Workshop on Forest management and Natura 2000 in the alpine and continental biogeographic regions: bridging research and practice

Forest management as a necessary measure to contrast alien species invasion: a review within the boundaries of the continental and alpine Natura 2000 biogeographic regions

Giuseppe Brundu
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1. Natura 2000 and Invasive Alien Species
2. Legislation and status definitions (Alien, Invasive)
3. Invasive alien trees
4. Invasive alien trees in Natura 2000
5. Prevention, management, control of invasive alien trees

http://wnmu.edu/academic/nspages/gilaflora/p_serotina2.jpg
The **Habitats Directive was adopted in 1992** to help maintain biodiversity. It protects over 1,000 animals and plant species and over 200 types of habitat. It also established the EU-wide Natura 2000 network of protected areas.

**Article 22**

In implementing the provisions of this Directive, Member States shall:

(b) ensure that the *deliberate introduction into the wild* of any species which is *not native* to their territory is *regulated* so as not to prejudice natural habitats within their natural range or the wild native fauna and flora and, if they consider it necessary, *prohibit* such introduction. The results of the assessment undertaken shall be forwarded to the committee for information; …

*Convention on the Conservation of European Wildlife and Natural Habitats, Bern, 19 September 1979.* Art.11.2 Each Contracting Party undertakes, … (b) to strictly control the introduction of *non-native* species.

Prunus serotina, Robinia pseudoacacia, Ailanthus altissima, Acacia sp.pl.
For the purposes of the **Regulation EU no. 1143/2014**, the following definition applies (Art. 3):

'**alien species**' means any live specimen of a species, subspecies or lower taxon of animals, plants, fungi or micro-organisms **introduced outside its natural range**; it includes any part, gametes, seeds, eggs or propagules of such species, as well as any hybrids, varieties or breeds that might **survive** and subsequently reproduce.

In this context, 'introduction' means the **movement, as a consequence of human intervention**, of a species outside its natural range (see also Art. 4.3.a).

Similarly for CBD, alien species" refers to a species, subspecies or lower taxon, introduced outside its natural past or present distribution; includes any part, gametes, seeds, eggs, or propagules of such species that might survive and subsequently reproduce.

**COP 6 Decision VI/23**, Alien species that threaten ecosystems, habitats or species. Note (57) to the Annex Guiding Principles for the prevention, introduction and mitigation of impacts of alien species that threaten ecosystems, habitats or species. Sixth Ordinary Meeting of the Conference of the Parties to the Convention on Biological Diversity, 7 - 19 April 2002 - The Hague, Netherlands.
Alien TO Europe, Alien IN Europe

Fig 1. *Pinus mugo* in dune habitat in Denmark, photo by Henrik Jørgensen.

specie alogenă
чужди видове
especie exotica (exotic)
нepůvodními druhy (alloctonous)
ikkehjemmehørende art (non-native)
gebietsfremde Art
espèce exotique
Espécie exotica
Specie esotica

Examples from the different translated versions of the Regulation

(Official Journal L 011, 15/01/2000 P. 0017 – 0040)

This Directive uses the terms autochthonous/indigenous, non-autochthonous/non-indigenous, unknown (origin). According to Article 2, d-e-f-g: an autochthonous stand or seed source is one which normally has been continuously regenerated by natural regeneration. The stand or seed source may be regenerated artificially from reproductive material collected in the same stand or seed source or autochthonous stands or seed sources within the close proximity; An indigenous stand or seed source is an autochthonous stand or seed source or is a stand or seed source raised artificially from seed, the origin of which is situated in the same region of provenance. For an autochthonous stand or seed source, the origin is the place in which the trees are growing. For a non-autochthonous stand or seed source, the origin is the place from which the seed or plants were originally introduced. The origin of a stand or seed source may be unknown; (For a species or sub-species, the region of provenance is the area or group of areas subject to sufficiently uniform ecological conditions in which stands or seed sources showing similar phenotypic or genetic characters are found, taking into account altitudinal boundaries where appropriate.).

Implementing measures: e.g., COMMISSION RECOMMENDATION of 14 February 2012 on guidelines for the presentation of the information for the identification of lots of forest reproductive material and the information to be provided on the supplier’s label or document (2012/90/EU) [12a ‘autochthonous/indigenous’; 12b ‘non-autochthonous/non-indigenous’, 12c ‘unknown’]. - COMMISSION REGULATION (EC) No 1597/2002 of 6 September 2002 laying down detailed rules for the application of Council Directive 1999/105/EC as regards the format of national lists of the basic material of forest reproductive material.

See Also: Council Directive 66/404/EEC of 14 June 1966 on the marketing of forest reproductive material. Within the text of this Directive indigenous vs non-indigenous trees are distinguished (e.g. in Article 3), but without providing any definition.
In UK The Forestry Commission manages the Voluntary Scheme for the Certification of Native Trees and Shrubs, (the Voluntary Scheme). This scheme allows seed collectors to certify their native seed collections for species not covered by the Regulations.
For the purposes of the Regulation EU no. 1143/2014, the following definition applies (Art. 3):

'invasive alien species' means an alien species whose introduction or spread has been found to threaten or adversely impact upon biodiversity and related ecosystem services.

The following categories are defined: “invasive alien species”, “invasive alien species of Union concern”, “invasive alien species of Member State concern”, “Invasive alien species of regional concern” (Art. 11), “widely spread invasive alien species of Union concern” (Art. 19).

Similarly for CBD, "invasive alien species" means an alien species whose introduction and/or spread threaten biological diversity (For the purposes of the guiding principles, the term "invasive alien species" shall be deemed the same as "alien invasive species" in decision V/8 of the Conference of the Parties to the Convention on Biological Diversity.)

COP 6 Decision VI/23, Alien species that threaten ecosystems, habitats or species. Note (57) to the Annex Guiding Principles for the prevention, introduction and mitigation of impacts of alien species that threaten ecosystems, habitats or species. Sixth Ordinary Meeting of the Conference of the Parties to the Convention on Biological Diversity, 7 - 19 April 2002 - The Hague, Netherlands.
Wild species pool

390,900 taxa

Kew 2016 – State of the World’s Plants
Wild species pool

Conservation, Cultivation, Breeding, GE, species pool

390,900 taxa

7,000 crops, 28,000 ornamentals, total = 35,000 taxa

Kew 2016 – State of the World’s Plants

Genetic Resources and Crop Evolution, 2008, Volume 55, Issue 7, pp 925-928
Wild species pool

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Kew 2016 – State of the World’s Plants

Genetic Resources and Crop Evolution, 2008, Volume 55, Issue 7, pp 925-928
Workshop on Forest management and Natura 2000 in the alpine and continental biogeographic regions: bridging research and practice

**Wild species pool**

13,168 taxa

M. Van Kleunen, Nature 525, 100–103. doi:10.1038/nature14910

**Naturalised alien plants**

390,900 taxa

Kew 2016 – State of the World’s Plants

**Conservation, Cultivation, Breeding, GE, species pool**

7,000 crops, 28,000 ornamentals, total = 35,000 taxa

Genetic Resources and Crop Evolution, 2008, Volume 55, Issue 7, pp 925-928

Naturalised alien plants

13,168 taxa

Invasive alien plants

Invasive alien Trees & Shrubs

751 species (434 trees and 317 shrubs) from 90 families

*(Forestry, Ornamental, Multi-Purpose species)*

M. Van Kleunen, Nature 525, 100–103. doi:10.1038/nature14910
Rejmánek and Richardson - Diversity and Distributions, (2013) 19, 1093–1094
For the purposes of the Regulation EU no. 1143/2014, the following definition applies (Art. 3):

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COP 6 Decision VI/23, Alien species that threaten ecosystems, habitats or species. Note (57) to the Annex Guiding Principles for the prevention, introduction and mitigation of impacts of alien species that threaten ecosystems, habitats or species. Sixth Ordinary Meeting of the Conference of the Parties to the Convention on Biological Diversity, 7 - 19 April 2002 - The Hague, Netherlands.
3.4. Pest risk analysis

38. In accordance with Article 5 of the SPS Agreement, the establishment of technically-justified border control and quarantine measures requires a pest risk analysis (PRA) to be conducted in cases where no relevant ISPMs exist. Border control and quarantine measures related to IAS also need to comply with this requirement. Since the IPPC was perceived as a convention to protect only cultivated plants, efforts have been undertaken to address the protection of wild flora and biodiversity, in particular through standards on PRA, notably ISPM 29 and ISPM 11.10

39. The PRA process provides a technical tool for identifying appropriate phytosanitary measures. It consists of three stages: (i) initiation; (ii) pest risk assessment; and (iii) pest risk management. PRA is applied to pests of cultivated plants and wild flora in accordance with the scope of the IPPC. ISPM 11 has been revised to take account of the threats to biodiversity from IAS that are plant pests. It includes details regarding the analysis of risks from plant pests for the environment and for biological diversity, including those risks affecting uncultivated/unmanaged plants, wild flora, habitats and ecosystems contained in the PRA area (see Case Study 2). An annex to ISPM 11 specifies that "the full range of pests covered by the IPPC extends beyond pests directly affecting cultivated plants. The coverage of the IPPC definition of plant pests includes weeds and other species that have indirect effects on plants, and the Convention applies to the protection of wild flora" (IPPC, 2004b).

### Box 3: IPPC definitions

| [PLANT] PEST: | any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products |
| QUARANTINE PEST: | a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled |

(FAO, 1997)

Inter-agency Liaison Group on Invasive Alien Species

https://www.cbd.int/invasive/lg/
Article 4 - List of invasive alien species of Union concern

1. The Commission shall adopt, by means of implementing acts, a list of invasive alien species of Union concern (‘the Union list’), on the basis of the criteria laid down in paragraph 3 of this Article. Those implementing acts shall be adopted in accordance with the examination procedure referred to in Article 27(2). The draft implementing acts shall be submitted to the Committee referred to in Article 27(1) by 2 January 2016.

2. The Commission shall undertake a comprehensive review of the Union list at least every six years and shall, in the meantime, update it, as appropriate, in accordance with the procedure referred to in paragraph 1 with:

(a) the addition of new invasive alien species;
(b) the removal of listed species if they no longer meet one or more of the criteria laid down in paragraph 3.

3. Invasive alien species shall only be included on the Union list if they meet all of the following criteria:

(a) they are found, based on available scientific evidence, to be alien to the territory of the Union excluding the outermost regions;
(b) they are found, based on available scientific evidence, to be capable of establishing a viable population and spreading in the environment under current conditions and in foreseeable climate change conditions in one biogeographical region shared by more than two Member States or one marine subregion excluding their outermost regions;
(c) they are, based on available scientific evidence, likely to have a significant adverse impact on biodiversity or the related ecosystem services, and may also have an adverse impact on human health or the economy;
(d) it is demonstrated by a risk assessment carried out pursuant to Article 5(1) that concerted action at Union level is required to prevent their introduction, establishment or spread;
(e) it is likely that the inclusion on the Union list will effectively prevent, minimise or mitigate their adverse impact.

4. Member States may submit to the Commission requests for the inclusion of invasive alien species on the Union list. Those requests shall include all of the following:

(a) the name of the species;
(b) a risk assessment carried out in accordance with Article 5(1);
(c) evidence that the criteria set out in paragraph 3 of this Article are met.
Article 5 - Risk assessment

1. For the purposes of Article 4, a risk assessment shall be carried out in relation to the current and potential range of invasive alien species, having regard to the following elements:

(a) a description of the species with its taxonomic identity, its history, and its natural and potential range;

(b) a description of its reproduction and spread patterns and dynamics including an assessment of whether the environmental conditions necessary for its reproduction and spread exist;

(c) a description of the potential pathways of introduction and spread of the species, both intentional and unintentional, including where relevant the commodities with which the species is generally associated;

(d) a thorough assessment of the risk of introduction, establishment and spread in relevant biogeographical regions in current conditions and in foreseeable climate change conditions;

(e) a description of the current distribution of the species, including whether the species is already present in the Union or in neighbouring countries, and a projection of its likely future distribution;

(f) a description of the adverse impact on biodiversity and related ecosystem services, including on native species, protected sites, endangered habitats, as well as on human health, safety, and the economy including an assessment of the potential future impact having regard to available scientific knowledge;

(g) an assessment of the potential costs of damage;

(h) a description of the known uses for the species and social and economic benefits deriving from those uses.
Invasive alien species – framework for the identification of invasive alien species of EU concern

**Table 4.2: Overview of the ten protocols (including protocol name, acronym, type and the expert representing the protocol within this project) that complied with ten or more minimum standards or impact assessments/horizon scanning tool with the potential to inform the development of risk assessment protocols in accordance with the minimum standards to be considered in detail through Task 4. The risk assessment protocols have been numbered to correspond with the numbering in Table 1.4.**

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<td>GBNNRA</td>
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## Decision-support scheme for an Express Pest Risk Analysis

### Specific scope

This Standard provides a simplified scheme for the rapid production of pest risk analyses.

### Specific approval and amendment

2012-09.
EPPO prioritization process for invasive alien plants

Specific scope
This Standard describes a process for the prioritization of alien plants to produce risk-based lists of invasive alien plants and also to determine those plants that require a pest risk analysis.

Specific approval
First approved in 2012-09.
IAP-RISK

Mitigating the threat of invasive alien plants in the EU through pest risk analysis to support the EU Regulation 1143/2014

The LIFE funded project Mitigating the threat of Invasive Alien Plants in the EU through pest RISK analysis support the EU Regulation 1143/2014 (IAP-RISK) will mitigate the threat of invasive alien plants to the environment through producing high quality assessments that meet the requirements of the Regulation (EU) no. 1143/2014.
Risk assessment

Robinia pseudoacacia L.

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Risks assessment scores using the ISEIA protocol — 16

This report was commissioned by the Invasive Alien Species Team of the Netherlands Food and Consumer Product Safety Authority.

Redrawn from van Wilgen & Richardson (2014).
Erosion on a hill-country farm compared with a radiata pine plantation, Hawkes Bay, New Zealand, following a storm in 2011.

PHOTO: PETER SCOTT
### Parte terza

**Il controllo della robinia come specie invadente**

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Workshop on Forest management and Natura 2000 in the alpine and continental biogeographic regions: bridging research and practice

The Bisamberg
A natural treasure in our hands

LIFE project Bisamberg
Layman’s report

Management of Robinia Pseudoacacia and other invasive species
7th March 2014, 9:30 A.M.
Sala Civica, Via Morandi 8 Albinea (RE)
False acacia (*Robinia pseudoacacia*)

- Hardwood tree species native to SE North America.
- Established in most European countries, considered invasive in many. Also invasive in parts of North and South America, Asia and Africa.
- Important forestry crop in Europe but not in GB.
- Beginning to show signs of invasiveness in GB.
- Could cause major impacts through competition and habitat alteration.

**History in GB**

Introduced around 1630, first recorded in the wild in 1888. Mainly locally distributed in GB – especially south, south-east and the midlands of England but also found in Wales and Scotland.

**Summary**

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<th>Confidence</th>
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<td>Entry</td>
<td>VERY LIKELY</td>
<td>VERY HIGH</td>
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<td>Establishment</td>
<td>VERY LIKELY</td>
<td>VERY HIGH</td>
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<tr>
<td>Spread</td>
<td>RAPID</td>
<td>HIGH</td>
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<td>Impacts</td>
<td>MAJOR</td>
<td>HIGH</td>
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<tr>
<td>Conclusion</td>
<td>HIGH</td>
<td>HIGH</td>
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Robinia pseudoacacia L.

https://www.infoflora.ch/assets/content/documents/maps/raster/i/346500.pdf
Robinia: una specie che fa discutere

Per alcuni, la robinia è una neofita invasiva che dovrebbe essere sistematicamente estirpata. Altri vedono nella robinia una specie che offre opzioni selvicolturali interessanti e sicure in proiezione futura. Essa rappresenta una specie alternativa tra le possibili specie arboree da gestire nelle aree marginali attualmente dominate dal faggio e dalla quercia. In Francia la bibliografia forestale riferisce che nessuna altra specie a legno duro ha delle prestazioni produttive tanto elevate ed è in grado di produrre in breve tempo del legname apprezzato per le sue eccellenti proprietà tecnologiche …..

http://www.waldwissen.net/waldwirtschaft/waldbau/wsl_robinie/index_IT
Robinia pseudoacacia in Europe: distribution, habitat, usage and threats

T. Sitzia, A. Cierjacks, D. de Rigo, G. Caudullo

*Robinia pseudoacacia* L., commonly known as black locust, is a tree native to North America and is one of the most important and widespread broad-leaved alien trees in Europe. It is a medium-sized, deciduous, fast-growing thorny tree with high suckering capacity. It has been extensively planted in Europe and now it is naturalised in practically the whole continent. Growing on a wide range of soil types, this tree species only avoids wet or compacted conditions. It is mainly distributed in sub-Mediterranean to warm continental climates and requires a rather high heat-sum. As a light-demanding pioneer species, it rapidly colonises grasslands, semi-natural woodlands and urban habitats, where it can persist for a long time. Owing to the capacity of fixing di-nitrogen through symbiotic rhizobia in root nodules, black locust can add high rates of nitrogen to soil which becomes available to other plants. The wood of black locust is durable and rot-resistant, making it adequate for multiple purposes such as fire and pulp wood, for fences, construction and furniture. In several parts of Europe, black locust is considered an invasive alien plant, because of shading and its ability to change soil conditions.

The black locust (*Robinia pseudoacacia* L.) is a medium-sized deciduous tree that commonly reaches 20 m as a single tree and 30 m within stands1, but capable of attaining heights up to 35 m.

**Biodiversity concerns**

Black locust invasion has been proven to have an impact on biodiversity when compared with the native habitats. This applies to both plain15-26 and hill17 and hillier18 communities. These effects depend on the stand age and the landscape type. For example, the presence of black locust in recent secondary stands in rural landscapes does not seem to play a major role in shaping the diversity of the understorey plant groups compared to native stands29. In urban areas, it seems to have the ability to homogenize processes at the plant community level30. Further research is needed to elucidate the effect of different management techniques on the ability of black locust to invade adjacent forest and semi-natural habitats30.
Strategy on Invasive Alien Species
Published May 2007

Forestry

There are two main issues to be considered relating to alien species and the forestry industry. One is the use of alien tree species in forestry, and the other is problems that can arise in connection with imports of timber and wood products.

About 50 introduced tree species have been used in Norwegian forestry. About 10 of these have been planted more widely than in purely experimental plots. Alien species have been particularly widely used in afforestation in Western and North Norway. The total area that has been afforested in Western Norway is about 160,000 hectares, which is equivalent to 18% of all productive forest in the region. The corresponding figures for Nordland and Troms counties in North Norway are 0.9 million hectares and about 10% of all productive forest in these counties. Most of the total area afforested and also areas replanted with different tree species have been planted with Norway spruce (Picea abies), which does not occur naturally in Western Norway or most of North Norway.

In 2005, about 3.5% of all trees planted were of alien species, and about 75% of these were planted for the production of Christmas trees and ornamental greenery. This means that alien species accounted for 0.9% of the trees planted in forested areas, or about 15,000 plants. This is somewhat lower than the average for recent years. There is no prohibition against using alien tree species, but the new Forestry Act and regulations on sustainable forestry will be used to regulate the use of introduced tree species. In recent years, the National Forest Inventory, a national monitoring programme, has been expanded to include alien tree species and their spread, and various projects have been carried out to gather information on alien tree species in Norway. Research in this field and analyses of the effects of

Sycamore (Acer pseudoplatanus)

The sycamore is native to hilly and mountainous areas of central and southern Europe. It was introduced to Norway as an ornamental tree, probably around 1780. It has gradually become established in various forest habitats, and has become the dominant broad-leaved tree in certain areas. It can also be found in spruce forests. It is now spreading very rapidly, observations from the coast and fjords of Western Norway show that it is competing strongly with native deciduous broad-leaved trees. Photo: Hilde Flåt Solås
Figure 3. Impact categories for alien species are dependent upon their invasion potential and ecological effect. The system is based upon five impact categories (Table 1), dependent upon the interaction between invasion potential (Table 2) and ecological effect (Table 3). Species with a severe or high impact make up the Black List.
Table 1. Impact categories for alien species. Assignment of species to these categories is according to Figure 3 and the criteria which are described in Tables 2 and 3 as well as in the main text. “Axis / axes” refer to the invasion and effect axes in Figure 3.

| SE | Severe impact | Alien species with a severe impact are actually or potentially ecologically harmful species and have the potential to become established across large areas. These species are included in the Black List. |
| HI | High impact | Alien species with a high impact are characterized by a combination of a high subcategory along one axis and an intermediate category along the other. These have either restricted/moderate ability to spread, but cause at least a medium ecological effect, or alternatively only a minor ecological effect but have a high invasion potential. These species are included in the Black List. |
| PH | Potentially high impact | Alien species with a potentially high impact have a maximum score along one axis, but a minimal score along the other. They have either high ecological effects combined with a low invasion potential, or a high invasion potential without any known ecological effect. These species are not included in the Black List. |
| LO | Low impact | Alien species with a low impact are not documented as having any substantial impact upon Norwegian nature. These species are not included on the Black List. |
| NK | No known impact | Alien species which achieve the lowest subcategory along both axes, have no known impact. These species are not included on the Black List. |

Table 2. Subcategories, criteria and threshold values for classifying the invasion potential of alien species. Species are assessed according to all criteria (B₁ - B₃ are considered as one criterion), and the highest subcategory which satisfies at least one criterion, is chosen.

<table>
<thead>
<tr>
<th>Subcategory for invasion potential</th>
<th>Criterion</th>
<th>A</th>
<th>B₁</th>
<th>B₂</th>
<th>B₃</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Small invasion potential</td>
<td>Expected population lifetime</td>
<td>&lt; 10 years, 5 generations</td>
<td>&lt; 0.3 km/year</td>
<td>&lt; 0 % per year</td>
<td>≤ 0 % per decade</td>
<td>&lt; 5 %</td>
</tr>
<tr>
<td>2: Restricted invasion potential</td>
<td>≥ 10 years, 5 generations</td>
<td>≥ 0.3 km/year</td>
<td>&gt; 0 % per year</td>
<td>&gt; 0 % per decade</td>
<td>≥ 5 %</td>
<td></td>
</tr>
<tr>
<td>3: Moderate invasion potential</td>
<td>≥ 50 years, 10 generations AND B ≥ 2²</td>
<td>≥ 10 km/year AND A ≥ 2²</td>
<td>&gt; 1 % per year AND A ≥ 2²</td>
<td>&gt; 25 % per decade AND A ≥ 2²</td>
<td>≥ 10 %</td>
<td></td>
</tr>
<tr>
<td>4: High invasion potential</td>
<td>≥ 1000 years AND B ≥ 3³</td>
<td>≥ 30 km/year AND A ≥ 3³</td>
<td>&gt; 2 % per year AND A ≥ 3³</td>
<td>&gt; 50 % per decade AND A ≥ 3³</td>
<td>≥ 20 %</td>
<td></td>
</tr>
</tbody>
</table>

Notes:

a. When the expected population lifetime is expressed in both years and generations, the one giving the shortest period is prevailing.

b. In order that categories A and B satisfy the two highest subcategories (3/4), the other criterion (B or A) must meet the conditions 2 or 3, respectively, for invasion potential. If these additional conditions are not met, the subcategory one step lower is chosen.
Box 23

Picea sitchensis as an example of an alien tree species

There is no good definition to separate between what is a tree and what is a bush. By tree we here refer to taxa which mainly grow from one trunk and reach at least 4-6 metres in height. In this project, a total of 91 of the alien species are defined as trees. This includes conifers in the genus Abies, Larix, Picea, Pinus*, Tuja, Pseudotsuga, Chamaecyparis and Tsuga, and deciduous trees in the genus Acer, Crataegus, Laburnum, Malus, Sorbus, Populus and Ulmus. In the genus Prunus, Salix and Sambucus are representatives of both bushes and trees.

With the exception of Acer pseudoplatanus, trees were not assessed in the Norwegian Black List 2007. However, some selected conifers were assessed under a separate project. The conclusion was then that the available set of criteria was unsuitable (Oyen et al. 2009). In Alien species in Norway – with the Norwegian Black List 2012 a total of 91 tree species are assessed, of which 25 species are on the Black List (categories SE and HI), 12 species are considered to have a potentially high impact (PH), 36 species as having a low impact (LO) and 18 species which have no known impact (NK).

One of the species which is considered to have a severe impact (SE) is Picea sitchensis. Due to a large population and good reproductive capabilities, this species is expected to be present in Norwegian nature in the indefinite future.

Picea sitchensis originates from the west coast of North America and is imported to Norway mainly as a production species for forestry purposes, although it is also used for shelter belts. Historically, the species has also been imported for research purposes, but such import has now ceased. Picea sitchensis has been established in Norway since the 1950s and is inarguably the most important alien tree species in terms of extent of planting. Picea sitchensis is mainly planted in coastal areas in heaths, grazed blueberry forest and small fern forest. It is also primarily in these types of habitats it is expected to spread further.

The high impact category is the result of Picea sitchensis being able to spread to coastal heaths, which are a threatened habitat type. Coastal heaths are particularly threatened by use coming to an end and consequently by overgrowing. The changes in state in coastal heaths due to Picea sitchensis occur instead of changes caused by native species such as Pinus sylvestris, Betula pubescens, Salix caprea and Sorbus aucuparia. Studies of biodiversity of coastal heaths (O.R. Vetleas pers. comm.) do not reveal negative effects from Picea sitchensis at landscape level, but some effects occur on a smaller scale. The future forest structure for Picea sitchensis in areas to where it spreads is likely to be small groups in open areas, with a scattering of other species, more or less like in natural forests in North America.

* Except Pinus mugo ssp. mugo
Table 1. Distribution of the individual species in the different risk categories. None of the present species were assigned to the No known risk category. The numbers in parenthesis represent the position on the x- and y-axis (Fig. 1), respectively.

<table>
<thead>
<tr>
<th>Very high risk (n=6)</th>
<th>High risk (n=3)</th>
<th>Potentially high risk (n=5)</th>
<th>Low risk (n=15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acer pseudoplatanus (4,3)</td>
<td>Abies alba (4,2)</td>
<td>Abies concolor (4,1)</td>
<td>Abies balsamea (2,1)</td>
</tr>
<tr>
<td>Larix decidua (4,3)</td>
<td>Picea glauca (4,2)</td>
<td>Abies grandis (4,1)</td>
<td>Abies lasiocarpa (3,1)</td>
</tr>
<tr>
<td>Picea sitchensis (4,3)</td>
<td>Pinus peuce (2,4)</td>
<td>Abies sibirica (4,1)</td>
<td>Abies procera (3,1)</td>
</tr>
<tr>
<td>Pinus mugo (4,3)</td>
<td>Pinus cembra (4,1)</td>
<td>Pinus contorta (4,1)</td>
<td>Larix kaempferi (3,1)</td>
</tr>
<tr>
<td>Pinus strobus (3,4) *</td>
<td>Pinus contorta (4,1)</td>
<td></td>
<td>Larix x maschlinii (3,1)</td>
</tr>
<tr>
<td>Tsuga heterophylla (4,3)</td>
<td></td>
<td></td>
<td>Larix sibirica (3,1)</td>
</tr>
</tbody>
</table>

*High score on the effect axis is due to being intermediate host for Cronartium ribicola (criterion 6, Tab. 2).
Plant invasions in the Czech Republic: current state, introduction dynamics, invasive species and invaded habitats

Rostlinně invaze v České republice: současný stav, dynamika zavlečení, invazní druhy a invadovaná stanoviště

Dedicated to the centenary of the Czech Botanical Society (1912–2012)

Petr Pyšek1,2, Milan Chytrý3, Jan Perg1, Jiří Sádlo1 & Jan Wild1

Quercus rubra L. (Fagaceae) is a tree up to 40 m tall, native to a large area in eastern North America where it is an important source of hardwood. It grows on a wide range of dry-mesic to mesic sites and occurs in various habitats ranging from nutrient-rich soils to sandy plains and rock outcrops. Currently the species is widely cultivated in temperate regions of Europe and Asia as a popular forestry and ornamental tree. It was introduced to Europe in 1691, and is known to have been planted in the Czech Republic since 1799 (Koblížek in Hejný et al. 1990). In this country, its use was mostly as a garden and park ornamental until several decades ago when it started to be introduced into forest plantations, often in monocultures; in the 2000s it was planted on more than 4000 ha (Křivánek et al. 2006). It is also used for reclaiming post-mining areas and for reforestation of arable land. It is now widespread, invading mainly in central and eastern Bohemia in the Elbe river lowland (Fig. 11). It is recorded from 14 habitat types (Table 2). Quercus rubra has a short juvenile period and spreads into surrounding vegetation because it is more shade-tolerant than native oaks. It prefers open forest on light, nutrient-poor soils. So far it does not spread outside forests. As a fast- and well-growing, shade-tolerant tree, it has an impact on forest understorey, exacerbated by slowly decomposing leaf litter inhibiting succession (Dobrylovská 2001). Economic evaluation of impact of Quercus rubra has been done for Germany and estimated that removal of invasive populations and restoration of invaded sites would cost 716,000 euros annually (Reinhardt et al. 2003).
<table>
<thead>
<tr>
<th>Species</th>
<th>Denmark</th>
<th>Belgium</th>
<th>Italy</th>
<th>Ireland</th>
<th>Malta</th>
<th>Norway</th>
<th>Portugal</th>
<th>Swiss</th>
<th>EPPO</th>
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<tbody>
<tr>
<td>Robinia pseudoacacia</td>
<td>Obs-List</td>
<td>WL B3</td>
<td>Black-List</td>
<td>Uncertain</td>
<td></td>
<td>HI</td>
<td>Annex I</td>
<td>Black-List</td>
<td></td>
</tr>
<tr>
<td>Ailanthus altissima</td>
<td></td>
<td>BL A2</td>
<td>Black-List</td>
<td>Uncertain</td>
<td>MPI</td>
<td></td>
<td></td>
<td>Black-List</td>
<td>Invasive</td>
</tr>
<tr>
<td>Prunus serotina</td>
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<td>BL A3</td>
<td>Black-List</td>
<td></td>
<td>HI</td>
<td></td>
<td></td>
<td>Black-List</td>
<td>Invasive</td>
</tr>
<tr>
<td>Quercus rubra</td>
<td></td>
<td>WL B3</td>
<td>Black-List</td>
<td>Uncertain</td>
<td></td>
<td>LO</td>
<td>Annex I</td>
<td>Black-List</td>
<td></td>
</tr>
<tr>
<td>Acacia dealbata</td>
<td></td>
<td></td>
<td>Potential</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Annex I</td>
<td>Watch-List</td>
</tr>
<tr>
<td>Lycium barbarum</td>
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<td></td>
<td>HI</td>
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<td>Invasive</td>
</tr>
<tr>
<td>Mahonia aquifolium</td>
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<td>HI</td>
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<td>Watch-List</td>
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<tr>
<td>Paulownia tomentosa</td>
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<td></td>
<td>Black-List</td>
<td>Potential</td>
<td></td>
<td></td>
<td></td>
<td>Annex II</td>
<td>Watch-List</td>
</tr>
<tr>
<td>Abies alba</td>
<td></td>
<td></td>
<td></td>
<td>HI</td>
<td>Annex I</td>
<td></td>
<td></td>
<td>Invasive</td>
<td></td>
</tr>
<tr>
<td>Amelanchier lamarckii</td>
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<td>WL B2</td>
<td></td>
<td></td>
<td>SE</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Amelanchier spicata</td>
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<td></td>
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<td>SE</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Picea sitchensis</td>
<td></td>
<td></td>
<td>Uncertain</td>
<td></td>
<td>SE</td>
<td></td>
<td>Annex II</td>
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<td></td>
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<tr>
<td>Pinus contorta ssp. contorta var. contorta</td>
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<td>Uncertain</td>
<td></td>
<td>PH</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Pinus nigra</td>
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<td></td>
<td>Black-List</td>
<td></td>
<td>LO</td>
<td>Annex I</td>
<td></td>
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</tr>
<tr>
<td>Prunus laurocerasus</td>
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<td>WL B1</td>
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<td></td>
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</tr>
<tr>
<td>Pseudotsuga menziesii</td>
<td></td>
<td></td>
<td>Uncertain</td>
<td></td>
<td>LO</td>
<td>Annex I</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Quercus cerris</td>
<td></td>
<td></td>
<td>Uncertain</td>
<td></td>
<td>LO</td>
<td>Annex II</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Rhus typhina</td>
<td></td>
<td>WL B1</td>
<td></td>
<td></td>
<td>NK</td>
<td></td>
<td>Black-List</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salix viminalis</td>
<td></td>
<td></td>
<td>Uncertain</td>
<td></td>
<td>PH</td>
<td>Annex I</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Alien Tree

<table>
<thead>
<tr>
<th>IN</th>
<th>Alien Tree</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Psedotsuga menziesii</td>
</tr>
<tr>
<td></td>
<td>Robinia pseudoacacia</td>
</tr>
<tr>
<td></td>
<td>Ailanthus altissima</td>
</tr>
<tr>
<td></td>
<td>Prunus serotina</td>
</tr>
<tr>
<td></td>
<td>Pinus strobus</td>
</tr>
<tr>
<td></td>
<td>Picea sitchensis</td>
</tr>
<tr>
<td></td>
<td>Acer negundo</td>
</tr>
<tr>
<td></td>
<td>Quercus rubra</td>
</tr>
<tr>
<td></td>
<td>Populus x canadensis</td>
</tr>
<tr>
<td>*</td>
<td>Pinus mugo</td>
</tr>
<tr>
<td>*</td>
<td>Acer pseudoplatanus</td>
</tr>
</tbody>
</table>

Alpine & Continental (but also Mediterranean and Pannonian, or even Atlantic)

This is just a very **preliminary selection** of species that are generally seen as problematic species (but, sometimes, also as beneficial ones) in many European countries within the Natura 2000 network.
SFM and biodiversity

The United Nations General Assembly defines sustainable forest management (SFM) as a “dynamic and evolving concept, which aims to maintain and enhance the economic, social and environmental values of all types of forests, for the benefit of present and future generations”.

The SFM concept encompasses both natural and planted forests in all geographic regions and climatic zones, and all forest functions, managed for conservation, production or multiple purposes, to provide a range of forest ecosystem goods and services at the local, national, regional and global levels.

Criteria and indicators developed for boreal, temperate and tropical forests provide a framework to assess, monitor and report on the implementation of SFM based on: the extent of forest resources; biological diversity; forest health and vitality; productive functions; protective functions; socio-economic functions; and the legal, policy and institutional framework. Certification processes and best-practices guidelines have been developed to guide, assess, attest to and monitor SFM at the forest management unit level.

There has been significant progress in implementing SFM, but many challenges remain. The objective of this series of fact sheets produced by the Collaborative Partnership on Forests is to inform decision-makers and stakeholders about some of the issues and opportunities facing the implementation of SFM in the 21st century.

For more information visit: www.cpfweb.org
Using forest management to control invasive alien species: helping implement the new European regulation on invasive alien species

Tommaso Sitzia · Thomas Campagnaro · Ingo Kowarik · Giovanni Trentanovi

Table 1  Example of silvicultural measures aimed at reducing the spread of four main invasive alien tree species in Europe

<table>
<thead>
<tr>
<th>Species</th>
<th>Example of silvicultural measures</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Acacia dealbata</em></td>
<td>Avoid clear cuts and openings(^{(1)})</td>
</tr>
<tr>
<td></td>
<td>Maintain or facilitate closed canopy and dense forest(^{(1, 2)})</td>
</tr>
<tr>
<td><em>Ailanthus altissima</em></td>
<td>Avoid coppicing(^{(3)})</td>
</tr>
<tr>
<td></td>
<td>Cutting seed plants, underplanting or seeding of shade-tolerant favour native species(^{(4)})</td>
</tr>
<tr>
<td><em>Prunus serotina</em></td>
<td>Avoid clear cuts and openings(^{(4-6)})</td>
</tr>
<tr>
<td></td>
<td>Underplanting or seeding of shade-tolerant native species(^{(4, 5)})</td>
</tr>
<tr>
<td></td>
<td>Aging with absence of treatments(^{(6, 7)})</td>
</tr>
<tr>
<td></td>
<td>Maintain or facilitate closed canopy and dense forest, favour native species(^{(8)})</td>
</tr>
<tr>
<td></td>
<td>Girdling(^{(9)})</td>
</tr>
<tr>
<td></td>
<td>Single-tree selection systems or group selection systems(^{(4, 8)})</td>
</tr>
<tr>
<td><em>Robinia pseudoacacia</em></td>
<td>Avoid coppicing(^{(3)})</td>
</tr>
<tr>
<td></td>
<td>Coppice aging(^{(6, 10)})</td>
</tr>
<tr>
<td></td>
<td>Favour native species, conversion from coppice to high forest(^{(4)})</td>
</tr>
<tr>
<td></td>
<td>Avoid clear cuts and openings(^{(4-6)})</td>
</tr>
<tr>
<td></td>
<td>Girdling(^{(11)})</td>
</tr>
</tbody>
</table>
Guiding principle 12: Mitigation of impacts

“Once the establishment of an invasive alien species has been detected, States, individually and cooperatively, should take appropriate steps such as eradication, containment and control, to mitigate adverse effects. ….”

Guiding principle 13: Eradication

“Where it is feasible, eradication is often the best course of action to deal with the introduction and establishment of invasive alien species. The best opportunity for eradicating invasive alien species is in the early stages of invasion, when populations are small and localized; hence, early detection systems focused on high-risk entry points can be critically useful while post-eradication monitoring may be necessary. ….”

Guiding principle 14: Containment

“When eradication is not appropriate, limiting the spread (containment) of invasive alien species is often an appropriate strategy in cases where the range of the organisms or of a population is small enough to make such efforts feasible. Regular monitoring is essential and needs to be linked with quick action to eradicate any new outbreaks. ….”

Guiding principle 15: Control

“Control measures should focus on reducing the damage caused as well as reducing the number of the invasive alien species. Effective control will often rely on a range of integrated management techniques, ….”

(CBD, 2002)
A. General
Guiding principle 1: Precautionary approach
Guiding principle 2: Three-stage hierarchical approach
Guiding principle 3: Ecosystem approach
Guiding principle 4: The role of States
Guiding principle 5: Research and monitoring
Guiding principle 6: Education and public awareness

B. Prevention
Guiding principle 7: Border control and quarantine measures
Guiding principle 8: Exchange of information
Guiding principle 9: Cooperation, including capacity-building

C. Introduction of species
Guiding principle 10: Intentional introduction
Guiding principle 11: Unintentional introductions

D. Mitigation of impacts
Guiding principle 12: Mitigation of impacts
Guiding principle 13: Eradication
Guiding principle 14: Containment
Guiding principle 15: Control
Planted forests and invasive alien trees in Europe: A Code for managing existing and future plantings to mitigate the risk of negative impacts from invasions

Giuseppe Brundu, David M. Richardson

1 Department of Agriculture, University of Sassari, Viale Italia 39, 07100 Sassari, Italy 2 Centre for Invasion Biology, Department of Botany & Zoology, Stellenbosch University, South Africa
AWARENESS

4.1 Awareness

4.1.1 Be aware of regulations concerning invasive alien trees

4.1.2 Be aware of which alien tree species are invasive or that have a high risk of becoming invasive, and of the invasion debt

4.1.3 Develop systems for information sharing and training programmes

PREVENTION & CONTAINMENT

4.2 Prevention & Containment

4.2.1 Promote – where possible – the use of native trees

4.2.2 Adopt good nursery practices

4.2.3 Modify plantation practices to reduce problems with invasive alien tree species

4.2.4 Revise general land management practices in landscapes with planted forests

4.2.5 Adopt good practices for harvesting and transport of timber

4.2.6 Adopt good practices for habitat restoration

EDRR

4.3 Early Detection & Rapid Response

4.3.1 Promote and implement early detection & rapid response programmes

4.3.2 Establish or join a network of sentinel sites

OUTREACH

4.4 Outreach

4.4.1 Engage with the public on the risks posed by invasive alien trees, their impacts and on options for management

FORWARD PLANNING

4.5 Forward Planning

4.5.1 Consider developing research activities on invasive alien trees species and becoming involved in collaborative research projects at national and regional levels

4.5.2 Take global change trends into consideration
Modify plantation practices to reduce problems with invasive alien tree species: (1/2):

Research findings should be applied to identify the most appropriate sites for cultivation within landscapes;

Biodiversity issues must be considered in plantation design (e.g., Carnus et al. 2006; COP 11 Decision XI/19 8 - 19 October 2012 - Hyderabad, India);

Avoid converting natural habitats for cultivation;

Restrict plantings to areas where alien tree species are already present;

Limit the total allowable area of planting, aggregate planting sites, and reduce the total boundary length;

Save or plant 2-3 rows of native and/or less invasive alien tree species around external boundaries or along margins of unplanted reserve areas inside plantations;

Design plantation shape to minimise edges at right angles to prevailing winds during seed release season;
Modify plantation practices to reduce problems with invasive alien tree species: (2/2):

Whenever possible, include sites with boundaries from where spread is difficult or acceptable (e.g., grazed areas, actively managed production forest, wide roads);

Whenever possible, use mixed-species plantations (Brockerhoff et al. 2008) and encourage structural diversity through different age classes (Evans 2009b);

Encourage the establishment of representative natural forest within the plantation estate and, where possible, restore natural forests on appropriate sites (Secretariat of the Convention on Biological Diversity 2009);

Prevent plantings at sites most favourable for long-distance dispersal of seed or pollen (hill tops, ridges);

Prevent plantings and minimize disturbance near wetlands, rivers and streams and create buffer zones;

Prevent plantings near Natura 2000 sites and other protected areas or endangered habitats;

Minimize soil movement, transport and disturbance in or around planted areas;

Stabilise disturbed soils as soon as possible.
In plantation forestry, climate change could affect the dynamics of alien tree invasions in many interacting ways, for example: (a) by causing modification in the native ecosystems **promoting range changes**, naturalisation and spread of both native and alien trees (e.g., Iverson et al. 2008; McKenney et al. 2011); (b) by **favouring individual traits** of particular alien trees (e.g. Capdevila-Argüelles & Zilletti 2008; Kawaletz et al. 2013; Castro-Díez et al. 2014); and (c) by **modifying introduction pathways** and promoting a larger use of certain alien trees (Courbet et al. 2012; Lindenmayer et al. 2012) including a process of **re-thinking the importance of always choosing native species** (UK Forestry Commission). Also **assisted migration** has been proposed as a means to maintain forest productivity, health, and ecosystem services under rapid climate change (e.g., Gray et al. 2011; Kreyling et al. 2011; Pedlar et al. 2012).
Climate change is likely to increase the future demand for imported FRM as forest managers and owners try to identify tree species and provenances that will be able to grow in their land under new climatic conditions (Konnert et al., 2015).

Some parts of the current distribution ranges of forest trees are expected to become unsuitable while new areas are likely become suitable for many species in higher latitudes or altitudes. The accelerating speed of climate change has raised serious concerns on how tree species can cope with the projected changes. Furthermore, the warming climate will probably facilitate the spread of pests and diseases, creating an additional threat to forest trees and their populations.

Thank YOU