Research paper

Alien trees and shrubs of Latvia – evaluation of current status and invasiveness

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Abstract. This article presents an updated list of annotated invasive trees and shrubs in Latvia. This list includes 178 taxa about which extensive information has been collected and analysed: family, first records in the area, native range, invasiveness status, vector of introduction, and species distribution in Latvia. In this article, the authors, for the first time in Latvia, provided an invasiveness risk assessment and distinguished risk classes for trees and shrubs. The methodology previously developed by E. Weber and D. Gut was used to assess the risk of invasiveness. The most widely represented families in the list of invasive trees and shrubs are Rosaceae (51 taxa or 28.65%) and Salicaceae (20 taxa or 11.24%). Having assessed the invasiveness status, two species (*Acer negundo* L. and *Sorbaria sorbifolia* (L.) A. Braun) were identified as transformers, and 42 tree and shrub taxa were identified as invasive. After the assessment of the invasiveness risk, the species were divided into three risk classes. The highest risk class includes 32 taxa that are threatening or are likely to threaten natural habitats in Latvia in the future. The results of this study can be used for further dendrological studies in relation to global change and for practical nature conservation and landscape gardening.

Key words: Latvia, dendroflora, invasive species, risk assessment, alien species.

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Introduction

Human activities on a global scale enable an increasing number of species to colonise regions outside of their native range, establish self-sustaining populations and expand further into natural habitats. This phenomenon is known as biological invasion (Elton, 1958; Nentwig *et al.*, 2018). Some alien species have a considerable negative environmental and socio-economic impact on their newly occupied habitats, requiring large efforts to mitigate this impact (Vilá *et al.*, 2008; 2010; Nentwig *et al.*, 2018).

Exotic species have long been considered valuable and desirable souvenirs imported from distant places (Nutt & Kubjas, 2020). A study of the economic uses of plant species that are invasive in various parts of the world showed that most are ornamentals (Weber, 2003). These species

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have been introduced for horticultural use by nurseries, botanical gardens, and horticultural enthusiasts (Reichard & White, 2001). Some of the exotic species introduced to Europe, initially planted in botanical gardens and later in parks and as urban greenery, have now become invasive (Stace & Crawley, 2015).

After the introduction of non-native tree and shrub species into Europe, their acclimatization and propagation for landscape gardening began. Alien tree and shrub species were often planted in parks and urban greeneries. In the 17th – early 18th century, mainly non-native berry bushes like *Cerasus avium* (L.) Moench, *Cerasus vulgaris* Mill., *Cydonia oblonga* Mill., *Malus domestica* Borkh., *Ligustrum vulgare* L., and other taxa were planted in manor gardens in Latvia (Janelis, 2010). The oldest known tree species introduced as greenery in Latvia is *Salix euxina* I.V. Belyaeva (syn. *S. fragilis* L.). The first documented evidence about this species dates from 1791 (Evarts-Bunders, 2005). More information about the introduction of non-native tree and shrub species was published in a catalogue of ornamental trees and shrubs in 1805 (Mauriņš & Zvirgzds, 2006). In the 19th century, many parks and urban greeneries were created in Latvia, which created a demand for a wide assortment of woody plants, and the first nurseries with a large range of trees and shrubs appeared (the most famous nursery business owners in Latvia were Johann Zigra, Karl Wagner and Cristian Schoch). Tree and shrub species and varieties were introduced from Germany, France and Russia (Mauriņš & Zvirgzds, 2006). In 1878, Maximilian von Sivers established the Skrīveri Arboretum and introduced many exotic plant species to Latvia (Cinovskis *et al*., 1991; Mauriņš & Zvirgzds, 2006).

Dendrological plantations in Latvia were intensively studied in the 20th century. The dendroflora of urban and rural parks and dendrological plantations (in total 4,806 sites), including trees and shrubs was investigated between 1971–1990 by dendrologists of the Botanical Garden of the Latvian SSR Academy of Sciences under the leadership of Dr Raimonds Cinovskis (Cinovskis *et al*., 1974; Laiviņš *et al*., 2009). In the study of Laiviņš *et al*., (2009), the list of dendrological plantations included parks, old fragments of parks, miniparks, the largest old private collections in Latvia. However, plantings in cemeteries and private houses were not assessed in this study.

Over the last 200 years, the number of alien tree and shrub taxa in synanthropic habitats have significantly increased. Most were introduced as garden and park plants. Furthermore, plant species invasions begin in these greeneries. In the context of global warming trends, the number of such taxa escaping from greeneries will increase in the near future (Laiviņš *et al*., 2009). Currently, however, the rate of human-assisted migration (i.e., invasion *sensu* Pyšek *et al*. (2004)) of tree and shrub species is relatively faster than 150 years ago. Humans have been relocating plant species for centuries, but human-assisted plant migration is currently accelerating due to increased international trade (Rejmánek *et al*., 2013).

Currently, the largest dendrological plantations in Latvia are found in the National Botanic Garden (about 4,000 tree and shrub taxa) and the Kalsnava Arboretum (2,268 taxa; Evarts-Bunders *et al*., 2021). Considering that a total of 112 tree and shrub species are found in nature in Latvia, the number of species, subspecies, varieties, and hybrids, cultivated in these collections is huge. Many of these taxa are introduced from areas with a similar climate to Latvia – North America, Asia, and therefore, these taxa can easily move to the wild in Latvia.

Recently the global database of invasive trees and shrubs was updated, including a total of 751 species (434 trees and 317 shrubs) from 90 families (Rejmánek & Richardson, 2013; Rejmánek, 2014). The first list of alien organism species in Lat-

via was compiled in 2007 and includes 637 vascular plant taxa, of which 155 are trees and shrubs (Svilāns *et al*., 2007). However, due to global climate change that is facilitating the rapid expansion of alien species, several of which are also invasive, it is necessary to combine knowledge about the occurrence of all alien tree and shrub species in Latvia.

Successful invasion by alien species is almost irreversible, because most invasive alien plant species are successively established in large numbers before they are observed. Subsequently, they are almost impossible and very expensive to eliminate (Anonymous, 2019). Some of the most significant invasive plant species are cultivated trees and shrubs, which have been cultivated for a long time, successfully naturalized, and are now classified as invasive, ecologically aggressive 'problematic' plants. All seed-producing (and even some sterile) trees and shrubs have the ability to spread (Rejmánek *et al*., 1982; Huntley & Birks, 1983; MacDonald, 1993; Petit *et al*., 2004; Bialozyt *et al*., 2012; Rejmánek, 2014). Therefore, it is necessary to assess the current level of invasiveness of alien tree and shrub species, as well as the invasiveness risk level of these species in Latvia.

The aim of the study is to increase knowledge about alien tree and shrub species distribution in Latvia and to evaluate their invasiveness in relation to significant species traits. The objectives of the study are: 1) to update the list of alien tree and shrub species in Latvia; 2) to evaluate the invasiveness of alien trees and shrubs (degree of naturalization); 3) to assess the invasiveness risk in association with species origin and important traits: status and reproduction strategy. Our hypotheses are as follows: 1) species introduced to Latvia from distant regions (e.g., Asia, North America) will have a significantly higher invasiveness risk; 2) the risk of invasiveness and the status of the species are closely related to their reproduction strategy.

Material and Methods

Compiling data for an annotated list of invasive tree and shrub species

The list of invasive tree and shrub species was updated based on earlier research of woody flora in dendrological plantations in Latvia conducted from 1971 to 1990 under the guidance of the dendrologist Raimonds Cinovskis of the Botanic Garden of the Latvian Academy of Sciences (currently the National Botanic Garden), when a total of 4,806 dendrological plantations were inventoried. The lists of native and alien tree and shrub species were later published in the Atlas of Latvian Woody Plants (Laiviņš *et al*., 2009), with information about the number of locations and potential invasiveness. In this study, previous knowledge on the occurrence of taxa and comments on species invasiveness have been used and are presented in detail. The list of Latvian alien species from 2007 was also used in updating the list of invasive species (Svilāns *et al*., 2007). The updated annotated list of 178 alien taxa with traits of invasiveness in Latvia has been compiled in Appendix 1. In order to update the list of invasive tree and shrub species, a total of 145 dendrological plantations and parks in the territory of Latvia in the period from 2006 to 2020 were inventoried (Figure 1). During the dendrological inventory, the presence of invasive tree and shrub species in the park and its vicinity was assessed – within a radius of approximately 50 m around park boundaries. Active vegetative and generative reproduction was assessed, also assessing whether the species grows in sites where it has not been planted previously. Some dendrological plantations have been inspected twice in this period – if it was not possible to collect qualitative data (e.g., due to mowing, or an inappropriate season) – Alūksne Park, Aizvīķu Parks, Eleja Park, Hoftenberga Park, Ilga Park, Juzefova Park, Kalsnava Arboretum, Kazdanga Park, Krāslava Park, Krote Park, Lielauce

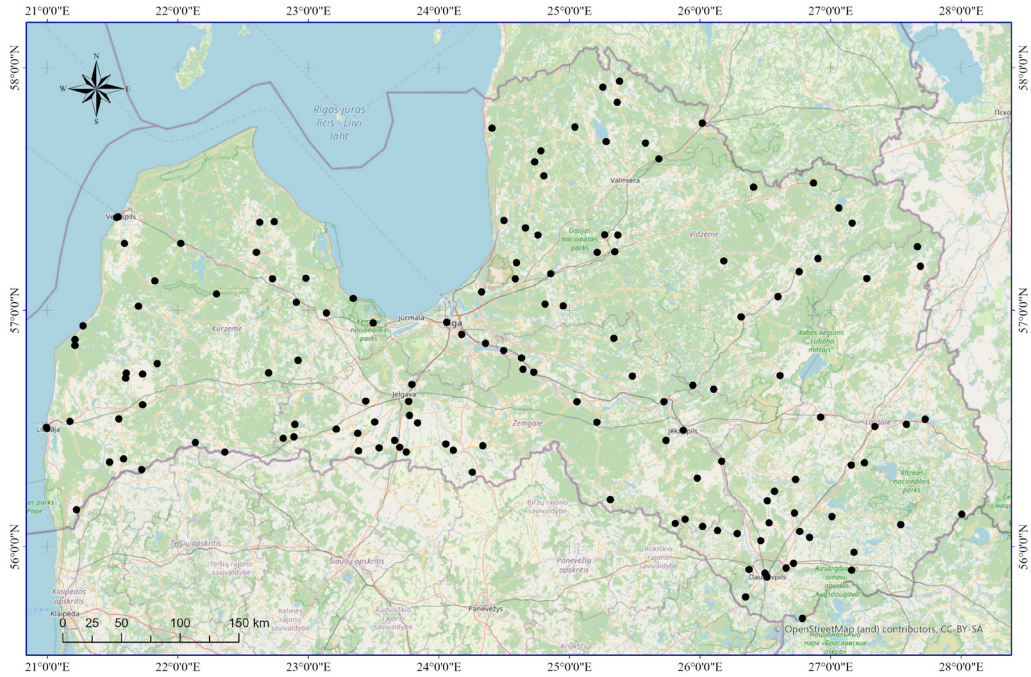

Figure 1. The locations of the studied dendrological plantations in Latvia.

Park, Lielezere Park, National Botanic Garden, Preiļi Park, Skrīveri Arboretum, Talsi Dendrological Park, Vabole Park, Vecsaule Park, Vilce Park, Višķi Park, Zentene Park.

In order to provide as detailed information as possible on the 178 listed tree and shrub taxa, the following information is provided in Appendix 1:

1. Taxonomic affiliation of the listed trees and shrubs to genera.
2. First report in the area. This column provides a summary of when the non-native woody plant species were introduced into the territory of Latvia, based on the first publication date (Laiviņš *et al.*, 2009).
3. Origin.
4. Non-native tree and shrub species were classified as alien, casual alien, naturalized, invasive and transformers or weeds following Pyšek *et al.* (2004) accordingly: Casual alien plants: alien plants that under favourable conditions can occasionally reproduce in the wild but are unable to form sustainable populations. These fail to exist in the area for an extended period without re-introduction. Naturalized alien plants: alien plants that sustain self-replacing populations for more than 10 years, supplemented by offspring that are able to grow independently. Invasive plants: plants which are naturalized, that produce fertile offspring, commonly in very large numbers, and thus are able to spread over a large area. Transformers: invasive plants that degrade ecosystems in a substantial area. Dual status: species, which occur naturally in some parts of Latvia, but, at the same time, have been cultivated and spread in the wild.
5. Vector. The mode of entry into Latvia is indicated for each taxon. The status describes the types of introduction of alien species as classified according to Stace & Crawley (2015). The evaluated trees and shrubs have two types of introduction in Latvia: F – as edible (human food), including herbs and spices,

plant seeds, fruits and other plant parts; H – horticultural introductions.

6. The type of spreading indicates whether the species reproduces in Latvia from seed and/or by vegetative propagation. The data were summarized based on the authors' observations and literature.
7. Species distribution in Latvia was estimated by applying the square method, which is related to the geographical coordinates, where one square corresponds approximately to 7.6 × 9.3 km or 71 km² for Latvia. The total number of the grid cells in Latvia is 1,017, from which 822 are completely and 195 partially located in the territory of Latvia (Laiviņš *et al.*, 2009).
8. Invasiveness risk. There are many challenges facing the field of risk assessment of species invasiveness. After revision of previously used methods (e.g., Pheloung, 1995; Van Wilgen *et al.*, 2001; Andersen *et al.,* 2004; Genovesi & Shine, 2004; Burgiel & Muir, 2010; Verbrugge *et al.*, 2010; Crossman *et al.*, 2011; McDougall *et al.,* 2011; Sandvik *et al.*, 2013) we have decided to follow the methodology of Weber & Gut (2004), where fairly simple criteria were used for assessing the potential risk of invasive woody plant species. The rating system allocates scores to the species for biogeographical, ecological, and experience-linked aspects. In this work the authors used 12 questions for the assessment, for which points have been awarded. We adapted the selected scheme to Latvian conditions and made corresponding changes. The term "Europe" has been changed to "Northern Europe". It was important to change this criterion, as a number of species found in nature in Central Europe have been introduced in Latvia and exhibit features of invasiveness.
9. Risk class. Each non-native woody plant species was assigned to one of the three risk classes, based on the total point score as follows (Weber & Gut, 2004): 3–20 low risk – species is unlikely to pose a threat to natural communities; 21–27 intermediate risk – species requires further observation; 28–38 high risk – species is likely to become a threat to natural communities if naturalized.

Data analysis

We applied Pearson's Chi-squared test for count data corresponding to the number of species (Hope, 1968) to evaluate the dependence between species invasiveness risk class and the following species characteristics: native distribution range (Europe, North America, Asia/Eastern Asia, Eurasia, Europe/Asia Minor, Eurosiberia, cultivar) for 178 species, status (transformer, invasive, casual, dual, natural) for 178 species and reproduction strategy (seeds, vegetative, seeds and vegetative) for 171 species.

To identify the most contributing associations of the Pearson's Chi-squared test results among species invasiveness risk class and native distribution range and among invasiveness risk class and status, Pearson's residuals were calculated from the Pearson's Chi-squared test results and visualized using the 'corrplot' package (Wei & Simko, 2017). All data analyses were conducted in R (R Core Team, 2020).

Results

Updated list of invasive trees and shrubs

The new annotated list of invasive trees and shrubs includes 178 taxa. The previous list of alien species (Svilāns *et al.*, 2007) has been supplemented with 46 new tree and shrub taxa (Appendix 1). Three species have naturalized – *Salix daphnoides* Vill., *S.* × *fragilis* L., *Syringa villosa* Vahl; six taxa are invasive – *Aronia* × *prunifolia* 'Floribunda', *Populus longifolia* Fisch., *P.* 'Lettland', *Rosa* × *malyi* A. Kern., *R.* × *regeliana* Linden & Andr, *Spiraea* × *rosalba* Dippel; one species

has dual status – *Salix acutifolia* Willd. We identified eleven most widespread casual alien tree and shrub species – *Acer tataricum* L. subsp. *ginnala* (Maxim.) Wesm., *Celastrus orbiculatus* Thunb., *Forsythia* × *intermedia* Zabel, *Juglans mandshurica* Maxim., *Juniperus sabina* L., *Malus sieboldii* (Regel) Rehder, *Padus maackii* (Rupr.) Kom., *Philadelphus coronarius* L., *Pinus strobus* L., *Spiraea japonica* L., *Syringa josikaea* Jacq. Fil. ex Rchb.

In total, 23 taxa from the previous alien plant list are not included in the current updated list. We did not find confirmation of the migration of these 23 alien taxa into the wild in the areas inspected during the study, for example, *Crataegus* × *media* Bechst., *C.* × *uhrovae* Soó, *Genista pilosa* L., *Malus dasyphylla* Borkh., *Rosa acicularis* Lindl., *R. multiflora* Thunb., and *R. alba* L.

Number and composition of taxa

The list of alien tree and shrub species in Latvia includes representatives from 28 families. There are five families with at least 10 species classified as alien that together comprise 62.36% of the total alien taxa of the country. The most frequent are from the Rosaceae family, containing 51 taxa (corresponding to 28.65% of all alien tree and shrub species), the Salicaceae family with 20 taxa (11.24%), the Aceraceae family with 15 taxa (8.43%), the Fabaceae family with 13 taxa, (7.30%), and the Pinaceae family with 12 taxa, (6.74%) (Appendix 1).

Of the taxa analysed, conifers are represented by 14 taxa (7.86%), belonging to two families Cupressaceae – 2 taxa (1.12%) and Pinaceae – 12 taxa (6.74%). The remaining 92.14% of species belong to deciduous trees. *Acer* – 15% of taxa, *Spiraea* – 11%, *Populus* – 10% and *Salix* – 10%. These are the most represented genera in the updated list of invasive alien species.

Plant traits

Most of the 178 alien taxa introduced in Latvia are native to North America (46 taxa, 26%), and Europe (39 taxa, 22%), the rest originated from Eurasia (17 taxa, 10%), East Asia (20 taxa, 11%) or are cultivars – decorative varieties, hybrids and other taxa without a natural native area (32 taxa, 18%; Figure 2, Appendix 1). In total, 18% of the studied alien taxa are cultivars.

During this study, 178 tree and shrub taxa were evaluated according to the selected criteria. In Latvia, all these species are successful at self-reproducing, of which two species (1%) are recognized as transformers: *Acer negundo* L. and *Sorbaria sorbifolia* (L.) A. Braun. Altogether, 42

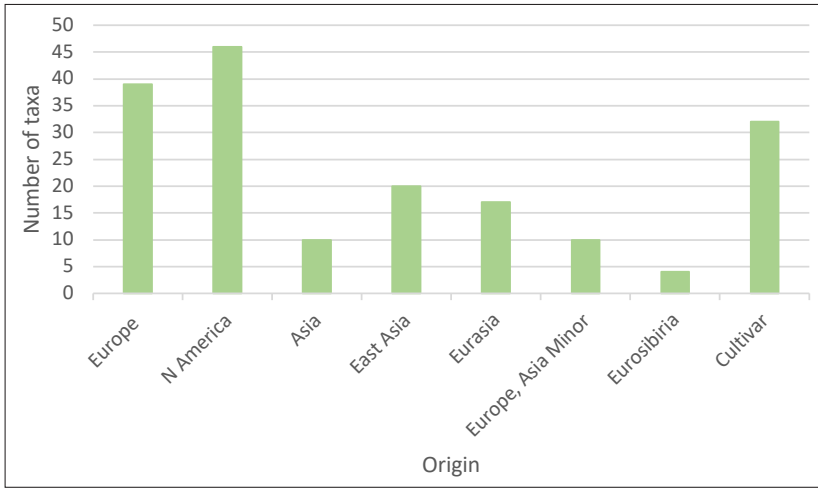

Figure 2. Share of the assessed species by origin.

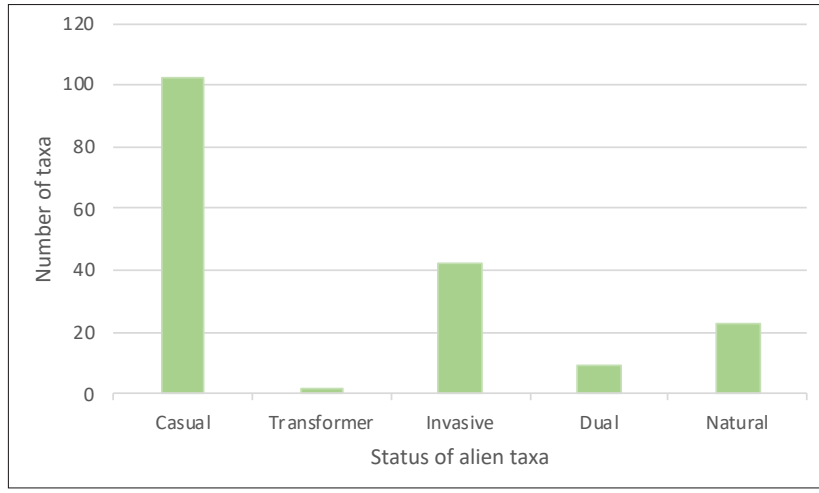

Figure 3. Distribution of alien trees and shrubs by invasiveness status.

species are considered invasive (24%), 23 – naturalized (13%); dual status was assigned to nine species (5%) and 104 species (57%) have casual status (Figure 3). After evaluating all alien tree and shrub species, which showed possible invasiveness, 44 taxa (25%) have been classified as aggressive invasive species in Latvia.

The results show that 89% of the identified invasive plants dispersed from horticulture, 6% as edible plants, including herbs and plant seeds, fruits and other plant parts, 3% horticulture and human food and 2% horticulture and timber.

Risk assessment

This study provides a risk assessment of invasive plants for all 178 tree and shrub taxa that show signs of invasiveness after introduction in Latvia. According to the scores obtained through the risk assessment, the taxa are divided into three risk classes. Class III (high risk) includes 32 species (18%). The alien taxa to belong to the high-risk class are: *Acer negundo* L., *A. pseudoplatanus* L., *A. tataricum* L. subsp. *ginnala* (Maxim.) Wesm., *Amelanchier spicata* (Lam.) K. Koch, *Celastrus orbiculatus* Thunb., *Cotoneaster lucidus* Schlecht., *Elaeagnus argentea* Pursh., *Hippophaë rhamnoides* L., *Parthenocissus quinquefolia* (L.) Planch., *Populus laurifolia* Ledeb., *P. longifolia* Fisch., *Rosa rugosa* Thunb., *Salix alba* L., *Spiraea* × *billardii* Herincq., *S.* × *rosalba* Dippel.

Class II (intermediate risk) includes 123 taxa or 69% of the alien species, while class I (low risk) includes 23 taxa or 13% of all alien taxa (Appendix 1). All three risk classes were present in each of the five alien species status categories (Figure 4). Class III included 23 species from the invasive taxa group (Appendix 1), the transformer *Acer negundo* and four species from the casual taxa group – *Acer tataricum* subsp. *ginnala*, *Celastrus orbiculatus*, *Cerasus tomentosa* (Thunb.) Wall., *Salix alba* 'Vitellina'. Class III also included taxa with dual status (*Salix alba*) and three taxa from the naturalized taxa group (*Salix alba* 'Sericea', *Salix daphnoides*, *Salix* × *fragilis*) (Figure 4).

We did not find significant differences between the area of origin of the taxa and invasiveness risk classes (X^2=16.26, p=0.28). Of the 32 taxa in Class III (high-risk class), 10 taxa or 31.25% are cultivated, 8 taxa or 25% are of North American origin, and four are from East Asia. Eurosiberian taxa were not found in Class III (Figure 5, Appendix 1).

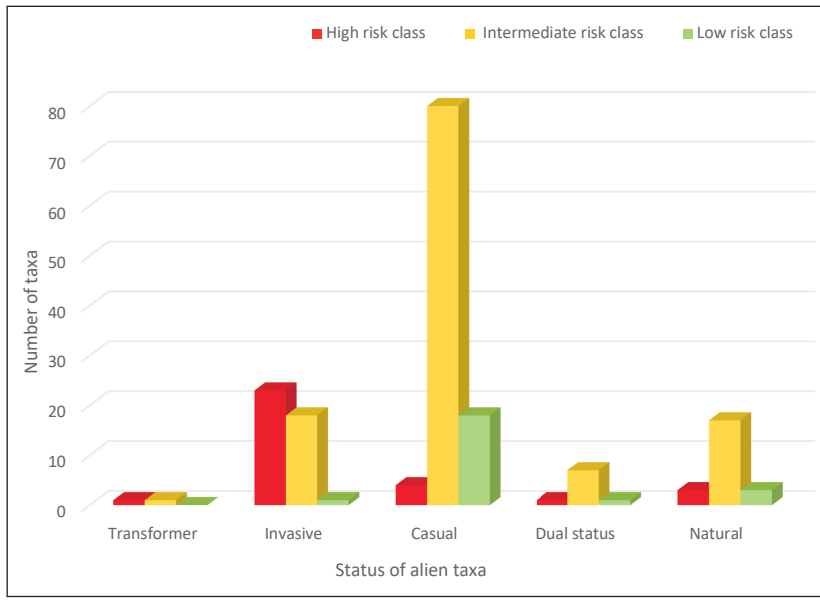

Figure 4. Number of studied tree and shrub taxa among invasiveness statuses and risk classes.

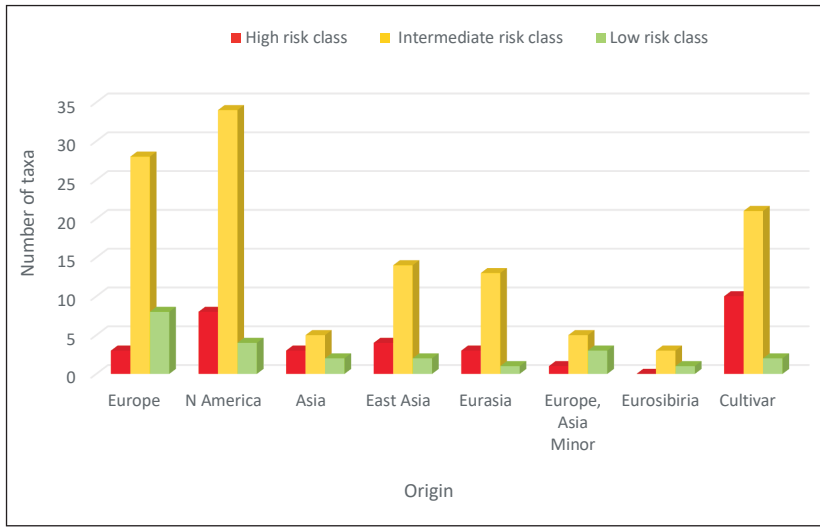

Figure 5. Number of studied tree and shrub taxa among origins and risk classes.

Associations between invasiveness risk classes and plant traits of trees and shrubs with different origin

We did not find a significant association between the studied species invasiveness risk class and species native distribution range (X^2=16.26, p=0.30). A significant association was found between the species invasiveness risk class and species status (X^2=55.92, p<0.01) and between the invasiveness risk class and species reproduction strategy (X^2=61.25, p<0.01).

Pearson's residuals showed the association between all three invasiveness risk classes and invasive and casual species status (Figure 6 A) which contributed to Pear-

son's Chi-squared test results. The highest positive association was found between a high invasiveness risk class and invasive species status, but the highest negative association was found between a high invasiveness risk class and casual species status (Figure 6 A).

Pearson's residuals showed the association between all three invasiveness risk classes and all three reproduction strategies (Figure 6 B) which contributed to the Pearson's Chi-squared test results. The highest contribution was found between a high invasiveness risk class and species having both seed and vegetative reproduction strategies, which showed a positive association. A high contribution was also found in the positive association between vegetative reproduction and low invasiveness risk. A high contribution was also found in the negative association between a high invasiveness risk class and species reproducing by seeds (Figure 6 B).

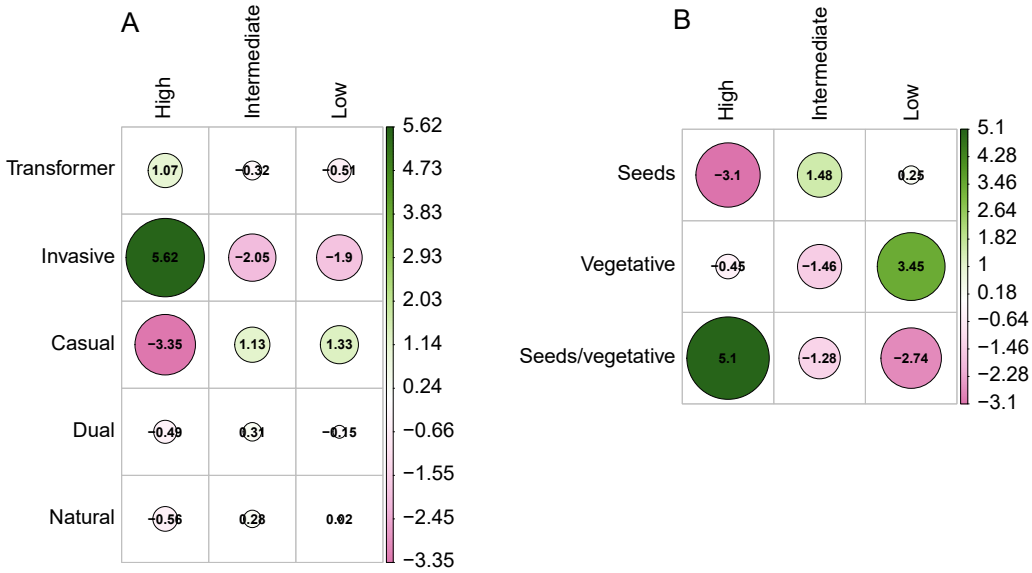

Figure 6. Contributing associations between species invasiveness risk classes (High, Intermediate, Low) and species statuses (Transformer, Invasive, Casual, Dual, Natural) (A) and species invasiveness risk classes and species reproduction strategies (Seeds, Vegetative, Seeds/Vegetative) (B) based on Pearson's residuals obtained from the Chi-squared test results. The colour map refers to Pearson's residual values and the circle size refers to the magnitude of positive or negative associations.

Discussion

As a result of this study, a national list of alien tree and shrub species was compiled, assessing observed invasiveness traits for the included species. The aim of a risk assessment for invasive trees and shrubs was to estimate which species should be listed on the national invasive plant list and to decide which new species infestations should be controlled or removed in order to prevent their spread and associated ecological consequences (Weber & Gut, 2004).

We did not prove the hypothesis that species from distant locations like Asia and North America show more pronounced invasiveness traits, namely, a higher risk class of invasiveness (Figure 5). This can be explained by the number of cultivars in our dataset. Accordingly, in other similar research (Andreu & Vilá, 2010; Fayvush *et al.*, 2018; Nutt & Kubjas, 2020), no associ-

ations were established between species origin and invasiveness classes.

In the present study, of the 32 tree and shrub taxa included in the high-risk invasiveness class, a considerable number of them were cultivars or hybrids of horticultural origin – 10 (31.25%), and an addition eight (25%), originated from North America. The majority of cultivars with a high risk of invasiveness belong to Rosaceae: *Cerasus vulgaris*, *Rosa* × *malyi*, *R. pimpinellifolia* L., *R.* × *regeliana*, *Spiraea* × *billardii*, *S.* × *rosalba*. The following cultivars are also in the high-risk invasiveness group: *Salix alba* 'Sericea', *Salix alba* 'Vitellina' and *Acer pseudoplatanus* 'Purpurascens'.

The family Rosaceae is the most widely represented in the list of invasive tree and shrub taxa (51 taxa, corresponding to 28.65% of all trees and shrubs aliens). Asia is the major source of invasive Rosaceae shrubs, as well as invasive Oleaceae species. Most of the invasive Salicaceae are of Eurasian origin. Because of increasing connections with many Asian countries, even more invasive tree and shrub species will be introduced from Asia (Rejmánek, 2014). The number of tree and shrub species with Asian origin has increased in Latvian nurseries in recent years, for example, *Ailanthus altissima* (Mill.) Swingle, *Lespedeza bicolor* Turcz., *Morus alba* L., *Paulownia tomentosa* (Thunb.) Steud. and *Wisteria floribunda* (Willd.) DC. (Anonymous, 2021). With increasing trade, we can expect that more alien tree and shrub taxa will sooner or later become invasive in the Baltic region. At present, in the first half of the 21st century, *Ailanthus altissima*, *Paulownia tomentosa* and *Wisteria floribunda* suffer from frost damage in Latvia, but in suitable climatic conditions they can survive.

The second hypothesis stated that the risk of invasiveness and the status of the species is closely related to the reproduction strategy. We have shown that species that reproduce both vegetatively and by seed dispersion are more aggressive and invade larger areas more quickly in comparison to other alien species (Stace & Crawley, 2015). For example, *Acer negundo*, *Elaeagnus argentea*, *Hippophaë rhamnoides*, *Parthenocissus quinquefolia*, *Physocarpus opulifolius*. (L.) Maxim. Such species may be used for berry production in plantations only under strict control. For aggressive invasive alien species, varieties with variegated leaves with slowed photosynthesis are recommended for landscape gardening (Gaskin & Kazmer, 2009), so that the taxon grows slowly and is less aggressive. Interspecific hybrids that do not produce germinating seeds are also recommended for landscape gardening as self-seeding is not possible for such taxa (Gaskin & Kazmer, 2009).

When creating parks, squares, and backyard greeneries, we recommend avoiding taxa included in the high invasiveness risk class in order to prevent the invasion of large areas by adult trees and shrubs that are already capable of producing seeds. In old parks where they were planted, taxa such as *Spiraea*, *Swida* and *Syringa*, are currently migrating to natural areas. Invasive species in natural habitats need to be controlled so that they do not destroy natural ecosystems.

Conclusions

Our study resulted in the compilation of an updated list of 178 alien tree and shrub taxa, that were identified as migrating into natural ecosystems (self-seeding). A total of 44 tree and shrub taxa have been identified as aggressive invasive species, either potentially invasive (with transformer status) or invasive.

Three classes of invasiveness risks were distinguished. The majority of alien tree and shrub species are already invasive – 18% of evaluated species belong to the high-risk class of invasiveness, or have a great potential to become invasive in future – 69% of species belong to the intermediate invasiveness risk group, and only few alien taxa (12% of species) have a low

risk of invasiveness. High-risk class species should be given special attention and monitoring in order to prevent the invasion of large areas by these species in the future. In addition, species with intermediate risk of invasiveness also require monitoring and periodic assessment as these taxa may become potentially hazardous over time.

Invasiveness risk and species status are closely related to reproduction strategy. We have proved that species that are able to reproduce both vegetatively and by seed dispersion are more aggressive and invade larger areas more quickly than species with only vegetative reproduction (have low risk of invasiveness). The planting of invasive species with both reproduction strategies should therefore be avoided. Therefore, we recommend planting varieties and hybrids that do not produce germinating seeds, thus avoiding self-seeding.

The Weber and Gut method is suitable for risk assessment of alien tree and shrub taxa in Latvia. Subsequently, the assessment of the tree and shrub taxa yielded interesting and reliable results, which can be used to assess the potential invasiveness risk of a species. The updated tree and shrub species list can be included in the list of invasive species of Latvia. The results of the present study can be used in future studies about alien tree and shrub species' distributional changes due to the global climate change. The results also contribute to practical nature conservation and landscape gardening in regions with similar climatic conditions.

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Appendix 1. Updated list of invasive tree and shrub taxa with traits of invasiveness in Latvia.

Abbreviations: Vector: F – edible plants, including herbs and spices, and fruit seeds or fruits; H – horticultural introductions, mainly ornamentals, but also grassland, hedging, game cover and green manure; T – with timber (Stace & Crawley, 2015); Type of spreading – indicates whether the species reproduces in Latvia from seed (s) and/or from vegetative propagation (v); Species distribution in Latvia – according to our data and literature (Laiviņš *et al.*, 2009); - no data.

No	*Species*	*Family*	*First reported in the area*	*Origin*	*Status of alien taxa*	*Vector*	*Type of spreading*	*Species distribution in Latvia (grid cells)*	*Invasiveness risk*	*Risk class*
1.	*Abies alba* Mill.	Pinaceae	1817	Europe	casual	H	s	150	22	II
2.	*Abies balsamea* (L.) Mill.	Pinaceae	1805	N America	casual	H	s	172	24	II
3.	*Abies concolor* (Gordon & Glend.) Lindl. ex Hildebr.	Pinaceae	1888	N America	casual	H	s	147	24	II
4.	*Abies nordmanniana* (Stev.) Spach	Pinaceae	1867	Europe	casual	H	s	22	24	II
5.	*Abies sibirica* Ledeb.	Pinaceae	1856	Asia	casual	H	s	362	21	II
6.	*Abies × phanerolepis* Fernald	Pinaceae	-	N America	casual	H	s	204	23	II
7.	*Acer barbinerve* Maxim.	Aceraceae	1957	East Asia	casual	H	s	8	22	II
8.	*Acer campestre* L.	Aceraceae	1805	Europe, Asia Minor	casual	H	s	73	26	II
9.	*Acer circinatum* Pursh	Aceraceae	1963	N America	casual	H	s	8	22	II
10.	*Acer mono* Maxim. var. *mayrii* (Schwer.) Nakai	Aceraceae	1969	East Asia	casual	H	s	5	22	II
11.	*Acer negundo* L.	Aceraceae	1817	N America	transformer	H	s/v	498	34	III
12.	*Acer palmatum* Thunb. subsp. *amoenum* (Carrière) Hara	Aceraceae	1958	Eurasia	casual	H	s	1	21	II
13.	*Acer platanoides* 'Crimson King'	Aceraceae	-	Cultivar	casual	H	s	17	24	II
14.	*Acer platanoides 'Schwedleri'*	Aceraceae	1883	Cultivar	casual	H	s	44	26	II
15.	*Acer pseudoplatanus* L.	Aceraceae	1804	Eurasia	invasive	H	s	210	31	III
16.	*Acer pseudoplatanus* 'Purpurascens'	Aceraceae	1805	Cultivar	invasive	H	s	17	29	III
17.	*Acer pseudosieboldianum* (Pax) Kom.	Aceraceae	-	East Asia	casual	H	s	10	24	II
18.	*Acer saccharinum* L.	Aceraceae	1805	N America	casual	H	s	119	25	II
19.	*Acer tataricum* L. subsp. *ginnala* (Maxim.) Wesm.	Aceraceae	1876	Eurasia	casual	H	s	280	29	III

No	Species	Family	First reported in the area	Origin	Status of alien taxa	Vector	Type of spreading	Species distribution in Latvia (grid cells)	Invasiveness risk	Risk class
20.	*Acer tataricum* L. subsp. *tataricum*	Aceraceae	1805	Eurasia	casual	H	s	178	27	II
21.	*Acer tegmentosum* Maxim.	Aceraceae	1880	Eurasia	casual	H	s	9	22	II
22.	*Aesculus hippocastanum* L.	Hippocas-tanaceae	1805	Europe, Asia Minor	casual	H	s	996	20	I
23.	*Amelanchier spicata* (Lam.) K. Koch	Rosaceae	1888	N America	invasive	H	s	1235	31	III
24.	*Aralia elata* (Miq.) Seem.	Araliaacee	1877	East Asia	casual	H	v	38	20	I
25.	*Aronia* × *prunifolia* 'Floribunda'	Rosaceae	1902	Cultivar	invasive	H	s/v	371	27	II
26.	*Artemisia abrotanum* L.	Asteraceae	-	Europe	casual	H	-	178	21	II
27.	*Berberis thunbergii* DC	Berberidaceae	1880	East Asia	casual	H	s	324	26	II
28.	*Berberis vulgaris* 'Atropurpurea'	Berberidaceae	-	Cultivar	casual	H	s	-	26	II
29.	*Caragana arborescens* Lam.	Fabaceae	1805	East Asia	invasive	H	s/v	1256	28	III
30.	*Caragana frutex* (L.) K. Koch	Fabaceae	1817	Eurosibiria	invasive	H	s/v	269	26	II
31.	*Carpinus betulus* L.	Corylaceae	-	Europe	dual status	H	s	190	21	II
32.	*Celastrus orbiculatus* Thunb.	Celastraceae	1873	East Asia	casual	H	s/v	60	29	III
33.	*Cerasus avium* (L.) Moench	Rosaceae	1778	Europe, Asia Minor	invasive	F	s/v	314	25	II
34.	*Cerasus tomentosa* (Thunb.) Wall.	Rosaceae	1930	East Asia	casual	F	s/v	43	29	III
35.	*Cerasus vulgaris* Mill.	Rosaceae	-	Cultivar	invasive	F	s/v	-	29	III
36.	*Chaenomeles japonica* (Thunb.) Lind. ex Spach	Rosaceae	1867	East Asia	casual	F,H	s	365	25	II
37.	*Chamaecytisus ratisbonensis* (Schaeff.) Rothm.	Fabaceae	1888	Europe, Siberia	casual	H	s/v	21	25	II
38.	*Clematis recta* L.	Ranunculaceae	1976	Europe	casual	H	s/v	12	27	II
39.	*Cotoneaster dammerii* C. K. Schneid.	Rosaceae	1960	East Asia	casual	H	s	26	24	II
40.	*Cotoneaster lucidus* Schlecht.	Rosaceae	1884	Asia	invasive	H	s	612	29	III
41.	*Cotoneaster multiflorus* Bunge	Rosaceae	1888	Asia	casual	H	s	18	22	II
42.	*Crataegus alemanniensis* Cinovskis	Rosaceae	1971	Europe	naturalized	H	s	358	25	II
43.	*Crataegus douglasii* Lindl.	Rosaceae	1867	N America	casual	H	s	64	24	II

No	*Species*	*Family*	*First reported in the area*	*Origin*	*Status of alien taxa*	*Vector*	*Type of spreading*	*Species distribution in Latvia (grid cells)*	*Invasiveness risk*	*Risk class*
44.	*Crataegus flabellata* (Bosc) K. Koch	Rosaceae	1965	N America	casual	H	s	71	24	II
45.	*Crataegus laevigata* (Poir.) DC	Rosaceae	-	Europe	dual status	H	s	-	25	II
46.	*Crataegus monogyna* Jacq.	Rosaceae	1859	Europe	casual	H	s	23	25	II
47.	*Crataegus submollis* Sarg.	Rosaceae	1856	N America	casual	H	s	216	24	II
48.	*Cytisus scoparius* (L.) Link	Fabaceae	1892	Europe	invasive	H	s	42	22	II
49.	*Elaeagnus angustifolia* L.	Elaeagnaceae	1817	Eurasia	casual	H	s/v	15	22	II
50.	*Elaeagnus argentea* Pursh.	Elaeagnaceae	1877	N America	invasive	H	s/v	187	31	III
51.	*Euonymus nanus* M. Bieb.	Celastraceae	1867	Eurasia	casual	H	s/v	32	25	II
52.	*Fagus sylvatica* L.	Fagaceae	1805	Europe	invasive	H	s	263	23	II
53.	*Fagus sylvatica* 'Purpurea Latifolia'	Fagaceae	-	Cultivar	invasive	H	s	-	24	II
54.	*Forsythia suspensa* (Thunb.) Vahl	Oleaceae	1880	East Asia	casual	H	v	64	24	II
55.	*Forsythia* × *intermedia* Zabel	Oleaceae	1894	Cultivar	casual	H	v	123	24	II
56.	*Fraxinus pennsylvanica* Marchall	Oleaceae	1821	N America	casual	H	s	117	24	II
57.	*Fraxinus pennsylvanica* Marchall var. *subinetegerrima* (Vahl) Fern.	Oleaceae	1856	N America	casual	H	s	117	24	II
58.	*Genista tinctoria* L.	Fabaceae	1805	Eurosibiria	casual	H	s	23	20	I
59.	*Grossularia reclinata* (L.) Mill. var. *reclinata*	Grossulariaceae	-	Europe	naturalized	F	s	481	27	II
60.	*Grossularia reclinata* (L.) Mill. var. *uva-crispa* (L.) Berger	Grossulariaceae	-	Europe	naturalized	F	s	-	24	II
61.	*Hedera helix* L. var. *helix*	Araliaceae	1817	Europe	casual	H	v	41	18	I
62.	*Hedera hibernica* (Kirchn.) Bean	Araliaceae	1867	Europe	casual	H	v	9	18	I
63.	*Hippophaë rhamnoides* L.	Elaeagnaceae	1817	Eurasia	invasive	F,H	s/v	230	28	III
64.	*Hydrangea paniculata* 'Grandiflora'	Hydrangeaceae	1884	Cultivar	casual	H	s	49	24	II
65.	*Hyssopus officinalis* L.	Labiatae	-	Europe	casual	F	s	-	19	I
66.	*Juglans ailanthifolia* Carrière	Juglandaceae	1884	East Asia	casual	H	s	52	27	II
67.	*Juglans cinerea* L.	Juglandaceae	1847	N America	casual	H	s	242	27	II

No	Species	Family	First reported in the area	Origin	Status of alien taxa	Vector	Type of spreading	Species distribution in Latvia (grid cells)	Invasiveness risk	Risk class
68.	*Juglans mandshurica* Maxim.	Juglandaceae	1910	East Asia	casual	H	s	119	27	II
69.	*Juniperus sabina* L.	Cupressaceae	1819	Eurasia	casual	H	s	143	24	II
70.	*Larix decidua* Mill.	Pinaceae	1805	Europe	naturalized	H	s	763	25	II
71.	*Lavandula angustifolia* Mill.	Labiatae	-	Europe	casual	F,H	s	7	16	I
72.	*Ligustrum vulgare* L.	Oleaceae	1805	Europe, Asia Minor	naturalized	H	s	378	22	II
73.	*Lonicera caerulea* L.	Caprifoliaceae	1805	Eurasia	casual	H	s	26	22	II
74.	*Lonicera caprifolium* L.	Caprifoliaceae	1805	Europe	casual	H	s/v	377	24	II
75.	*Lonicera periclymenum* L.	Caprifoliaceae	1805	Europe	casual	H	s/v	112	24	II
76.	*Lonicera tatarica* L.	Caprifoliaceae	1805	Eurasia	naturalized	H	s	573	27	II
77.	*Lycium barbarum* L.	Solanaceae	1805	Eurasia	casual	H	s/v	27	21	II
78.	*Mahonia aquifolium* L.	Berberidaceae	1853	N America	casual	H	s	178	24	II
79.	*Malus baccata* (L.) Borkh.	Rosaceae	1805	East Asia	casual	H	s	33	27	II
80.	*Malus domestica* Borkh.	Rosaceae	1778	Cultivar	invasive	F	s	117	27	II
81.	*Malus pumila* Mill.	Rosaceae	1805	Cultivar	casual	H	s	4	22	II
82.	*Malus* × *purpurea* (Barbier) Rehder	Rosaceae	1956	Cultivar	casual	H	s	29	24	II
83.	*Malus sachalinensis* Juz.	Rosaceae	1959	East Asia	casual	H	s	7	24	II
84.	*Malus sieboldii* (Regel) Rehder	Rosaceae	1885	East Asia	casual	H	s	20	24	II
85.	*Malus sieversii* (Ledeb.) M. Roem.	Rosaceae	1888	Asia	casual	H	s	27	24	II
86.	*Oxycoccus macrocarpus* (Aiton) Pursh.	Ericaceae	-	N America	casual	F	s	-	27	II
87.	*Padus maackii* (Rupr.) Kom.	Rosaceae	1956	N America	casual	H	s	28	23	II
88.	*Padus serotina* (Ehrh.) Borkh.	Rosaceae	1805	N America	casual	H	s	38	23	II
89.	*Parthenocissus inserta* (A. Kern.) Fritsch	Vitaceae	1929	N America	casual	H	s/v	24	26	II
90.	*Parthenocissus quinquefolia* (L.) Planch.	Vitaceae	1847	N America	invasive	H	s/v	210	31	III
91.	*Pentaphylloides fruticosa* (L.) O. Schwarz	Rosaceae	-	Cultivar	dual status	H	s	86	24	II
92.	*Philadelphus coronarius* L.	Hydrangeaceae	1805	Europe	casual	H	s	1229	21	II
93.	*Philadelphus pubescens* Loisel. var. *verrucosus* (Schrad.) S.Y.Hu	Hydrangeaceae	1856	N America	casual	H	s	474	23	II
94.	*Physocarpus opulifolius* (L.) Maxim.	Rosaceae	1805	N America	invasive	H	s/v	366	29	III

No	Species	Family	First reported in the area	Origin	Status of alien taxa	Vector	Type of spreading	Species distribution in Latvia (grid cells)	Invasiveness risk	Risk class
95.	*Picea glauca* (Moench) Voss	Pinaceae	1805	N America	casual	H	s	194	24	II
96.	*Pinus mugo* Turra	Pinaceae	1805	Europe	casual	H	s	103	22	II
97.	*Pinus strobus* L.	Pinaceae	1805	N America	casual	H,T	s	166	27	II
98.	*Populus alba* L.	Salicaceae	1805	Eurasia	invasive	H	s/v	451	27	II
99.	*Populus alba* 'Nivea'	Salicaceae	-	Cultivar	casual	H	v	-	26	II
100.	*Populus balsamifera* L.	Salicaceae	1805	N America	naturalized	H	s/v	618	26	II
101.	*Populus* × *berolinensis* K. Koch	Salicaceae	1879	Europe	casual	H	-	118	20	I
102.	*Populus* × *canadensis* Moench	Salicaceae	-	Cultivar	naturalized	H	v	251	20	I
103.	*Populus* × *canescens* (Aiton) Sm.	Salicaceae	-	Europe, Asia Minor	naturalized	H	v	173	20	I
104.	*Populus* 'Lettland'	Salicaceae	-	Cultivar	invasive	H	v	349	20	I
105.	*Populus laurifolia* Ledeb.	Salicaceae	1856	Asia	invasive	H,T	s/v	69	29	III
106.	*Populus longifolia* Fisch.	Salicaceae	1847	N America	invasive	H	s/v	298	29	III
107.	*Populus trichocarpa* Torr. & A. Gray	Salicaceae	1913	N America	casual	H,T	v	33	20	I
108.	*Prunus cerasifera* Ehrh. var. *divaricata* (Ledeb.) Bailey	Rosaceae	1883	Europe, Asia Minor	invasive	F,H	s/v	366	29	III
109.	*Prunus domestica* L. var. *instititia* (L.) C.K. Schneid.	Rosaceae	1888	Europe	invasive	F,H	s/v	15	29	III
110.	*Prunus spinosa* L.	Rosaceae	-	Europe	dual status	H	s/v	-	27	II
111.	*Pseudotsuga menziesii* (Mirb.) Franco var. *menziesii*	Pinaceae	1888	N America	casual	H	s	153	24	II
112.	*Pseudotsuga menziesii* (Mirb.) Franco var. *glauca* (Beissn.) Franco	Pinaceae	1883	N America	casual	H	s	162	24	II
113.	*Pterocarya fraxinifolia* (Poir.) Spach	Juglandaceae	1867	Asia	casual	H	v	14	20	I
114.	*Pyrus communis* L.	Rosaceae	-	Europe	casual	F	s	-	25	II
115.	*Quercus petraea* (Matt.) Liebl.	Fagaceae	1968	Europe	casual	H	s	13	18	I
116.	*Quercus rubra* L.	Fagaceae	1859	N America	invasive	H,T	s	183	27	II
117.	*Rododendron catawbiense* Michx.	Ericaceae	1872	N America	casual	H	s	32	24	II
118.	*Rododendron japonicum* (A.Gray) J.V. Suringar	Ericaceae	1877	East Asia	casual	H	s	50	24	II
119.	*Rhus typhina* L.	Anacardiaceae	1817	N America	casual	H	v	152	20	I
120.	*Ribes nigrum* L.	Grossulariaceae	-	Eurasia	dual status	F	v/s	1646	26	II
121.	*Ribes rubrum* L.	Grossulariaceae	-	Europe	naturalized	F	s	1408	27	II

No	Species	Family	First reported in the area	Origin	Status of alien taxa	Vector	Type of spreading	Species distribution in Latvia (grid cells)	Invasiveness risk	Risk class
122.	*Robinia luxurians* (Diec ex Goehabitatze) C.K. Schneid.	Fabaceae	1909	N America	invasive	H	s	67	22	II
123.	*Robinia pseudoacacia* L.	Fabaceae	1805	N America	invasive	H	s	323	25	II
124.	*Robinia pseudoacacia* 'Semperflorens'	Fabaceae	-	Cultivar	invasive	H	s	-	22	II
125.	*Robinia viscosa* var. *hartwigii* (Koehne) Ashe	Fabaceae	1961	N America	invasive	H	s	45	22	II
126.	*Rosa glabrifolia* C.A. Mey. ex Rupr.	Rosaceae	1894	Europe, Siberia	naturalized	H	s	172	24	II
127.	*Rosa glauca* Pourr.	Rosaceae	1888	Europe	naturalized	H	s	195	27	II
128.	*Rosa* × *malyi* A. Kern.	Rosaceae	-	Cultivar	invasive	H	s/v	-	29	III
129.	*Rosa pimpinellifolia* L.	Rosaceae	1805	Cultivar	invasive	H	s/v	1140	29	III
130.	*R. pomifera* Herrm. subsp. *pomifera*	Rosaceae	1894	Europe, Asia Minor	casual	H	s	156	26	II
131.	*Rosa* × *regeliana* Linden & Andr	Rosaceae	-	Cultivar	invasive	H	s/v	-	31	III
132.	*Rosa rugosa* Thunb.	Rosaceae	1888	East Asia	invasive	H	s/v	872	33	III
133.	*Rubus odoratus* L.	Rosaceae	1805	N America	naturalized	H	s/v	64	24	II
134.	*Rubus parviflorus* Nutt.	Rosaceae	1859	N America	casual	H	s/v	15	24	II
135.	*Salix acutifolia* Willd.	Salicaceae	-	Europe	dual status	H	s/v	510	27	II
136.	*Salix acutifolia* × *S. daphnoides*	Salicaceae	-	Cultivar	dual status	H	s/v	167	27	II
137.	*Salix alba* L.	Salicaceae	-	Europe	dual status	H	s/v	1349	29	III
138.	*Salix alba* 'Britzensis'	Salicaceae	-	Cultivar	casual	H	s/v	-	26	II
139.	*Salix alba* 'Sericea'	Salicaceae	1875	Cultivar	naturalized	H	s/v	417	29	III
140.	*Salix alba* 'Vitellina'	Salicaceae	1805	Cultivar	casual	H	s/v	129	29	III
141.	*Salix daphnoides* Vill.	Salicaceae	1839	Europe	naturalized	H	s/v	271	29	III
142.	*Salix euxina* I.V. Belyaeva	Salicaceae	1791	Europe	naturalized	H	s/v	1974	27	II
143.	*Salix purpurea* 'Lambertiana'	Salicaceae	-	Cultivar	casual	H	s/v	-	26	II
144.	*Salix* × *fragilis* L.	Salicaceae	1853	Cultivar	naturalized	H	s/v	92	28	III
145.	*Sambucus nigra* L.	Caprifoliaceae	1805	Europe, Asia Minor	invasive	H	s	487	23	II
146.	*Sambucus racemosa* L.	Caprifoliaceae	1805	Eurasia	invasive	H	s	1048	27	II
147.	*Sambucus racemosa* 'Plumosa'	Caprifoliaceae	-	Cultivar	casual	H	s	-	24	II
148.	*Sorbaria sorbifolia* (L.) A. Braun	Rosaceae	1805	Asia	transformer	H	s/v	705	27	II
149.	*Spiraea alba* Du Roi	Rosaceae	1885	N America	invasive	H	s/v	717	28	III
150.	*Spiraea betulifolia* Pall.	Rosaceae	1960	East Asia	casual	H	s	18	21	II
151.	*Spiraea* × *billardii* Herincq.	Rosaceae	1856	Cultivar	invasive	H	v	283	28	III

No	Species	Family	First reported in the area	Origin	Status of alien taxa	Vector	Type of spreading	Species distribution in Latvia (grid cells)	Invasiveness risk	Risk class
152.	*Spiraea chamaedryfolia* L.	Rosaceae	1805	Asia	invasive	H	s	702	22	II
153.	*Spiraea douglasii* Hook.	Rosaceae	1847	N America	casual	H	s/v	12	23	II
154.	*Spiraea japonica* L.	Rosaceae	1859	Cultivar	casual	H	-	113	22	II
155.	*Spiraea latifolia* (Aiton) Borkh.	Rosaceae	1817	N America	casual	H	-	47	20	I
156.	*Spiraea media* F. Schmidt	Rosaceae	1856	Eurasia	naturalized	H	-	405	21	II
157.	*Spiraea menziesii* Hook.	Rosaceae	1913	N America	casual	H	-	5	20	I
158.	*Spiraea nipponica* Maxim.	Rosaceae	1964	East Asia	casual	H	-	14	18	I
159.	*Spiraea* × *rosalba* Dippel	Rosaceae	-	Cultivar	invasive	H	v	47	29	III
160.	*Swida alba* (L.) Opiz	Cornaceae	1805	Asia	invasive	H	v	441	29	III
161.	*Swida alba* 'Sibirica'	Cornaceae	-	Cultivar	casual	H	v	-	25	II
162.	*Swida sericea* L.	Cornaceae	1817	N America	casual	H	v	25	26	II
163.	*Swida sericea* 'Flaviramea'	Cornaceae	-	Cultivar	casual	H	v	-	25	II
164.	*Symphoricarpos albus* (L.) S. F. Blake var. *laevigatus* (Fernald) S. F. Blake	Caprifoliaceae	1805	N America	invasive	H	s/v	932	33	III
165.	*Syringa josikaea* Jacq. Fil. ex Rchb.	Oleaceae	1847	Europe	casual	H	s	349	17	I
166.	*Syringa villosa* Vahl	Oleaceae	1955	Asia	naturalized	H	s	376	19	I
167.	*Syringa vulgaris* L.	Oleaceae	1805	Europe	invasive	H	v	1565	26	II
168.	*Teucrium chamaedrys* L.	Labiatae	-	Europe	dual status	H	s	-	19	I
169.	*Thuja occidentalis* L.	Cupressaceae	1805	N America	casual	H	s	1047	25	II
170.	*Thymus marschallianus* Willd.	Labiatae	1932	Eurasia	casual	H	s	9	17	I
171.	*Tilia platyphyllos* Scop. subsp. *cordifolia*	Tiliaceae	1805	Europe	naturalized	H	s	190	25	II
172.	*Toxicodendron pubescens* Mill.	Anacardiaceae	-	N America	casual	H	v	-	23	II
173.	*Ulmus minor* Mill.	Ulmaceae	1877	Europe	naturalized	H	s	88	22	II
174.	*Ulmus minor* Mill. f. *suberosa* (Moench) Cin.	Ulmaceae	-	Europe	casual	H	s	18	22	II
175.	*Ulmus pumila* L.	Ulmaceae	1956	N America	naturalized	H	s	15	24	II
176.	*Viburnum lantana* L.	Caprifoliaceae	1805	Europe	naturalized	H	s	157	25	II
177.	*Vinca major* L.	Apocynaceae	1856	Europe, Asia Minor	casual	H	v	4	19	I
178.	*Vinca minor* L.	Apocynaceae	1856	Europe, Asia Minor	invasive	H	v	136	26	II