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Code of conduct on horticulture and invasive alien plants

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CODE OF CONDUCT ON HORTICULTURE AND INVASIVE ALIEN PLANTS

This code of conduct was prepared by Vernon Heywood and Sarah Brunel as a joint collaboration of the Council of Europe and the European and Mediterranean Plant Protection Organization (EPPO).

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CODE OF CONDUCT ON HORTICULTURE AND INVASIVE ALIEN PLANTS

INTRODUCTION

‘Most invasive plants have been introduced for horticultural use by nurseries, botanical gardens, and individuals’ (Reichard & White 2001)

Many of the plants used in European agriculture, horticulture and forestry are not native to the continent but have been introduced deliberately or accidentally at various times over the past 2000 years from different parts of the world as a consequence of human activity. A distinction is often made in Europe between archaeophytes and neophytes – plants introduced before or after 1492/1500 respectively (cf. Webb 1985; Elorza & al. 2004).

The European economy depends to a large extent on the cultivation of such alien plants. Most of these introductions have been beneficial to humans and have not caused problems through their becoming weedy or invasive. However, a small percentage of these introductions escape from cultivation, become naturalized and invade natural, semi-natural or human-made ecosystems. They are known as **Invasive Alien Plants (IAP)** and may have significant ecological or economic consequences or become harmful to human health. Their potential to alter ecosystem structure and function drastically has been widely recognized in recent years (cf. Levine & al., 2003). Globally, invasive alien species are widely acknowledged (e.g. by the Convention on Biological Diversity and the Millennium Ecosystem Assessment) as one of the major threats to biodiversity, second only to habitat loss and degradation. In South Africa, alien plant species are considered the single biggest threat to the country’s biological biodiversity¹, and now cover more than 10.1 million hectares (ha), threatening indigenous plants. They cause billions of South African Rands of damage to the country’s economy every year. A comprehensive overview of invasive species in natural areas is provided by Weber’s *Invasive plant species of the world. A reference guide to environmental weeds*². It covers 450 species that affect natural habitats in various parts of the world areas.

The terminology applied to invasive plants can be very confusing and there is no consistency of usage of the various terms applied. For details see Appendix 1.

1. Characteristics of horticultural invasive alien plants

It is exceedingly difficult to determine which biological characteristics are good indicators of invasiveness but although there are no generally applicable characteristics that apply to plants that become invasive in horticulture, they often share some of the following features: rapid growth and reproduction, ability to colonize disturbed or weedy ground, short growth cycle, early flowering and seeding, production of large quantities of fruits and/or seeds, effective vegetative propagation and spread (especially in aquatic plants), ability to use local pollinators, different phenology from native species allowing them to out compete, and disease and pest resistance. These are also the characteristics of many weeds. Moreover, some of these features which make them easy to grow may be the very reason that the plants are popular in horticulture. Thus successful garden plant introductions may well have features that predispose them to becoming invasive (Dehnen-Schmutz & al. 2007). An analysis of traits that might serve to separate invasive from non-invasive species which was carried out on 235 woody invasives and 114 woody non-invasives that had been available in the United States since before 1930, found that 54% of the woody species that invade the United States also invade other parts of the world, 44% of them spread by vegetative means and have shorter juvenile phases and 51% do not require pretreatment of the seeds for germination (Reichard 2000). The non-invasive species scored much less for these traits.

Taxonomic affinity may also give some clues as to invasiveness: Reichard’s study also showed that of 76 serious invaders, 48 (63%) occurred in six families, Rosaceae, Leguminosae, Myrtaceae, Salicaceae Oleaceae and Caprifoliaceae. A broader study by Heywood (1989) showed that invasive species were more frequent in large ‘natural’ families such as the Apiaceae, Asteraceae, Brassicaceae,

¹ <http://www.dwaf.gov.za/wfw/>

² E. Weber, *Invasive plant species of the world: A reference guide to environmental weeds*. CABI Publishing, Wallingford, UK (2003).

Lamiaceae, Leguminosae and Poaceae, which possess complex and successful reproductive and dispersal mechanisms. As he notes, it is largely true that the very features that have been responsible for the evolutionary success and diversification of these families are the very ones that have been responsible for their success as invasives.

Since ornamental species are the largest pool for species that subsequently become invasive, there is clearly a need to adopt a more risk based approach, combined with the use of the precautionary principle and good scientific research, to try and avoid the undesirable consequences of this continued importation of new ornamental species whose invasive potential is unknown.

Because of the diversity of pathways of introduction and of the species currently or potentially involved, designing a regulatory mechanism, albeit voluntary, is a major challenge. Other difficulties stem from the fact that there is often a delay before introduced taxa become invasive (known as the lag phase).

2. Pathways of introduction of invasive alien plants

Ornamental horticulture has been recognized as the main pathways of plant invasions worldwide (Reichard & White 2001; Dehnen-Schmutz & al. 2007) but as Shine (2005) notes, there is no consistency of approach between countries or regions on the assessment and management of these risks. It is estimated that 80% of current invasive alien plants in Europe were introduced as ornamental or agricultural plants (Hulme, 2007).

The horticultural industry in Europe and elsewhere in the world has brought great benefit, both social and economic, and has made a vast array of plant diversity available to the public. In Europe about 17 000 taxa (12 000 species plus subspecies, varieties and hybrids) are grown in gardens (European Garden Flora Committee 1984–2000) and new introductions are constantly being sought and there are strong incentives to introduce new plants into horticulture and these are often welcomed by the public who shows a fascination for novelty in this as in other areas.

Although biological invasions have occurred in Europe in the past, a classic example being the aphid *Phylloxera vastatrix* which devastated European vineyards, destroying a million ha in France alone, concern at the impacts of alien invasive plant species has not been a major concern until recently. There was, however, a backlash in the 19th century against the introduction of large numbers of ornamental species to gardens and the merits of growing foreign plant species, especially those from the tropics was much debated (Heywood 2006; Preston 2002). More recently, such approaches to limit or control introduced species have been criticized as being nativist, racist or xenophobic (Simberloff 2003) but this is seldom justified as in most cases the motivation for this action is soundly based on documented assessment of the likely economic or ecological impacts that bioinvasions will cause (Heywood 2006).

Some of the most serious problems caused in Europe by invasive aliens are from aquatic plants which have escaped from garden ponds, aquaria or water gardens.

These plants often reproduce rapidly by vegetative means and can rapidly colonise large areas. They may pose a threat to native plants and animals and ecosystems and can choke waterways and rivers. Some aquatic invaders are readily available from garden centres, aquarium shops and similar outlets, and as the Royal Horticultural Society's guidelines on invasive non-native species³ notes, they are frequently misidentified and no indication is given of their invasive nature. An investigation has shown that effectively every aquatic or wetland plant listed in the United States as a Federal Noxious Weeds or as a noxious weed in one or more states was available through mail-order or the Internet (Kay & Hoyle 2001). On-line sites selling invasive aquatics were worldwide and one of the largest sites was in Denmark.

Other unintentional pathways include discarded garden waste, compost heaps, packaging materials, ballast water (in the case of aquatic plants), soil as a growing media, machinery and equipment, packaging and containers.

³ [RHS Conservation & Environment Guideline Invasive non-native species](http://www.rhs.org.uk/learning/research/documents/c_and_e_nonnative.pdf). Royal Horticultural Society, Wisley.
http://www.rhs.org.uk/learning/research/documents/c_and_e_nonnative.pdf

Neither the number of naturalized or alien invasive species in Europe is known with any degree of accuracy. In an analysis of the data in *Flora Europaea* (Tutin, Heywood & al. 1964–80), Weber (1997) arrived at a figure of 1568 for plant species naturalized in Europe, but no comprehensive survey of invasive plant species in Europe has been produced, although data are available for individual countries, e.g. North Europe and Baltic (NOBANIS)⁴ Hungary, Spain, United Kingdom. In 2003, EPPO sent a questionnaire to its 44 member states asking for plants that have been intentionally or unintentionally introduced into EPPO countries and are considered to be listed as invasive. The member states reported hundreds of plant species, of which an initial 40 were selected for further assessment. This list is currently under review and EPPO is working on a wider prioritization process.

Although in Europe, invasive plant species do not constitute such a serious a problem as in other parts of the world such as Australia, Africa and the United States, their impact is quite often highly damaging and likely to increase as a consequence of climate change, the greater mobility of human populations, rapidly growing transport technology, expanding tourism and travel activities, and the expansion and globalization of trade (and of the European Union borders).

3. Environmental and economic impacts

In addition to the economic costs of eradication, alien invasive species can have various adverse impacts such as reduction or loss of land value, reduction in yields of crops and damage to infrastructure. For instance, in Morocco, the value of infested fields decreased by 25% when invaded by *Solanum elaeagnifolium*, and losses of up to 64% in maize without treatment and 78% in cotton have been reported (EPPO Datasheet). Examples of the economic costs of invasive species are given in various reports. For example, in Germany the annual costs incurred by infestation by Giant Hogweed (*Heracleum mantegazzianum*) is estimated at €12 313 000 (Reinhardt & al. 2003). The eradication of *Carpobrotus edulis* and *C. acinaciformis*, in various parts of the Mediterranean, notably Mallorca, Menorca, Spain incurs annual costs of hundreds of thousands of euros and has been included in *LIFE Nature* projects (see Scalera & Zaghi 2004). Some idea of the scale of the operations involved can be obtained from the campaign to eradicate *Carpobrotus* undertaken in Minorca from 2002 to 2005: 233,785 m² of *Carpobrotus* were eliminated, representing the removal of 832,148 kg of biomass and involving 9,041 hours of work (Fraga i Arguimbau 2007). In the UK, the estimate for control by herbicides of the total area infested by the aquatic invasive *Hydrocotyle ranunculoides* introduced from North America is between £250 000 and £300 000 per year while adequate control of another invasive aquatic *Crassula helmsii*, from Australasia, is estimated at about £3 000 000 (Leach & Dawson 1999).

Another example is *Rhododendron ponticum* introduced into Britain c. 1763, probably from Spain, as an ornamental and which subsequently became naturalized and invasive, displacing native species, and today affects 52,000 ha of land, more than 30,000 ha of which is in nature reserves. An economic analysis of the cost of controlling it in Britain based on the responses to a questionnaire to land owners and managers, indicated that in 2001, respondents controlled 1275 ha of *R. ponticum*⁵ at a cost of £670 924 (Dehnen-Schmutz & al. 2004) although an optimal level of control would be very much higher.

4. Botanic gardens and invasives

Europe's numerous botanic gardens which cultivate tens of thousands of exotic plants have also been responsible for the introduction of a number of invasive species. An example is the Oxford Ragwort (*Senecio squalidus*), a hybrid of two Sicilian species, *S. aethnensis* and *S. chrysanthemifolius* first grown in Oxford University botanic garden in the early 18th century and after some years escaped and spread into the city and then with the advent of the railway along the tracks (Abbott & al. 2000). Subsequently it has hybridized with native British species, resulting in fertile derivatives some of

⁴ [North European and Baltic Network on Invasive Alien Species \(NOBANIS\)](http://www.nobanis.org/default.asp): Denmark, Estonia, Finland, Faroe Islands, Germany, Greenland, Iceland, Latvia, Lithuania, Norway, Poland, European part of Russia, Sweden. <http://www.nobanis.org/default.asp>

⁵ Recent research suggests that *Rhododendron ponticum* is at least partly, possibly largely a hybrid formed in Britain between *R. ponticum* and the American *R. catawbiense* and other species (Milne & Abbott 2000).

which have been recognized as separate species such as *S. cambrensis* and *Senecio eboracensis* (James & Abbott 2006).

This Code of Conduct is not addressed at European botanic gardens, although many of its recommendations may be relevant to their activities. Further, the European horticultural trade and botanic gardens are increasingly working in partnership on some issues and invasive ornamental species is a highly appropriate topic for working out joint policies. Various other Codes or guidelines do exist that are aimed specifically at botanic gardens such as the International Plant Exchange Network (IPEN) Code of Conduct⁶ and, in the United States, the *Chicago Botanic Garden Invasive Plant Policy Synopsis* and the *Missouri Botanical Garden Code of Conduct*.

⁶ An exchange system for botanic gardens for non-commercial exchange of plant material, based on the CBD. IPEN is a registration system open for botanic gardens that adopt a common policy (Code of Conduct) regarding access to genetic resources and sharing of the resulting benefits. It has been developed by the Verband Botanischer Gärten (an association of gardens in German speaking countries) and was taken over by the European Consortium of Botanic Gardens. <http://www.botgart.uni-bonn.de/ipen/description.html>

5. Existing initiatives

European legal and policy framework

The **Convention on the Conservation of European Wildlife and Natural Habitats (Bern, 1979), (Bern Convention)** implements the CBD at regional level, and coordinates action of European governments in matters related to the conservation biological diversity. In 2002, the Bern Convention adopted a European Strategy on Invasive Alien Species aimed to provide guidance to countries to draw up and implement national strategies on IAS (Genovesi & Shine 2002). The Strategy identifies priorities and key actions for governments and conservation agencies, promotes the development and implementation of coordinated measures and cooperative efforts throughout Europe to prevent or minimise adverse impacts of invasive alien species, and proposes measures required to recover species and natural habitats affected by IAS.

The **European and Mediterranean Plant Protection (EPPO)** promotes the exchange and synthesis of information and facilitates collaboration in support of the role of National Plant Protection Organizations (i.e. Ministries of Agriculture). EPPO has launched a list of Invasive Alien plants and *Guidelines for the management of invasive alien plants or potentially invasive alien plants which are intended for import or have been intentionally imported* (EPPO Standard PM3/67, 2005).

The **Nature and Biodiversity Unit of the European Commission** is currently developing an EU Framework on IAS, and the Commission and the Member States have to prepare an EU strategy and an effective early warning and information system. It will also consider issues such as trade, communication, education and public awareness, improved coordination and building partnerships, support of action at MS level, knowledge base, financing, removing of inconsistencies, and EU as an exporter of IAS. This work will be done taking into account the European Strategy on IAS, and recognising efforts made by relevant Conventions (e.g. IPPC, EPPO).

A recent review of European Union Member State provisions for invasive alien species (Miller & al. 2006) covers the 27 EU Member States and provides a review of the existing legal and policy framework for IAS at international, EU and Member State level. It identifies areas of relevance to Community competence (totally or partially) in the CBD's Guiding Principles on IAS and the European Strategy on Invasive Alien Species developed under the Bern Convention. Based on the information on the existing international, EU and national legal/policy frameworks, the report identifies gaps in the existing EU IAS framework and makes recommendations for filling such gaps. See also the section of the Code (below) "Be aware of regulation concerning invasive alien plants".

Other European-level initiatives

In addition to the directives and recommendations made by the Council of Europe and the European Union and institutions such as EPPO, which apply to their member states, a number of other European initiatives address the issues of invasive species in Europe. These are summarized in Appendix 2.

Relevant European national initiatives and sources of information

At a national level, a few European countries have addressed the issues of invasive species and horticulture and developed a strategy. For example, in Great Britain a working group⁷, developed a code of practice for horticulture – *Helping to prevent the spread of invasive non-native species. Horticultural Code of Practice*, DEFRA⁸, – as well as The Invasive Non-Native Species Framework Strategy for Great Britain⁹ and a *Review of non-native species policy. Report of the Working Group*.

⁷ consisting of DEFRA, the Scottish Executive, the Welsh Assembly Government, Gardening Which?, the Garden Centres Association, the Horticultural Trades Association, the Royal Horticultural Society, the National Trust, the Ornamental and Aquatic Trades Association, Plantlife International, and the Royal Botanic Gardens (Kew)

⁸ <http://www.defra.gov.uk/wildlife-countryside/non-native/pdf/non-nativeecop.pdf>

⁹ *The Invasive Non-Native Species Framework Strategy for Great Britain. Protecting our natural heritage from invasive species*. Department for Environment, Food and Rural Affairs, London (2007). http://www.nonnativespecies.org/documents/Draft_StrategyV6.4.pdf

In Germany, a report on the economic impact of the spread of alien species has been published (Reinhardt & al. 2003).

In Spain, an Atlas of alien invasive species has been published by the Ministry of the Environment as part of a series resulting from the National Biodiversity Inventory (Sanz Elorza & al. 2005). Many of the species listed derive from ornamental horticulture.

Some other countries (e.g. Ireland, Germany, etc.) also have projects to prepare a code of conduct.

Relevant non-European national initiatives

Although this Code of Conduct is intended for use in Europe, invasive species are a global problem and it is important that proper cognizance is taken of actions and initiatives in other parts of the world. Some of these are outlined in continuation.

In countries such as Australia, New Zealand, South Africa and the USA, where invasive species constitute a major threat to biodiversity, a majority of which are derived from ornamental horticultural introductions, it is not surprising that policy, structures and mechanisms are in place and an extensive literature exists.

In the United States, a Workshop was held in 2001 at the Missouri Botanical Garden – ‘Linking Ecology & Horticulture to Prevent Plant Invasions’ – the Proceedings¹⁰ of which contain much information that is relevant to potential users of this Code of Conduct. One of the outputs, included in the Proceedings, was the St Louis Voluntary Codes of Conduct, including a Code for nursery professionals (See Appendix 2). A subsequent meeting, ‘Linking Ecology and Horticulture to Prevent Plant Invasions II’¹¹, was held in Chicago in 2002.

In Australia, according to a CSIRO report¹² for WWF-Australia, *Jumping the Garden Fence: Invasive garden plants in Australia and their environmental and agricultural impacts*, invasive garden plant species make up the vast majority of the 1,953 combined agricultural, noxious and natural ecosystem weeds. About two-thirds (1831) of the established alien plants in the Australian environment are escaped garden plant species and they contribute substantially to the estimated \$4 billion annual costs caused by weeds in agricultural ecosystems in Australia. As an example of the vast scale of some ornamental plant invasions, the report notes that rubbervine (*Cryptostegia grandiflora*), an escaped garden plant, has been recorded across 34.6 million ha, or 20% of the state of Queensland alone.

In the light of the information gathered in the report, a set of recommendations is proposed to lessen the overall impact of invasive plant species deliberately introduced for horticulture and currently available for sale (Appendix 4).

A draft strategy for invasive garden plants, developed by the Australian government and the Nursery Industry Association of Australia – *Garden Plants Under the Spotlight: an Australian strategy for invasive garden plants* (Roush & al. 1999) – although the result of comprehensive consultation with the horticultural industry, did not apparently move forward and its attempt to voluntarily remove from sale 52 species of garden plant failed, largely because nursery associations in some individual states did not embrace the initiative (Moss & Walmsley 2005). As the CSIRO report (Groves & al. 2005) notes, many invasive garden plant species that impact on the environment and agriculture continue to be available for sale, and they represent a significant risk to the agricultural industry and Australia’s environment. This should not be taken, however, as an argument against a voluntary strategy but as an indication of the need to ensure that adequate steps are taken to ensure effective participation.

¹⁰ ‘Linking Ecology & Horticulture to Prevent Plant Invasions’. Proceedings of the Workshop at the Missouri Botanical Garden, St. Louis, Missouri, 1-4 December 2001.

¹¹ *Linking Ecology and Horticulture to Prevent Plant Invasions II* Proceedings of the Meeting at the Chicago Botanic Garden, Chicago, Illinois, 31 October 2002.

http://www.centerforplantconservation.org/invasives/Download%20PDF/CBG_Proceedings.pdf

¹² Groves, R.H., Boden, R. & Lonsdale, W.M. (2005).

In South Africa, the *Working for Water* programme¹³ initiated in 1995 was created to eradicate invasive alien plants, through support for a variety of labour-intensive projects for clearing invasive alien plants from water catchment areas and river courses. Although initially focusing on watersheds and riparian areas. It is currently the lead focus for managing alien plants in all natural and semi-natural ecosystems in South Africa. It is administered through the Department of Water Affairs and Forestry and is now one of the world's largest programmes dealing with alien invasive species and has also a social scope since it works with unemployed people (Richardson & van Wilgen 2004).

International initiatives

In addition to the Convention on Biological and other treaties that provide the global mandate for handling invasive alien species, a considerable numbers of international initiatives exist and these are summarized in Appendix 2.

6. The Code of Conduct – a voluntary instrument

This Code of Conduct is voluntary. Its aim is to enlist the cooperation of the horticultural trade and industry, and associated professionals in reducing and controlling possible introductions of alien invasive species into European and Mediterranean countries.

It is based on the principle of self-regulation which some believe is likely to be more successful and effective than any legally binding scheme. Reasons that support such an approach are discussed by Burt & al. (2007): for example, the horticulture trade deals primarily in non-essential commodities, and similar or equally appealing non-invasive alternative plants can often be used as alternatives for particular invasive plants; it maintains close contact with consumers and the high public visibility of the horticulture trade increases the potential for self-regulation within this industry; many in the industry will wish to project an environmentally friendly image; and the threat of increased government regulation can act as a motivation for the adoption of self-regulating approaches. The expectation must be that if the horticultural trade is made properly aware of the environmental and economic consequences of introducing and distributing invasive plants, it will surely wish to engage in a voluntary code aimed at avoiding such damage. The public will also have to be convinced that voluntary schemes are credible and can be made to work.

One of the benefits of such a code could be the development of an international standard of good practice regarding trade in alien invasive plants through the ISO (International Organization for Standardization) and the setting up of national accreditation bodies to authorize the issue of certificates of compliance with the standard. A graphic symbol could be developed to indicate compliance with the standard and incorporated in plant labels and company letterheads and stationery.

¹³ <http://www.dwaf.gov.za/wfw/>

THE CODE OF CONDUCT

Audience and aims

This Code of Conduct is addressed at Governments and the horticultural industry and trade – plant importers, commercial nurseries, municipal nurseries, garden centres, aquarists – and to those who play a role in deciding what species are grown in particular areas such as landscape architects, municipal Parks and Gardens departments, Recreation and Leisure Departments.

Its aim is to enlist the cooperation of the horticultural trade and industry and associated professionals to adopt good practices in (a) raising awareness on the topic among professionals, (b) preventing the spread of alien invasive species already in cultivation, and (c) preventing the introduction of possible new plant invaders into Europe.

As noted in the Introduction, the Code is voluntary and depends on there being a high level of self-regulation by the horticultural industry.

A short version of this code is published by EPPO and directed at National plant Protection Organisation (available at www.eppo.org).

Be aware of which species are invasive in your area

It is incumbent on all those engaged in the horticultural trade and associated professions to ascertain if the plants they are selling, storing, or envisage introducing or planting are known to be invasive in their country, in the European-Mediterranean region or anywhere in the world. When they exist, national lists of invasive species should be consulted and provided in national codes of conduct. If in doubt, professional advice should be obtained from local or national environment agencies, botanic gardens or institutes.

Many references, Internet links, books and databases provide information on which species are invasive throughout the world (see Introduction). Non-exhaustive lists are also provided for the Euro-Mediterranean area (see Appendix 5), both of invasive alien species occurring in the region, and of potentially species not introduced yet in the region, and those engaged in the horticultural industry and trade should check the species they are or are planning to trade against these lists.

Know exactly what you are growing: ensure that material introduced into cultivation is correctly identified

The correct identification of alien invasive species is a necessary requisite for any subsequent action. Those in the horticultural trade involved in the introduction or dissemination of plant material should take all possible steps to ensure that the material in question is properly identified.

Misidentifications in horticulture are frequent. A particular source of error is the Seed Lists (Indices Seminum) issued by some 600 or so botanic garden around the world but more especially in Europe. Great care should be taken if material obtained through such Seed Lists is available as these lists often contain misidentifications or even fictitious plants (Heywood 1987)!

Many species are found in the literature under several different names (synonyms), as a consequence of it having been described more than once or as a result of changes in taxonomy such as transfer from one genus to another. There is no simple solution to this problem but those working with invasive species (and plants in general) need to be aware of this. For example, the American *Opuntia ficus-indica*, invasive in most south European and Mediterranean countries, is sometimes referred to in recent literature and Floras as *O. maxima*. Also, *Cabomba asiatica* is quoted as a traded plant but does

not exist in any Flora. The genus *Cabomba* is endemic to the western hemisphere, but *C. caroliniana*, a native of south-America, is naturalized in China, India, Japan, Malaysia, the south east of the USA and parts of Australia. It is therefore hypothesized that *C. asiatica* is a wrong appellation for *C. caroliniana* (JM Tison pers. comm.).

The literature available for plant identification is very extensive (see for example the Sources of information for plant identifications on the website of the Royal Botanic Gardens Kew)¹⁴. For Europe, the following references are useful:

Tutin TG, Heywood VH, Burges NA, Moore DM, Valentine DH, Walters SM, Webb DA (eds.) (1964–1980) *Flora Europaea*, Vols. 1-5, Cambridge University Press, Cambridge.

Tutin TG, Burges NA, Chater AO, Edmondson JR, Heywood VH, Moore DM, Valentine DH, Walters SM, Webb DA (eds.) (1993) *Flora Europaea* ed. 2, vol.1. Cambridge University Press, Cambridge.

European Garden Flora Editorial Committee (eds) (1984–2000) *European Garden Flora. A Manual for the Identification of Plants Cultivated in Europe, both Out-of-Doors and under Glass*. Vols 1-6.

It is recognized that identification can, however, often be quite difficult and professional help may be necessary. In some countries identification services are available although a fee may be chargeable. Enquiries should be made at national or local botanic gardens.

Increasingly web tools are becoming available to identify, report and map invasive species but no comprehensive European web identification facility is available. Some such tools are becoming available at a national level (e.g. “Invasive Plants in Northern Ireland”¹⁵).

Be aware of regulations concerning invasive alien plants

All those engaged in the horticultural trade and associated professions should ensure that they are aware of their obligations under regulations and legislations. The main obligations under existing treaties are given below:

Many international conventions address issues of alien invasive species (Shine 2007) – the Convention on Biological Diversity (CBD), the International Plant Protection Convention (IPPC), the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the Ramsar Convention – have been ratified by European, Mediterranean and Eastern Countries

The Plant Health Directive 2000/29/EC (Council of Europe Union 2000), the wildlife trade regulations (338/97/EC and 1808/2001/EC), Habitat Directives (92/43/EEC) only apply to the 27 countries of the European Union.

These texts address recommendations to Governments on invasive alien plants (CBD and IPPC), as well as on wildlife (CITES¹⁶, Ramsar Convention¹⁷). These recommendations may be implemented in the European Union or in national legislations (of countries that ratified these treaties) and lead to the regulation of import and exports of plants and plant products, inspections, phytosanitary measures, possession, trade and release in the wild of invasive alien plants and quarantine pests. These regulations may therefore impact the every day work of nursery industries.

Of the international treaties, only the CBD provides direct recommendations to the nursery industry (see below), although these are not specifically implemented by it as noted below. The obligation is on individual governments to ensure implementation of such recommendations.

¹⁴ <http://www.kew.org/shops/listident.html>

¹⁵ <http://www.habitas.org.uk/invasive/index.html>

¹⁶ See CITES Conf. 13.10 (Rev. CoP14) Trade in alien invasive species <http://www.cites.org/eng/res/13/13-10R14.shtml>

¹⁷ See Ramsar Resolutions VII.14 and VIII.18 on invasive species and wetlands. http://www.ramsar.org/res/key_res_vii.14e.htm; http://www.ramsar.org/res/key_res_viii_18_e.htm

International

Obligations concerning importation that affect the horticultural nursery under the CBD

Article 8(h) of the CBD states that ‘Each Contracting Party shall, as far as possible and as appropriate prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species’.

In 2002, the CBD issued Guiding Principles on the implementation of Article 8(h). Of particular interest for the nursery industry is Guiding Principle 10 on intentional introduction which states that the first or subsequent intentional introduction of an alien species known to be invasive or potentially invasive within a country should be subject to prior authorization from a competent authority of the recipient State(s). This means that an appropriate risk analysis (including an environmental impact assessment) should be conducted by national authorities. For more details about risk analysis, please refer to section “Be aware of which species you are introducing: risk analysis”.

Nevertheless, Guiding Principle 10 also states that the burden of proof that a proposed introduction is unlikely to threaten biological diversity should be with the **proposer of the introduction** (i.e. the nursery exporting). In practice, risk analyses are performed by national authorities, but information on the species to introduce may be requested to the introducer. While introducing a new plant, the introducer should be able to provide information on the likely non-invasiveness of the species.

Recommendation by the CBD concerning possession and trade of IAS for the horticultural nursery

Decision VIII/27 of the Conference of the Parties of the CBD held in Brazil in 2006 encourages industry, trade and shipment organizations to raise awareness with consumers, including through Internet sites that facilitate transactions or may otherwise be visited by consumers, and to further study, as appropriate, current safe disposal measures for imported alien species.

Plant Health: Directive 2000/29

The aim of the Community plant health regime is to prevent the introduction into the community of organisms harmful to plants or plant products or their spread within the Community. Council Directive 2000/29/EC regulates the import of plants and plant products but also the movement within Member States of certain plants, plant products and other objects which are potential carriers of harmful organisms of relevance for the entire community (listed in Part A of Annex V to the said Directive). These plants, plant products and other objects have in general a high economic importance. They are subject to specific conditions governing the control of their production that include inspections at the place of production at the most appropriate time, i.e. during the growing season and immediately after harvest. Therefore, any producers of the material listed in Part A of Annex V must be listed in an official register. The plants, plant products and other objects are also to be accompanied by a plant passport when moved. This document gives evidence that the material has successfully undergone the Community checking system. It replaces the phytosanitary certificate, used for trade between Member States before the establishment of the Single Market.

Nursery professionals from, or exporting to, European countries will be familiar with this Directive. As an example, it ensures that stocks of apples, pears and other Rosaceous plants are free from fire blight (*Erwinia amylovora*).

Habitat Directive 92/43/EEC

Individuals in general should be aware that under the Habitat Directive, deliberate introduction into the wild of non native species is regulated or prohibited, so as not to prejudice natural habitats or the wild native fauna and flora.

National obligations for the horticultural nursery

At the national level, some countries have legislation and/or regulations aimed at preventing possession, transport, trade or release in the wild of specific invasive alien plants.

Information may be found either from National Plant Protection Organizations (i.e. Ministries of Agriculture) or from Ministries of Environment in individual countries.

For instance, in 1999, specific legislation (Decreto - Lei 565/99) was prepared in Portugal to address Invasive Alien Plants¹⁸. A list of introduced invasive alien plants has been established and it is prohibited to introduce any new plant species unless it has been shown to be not harmful (with a few exceptions granted for forestry and agricultural purposes). Penalties will be applied to those using any listed invasive species. It is planned that the list will be regularly updated. The implementation of these new regulations will imply inspections of the horticultural sector (e.g. nurserymen, landscape designers, gardeners).

The following species are listed as invasive by this law and cultivation, detention in a confined place, use as an ornamental plant, release, sale, exchange and transport are prohibited in order to prevent their additional introduction into the wild: *Acacia cyanophylla*, *Acacia dealbata*, *Acacia karroo*, *Acacia longifolia*, *Acacia mearnsii*, *Acacia melanoxylon*, *Acacia pycnantha*, *Acacia retinodes*, *Ailanthus altissima*, *Arctotheca calendula*, *Arundo donax*, *Azolla caroliniana*, *Azolla filiculoides*, *Carpobrotus edulis*, *Conyza bonariensis*, *Cortaderia selloana*, *Datura stramonium*, *Eichhornia crassipes*, *Elodea canadensis*, *Erigeron karvinskianus*, *Eryngium pandanifolium*, *Galinsoga parviflora*, *Hakea sericea*, *Hakea salicifolia*, *Ipomoea acuminata*, *Myriophyllum aquaticum*, *Myriophyllum brasiliensis*, *Oxalis pes-caprae*, *Pittosporum undulatum*, *Robinia pseudoacacia*, *Senecio bicolor*, *Spartina densiflora*, *Tradescantia fluminensis*.

Potentially invasive plants are also listed: *Agave americana*, *Acacia baileyana*, *Acacia cyclops*, *Acacia decurrens*, *Arundo donax*, *Lantana camara*, *Opuntia ficus-indica*, *Ricinus communis*.

Moreover, the following species are considered as an ecological threat, and cultivation, sale, exchange, transport, cultivation and detention in a confined place are prohibited so as to prevent their introduction in the wild: *Acacia farnesiana*, *Alternanthera caracasana*, *Alternanthera herapungensis*, *Alternanthera nodiflora*, *Alternanthera philoxeroides*, *Azolla* spp., *Hydrilla verticillata*, *Impatiens glandulifera*, *Ludwigia peploides*, *Ludwigia uruguayensis*, *Pistia stratiotes*, *Pueraria lobata*, *Reynoutria japonica*, *Sagittaria latifolia*, *Senecio inaequidens*.

Plant introductions and Pest Risk Analysis

In addition to the invasive alien plants that are known in Europe, many others are present and have the potential to become invasive in the future. There is usually a lag phase before a species becomes invasive, estimated to last on average 147 years, 170 for trees and 131 for shrubs (Kowarik 1995). Preventing the introduction of invasive species instead of managing them once they impact biodiversity, agriculture or health is more effective, both from economic and ecological points of view (see introduction for information of costs of IAP).

A process to identify species that are likely to present the greatest risk for the European and Mediterranean region has been initiated within the European and Mediterranean Plant Protection Organization. A list of Invasive Alien Plants has been established and a prioritization process is being developed in order to select the species which should be given priority for risk assessment. Nevertheless, there is no systematic process in place to evaluate plants prior to introducing and marketing them.

Risk assessment of plants

Risk is assessed on the basis of biological, scientific and economic information organized in a logical sequence called Pest Risk Analysis (PRA). Risk assessment performed by the relevant bodies should preferably be undertaken following the International Standard on Phytosanitary Measures n. 11 on *Pest risk analysis for quarantine pests including analysis of environmental risks and living modified organisms* as adapted by the European and Mediterranean Plant Protection Organization in the form of a decision scheme (EPPO 1997). The information required and assessed is: preferred habitats, climatic, soil and water requirements, life history of the plant, natural or human assisted spread, reproduction, intended use, detectability of the plant, adaptability, persistence, competitiveness, possibility to be controlled, possible economic impacts (including threat to the environment).

¹⁸ http://www.diramb.gov.pt/data/basedoc/TXT_LN_21196_1_0001.htm

If the plant assessed is determined by PRA not to present a significant risk, the plant may be imported and no measures are needed.

If the plant assessed is determined by PRA to present a significant risk, the plant may be:

- prohibited from import if it not yet imported and/or not established in the area considered (it implies that species present in garden but not naturalized in the wild could be of concern, see definitions in Appendix 1)
- subject to the following national management measures if the plant is already imported and/or established in the area considered: publicity, labelling of plants, surveillance, control plan, restriction on sale, on holding, on movement, on planting, obligation to report new findings, emergency plan (EPPO PM 3/67).

Other examples of rapid risk assessments include initiatives in Western Australia with the Weed Risk Assessment System (Australian Government, undated) and in North-America (Reichard and Hamilton 1997). In Western Australia, importers have to fill an application for assessment of new plants they wish to import (Department of Agriculture and Food, undated). The Department of Agriculture performs the risk assessment and allows or prohibits the import(s).

What the industry could do?

For each new plant introduced which has not already been evaluated (see www.eppo.org), those introducing the plant or trading them are encouraged to run the 'pest categorization part' of the EPPO PRA¹⁹ (EPPO Standard PM5/1(1)) scheme consisting in a few questions. Suggestions for screening plant species for potential invasiveness by horticultural are given by Reichard (2000).

For a very quick preliminary assessment, a useful criterion is the plant's invasive behaviour in other parts of the world, especially those with similar climatic features. The Global Compendium of Weeds (Randall 2002) is a valuable source of information. Monitoring of new species at the nursery site to check their behaviour prior to further distribution may also give additional insights.

It is recommended that if there is any indication that the plant may present invasive characteristics, contacts should be taken with the relevant bodies in charge of invasive alien plants.

Work in cooperation: cooperative arrangements between nursery associations and conservation and plant protection sectors should be considered

Preventing the spread of alien invasive species that are already in cultivation should be possible and the horticultural industry and nursery trade should be prepared to cooperation with the authorities in achieving this. On the other hand, the prevention or avoidance of the introduction of invasive plants into cultivation through the horticulture pathway is a complex process involving many actors. To be effective, those implementing this Code should endeavour to enter into cooperative arrangements or at least engage with others engaged in the control of invasive plants, notably in the conservation and plant protection sectors such as local environment and conservation agencies, societies and associations, botanic gardens, universities.

Concretely, these agreements between the Government and the nursery industry (either individual producers or traders, or consortiums) could take the following form:

- a label or a charter
- mandatory labelling of plants
- certification ISO, or environmentally friendly code of conduct

¹⁹ http://archives.eppo.org/EPPOStandards/PM5_PRA/PRA_scheme_2007.doc

Cooperate with other stakeholders in reaching agreement on which invasive species are a threat and cease to stock them or make them available

Once it has been determined which plant species represent a threat, locally or nationally, nurseries, garden centres and other suppliers of plants should agree voluntarily to destock and no longer make them available for purchase.

As an example of cooperation between stakeholders, in the north of France, the Conservatoire Botanique National of Bailleul, with state and regional support, has recently established a charter (charte d'engagement) with plant retailers on a voluntary basis. Under the charter, retailers voluntarily committed themselves to withdraw from sale within six months, the following species which are highly invasive in the Picardy region:

Ailanthus altissima (Simaroubaceae)
Ambrosia artemisiifolia (Asteraceae)
Azolla filiculoides (Azollaceae)
Crassula helmsii (Crassulaceae)
Fallopia (Reynoutria) japonica/ *F. sacchalinensis* and *F. × bohemica* (Polygonaceae)
Heracleum mantegazzianum (Apiaceae)
Hydrocotyle ranunculoides (Araliaceae)
Ludwigia grandiflora / *L. peploides* (Onagraceae)
Myriophyllum aquaticum (Haloragaceae)
Prunus serotina (Rosaceae)

Be careful how you get rid of plant waste: disposal of unwanted stock of plants and plant-containing waste

Discarded garden waste, compost heaps, packaging materials, ballast water (in the case of aquatic plants) are well known pathways for the escape of garden plants into nature. Compost heaps often contain viable seed and other propagules. To avoid such unintentional introductions and their possible spread, strict procedures should be employed to mitigate the risk.

The EPPO *Guidelines for the management of plant health risks of biowaste of plant origin*²⁰ (EPPO, 2006) (PM 3/66(1)) should be followed where appropriate. The standard describes:

- requirements for the treatment process to ensure phytosanitary safety of treated biowaste;
- special requirements for biowaste that may contain quarantine pests or heat-resistant pests;
- supervision, test procedures and validation methods to ensure that the treatment process and final product comply with plant health requirements;
- documentation and labelling requirements during production and exchange of treated biowaste.

National regulations for the safe and effective disposal of waste should also be followed. For example, in Britain, Japanese knotweed (*Fallopia japonica*) is classed as 'controlled waste' under the Environmental Protection Act 1990 and is subject to strict regulations and there is an Environment Agency Code of Practice for its management, destruction and disposal of polluted material containing it.

Plant waste should never be dumped in the countryside or in places where they might escape into the wild. It may be taken to officially approved municipal recycling sites but if there is any suspected risk of the waste or compost containing material of invasive plants, it should be treated, in accordance

²⁰ <http://www.blackwell-synergy.com/doi/abs/10.1111/j.1365-2338.2006.01022.x>

with national regulations, on site, taken to approved sites for disposal, or disposed of through specialized contractors.

Terrestrial plants

While decomposition by composting of garden waste has many advantages, it does not effectively destroy some invasive plants or their seeds (such as *Fallopia japonica* noted above). An alternative is burning or incineration and again any national or local regulations should be followed.

Aquatic plants

Aquatic plants pose special problems and great care should be taken to avoid their getting into rivers, waterways or seas. The killer alga *Caulerpa taxifolia*, a handsome tropical seaweed, is an example of an escaped ornamental aquarium species that has escaped from cultivation as an ornamental and is now a serious threat to the native marine fauna and flora in the northern Mediterranean. Cuttings were obtained by the Oceanographic Museum in Monaco and were later found in the sea beneath the building probably having escaped via a flow-through holding tank system that allowed fragments to pass into the sea.

Various methods are available for the disposal of aquatic plants such as composting and burying, drying or freeze drying and subsequent safe disposal. Disposal of the packaging of aquatic species is also a major concern, especially as it may house 'hitchhikers' including spores, parasites or other 'hidden' species which may be found in the tissues of the specimens, on surfaces of their packaging or in the holding water or sediments. If not handled properly, there is a risk of the hitchhikers escaping. A useful guide and protocols for the handling and disposal of non-native aquatic species and their packaging are provided by the Washington Sea Grant Program Olson & al. 2000). The Ornamental Aquatic Trade Association (OATA) provides advice on composting plants removed from ponds on the back of a leaflet entitled 'Keep your pond plants in the garden!!'²¹.

Use appropriate production techniques to avoid unintentional introduction and spread

Great care should be taken to prevent contamination by invasive alien plants. Apart from the damage they cause, they may well result in high additional management costs for the nursery.

Further, if invasive alien plants do manage to contaminate a nursery or other plant growing area, every precaution should be taken so as to prevent unintentional spread of the contaminants.

This section contains guidance for all those in the horticultural industry and nursery trade involved in growing plants.

A nursery may become contaminated by seeds that persist in the soil (soil seed bank) or by vegetative propagules of invasive alien plants that come from:

- an ornamental plant grown in the nursery
- the imported growing medium attached to, or associated with, rooted plants for planting which roots may be contaminated with seeds of vegetative propagules of invasive alien plants. Imported aquatic plants may also be contaminated by vegetative fragments of other aquatic invasive alien plants
- an invasive alien plant or quarantine pest colonizing the nursery from surrounding fields or entrant water and growing media.

The following recommendations provide guidance to avoid involuntary introduction and spread of invasive alien plants and quarantine pests in a nursery while importing plants or plant products.

²¹ <http://www.ornamentalfish.org/aquanautconservation/invasiveplants.php>

Newly imported plants

Adopt the good practice of keeping imported plant material isolated from locally produced plants and from those growing in the wild.

Use of soil and growing media (see EPPO PM 3/54²²)

Imported topsoil should be free of all viable propagules of invasive alien plants and other pests. Topsoil should be inspected on delivery and a representative sample should be requested before purchase, as well as guidance on the source.

To prevent contamination of growing media:

- the growing media shall be free from invasive alien plants and other pests, which could be achieved:
 - by using inorganic growing media
 - by treating organic growing media to kill the contaminants (e.g. chemical disinfestations or steam sterilization)
 - by inspecting or testing the growing media for particular pests, by various methods (for pests other than invasive alien plants), as for instance for flatworms (see EPPO PM 1/4(1)²³ “Nursery inspection, exclusion and treatment for *Arthurdendyus triangulates*”)
- the plants must be grown at all stages in the growing media of the quality specified above, or grown in such a way that they cannot become infested. Thus, growing media should not have a production link with other potentially infested growing media, and this can be avoided by:
 - growing the plants in pots separated from the soil surface; the separation can be established by a cover on the soil (e.g. plastic), and the open side of the pots shall be screened to prevent infestation (by water splashes for instance, as for *Phytophthora ramorum*, by wind dispersed seeds of *Cortaderia selleana*)
 - not contaminating non-infested growing medium with water carrying contaminants.

Moreover, movement of soil should be avoided from places where invasive plants such as *Ambrosia artemisiifolia*, *Solanum elaeagnifolium*, *Heracleum mantegazzianum*, etc. are present, either within the nursery or in soil coming from outside the nursery.

Use of machinery, tools and equipments

Machinery, tools and other equipments should not be used, either for non-infested or potentially infested growing media without proper disinfection or cleaning.

Storage of soil and growing media, pots and supplies should be isolated from potential contamination.

Human activities on the nursery

Operators should be careful not to carry contaminants on footwear, gloves, etc. and appropriate training and instruction of staff should be given.

Packaging and containers

Packaging is recognized as being a pathway for import and export of invasive plants. It is therefore good practices:

- to keep clean packaging material to be used to send plants isolated from produced plants, and from those growing in the wild
- to destroy or clean imported packaging material.

²² http://archives.eppo.org/EPPOStandards/PM3_PROCEDURES/pm3-54-e.doc

²³ http://archives.eppo.org/EPPOStandards/PM1_GENERAL/pm1-04-e.doc

Production of aquatic plants

During the production of aquatic plants for ponds or for aquaria great care should be taken to ensure that these species cannot escape from growing tanks or closed ponds into the wild.

Since traded aquatic have shown to be contaminated by other aquatic plants (EPPO RSE n°1 2007), the following precautions are suggested:

- avoid mixing of grown potentially invasive with non invasive plants in growing tanks
- use high pressure rinsing before packaging
- remove soil from aquatic plants.

Apply good practice for labelling

This section contains guidance for all those involved in the supply or retail of plants (nurseries, superstores, garden centres, aquarists).

All species on sale should be clearly and correctly labelled with the correct scientific name (see section Know what you are growing) – genus and species and where appropriate variety or cultivar – as well as the common name so to avoid confusion. It is advisable to provide the family name. For example, *Zantedeschia aethiopica* is invasive in Western Australia and a dwarf form on sale in the nursery trade has the same invasive potential. This dwarf form should be labelled *Zantedeschia aethiopica* ‘Childsiana’, instead of *Zantedeschia childsiana* – dwarf white calla lily (Martin *et al.* 2005), the latter name being incorrect and misleading for the consumer.

For invasive or potentially invasive alien species traded (cf. for species listed in Appendix 4), additional information should be given:

- origin of the plant, its ability to escape from the garden and the countries where it is reported as invasive
- Indication of the invasive behaviour of the plant may include growth rate, reproduction ability, and habitats invaded (certain habitats are more vulnerable, such as riparian ones and dune ecosystems)
- Recommendations for managing the plant may also be provided (see paragraph on “Publicity and outreach”).

An example of labelling could be:

<p><i>Rosa rugosa</i> (Rosaceae) Rugosa rose, Hedgehog rose Native to Eastern Asia</p> <p>It escapes from gardens and is highly invasive in northern and central Europe</p> <p>The species reproduces vegetatively. It can invade coastal dunes and threaten other species of plants, mosses and lichens, as well as some animals (e.g. butterflies) and modify the habitat.</p>
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Labelling is being conducted in the Picardy region of the north of France by the Conservatoire Botanique National of Bailleul as part of a voluntary charter with plant retailers for the following species: *Baccharis halimifolia* (Asteraceae), *Buddleja davidii* (Buddlejaceae), *Cortaderia selloana* (Poaceae), *Egeria densa* (Hydrocharitaceae), *Elodea canadensis* (Hydrocharitaceae), *Elodea nuttallii* (Hydrocharitaceae), *Impatiens glandulifera* (Balsaminaceae), *Lagarosiphon major* (Hydrocharitaceae), *Mahonia aquifolium* (Berberidaceae), *Robinia pseudoacacia* (Fabaceae) and *Rosa rugosa* (Rosaceae).

Another positive and educational initiative on labelling consists of withdrawing the plant from production and indicating this in the nursery catalogue. For instance, a horticulturist in the south of France (Pépinieres Filippi 2007) indicates for *Baccharis halimifolia*: ‘we do not grow this plant anymore as it can become invasive in certain places and out-compete native flora. As a substitute, we suggest the use of *Atriplex halimus* or *Limoniastrum monopetalum*’.

Make substitutes for invasive available

Nurseries and garden centres should consider suggesting and offering substitutes for invasive alien species that are no longer sold. These may be native species or other exotic but non-invasive species.

This not only helps avoiding damage to agriculture and the environment but also allows the nursery industry to offer an innovative and green image to their consumers.

Some suggestions for alternative species exist (see Appendix 5). It should be borne in mind that just as invasive plants show aggressive behaviour under certain conditions (soil, temperature, rainfall, habitats, etc.) and in some areas only, so alternative species may have the potential to become invasive. Substitute species recommended for one country should not be assumed to be suitable for another country. Professionals and trade associations may also consider developing and promoting alternative plant material and sterile cultivars through plant selection and breeding. care should be taken to ensure that the species proposed are effectively non-invasive.

For example, in the south of France, the hybrid *Buddleja* ‘Lochinch’ whose parents originate in China (*B. davidii* × *B. fallowiana*) has been proposed as an alternative plant to the highly invasive *Buddleja davidii*, since it is considered to be sterile. Nevertheless, a horticulturist reported that the plant reproduces abundantly by seeds in this nursery and shows invasive characteristics

In selecting substitutes, nursery professionals should consult with and seek advice from trade associations, conservation professionals, other growers or retailers and state authorities if needed. While looking for suitable alternative non-invasive plants, the characteristics of the traded invasive alien plant and its attractiveness to the consumer should be determined. Alternative species should have similar characteristics to the invasive alien plant they replace (Baxter & al., 2002).

Engage in publicity and outreach

It is important to engage the public. It is the public who inadvertently demand the plant introductions which may turn out to be invasive, so messages about the significance of invasive plants and the damage that they can cause need to be targeted at them. At the same time, they are also a powerful force in supporting actions to identify and control such invasions. The horticultural industry needs to work with the public as well as with conservation and protection agencies.

Agreed list of invasive alien species that represent a threat and their substitutes should be publicized and information about them in the form of posters, leaflets and brochures should be displayed or made available in nurseries and garden centres, aquaria and other outlets such as supermarkets, stores, service stations and Internet suppliers. Nursery catalogues should indicate which species are invasive and also contain warnings about them and the broader issues of plant invaders, as well as indications on substitutes (see section on labeling and on substitutes). Numerous initiatives promoting substitutes exist, e.g. ‘Don’t plant a pest’ in California²⁴, ‘Garden Wise’ in Washington State²⁵, and ‘Plantes envahissantes de la region Méditerranéenne’ in the South of France²⁶ (see Appendix 5).

²⁴ <http://www.cal-ipc.org/shop/index.php#brochures>

²⁵ <http://www.invasivespeciescoalition.org/GardenPlants/WISCFINALweb.pdf>

Numerous brochures, leaflets and posters on the risks posed by alien invasive species have been produced. The Ornamental Aquatic Trade Association (OATA) has issued a poster "Keep your pond plants in the garden!!"²⁷. An example of a website dedicated to invasive species and horticulture is that of PlantRight²⁸, a voluntary, proactive programme for the horticultural community to prevent invasive plant introductions through horticulture, designed by the steering committee of California Horticultural Invasives Prevention (Cal-HIP) partnership to communicate the need to transition away from invasive plants in the gardening and landscaping trade.

The Nature Conservancy (TNC) in the USA runs 'Invasive Species Learning Networks'²⁹ which bring together Conservancy staff, agency partners, and scientific experts in a series of facilitated, progressive workshops focused on abating the threats that invasive species pose for conservation objectives.

The 'Other Resources' page of the Global Invasive Species Initiative (GISI)³⁰ lists a diversity of resources including leaflets, lists, websites and other resources on invasive alien plant species.

Take into account the increased risks of alien plant invasions due to global change

It is generally accepted that altered climate patterns will have appreciable effects on the spread of invasive alien species although precise local details are far from clear and will differ from region to region. The Mediterranean region is predicted to be one of the areas likely to suffer most from climate change while western and northern Europe may expect higher summer temperatures and wetter and cloudier winters.

The implications for the horticultural industry and the nursery trade are likewise still being worked out. Some are likely to be beneficial while others will probably be negative. Climate change is likely to put increasing pressure on the industry and is likely to affect production, selection of species grown, fuel and water efficiency and competition. It is clear that the profession will need to adapt to climate change, especially rising temperatures, by developing both pre-emptive and reactive adaptation strategies or options.

The report *Gardening in the Global Greenhouse*³¹ is one of the few documents to describe in detail the impacts of climate change on gardens and gardening and although dealing only with the United Kingdom, is relevant to other parts of Europe. It indicates that climate change will have impacts on many components of the garden and addresses in particular potential impacts on:

- soils, water supplies and water bodies
- trees, shrubs, sub-shrubs, herbaceous perennials, bulbs and annuals
- lawns
- paths, buildings and other structures
- garden staff

It also details the various ways climate change will affect plant growth.

A conference on 'Trees in a Changing Climate Conference'³² held at the University of Surrey in Guildford in June 2005, considered the effects of climate change on the UK's trees in the 21st century

²⁶ <http://www.ame-lr.org/plantesenvahissantes/>

²⁷ <http://www.ornamentalfish.org/aquanautconservation/invasiveplants.php>

²⁸ <http://www.plantright.org/>

²⁹ <http://tncweeds.ucdavis.edu/products.html>

³⁰ <http://tncweeds.ucdavis.edu/horticulture/resources.html>

³¹ Bisgrove, R. and Hadley, P. *Gardening in the Global Greenhouse. The impacts of climate change on gardens in the UK. Technical Report. The UK Climate Impacts Programme, Oxford (2002).*

³² http://www.rhs.org.uk/research/climate_change/trees_conference.asp

and the serious implications for tree survival, species choice and cultivation in our woodlands, parks and gardens. It covered implications of and adaptations to climate change as regards species choice and timber production, and nature conservation and biodiversity.

There is a strong likelihood that there will be a growing demand by the public for species that may be suited to the new climatic envelopes that are predicted. Indirect effects of climate change, such as water shortages, will have a serious impact on gardening and on types of planting. An increasing demand for drought-resistant plants such as cacti and succulents may be expected. Higher temperatures will increase the range of species that can be grown in some European countries while in others this will cause stress and restrict the growth of many species. Flowering and fruiting times of some species will be affected and there will be a need for new cultivars that are suited to the new conditions. The selection of trees grown will change and this in turn will have significant landscape effects. In some parts of Europe, plants that are today grown with difficulty and therefore not likely to escape from cultivation will flourish and may become invasive.

Other elements of global change such as changes in disturbance regimes, increased risk from fire, and population movements will affect both Europe's ecosystems and individual species and increase the risks of alien plant invasions. Examples are increasing urbanization, increased mobility across frontiers, population movement from the country to the towns, increase in environmental refugees as a result of climatic disasters or wars, abandonment of terracing and loss of traditional agricultural practices.

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Appendix1

DEFINITIONS

The term **alien species** (CBD definition) refers to a species, subspecies or lower taxon, introduced outside its normal past or present normal distribution; it includes any part, gametes, seeds, eggs, or propagules of such species that might survive and subsequently reproduce.

The term **native (indigenous)** refers to those species that are occur naturally in an area and thus have not been introduced deliberately or accidentally by humans. The term is usually applied to plants which evolved *in situ* or which arrived in the area before the beginning of the Neolithic period (see discussions in Heywood 1989; Webb 1985).

The term **alien** is used to refer to plants that are not native to the country, territory, area or ecosystem under consideration. Such plants are also referred to in the literature as exotic, non-native, non-indigenous, anthropophytes, metaphytes, neophytes or neobiota. For a discussion of terminology and a set of recommended definitions see Richardson & al. (2000); see also discussion in Riley (2005). Colautti & MacIsaac (2004) list in their Table 1 some 32 common terms in the English literature on invasion ecology. They also propose a neutral invasion terminology based on current models that break the invasion process into a series of consecutive, obligatory stages.

Transience according to the IPPC refers to the presence of a pest that is not expected to lead to establishment [ISPM No. 8, 1998]. A ‘transient species’ is considered to be ‘a casual species’

Casual alien plants according to Pyšek *et al.* (2004) are aliens that may flourish and even reproduce occasionally in an area, but which do not form self-replacing populations, and which rely on repeated introductions for their persistence. Most of them do not persist and they are widely referred to in the literature as ‘casuals’, ‘adventives’, ‘waifs’, ‘transients’, ‘occasional escapes’ and ‘persisting after cultivation’.

Establishment is the stage in the invasion process at which the plant becomes successfully self-reproducing. According to the CBD, **establishment** is the process whereby a species in a new area is able to reproduce successfully at a level sufficient to ensure its continued survival without infusion of new genetic material from outside the area. The invasive plant is then said to be **established** and in this sense is equivalent to ‘naturalized’.

The term ‘**naturalized**’ is applied to alien plants that reproduce successfully without human intervention and form self-replacing populations over several generations.

The term ‘**invasive**’ is applied to alien plants that have become naturalized and are or have the potential to become a threat to biodiversity through their ability to reproduce successfully at a considerable distance from the parent plants and have an ability to spread over large areas and displace elements of the native biota. When they cause significant habitat transformation, leading to biodiversity loss and reduction in ecosystem service, they are often known as ‘**transformers**’ or ‘**transformer species**’ (Richardson & al. 2000).

According to the Convention on Biological Diversity (CBD), an **invasive alien species** is ‘an alien species whose introduction and/or spread threaten biological diversity’ (annex footnote 57, CBD, 2002). This definition can be interpreted as covering both natural and agricultural systems, unlike the definition in the IUCN Guidelines (IUCN 2000) which defines an invasive alien species as an alien species which ‘becomes established in natural or semi-natural ecosystems, is an agent of change, and threatens native biological diversity’.

Although originally aimed at protecting human health and trade in agricultural commodities, one of the most effective means of containing the spread of IAS is the use of quarantine measures, especially in the case of invasive plants. This introduces the notion of ‘**pests**’ which describe species that threaten or harm agricultural activity (Riley, 2005).

The term “pest” is not normally employed or defined outside this context. According to the International Plant Protection Convention (IPPC) a **pest** is ‘any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products’, while a **quarantine pest** is ‘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'. As a consequence, considering that potential economic importance can account for environmental concern (according to the supplement the International Standard on Phytosanitary Measures n°5 *Glossary of phytosanitary terms*), the IPPC definition of a quarantine pest covers much of what is considered an invasive alien species under the CBD. Differences arise from the fact that a quarantine pest does not necessarily threaten biodiversity and may only affect agriculture (Lopian, 2005), and that an invasive alien plant may not be considered a quarantine pest if it is widely distributed.

The term '**weed**' is applied to plants, whether native or alien, which infest agricultural or horticultural crops or domestic gardens and adversely affect the plants being cultivated, often reducing yield. Their control costs the industry hundreds of millions of euros annually. They also occur in waste ground or disturbed habitats to which they are often adapted and tend to be vigorous and fast-growing and often have a high reproductive capacity which allows them to spread rapidly. Unlike invasive species, they do not invade natural ecosystems or displace native wild species.

Appendix 2

EXAMPLES OF EXISTING INITIATIVES

European

The **European Weed Research Society (EWRS)** has a **Working Group on Invasive Plants**³³ which aims to encouraging and assisting education and training on invasive plants (control, horticultural and environmental aspects) for institutions, students, professionals (road services) and general public.

A European Union consortium called **DAISIE (Delivering Alien Invasive Inventories for Europe)**³⁴ was initiated to address this need across Europe and the Mediterranean Basin for terrestrial, marine, and freshwater environments. DAISIE aims to integrate information on current invasions across Europe through the development of an online, peer-reviewed database of alien species. Linking information on the species' status at both country- and Europe - wide levels should improve understanding and prediction of invasion dynamics and help prevent their spread into new areas. The research teams in DAISIE were drawn from more than 15 countries.

German biologists have set up **NEOBIOTA – The European Group on Biological Invasions**³⁵ – one of whose task is to collect all available information on non-native species in Central Europe, their traits and their distribution. They issue a publication series of conference proceedings and monographs called NEOBIOTA³⁶.

The **North European and Baltic Network on Invasive Alien Species (NOBANIS)**³⁷ has developed a network of common databases on alien and invasive species of the region. The participating countries are Denmark, Estonia, Finland, Faroe Islands, Germany, Greenland, Iceland, Latvia, Lithuania, Norway, Poland, European part of Russia, Sweden. The common portal facilitates access to IAS-related data, information and knowledge in the region.

The European Union Consortium **ALARM (Assessing Large Risks for Biodiversity with tested Methods)**³⁸ focuses its research on assessment and forecast of changes in biodiversity and in structure, function, and dynamics of ecosystems. This relates to ecosystem services and includes the relationship between society, economy and biodiversity. In particular, risks arising from climate change, environmental chemicals, biological invasions and pollinator loss in the context of current and future European land use patterns will be assessed.

International

– *Global Invasive Species Programme (GISP)*³⁹

The GISP mission is to conserve biodiversity and sustain human livelihoods by minimizing the spread and impact of invasive alien species. The primary objective of GISP is to facilitate and assist with the prevention, control and management of invasive species throughout the world.

³³ <http://www.ewrs.org/ewrs-iw.htm>

³⁴ <http://www.europe-aliens.org>

³⁵ http://www2.tu-berlin.de/~oekosys/e/neobiota_e.htm

³⁶ Kowarik, I. & Starfinger, U. (Hrsg.) 2002: Biologische Invasionen - eine Herausforderung zum Handeln? NEOBIOTA 1, 377 pp.; Seitz, B. & Kowarik, I. (Hrsg.) 2003: Perspektiven für die Verwendung gebietseigener Gehölze. NEOBIOTA 2, 116 pp. (leider vergriffen); Kühn, I. & Klotz, S. 2004: Biological Invasions - challenges for science. NEOBIOTA 3, 154 pp.; Heger, T. 2004: Zur Vorhersagbarkeit biologischer Invasionen - Entwicklung und Anwendung eines Modells zur Analyse der Invasion gebietsfremder Pflanzen. NEOBIOTA 4, 202 pp.; Goßner, M. 2004: Diversität und Struktur arborikoler Arthropodenzönosen fremdländischer und einheimischer Baumarten. Ein Beitrag zur Bewertung des Anbaus von Douglasie (*Pseudotsuga menziesii* (Mirb.) Franco) und Roteiche (*Quercus rubra* L.). NEOBIOTA 5: 319 pp. Nentwig, W., Bacher, S., Cock, M.J.W., Dietz, H., Gigon, A. & Wittenberg, R. (Eds.) 2005: Biological Invasions - from Ecology to Control. NEOBIOTA 6: 199 pp.+

³⁷ <http://www.nobanis.org/>

³⁸ <http://www.alarmproject.net/alarm/>

³⁹ <http://www.gisp.org/>

– ***GISP Global Strategy on Invasive Alien Species***⁴⁰

This strategy highlights the dimensions of the problem and outlines a framework for mounting a global-scale response. While both the problem and the scale of the solution may appear dauntingly complex, the issue presents an unparalleled opportunity to respond with actions that link preservation of biodiversity with protection of the health and livelihood of the world's human populations.

– ***Global Invasive Species Information Network (GISIN)***⁴¹

GISIN was formed to provide a platform for sharing invasive species information at a global level, via the Internet and other digital means.

Results of the GISIN needs assessment survey are available at
<http://www.gisinetnetwork.org/Survey/SurveyResultsFinal.pdf>

– ***Invasive Species System Task Group [part of the Biodiversity Information Standards (TDWG)]***⁴²

Biodiversity Information Standards (TDWG) is an international not-for-profit group that develops standards and protocols for sharing biodiversity data.

– ***Invasive Alien Species: A Toolkit of Best Prevention and Management Practices***⁴³.

The toolkit also provides advice, references, and contacts to aid in preventing invasions by harmful species and eradicating or managing those invaders that establish populations.

⁴⁰ McNeely, J.A., Mooney, H.A., Neville, L.E., Schei, P. & Waage, J.K. (eds.) 2001. *Global Strategy on Invasive Alien Species*. IUCN on behalf of the Global Invasive Species Programme, Gland, Switzerland and Cambridge, UK <http://www.gisp.org/publications/brochures/globalstrategy.pdf>

⁴¹ <http://www.gisinetnetwork.org/>

⁴² Biodiversity Information Standards (TDWG) [formerly Taxonomic Databases Working Group] www.tdwg.org

⁴³ Wittenberg, R., Cock, M.J.W. (eds.) 2001. *Invasive Alien Species: A Toolkit of Best Prevention and Management Practices*. CAB International, Wallingford, Oxon, UK, xvii - 228.
<http://www.gisp.org/publications/toolkit/Toolkiteng.pdf>

Appendix 3

ST LOUIS VOLUNTARY CODES OF CONDUCT

Codes of Conduct For Nursery Professionals

February 2002, Revised April 2002

1. Ensure that invasive potential is assessed prior to introducing and marketing plant species new to North America. Invasive potential should be assessed by the introducer or qualified experts using emerging risk assessment methods that consider plant characteristics and prior observations or experience with the plant elsewhere in the world.

Additional insights may be gained through extensive monitoring on the nursery site prior to further distribution.

2. Work with regional experts and stakeholders to determine which species in your region are either currently invasive or will become invasive. Identify plants that could be suitable alternatives in your region.

3. Develop and promote alternative plant material through plant selection and breeding.

4. Where agreement has been reached among nursery associations, government, academia and ecology and conservation organizations, phase-out existing stocks of those specific invasive species in regions where they are considered to be a threat.

5. Follow all laws on importation and quarantine of plant materials across political boundaries.

6. Encourage customers to use, and garden writers to promote, non-invasive plants.

Source: <http://www.centerforplantconservation.org/invasives/Download%20PDF/nursery.pdf>

Appendix 4

RECOMMENDATIONS PROPOSED TO LESSEN THE OVERALL IMPACT OF INVASIVE PLANT SPECIES DELIBERATELY INTRODUCED FOR HORTICULTURE AND CURRENTLY AVAILABLE FOR SALE

From: Grove & al. (2004) *Jumping the Garden Fence: Invasive Garden Plants in Australia*. WWF-Australia.

Recommendation 1. At least 80 species that are currently available for sale should be prohibited nationally from sale as an urgent priority. These include the species that are Weeds Of National Significance, species on the Alert List, the species that are declared or noxious, and the 10 species that impact on Rare or Threatened Australian

Plants species.

Recommendation 2. The ten most important species available for sale currently in Australia should be prohibited from sale nationally from July 1, 2005.

Recommendation 3. Many other invasive garden plants nominated by individual states, territories or regions should be added progressively to the list of weeds prohibited from sale nationally.

Recommendation 4. Amendments or new regulations to the current *Environment Protection and Biodiversity Conservation Act* (Federal) should be considered, to allow national prohibition of the sale of specific invasive garden plants known to be major weeds and to ensure uniformity between all States and Territories.

The following three pro-active recommendations will further reduce the future impacts of invasive garden plants and promote responsibility shared between government, weed managers and the wider Australian community.

Recommendation 5. Voluntary associations between nursery groups and weed managers at the local and regional levels should be fostered to increase the number and effectiveness of future associations.

Recommendation 6. Bushland areas adjoining peri-urban settlements around Australian cities should be actively and regularly searched by experienced botanists and trained community volunteers to detect and eradicate newly naturalized plant species that have already 'jumped the garden fence'.

Recommendation 7. Increased resources should be provided to advance the awareness of the Australian community to the negative impacts that many established and emerging weeds are having on natural and agricultural ecosystems and will have in the future, focusing especially on those already growing in Australian private and public gardens.

Appendix 5

LIST OF SPECIES CONSIDERED INVASIVE IN THE EURO-MEDITERRANEAN REGION

It would be useful for a national code of conduct to contain a list of invasive alien plants. Many lists of plants considered invasive in European countries or in the Euro-Mediterranean region exist.

The European and Mediterranean plant Protection Organization (EPPO) intends to provide up-dated lists of invasive alien plants. These lists will be available at www.eppo.org

A ‘metalist’ has been drafted by Genovesi & Scalera (2007): Assessment of existing lists of existing invasive alien species, with particular focus on species entering Europe through trade, and proposed responses. Convention on the Conservation of European Wildlife and Natural Habitats. The Council of Europe, Strasbourg. 37 p.

It is available at:

http://www.coe.int/t/dg4/cultureheritage/conventions/Bern/T-PVS/sc27_inf02_en.pdf

Appendix 6

EXAMPLE OF PROPOSALS OF ALTERNATIVE PLANTS FOR THE SOUTH OF FRANCE

In France, collaboration has been initiated between the Conservatoire Botanique National Méditerranéen, Porquerolles and the nursery industry to prevent the introduction of invasive alien plants, essentially by proposing substitute plants. A Panel of representatives from the nursery and landscaping industries was established and issued in 2003 a booklet presenting the 15 most invasive plants in the Mediterranean area and their corresponding substitute plants. Descriptions of the morphology, biology, habitats, history of introduction, impacts, management and use of the plants are provided for the following invasive plants, and substitute plants are proposed:

Invasive species	Substitute species
<i>Acacia dealbata</i> (Fabaceae) (EPPO List of Invasive Alien Plants)	For dry areas: <i>Colutea arborescens</i> , <i>Coronilla glauca</i> , <i>Callicotome spinosa</i> , Fabaceae originating from the Mediterranean Basin. For ornamental purposes: <i>Sophora microphylla</i> and <i>S. tetraptera</i> , Fabaceae originating from New Zealand.
<i>Ailanthus altissima</i> (Simaroubaceae) (EPPO List of IAP)	For dry areas: <i>Colutea arborescens</i> , <i>Coronilla glauca</i> , <i>Callicotome spinosa</i> , Fabaceae originating from the Mediterranean Basin. For ornamental purposes: <i>Fraxinus angustifolia</i> (Oleaceae) and <i>Celtis australis</i> (Ulmaceae) originating from the Mediterranean area.
<i>Amorpha fruticosa</i> (Fabaceae) (EPPO List of IAP)	In humid environments, indigenous species from the Mediterranean area such as <i>Populus alba</i> (Salicaceae), <i>Fraxinus angustifolia</i> (Oleaceae), <i>Salix alba</i> (Salicaceae), <i>Alnus glutinosa</i> (Betulaceae) and <i>Cornus sanguinea</i> (Cornaceae) can be used. On dry dunes, <i>Juniperus phoeniceae</i> (Cupressaceae) is recommended for sand stabilization.
<i>Baccharis halimifolia</i> (Asteraceae) (EPPO List of IAP)	For embankments: the Mediterranean <i>Atriplex halimus</i> (Chenopodiaceae). For ornamental purposes: <i>Leucophyllum frutescens</i> (Scrophulariaceae), originating from North and Central America and <i>Xanthoceras sorbifolia</i> (Sapindaceae) originating from China.
<i>Buddleia davidii</i> (Buddlejaceae) (EPPO List of IAP)	For ornamental purposes: <i>Syringa persica</i> (Oleaceae). Note: the hybrid <i>Buddleja</i> 'Lochin' (<i>B. davidii</i> x <i>B. fallowiana</i>) was recommended but has been recorded as escaping (see RSE 2005/131).
<i>Carpobrotus acinaciformis</i> and <i>C. edulis</i> (EPPO List of IAP)	For dunes, a mixture of spontaneous species is recommended. For ornamental purposes, <i>Armeria maritima</i> (Plumbaginaceae) originating from Southern Europe can be used.
<i>Cortaderia selloana</i> (Poaceae) (EPPO List of IAP)	<i>Saccharum ravennae</i> (Poaceae) originating from the Mediterranean Basin can be used for ornamental and re-vegetation purposes.
<i>Lippia canescens</i> (Verbenaceae)	<i>Frankenia laevis</i> (Frankeniaceae), <i>Thymus ciliatus</i> and <i>Thymus serpyllum</i> var. <i>albus</i> are creeping plants originating from the Mediterranean Basin.
<i>Ludwigia grandiflora</i> and <i>L. peploides</i> (Onagraceae) (EPPO List of IAP)	<i>Ranunculus aquatilis</i> (Renonculaceae) from Europe and <i>Hottonia palustris</i> (Primulaceae) from Eurasia.
<i>Opuntia</i> spp.	To constitute defensive hedges: <i>Callicotome spinosa</i> (Fabaceae), originating from the Mediterranean Basin.
<i>Robinia pseudoacacia</i> (Fabaceae)	For dry areas: <i>Colutea arborescens</i> , <i>Coronilla glauca</i> , <i>Callicotome spinosa</i> , Fabaceae originating from the Mediterranean Basin. For ornamental purposes: <i>Sorbus domestica</i> (Rasaceae) originating from Central and Southern Europe.

Reference:

Agence Méditerranéenne de l'Environnement, Conservatoire Botanique National Méditerranéen de Porquerolles, 2003 – Plantes envahissantes de la région méditerranéenne. Agence Méditerranéenne de l'Environnement. Agence Régionale Pour l'Environnement Provence-Alpes-Côte d'Azur. 48 pp.

<http://www.ame-lr.org/plantesenvahissantes/>

Proposals for alternative aquatic plant species for oxygenating garden ponds

In Scotland Schedule 9 of the UK Countryside and Wildlife Act 1981 that lists plants that cannot be planted or caused to grow in the wild. was updated on 30 June 2005 and now includes nine invasive aquatic plants and four more terrestrial plants:

Allium paradoxum Few-flowered Leek
Azolla filliculoides Fern
Cabomba caroliniana Fanwort
Carpobrotus edulis Hottentot Fig
Crassula helmsii New Zealand Pigmyweed (Australian Swamp Stonecrop)
Eichhornia crassipes Water Hyacinth
Gaultheria shallon Shallon
Hydrocotyle ranunculoides Floating Pennywort
Lagarosiphon major Curly Waterweed
Myriophyllum aquaticum Parrot's-feather
Pistia stratiotes Water Lettuce
Robinia pseudoacacia False-acacia
Salvinia molesta Giant Salvinia

The UK organization Plantlife has proposed the following list of alternative plants to non-native species to oxygenate garden ponds. These must never be collected from wild and should only be bought from reputable garden centres, where their origin as cultivated plants can be assured.

Callitriche stagnalis Starwort
Ceratophyllum demersum Hornwort
Eleocharis acicularis Hair Grass
Fontinalis antipyretica Willow Moss
Hippuris vulgaris Maretail
Hottonia palustris Water Violet
Myriophyllum spicatum Water Milfoil
Myriophyllum verticillatum Whorled Milfoil
Potamogeton crispus Curly Pondweed
Ranunculus aquatilis Water Crowfoot

Reference

<http://www.plantlife.org.uk/uk/plantlife-campaigning-change-invasive-plants.html>