Input paper for the interregional workshop on the assessment of ecosystem vulnerability to invasive alien species

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Index

Introduction

According to definition, an alien species is a species outside its normal distribution range. In addition, according to Convention on Biological Diversity (2009), to become invasive the species must outcompete the native organisms for food and habitat, and successfully spread to new environment, increasing its population. It means that a species must pass through a number of transitions which, firstly, includes entry in a pathway, secondly, introduction, and, finally, establishment (Keller et al., 2011). The invasive alien species are non-native to an ecosystem; they spread widely, have negative impacts like disrupting the local ecology, having adverse effects on human health and producing serious economic and social effects. Invasive alien species decrease or eliminate native species and change local ecosystems and ecosystem functions, thus contributing to the loss of biodiversity and species extinctions (Convention on Biological Diversity, 2009).

Biological invasions are considered to be one of the greatest threats to the biodiversity and natural ecosystems that is related with increased number of pathways of introduction and spread of species. Also global change is one of the drivers for biological invasions. As the result, all biomes throughout the world are increasingly affected by invasive alien species which could cause complex and often long-term direct and indirect impacts (Pyšek et al., 2020).

It has been pointed out that multidisciplinary collaboration and integrated approaches are important to reduce the impacts of invasive alien species (Pyšek et al., 2020). Thereby, sharing of new knowledge at territorial level between regional authorities as well as cooperation at international level may contribute to viable solutions and answers to various economic, social and environmental problems which are also associated with policy. For that to happen, collaboration between researchers, policymakers, stakeholders and the general public is essential (Packer et al., 2016). The Interreg Europe programme is one of the ways providing opportunity to tackle the above mentioned problems related to invasive species (Protecting European biodiversity from invasive alien species, 2021).

The aim of this study is to develop guidelines that will be the main source of knowledge to promote further work in international working groups related to assessment of ecosystem vulnerability to invasive species. It aims to demonstrate the current situation

concerning the invasive species in Latvia and the species of Union concern (EU). The guidelines contain following sections as the main source for topic issues of interregional workshop: an overview of the recent studies on invasive species in EU and Latvia, the main regulations concerning the invasive species in EU and Latvia, the climate and territorial aspects in Latvia, as well as an overview about environmental impact assessment of invasive alien species (IAS). In connection with these guidelines, possible indicative topics for further work organization will be compiled.

General information about invasive species

Biological invasions in Europe: Current situation

Biological diversity in Europe has become one of the most important subjects in environmental policy (Convention on Biological Diversity, 2020). It is most likely because of dramatic changes in ecosystems over the last century (Bengtsson et al., 2000), caused by different pressures such as habitat change, climate change, overexploitation, pollution and invasion of alien species. At the moment, invasive species are recognized as one of the major drivers of biodiversity change (Keller et al., 2011). In the last decade, the EU is working to find a different solution how to minimize invasive species' distribution and their negative impact to ecosystems. Although much has been achieved there is still need to find answers that will help to effectively manage the spread and impact of invasive alien species. However, even though policy and science in Europe have been collaborating effectively and on a high level compared to other regions (Packer et al., 2016), the level of knowledge about invasive species differs significantly between different European countries.

As the result of Europe being a center for international trade for many centuries, the large number of non-native species has been established already since 1500 (Keller et al., 2011; GBIF, 2020). The number and diversity of alien species in Europe have been increasing continuously over the last 200 years, and it is expected that due to human economical activities the number of non-native species will continue to grow in the future (Keller et al., 2017).

At the moment, there are more than 12,000 invasive taxa, mostly species, including terrestrial and aquatic free living, as well as parasitic organisms (GBIF, 2020). According to the European Commission website, 14,000 species are identified as alien species for Europe, of which several are invasive alien species (Assessing the economic cost of invasive alien species, 2019). The most part of alien species in Europe is represented by vascular plants, and Europe is one of the continents with the highest number of naturalized alien vascular plant species. Also the richness of alien crustaceans is high compared to other regions (Pyšek et al., 2017). Many of alien species are invasive and they are affecting all European habitats (Keller et al., 2017).

The EU Regulation no. 1143/2014 that has been adopted by European Parliament and the Council coordinates a set of actions to prevent, control and mitigate the adverse impact of invasive alien species on biodiversity (Regulation (EU) No 1143/2014, 2014). This list of Invasive Alien Species of Union concern has been amended twice - in 2017 and 2019. Currently this regulation identifies 66 invasive alien species of EU concern, from which 36 are vascular plant species, but 30 – animal species (Commission Implementing Regulation (EU) 2017/1263, 2017; Commission Implementing Regulation (EU) 2019/1262, 2019). These species are recognized as a significant threat to the biodiversity and ecosystem services in the EU, and they could cause significant ecological and socio-economic damages (Assessing the economic cost of invasive alien species, 2019).

Biological invasions in Latvia: Current situation

Animals

During last ten years increased attention has been directed towards studying introduced animal species. Until then and also now mainly information about their distribution and detection in Latvia has been published (Ozolinš and Pilāts, 1995; Tauriņš, 1982; Timm et al., 1998; Zorenko, 2008; Pupiņš, 2007; Pupiņš and Pupiņa, 2011; Gudžinskas et al., 2015; Pupiņa et al., 2015; Aleksejevs, 2015, 2019; Aleksejevs and Birzaks, 2020; www.putni.lv), but there is little information about specific species and their impact (Lapiņa, 1966; Opermanis et al., 2001; Bagrade et al., 2016; Čeirāns and Pupiņš, 2019).

More attention is paid to those alien species who have caused problems in Latvia or are still causing them. These are *Arion vulgaris*, *Perccottus glenii* and *Trachemys scripta*. There is information about distribution of *Arion vulgaris* and its control, and also a plan for the control of the species has been developed (Jakubāne et al., 2016; Pilāte et al., 2018; Zolovs et al., 2020). There are guidelines developed for the control measures of *Perccottus glenii* and *Trachemys scripta elegans,* and a study about the impact of these IAS on the local amphibian and turtle species has been carried out (Čeirāns et al., 2018; Čeirāns and Pupiņš, 2019; Čeirāns et al., 2019). Since 2018 there is a monitoring of *A.vulgaris*, *Perccottus glenii*, *Pacifastacus leniusculus*, *Orconectes limosus* (Nature Conservation Agency, 2020). In 2020 Latvian Institute of Aquatic Ecology has performed an analysis of pathways of introduction and distribution of *Eriocheir sinensis* as the first step in developing an action plan on priority pathways (Nature Conservation Agency, 2020).

Plants

There is abundance of published literature and herbariums of alien flora in Latvia (Evarts-Bunders and Evarte-Bundere, 2020), and during the last decades several studies have been published about the occurrence of invasive alien species in Latvia. Mostly the research is related to invasive alien species' distribution in specific habitats or territories (Priede, 2008; Gavrilova et al., 2011; Rutkovska et al., 2013; Rutkovska et al., 2017). Some of the research is focused only on specific taxon studies, for example, species like *Bunias oreintalis* (Laiviņš, 2006), *Sorbaria sorbifolia* (Laviņš et al., 2008), *Solidago* species (Priede, 2008), and species from family *Brassicaceae* (Rurāne et al., 2018) have been studied. Also international projects have been implemented studying the invasive species along the border between Latvia and Lithuania (Gudžinskas et al., 2014). As the results of the studies differ, there are different criteria used to prove the invasiveness of species, and, consequently, different lists. At the same time Evarts-Bunders and Evarte-Bundere (2020) in their research indicate that the list of alien species has been critically revised and edited in 1999, and that update is critically needed. Currently there is only one plant species –

Heracleum sosnowsky - in the official list of invasive species, and no other plant species have been included (Regulations of the Cabinet of Ministers No 588, 2008).

At this moment, the actual list of alien species in Latvia includes 640 taxa with different levels of invasiveness comprising 33% of all Latvian flora. Of these, 35 species were included in the inventory of priority invasive species, from which 15 species require priority monitoring (species from 'Black list') and 20 species - monitoring ('Grey list'). Those invasive species, which have been introduced in Latvia, have their native range in North America, Europe, Eurasia, Mediterranean, Western Europe, and Asia. In Latvia these species have invaded mostly anthropogenic sites, forests and uncultivated lands (Evarts-Bunders and Evarte-Bundere, 2020). According to NOBANIS (North European and Baltic Network on Invasive Alien Species, 2021) data, a lower number of plant species (370) is considered as alien for Latvia. Of these, 29 species are considered invasive and 12 - potentially invasive in Latvia. Transport, agriculture, horticulture and landscaping have been considered as the main pathways of introduction of invasive alien plant species in Latvia (NOBANIS, 2021). Overall, there are many issues which still need to be improved and developed, for example, assessment of invasion extent and assessment of spreading speed, as well as development of possible methods for invasive species' control in the whole country (Evarts-Bunders and Evarte-Bundere, 2020).

Species of EU concern

Latvia as an EU member state is required to act in accordance with EU invasive alien species regulation and to perform all necessary measures to prevent intentional and unintentional introduction and distribution of the invasive alien species with particular attention to the species of EU concern. Today, there are approximately 797 alien species recorded in the territory of Latvia (Priede, 2014). Only a small part of these species are defined as invasive. Even more, from the list of invasive species of the EU List, only 11 species have been found in the wild in Latvia, namely two plant species – *Heracleum sosnowskyi* and *Impatiens glandulifera*,- and nine animal species - *Alopochen aegyptiacus, Eriocheir sinensis, Myocastor coypus, Nyctereutes procyonoides, Ondatra zibethicus,*

Orconectes limosus, Pacifastacus leniusculus, Perccottus glenii, Trachemys scripta (Table 1).

The introduction of the raccoon dog in Latvia started in 1948, the muskrat spread from the neighboring countries in the middle of 20th century (Tauriņš, 1982). During 60-80 years these species have spread in all territory of Latvia and occupied their ecological niche (Zorenko, 2008; State Forest Service, 2020). Nutrias were often kept in rural farms in the second half of the 20th century. During this time they were often spotted in the wild after escaping. Due to climatic conditions these animals have not established in the wild (Zorenko, 2008), but if the winters will grow warmer it will be possible. Keeping of nutrias in rural farms becomes popular again, and there is a trade of these animals (Klovāne, 2018). In the beginning of 20th century the introduction of *Eriocheir sinensis* started (Nature Conservation Agency, 2021).

Crayfish and *Perccottus glenii* are more recent incomers. *Pacifastacus leniusculus* was released in the wild intentionally in 1983 but in the end of 1990s *Orconectes limosus* it has been found in Latvia. The entry of the spiny cheek crayfish into Latvia is unclear. It can also be found in Lithuania, from where it may possibly have migrated to Latvian territory (Aleksejevs and Birzaks, 2020) Further spread of these species is facilitated by unsanctioned transporting and release in waterbodies (Nature Conservation Agency, 2021). *Perccottus glenii* was identified in the wild in 1974 (Pupiņa et al., 2015).

Two new invasive species have been identified during the last ten years – since 2006 observations of *Trachemys scripta* are being reported (Čeirāns et al., 2019) and in 2015 some specimens of *Alopochen aegyptiacus* were observed for the first time (www.putni.lv).

Part of the animal species that do not occur in the wild in Latvia are being kept in zoos, private collections, used in aquacultures, part of these are being kept in aquariums or as pets.

The plant species *Heracleum sosnowskyi* is native to the north of Caucasus and was introduced in Latvia in 1948. It was cultivated as a perspective forage plant species. Later it was also grown for ornamental purposes and beekeeping. Since then it has spread in almost all territory of the country and nowadays is one of the most dangerous invasive alien

species in Latvia. The second plant species *Impatiens glandulifera* originates from the western part of the Himalayas. The first record of this species in Latvia is dated with 1898, but a massive naturalization of this species started in the middle of 20th century. It was introduced as decorative plant species in the Baltic countries. Today it is included in the "Black list" of invasive species (Gudžinskas et al., 2014).

Part of the species (together nine plant species) of EU List are offered for sale in different nurseries and some aquatic plant species are also provided through aquarium clubs (Table 1). According to literature the species *Heracleum mantegazzianum* has been mentioned in flora of Latvia (Gavrilova and Šulcs, 1999) but has not been recently found in the wild. It is the same with the species *Ailanthus altissima* that has been included in atlas of Latvian woody plants, but at the same time it has only four records (Laiviņš et al., 2009).

Table 1

The occurrence of invasive species of European Union concern in the territory of Latvia

Plants		**Animals**	
Acacia saligna		*Acridotheres tristis*	
Ailanthus altissima	Trade	*Alopochen aegyptiacus*	Wild, Zoo
Alternanthera philoxeroides		*Arthurdendyus triangulatus*	
Baccharis halimifolia	Trade	*Callosciurus erythraeus*	
Cabomba caroliniana	Trade	*Corvus splendens Viellot*	
Cardiospermum grandiflorum		*Eriocheir sinensis*	Wild
Cortaderia jubata		*Herpestes javanicus*	Zoo
Elodea nuttallii		*Lepomis gibbosus*	
Gunnera tinctoria	Trade	*Lithobates (Rana) catesbeianus*	
Gymnocoronis spilanthoides		*Muntiacus reevesi*	Zoo
Heracleum mantegazzianum	Greenery	*Myocastor coypus*	Farms, Wild
Hydrocotyle ranunculoides		*Nasua nasua Linnaeus*	Zoo
Lagarosiphon major		*Nyctereutes procyonoides*	Wild
Lespedeza cuneata		*Ondatra zibethicus*	Wild
Ludwigia peploides		*Orconectes limosus*	Wild
Lygodium japonicum	Botanical garden	*Orconectes virilism*	
Lysichiton americanus	Trade	*Oxyura jamaicensis*	

Plants		**Animals**	
Myriophyllum aquaticum		*Pacifastacus leniusculus*	Wild
Andropogon virginicus	Trade	*Perccottus glenii*	Wild
Asclepias syriaca	Trade	*Plotosus lineatus*	
Ehrharta calycina		*Procambarus clarkii*	
Eichhornia crassipes	Trade	*Procambarus fallax*	
Heracleum persicum		*Procyon lotor Linnaeus*	Zoo, Pets
Heracleum sosnowskyi	Wild	*Pseudorasbora parva*	
Humulus scandens		*Sciurus carolinensis*	
Impatiens glandulifera	Wild	*Sciurus niger*	
Ludwigia grandiflora		*Tamias sibiricus*	Pets, Zoo
Microstegium vimineum		*Threskiornis aethiopicus*	
Myriophyllum heterophyllum		*Trachemys scripta*	Wild, Pets
Parthenium hysterophorus		*Vespa velutina*	
Pennisetum setaceum	Trade		
Persicaria perfoliata			
Prosopis juliflora			
Pueraria montana			
Salvinia molesta			
Triadica sebifera			

Assessment of ecosystem vulnerability to invasive alien species

Climate

Latvia is located in the temperate climate zone beside the Baltic Sea and Gulf of Riga, which mostly determine the climate in the country. The average annual air temperature is +6.4°C. The warmest month is July with average temperature +17.4°C and average maximum temperature +22.5°C. The coldest month is February with average temperature -3.7°C and average minimum air temperature -6.6°C. The annual precipitation in Latvia is 692 mm. The months with the highest precipitation are August and July, with an average precipitation of 77 and 76 mm, respectively, and the driest month is April with an average precipitation of 34 mm. The average relative humidity is 81%. There are 1700-2000 hours of sunshine annually, mostly in July, but the least amount in December. The

observed long-term data show that the climate in Latvia is changing, particularly in the last 50 years (Latvian Environment, Geology and Meteorology Centre, 2020).

Overall, the rise in air temperature has been observed, and therefore, the length of the growing season, as well as the number of summer days and of tropical nights has increased, while the number of frosty winter days and of days without thaw has decreased. The predictions of the climate change scenarios are showing that in the future these changes will be persistent. Also an increase of the atmospheric precipitation amount and intensity has been recorded during the last decades, especially in winter and spring seasons. Therefore, more frequent uncharacteristic and extreme weather conditions in Latvia may be expected (Avotniece et al., 2017).

Climate changes may affect introduction, colonization and spread of the invasive species. It is important to continue and broaden the research to understand how specific invasive species may behave under different climate change scenarios and which new species may emerge as invasive before the invasive species' responses are having ecological and economic implications (Hellmann et al., 2008).

Policy framework

EU regulation

Certain tools in the combat against invasive alien species have already been developed and described within a variety of existing EU legislations, research programs, action plans and other initiatives. For example, the Plant Health Directive 2000/29/EC, EU Wildlife Trade Regulations, Regulation on the Use of Alien and Locally Absent Species in Aquaculture are part of this framework. In addition to these regulations, however, there is an urgent need to pay more attention and to limit more strongly the invasive alien species' distribution and also to coordinate at European level actions which could be more effective than individual activities at the Member State level. With regard to this the EU has adopted Regulation (EU) 1143/2014 on Invasive Alien Species which entered into force on 1st January 2015. This IAS Regulations are fulfilling the Convention on Biological Diversity (Aichi Target 9 of the Strategic Plan for Biodiversity 2011 – 2020) and EU Biodiversity strategy (Action 16 of Target of the EU 2020). According to IAS Regulation a list of 66

invasive alien species of Union concern has been adopted, which is the core of this regulation. The main actions across the EU in relation to invasive alien species include three main measures: prevention, early detection and rapid eradication and management, providing internationally agreed hierarchical approach in the fight against invasive alien species (Invasive Alien Species, 2020).

Regulation in Latvia

Latvia as a member State of the EU has to take into consideration requirements of IAS Regulation of EU. At national level, the Ministry of Environmental Protection and Regional Development of the Republic of Latvia is responsible for the implementation of IAS Regulation (EU) into legislation and its integration into Latvian environmental policy. Currently five main regulations are related to invasive species' distribution in Latvia – two laws and three regulations of the Cabinet of Ministers (Ministry of Environmental Protection and Regional Development of the Republic of Latvia, 2020).

The introduction and release in the wild of individuals of species uncharacteristic to the natural conditions of Latvia is prohibited according to the Law on the Conservation of Species and Biotopes (2000). The Plant Protection Law (1999) defines the invasive plant species and outlines the responsibilities for identification of invasive plant species and limiting their distribution. According to the Plant Protection Law, the Regulations No. 467 of the Cabinet of Ministers and the Regulations No. 468 of the Cabinet of Ministers have been published. All three regulations of the Cabinet of Ministers – Regulations Regarding Restriction of the Distribution of Invasive Alien Plant Species No. 467; List of Invasive Plant Species No. 468; Regulation Regarding Restricting the Spread of the Invasive Alien Plant Species - *Heracleum sosnowskyi* Manden No. 559 - address only the invasive plant species (Environmental Protection and Regional Development of the Republic of Latvia, 2020).

Indirectly the invasions, alien species and/or invasive species have been mentioned in the following documents and policies in Latvia:

- Animal Protection Law;
- Administrative Violations Code;

- General Regulations on Protection and Use of Specially Protected Nature Territories, Regulations No. 264 of the Cabinet of Ministers;
- Methodology for the Risk Assessment of Genetically Modified Organisms, Regulations No. 1078 of the Cabinet of Ministers;
- Procedure for issuing permits for individuals of non-game wild animals, introduction of wild animals not characteristic to the nature of Latvia as well as reintroduction of species populations in nature, Regulation No.1165 of the Cabinet of Ministers;
- Procedures by which State and European Union Support is Granted to Agriculture in the Framework of Direct Support Schemes, Regulations No. 269 of the Cabinet of Ministers (European Commission, 2011);
- Procedures for ensuring international trade in endangered species of wild animals and plants, Regulations No. 133 of the Cabinet of Ministers.
- Hunting Rules No. 421 (A comparative assessment of existing policies on invasive species in the EU member states and in selected OECD countries, 2011).

The official list of invasive plant species currently includes only one species - the giant hogweed *Heracleum sosnowsky* Manden. In 2006 the control programme for giant hogweed *Heracleum sosnowsky* 2006-2012 was approved. Several institutions are responsible about the implementation of IAS Regulation (EU) – Nature Conservation Agency, State Plant Protection Service, State Forest Service, Food and Veterinary Service (Par invazīvajām svešzemju sugām un to kompetenču sadalījumu, 2019).

Planning and management

Today, with the rapid global increase in trade, travel, transport and tourism, preventive measures are the most effective defense against invasive alien species. The most common approach is to target individual species. For this purpose, the assessment of species' pathways has been identified as a very important element to prevent the species from entering the country. This method identifies the route and mechanisms of the introduction and spread of invasive alien species, thus helping to manage the risks that are

associated with invasive alien species in a particular geographic area (Wittenberg et al., 2005).

Identification of pathways requires that species' environmental impact assessment should be carried out, to identify the potential damage caused by invasive species. This assessment allows classifying invasive alien species according to their level of impact in the particular country. It could help to offer scientific background to prioritise actions needed to prevent introduction and mitigate the impact of invasive species, including improvement of policy. It is important to choose the appropriate method which has been already developed and adapted in other EU countries, thus collecting standardised information on alien species which are assumed to be detrimental to native biodiversity in Latvia (Guidelines for environmental impact assessment and list classification of non-native organisms in Belgium, 2009).

Therefore, the development of criteria and evaluation method for invasive species' environmental assessment is performed following Madsen et al. (2014), with some modifications. The scores' descriptions and explanations are according to Vanderhoeven et al. (2015). Supplemental information is added to some scores to adapt the system to the situation in Latvia. In total, four different variables of impact are used for invasive species' environmental assessment: dispersal potential and invasiveness, colonization of high conservation value habitats, adverse impacts on native species, and alteration of ecosystem functions (Table 2). Each variable is divided in semi-quantitate scores from 0 till 3 according to the magnitude of impact. Thus, the maximum score for one invasive species may reach 12. In result, according to the obtained score value, the analysed species may be divided in four risk groups: unknown risk species (total score 0); low risk species (total score 1-6); medium risk species (total score 7-9) and high risk species (total score 10-12). The information on invasive species with occurrence in Latvia has to be based on literature and on other data sources about territory of Latvia.

Table 2

Methodology of environmental impact assessment

I Dispersion potential or invasiveness	
0	Deficient data, no score
1	Invasions have not been documented (there is only expert opinion or observation in nature) or it is very low: the species does not spread in the environment because of poor dispersal capacities and low reproduction potential; the species is common in all territory of Latvia, the species has found its ecological niche and does not demonstrate invasiveness.
2	Moderate dispersion potential has been documented; dispersion potential is low, except when assisted by humans. The fecundity is medium or high. The species does not colonise remote places, except with human assistance. Natural dispersal rarely exceeds more than 1 km per year. The species can become locally invasive because of strong reproduction potential.
3	High dispersion and fecundity potential has been documented (high invasiveness); the species is highly fecund, can easily disperse through active or passive means over distances > 1 km per year and initiate new populations. Here plant species that take advantage of anemochory, hydrochory and zoochory should be considered.
II Colonisation of high conservation value habitats of EU	
0	Deficient data, no score
1	Colonization has not been documented (there is only expert opinion or observation in nature); the species does not spread in the environment or its reproduction potential is very low: colonisation is happening/the species colonise only man-made habitats.
2	Moderate colonisation has been documented; the colonisation is happening to habitats with low or a medium conservation value and the species may occasionally colonise high conservation value habitats.
3	High colonisation has been documented; the species often colonises high conservation value habitats (most of the sites of a given habitat are likely to

	be readily colonised by the species when source populations are present in the vicinity) and therefore poses a potential threat for red-listed species.
III Adverse impacts on native species	
0	Deficient data, no score
1	The parameter has not been documented (there is only expert opinion or observation in nature), the impact is low; the impact on native species is negligible; data from invasion histories suggest that the negative impact on native populations is negligible.
2	Moderate impact has been documented; The species is known to cause local changes, but effect is usually considered as reversible. It has been demonstrated that non-native species may cause local changes (<80%) in population abundance, growth or distribution of one or several native species, especially among common and ruderal species.
3	High impact has been documented; the species cause important local changes that mostly are irreversible; the development of non-native species often cause local severe (>80%) population declines and the reduction of species diversity. At the region scale the development of high risk species can be considered as a factor precipitating species decline, including rare species decline. Those alien species form long-standing populations and their impacts on native biodiversity are considered as hardly reversible.
IV Alteration of ecosystem functions	
0	Deficient data, no score
1	The changes has not been documented (there is only expert opinion or observation in nature) or the changes are small. The impact on ecosystem processes and structures is considered as negligible.
2	Moderate changes have been documented; the impact on ecosystem processes and structures is moderate and is considered as easily reversible.
3	Large changes have been documented. The impact on ecosystem processes and structures is strong and difficult to reverse.

In addition, the assessment of the establishment potential was calculated for invasive alien species, which were not recorded in Latvia. The scale from 1 to 5 was used according to the method of pathway prioritization in Belgium (Pathways of unintentional introduction and spread of IAS of Union concern in Belgium, 2018). The assessment is based on the information about species' natural range, population size, occurrence and survival in Latvia and their distribution in similar climatic conditions in other European countries. The maximum score of scale was 5 meaning that the particular species has been recorded in Latvia already for 50 years and is forming stable and vital populations. The score 1 means that establishment potential is very low, this most likely refers to the tropical and (sub) equatorial species.

Territorial aspect

The total area of Latvia is 64,589 km^2. It is situated on the shores of the Baltic Sea and the Riga Gulf with 496 km total length of coastline. Latvia has terrestrial borders with Estonia, Russia, Belarus and Lithuania and marine borders with Lithuania, Estonia and Sweden. Latvia has around 12.5 thousand rivers, including streams and large diches. Large part of Latvia's rivers have the source in one of the neighboring countries – Lithuania, Estonia, Belarus or Russia, therefore, the runoffs of rivers have transit nature. Lakes are common landscape elements in the country. In total, there are 2265 lakes with surface larger than 1 hectare. In addition, the country has about 800 reservoirs with water surface area at least 1 hectare. The territory of Latvia is located in the Great European Plain, and the elevation varies from 0 to 311.9 meters above the sea level. Twelve hills are more than 276 meters above the sea level high (Nikodemus et al., 2018).

During the cold season considerable part of precipitation falls as snow. The first snow cover is formed in November; on the shore of the Baltic Sea it usually forms only starting from the 3rd decade of November, but in Zemgale plain, Kurzeme highland and close to the Gulf of Riga – starting from the 2nd decade of November. The earliest formation of snow cover occurs in Vidzeme highland and regions to the north, Eastern Latvia lowland and Latgale highland. Stable snow cover is formed from December to January. The average number of days with the snow cover increases in the west-east direction – from 62 days in

Rucava on the shore of the Baltic Sea to 133 days in Alūksne highland, and the number of days with stable snow cover varies from 50 to 110 days. There is considerable variation in the annual characteristics of the snow cover. The thickest snow cover, on average, is formed during the 3rd decade of February (from 7 cm in the western part of the country to 42 cm in the eastern part). The thickest registered snow cover is 130 cm (in Gaiziņkalns vicinity). Thaws are frequent during winter, usually characterized by low intensity and short periods (5-6 days on average) (Briede, 2020).

Latvia is located in the northern part of Europe, in the Eurasian or Palearctic region. It belongs to boreo-nemoral vegetation zone which is the transition zone characterized with both coniferous and deciduous trees. According to marine biogeographic areas, Latvia is placed along Atlantic boreal marine zone. Consideration of these zones and the climate enables predictions of flora and fauna which could establish themselves in the country (Mallanaro and Pylvänäinen, 2002).

Organization of discussions in working groups

Technical aspects

Considering the current epidemiological situation and travel limitations, the workshop will be organized through an internet platform.

Potential indicative topics for discussions

The workshop will be structured around three related topics related to the regional risk assessments: 1) legislative framework; 2) assessment methodologies; 3) risk assessment of IAS. Presentations from the partners will give an overview on the existing experience and applied practices, thus paving way for a more unified approach and more efficient management of the IAS in the EU. Discussions will highlight the existing knowledge gaps and facilitate the information exchange on the best and most efficient practices applied in the partner countries.

Following topics for discussions have been drafted.

On legislative framework:

— Establishment of IAS experts and responsible institutions working group, delineation of responsibilities and activity areas, coordination of cooperation;
— Improvement of legislation;
— Private zoos, nurseries, collections, gardens as one of the most significant unintentional IAS vectors.

On assessment methodologies:

— Development of a unified methodology for the environmental impact assessment of IAS;
— Unified methodology of risk assessment for the IAS currently not occurring in Latvia;
— Challenges of development of a methodology for identifications of IAS introduction pathways, vectors, types and mode of entry with regard to specific countries (experience exchange).

On risk assessment of IAS (pathways of introduction)

— International collaboration between neighboring countries;
— Climate changes and challenges in the future for new species establishment potential;
— Territorial aspect;
— Environmental change;
— Research on introduction pathways.

The suggested topics to be discussed during the workshops, together with potential questions and finally, the potential expected results are compiled in Table 3. The host organization can choose which topic to present/include in the workshop.

Table 3

Potential discussion topics (questions, expected results)

Discussion topic	**Question to be discussed**	**Expected results**
Establishment of IAS experts and	• Identification of IAS experts;	Working group of IAS experts and institutions responsible for

Discussion topic	Question to be discussed	Expected results
responsible institutions working group, delineation of responsibilities and activity areas, coordination of cooperation.	• Establishment of working group of institutions responsible for IAS; • Development and division of tasks; • Coordination of the work of the established working group.	IAS is established, with its main goal of collecting, summarizing and accumulating information about IAS, development of IAS risk plans, organizing implementation, supervision and control of IAS limiting measures. Development of an information system on non-native invasive species in Latvia.
Improvement of legislation (challenge).	• In national level there is regulation only concerning plant species – Plant Protection Law and related regulations of the Cabinet of Ministers (No. 467 'Regulations Regarding Restriction of the Distribution of Invasive Alien Plant Species' of June 30, 2008; No. 468 'List of Invasive Plant Species' of June 30 2008). The list of invasive plant species includes one species – giant hogweed *Heracleum sosnowskyi*. • Latvian Administrative Violations Code does not foresee responsibility for the trade with alien plant species and actions concerning alien animal species.	Suggestions for changes, amendments or alterations of the legislative acts are developed, defining limitations for the spread of invasive species, compensations and responsible institutions for organizing, implementing and controlling the limitation measures of IAS.
Development of new legislative documents (challenge).	• Development of the national list of IAS and identification of institutions responsible for organizing, implementing	According to articles 12 and 23 of the Regulation (EU) No 1143/2014 of the European Parliament and of the Council

Discussion topic	Question to be discussed	Expected results
	and controlling the limitation measures of IAS.	of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species, national list of the IAS is developed, with all consequential commitments.
Private zoos, nurseries and collections also is one of the most significant unintentional IAS vectors (challenge).	• Inventory of private zoos and collections.	Objective information on IAS in Latvia is obtained and used to develop the action plan for prevention of the distribution of IAS, including the public education and information.
Development of a unified methodology for the environmental impact assessment of IAS.	• IAS risk analysis; • Unified methodology of risk assessment for the IAS currently not occurring in Latvia; • Development of the methodology of environmental risk assessment.	Unified methodology for the IAS risk assessment is developed for the species both occurring and not yet occurring in Latvia; risk analysis carried out for each IAS species occurring in Latvia.
Development of a methodology for identifications of IAS introduction pathways, vectors, types and mode of entry that applies to Latvia.	• Development of the methodology of pathway, vector, type and mode of entry determination for species which could be identified as a risk and not yet occurring in Latvia; • Collaborations with IAS experts.	The analysis of pathways, vectors, types and mode of entry will apply to Latvia for species which are not yet occurring in Latvia, but are identified at EU list.
Research and monitoring of IAS.	• Monitoring principles • Main research directions	Long – term monitoring.

Discussion topic	Question to be discussed	Expected results
International collaboration	• Develop collaboration in the Baltic Sea region to limit marine IAS, facilitate collaboration within river basins with Estonia, Russia and Belarus to prevent the distribution of the species with watercourses as the main pathways; • Collaborate with countries that have terrestrial border with Latvia.	Ideas for collaboration under national and international platforms developed.

Organizational issues

The date and venue of the event will be clarified by the host Zemgale Planning Region. The workshop will last one day and will be organized as an online event. Thematic focus of the workshop will be: Territories' vulnerability to invasive alien species (Table 4).

Table 4

Interregional workshop details

Interregional workshop on territories' vulnerability to invasive alien species	
Thematic focus	Territories' vulnerability to invasive alien species
Host organization	Zemgale Planning Region
Venue	Online event
Language	English
Number of participants	20-30 participants
Type of participants	Regional authorities' officials, experts, stakeholders
Participating countries	Greece, Spain, Portugal, Italy, France, Romania, Latvia
Format	Oral presentations, plenary, discussions

The draft version of agenda is provided in Table 5.

Table 5

Tentative program

Interregional workshop on territories' vulnerability to invasive alien species Latvia		
Eastern European Summer Time (EEST)		
10.00 – 10.20	Opening of the workshop.	Two presentations (each 10 minutes)
10.20 – 11.20	Legislative framework; Presentations from partners.	Two presentations (each 20 minutes plus 10 minutes questions, discussion).
11.20 – 12.20	Assessment methodologies; Presentations from partners.	Two presentations (each 20 minutes plus 10 minutes questions, discussion).
12.20 – 12.30	Coffee break	Moderator
12.30 – 14.30	Risk assessment of IAS (pathways of introduction); Presentations from partners.	Four presentations (each 20 minutes plus 10 minutes questions, discussion).
14.30 – 15.10	Break	Moderator
15.10 – 17.10	Discussions on the defined three topics; Participating all partnership countries – the main problems, indicative questions, challenges.	For each topic 30 minutes.
17.10 – 17.40	Plenary, final discussion and conclusions.	

Concluding remarks

In this paper we attempted to summarize the main factors affecting the environmental vulnerability of ecosystems to invasive alien species, thus pointing out the main current issues which could be solved in the future and discussed in collaboration with other countries. Mostly the main aspects of environmental vulnerability of ecosystems to

invasive alien species were viewed with regard to the situation in Latvia. As the result, the most indicative topics in Latvia are related to the policy framework, development of methodology of environmental impact assessment, identification of pathways of introduction. As only two invasive alien plant species and nine animal species from the EU List are found in the wild in Latvia there is a need to develop methodologies for assessing the establishment potential, environmental impact, as well as for the identification of potential pathways of introduction with regard specifically to Latvia. Even though the main pathways in the EU are similar, it has been mentioned that they may vary among regions or countries, depending on territorial aspects and climate, as well as the climate change. At the same time it is very important to develop a unified methodology for the environmental impact assessment of IAS which could help to reach one of the main goal of IAS Regulation – the rapid prevention of IAS distribution.

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