Strasbourg, 15 October 2007 **T-PVS/Inf (2007) 9**
[Inf09e_2007.doc]

CONVENTION ON THE CONSERVATION OF EUROPEAN WILDLIFE
AND NATURAL HABITATS

Standing Committee

27th meeting
Strasbourg, 26-29 November 2007

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TOWARD A BLACK LIST OF INVASIVE ALIEN SPECIES ENTERING EUROPE THROUGH TRADE, AND PROPOSED RESPONSES

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ACKNOWLEDGMENTS

The present report has been made possible by the support of many specialists, who provided valuable information and comments. In particular, we would thank the DAISIE consortium, which allowed us to use the information gathered for producing the list of 100 among the worst invasive alien species in Europe. Phil Hulme provided us with very helpful comments on the categories on the main trade related pathways of alien species introduction. Melanie Joseffson much helped us in regard to data gathered within the NOBANIS project, and contributed with useful comments and suggestions that much improved the report. Tor-Björn Larsson gave us support with regard to the SEBI2010 initiative. Maj De Poorter made available an unpublished report on Protected Areas and alien species that permitted us to test the validity of the metalist produced within this report. Michael Browne and Charles Copp provided us with preliminary information on the results of the GRIS, including the list of alien species considered in the relative database, that we used to assess the limits and potentialities of producing global and/or regional species lists for regulation of trade related activities. We particularly thank Sarah Brunel for her valuable comments, and for having provided and discussed, with the support of Jean-Marc Tison, the data of the EPPO lists. Stephan Gollash and Bella Galil classified all marine species. Alain Roques provided information on the role of trade in the transport of all terrestrial invertebrates. Marie Laure Loustau classified all fungi. Vadim Panov, Francesca Gherardi and Elena Tricarico provided data on freshwater alien species. Other experts contributed with comments and suggestions on the preliminary draft presented at the 7th meeting of the Group of Experts on Invasive Alien Species of the Council of Europe, held in Reykjavik (Iceland) 22-24 May 2007. Among them a special thank to Joan Mayol Serra, Czirák Zoltán, Ema Gojdieová, Oksana Abduloyeva, and Eladio Fernandez-Galiano.

Summary

Introduction

The number of unwanted alien species invading Europe is dramatically increasing, and scientifically documented clues of their ecological, economic and health impacts are being collected. For this reason European countries and institutions are urgently requested to develop effective policies based on sound stringent rules to prevent further unwanted introductions and, when feasible and appropriate, to manage the impact of those species already established.

Several international and regional provisions and recommendations underline the pivotal role of trade regulations for preventing biological invasions of alien species, based on a system of lists of unwanted, authorised, and un-screened species.

The European Strategy on Invasive Alien Species, adopted by the Standing Committee of the Bern convention with Recommendation n. 99/2003, calls Member States to prevent the introduction of invasive alien species (IAS) in Europe through a coordinated framework of legal and management measures, including measures for the regulation of trade and possession of alien species, based on an authorisation system. The authorisation process shall take into account the mandatory rules of those agreements related to the European Community free-market policy and the provisions of the World Trade Organisation (WTO), according to which any trade restriction must be justified on a case by case evaluation, based on a objective risk analysis.

The Convention on Biological Diversity (CBD) imposes on Parties to "prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species" (art. 8(h)), preventing, as a matter of priority, the introduction of invasive or potentially invasive alien species into the region.

A report produced in 2006 by the Institute for European Environmental Policy (IEEP) for the European Commission on European policies on alien species (Miller et al. 2006), recommends to consider producing a "black list" of species prohibited for import into the European Community (EC), giving priority to those species which carry a high risk of being invasive and which might cause a negative impacts on the conservation of regional biodiversity.

An overview of the existing international/regional mechanisms to ban or restrict trade in potentially invasive alien species in Europe (Shine 2006) concluded that a robust level of protection consistent with WTO rules (i.e. sanitary and phytosanitary or SPS standards), based on regional risk assessment, is needed.

In order to substantially reduce the impact on European biodiversity, the European Union (EU) approved in 2006 a policy document (Biodiversity Communication, COM(2006)216)[1] according to which "invasive alien species were identified in the 6th EAP as a priority for action". The document also states that "while support has been given to some localized eradication programmes via LIFE funding [see Scalera and Zaghi 2004], the European Community has still to develop a comprehensive strategy to address this issue". A specific objective of such a strategy should be "to substantially reduce the impact on EU biodiversity of invasive alien species and alien genotypes". The document states that "various measures for the prevention and control of invasive alien species are in place but some policy gaps may remain; a comprehensive EU strategy should be developed for this purpose as well as specific actions including an early warning system".

In regard to the above considerations, the objectives of this report are to: 1) review and collate existing lists of known IAS for Europe, 2) analyse the role of trade in the introduction of the IAS included in the existing lists, 3) review gaps and potentialities of the existing IAS listing systems for Europe, 4) propose recommendations for a more effective response by European institutions and governments in regard to trade regulations based on a listing system.

This report analyses the points listed above, providing an overview of the existing lists and a preliminary assessment of the role of trade in the introduction of the IAS included in such lists. The first part of the work has been devoted to collating the available lists of species, to associate each

[1] See http://ec.europa.eu/environment/nature/biodiversity/current_biodiversity_policy/biodiversity_com_2006/index_en.htm

species to the main category of trade that is considered to be related to its introduction, and to identify major patterns of trade related invasions. The report also takes into account the suggestions and recommendations by the representatives of European States and Institutions on a preliminary draft presented at the 7th meeting of the Group of Experts on Invasive Alien Species of the Council of Europe (Reykjavik, 22-24 May 2007)[2].

Legal aspects of trade regulations with respect to biological invasions have already been comprehensively addressed by other recent reports (i.e. Miller et al. 2006, Shine 2006) and thus the present document will focus only on the role of trade in the patterns of invasions.

Abbreviations

CBD	Convention on Biological Diversity
CITES	Convention on International trade in endangered species of wild fauna and flora
DAISIE	Delivering Alien Invasive Species Inventories for Europe
DG Environment	Directorate General for the Environment
EAP	Environment Action Programme
EC	European Community
ECJ	European Court of Justice
ECNC	European Centre for Nature Conservation
EEA	European Environment Agency
EPPO	European and Mediterranean Plant Protection Organisation
EU	European Union
FP6	Sixth Framework Programme
GISD	Global Invasive Species Database
GRIS	Global Register of Invasive Species
IAS	Invasive alien species
IEEP	Institute for European Environmental Policy
IPPC	International Plant Protection Convention 1951, revised 1997
ISSG	Invasive Species Specialist Group
IUCN	World Conservation Union
LIFE	The financial instrument for the environment
MS	Member States
NOBANIS	North European and Baltic Network on Invasive Alien Species
SEBI2010	Streamlining European 2010 Biodiversity Indicators
SPS	Agreement on the Application of Sanitary and Phytosanitary Measures (1995)
SRG	Scientific Review Group
SSC	IUCN Species Survival Commission
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Environment Programme

[2] http://www.coe.int/t/e/cultural_co-operation/environment/nature_and_biological_diversity/agenda/04IAS.asp#TopOfPage

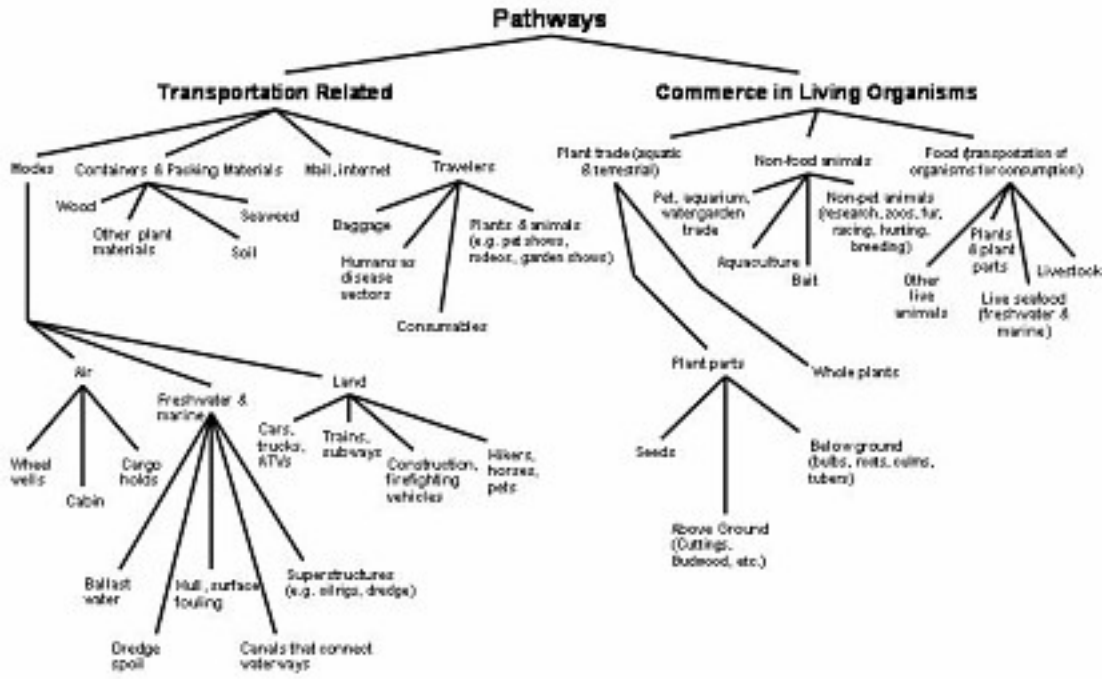
PEBLDS	Pan-European Biological and Landscape Diversity Strategy
WCMC	World Conservation Monitoring Centre
WTO	World Trade Organization

I ROLE OF TRADE IN THE INTRODUCTION OF INVASIVE ALIEN SPECIES

An alien species is defined as a species, subspecies or lower *taxon*, introduced outside its natural past or present distribution range by human agency, either directly or indirectly (for a review see Genovesi and Shine 2004). This definition thus implies an active movement by humans, and covers both intentional and unintentional movements of species. Transport can in fact be voluntary– as in the case of species traded for forestry, agriculture, or angling – and accidental, as in the case of hitchhikers or species transported through ballast water.

A synthesis of the different known pathways is reported in figure 1 (source: Lodge et al. 2006), where the role of different types of commerce in the movement of alien species worldwide is evident. There is in fact a vast array of trade related activities that cause the movement of species, ranging from the direct trade of live animals and plants as food, to the movement of marine and freshwater species for aquaculture, to the commerce with pets and horticultural species, to the movement of species for research, fur farming, hunting, angling, etc.

Figure 1. Pathways of introduction of alien species (from Lodge et al. 2006)



An aspect that makes the role of commerce particularly critical with regard to biological invasions is that regulation of trade may contradict the free trade policy that is the fundament of the WTO and of the European Community treaty (Miller et al. 2006, Shine 2006). Therefore, on the one hand any prevention policy based on trade regulations has to address the compatibility with the general free trade policies, and on the other hand regional and national institutions may be reluctant to introduce bans or regulation, because of the prevalent importance given to free trade in respect to nature protection (Genovesi 2007).

II POLICIES AND TRADE REGULATIONS WITH REGARD TO ALIEN SPECIES MOVEMENTS

1. EUROPEAN SCALE

Trade rules with relevant provisions in regard to IAS are active both at the regional (i.e. European Union) and the national scale (in particular for non-EU Member States).

In 2006 the Institute for European Environmental Policy published a report reviewing European Community policies on alien species (Miller et al. 2006). In regard to legal restrictions to trade, the report concluded that, at the EU scale, some legislation regulating the imports and exports of potential IAS into and out of the European Community is already established and enforced. The sectors somehow covered are those related to wildlife protection and to the spread of plants' pests, animal pathogens, and genetically modified organisms. According to Miller et al. (2006) and Shine (2006), the European Community legislation does not cover issues related to the introduction of other groups of species. For example, with the exception of four species listed under the EU Wildlife Trade Regulations (see Scalera 2007), no European legislation covers the movement of non-genetically modified animals and plants, as well as potential alien invertebrates that fall outside the definition of 'harmful organism' given in the Plant Health Directive no. 2000/29/EC.

2. NATIONAL SCALE

At the state level, the framework of IAS trade restrictions is largely different and partly incoherent among countries. Several states have in fact established bans of import on some species or groups (i.e. alien crayfishes in Sweden), or have legal tools imposing general prohibitions of import for certain species or groups of species, but with a very variable level of enforcement (Shine 2006) and in many cases with purposes not explicitly directed to prevent the unwanted introduction of IAS.

Miller et al. (2006) summarised the following gaps in the national trade rules with regard to alien species in EU Member States (MS):

- restrictions on possession and trade in known or potential IAS do not exist in all MS;
- where restrictions do exist, they vary widely in terms of scope and purpose, e.g. taxonomic groups affected, scientific analysis undertaken, scale of implementation, etc;
- there are no mechanisms in place to support harmonisation or basic consistency of approach between neighbouring countries or countries in the same sub-region;
- fragmented measures of this kind are unlikely to make a substantial contribution to lowering the risks posed by IAS to European ecosystems;
- the limited European Court of Justice (ECJ) case law so far does not provide individual MS with full legal certainty about the kinds of IAS possession/domestic trade/internal movement restrictions that are compatible with EU laws;
- the measures that are already in place in some MS are not sufficient in their current form to provide a foundation for wider application as part of a future EU framework on IAS, although there is some good practice occurring.

In order to regulate trade with IAS, it is critical to develop reference lists. The European Strategy on Invasive Alien Species (Genovesi and Shine 2004) calls for the establishment of a policy where any proposed introduction is assessed through a comprehensive screening system based on risk analysis, and introduction is allowed only for species unlikely to threaten biodiversity. For this aim, the Strategy underlines the need to work towards a regional or subregional species listing system consistent with European and international law.

Such a listing system should include a list of species whose introduction is strictly regulated (black list), as well as a list of species classified as low risk whose introduction may be authorised without restriction or under conditions (white list), and - lastly - a list including any species not included in the black or white lists, or which is data-deficient, that should therefore be subject to risk assessment prior to a decision on authorisation is taken.

The enforcement of such approach, that would apply to all species, requires the development of lists based on a risk assessment, with particular reference to alien species known as invasive or potentially invasive, to be included on the black list.

In regard to this need, in the following pages we synthesise the availability of lists of known IAS in Europe and compare the criteria and contents of these lists.

3. SUB-NATIONAL SCALE

Subnational trade regulations can be of particular importance, especially in the case of insular regions. For example, the Balearic Government has introduced a local ban of trade of the Ruddy duck (*Oxyura* genus; Joan Mayol com. pers.).

III EXISTING LISTS OF KNOWN INVASIVE ALIEN SPECIES IN EUROPE

Several European institutions and organisms have produced lists of alien species causing impacts on health, economic activities and biological diversity. In the following text, we provide a synthesis of the existing lists developed at the regional level, with a description of major features in terms of aims, legal power, criteria for inclusion, geographical scope, and taxonomic coverage. Lists developed at the national/local level (i.e. see the 2007 Norwegian Black List, Gederaas et al. 2007) have not been considered in this report.

1. EPPO (EUROPEAN AND MEDITERRANEAN PLANT PROTECTION ORGANIZATION)

EPPO is a European intergovernmental organization with 48 Member States, aimed at protecting plants, developing international strategies against the introduction and spread of dangerous pests and promoting safe and effective control methods.

Aims: to prevent impacts on plant health, environment and biodiversity in the EPPO region.

Geographical scope: EPPO region covers all Europe, Israel, Turkey, several countries of Eastern Europe, including Russia, and some countries of North Africa. Two lists of species have been developed: the A1 includes species which are not yet present in the EPPO region, while the A2 includes species already present in the EPPO region.

Taxonomic scope: EPPO activities focus on cultivated and non-cultivated plants. Listing systems cover a wide range of plant pests, parasites and pathogens, among which several invertebrates, virus and fungi.

Legal power: EPPO is an inter-government body, producing non-binding recommendations to its 48 Member States. The A1 and A2 lists have been formally approved by EPPO Council in September 2006. EPPO recommends its Member Countries to regulate the pests listed in A1 and A2 as quarantine pests. As well as the A1 and A2 lists, EPPO has also developed a specific list of invasive alien plants for which States are requested to take measures to prevent their introduction and spread or to manage unwanted populations (for example with publicity, restrictions on sale and planting, controls).

Criteria: species included in A1 and A2 lists are pests presenting risks and for which phytosanitary measures should be taken. Inclusion on the EPPO lists - at least in the last years - is based on transparent Standards on Pest Risk Analysis. The prioritization procedure for the realisation of the list of invasive alien plants is based on several factors including: plant/agent considered invasive or potentially invasive; plant/agent absent from Europe or still containable; plant/agent potential for spread and damage; plant/agent reported to be actively spreading or increasing impacts**.**

Number of species included in list: EPPO A1 list comprises 181 species; A2 list: 120 species; list of invasive alien plants: 44 species.

2. SEBI2010 LIST OF WORST INVASIVE ALIEN SPECIES THREATENING BIODIVERSITY IN EUROPE

SEBI2010 (Streamlining European 2010 Biodiversity Indicators) is a Pan European initiative launched in 2004 in collaboration between EEA (the European Environment Agency), DG Environment of the European Commission, ECNC (the European Centre for Nature Conservation),

UNEP/ PEBLDS Secretariat with the lead of Czech Republic and UNEP-WCMC (the World Conservation Monitoring Centre). SEBI2010 aims at compiling a set of biodiversity indicators to assess and inform about progress towards the CBD 2010 targets for halting the loss of biodiversity in Europe. The indicator framework covers several aspects including the global indicator '*Trends in invasive alien species'*.

Aims: to contribute to the general indicator *Trends in invasive alien species* - and to the other identified subindicator *Cumulative numbers of alien species in Europe since 1900* - by distinguishing a number of most harmful IAS with respect to their impacts upon European biodiversity (Subindicator 'Worst invasive species threatening biodiversity in Europe'). The list provides certain information in relation to the 2010 target e.g. as regards the development of the impacts caused by IAS, but it should mainly be interpreted as an information tool and a basis for collecting additional more detailed information on distribution and impact of the listed species (this work is in progress). The list of worst invasive alien species will also serve to communicate the issue of IAS to policymakers, stakeholders and the wider public.

Geographical scope: Europe (56 UNECE Member Countries)

Taxonomic scope: The SEBI2010 list deals with the most harmful IAS (from a biodiversity point of view) in all environments and taxonomic groups.

Legal power: The indicator framework to assess the 2010 biodiversity target has been established within the Convention on Biological Diversity (CBD). On a European level it has been endorsed by the Environment for Europe process (PEBLDS) and, within European Union, by the European Council of Ministers. The SEBI2010 process is currently consulting the countries and other involved to obtain acceptance for the proposed indicators to be used for reporting to CBD and if needed, to establish European-level dataflows.

Criteria: Species are selected based on recognition of causing impact on biological diversity of Europe. Impacts are evaluated by different criteria, including: severe impacts on ecosystem structure and function; replacement of native species throughout its range; hybridization with native species; posing threats to unique biodiversity; species having - in addition to its impact on biodiversity - negative consequences for human activities, health and/or economic interests (e.g. is a pest, pathogen or a vector of disease). Selection was in the first step ('2007 list') made by experts nominated by countries/organisations participating in the SEBI2010 process. The underlying information was gathered through literature studies, contact with other experts and own knowledge. Lack of information and time constraints did not allow a formal Risk Analysis.

Number of species included in list: The SEBI2010 list of worst invasive alien species threatening biodiversity comprises 168 species/species groups (2007).

3. NOBANIS FACT SHEETS ON INVASIVE ALIEN SPECIES

NOBANIS (North European and Baltic Network on Invasive Alien Species) is a network supported by the Nordic Council of Ministers for cooperation between competent authorities of the Baltic region in the field of IAS. One of the products of NOBANIS is a database of alien species, identifying actual and potential invasive species. For invasive species identified as most invasive, fact sheets are produced, providing key information on distribution and recommended preventive, eradication and control measures.

Aims: NOBANIS is aimed at providing tools for preventing the unintentional dispersal of invasive alien species, and promoting regional cooperation for the eradication, control and mitigation of ecological effects of IAS.

Geographical scope: countries participating in NOBANIS are Denmark, Estonia, Finland, Faroe Islands, Germany, Greenland, Iceland, Latvia, Lithuania, Norway, Poland, Sweden and the European part of Russia.

Taxonomic coverage: worst invasive species include some of the IAS of the Baltic region, including both animals and plants as well as micro-organisms.

Criteria: The worst IAS are defined on the basis of experts' opinion. The fact sheets are not to be regarded as a pure consensus list of worst invasive alien species for the region. Although the majority of the species selected for writing fact sheets were included on a consensus list of worst invasive alien species in the region, other species were selected because of their potential invasiveness or because expertise was available in the region to write a fact sheet. The fact sheets fall into several categories, some can indeed regarded as the worst invaders of the entire region, while others are only a problem in one or a few countries.

Number of species included in list: NOBANIS fact sheets of IAS comprise so far 55 species; 5 will be added in the future.

4. DAISIE

DAISIE (Delivering Alien Invasive Species Inventories for Europe, www.europe-aliens.org) is a three year project supported by the European Commission under the Sixth Framework Programme (FP6) that aims to create an inventory of all alien species present in Europe, with particular reference to the invasive species that threaten European terrestrial, freshwater and marine environments. DAISIE is a consortium that comprises an outstanding team of partners from 15 nations and collaborators from additional 9 countries. Among the deliverables of the project is a list of 100 of the worst IAS in Europe, and relative species' accounts.

Aims: to undertake an inventory of all terrestrial, freshwater and marine *taxa* known to be invasive in Europe, based on common definitions and criteria, and present the distribution of known invasions graphically.

Geographical scope: all Europe, including Israel and European Russia.

Taxonomic coverage: all taxonomic groups, including viruses.

Criteria: the "100 of the worst IAS of Europe" have been identified by DAISIE experts. Main criterion for inclusion in the list is the known impact to biodiversity, based on published evidences. In establishing the list, DAISIE experts also tried to provide examples among the different taxonomic groups and environments. The DAISIE list excludes species native in some part of Europe, and domestic forms.

Number of species included in list: DAISIE List of "100 of the worst IAS in Europe" comprises 100 species in all taxonomic groups.

5. EU WILDLIFE TRADE REGULATIONS

Wildlife Trade Regulations are aimed at implementing the Washington Convention on International trade in endangered species of wild fauna and flora (also known as CITES) within the EU.

Aims: Wildlife trade regulations deal with import and export of wildlife and wildlife products to and from the EU, as well as trade between and within individual Member States. All CITES provisions are incorporated in these regulations, in addition to other measures in order to be coherent with the overall EU nature conservation policy.

Geographical scope: all 27 EU Member States.

Taxonomic coverage: potentially all *taxa*.

Criteria: According to Article 9(6) of Council Regulation (EC) No 338/97 the Commission may establish restrictions on the import of "live specimens of species for which it has been established that their introduction into the natural environment of the Community presents an ecological threat to wild species of fauna and flora indigenous to the Community". Such restrictions are adopted in consultation with the countries of origin concerned, taking account of the views of the Scientific Review Group (SRG). The SRG consists of representatives of each Member State and is chaired by a representative of the Commission. Proposals for listing may be raised by the chairman or any SRG member (see also European Commission, 2003).

Number of species included in list: Reg. (EC) No 338/97 (as amended) comprises only 4 species of vertebrates so far (see Community Regulation (EC) No 252/2005 suspending the introduction into the Community of specimens of certain species of wild fauna and flora).

IV THE CUMULATIVE LIST OF INVASIVE ALIEN SPECIES IN EUROPE

1. MATERIALS AND METHODS

Data on the different lists were excerpted from websites and published reports, and have been verified with the support of the coordinators of the different projects who have been contacted directly (particularly for EPPO, SEBI2010, NOBANIS, and DAISIE). All collected data have been collated in a single, cumulative list, annotated with information on the lists where each species (or group of species) is included and main pathways.

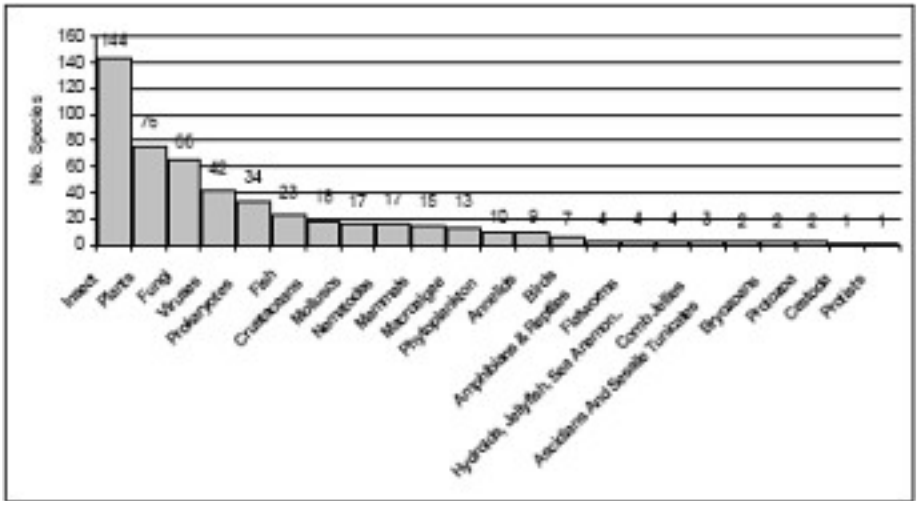
Hereafter this collated inventory of species included in existing lists of invasive alien species of Europe will be called "metalist" (see Appendix I).

The metalist includes 514 taxa (mostly at the species level, but in some cases relative to group of species belonging to the same genus) listed in the 6 European "worst lists" described above.

The following 23 taxonomic groups are considered within the cumulative list (in alphabetical order): 1) amphibians and reptiles, 2) annelids, 3) ascidians and sessile tunicates, 4) birds, 5) bryozoans, 6) cestoda, 7) comb jellies, 8) crustaceans, 9) fish, 10) flatworms, 11) fungi, 12) hydroids, jellyfish, sea anemones and corals, 13) insect, 14) macroalgae, 15) mammals, 16) molluscs, 17) nematodes, 18) phytoplankton, 19) plants, 20) prokaryotes, 21) protists, 22) protozoa, 23) viruses.

As shown in the graph below, insects are the most represented *taxa* (28% of total), followed by plants (14.8%) and fungi (12.8%). This clearly reflects the considerable effort to list invasive species made by EPPO for the purpose of protecting plant health. On the other hand protists and cestoda are represented by just one single species each, confirming the limited attention given to these *taxa* by most IAS related tools and initiatives. Vertebrates (including mammals, birds, amphibians and reptiles, and fish) account for 9.5% of total number of *taxa*.

Figure 2. *Taxa* covered by the existing lists of known invasive alien species for Europe



Of the 514 species included on the cumulative list, 78.6% (corresponding to 404 species) are included on only one of the 6 lists considered in this work, while not a single species is present on more than 4 lists. This pattern reflects the major contribution of the lists developed by EPPO, and the fact that such species are considered harmful only relative to plant health and thus are not covered by the other lists.

However, also excluding the 3 EPPO lists, over half (59.9%) of the 177 species included in one of the three other lists are not included in any other list. Of the total 514 species included on at least one of the existing lists, 66 (12.8%) are covered by 2 lists, 36 (7%) by 3 lists, and only 8 species (1.6%)

are considered in 4 lists out of the 6 considered in this analysis. These are represented by plants (*Crassula helmsii, Heracleum mantegazzianum*, *Impatiens glandulifera, Lysichiton americanus*, *Prunus serotina,* and the group *Fallopia japonica, F. sachalinensis, Fallopia* x *bohemica*), birds (*Oxyura jamaicensis*) and reptiles (*Trachemys scripta elegans*).

This limited overlap among the different lists, partly reflects the different criteria used for producing the inventories and the influence of subregional factors and approaches, but indeed also shows the limited comprehensiveness of the overall set of available lists in Europe and lack of scientific knowledge.

V CLASSIFICATION OF SPECIES WITH REGARD TO TRADE

With the aim of analysing the influence of trade on the presence of known IAS in Europe, with the support of leading experts in the different groups, we classified all species included in the metalist according to the known pathways of introduction into the region.

The classification is based on several categories, developed also on the basis of comments received from the experts contacted. In particular, the following four categories were identified:

A) the alien species is intentionally introduced, as the commodity itself, for being released into the environment (i.e. game species, freshwater fish, tree species of interest for forestry, biocontrol agents, etc.)

B) the alien species is intentionally introduced as the commodity itself (i.e. ornamental plants, agricultural plants, pets, crayfishes, etc.) in a containment facility or in a controlled environment (i.e. botanic gardens, greenhouses, agricultural land, zoos, animal-breeding establishments, fish farms, etc.).

C) the alien species is unintentionally introduced as a contaminant of a specific commodity (i.e. *Anoplophora chinensis* introduced in Italy through import of bonsai; parasites of specific fish species, fruit flies, microcell disease *Bonamia ostreae* transported with oyster shipments, etc)

D) the alien species is unintentionally introduced with movements of people or of machinery (i.e. pests in wood packaging, hull fouling, ballast waters, contaminants in containers, hitchhikers on planes, etc.).

Considering the specific purposes of this report, we excluded from our classification the category relative to species entering into a country through secondary dispersal from a neighbouring country.

1. CAUSES OF INTRODUCTION

On the basis of information collected on literature and provided by contacted experts, 73.9% of the 514 species included in the metalist (corresponding to 380 *taxa*) were assigned one or more specific trade category. Moreover three *taxa* included in the metalist are indigenous, and only two of them were assigned a trade category. For one more taxa trade category was explicitly considered "unknown".

The species not yet associated to at least a trade category (either because they did not enter Europe by means of trade related activities, or because we did not manage to obtain exhaustive information) have not been considered within the analysis. In table 1 all data concerning the *taxa* associated to a trade category are summarized.

In particular, the groups for which we collected limited information are the following: ascidians and sessile tunicates, fungi, prokaryotes and protozoa. Viruses were excluded from the analysis (44 *taxa*).

In general, of the 380 species covered by this analysis, 82.1% (312 *taxa*) were associated to a single trade category (either A, or B, or C, or D), while the rest were assigned to 2 or more trade categories (thus sum of percentages can be over 100).

Of the total number of species included in the cumulative list, 20.2% were introduced intentionally (categories A, B: 104 *taxa*) and - of these – a large proportion (77 *taxa*) were predominantly introduced through trade for being released into the environment (cat A). It should be

noted that species classified as A include IAS causing major impacts in Europe, like the American bullfrog (*Rana catesbeiana*), the American beaver (*Castor canadensis*), the Sika deer (*Cervus nippon*), the alien crayfish *Pacifastacus leniusculus*, the mosquitofish (*Gambusia affinis*), or several particularly invasive plants such as the giant hogweed (*Heracleum mangezzianum*), the Japanese knotweed (*Fallopia japonica*) or the tree of heaven (*Ailanthus altissima*). It is thus evident that effective trade regulation of such species would have prevented a significant proportion of the biological invasions affecting our region.

Some 45 species have been introduced into Europe through trade for being held in some form of containment facilities or controlled environment (cat. B). However, for some reasons such species managed to escape (or were released as a consequence of mismanagement) and to establish invasive populations in the wild. These include several pet species - such as the American grey squirrel (*Sciurus carolinensis*), the ruddy duck (*Oxyura jamaicensis*) and the red eared terrapin (*Trachemys scripta elegans*). These examples highlight that effective trade regulation of species, imposing measures for preventing release or escape of certain species into the wild (i.e. sterilisation of traded animals, control of containment facilities, polluter pays principles, etc), would have prevented many severe impacts on European biodiversity.

Table 1. Number of species classified by the following trade categories: **A)** the alien species is intentionally introduced, as the commodity itself, for being released into the environment (i.e. game species, freshwater fish, tree species of interest for forestry, biocontrol agents, etc.) **B)** the alien species is intentionally introduced as the commodity itself (i.e. ornamental plants, agricultural plants, pets, crayfishes, etc.) in a containment facility or in a controlled environment (i.e. botanic gardens, greenhouses, agricultural land, zoos, animal-breeding establishments, fish farms, etc.). **C)** the alien species is unintentionally introduced as a contaminant of a specific commodity (i.e. *Anoplophora chinensis* introduced in Italy through import of bonsai; parasites of specific fish species, fruit flies, microcell disease *Bonamia ostreae* transported with oyster shipments, etc) **D)** the alien species is unintentionally introduced with movements of people or of machinery (i.e. pests in wood packaging, hull fouling, ballast waters, contaminants in containers, hitchhikers on planes, etc.).

Taxa	No. Species	No. Species classified	A	B	C	D
Insect	144	144	1		134	32
Plants	76	75	40	11	31	19
Fungi	66	10			9	1
Viruses	42	0				
Prokaryotes	34	1				1
Fish	23	23	13	3		11
Crustaceans	18	18	8	5		11
Molluscs	17	17	7	5	5	10
Nematodes	17	17			13	12
Mammals	15	15	5	9		1
Macroalgae	13	12	1	1	5	6
Phytoplankton	10	10				10
Annelids	9	9			1	8
Birds	7	7	1	6		
Amphibians and reptiles	4	4	1	3		
Flatworms	4	4			4	
Hydroids, jellyfish, sea anemones and corals	4	4			1	3
Comb jellies	3	3		2		1
Ascidians and sessile tunicates	2	1				1
Bryozoans	2	2				2
Protozoa	2	2				2
Cestoda	1	1			1	
Protists	1	1			1	

Category C and D (species introduced unintentionally) account for 56% of all IAS in the cumulative list of Europe (288 species). It should also be noted that most unclassified species are likely to have been introduced unintentionally. Known cases of unintentional introductions occurred through activities related to trade (category C: 205 species) include species whose arrival would have been prevented by regulating some specific trade activities (i.e. citrus longhorned beetle *Anoplophora chinensis* introduced into Italy through import of ornamental bonsai species).

In the case of "hitchhikers" or species transported as "stowaways" with the movement of people and goods (cat D: 131 species), prevention would have required effective interception measures (i.e. treatments of ballast waters, application of anti-fouling systems, regulation of movement of soils).

Species listed in category A account for 15% of the entire cumulative list. As shown in figure 3, over 50% of species introduced intentionally as the commodity itself are plants, that are often planted intentionally into the wild for forestry, landscaping, habitat restoration, roadside planting, erosion control, watercourse management, etc. Other most numerous *taxa* are vertebrates (mammals, birds, amphibians, reptiles and fish, which all together account for 26%), crustaceans (10.4%) and molluscs (9.1%). Macroalgae and insects account for 1.3% each.

Species listed in category B account for 8.8% of the cumulative list. As shown in figure 4, the *taxa* listed in this category are the same of those occurring in category A, with the exception of comb jellies, which are added, and insects, which are excluded. However, the proportion of vertebrates and plants differ significantly in the two categories. In fact, more than 46% of species listed in category B are vertebrates, reflecting the high number of pet or farmed species escaped from captivity, and 24.4% are plants.

Category C is the most numerous of the cumulative list, including 39.9% of the total number of species. Insects have the highest percentage (65.4%), followed by plants (15.1%) and nematodes (6.3%). Other groups of species included in this category are fungi (4.4%), molluscs and macroalgae (2.4% each), and flatworms (2%), followed by hydroids, jellyfish, sea anemones and corals, cestoda, protists and annelids (each one with 0.5%) (fig. 5).

Category D has been associated with 25.5% of species introductions. In this category – that covers species involuntarily introduced as "stowaways" or "hitchhikers" –nearly all *taxa* are present, and even those *taxa* that are not listed as D - like amphibians and reptiles, whose species included in the cumulative list are not known to have entered Europe in this way, or viruses, that were not considered in this analysis – have the potentiality to be introduced unintentionally as a consequence of the movements of people or of machinery (Fig. 6). This category includes also those species that have likely entered the Mediterranean Sea by Lessepsian migration.

Figure 3 : Proportion of different taxonomic groups listed as category A (species introduced intentionally as the commodity itself for being released into the environment, n = 77 species)

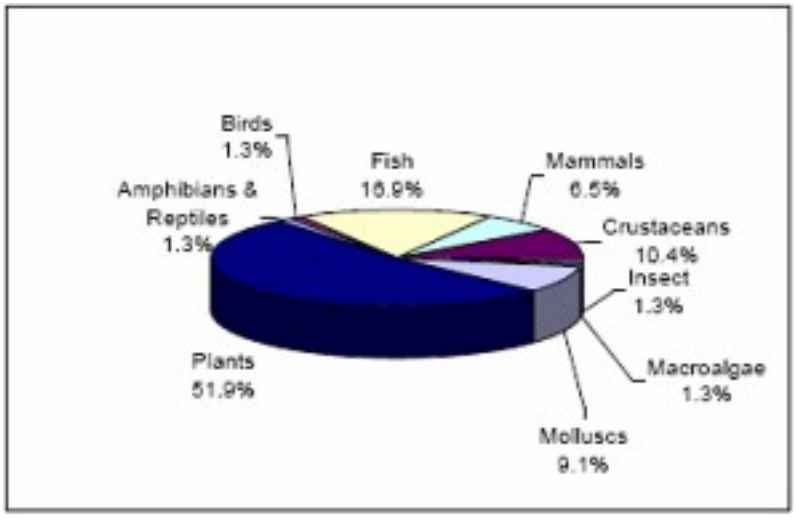


Figure 4 : Proportion of different taxonomic groups listed as category B (species introduced intentionally as the commodity itself for being kept in a controlled environment, n = 45 species)

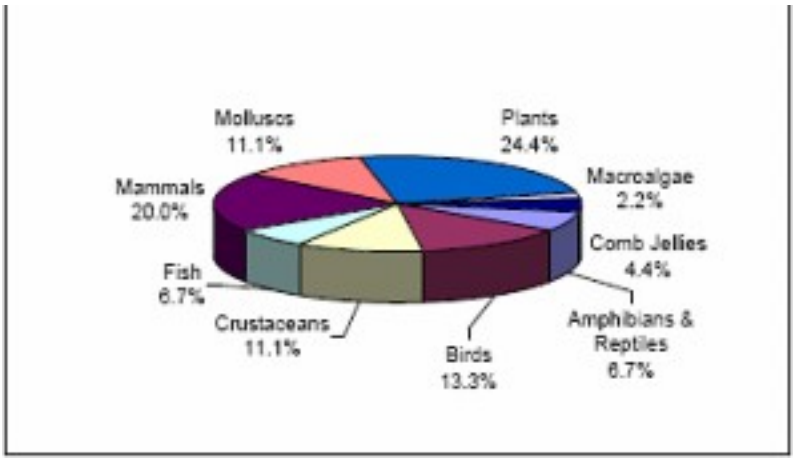


Figure 5 : Proportion of different taxonomic groups listed as category C (sp. unintentionally introduced as a contaminant of a specific commodity: n = 205 species)

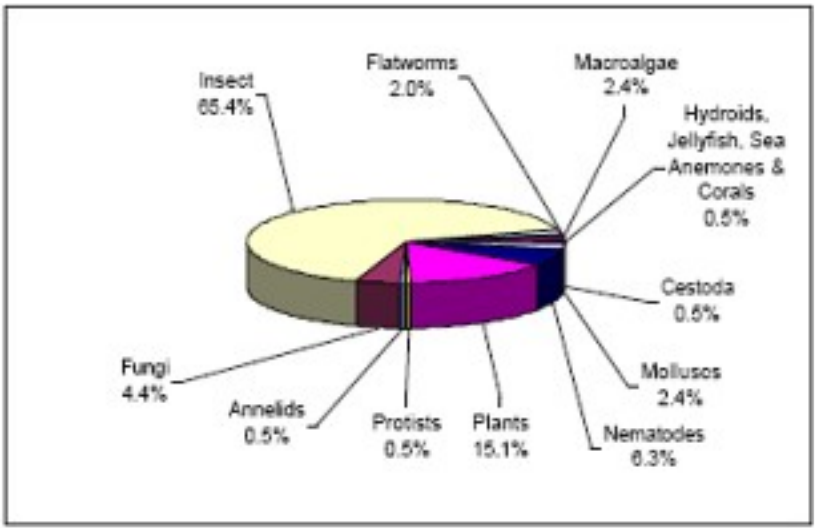
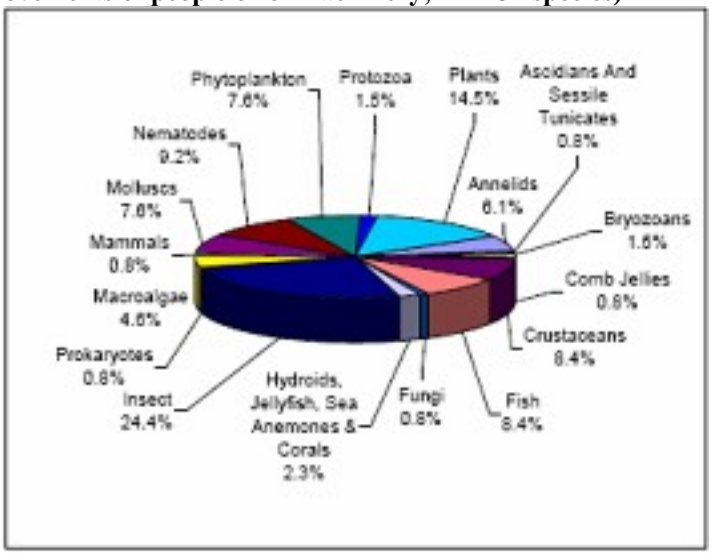


Figure 6 : Proportion of different taxonomic groups listed as category D (sp. unintentionally introduced with movements of people or of machinery; n = 131 species)



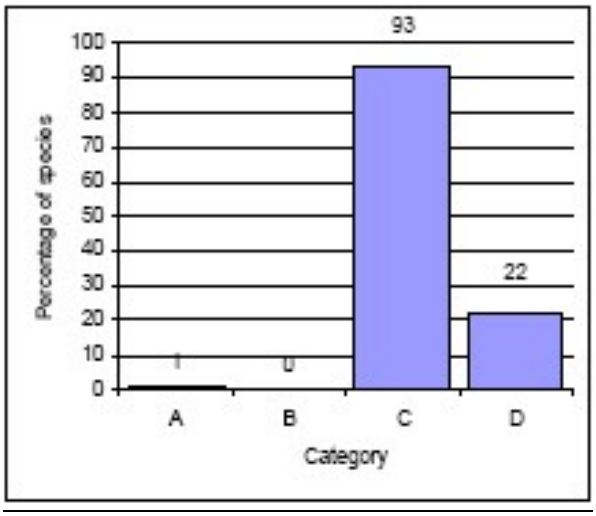
2. ANALYSIS BY TAXONOMIC GROUPS

We also analysed the situation for those *taxa* including more than 20 species, namely insects, plants and fish. We analysed also terrestrial vertebrates as a single unified group, including mammals, birds, amphibians and reptiles together. Fungi, viruses and prokaryotes were not considered. Note that the total sum of the percentages in the 4 columns is different from 100% because a single species could be associated to more than one category.

Insects

Insects are clearly introduced mainly unintentionally, as a contaminant of a specific commodity (category C) or as "hitchhiker" (category D). A few species are also introduced intentionally for biological control of arthropod pests, like in the classical case of the multicolored Asian lady beetle *Harmonia axyridis*. A major contribution to preventing the spread of alien insects would therefore come from improving the possibility to intercept their transport with other goods (i.e. plants, food, soil, wood, etc.).

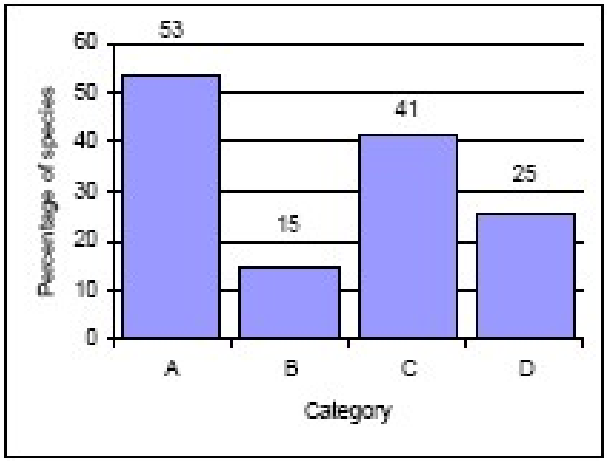
Figure 7 Proportion of species in each trade category: insects (n = 144 species)



Plants

Plants are frequently introduced either intentionally or unintentionally. However, a slightly lower number (36 versus 47) is known to have entered Europe as a contaminant of a specific commodity (category C) or otherwise passively transported (category D) rather than imported as the commodity itself (category A and B).

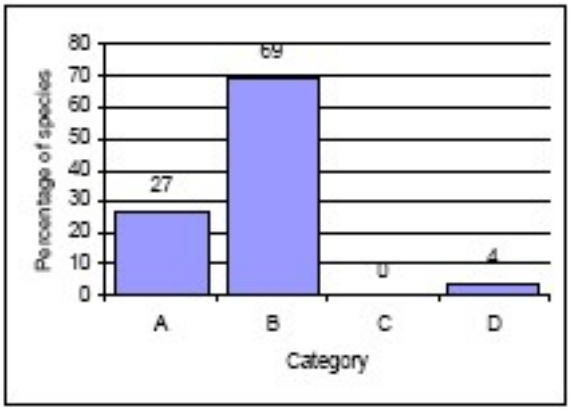
Figure 8 Proportion of species in each trade category: plants (n = 76 species)



Terrestrial vertebrates

It is quite interesting to notice that most vertebrates (including mammals, birds, amphibians and reptiles) have been introduced intentionally as the commodity itself (i.e. for ornamental purpose, for hunting or fishing, for food or for the fur trade, etc.). Actually, only one species among those in the cumulative list, namely *Rattus norvegicus*, is known to have entered Europe as a "stowaway" (category D). In this case it is therefore important to notice that a good regulation of trade and possession of those species would reduce almost totally the chance of terrestrial vertebrates to get established outside their natural range.

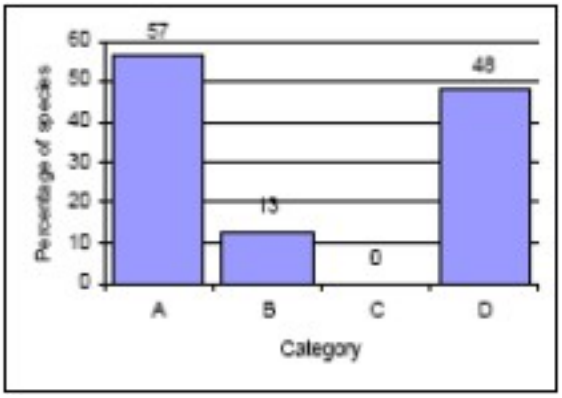
Figure 9 Proportion of species in each trade category: terrestrial vertebrates (n = 26 species)



Fish

Like plants, fish are known to have entered Europe either intentionally or unintentionally, in similar percentage. This distribution apparently reflects the different pathways related to introduction of two fish groups: freshwater species and marine species, the former being usually introduced intentionally as the commodity itself (category A and B), and the latter entering especially the Mediterranean Sea as a consequence of Lessepsian migration (4 species) or through the Straits of Gibraltar (3 species) (category D). As a consequence, although it would be quite impossible to deal with marine species, an effective regulation of trade on freshwater species would give a major contribution in preventing further introduction of invasive fish.

Figure 10 Proportion of species in each trade category: fish (n = 23 species)



VI GAPS AND LIMITS OF EXISTING EUROPEAN IAS LISTS

1. EXISTING LISTS

The existing lists of known IAS in Europe cover a large number of species in all taxonomic groups, but have major gaps that limit their use for improving responses to invasions. The different lists focus on inconsistent geographical ranges, varying from the regional scale (NOBANIS), to EU (Wildlife Trade Regulations), to a wider European area (SEBI2010) encompassing part of the Middle East (DAISIE, EPPO) and Northern Africa (EPPO).

The taxonomic scope is also very variable. Only the DAISIE and SEBI2010 lists attempted to cover all taxonomic groups, while in other cases (i.e. Wildlife Trade Regulations, NOBANIS) there is a prevalence of vertebrates. EPPO list reflects the specific aims of the organisation related to agriculture, while in the case of the SEBI2010 list, species were selected for providing indicators of changed biodiversity caused by IAS. In some cases the lists reflect the demonstration scope of the programmes; in fact, the lists produced within NOBANIS, DAISIE and SEBI2010 were also aimed at providing examples of representative IAS in all main taxonomic groups and affecting different ecosystems, and therefore cannot be considered primarily as a list of the most impacting species. All lists are also aimed at providing tools for response to invasions; furthermore, the lists reflect the available knowledge for Europe, and take into account the opinion of leading experts in the region.

Despite these common traits, the comparison of the lists has highlighted the limited overlap of species included in the different lists. Also in this regard, for allowing a potential use of the existing lists as a basis for legal regulation of species, it would be critical to revise the criteria adopted for developing these tools, taking into account a more solid and justified decision process in order to guarantee a standardised inclusion/exclusion in the lists.

2. THE METALIST

The "metalist" produced for the present report is the first attempt to collate all the existing information on known IAS in Europe, and provides a reference tool for identifying priority cases of invasions to be addressed in the region. However, the inventory has several gaps and limits, partly derived from the datasets used to produce it. The merged list is in fact neither comprehensive nor exhaustive. The geographical range of the metalist is wide, and covers all European continent, including some Mediterranean countries within Northern Africa and the Middle East. The taxonomic scope reflects the differences in the source datasets, with a prevalence of invertebrates and plant species over vertebrates. Furthermore, even among these *taxa*, the list does not include several species that are known to pose serious threats to the European biodiversity, either at the regional or local scale[3].

Due to the prevalent contribution of species from the EPPO lists (which is characterised by being interested in plant protection), a number of taxa in the metalist is not proven to pose a threat to biodiversity. For example, among invertebrates, agricultural pests are more represented than species impacting biodiversity.

In regard of the specific focus of the EPPO lists, it should be noted that three species extracted from the EPPO database (*Ambrosia artemisiifolia*, *Bunias orientalis*, *Iva (Cyclachaena) xanthiifolia*), are exclusively known as agricultural pests and not for causing significant impacts on biodiversity (Sarah Brunel com. pers.). More in general, among the 75 species or groups of species taken from the

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[3] Just as an example, the metalist fails to report of several invasive alien species recorded in Ukraine (Burda R.I., 1991. Антропогенная трансформация флоры.- К.: Наук. думка.-168 с. [in Ukrainian]; Protopopova V.V., Mosyakin S.L., Shevera M.V., 2002). Фітоінвазії в Україні як загроза біорізноманіттю:сучасний стан і завдання на майбутнє.- Київ.-32 с. [in Ukrainian]) and Belgium (species included in A0, A1, A2 lists by E. Branquart (Ed.) 2007, Alert, black and watch lists of invasive species in Belgium. Harmonia version 1.2, Belgian Forum on Invasive species, accessed on 8/10/2007 from: http://ias.biodiversity.be)

EPPO lists, 43 species (one of which is dubious) are considered a threat for the environment, and 10 (one dubious) are characterised by having an impact on both agriculture and environment.

Furthermore, the list also reflects the different criteria used for developing the source datasets. For example, the metalist includes species causing only limited impacts (i.e. *Eutamia sibiricus*) and - on the other hand – it underrepresents feral alien species as the domestic cat (*Felis catus*), the ferret (*Mustela furo*) or the goat (*Capra hircus*), although these are considered as top invasive alien species even at the global level (i.e. Lowe et al 2000).

Only a portion of the species included in the metalist has been identified through a formal risk analysis. Considering the requirements of the SPS standards under the WTO, the lack of a sound - scientifically based - evaluation of IAS included in the metalist, may limit the legal power of the metalist as a justification for trade regulations.

As a preliminary exercise, in order to test the comprehensiveness of the metalist, we compared this list with an independent list of known IAS for Europe, developed by the IUCN SSC Invasive Species Specialist Group for the World Bank (De Poorter and Pagad 2007). The report includes a list of species considered concern IAS in protected areas of Europe. The list combines two different dataset, both produced by questionnaires circulated by the Ramsar Convention, and the ISSG Global Invasive Species Database (GISD). Considering the different sources of information, we assumed that this list can be considered an independent dataset in respect to the metalist.

A comparison of the metalist with the list of IAS of concern for protected areas in Europe shows that only 50% of the included species are reported also in the metalist (27 out of a total of 54), confirming the scarce comprehensiveness of the metalist.

Another consideration that is raised from this comparison, is that the species shared by both the metalist and the list of species threatening protected areas in Europe (indicated with an asterisk (*) in appendix I), reflect the growing concern of biological invasions in regard to protected areas. In fact, there is a large number of particularly harmful IAS that affect protected areas and require urgent responses by wildlife managers and administrations. The need of response in this regard is particular relevant for the Natura 2000 network within the EU (Scalera and Zaghi 2004) as well as for the Emerald Network within the Council of Europe. Species of major concern in protected areas include mostly plants (17 species), followed by mammals (4 species), fish (3 species), crustaceans (2 species) and macroalgae (1 species).

3. THE METALIST AS A TOOL FOR PREVENTING BIOLOGICAL INVASIONS IN EUROPE

The best predictor of a species invasiveness in a new area, is whether the species has shown invasive patterns in other areas. Therefore, the metalist illustrated in the present report - being based on the best available information on invasive alien species known to cause impacts in some parts of Europe - represents the best available dataset of IAS for the region, with reference to European countries not yet invaded, and it provides a summary of priority species to address by European institutions and states. For this reason, the metalist can be a valid precursor of a back list of alien species for Europe.

As far as trade is regarded, the metalist would permit identification of priority IAS for which trade regulations are needed, and also provides critical information for designing such regulations. However, the metalist should not be considered as a complete list of IAS that should be regulated. In fact, the metalist has been realised by merging heterogeneous existing lists, made for different purposes than regulating trade. As an example, the metalist also includes species that have had a commercial interest in the past although they no longer have an economic value, and that are currently widespread in Europe (i.e. the coypu *Myocastor coypus*). In this case a regulation of trade would likely have a limited effect from a commercial perspective, and would unlikely contribute in preventing further spread of the species. However, it should be noted that the metalist also includes several species that maintain a commercial value and that are still very localised (i.e. pets as the *Callosciurus finlaysoni*, several ornamental plant species, etc.), for which a regulation of trade would have a major prevention role. For this reason such typology of species should be given priority for applying trade regulations. This justifies the revision of the metalist through a dedicated “ecological” risk assessment,

in order to associate a level of risk (i.e. high, low, unknown) on at least a subset of the species listed (see for example Gederaas et al. 2007).

Another aspect of particular relevance for the aims of the present report is that for preventing further biological invasions in Europe, priority should also be given to halting the introduction of species not yet present in the region, while the metalist (with the only exception of the EPPO A1 list) is mostly composed of species already present and established in the region. For example, a group of species which should be considered for inclusion within the cumulative list, is the one of the so-called "replacement species" (see Adrados and Briggs 2002). Replacement species are those *taxa* to which the market could switch its interest after having suspended/regulated trade on certain closely related species (either ecologically or taxonomically). Adrados and Briggs (2002) emphasise the need to foresee adequate measures to control their trade once they are found to occur on the market above a recommended threshold.

Indeed, analysing the situation within the United States, Simberloff (2006) has underlined that a major shortcoming of blacklists is that they are largely reactive rather than proactive, since species have often been blacklisted only after they have been introduced. However, in this regard, we must highlight that the development of a comprehensive, exhaustive list of IAS or potential IAS not yet present in Europe, and whose trade should be regulated, appears an unrealistic objective. In fact, Europe is characterised by a wide variety of ecosystems and climate conditions, ranging from the arctic tundra and polar deserts to boreal forests and steppes, and from subarctic climates, to humid subtropical and semiarid ones. It is thus evident that almost any living organism in the world can potentially establish in some part of Europe, and a list of potential alien species for the region would likely include hundreds of thousands species.

To give an idea of the order of magnitude of what a comprehensive black list of alien species for Europe should be, we synthesise the preliminary results of the GRIS project. The IUCN SSC Invasive Species Specialist Group (ISSG) has been developing plans for a Global Register of Invasive Species (GRIS), aimed at producing a list of all known invasive animal species with annotations providing evidence of their invasiveness in order to support pre-import screening for proposed imports. A prototype has been compiled from multiple sources including the Global Invasive Species Database, dataset referred to 16 countries in the world, plus records from and any other authoritative databases and scientific sources that list potentially invasive or harmful animals. The resulting register includes 16,051 *taxa*, of which 1,453 have records of invasiveness and 14,121 are considered potentially invasive according to sources that have conducted risk assessments (Browne et al 2007).

In this regard, we believe that – also in accord with the recommendations of the European Strategy on IAS, a more dynamic system of lists should be established, based on a black, white and grey lists approach. Such a system requires the development of a black list of species whose introduction into Europe is strictly regulated, a white list of species identified as low risk following a risk assessment, and a grey list covering any species not included in the black or white list, or which is data-deficient. Grey list species should be subject to risk assessment prior to a decision on authorisation to introduction. This approach seems to produce net bioeconomic benefits, as shown by an analysis carried out by Keller et al. (2007) on the Australian plant quarantine program. However, as reported by Simberloff (2006) the proactive approach to listing a species, using a formal risk assessment seems unlikely to work well because legal treaties usually require quantified risk assessments and ecologists simply cannot adequately quantify risk, particularly because of some inherently unpredictable aspects of species biology and population dynamics.

In regard of a possible European listing system, the metalist can thus be considered as a provisional black list, since it presents the most comprehensive inventory of known invasive alien species for Europe and identifies priority species to be regulated. However, the gaps above described make clear as the development of a structured black list for Europe will require the definition of explicit and solid criteria for inclusion, also considering to ensure proper justification of trade regulations in regard of the free trade regional and international agreements (EU treaty, WTO SPS). Furthermore, a regional black list aimed at regulating trade should also consider and describe the current distribution range and a detailed description of the overall status of the species (i.e. species

with widespread distribution; species native in some European countries, and invasive in others like the rabbit; etc).

Although a regional black list is fundamental for preventing further invasions in Europe, it must be stressed that no black list can substitute a grey list approach, requiring that any proposed introduction into Europe of alien species not yet known as IAS or low risk be conditioned to a risk analysis, based on a case by case evaluation.

For this reason, together with a list of those IAS known to occur in Europe and to have an impact on ecosystems, economy and plant, animal and human health, an *ad hoc* list for regulating trade on alien species, should include also a list of potential IAS not yet known to occur in Europe. While the former list will be soon available for all *taxa* as a major output from the above mentioned DAISIE project, the latter could be developed selecting those species included in other global database (i.e. see the GRIS database developed by the ISSG). For either IAS actually or potentially occurring in Europe, a standardized prioritization process, taking into account the experience accumulated within other sectors (i.e. for weed management, see EPPO), should be developed in order to consider only those species not yet widespread in Europe, and which have the potential to get invasive.

Derogations should be also taken into account for those countries/islands/regions which might have developed local black list and/or which might need the adoption of more stringent rules to face some specific conservation threat (as it happens for sanitary reasons). Of course such stricter measures needs to comply with the sometimes conflicting rules of the free trade agreements, however there are experiences which would suggest some optimism in this direction (i.e. the already mentioned ban on *Oxyura* genus in the Balearics).

VII RECOMMENDED ACTIONS:

1) Promote the development of an *ad hoc* list of invasive alien species for Europe, through a Risk Assessment based on objective and scientific criteria. Such list should include all invasive alien species already present in Europe or expected to arrive in the next future. It should give priority to species that are not yet widespread in the region and which have an actual or potential commercial interest.

2) Consider a regional ban of trade for species classified as A category in the cumulative list reported in Annex I, and for which trade is still an actual and direct pathway of introduction.

3) Consider a regional regulation of trade and/or stringent regulation of containment facilities for species classified as B category, and for which trade is still an actual, although indirect, pathway of introduction.

4) For species classified as C category, and for which trade is still an actual pathway of introduction, consider a regional regulation of trade of related consignments (including obligation to apply specific treatments), in all relevant involved sectors (i.e. transport, agriculture, fishery, etc.).

5) For species classified as D category, monitor pathway of introduction and consider regulation of related vectors in all relevant involved sectors (i.e. transport, agriculture, fishery, etc.).

6) Any trade regulation shall be accompanied – when feasible and appropriate - by stringent management provisions (i.e. regulation of containment facilities; eradication of already established populations; enforcement of control/containment campaigns, awareness raising at custom points, effective communication campaigns, etc.).

7) Support maintenance and constant update of regional inventories of invasive alien species (i.e. DAISIE database) and the development of international comprehensive registers, such as the Global Register of Invasive Species (GRIS) being developed by IUCN ISSG.

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Appendix I: Metalist of known invasive alien species for Europe

Species / Group of species *species listed in De Poorter and Pagad (2007)	**Trade category**	**EPPO A1 list**	**EPPO A2 list**	**EPPO list of invasive alien plants**	**SEBI2010**	**Nobanis**	**Daisie**	**Reg. 338/97**
Mammals								
Ammotragus lervia	A				X			
Callosciurus finlaysoni	B				X			
Castor canadensis	A				X	X		
Cervus nippon	A				X		X	
Eutamia sibiricus	B						X	
Herpestes javanicus *	A				X			
Muntiacus reevesii	A				X			
Mustela vison *	B				X	X	X	
Myocastor coypus	B				X		X	
Nyctereutes procyonoides	B				X	X	X	
Ondatra zibethicus	B				X	X	X	
Oryctolagus cuniculus *	B				X			
Procyon lotor	B				X		X	
Rattus norvegicus *	D				X		X	
Sciurus carolinensis	B				X		X	
Birds								
Acridotheres tristis	B				X			
Alopochen aegyptiacus	B				X			
Branta canadensis	B				X	X	X	
Corvus splendens	B				X			
Oxyura jamaicensis	A				X	X	X	X
Psittakula krameri	B						X	
Threskiornis aethiopicus	B				X		X	
Amphibians & reptiles								
Chrisemys picta	B							X
Rana catesbeiana	A				X		X	X

Species / Group of species *species listed in De Poorter and Pagad (2007)	**Trade category**	**EPPO A1 list**	**EPPO A2 list**	**EPPO list of invasive alien plants**	**SEBI2010**	**Nobanis**	**Daisie**	**Reg. 338/97**
Trachemys scripta elegans	B				X	X	X	X
Xenopus laevis	B				X			
Fish								
Ameiurus nebulosus	A				X			
Aphanius dispar	D						X	
Carassius auratus gibelio	A				X			
Carpio haematopterus/Cyprinus carpio *	A				X			
Fistularia commersoni	D				X		X	
Gambusia affinis	A				X			
Lepomis gibbosus *	A				X			
Liza haematocheila ex *Mugil soiuy*	A, B, D				X			
Micropterus salmoides	A				X			
Neogobius melanostomus *	D				X	X	X	
Oncorhynchus mykiss	A				X	X		
Perccottus glenii	B, D				X			
Phoxinus phoxinux	D					X		
Pseudorasbora parva	A				X	X	X	
Salmo salar	A, B				X	X		
Salvelinus fontinalis	A				X	X	X	
Saurida undosquamis	D				X		X	
Seriola fasciata	D				X			
Siganus luridus	D				X			
Siganus rivulatus	D				X		X	
Silurus glanis	A				X			
Sphoeroides pachygaster	D				X			
Stizostedion lucioperca	Indigenous, A					X		
Crustaceans								
Acartia tonsa	D				X		X	
Balanus improvisus	D						X	
Cercopagis pengoi	D				X	X	X	

Species / Group of species *species listed in De Poorter and Pagad (2007)	**Trade category**	**EPPO A1 list**	**EPPO A2 list**	**EPPO list of invasive alien plants**	**SEBI2010**	**Nobanis**	**Daisie**	**Reg. 338/97**
Charbydis logicollis	D						X	
Chelicorophium curvispinum	D				X			
Dikerogammarus villosus	A, D				X		X	
Elminius modestus	D				X			
Eriocheir sinensis	D				X	X	X	
Gammarus tigrinus	D				X			
Homarus americanus	B					X		
Marsupenaeus japonicus	A, B						X	
Metapenaeus (Marsupenaeus) japonicus	A, B				X			
Orconectes limosus *	A				X			
Pacifastacus leniusculus	A				X	X		
Paralithodes camtschatica	A				X	X	X	
Percnon gibbesi	B, D				X		X	
Pontogammarus robustoides	A, D					X		
Procambarus clarkii *	A, B				X		X	
Insects								
Acleris gloverana	C	X						
Acleris variana	C	X						
Aculops fuchsiae	C	X						
Aedes albopictus	D						X	
Aeolesthes sarta	C		X					
Agrilus planipennis	C	X						
Aleurocanthus spiniferus	C	X						
Aleurocanthus woglumi	C	X						
Amauromyza maculosa	C	X						
Anastrepha fraterculus	C	X						
Anastrepha ludens	C	X						
Anastrepha obliqua	C	X						
Anastrepha suspensa	C	X						
Anoplophora chinensis	C	X			X		X	
Anoplophora glabripennis	D, C	X			X		X	

Species / Group of species *species listed in De Poorter and Pagad (2007)	**Trade category**	**EPPO A1 list**	**EPPO A2 list**	**EPPO list of invasive alien plants**	**SEBI2010**	**Nobanis**	**Daisie**	**Reg. 338/97**
Anthonomus bisignifer	C	X						
Anthonomus eugenii	C	X						
Anthonomus grandis	C	X						
Anthonomus signatus	C	X						
Aphis gossypi	C						X	
Bactrocera cucumis	C	X						
Bactrocera cucurbitae	C	X						
Bactrocera dorsalis	C	X						
Bactrocera minax	C	X						
Bactrocera tryoni	C	X						
Bactrocera tsuneonis	C	X						
Bactrocera zonata	C	X						
Bemisia tabaci	C		X					
Blitopertha orientalis	D, C	X						
Cacoecimorpha pronubana	C		X					
Cacyreus marshalli	C		X					
Cameraria ohridella	D, C				X	X	X	
Carposina sasakii	C		X					
Ceratitis capitata	C		X				X	
Ceratitis rosa	C	X						
Choristoneura conflictana	C	X						
Choristoneura fumiferana	C	X						
Choristoneura occidentalis	C	X						
Choristoneura rosaceana	C	X						
Conotrachelus nenuphar	D	X						
Corythucha arcuata	C				X			
Cydia inopinata	C, D		X					
Cydia packardi	C, D	X						
Cydia prunivora	C, D	X						
Dacus ciliatus	C		X					
Dendroctonus adjunctus	C	X						

Species / Group of species *species listed in De Poorter and Pagad (2007)	**Trade category**	**EPPO A1 list**	**EPPO A2 list**	**EPPO list of invasive alien plants**	**SEBI2010**	**Nobanis**	**Daisie**	**Reg. 338/97**
Dendroctonus brevicomis	C	X						
Dendroctonus frontalis	C	X						
Dendroctonus ponderosae	C	X						
Dendroctonus pseudotsugae	C	X						
Dendroctonus rufipennis	C	X						
Dendrolimus sibiricus	C		X					
Dendrolimus superans	C		X					
Diabrotica barberi	C, D	X						
Diabrotica speciosa	C, D	X						
Diabrotica undecimpunctata	C, D	X						
Diabrotica virgifera	C, D		X				X	
Diaphorina citri	C	X						
Dryocoetes confusus	C	X						
Dryocosmus kuriphilus	C		X					
Epitrix cucumeris	D	X						
Epitrix tuberis	D	X						
Erschoviella musculana	C, D		X					
Eutetranychus orientalis	C		X					
Frankliniella occidentalis	C		X				X	
Gnathotrichus sulcatus	C	X						
Gonipterus gibberus	C, D	X						
Gonipterus scutellatus	C, D		X					
Harmonia axyridis	A				X		X	
Helicoverpa armigera	C		X					
Helicoverpa zea	C	X						
Heteronychus arator	C, D	X						
Homalodisca coagulata	C	X						
Hyphantria cunea	C				X			
Ips calligraphus	C	X						
Ips confusus	C	X						
Ips grandicollis	C	X						

Species / Group of species *species listed in De Poorter and Pagad (2007)	**Trade category**	**EPPO A1 list**	**EPPO A2 list**	**EPPO list of invasive alien plants**	**SEBI2010**	**Nobanis**	**Daisie**	**Reg. 338/97**
Ips hauseri	C		X					
Ips lecontei	C	X						
Ips pini	C	X						
Ips plastographus	C	X						
Ips subelongatus	C		X					
Lasius neglectus	D				X			
Lepidosaphes ussuriensis	C		X					
Leptinotarsa decemlineata	C		X				X	
Limonius californicus	D, C	X						
Linepithema humile	D				X		X	
Liriomyza huidobrensis	C		X				X	
Liriomyza sativae	C		X					
Liriomyza trifolii	C		X					
Listronotus bonariensis	C, D	X						
Lopholeucaspis japonica	C		X					
Lymantria mathura	D, C		X					
Maconellicoccus hirsutus	C	X						
Malacosoma americanum	C	X						
Malacosoma disstria	C	X						
Malacosoma parallela	C		X					
Margarodes prieskaensis	D, C	X						
Margarodes vitis	D, C	X						
Margarodes vredendalensis	D, C	X						
Melanotus communis	D	X						
Naupactus leucoloma	C, D	X						
Numonia pirivorella	C		X					
Oligonychus perditus	C	X						
Opogona sacchari	C		X					
Orgyia pseudotsugata	C	X						
Paysandisia archon	C		X					
Pissodes nemorensis	C	X						

Species / Group of species *species listed in De Poorter and Pagad (2007)	**Trade category**	**EPPO A1 list**	**EPPO A2 list**	**EPPO list of invasive alien plants**	**SEBI2010**	**Nobanis**	**Daisie**	**Reg. 338/97**
Pissodes strobi	C	X						
Pissodes terminalis	C	X						
Popillia japonica	D, C		X					
Premnotrypes latithorax, P. suturicallus & P. vorax	C	X						
Quadraspidiotus perniciosus	C		X					
Rhagoletis cingulata	C		X					
Rhagoletis fausta	C	X						
Rhagoletis indifferens	C	X						
Rhagoletis mendax	C	X						
Rhagoletis pomonella	C	X						
Rhizoecus hibisci	C	X						
Rhynchophorus ferrugineus	C		X		X			
Rhynchophorus palmarum	C	X						
Scirtothrips aurantii	C	X						
Scirtothrips citri	C	X						
Scirtothrips dorsalis	C		X					
Scolytus morawitzi	C		X					
Sirex ermak	D, C		X					
Spodoptera eridania	C	X						
Spodoptera frugiperda	C	X						
Spodoptera littoralis	C		X				X	
Spodoptera litura	C	X						
Sternochetus mangiferae	C	X						
Strobilomya viaria	D		X					
Tecia solanivora	C		X					
Tetropium gracilicorne	C		X					
Thrips palmi	C	X						
Toxoptera citricida	C	X						
Trialeurodes vaporarium	C						X	
Trioza erytreae	C	X						
Trogoderma granarium	D		X					

Species / Group of species *species listed in De Poorter and Pagad (2007)	**Trade category**	**EPPO A1 list**	**EPPO A2 list**	**EPPO list of invasive alien plants**	**SEBI2010**	**Nobanis**	**Daisie**	**Reg. 338/97**
Tuta absoluta	C	X						
Unaspis citri	C	X						
Viteus vitifoliae	C		X					
Xylotrechus altaicus	C		X					
Xylotrechus namanganensis	C		X					
Annelids								
Artioposthia triangulata	C				X			
Ficopomatus enigmaticus	D				X		X	
Hydroides dianthus	D				X			
Hydroides elegans	D				X			
Hydroides ezoensis	D				X			
Marenzelleria neglecta	D				X	X		
Marenzelleria viridis	D				X		X	
Pileolaria berkeleyana	D				X			
Spirorbis marioni	D				X			
Molluscs								
Anadara spp *inaequivalvis/demiri*	A, B				X			
Anodonta (Sinanodonta) woodiana	C, A				X			
Arion vulgaris/ lusitanicus	C				X	X	X	
Brachiodontes pharaonis	D						X	
Corbicula fluminea	D				X		X	
Crassostrea gigas	A, B					X		
Crepidula fornicata	C, D				X		X	
Dreissena bugensis	D				X			
Dreissena polymorpha	D				X	X	X	
Ensis americanus	D				X			
Musculista senhousia	A, B				X		X	
Petricola pholadiformis	A, B				X			
Pinctada radiata	A, B, C, D				X		X	
Potamopyrgus antipodarum	D				X			

Species / Group of species *species listed in De Poorter and Pagad (2007)	**Trade category**	**EPPO A1 list**	**EPPO A2 list**	**EPPO list of invasive alien plants**	**SEBI2010**	**Nobanis**	**Daisie**	**Reg. 338/97**
Rapana venosa	C, D				X		X	
Ruditapes philippinarum	A				X			
Teredo navalis	D						X	
Comb jellies								
Beroe cucumi	D				X			
Blackfordia virginica	D				X			
Mnemiopsis leidyi	D				X		X	
Hydroids, jellyfish, sea anemones & corals								
Cordylophora caspia	D				X		X	
Craspedacusta sowerbyi	D					X		
Polypodium hydriforme	C				X			
Rhopilema nomadica	D				X		X	
Ascidians and sessile tunicates								
Microcosmus squamifer	D				X			
Styela clava	D				X		X	
Bryozoans								
Tricellaria inopinata	D				X		X	
Victorella pavida	D				X			
Flatworms								
Artioposthia triangulata (*Arthurdendyus triangulatus*)	C					X		
Fasciola gigantica	C				X			
Gyrodactylus salaris	C				X	X	X	
Pseudodactylogyrus anguillae	C				X			
Cestoda								
Botriocephalus acheilognathi	C				X			
Nematodes								
Anguillicola crassus	C				X	X	X	
Aphelenchoides besseyi	C		X					
Ashworthius sidemi	C				X			

Species / Group of species *species listed in De Poorter and Pagad (2007)	**Trade category**	**EPPO A1 list**	**EPPO A2 list**	**EPPO list of invasive alien plants**	**SEBI2010**	**Nobanis**	**Daisie**	**Reg. 338/97**
Bursaphelenchus xylophilus and its vectors in the genus *Monochamus*	C, D	X			X		X	
Ditylenchus dipsaci	C, D		X					
Globodera pallida	C		X					
Globodera rostochiensis	C		X					
Heterodera glycines	C, D		X					
Meloidogyne chitwoodii	C, D		X					
Meloidogyne fallax	C, D		X					
Nacobbus aberrans	C, D	X						
Radopholus citrophilus	C, D	X						
Radopholus similis	C, D		X					
Xiphinema americanum sensu stricto	D	X						
Xiphinema bricolense	D	X						
Xiphinema californicum	D	X						
Xiphinema rivesi	D		X					
Plants								
Acacia dealbata	A			X			X	
Acacia saligna	A				X			
Acer negundo *	A				X	X		
Acer pseudoplatanus	A					X		
Acroptilon repens	C, D			X				
Ailanthus altissima *	A			X	X		X	
Ambrosia artemisiifolia *	C, D			X	X		X	
Amelanchier spicata	A, B			X		X		
Amorpha fruticosa *	A, D			X	X			
Anthriscus sylvestris	Indigenous, A					X		
Arceuthobium abietinum	C	X						
Arceuthobium americanum	C	X						
Arceuthobium campylopodum	C	X						
Arceuthobium douglasii	C	X						
Arceuthobium laricis	C	X						

Species / Group of species *species listed in De Poorter and Pagad (2007)	**Trade category**	**EPPO A1 list**	**EPPO A2 list**	**EPPO list of invasive alien plants**	**SEBI2010**	**Nobanis**	**Daisie**	**Reg. 338/97**
Arceuthobium minutissimum	C	X						
Arceuthobium occidentale	C	X						
Arceuthobium pusillum	C	X						
Arceuthobium spp. (non-European)	C	X						
Arceuthobium tsugense	C	X						
Arceuthobium vaginatum	C	X						
Aster novi-belgii agg.	A				X			
Azolla filiculoides	B, C, D			X	X	X		
Baccharis halimifolia	A			X				
Bidens frondosa	C, D			X	X			
Buddleja davidii	A			X				
Bunias orientalis	D				X	X		
Campylopus introflexus	C				X	X	X	
Cabomba caroliniana	B			X				
Carpobrotus edulis * & *C.* spp.	A			X	X		X	
Cenchrus incertus	D			X				
Cenchrus longispinus	D				X			
Cortaderia selloana	A			X	X		X	
Crassula helmsii	B, C, D		X	X	X		X	
Cyperus esculentus	C			X				
Echinocystis lobata *	B, C, D				X		X	
Egeria densa	B, C, D			X				
Elodea canadensis	C, D				X	X	X	
Elodea nuttallii	C, D			X	X	X		
Epilobium ciliatum	D				X			
Fallopia japonica *, *F. sachalinensis, Fallopia x bohemica*	A			X	X	X	X	
Galinsoga quadriradiata	C, D					X		
Grindelia squarrosa	B				X			
Halophila stipulacea	C				X		X	
Hedychium gardnerianum *	A				X		X	

Species / Group of species *species listed in De Poorter and Pagad (2007)	**Trade category**	**EPPO A1 list**	**EPPO A2 list**	**EPPO list of invasive alien plants**	**SEBI2010**	**Nobanis**	**Daisie**	**Reg. 338/97**
Helianthus tuberosus *	A			X	X			
Heracleum mantegazzianum	A			X	X	X	X	
Heracleum sosnowskyi	A			X	X	X		
Hydrocotyle ranunculoides	A		X	X	X			
Impatiens glandulifera *	B, A			X	X	X	X	
Iva (Cyclachaena) xanthiifolia	C				X			
Lagarosiphon major	A			X				
Ludwigia peploides	A			X	X			
Ludwigia uruguayensis	A			X				
Lupinus nootkatensis *	A					X		
Lupinus polyphyllus *	A			X		X		
Lysichiton americanus	A, B		X	X	X	X		
Myriophyllum aquaticum	A, B, C			X				
Opuntia ficus-indica & *Opuntia* spp.	A				X		X	
Oxalis pes-caprae	B, C, D			X	X		X	
Paspalum paspalodes (= *P. distichum*)	C			X			X	
Pinus mugo *	A					X		
Prunus serotina *	A			X	X	X	X	
Pueraria lobata (= *P. montana* var. *lobata*)	A		X	X				
Rhododendron ponticum *	A			X	X		X	
Robinia pseudoacacia *	A				X		X	
Rosa rugosa	A				X	X	X	
Sambucus nigra	Indigenous					X		
Sambucus racemosa	A					X		
Senecio inaequidens	C, D			X	X	X		
Sicyos angulatus	C, D			X				
Solanum elaeagnifolium	C, A, D		X	X				
Solidago canadensis	A			X	X	X		
Solidago gigantea *	A			X	X			
Solidago nemoralis	A			X				
Spartina townsendi /anglica	A				X	X		

Species / Group of species *species listed in De Poorter and Pagad (2007)	**Trade category**	**EPPO A1 list**	**EPPO A2 list**	**EPPO list of invasive alien plants**	**SEBI2010**	**Nobanis**	**Daisie**	**Reg. 338/97**
Macroalgae								
Acrothamnion preisii	D				X			
Asparagopsis armata	C				X			
Asparagopsis taxiformis	unknown				X			
Bonnemaisonia hamifera	C						X	
Caulerpa racemosa	D				X		X	
Caulerpa taxifolia *	B				X		X	
Codium fragile	D				X		X	
Grateloupia doryphora	C				X			
Polysiphonia morrowii	C				X			
Sargassum muticum	C				X			
Stypopodium schimperi	D				X			
Undaria pinnatifida	A, D				X		X	
Womersleyella setacea	D				X			
Phytoplankton								
Alexandrium catenella	D				X		X	
Alexandrium minutum	D				X			
Alexandrium tamarense	D				X			
Chattonella verruculosa	D				X	X	X	
Coscinodiscus wailesii	D				X		X	
Karenia mikimotoi	D				X			
Odontella sinensis	D						X	
Phaeocystis pouchetii	D				X			
Prorocentrum minimum	D						X	
Rhizosolenia calcar-avis	D				X			
Fungi								
Alternaria mali		X						
Anisogramma anomala		X						
Aphanomyces astaci	C				X	X	X	
Apiosporina morbosa		X						

Species / Group of species *species listed in De Poorter and Pagad (2007)	**Trade category**	**EPPO A1 list**	**EPPO A2 list**	**EPPO list of invasive alien plants**	**SEBI2010**	**Nobanis**	**Daisie**	**Reg. 338/97**
Atropellis pinicola		X						
Atropellis piniphila		X						
Botryosphaeria laricina			X					
Ceratocystis fagacearum and its vectors		X						
Ceratocystis fimbriata f.sp. *platani*	D		X					
Chrysomyxa arctostaphyli		X						
Ciborinia camelliae	C		X					
Cronartium coleosporioides		X						
Cronartium comandrae		X						
Cronartium comptoniae		X						
Cronartium fusiforme		X						
Cronartium himalayense		X						
Cronartium kamtschaticum			X					
Cronartium quercuum		X						
Cryphonectria parasitica	C		X					
Deuterophoma tracheiphila			X					
Diaporthe vaccinii		X						
Didymella ligulicola			X					
Endocronartium harknessii		X						
Fusarium oxysporum f.sp. *albedinis*			X					
Gibberella circinata		X						
Glomerella gossypii			X					
Guignardia citricarpa		X						
Gymnosporangium asiaticum			X					
Gymnosporangium clavipes		X						
Gymnosporangium globosum		X						
Gymnosporangium juniperi-virginianae		X						
Gymnosporangium yamadae		X						
Melampsora farlowii		X						
Melampsora medusae			X					
Melampsoridium hiratsukanum	C					X		

Species / Group of species *species listed in De Poorter and Pagad (2007)	**Trade category**	**EPPO A1 list**	**EPPO A2 list**	**EPPO list of invasive alien plants**	**SEBI2010**	**Nobanis**	**Daisie**	**Reg. 338/97**
Monilinia fructicola			X					
Mycosphaerella dearnessii			X					
Mycosphaerella gibsonii		X						
Mycosphaerella laricis-leptolepidis		X						
Mycosphaerella populorum		X						
Ophiostoma novo-ulmi	C				X		X	
Ophiostoma wageneri		X						
Phaeoramularia angolensis		X						
Phellinus weirii		X						
Phialophora cinerescens			X					
Phoma andigena		X						
Phyllosticta solitaria		X						
Phymatotrichopsis omnivora		X						
Phytophthora cinnamomi	C				X		X	
Phytophthora fragariae			X					
Phytophthora lateralis		X						
Phytophthora ramorum	C					X		
Pseudopityophthorus minutissimus		X						
Pseudopityophthorus pruinosus		X						
Puccinia horiana			X					
Puccinia pittieriana		X						
Seiridium cardinale	C						X	
Septoria lycopersici var. *malagutii*		X						
Sirococcus clavigignenti-juglandacearum		X						
Stegophora ulmea		X						
Stenocarpella macrospora			X					
Stenocarpella maydis			X					
Synchytrium endobioticum	C		X					
Thecaphora solani		X						
Tilletia indica		X						

Species / Group of species *species listed in De Poorter and Pagad (2007)	**Trade category**	**EPPO A1 list**	**EPPO A2 list**	**EPPO list of invasive alien plants**	**SEBI2010**	**Nobanis**	**Daisie**	**Reg. 338/97**
Verticillium albo-atrum & *V. dahliae* (hop-infecting strains)			X					
Protists								
Bonamia ostreae	C				X			
Prokaryotes								
Apple proliferation phytoplasma			X					
Burkholderia caryophylli			X					
Clavibacter michiganensis subsp. *insidiosus*			X					
Clavibacter michiganensis subsp. *michiganensis*			X					
Clavibacter michiganensis subsp. *sepedonicus*			X					
Curtobacterium flaccumfaciens pv. *flaccumfaciens*			X					
Elm phloem necrosis phytoplasma		X						
Erwinia amylovora			X					
Erwinia chrysanthemi			X					
Grapevine flavescence dorée phytoplasma			X					
Liberobacter africanum & *L. asiaticum*		X						
Palm lethal yellowing phytoplasma		X						
Pantoea stewartii pv. *stewartii*			X					
Peach rosette phytoplasma		X						
Peach X-disease phytoplasma		X						
Peach yellows phytoplasma		X						
Pear decline phytoplasma			X					
Potato purple-top wilt phytoplasma		X						
Pseudomonas syringae pv. *persicae*			X					
Ralstonia solanacearum			X					
Stolbur phytoplasma			X					
Vibrio cholerae	D				X			
Xanthomonas arboricola pv. *corylina*			X					
Xanthomonas arboricola pv. *pruni*			X					

Species / Group of species *species listed in De Poorter and Pagad (2007)	**Trade category**	**EPPO A1 list**	**EPPO A2 list**	**EPPO list of invasive alien plants**	**SEBI2010**	**Nobanis**	**Daisie**	**Reg. 338/97**
Xanthomonas axonopodis pv. *citri*		X						
Xanthomonas axonopodis pv. *dieffenbachiae*			X					
Xanthomonas axonopodis pv. *phaseoli*			X					
Xanthomonas axonopodis pv. *vesicatoria and Xanthomonas vesicatoria*			X					
Xanthomonas fragariae			X					
Xanthomonas oryzae pv. oryzae		X						
Xanthomonas oryzae pv. oryzicola		X						
Xanthomonas translucens pv. translucens			X					
Xylella fastidiosa		X						
Xylophilus ampelinus			X					
Viruses								
American plum line pattern virus (*Ilarvirus*)		X						
Andean potato latent virus (*Tymovirus*)		X						
Andean potato mottle virus (*Comovirus*)		X						
Bean golden mosaic virus (*Begomovirus*)		X						
Beet leaf curl virus			X					
Beet necrotic yellow vein virus (*Benyvirus*)			X					
Blueberry leaf mottle virus (*Nepovirus*)			X					
Cherry rasp leaf virus (*Cheravirus*)		X						
Chrysanthemum stem necrosis virus (*Tospovirus*)		X						
Chrysanthemum stunt viroid (*Pospiviroid*)			X					
Citrus blight disease		X						
Citrus leprosis virus		X						
Citrus mosaic virus (*Badnavirus*)		X						
Citrus tatter leaf virus (*Capillovirus*)		X						
Citrus tristeza virus (*Closterovirus*)			X					
Coconut cadang-cadang viroid (*Cocadviroid*)		X						
Cucumber vein yellowing virus (*Ipomovirus*)			X					
Cucurbit yellow stunting disorder virus (*Crinivirus*)			X					
Impatiens necrotic spot virus (*Tospovirus*)			X					

Species / Group of species *species listed in De Poorter and Pagad (2007)	**Trade category**	**EPPO A1 list**	**EPPO A2 list**	**EPPO list of invasive alien plants**	**SEBI2010**	**Nobanis**	**Daisie**	**Reg. 338/97**
Lettuce infectious yellows virus (*Crinivirus*)		X						
Peach mosaic virus (*Trichovirus*)		X						
Peach rosette mosaic virus (*Nepovirus*)		X						
Plum pox virus (*Potyvirus*)			X					
Potato black ringspot virus (*Nepovirus*)		X						
Potato spindle tuber viroid (*Pospiviroid*)			X					
Potato virus T		X						
Potato yellow dwarf virus (*Nucleorhabdovirus*)		X						
Potato yellow vein virus (*Crinivirus*)		X						
Potato yellowing virus		X						
Raspberry leaf curl virus (*Nepovirus*)		X						
Raspberry ringspot virus (*Nepovirus*)			X					
Satsuma dwarf virus (*Sadwavirus*)			X					
Squash leaf curl virus (*Begomovirus*)			X					
Strawberry latent C virus		X						
Strawberry veinbanding virus (*Caulimovirus*)			X					
Tobacco ringspot virus (*Nepovirus*)			X					
Tomato chlorosis virus (*Crinivirus*)			X					
Tomato mottle virus (*Begomovirus* - and other American *Geminiviridae* of capsicum and tomato)		X						
Tomato ringspot virus (*Nepovirus*)			X					
Tomato spotted wilt virus (*Tospovirus*)			X					
Tomato yellow leaf curl virus (*Begomovirus*) and related viruses			X					
Watermelon silver mottle virus (*Tospovirus*)		X						
Protozoa								
Eimeria sinensis	C				X			
Trichodina nobilis	C				X			