The EPPO prioritization process for invasive alien plants

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Although invasive alien plants are gaining increased attention within EPPO countries, there is no existing widely agreed method to identify those alien plants that are considered invasive and represent the highest priority for pest risk analysis. In the framework of the *ad hoc* Panel on Invasive Alien Species, EPPO proposes a prioritization process for invasive alien plants designed (i) to produce a list of invasive alien plants that are established or could potentially establish in the EPPO region and (ii) to determine which of these have the highest priority for an EPPO pest risk analysis. The process consists of compiling available information on alien plants according to pre-determined criteria, and can be run at the EPPO region level, or at a country or local area level. These criteria examine whether the species is alien in the area under study, and whether it is established or not. The criteria used primarily rely on observations in the EPPO region but, if the species is not established, the invasive behaviour of the species in other countries should be investigated, as well as the suitability of the ecoclimatic conditions in the area under consideration. The spread potential, the potential negative impacts on native species, habitats and ecosystems, as well as on agriculture, horticulture or forestry are considered. If the species qualifies as an invasive alien plant of major concern through this first set of questions, the process then investigates the efficiency of international measures (to be justified through a pest risk analysis) to prevent the entry and spread of the species. The second set of questions are designed to determine whether the species is internationally traded or enters new countries through international pathways for which the risk of introduction is superior to natural spread, and whether the species still has a significant suitable area for further spread. If used by several EPPO countries, this prioritization process represents an opportunity to provide consistent country lists of invasive alien plant species, as well as a tool for dialogue and exchange of information.

Introduction

One of EPPO's objectives is to develop an international strategy against the introduction and spread of pests that damage cultivated and wild plants, in both cultivated and uncultivated ecosystems. Since 2002, this includes specific activities on invasive alien plants and a specific *ad hoc* Panel on Invasive Alien Species has been created which has the following aims:

- to collect data on invasive alien plants in the EPPO region,
- to collect information on official control measures existing in the EPPO region for invasive alien plants,
- to conduct pilot studies on pest risk assessment and pest risk management of specific invasive alien plants.

In 2002, the EPPO Secretariat asked EPPO member countries to submit lists of plants which were to be a basis for the compilation by the Secretariat of a general list of invasive alien plants for the EPPO region. Replies were received from 16 EPPO member countries. A preliminary prioritization of these species was performed by expert judgment (details about this prioritization process are presented in Appendix 1).

Since this was conducted by the *ad hoc* Panel on Invasive Alien Species, several plants have been added to the EPPO list of

invasive alien plants and the Panel considered that a prioritization process should be developed and described more precisely. The purpose of this document is to describe the criteria used in the prioritization process. Such a process may also be used at a national or biogeographical level.

Terms used in this document follow ISPM no. 5 *Glossary of Phytosanitary Terms* (IPPC, 2010). They are presented in Appendix 2 together with other terms from the Convention on Biological Diversity.

Objectives

This process is designed (i) to produce a list of invasive alien plants that are established or could potentially establish in the EPPO region and (ii) to determine which of these have the highest priority for an EPPO Pest Risk Analysis (PRA).

The highest priority for performing PRA is given to species that satisfy one or more of the following:

- are spreading rapidly (or are known to have a capacity to spread rapidly)
- are capable of causing major economic and environmental impacts.
- are moved from country to country primarily by human activities
- still have a significant area suitable for further spread and can still be eradicated or contained

It should be kept in mind that the process is designed to perform rapid assessments, and to provide structured and traceable information on species. It does not in any way provide a substitute for a PRA.

Methods

The process is applied to lists of plants which are considered invasive alien plants or potential invasive alien plants in EPPO member countries, but it can be applied to any plant.

The process was initially designed to be used at the level of the EPPO region, but can be used at any regional, national or local level.

The process consists of compiling available information on alien plants according to pre-determined criteria. To consider whether a species already present in the EPPO region qualifies as an invasive alien plant, the criteria used primarily rely on observations and invasion histories in the EPPO region.

The process produces several lists of plant species, the most important being the list of invasive alien plants for the EPPO region, the list of potential invasive plants for the EPPO region and the list of priority species for performing a PRA. For all species, information gathered is included in a database. The process is summarized in Fig. 1.

Information gathering

A database of all species considered by the process has been created on the basis of available sources of information such as: national lists of invasive alien plants, information provided to EPPO by NPPOs (in particular through questionnaires), scientific literature, personal communications from scientists and amateur botanists, websites and databases on invasive alien plants, etc. Information is updated on a regular basis. This database includes all references and contacts to allow traceability.

For each species the type of information available in the database includes:

- family,
- origin,
- whether the plant is aquatic or can grow in aquatic environments,
- known presence/absence and characterization (established, transient) of the species in each EPPO country,
- spread potential of the plant,
- ability to colonize uncultivated and cultivated habitats,
- detrimental impacts,
- whether the species is recorded as traded.

Whenever possible, evidence should be obtained from previously observed invasive behaviour in the EPPO region. Information on invasive behaviours elsewhere may also provide guidance. When contradictory information is found within the EPPO region, the worst case should be considered. As much information as possible should be included when documenting each species, and references should be provided. Communication between experts may be organized to increase the quality of the outcome of this process. For questions which need a rating, a three point scale (i.e. low, medium, high) is used, as in Branquart (2007). Uncertainty should be recorded for questions on spread and impact, and should be summarized in an overall uncertainty rating of low, medium or high.

Lists of results

The first step produces 4 different lists of invasive alien plants for the EPPO region:

- Lists of plants established in the EPPO region:
  - The list of invasive alien plants.
    Plants in this list will be submitted to the second step of the process to establish priorities between species for which an EPPO PRA is needed.
  - The observation list of invasive alien plants.
    More information is needed on these species to determine their invasive behaviour in the EPPO region.
- Lists of plants not known to be established in the EPPO region:
  - The list of potential invasive alien plants.
    The plants in this list will be submitted to the second step of the process to establish priorities between species for which an EPPO PRA is needed.
  - The observation list of potential invasive alien plants.
    More information is needed on these species.

The list of invasive alien plants contains species that have already shown highly invasive behaviour in the EPPO region.

The list of potential invasive alien plants contains species that are not yet established in the EPPO region, have proven to be

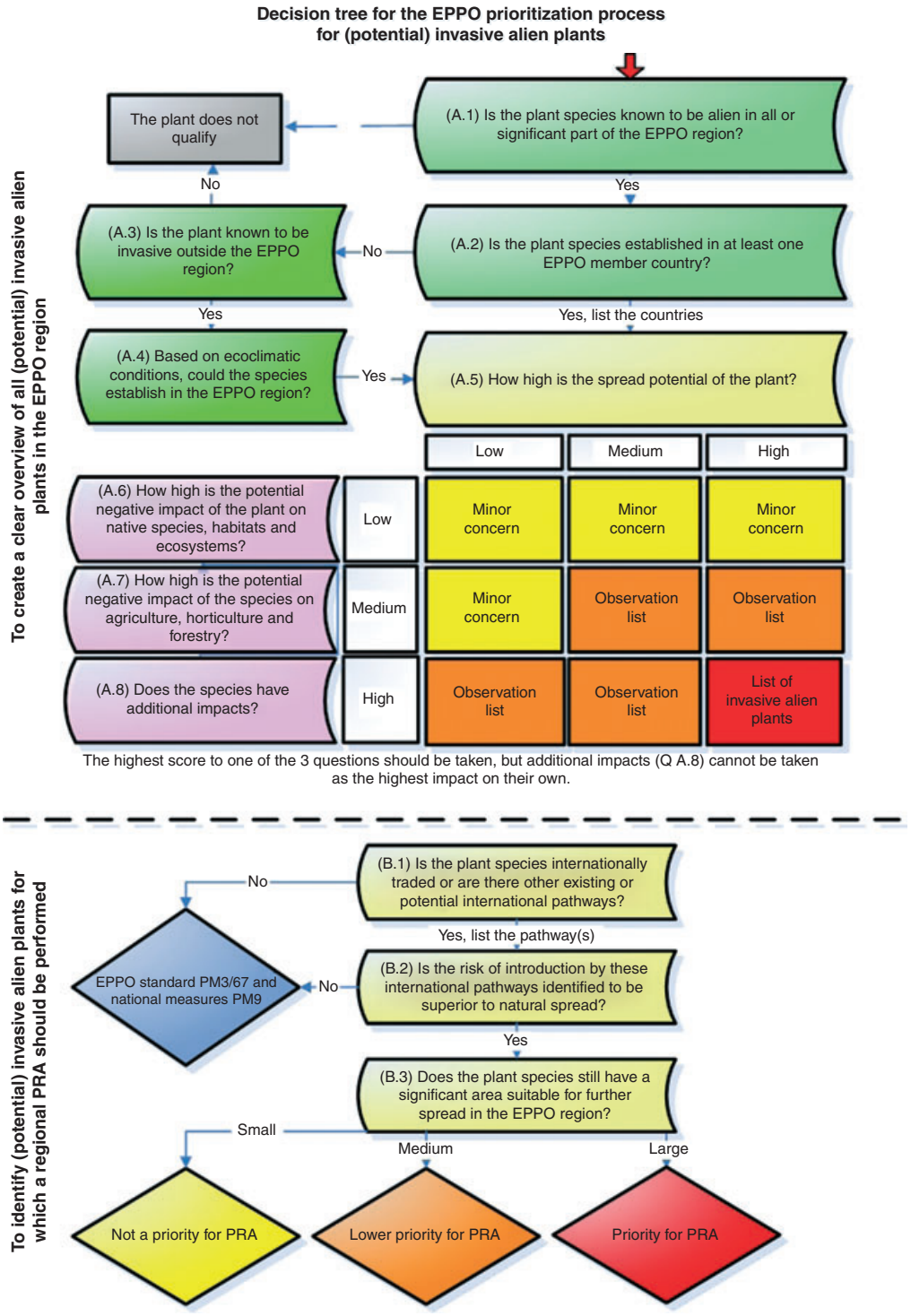

Fig. 1 EPPO prioritization process for invasive alien plants.

highly invasive outside the EPPO region, and are considered to represent a high risk of invasive behaviour in the future in the EPPO region.

The observation lists contain species of concern if shifts in invasive behaviour occur or if knowledge improves. It is stressed that inclusion in the observation list is not definitive, and changes can be made when additional information is recorded, particularly when information on invasiveness becomes available.

The second step of the process will consider the species on both the list of invasive alien plants and the list of potential invasive alien plants to prioritize the species for which an EPPO PRA is needed. Two outcomes are possible:

- International action might prevent the risk of introduction and spread of the species: a PRA should be performed as a priority aiming to produce international recommendations. The EPPO Standard PM 3/67 *Guidelines for the management of invasive alien plants or potential invasive alien plants which are intended for import or have been intentionally imported* may be used to identify international actions. The larger the area for further spread of the species, the higher the priority for PRA.
- International action is not recommended. An EPPO PRA is not considered a priority, but national action could be recommended, see EPPO Standard PM 3/67, *Guidelines for the management of invasive alien plants or potential invasive alien plants which are intended for import or have been intentionally imported.*

A. Prioritization process scheme for the elaboration of different lists of invasive alien species or potential invasive alien species (pests or potential pests) for the EPPO region

See Fig. 1 for the summary of this process in the form of a decision tree.

A.1 Is the plant species known to be alien in all or a significant part of the EPPO region?

Note: Tutin *et al.* (1964/80) (Flora Europeae) is taken as the reference to state whether a plant species is indigenous or not in the Western and Central EPPO region. Other references may be used for other areas: Maire (1952–1987) for North-Africa, Davis (1965–1985) for Turkey, etc.

The EPPO region is huge and comprises different biogeographical areas. For instance, whereas *Heracleum mantegazzianum* is native to the Caucasus (EPPO region), it is alien in Western European countries. The answer to this question for *H. mantegazzianum* would therefore be yes as it is alien in a significant part of the EPPO region.

For the purpose of the process of prioritization, the answer to this question should also be yes for those species that are not present in the EPPO region.

If yes: go to A.2

If no: the plant does not qualify as an alien plant for the EPPO region.

A.2 Is the plant species established in at least one EPPO member country?

If yes: List the countries and go to assessment of spread and impacts. (Questions A.5–A.8).

If no: the plant has never been observed in the wild in the EPPO region or is only recorded as transient and may be in the process of establishment. **Go to A.3**

Invasive behaviour outside the EPPO region

A.3 Is the plant species known to be invasive outside the EPPO region?

Note: As the species is not established in the EPPO region, it is only possible to assess its behaviour elsewhere (i.e. potential to spread easily in the environment and to affect native biodiversity and/or managed ecosystems). The fact that the species is reported as invasive elsewhere, at least in regions having similar ecological and climatic conditions, is considered as one of the most relevant criteria in predicting the invasive behaviour of a species (Williamson, 1996).

Note that transient species may still have seasonal adverse impacts, such as *Eichhornia crassipes* and *Pistia stratiotes* in the Netherlands (Bruinsma, 2000).

If yes: go to A.4

If no: the plant does not qualify as a potential invasive alien plant for the EPPO region and is considered of minor concern.

Assessment of establishment and spread

A.4 Based on ecoclimatic conditions, could the species establish in the EPPO region?

Note: Aquatic plants are less susceptible to climate than terrestrial plants, and this element should be taken into account while answering this question.

World hardiness zones map (Magarey *et al.*, 2008) and World Köppen-Geiger climate classification map (Kottek *et al.*, 2006) can be used to compare the areas where the species is recorded and the area under assessment (See maps: Figs A1 and A2 in Appendix 3).

If yes: go to assessment of spread and impacts. (Questions A.5–A.8).

If no: the plant does not qualify as a potential invasive alien plant for the EPPO region and is considered of minor concern. For instance, the tropical plant *Psidium cattleianum* (Myrtaceae) is unlikely to establish in almost all parts of the EPPO region.

Assessment of spread and impacts

Questions A.5, A.6, A.7 and A.8 all have to be assessed independently. The results from other questions should not influence the answers.

As far as possible, evidence should be obtained from records of invasive behaviours in the EPPO region. Information on invasive behaviours elsewhere may also provide guidance.

It should be ensured that suitable habitats are present in the area under assessment (e.g. mangroves and some specific cropping systems are not found in the EPPO region).

Any impact through hybridization on native plant species, crops or wild crop relatives should also be considered in this section

A.5 How high is the spread potential of the plant?

Note: This section addresses the potential of an organism to spread to unintended habitats by natural means (water, birds, wind, etc.) or by unintentional human assistance (movement of soil, discarded aquarium plants, etc.) via seeds, plant fragments or any other propagules able to regenerate a plant. Intentional introduction by man is not taken into consideration so as to focus on the intrinsic spread capacity of the species. The potential effects of climate change should also be taken into account while considering this question.

- **Low**: the plant does not spread because of poor dispersal capacities (e.g. gravity dispersal) and a low reproduction potential. Propagules are rarely found over distances exceeding a few meters from the mother plant. For example *Aloe vera* does not reproduce vegetatively and hardly produces seeds.
  Go to the assessment of impacts
- **Medium**: the plant reproduces vigorously vegetatively and/or sexually and mainly spreads in the vicinity of the mother plant; dispersion capacity in the environment rarely exceeds 100–200 m from the mother plant. For example *Quercus rubra* reproduces by seeds and stem sprouts which are dispersed around the mother plant. Examples of medium spread include species dispersed by wind but with heavy diaspores or spread by ants. Unintentional dispersion by man is infrequent.
  Go to the assessment of impacts
- **High**: the plant is highly fecund and is regularly observed to spread over distances >500–1000 m from the mother plant, either
  - by water; especially species invading riparian habitats that have diaspores with high buoyancy. For example fruits, seeds or fragments of aquatic or riparian herbaceous plants like *Heracleum mantegazzianum*, *Impatiens glandulifera* or *Ludwigia* spp. but also of primarily wind-dispersed ornamental trees like *Acer negundo, Ailanthus altissima* or *Fraxinus pennsylvanica* (Säumel & Kowarik, 2010).
  - by wind; especially species with light seeds and/or seeds with special adaptations to long-distance dispersal such as pappus. For example *Cortaderia selloana* produces thousands of seeds which are wind dispersed over long distances.
  - by animals; especially species with edible fruits dispersed by birds and other highly mobile animals. For example seeds of *Opuntia ficus-indica* and *Prunus serotina* are dispersed by birds feeding upon fruits (Pairon *et al.*, 2006; Deckers *et al.*, 2005).
  - spread unintentionally by human activities (movement of soils, dispersed by farm machinery or by traffic vehicles). For example *Ambrosia artemisiifolia* is dispersed along roads by vehicles and by machines used to mow road verges; rhizomes of *Fallopia* spp. are often dispersed with soil movements. **Go to the assessment of impacts**

Uncertainty rating: Low Medium High

A.6 How high is the potential negative impact of the plant on native species, habitats and ecosystems?

Note: This addresses the potential for a plant to induce long term population loss affecting rare and threatened species and to cause serious habitat or ecosystem effects that are difficult to reverse. Ecosystem effects include disruption of natural processes (alteration of food webs, modification of nutrient cycling, alteration of natural successions) and modification of habitat structure (light interception, water cover, alteration of river banks, etc.).

The potential to displace native species by competitive interactions (including allelopathy, competition for pollinators, etc.) and to alter ecosystems is difficult to demonstrate and is rarely documented in the scientific literature, especially at the beginning of the invasive behaviour process. As these effects are known to be typically density-dependent (Richardson *et al.*, 1989, 2000; Bímová *et al.*, 2004), such impacts can be estimated by considering the species' ability to build large, dense and persistent populations (cover of at least 80%), as proposed by Brunel & Tison (2005) and Branquart (2007). This is expected to be more often encountered with perennial plants than with annual plants, especially tall perennials (Hejda *et al.*, 2009). There are exceptions for alien species hybridizing with native species, which may pose a high risk even at low densities of the alien plant (Daehler & Strong, 1997; Huxel, 1999; Wolf *et al.*, 2001).

Serious effects on biodiversity may occur in habitats of value for nature conservation, where rare or threatened species are likely to occur and in areas of endemism (e.g. islands). For the habitats of value for nature conservation in Europe, see for instance the list of habitats in the Appendix 1 of the Directive 92/43/EEC.

- **No information available**
- **Low**: the plant does not form dense persistent populations and rarely colonizes habitats that have a value for nature conservation. For example *Oxalis stricta* is found in disturbed or man-made habitats without making dense populations. This can also be the case for summer annuals invading riverbeds, such as *Xanthium* spp.
- **Medium**: the plant forms large, dense and persistent populations only in habitats modified by human activities and/or occurs in habitats that have value for nature conservation but does not form large, dense and persistent populations. For example *Amelanchier lamarckii* is found in some high conservation value habitats without making dense populations (Muller, 2004), this is also the case for *Berteroa incana*.
- **High**: the plant is reported to colonise habitats that have a value for nature conservation where it forms large, dense and persistent populations. For example *Crassula helmsii, Eichhornia crassipes* and *Ludwigia grandiflora* in water bodies (Langdon *et al.*, 2004; Muller, 2004; Ruiz Téllez *et al.*, 2008), *Carpobrotus* spp. and *Rosa rugosa* in dune ecosystems (Muller, 2004; Kollmann *et al.*, 2007), *Acer negundo* in alluvial forests (Wittenberg, 2005).

  Alien plant species that may easily produce fertile hybrids with native congeneric species may pose a significant risk to the survival of these plant species by assimilation/introgression, even if they do not form dense populations. They therefore should be considered in this category. Examples include: *Spartina alterniflora* × *S. foliosa* in the San Francisco Bay (Daehler & Strong, 1997), *Hyacinthoides hispanica* × *H. non-scripta* in Scotland (Kohn *et al.* 2009), *Populus x canadensis* which threatens *Populus nigra* in Central Europe (Bleeker *et al.*, 2007; Smulders *et al.*, 2008).

  Species that significantly alter soil conditions are also considered, e.g. nitrogen fixing species that increase nitrogen soil content such as *Robinia pseudacacia, Acacia* spp. (Marchante *et al.*, 2008) and *Lupinus polyphyllus* (Fremstad, 2006); as well as species modifying soil pH and/or organic

content due, for example, to low decomposition rate, such as *Carpobrotus* spp. (Conser & Connor, 2009).

Uncertainty rating: Low Medium High

A.7 How high is the potential negative impact of the species on agriculture, horticulture or forestry?

Note: Negative impacts on managed areas such as parks or golf courses should also be considered in this sector.

- **No information available**
- **Low**: no yield or other economic losses are reported, the species is mainly reported as 'accidental': the presence of the species is sporadic and generally only a few individuals are found in the crop. Even where the species is frequent or abundant, it is a weak competitor, e.g. *Coronopus didymus* is a small creeping species, which usually has a scattered distribution and a low competitiveness in most crops, even when the species forms dense populations.
- **Medium**: yield or other economic losses are reported, but only occur in particular conditions (e.g. with inappropriate management practices, under favourable climatic conditions for the pest, etc.). For example, *Amaranthus retroflexus* (Vizantinopoulos & Katranis, 1998), *Galinsoga parviflora* and *Galinsoga quadriradiata* (Rai & Tripathi, 1983, 1986a,b) in maize.
- **High**: the species is frequently reported to cause significant yield reduction or other significant economic losses: the species can be dominant in a crop with regular management and is often very abundant, e.g. *Solanum elaeagnifolium* in orchards or potato fields (Mekki, 2007), *Sorghum halepense* in sorghum, sunflower or maize (Pal, 2004), *Panicum* spp. (Holec *et al.*, 2002; Clements *et al.*, 2004), and *Sicyos angulatus* (Shimizu, 1999; Smeda & Weller, 2001) in maize; *Eichhornia crassipes* blocks waterways and irrigation channels (Gopal, 1987). *Prunus serotina* causes yield reduction and increases control costs in forestry and impedes the natural rejuvenation of forest trees (Starfinger *et al.*, 2003; Decocq, 2007). Crop-wild and crop-weed hybridization is also recognized as being very important in generating more noxious weeds (Campbell *et al.*, 2006). For example the hybridization of wild and cultivated sunflower (*Helianthus annuus*) has formed hybrids in Spain and France that evolved to become locally invasive weedy populations (Muller *et al.*, 2009).

Uncertainty rating: Low Medium High

A.8 Does the species have additional impacts (e.g. on animal and human health, on infrastructures, on recreational activities, etc.)?

(If yes, list them and notify competent authorities)

- **No information available**
- **Low**: *Datura stramonium* is a toxic plant when ingested.
- **Medium**: *Rhus toxicodendron* is established in the Netherlands and in France and causes burns when in contact with the skin.
- **High**: *Ambrosia artemisiifolia* has a high impact on human health as its pollen is considered to be allergenic to 10% of the population.

Uncertainty rating: Low Medium High

The overall uncertainty for Part A should be summarized:

Overall uncertainty rating: Low Medium High

Please, report results to questions on impacts (A.6, A.7 and A.8) into the following matrix (Fig. 2) to categorize the species. The highest score should be considered. Nevertheless, impacts listed in question A.8 cannot be taken on their own as the highest impacts. Indeed, these additional impacts are worth considering but are not the responsibility of National Plant Protection Organizations if they are not coupled with other economic impacts.

When no information is available for a species, the process does not allow any conclusion to be made.

Those species that have both a high spread potential and a high impact (either on cultivated or uncultivated ecosystems) are included on the list of (potential) invasive alien plants. Species with either medium spread or impacts are included in the observation list. Other species with high impact are included in the observation list even if they have a low spread. All other species are considered of minor concern.

The conclusions of the process can be presented in a matrix (see Fig. 2). A few examples of invasive alien plants which have been the object of the prioritization at the level of the EPPO regions are also presented in a table in Appendix 4 (Table A1).

B. Prioritization process scheme for the identification of (potential) invasive alien plants for which a regional PRA is needed

B.1 Is the plant species internationally traded or are there other existing or potential international pathways?

Note: The species may be intentionally imported, e.g. for ornamental purposes (as a plant to be planted in the wild, as an aquarium plant, etc.), for agricultural or forestry purposes, e.g. as a bio-energy crop or for research purposes. The species may be unintentionally imported as, for example a contaminant of consignments (of grain, of seeds, of soil as a growing medium, etc.), or as hitchhikers on travellers or machinery.

National pathways that only spread the plant within a given country are not considered (e.g. natural spread over short distances, movements of soil within a country, movement of cattle within a country, etc.).

If yes: at least one international pathway is identified, **list the pathways**, **Go to B.2**

If no: only national pathways are identified, this plant is not a priority for EPPO PRA, see EPPO Standard PM 3/67, on *Guidelines for the management of invasive alien plants or potential invasive alien plants which are intended for import or have been intentionally imported*. Recommendations for management at a national level through National Regulatory Control Systems (PM9) may be developed.

B.2 Is the risk of introduction by these international pathways identified to be superior to natural spread?

Note: As stated in ISPM No. 11 *Pest risk analysis for quarantine pests including analysis of environmental risks and living*

		A.5 – Spread potential		
		Low	**Medium**	**High**
Adverse impacts (maximum rating from questions A.6, A.7 and A.8)	**Low**	Minor concern	Minor concern	Minor concern
	Medium	Minor concern	Observation list	Observation list
	High	Observation list	Observation list	**List of (potential) invasive plants** **Go to B.1.**

Fig. 2 Matrix combining spread potential and adverse impacts.

modified organisms, 'Measures are not justified if the risk is already acceptable or must be accepted because it is not manageable (as may be the case with natural spread)'.

If yes: **Go to B.3**

If no: This plant is not a priority for PRA, see EPPO Standard PM*3*/67 *Guidelines for the management of invasive alien plants or potential invasive alien plants which are intended for import or have been intentionally imported*. Recommendations for management at a national scale through National Regulatory Control Systems (PM9) may be made (e.g. *Senecio inaequidens*).

B.3 Does the plant species still have a significant area suitable for further spread in the EPPO region?

Note: Consider the extent to which the species has colonised all suitable habitats in the areas where ecological factors favour its establishment in the EPPO region. This will depend on the area invaded and the number of distinct populations.

The figures provided below are only indicative:

- **Small area suitable for further spread**: More than 40% of the potential suitable area in the EPPO region is already occupied, e.g. *Carpobrotus* spp., *Ailanthus altissima*.
  A PRA is not considered a priority.
- **Medium area suitable for further spread**: 10–40% of the potential suitable area in the EPPO region is currently occupied, e.g. *Cortaderia selloana, Buddleia davidii.*
  These species are lower priorities for PRA.
- **Large area suitable for further spread**: Less than 10% of the potential suitable area in the EPPO region is currently occupied e.g. *Althernathera philoxeroides, Ludwigia grandiflora* and *L. peploides.*
  These species are high priorities for PRA

Discussion and conclusion

The need to standardize approaches

The standardization of invasiveness assessment is a major prerequisite for developing early warning and information systems across EPPO countries. The results of a recent survey (Genovesi *et al.*, 2010) show that international coordination is still lacking and that common data, protocols and standards are still needed. The EPPO prioritization process is intended as a simple and flexible tool to provide consistent lists of invasive alien plant species for EPPO countries, and to allow constructive discussions on and comparisons of invasive alien plants. It also enhances the exchange of data on invasive alien plants between EPPO countries and helps priorities to be identified for prevention and rapid eradication measures. Its use can also reduce the variability between invasiveness assessments when done in the framework of a group composed of different experts (Branquart *et al.*, 2010). It is also important to provide straight-forward and transparent criteria that can be presented to relevant stakeholders such as land managers, the horticultural industry, as well as the general public so as to be able to justify and explain actions to be undertaken on invasive alien plants.

Three types of potential negative impacts are considered in the process: impacts on native species, habitats and ecosystems, impacts on agriculture, horticulture or forestry, as well as additional impacts (e.g. on animal and human health, on infrastructures, on recreational activities, etc.). It is to be noted that both environmental and agricultural impacts are considered, the prioritization process being intended to create synergies between these two sectors.

Definitions and concepts

The prioritization process has two particularities.

First, it considers both the spread potential of a species and its behaviour in the environment and agricultural systems (leading to impacts) to reach a conclusion on its invasive behaviour. In this regard, adverse impacts (assessed through the behaviour of the species) have a higher weight than the spread potential. Indeed, a species causing high impacts but having a low spread capacity is registered on the observation list, while a species with a high spread potential and a low impact is considered of minor concern.

Second, the prioritization process proposes as a proxy to environmental impacts the ability of an alien plant to form dense persistent populations in habitats that are valuable for nature conservation.

The integration of both spread and adverse impacts in the assessment of a species (including environmental, agricultural and other impacts) fits with the Convention on Biological Diversity's definition of an invasive alien plant and its explanation in the IPPC Context, although the prioritization process also considers impacts other than solely environmental ones. The prioritization process also extends the definition of a pest according to the IPPC (2010; any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products) in integrating other types of impacts than those to plants or plant products.

Other definitions of an invasive alien species exist in the academic world. Richardson *et al.* (2000) define an invasive alien plant according to its spread capacity (Naturalized plants that produce reproductive offspring, often in very large numbers, at considerable distances from parent plants (approximate distances >100 m in <50 years for taxa spreading by seeds and other propagules; >6 m in 3 years for taxa spreading by roots, rhizomes, stolons, or creeping stems), and thus have the potential to spread over a considerable area). The EPPO prioritization process registers in the list of (potential) invasive alien plants species that are closer to the definition of a 'transformer species' provided by Richardson *et al.* (2000) 'A subset of invasive plants which change the character, condition, form or nature of ecosystems over a substantial area relative to the extent of that ecosystem', except that in the prioritization process, EPPO also considers further impacts than the ones on ecosystems.

As stressed by Colautti & MacIsaac (2004), using the term 'invasive' implies subjective criteria with the use of words such as 'nuisance' or 'impacts' which have more to do with human perception than with any inherent ecological characteristic. They therefore advocate the use of an invasion framework. These authors consider that an established species (stage III according to their framework) can become widespread and dominant (Stage V) when they overcome 2 filters: the 'local dispersal' and the 'environment and community suitability' ones. This approach is in line with the EPPO prioritization process, the 'local dispersal' factor corresponding to the spread potential of the species (question A.5) leading to the widespread distribution of a species, and the 'environment and community suitability' corresponding to the ability of a species to form dense and persistent populations (question A.6) leading to its dominance in ecosystems. Species considered on the (potential) list of invasive alien plants by the EPPO prioritization process in its stage A therefore correspond to plants which have the potential to be in stage V of Colautti & MacIsaac (2004). As the prioritization process aims to identify emerging invasive alien plants, the priority species considered in stage B are identified while they still have a limited distribution, and are in the stage IVb of Colautti & MacIsaac (2004). The EPPO prioritization process attempts to characterize the invasive behaviour of a plant with concrete elements and guidance concerning impacts on native species, habitats and ecosystems, and on agriculture, horticulture or forestry. As recommended by Colautti & MacIsaac (2004), the prioritization process can be considered as a useful invasion framework which is process-based and includes operational terms.

The outcomes of the EPPO prioritization process are also in line with Valéry *et al.* (2008) according to which 'a biological invasion consists of a species' acquiring a competitive advantage following the disappearance of natural obstacles to its proliferation, which allows it to spread rapidly and to conquer novel areas within recipient ecosystems in which it becomes a dominant population'. According to these authors, 'a biological invasion is characterized by its rapidity' and 'the overwhelming competitive advantage of an invasive species always results in an exponential-type increase of the demography and/or of spatial occupation'. In the EPPO prioritization process, the rapidity of the phenomenon is indeed captured in assessing the spread potential of the species in question. The competitive advantage of the species in recipient ecosystems and its dominance are then evaluated in question A.6 when considering the ability of the species to form dense persistent populations. In this sense, the EPPO prioritization process evaluates the intrinsic behaviour of a species in a given environment rather than considering effects or consequences, which are as Valéry *et al.* (2008) state 'circumstantial and variable'.

Further steps

The method will be used in the near future at workshops with experts from different EPPO countries to provide agreed lists of emerging invasive alien plants. The EPPO lists of plants, i.e. the EPPO alert list and the EPPO list of invasive alien plants, will be processed through the prioritization process in order to provide documented advice on each species and identify those species that represent the highest risk. The species can be considered at the level of one or more biogeographical regions to allow comparisons between the countries of the region, as well as between different regions. Such an exercise has been undertaken to identify emerging invasive alien plants relevant for the Mediterranean Basin (Brunel *et al.*, 2010). The acquired experience will enhance the implementation of the prioritization process and add further case studies. The EPPO prioritization process, if used by several countries, could open the field to further work on invasive alien plants in partnership with other organizations.

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Méthode OEPP de priorisation des plantes exotiques envahissantes

Bien que les plantes envahissantes soient l'objet d'une attention croissante au sein des pays de l'OEPP, il n'existe pas de méthode largement acceptée pour identifier les espèces exotiques qui sont considérées comme envahissantes et qui représentent des priorités pour l'analyse du risque. Dans le cadre du Panel ad hoc sur les espèces envahissantes, l'OEPP propose une méthode de priorisa-

tion pour les plantes exotiques envahissantes qui a pour but de (i) produire une liste de plantes exotiques envahissantes naturalisées ou qui pourraient potentiellement s'établir dans la région OEPP et (ii) de déterminer lesquelles de ces espèces représentent des priorités pour l'analyse du risque phytosanitaire à l'échelle de la région OEPP.

La méthode consiste à compiler les informations disponibles sur des espèces exotiques en fonction de critères prédéterminés. La priorisation peut être conduite aussi bien à l'échelle de la région OEPP, qu'à l'échelle nationale ou locale. Les critères examinent si l'espèce est exotique du territoire considéré et si elle y est établie ou non. L'information utilisée s'appuie en premier lieu sur des observations réalisées dans la région OEPP. Si l'espèce n'est pas établie dans la région OEPP, son comportement envahissant ailleurs dans le monde devra alors être investigué, ainsi que l'adéquation des conditions éco-climatiques dans la zone considérée. La capacité de dissémination, les impacts négatifs potentiels sur les espèces natives, les habitats et les écosystèmes, ainsi que sur l'agriculture, l'horticulture ou la sylviculture sont analysés. Si à l'issue de ce premier groupe de questions, l'espèce s'avère être une plante exotique envahissante majeure, la méthode s'attachera alors à analyser l'efficacité de mesures internationales (devant être justifiées par une analyse du risque) pour en prévenir l'entrée et la dissémination. Ce second groupe de questions considère en effet si l'espèce est commercialisée internationalement ou est introduite sur de nouveaux territoires par le biais de filières internationales qui représentent un risque supérieur à la dissémination naturelle, et si l'espèce pourrait encore se disséminer sur des aires significatives. Cette méthode de priorisation, si elle est utilisée par plusieurs pays OEPP, représenterait une opportunité pour fournir des listes cohérentes de plantes exotiques envahissantes ainsi qu'une base pour le dialogue et l'échange d'informations.

Процесс установления приоритетов ЕОКЗР для чужеземных инвазивных растений

Несмотря на то, что на чужеземные инвазивные растения обращается все больше внимания в странах ЕОКЗР, в настоящее время не существует широко согласованного метода, позволяющего идентифицировать те чужземные растения, которые считаются инвазивными и представляют собой наибольший приоритет для анализа фитосанитарного риска. В рамках временной группы экспертов по чужеземным инвазивным видам ЕОКЗР предлагает создать процесс установления приоритетов для чужеземных инвазивных растений с тем, чтобы: (A) составить перечень чужеземных инвазивных растений, которые уже акклиматизировались или могли бы акклиматизироваться в регионе ЕОКЗР, и (B) чтобы определить те из них, которые обладают наибольшим приоритетом для анализа фитосанитарного риска. Процесс этот состоит из компиляции доступной информации относительно чужеземных растений по определенным критериям и может проводиться в масштабе либо региона ЕОКЗР, либо страны, либо зоны. Согласно этим критериям определяют, является ли тот или иной вид чужеземным в изучаемой области, и акклиматизировался ли он. Используемые критерии, прежде всего, основываются на наблюдениях, проводившихся в регионе ЕОКЗР, однако, если данный вид еще не акклиматизировался, следует исследовать его инвазивное поведение в других странах, а также пригодность экологических и климатических условий в изучаемой области. Рассматриваются также: потенциал распространения, возможные отрицательные воздействия на местные виды, среду обитания и экосистемы, а также на сельское хозяйство, садоводство или лесоводство. Если, проходя через этот первый набор вопросов, тот или иной вид характеризуется как инвазивное чужеземное растение первостепенной важности, исследуется эффективность международных мер (для обоснования с помощью анализа фитосанитарного риска), позволяющих предотвратить завоз и распространение этого вида. Второй набор вопросов был разработан с тем, чтобы определить, является ли такой вид предметом международной торговли или попадает ли он в новые страны по международным торговым путям, для которых риск интродукции превосходит риск естественного распространения, и имеется ли для таких видов обширная подходящая для их дальнейшего распространения зона. Благодаря использованию в нескольких странах ЕОКЗР, этот процесс установления приоритетов дает возможность создать согласованные для стран ЕОКЗР перечни чужеземных инвазивных видов растений, а также предпосылки для ведения диалога и обмена информацией.

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Appendix – 1 First prioritisation of Invasive Alien Plants (IAPs) in the EPPO region for pest risk analysis

At the first meeting of the EPPO Invasive Alien Species Panel in November 2002, it was agreed that, because a very large number of IAPs are already present in the EPPO region, it was important to set priorities for Pest Risk Analysis (PRA). The highest priority was given to those species that are considered to pose the greatest threat to species, habitats and ecosystems in the EPPO region and for which international regulations are likely to be most effective.

The following activities were conducted:

- A list of IAPs in the EPPO Region was created from the literature, web sites and official contacts in EPPO member countries.
- A preliminary prioritisation of species in the list (approximately 500) was undertaken to produce a list of 44 species based on:
  - the number of countries in which invasiveness had been reported
  - reported impacts
  - the extent to which the species is still spreading
  - expert judgement.
- EPPO member countries were requested to review the list of 500 species and, for the 44 species initially selected, confirm presence/absence, invasiveness and provide the following additional information:
  - date of first record
  - existence of a lag phase
  - original pathway of introduction/reintroduction
  - typical habitat(s)
  - geographical distribution within the country (with maps if available)
  - identification of areas where the species is creating most problems
  - abundance
  - existence of present pathways
  - mode of spread
  - cultivation (is the species cultivated or not?)
  - type of threat (see ISPM 11), severity of threat and recent change in severity.
  - is the species under official control or being considered for possible official control?
  - is the control of the species necessary and if yes what is its cost?
  - does the species present herbicide resistance?
- The responses from each country were considered for the 44 species and each species was scored from 0 (zero) to 3 (very high) according to expert judgement for:
  - general invasiveness
  - crop damage
  - damage to natural flora and habitats
  - damage to man-made disturbed habitats
  - still spreading?
- For each of the 44 species, whether international control measures should be developed was considered and whether a PRA is a high priority or whether national measures are more appropriate.
- The list was amended, taking into account new information received from EPPO member countries and obtained from the literature, particularly from the countries bordering the Mediterranean.
- An Action List of 34 IAPs was published on the EPPO web site in October 2005. Species in terrestrial (25) and aquatic (9) environments were distinguished.

Although the EPPO IAP Action List is accepted by EPPO member states as representing the species that are of very high priority for PRA, it is recognised that additional species, especially those that are poorly known or of limited distribution, may have been omitted or given an inappropriately low priority by the first prioritisation procedure. A second, more detailed, prioritization procedure has therefore been conducted to identify additional species, review the priorities made and, as appropriate, modify the Action List taking into account the new information received.

Appendix – 2 Definitions

Definitions from both the International Plant Protection Convention (IPPC) and the Convention on Biological Diversity (CBD) are provided.

International plant protection convention (from IPPC, 2010)

Endangered area: an area where ecological factors favour the establishment of a pest whose presence in the area will result in economically important loss.

Entry (of a pest): movement of a pest into an area where it is not yet present, or present but not widely distributed and being officially controlled.

Establishment: perpetuation, for the foreseeable future, of a pest within an area after entry.

An 'established plant' can also be referred to as a 'naturalized plant'.

Introduction: the entry of a pest resulting in its establishment.

Occurrence: the presence in an area of a pest officially reported to be indigenous or introduced and/or not officially reported to have been eradicated.

Pathway: any means that allows the entry or spread of a pest.

Pest: any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products.

Pest Risk Analysis: the process of evaluating biological or other scientific and economic evidence to determine whether a pest should be regulated and the strength of any phytosanitary measures to be taken against it.

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.

Spread: extension of the geographical distribution of a pest within an area.

Transience: Presence of a pest that is not expected to lead to establishment.

'Transient plants' can be referred to as 'casual plants'.

Convention on Biological Diversity

Definitions in this section were taken from the Convention on Biological Diversity Glossary of terms available at: http://www.cbd.int/invasive/terms.shtml **Alien species**: refers to a species, subspecies or lower taxon, introduced outside its normal past or present normal distribution; includes any part, gametes, seeds, eggs, or propagules of such species that might survive and subsequently reproduce.

Biodiversity: Article 2 of the United Nations Convention on Biological Diversity (CBD) defines the term, 'biological diversity' to mean the 'variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.'

Ecosystem: Means a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit (Article 2 of the Convention).

Invasive alien species means an alien species whose introduction and/or spread threatens biological diversity.

For further explanation of definitions see the Appendix of ISPM 5 for the terminology of the Convention on Biological Diversity in relation to the glossary of phytosanitary terms.

Appendix – 3

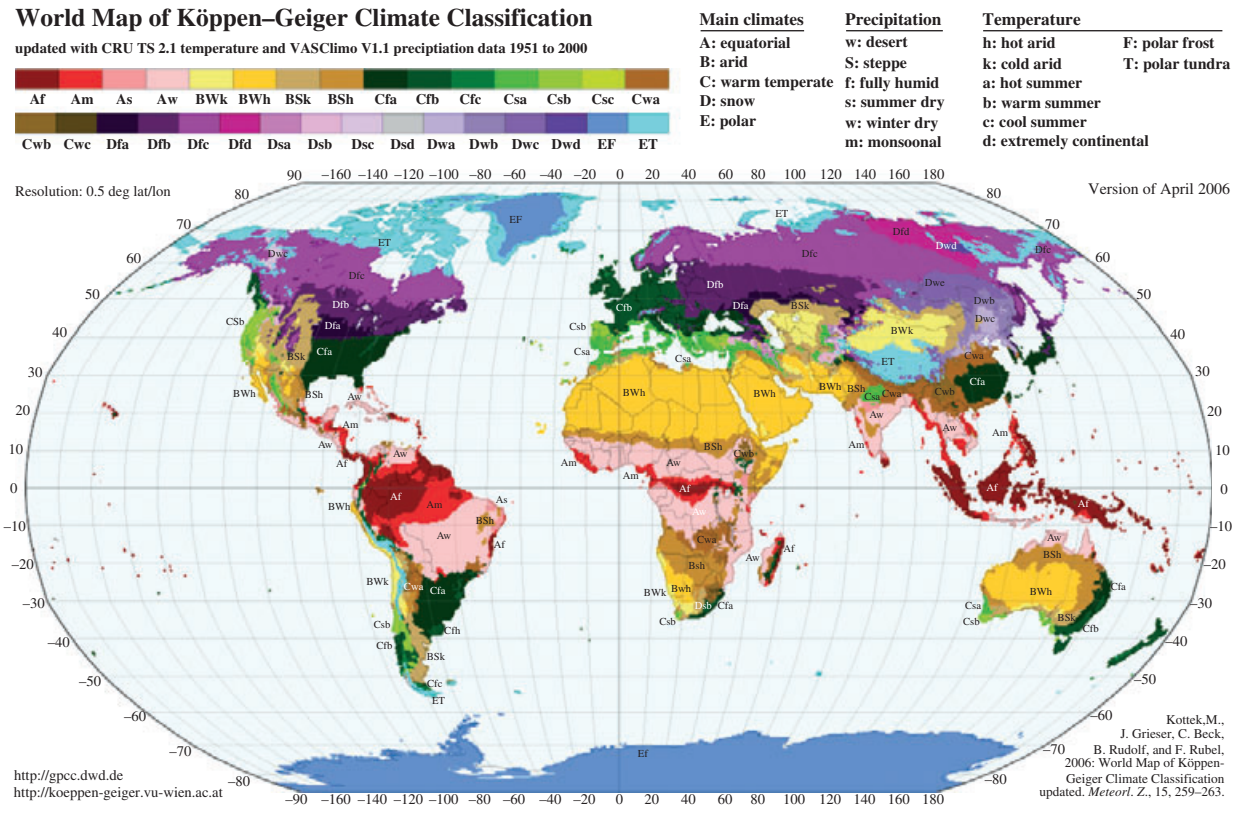

Fig. A1 World Map of the Köppen-Geiger climate classification updated. Adapted from Kottek *et al.* (2006) World Map of the Köppen-Geiger climate classification updated. *Meteorologische Zeitschrift* **15**, 259–263. DOI: 10.1127/0941-2948/2006/0130.

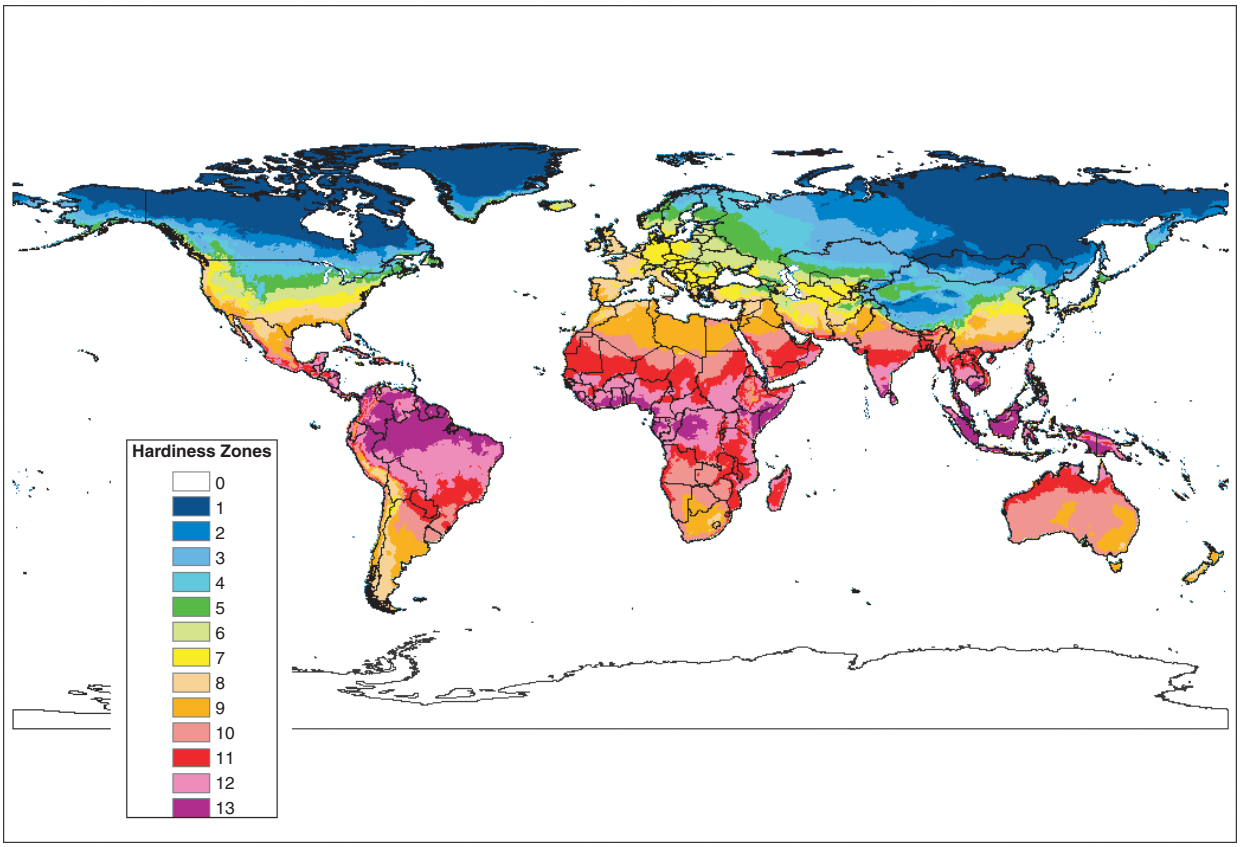

Fig. A2 World Hardiness Zones map. Adapted from Magarey *et al.* (2008) Global plant hardiness zones for phytosanitary risk analysis. *Scientia Agricola* **65**, 54–59.

Appendix – 4

Table A1 Results of the prioritization process for species recorded on the EPPO List of Invasive Alien Plants and the EPPO Alert List at the level of the EPPO region. The outcome is simplified, but for each answer, justification and references need to be provided. This compilation has been elaborated during a meeting attended by the authors of this article. Participants had prepared answers for their own countries which were discussed.

	Stage A Elaboration of lists of (potential) invasive alien plants						Stage B Identification of the need for an EPPO PRA			
Species	A.5 Spread	A.6 Impact on the environnent	A.7 Impact on agriculture and forestry	A.8 Other impacts	Uncertainty	Conclusion of the stage A	B.1 International trade	B.2 Superior to natural spread	B.3 Area for further spread	Conclusion of State B
Akebia quinata (Lardizabalaceae) (EPPO Alert List)	Medium	Medium	Low	/	High	Observation List	/	/	/	/
Ailanthus altissima (Simaroubaceae) (EPPO List of Invasive Alien Plants)	High	High	Medium	Roots damage sewers and foundations, historical sites, etc.	Low	List of (potential) invasive alien plants	Yes, ornamental plant	Yes	Small	EPPO PRA is not considered a priority
Alternanthera philoxeroides (Amaranthaceae) (EPPO Alert List)	High	High	Medium	Favors habitats for mosquitoes	Medium	List of (potential) invasive alien plants	Yes, ornamental plant	Yes	Large	High priority for EPPO PRA
Ambrosia artemisiifolia (Asteraceae) (EPPO List of IAP)	High	Low	High	The pollen is very allergenic	Low	List of (potential) invasive alien plants	Yes, contaminant of bird seeds	Yes	Medium	Lower priority for EPPO PRA
Araujia sericifera (Apocynaceae) (EPPO Alert List)	High	Medium	Medium	Poisonous sap causes skin irritation	Medium	Observation List	/	/	/	/
Baccharis halimifolia (Asteraceae) (EPPO List of IAP)	High	High	Low	Detrimental to salt production. Very inflammable.	Low	List of (potential) invasive alien plants	Yes, ornamental plant	Yes	Large	High priority for EPPO PRA
Buddleia davidii (Buddleiaceae) (EPPO List of IAP)	High	High	Low	Blocks access to watercourses	Medium	List of (potential) invasive alien plants	Yes, ornamental plant	Yes	Medium	Lower priority for EPPO PRA
Carpobrotus acinaciformis & C. edulis (Aizoaceae) (EPPO List of IAP)	High	High	Low	/	Low	List of (potential) invasive alien plants	Yes, ornamental plant	Yes	Small	EPPO PRA is not considered a priority
Cortaderia selloana (Poaceae)	High	High	Low	Very inflammable, provokes cuts.	Low	List of (potential) invasive alien plants	Yes, ornamental plant	Yes	Medium	Lower priority for EPPO PRA

Appendix – 4 (Continued)

	Stage A Elaboration of lists of (potential) invasive alien plants						Stage B Identification of the need for an EPPO PRA			
Species	A.5 Spread	A.6 Impact on the environnent	A.7 Impact on agriculture and forestry	A.8 Other impacts	Uncertainty	Conclusion of the stage A	B.1 International trade	B.2 Superior to natural spread	B.3 Area for further spread	Conclusion of State B
Delairea odorata (Asteraceae) (EPPO Alert List)	Medium	Medium	No information	Contains toxic substances	Medium	Observation List	/	/	/	/
Eriochloa villosa (Poaceae) (EPPO Alert List)	High	Low	High	/	High	List of (potential) invasive alien plants	Yes, seed contaminant	Yes	Large	High priority for EPPO PRA
Fallopia baldschuanica (Polygonaceae) (EPPO Alert List)	High	High	No information	/	High	List of (potential) invasive alien plants	Yes, ornamental plant	Yes	Medium	Lower priority for EPPO PRA
Fallopia japonica, F. sacchalinensis and *F. x bohemica* (Polygonaceae)	High	High	High	Impedes water flow. Damages infrastructures	Low	List of (potential) invasive alien plants	No, not used anymore	/	/	EPPO PRA is not considered a priority. Management at the national level
Hakea sericea (Proteaceae) (EPPO Alert List)	High	High	No information	Increased fire regimes	Low	List of (potential) invasive alien plants	Yes, ornamental plant	Yes	Large	High priority for EPPO PRA
Humulus japonicus (Cannabaceae)	High	High	No information	Provokes pollinose	High	List of (potential) invasive alien plants	Yes, ornamental plant	Yes	Large	High priority for EPPO PRA
Hydrilla verticillata (Hydrocharitaceae) (EPPO Alert List)	High	High	Low	Favors habitats for mosquitoes	Medium	List of (potential) invasive alien plants	Yes, aquarium plant	Yes	Large	High priority for EPPO PRA
Ludwigia grandiflora and *L. peploides* (Onagraceae) (EPPO List of IAP)	High	High	High	Disturbs recreational activities	Low	List of (potential) invasive alien plants	Yes, ornamental plant	Yes	Large	High priority for EPPO PRA
Microstegium vimineum (Poaceae) (EPPO Alert List)	High	High	No information	/	Medium	List of (potential) invasive alien plants	Yes, contaminant of bird seed, soil and hay. Used as an ornamental, for erosion control or for forage.	Yes	Large	High priority for EPPO PRA

Appendix – 4 (Continued)

Species	Stage A Elaboration of lists of (potential) invasive alien plants						Stage B Identification of the need for an EPPO PRA			
	A.5 Spread	A.6 Impact on the environnent	A.7 Impact on agriculture and forestry	A.8 Other impacts	Uncertainty	Conclusion of the stage A	B.1 International trade	B.2 Superior to natural spread	B.3 Area for further spread	Conclusion of State B
Myriophyllum heterophyllum (Haloragaceae) (EPPO Alert List)	High	High	High	/	High	List of (potential) invasive alien plants	Yes, ornamental and aquarium plant	Yes	Large	High priority for EPPO PRA
Nassella neesiana, N. tenuissima and *N. trichotoma* (Poaceae) (EPPO Alert List)	Medium to High	Medium	Medium	/	Medium	Observation List	/	/	/	/
Pistia stratiotes (Araceae) (EPPO Alert List)	High	High	Low	Favors habitats for mosquitoes	Medium	List of (potential) invasive alien plants	Yes, ornamental and aquarium plant, ships' ballast.	Yes	Large	High priority for EPPO PRA
Salvinia molesta (Salviniaceae) (EPPO Alert List)	High	High	Low	Favors habitats for mosquitoes	Medium	List of (potential) invasive alien plants	Yes, ornamental and aquarium plant	Yes	Large	High priority for EPPO PRA
Sesbania punicea (Fabaceae) (EPPO Alert List)	Medium	Medium	Low	Toxic	Medium	Observation List	/	/	/	/
Verbesina encelioides (Asteraceae) (EPPO Alert List)	High	Medium	Medium	Toxic to livestock	Medium	Observation List	/	/	/	/
Pennisetum setaceum (Poaceae) (EPPO Alert List)	High	High	Low	/	Medium	List of (potential) invasive alien plants	Yes, used as a landscape ornamental plant, and for soil stabilization.	Yes	Large	High priority for EPPO PRA