remains quite patchy.

The problems caused by non-native or alien species are not new. The contracting parties of 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 since the 1980s (Anonymous 1979). Nonetheless the dispersal of non-native species continues unimpaired.

Invasive alien species (IAS) are affecting numerous natural habitats and constitute a threat for fragile ecosystems. Biological invasions are one of the main drivers of biodiversity loss, cause high economic costs i.e. in agriculture, forestry and fisheries and, in some cases, constitute a serious hazard to human health. The economic, health related and management costs are estimated to be at least EUR 12 billion per year in Europe alone (Scalera et al. 2012). Target 5 of the EU biodiversity strategy

for 2020 reads: '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' (Anonymous 2011). Even if international standards are about to be elaborated (Brunel et al. 2010), risk assessments are mainly made on national level.

While Luxembourg lists 7 vascular plant species as invasive and problematic in its National Plan for Nature Conservation (Anonymous 2007), no animal species are cited in that context.

Risk assessments are efficient tools enabling 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 are 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 enabling 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 first been applied in Luxembourg to assess vascular plants (Ries et al. 2013). The present study presents the application of the ISEIA Protocol to classify invasive alien vertebrates in Luxembourg.

2. Methods

In 2013, the consultancy firm EFOR-ERSA was contracted by the department of Ecology of the NNHM in Luxembourg to establish a list of invasive vertebrates present in Luxembourg and/or occurring and creating problems in at least one of the three adjacent countries. The initial result was a compilation of 12 species (5 birds, 7 mammals). The nomenclature of birds follows the AERC Taxonomic Recommendations.

The following information (subject to availability) was gathered for the assessment process:

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

2) Invasiveness: reproduction in the wild, dispersion potential, places where the species is already invasive, additional information on invasiveness.

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

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

5) Data sources and references.

Two expert groups, convened on the initiative of the department of Ecology of the NNHM, were invited to evaluate the draft list in compliance with the ISEIA Protocol (Branquart 2009):

Birds (Aves), 05.11.2013: Mikis Bastian, Gilles Biver, Sandra Cellina, Jean-Claude Heidt, Manou Pfeiffenschneider, Christian Ries.

Mammals (Mammalia), 05.11.2013: Sandra Cellina, Edmée Engel, Jan Herr, Manou Pfeiffenschneider, Frank Richarz, Christian Ries, Laurent Schley.

During this last session, the experts also suggested and assessed potentially invasive amphibians (Amphibia) and reptiles (Reptilia). A third meeting was held on November 18th with Max Lauff, biologist at the National Water Agency, to evaluate the potential impact of alien fish species.

In total 26 taxa have been assessed: 1 amphibian, 4 birds, 9 mammals, 10 fish and 2 reptiles.

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

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

2) 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;

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

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

Scores for each section were based on the organism's history of impact in neighbouring areas together with its ecological profile according to the following scale: low risk (1), medium risk (2), high risk (3). When data was insufficient, the following alternative scale was used: unlikely (1), likely (2), deficient data (0).

The sum of the four 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 were assigned to the alert list.

The combination of these scores and the actual spatial distribution of each species produced the ISEIA index as can be seen in Fig. 1. The assessment was made by strictly applying the ISEIA protocol and did not take into consideration economic impacts or health related aspects.

3. Results

The results of the assessment of the 26 non-native taxa are compiled in Table 1. While 16 taxa were considered of low ecological impact and are consequently not included in any list (C), 3 species are regarded as being of high ecological impact and were assigned to the black list. The watch list includes 5 species of medium impact. Finally, 2 species that are not yet present in Luxembourg, but already cause major problems in neighbouring areas - at least locally - were assigned to the alert list.

Pisces

Ten fish species were evaluated in accordance with the ISEIA protocol. Two species, only present in Luxembourg for a few years, were assigned to the black list (*Neogobius kessleri* - A2 and *Neogobius melanostomus* - A2). One species, present mainly in the Moselle and the artificial lake of Esch/Sûre was added to the watch list (*Sander luciopera* - B2) (Troschel 2010). The other seven species were not added to any list (C0, C1, C2).

Amphibia

One amphibian, the American bullfrog (*Rana catesbeiana*) was assigned to the alert list (A0). Once established, the species is known to have enormous impacts on native ecological communities.

Reptilia

Native to southern parts of Northern America, both turtle subspecies considered in the risk assessment, the red-eared slider (*Trachemys scripta elegans*) and the yellow-bellied slider (*Trachemys scripta scripta*), were not assigned to any list (C1). The species are considered to have an important negative impact on native species (predation especially of amphibians). However because of their limited dispersal potential (no reproduction observed in the wild in Luxembourg so far) and an impact on ecosystem processes and structures that is considered negligible, the overall impact of these species on biodiversity is esteemed to be low.

Aves

Four bird species were assessed by the expert group. The Canada goose (*Branta canadensis*) was added to the black list (A1), the Egyptian goose (*Alopochen aegyptia-*
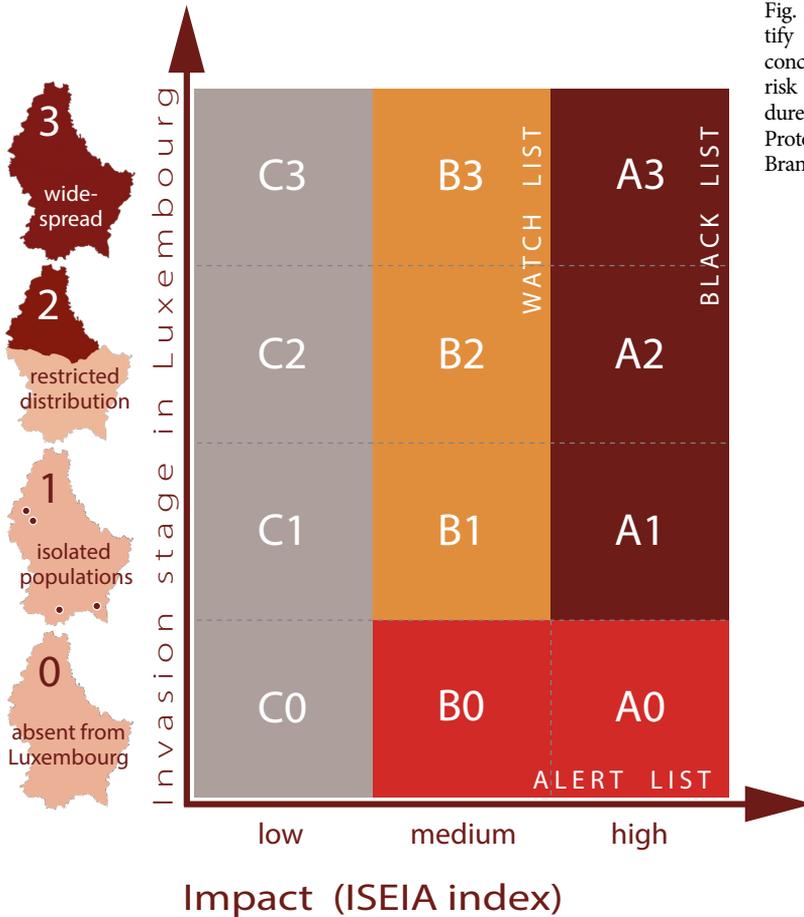
Fig. 1. List system to identify organisms of most concern in the frame of risk assessment procedures using the ISEIA Protocol (adapted after Branquart 2009: 1).

The axes of the figure are labelled: vertical axis "Invasion stage in Luxembourg" with levels 3 (wide-spread), 2 (restricted distribution), 1 (isolated populations), 0 (absent from Luxembourg); horizontal axis "Impact (ISEIA index)" with levels low, medium, high. Cells: C3, B3, A3; C2, B2, A2; C1, B1, A1; C0, B0, A0. Lists indicated: WATCH LIST, BLACK LIST, ALERT LIST.

cus) to the watch list (B3). Because of their low impact on biodiversity, Mandarin duck (*Aix galericulata*) and Ring-necked parakeet (*Psittacula krameri*) were not included in any list (C0). Both species are considered as not established in Luxembourg.

The Bar-headed goose (*Anser indicus*) was excluded from the original list, as the few birds observed in Luxembourg escaped from captivity and are not breeding. The inclusion of another bird species - the Ruddy duck (*Oxyura jamaicensis*) - was considered but abandoned because both the Ruddy duck itself and the european White-headed duck (*Oxyura leucocephala*) for which the Ruddy duck is considered a serious threat (Cranswick & Hall 2010) are absent from Luxembourg and its neighbouring regions.

Mammalia

The expert group added two species, the North American beaver (*Castor canadensis*) and the Sika deer (*Cervus nippon*), to the original list of potentially invasive mammals resulting in nine mammals being assessed.

The American mink (*Mustela vison*), trapped once in Luxembourg in 1993 (Schley 2001), was included in the alert list (A0). Four species were added to the watch list: *Castor canadensis* (B1), *Cervus nippon* (B1), which was first reported for Luxembourg in 2012 (Cellina & Schley 2014), *Dama dama* (B2) and *Ondatra zibethicus* (B3). *Myocastor coypus* (C0), which lacks a secure detection in Luxembourg (Schley et al. 2001)*, Nyctereutes procyonoides* (C0), *Ovis aries* (C2) and *Procyon lotor* (C3) were not included in any list.

Table 1. Risk assessment of 25 non-native vertebrates 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
AMPHIBIA				
Rana catesbeiana	Ranidae	3+3+3+3=12	absent	A0
AVES				
Aix galericulata	Anatidae	3+1+1+1=6	isolated, not established	C0
Alopochen aegyptiacus	Anatidae	3+3+2+1=9	widespread	B3
Branta canadensis	Anatidae	3+3+3+3=12	isolated	A1
Psittacula krameri	Psittacidae	3+1+1+1=6	isolated, not established	C0
MAMMALIA				
Castor canadensis	Castoridae	3+3+2+1=9	isolated	B1
Cervus nippon	Cervidae	3+2+3+1=9	isolated	B1
Dama dama	Cervidae	3+3+2+1=9	restricted	B2
Mustela vison	Mustelidae	3+3+3+2=11	absent	A0
Myocastor coypus	Echimyidae	3+2+1+1=7	absent	C0
Nyctereutes procyonoides	Canidae	3+3+1+1=8	absent	C0
Ondatra zibethicus	Muridae	3+3+3+1=10	widespread	B3
Ovis aries	Bovidae	3+2+1+1=7	restricted	C2
Procyon lotor	Procyonidae	3+2+2+1=8	widespread	C3
PISCES				
Ameiurus nebulosus	Ictaluridae	1+1+2+2=6	isolated	C1
Carassius gibelio	Cyprinidae	2+2+1+1=6	isolated	C1
Lepomis gibbosus	Centrarchidae	2+2+2+2=8	restricted	C2
Neogobius kessleri	Gobiidae	3+3+3+2=11	restricted	A2
Neogobius melanostomus	Gobiidae	3+3+3+2=11	restricted	A2
Oncorhynchus mykiss	Salmonidae	1+2+1+1=5	restricted	C2
Pimephales promelas	Cyprinidae	1+1+1+1=4	absent	C0
Pseudorasbora parva	Cyprinidae	1+1+1+1=4	isolated	C1
Salvelinus fontinalis	Salmonidae	1+1+1+1=4	isolated	C1
Sander lucioperca	Percidae	2+2+3+2=9	restricted	B2
REPTILIA				
Trachemys scripta elegans	Emydidae	1+2+3+1=7	isolated	C1
Trachemys scripta scripta	Emydidae	1+2+3+1=7	isolated	C1

4. Discussion

The results show that at present only a few vertebrate species are to be considered a threat to biodiversity in Luxembourg. However, current knowledge is often patchy and regular updates on a broader data basis are necessary because changes in the impact of an invasive species can occur quite rapidly. It is therefore essential to continuously update such lists (Kowarik 2010: 398). This underlines the need for inventories of known and new alien species. While such inventories have been conducted for vascular plants and for fish (monitoring in accordance with the Water framework directive), no equivalent studies exist for other alien animal species in Luxembourg.

Only accurate and up-to-date data will enable the competent authorities to prioritize, elaborate and implement management plans for specific IAS, which will be

particularly relevant in the light of upcoming EU regulations such as the Commission proposal for EU legislation to address invasive alien species and protect biodiversity (Anonymous 2013).

Three of the treated species - *Myocastor coypus, Oncorhynchus mykiss, Trachemys scripta elegans* - are on the list of the "One Hundred of the World's Worst Invasive Alien Species" as defined by the Global Invasive Species Database (Invasive Species Specialist Group 2014). These species have been recognised as a major threat to biodiversity as well as to agriculture and other human interests on a global scale. Therefore the monitoring of the population of these species is essential.

Observations of IAS in Luxembourg and its bordering regions, particularly of 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).

The first risk assessments based on the ISEIA Protocol in Luxembourg encompassing only vascular plants (Ries et al. 2013) and vertebrates, further taxonomic groups still need to be assessed in subsequent exercises.

Acknowledgements

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