

Chapter 16

Approach of the European and Mediterranean Plant Protection Organization to the Evaluation and Management of Risks Presented by Invasive Alien Plants

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Abstract Invasive alien plants may be introduced intentionally with trade (80% of current invasive alien plants in Europe were introduced as ornamental or agricultural plants) or unintentionally (as contaminants of grain, seeds, soil, machinery etc., or with travellers). Preventing the introduction of invasive alien plants is considered more cost-effective, from both environmental and economic points of view, than managing them after introduction. Pest risk analysis (PRA) standards have been developed by the International Plant Protection Convention (IPPC) and the European and Mediterranean Plant Protection Organization (EPPO) to allow assessment of the phytosanitary risk presented by invasive alien plants, and the development of appropriate measures to prevent their introduction and spread. These measures may in turn have an impact on international trade, and the obligations arising from trade agreements have also to be taken into account when phytosanitary measures are established. PRA basically consists in a framework for organizing biological and other scientific and economic information to assess risk. This leads to the identification of management options to reduce the risk to an acceptable level. Within the EPPO context, the results of these PRAs are translating into recommendations for countries to implement their national regulations. This article gives an overview of the international framework for regulation of invasive alien plants under the IPPC. It then presents the approach followed by EPPO for the evaluation and management of risks presented by such plants, as well as its application.

Keywords European and Mediterranean Plant Protection Organization • Pest risk analysis

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16.1 Introduction

Modern methods of travel, trade and communication have allowed an enormous increase in the movement of people, commodities and conveyances over the past century and this is still accelerating. This has resulted in a higher risk of introduction and spread of organisms harmful to plants and plant products, including invasive alien species. Trade in agricultural products provides a clear economic benefit but prevention of introduction of pests with trade is recognized as an important target for countries. In this respect, the International Plant Protection Convention (IPPC) (FAO 1997) has been the major agreement for countries that trade in agricultural, horticultural and forestry products. The Conference of the Parties to the Convention on Biological Diversity (CBD, <http://www.cbd.int/default.shtml>. Accessed on 1 February 2008) has responsibility for global policies on invasive alien species, but has recognized the role of the IPPC in this sector. In the framework of the IPPC, the European and Mediterranean Plant Protection Organization (EPPO) has recently developed a work programme specifically addressing invasive alien plants, as part of its ongoing programme on quarantine pests.

Invasive alien plants may be introduced intentionally with trade (80% of current invasive alien plants in Europe were introduced as ornamental or agricultural plants; Hulme 2007) or unintentionally (as contaminants of grain, seeds, soil, machinery, etc., or with travellers). Preventing the introduction of invasive alien plants is considered more cost-effective, from both environmental and economic points of view, than managing them after introduction. Pest risk analysis (PRA) standards have been developed by IPPC and EPPO to allow assessment of the phytosanitary risk presented by invasive alien plants, and the development of appropriate measures to prevent their introduction and spread. These measures may in turn have an impact on international trade, and the obligations arising from trade agreements have also to be taken into account when phytosanitary measures are established.

This article gives an overview of the international framework for regulation of invasive alien plants under the IPPC. It then presents the approach followed by EPPO for the evaluation and management of risks presented by such plants. Terms used are defined in the *Glossary of phytosanitary terms* (IPPC 2007c).

16.2 International Context

16.2.1 World Trade Organization (WTO)

The WTO was established in January 1995 and deals with the rules of trade between nations at a global or near-global level. It is a negotiation forum for 150 member countries. It results from the 1986 to 1994 negotiations called the Uruguay Round and earlier negotiations under the General Agreement on Tariffs and Trade (GATT).

The GATT (1994) is WTO's core agreement with respect to trade in commodities, and its objective is to limit tariff and non-tariff barriers to trade. Its two main requirements are that (1) imported commodities should not be treated less favourably than equivalent domestic commodities (the "national treatment" obligation), (2) there should not be discrimination for imported commodities between countries where the same conditions prevail. Nevertheless, article XX of the GATT states that "nothing in the Agreement shall prevent the adoption or enforcement by any contracting party of measures necessary to protect human, animal or plant life or health, provided that measures are not applied in a manner which would constitute a means of arbitrary or unjustifiable discrimination between countries where the same conditions prevail, or a disguised restriction on international trade".

The Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement) (WTO 1994) elaborates rules for the application of the provision of GATT related to the use of sanitary or phytosanitary measures, in particular article XX. It defines the basic rights and obligations of members to protect animal and plant life or health from risks arising from the entry, establishment or spread of pests, where such measures may directly or indirectly affect international trade. Consequently this agreement covers phytosanitary regulations established to prevent the introduction of invasive alien plants. Preventive measures have to comply with a set of principles such as "harmonization", "equivalence", "assessment of risk", "transparency", etc. The agreement also provides for a dispute settlement mechanism so that in case of dispute between countries, the two contracting parties should consult bilaterally with the aim of resolving the problem. In the SPS agreement, the IPPC is recognized as the relevant international standard-setting organization for the elaboration of international standards ensuring that phytosanitary measures are not used as unjustified barriers to trade.

16.2.2 IPPC

The IPPC is an international treaty to which 165 governments currently adhere (as of September 2007). Its objectives are to secure action to prevent the spread and introduction of pests of plants and plant products, and to promote appropriate measures for their control. It came into force in 1952. It is governed by the Commission on Phytosanitary Measures (CPM), which adopts International Standards on Phytosanitary Measures (ISPMs). The IPPC Secretariat coordinates the activities of the Convention and is hosted by the Food and Agriculture Organization of the United Nations (FAO). See IPPC website at <https://www.ippc.int/IPP/En/default.jsp>.

The IPPC is implemented at a national level by phytosanitary authorities called National Plant Protection Organizations (NPPOs), usually within the Ministry of Agriculture. NPPOs carry out the important task of preventing the introduction and spread of quarantine pests. An efficient infrastructure (such as border controls, national surveillance programmes, technical and scientific institutions, as well as

export-oriented certification programmes) has been established to achieve the tasks of phytosanitary authorities (Lopian 2005).

As explained before, IPPC is recognized as the standard-setting organization for phytosanitary measures and is developing ISPMs. So far, 29 ISPMs have been adopted, of which 3 are of particular interest for risk analysis:

- ISPM no.1 *Phytosanitary principles for the protection of plants and the application of phytosanitary measures in international trade.* (IPPC 2007a)
- ISPM no. 2 *Framework for pest risk analysis.* (IPPC 2007b)
- ISPM no. 11 *Pest risk analysis for quarantine pests including analysis of environmental risks and living modified organisms.* (IPPC 2007d)

At one time, the IPPC was interpreted as referring mainly to the protection of cultivated plants, but in 1999 the CPM recognized that it always had a wider scope, extending to wild plants and the environment. Major changes were made to two ISPMs in consequence. Firstly, a supplement (no. 2) was added to the *Glossary of phytosanitary terms*, providing “*Guidelines on the understanding of potential economic importance and related terms including reference to environmental considerations*”. This made it clear that “potential economic importance” (as referred to in the IPPC definition of a quarantine pest) can include environmental concerns. Thus, the scope of the IPPC covers the protection not only of cultivated plants in agriculture (including horticulture and forestry), but also of uncultivated/unmanaged plants, wild flora, habitats and ecosystems. Secondly, extensive changes were made to ISPM no. 11 on *Pest risk analysis for quarantine pests*. This standard describes the integrated processes to be used for the assessment of risks presented by plant pests, as well as the selection of risk management options. The concerns for the environment originally concerned only the side effects on the environment of pests mainly affecting cultivated plants. This was now extended to any organisms having harmful effects on plants in the environment, whether or not they affect cultivated plants. The analysis of risks to the environment and biological diversity, including risks affecting uncultivated/unmanaged plants, wild flora, habitats and ecosystems contained in the PRA area, was set out in greater detail and, most importantly for the present purpose, invasive alien plants were recognized as an important hazard for the environment. As a result, invasive alien plants can now be the subject of PRA under the IPPC.

16.2.3 CBD

In June 1992, the United Conference on Environment and Development (UNCED) known as the “Earth Summit” was held in Rio de Janeiro. One of the main results of this summit was the signature of the CBD, which aims at the conservation and sustainable use of biological diversity and the fair and equitable sharing of benefits arising out of the utilization of genetic resources. To date, it has been signed by 150 governments, including those of all the European countries. More information is available at

<http://www.cbd.int/default.shtml>. In its Article 8(h), the CBD asks its members “to prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species” as far as possible and when appropriate.

In 2002, at the sixth meeting of the CBD Conference of the Parties in The Hague, “*Guiding Principles for the prevention of introduction and mitigation of impacts of alien species that threaten ecosystems, habitats or species*” were adopted (CBD 2002). This text provides further advice to members on Article 8(h) of the Convention. More recently, the eighth CBD Conference of the Parties held in Brazil in 2006 encouraged members to work at a regional level and to ensure close inter-agency cooperation at the national and regional levels among the various sectors (Ministries of Environment and of Agriculture, traders), as well as sharing information necessary for risk analysis (COP 8 2006).

16.2.4 Cooperation Between the IPPC and the CBD

Since activities of the CBD in relation to invasive alien species correspond to a certain degree with those of the IPPC for those invasive alien species that are harmful to plants, cooperation between the CBD and the IPPC has been established since 2004. This avoids overlap and duplication of work between the two Conventions. The respective Secretariats participate in each other’s meetings. A Memorandum of Understanding has been established between CBD and IPPC and the revision of ISPMs no. 5 and no. 11 (see previous paragraph) was accordingly done in consultation.

The relationship between the CBD guiding principles on invasive alien species and the IPPC and its ISPMs has been described by Schrader and Unger (2003) and Lopian (2005), and will be the subject of a new supplement to the *Glossary of phytosanitary terms*, whose purpose is to give an interpretation of the terminology of the Convention on Biological Diversity in relation to the *Glossary of phytosanitary terms*. Essentially, the CBD defines an “alien” as a “species ... introduced outside its natural ... distribution” and an invasive alien species as “an alien species whose introduction and/or spread threatens biological diversity” (annex footnote 57, CBD 2002). The *Glossary of phytosanitary terms* defines a quarantine pest as “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”. Evidently, the two definitions cover similar ground. The main differences are that, unless “biodiversity” is taken in a very wide sense to include agro-ecosystems, a quarantine pest does not necessarily threaten biodiversity and may only affect agriculture (Lopian 2005). On the other hand, according to the CBD, an invasive alien species has already been introduced. If it has also spread to the point that it is widely distributed, it can no longer be considered as a quarantine pest. Thus, ISPM no. 11 on “*Pest risk analysis for quarantine pests including analysis of environmental risks and living modified organisms*” applies to invasive alien plants that have been introduced but are not widely distributed. It also applies to potentially invasive plants that have not yet been introduced.

16.3 European Regional Context

16.3.1 EPPO

To promote regional cooperation, the IPPC includes provisions for the establishment of Regional Plant Protection Organizations (RPPOs) functioning as coordinating bodies in the areas they cover. EPPO is the RPPO for Europe and the Mediterranean area, and establishes regional standards on phytosanitary measures. It was created in 1951, and in 2008 it has 49 member countries, including all members of the European Union, Russia and several other countries of the Commonwealth of Independent States, and Mediterranean countries in North Africa and the Near East. EPPO's members are represented by their NPPOs, i.e. the official services that are responsible for plant protection in each country (usually part of the Ministry of Agriculture). One of EPPO's main priorities is to prevent the introduction of dangerous pests from other parts of the world, and to limit their spread within the region should they be introduced. EPPO is also conducting regional PRA activities for the European and Mediterranean region. More information on EPPO's activities is available at www.eppo.org.

16.3.2 Bern Convention

The Convention on the Conservation of European Wildlife and Natural Habitats (Bern 1979), generally known as "the Bern Convention" is a nature conservation treaty, which deals with a wide array of aspects concerning the conservation of natural heritage in Europe. It counts at present 44 Contracting Parties, including the 27 Member States of the European Union, the European Community and four African states. It is administered by the Council of Europe, based in Strasbourg. It implements the CBD within its region and has a threefold objective: to conserve wild flora and fauna and their natural habitats, to promote co-operation between states in the field of conservation of biological diversity and, in particular, to protect endangered and vulnerable species and endangered natural habitats.

The Bern Convention requires Contracting Parties "to strictly control the introduction of non-native species" (Article 11 par. b). The Convention coordinates action of European Ministries of the Environment in matters related to the conservation of biological diversity. It started activities on invasive alien species in 1984 with the launch of a general recommendation to the member states of the Council of Europe, followed by the establishment of a group of experts on invasive alien species. Specific recommendations were then adopted, as for instance on the control of *Caulerpa taxifolia* (an invasive alga in the Mediterranean). In 2002, the Convention adopted a European Strategy on invasive alien species, with the aim of providing guidance to countries in drawing up and implementing their national strategies (Genovesi and Shine 2002). The Strategy identifies priorities and key

actions in this field and includes precise proposals on (1) awareness and information issues concerning invasive alien species, (2) the need to strengthen national and regional capacities, (3) prevention of new introductions and early warning systems for new arrivals, (4) reduction of the adverse impacts of invasive alien species on biological diversity, (5) measures required to recover species and natural habitats affected by invasive alien species.

16.3.3 Cooperation Between EPPO and the Bern Convention

The Bern Convention and EPPO have established a partnership on the topic of invasive alien species, and work closely together on invasive alien plants at the regional scale, as recommended by the CBD (COP 8 Decision VIII/27). As IPPC-related activities are in most countries under the responsibility of the Ministry of Agriculture, while CBD matters are under the responsibility of the Ministry of the Environment, this partnership allows a concrete partnership to be established between the Plant Health and Biodiversity Conservation sectors.

16.4 EPPO Regional Approach to the Evaluation and Management of Risks Presented by Invasive Alien Plants

16.4.1 PRA Systems in Place Within EPPO

The EPPO Convention lays down that one of the aims of EPPO is “to pursue and develop, by cooperation between the Member Governments, the protection of plants and plant products against pests and the prevention of their international spread and especially their introduction into endangered areas”. EPPO Council has consequently decided to draw up lists of pests, which present an unacceptable risk, and whose regulation is relevant for the whole of, or large parts of, the EPPO region. The first list is of A1 pests, not present in the EPPO region. The second list is of A2 pests, present in the EPPO region but not widely distributed (i.e. absent from or not widely distributed in certain countries, where they are therefore subject to official control). The first lists were approved in 1975. In 2007, they contained 298 quarantine pests recommended for regulation (available on the EPPO website).

Addition of a pest to the A1 or A2 list may be proposed by a member government, or result from the appearance of the pest on the EPPO Alert List (a pest warning system managed by the Secretariat). In either case, the proposal has been since the mid 1990s subject to PRA following the standards of the IPPC and EPPO. Originally, this PRA was usually put forward by the proposing member, commissioned from an expert or prepared by the Secretariat. Since 2006, however, in

addition to the process mentioned earlier, PRAs on specific pests are performed by Expert Working Groups (EWG), following EPPO PM 5/3 *Decision-support scheme for quarantine pests*. Expert Working Groups have already been organized for several plant pests (*Phytophthora lateralis*, *Iris yellow spot virus*, *Megaplatus mutatus* and *Tetranychus evansi*), which are not plants. EWG will also be organized on plants from 2008 on.

The output of a PRA takes the form of a general recommendation to countries, with measures proposed for each organism concerned, distinguishing different levels of risks for different parts of the EPPO region if necessary (Smith 2005). This recommendation has then to be adopted by consensus by the EPPO Members, after appropriate consultation. Members decide individually whether the reported risks concern them, and select appropriate measures if they do. The EPPO Convention creates no greater obligation on members than that they should "endeavour to implement" EPPO recommendations. However, there is a general policy of "regional solidarity", by which Members do take phytosanitary measures against A1 pests (unless the risk of establishment on their territory is very low) and do select their measures from those recommended.

The PRA documents are freely available on the EPPO website as recommended in Decision VIII/27 of the CBD Conference of the Parties held in 2006 in Brazil (CBD 2006). EPPO organizes periodic training sessions on PRA for staff of the NPPOs of EPPO countries.

16.4.2 *Initiation of an EPPO Work Programme on Invasive Alien Plants*

In 2002, the EPPO Council recognized that invasive alien species that have an effect on plants are quarantine pests under the IPPC (and therefore should be evaluated following ISPM no. 11), and that NPPOs should consider their responsibility for the management of invasive alien plants (which are considered quarantine pests under the IPPC), in cooperation with the environmental authorities. As a consequence, EPPO initiated a work programme on invasive alien species (Schrader 2004) and a Panel on invasive alien species was created to help the EPPO member countries to achieve this aim. This Panel now has experts from 18 countries of the EPPO region.

The Panel started its work by assembling a preliminary list of approximately 500 invasive alien plants in the EPPO region from the scientific and technical literature, from web sites and from official contacts in EPPO member countries (by questionnaire). Technical evaluation of this list led to the first achievement of the Panel: a list of 40 terrestrial or aquatic invasive alien plants identified as posing an important threat to plant health, environment and biodiversity in the EPPO region.

The prioritization of these species was done by expert judgment based on the following factors:

- Whether the plant is considered invasive or potentially invasive by several EPPO countries
- Whether the plant is absent or still containable by appropriate measures in several EPPO countries
- Whether the plant has potential for further spread and damage into significant areas where it is absent
- Whether the plant is reported to be actively spreading or becoming more damaging in its current distribution area

EPPO strongly recommends countries endangered by these species to take measures to prevent their introduction and spread or to manage unwanted populations (for example by publicity, restrictions on sale or planting, control campaigns). The species mentioned on this list may in fact be quite widely distributed, and the EPPO recommendations concerning them are intended to be applied nationally (by the NPPO, or more probably by some other national or subnational authority).

This list, with additional information on the individual plants, is available on the EPPO website. It is open to revision and extension, and the Panel is further developing a prioritization process to take more species into account and to determine priorities for PRA.

Besides this, the EPPO Reporting Service (the EPPO monthly web-based phytosanitary newsletter) has been extended to include many items on invasive alien species, for example reports from individual countries concerning the species to which they give priority, and information on pathways for the introduction of invasive alien plants such as aquatic plants (EPPO RSE 2007/016) or bird seed (EPPO RSE 2007/123).

16.4.3 PRA of Invasive Alien Plants

The EPPO Panel's work as described earlier was not based on formal PRA, and concentrated on species already present within the region and already recognized to be invasive. The aim was to develop activities and to reach a rapid consensus on priorities for the EPPO region. The next phase of the work programme was to apply the EPPO PRA system to invasive alien plants, in the same way as it is used for other plant pests, i.e. to place certain invasive alien plants in the EPPO A1 or A2 lists, and to recommend measures against them.

16.4.3.1 A1 List

The first question that arose was whether to place invasive alien plants on the EPPO A1 list. It should be recalled that A1 pests are not present in the EPPO region (i.e. have not been introduced), so that they do not fit the CBD definition of having already been introduced. In practice, the EPPO Panel ignored this distinction, and

considered that, in principle at least, EPPO could conduct PRA for plants not present in the EPPO region, which could be considered potentially invasive. The difficulty was, however, that there is a great number of plant species, which may be introduced into Europe and there they become invasive alien plants. Furthermore, the horticultural industry introduces new plant species into cultivation in Europe every year. Performing a PRA is a time-consuming and laborious process, and it is difficult to make confident predictions of the behaviour of alien species in Europe. Accordingly, although a preventive CBD approach would be ideal, it has not appeared feasible within EPPO to conduct PRAs on potentially invasive plants for addition to an A1 list. In particular, European countries do not currently regulate the import of non-European plants as such, except as pathways for plant pests or for quite other reasons (e.g. regulations on illegal drugs). The possibilities of reaching international agreement on a list of plants to be internationally regulated, and of undertaking the work programme to establish such a list, seem remote. For this reason, the main focus of attention for PRA for plants has been on the A2 list, i.e. invasive alien plants that are already present in Europe.

16.4.3.2 A2 List

Adding invasive alien plants to the A2 list implies performing PRAs on alien species, which already have a limited distribution in the EPPO region and which have shown invasive behaviour in Europe and/or elsewhere in the world. It also implies that international phytosanitary measures are appropriate concerning the movement of these species between countries, which is not always the case, since national measures may be more appropriate. A2 candidates are more likely to be very recent arrivals, present in very few countries, and could include species that have only just been introduced into cultivation in Europe and have not established in the wild. In these cases, international measures are especially appropriate.

16.4.4 The EPPO A2 List and the EPPO List of Invasive Alien Plants

As noted earlier, EPPO has established a list of “invasive alien plants identified as posing an important threat to plant health, environment and biodiversity in the EPPO region”. All these listed species do not necessarily qualify as potential A2 pests, subject to international regulation, because of the following:

- They may be widely distributed (and so not fit the definition of a quarantine pest)
- It may not be possible to apply national measures equivalent to those required internationally, so that non-discrimination cannot be assured
- It may not be relevant to apply measures related to international movement

In fact, the EPPO Panel has undertaken to operate as an Expert Working Group (see earlier) to perform PRAs on alien plants for the EPPO A2 list. Five species have been subjected to PRA and are now recommended for regulation to the 49 EPPO countries (*Crassula helmsii*, *Hydrocotyle ranunculoides*, *Lysichiton americanus*, *Pueraria lobata*, *Solanum elaeagnifolium*). As of September 2007, further PRAs are in preparation for *Heracleum sosnowskyi*, *H. persicum*, *Polygonum perfoliatum* and *Eichhornia crassipes*. On the basis of information gathered by the EPPO Secretariat, it appears that all these species have a limited distribution within the EPPO region and their entry into other countries of the region could be prevented. A process is now being developed to identify further candidates on the basis of simple transparent criteria.

16.4.5 Practical Application

So far, of the five species recommended for regulation by EPPO, only *Hydrocotyle ranunculoides* is regulated: its possession and trade are prohibited in The Netherlands. These preventive measures are implemented in a single country, and may be compromised if efforts by neighbouring countries are inadequate (Burgiel et al. 2006). Indeed, there are no international measures established for this plant and, other than in an extreme emergency, the EU phytosanitary system would not allow an individual country to put in place such measures unilaterally (though non-EU countries could do so). So, at a practical level, it must be recognized that the recommendations made by EPPO on invasive alien plants are fairly recent, and time will be needed before national (or EU) regulations are implemented. In addition, NPPOs may also have to consult with national environmental authorities in evaluating the risk to their territory and in determining the measures to be established (Smith 2005). It is possible to regulate invasive alien plants under the IPPC, and EPPO has taken the first steps in creating a situation in which the European countries (and the EU) can do so.

16.5 Application of the EPPO Decision-Support Scheme on PRA to Invasive Alien Plants

As outlined earlier, EPPO has developed a scheme for PRA of quarantine pests, and has also started to perform PRAs on invasive alien plants. Since PRA is a technical analysis providing a basis for administrative and legislative decisions, it is important that it should be done transparently according to accepted standards. Thus, EPPO has adapted and extended its decision-support scheme so that it can be used for all sorts of plant pests, including invasive alien plants. This scheme therefore provides an example of how a PRA scheme developed in the framework of the IPPC can be used to assess invasive alien plants (Schrader 2004).

The EPPO scheme originally took the form of two separate standards: pest risk assessment (PM 5/3 adopted in 1997) and pest risk management (PM 5/4 adopted in 2000). More recently, these have been merged into a single revised EPPO Standard PM 5/3: *Decision support scheme for quarantine pests*, compatible with ISPM no. 11 *Pest risk analysis for quarantine pests including analysis of environmental risks and living modified organisms*. The scheme provides detailed instructions for the successive stages of PRA: initiation, pest categorization, probability of introduction, assessment of potential economic consequences and pest risk management. Basically, it is a framework for organizing biological and other scientific and economic information, and using it to assess risk. This leads to the identification of management options to reduce the risk to an acceptable level. PRAs can be very short and simple, or very long and complex. There is no fixed criterion for the quantity of information needed. The evaluation does not necessarily have to be quantitative and it can include qualitative considerations, as long as it is scientifically sound (Burgiel et al. 2006). Expert judgement may be used in answering the questions.

The successive stages of the scheme are reviewed here, with particular reference to its use for invasive alien plants. The scheme follows the sequences presented in Appendices 1, 2 and 3.

16.5.1 *Initiation*

Initiation aims to identify the pests or pathway to be considered for risk analysis in relation to the identified PRA area. The EPPO scheme is primarily concerned with the assessment of individual pests, since this is the basis on which European countries formulate their phytosanitary regulations. So, European countries do PRAs for pests, and thus for individual invasive alien species if appropriate.

However, ISPM no. 11 also provides for PRA of a pathway. Countries that prohibit the import of most plants and plant products frequently have to consider whether a new trade can be opened for a previously prohibited plant. The PRA then concerns all the pests that might be carried by this new pathway. Such PRAs are not normally done in Europe (though the EPPO Standard follows ISPM no. 11 in allowing the possibility). For invasive alien plants, the evaluation of a pathway such as internationally traded birdseed could be relevant for EPPO, and could be the initiation point for PRAs of new candidate plants.

In doing PRAs for individual pests, it is important to establish that their identity is clear. The pests should as far as possible be well and accurately documented before the PRA starts. The information generally needed is listed in EPPO Standard PM5/1(1) *Check-list of information required for pest-risk analysis (PRA)* (EPPO 1998), though it needs revision to cover invasive alien plants. While using the scheme, the user should specify all details that appear relevant to the replies to individual question, indicating the source of the information (Schrader 2005).

Although the EPPO scheme specifies many possible initiation points for PRAs, most are not relevant for invasive alien plants. From experience so far, there are

broadly two initiation points for invasive alien plants. PRAs may be appropriate for the following:

- Plants that have been (or are proposed to be) intentionally introduced for ornament, and that have, or might in future, escaped from plantations to invade and threaten unmanaged ecosystems (i.e. semi-natural or natural habitats). According to Hodkinson and Thompson (1997), these species tend to be spreading perennials with transient seed banks. Such species represent about 80% of invasive alien plants (Hulme 2007). With respect to the PRAs performed so far by EPPO, *Crassula helmsii*, *Hydrocotyle ranunculoides*, *Lysichiton americanus*, *Pueraria lobata*, *H. sosnowskyi*, *H. persicum*, and *Eichhornia crassipes* fall into this category.
- Plants that are unintentionally introduced as contaminants associated with international movement of various commodities and articles, including soil and vehicles. According to Hodkinson and Thompson (1997), these plant species are often small and fast growing, but their most unifying characteristic is the production of numerous, small, persistent seeds. Grain and seeds for planting are important commodities likely to act as a pathway for unintentional introduction of such plants. Because such plants are originally associated with the agricultural or managed plants or plant products that are traded, they are also likely to be a greater threat to agriculture and cultivated ecosystems (as weeds) than to uncultivated ecosystems. With respect to the PRAs performed so far by EPPO, *Solanum elaeagnifolium* and *Polygonum perfoliatum* fall into this category.

16.5.2 Pest Risk Assessment

16.5.2.1 Pest Categorization

A rapid qualitative assessment is first made, with little information, to determine whether the organism meets the criteria of the definition of a quarantine pest (see paragraph *Cooperation between the IPPC and the CBD*) and could therefore be regulated in international trade. The main aim of this step is to avoid conducting a full PRA in a case that can immediately be seen not to require one.

If the pest categorization step leads to a positive answer, the main PRA starts. It is essentially composed of a series of questions, made in terms of “likeliness” for qualitative questions (very unlikely, unlikely, moderately likely, likely, very likely), and an estimate for quantitative questions (very few, few, moderate number, many, very many).

16.5.2.2 Probability of Introduction

Introduction, as defined by the *Glossary of phytosanitary terms* is the entry of a pest resulting in its establishment. Entry and establishment are separate processes and

need to be evaluated separately. It may be noted that, in CBD terminology, introduction does not include establishment, and is thus effectively entry. This text follows IPPC terminology.

16.5.2.3 Probability of Entry

For quarantine pests other than invasive alien plants, there may be many alternative pathways of entry to be considered. For any of these to be regulated in international trade, the PRA should show that other relevant pathways have been considered. Each has to be considered in turn.

For invasive alien plants, the possibilities of entry are in practice more limited. Following Burgiel et al. (2006) and Genovesi (2007), pathways of entry of invasive plants can be categorized as follows:

Intentional entry		Unintentional entry
Direct entry into the environment	Entry into a containment facility or in a controlled environment	<ul style="list-style-type: none"> The alien species unintentionally enters as a contaminant of a specific commodity: plant products such as plants for planting, seeds, grain, and soil and packaging
<ul style="list-style-type: none"> For ornament in landscaping (the most frequent case) For agriculture For forestry 	<ul style="list-style-type: none"> In botanical and private gardens In greenhouses In aquarium and horticultural pond trade For research 	
		<ul style="list-style-type: none"> The alien species unintentionally enters with movements of people or of machinery

For invasive alien plants, the pathway most often assessed is intentional import for ornamental purposes (including aquatic plants). In this case, entry is certain and does not need to be considered as a variable. The assessor can go directly to the probability of establishment (in particular the probability of establishment in non-intended habitats).

Nevertheless, species introduced for ornament may also be introduced as contaminants. For instance, seeds of *Heracleum* spp. may contaminate soil and growing media.

In the cases that EPPO has considered so far, intentional entry was the only pathway evaluated for *Crassula helmsii*, *Hydrocotyle ranunculoides*, *Lysichiton americanus* and *Pueraria lobata*. In the other case (*Solanum elaeagnifolium*), unintentional entry by several pathways was considered: contaminant of plants for planting, soil/growing media, used machinery, grain, seeds for planting.

A plant associated with a pathway is assessed first for the probability that it should enter, then for its survival during transport and its probability of transfer

to a suitable habitat. Thus, a plant that occurs in nurseries in the exporting country is likely to be carried by plants for planting in growing media moving in international trade, is likely to survive especially if it is in the form of seeds rather than young plants, and is likely to escape as a weed in the nursery of destination. A plant that contaminates grain at harvest is likely to survive as seeds in the grain, but relatively unlikely to reach a suitable habitat if the grain is processed in the usual way.

16.5.2.4 Probability of Establishment

Whatever the type of pest, an organism that enters does not necessarily establish. Many exotic plants enter intentionally or unintentionally, but few escape. Of those that do, many are only reported as casual and then disappear since they cannot maintain sustainable populations. Only a small fraction can establish in the wild, and it is this probability that has to be assessed.

The first parameter necessary for the establishment of the plant is the presence of suitable habitats. These are listed and their number and distribution are assessed to determine whether the invasive plant will find adequate environment to establish. A plant like *Pueraria lobata*, for example, which colonizes disturbed habitats such as roadsides, fallows and edges of forests, has numerous potential habitats.

The second parameter is the suitability of the environment. The similarity of climatic conditions in the PRA area and in the current area of distribution of the species is considered. When possible, a climatic prediction analysis can be performed with softwares such as CLIMEX indicating different levels of risk. Full details of the software can be found on the Hearne website (<http://www.hearne.com.au/products/climex/>) and in the CLIMEX User's Guide (Sutherst et al. 2004). For instance, in the case of *Solanum elaeagnifolium*, Mediterranean countries are considered more at risk than temperate countries, and northern countries are not at risk. Other relevant environmental factors are abiotic factors such as soil type, and biotic factors such as competition and natural enemies.

The reaction of an introduced plant to current management practices and possible control measures will affect the probability of establishment, together with various other characteristics of the plant such as reproductive strategy, genetic diversity, and adaptability.

16.5.2.5 Probability of Spread

A plant that can rapidly spread after establishment presents a much greater risk. An assessment is made of the risk of natural spread, including movement by wind or water dispersal, transport by vectors such as insects or birds, natural migration, rhizome growth, combined with the presence of natural barriers and the quantity of pest to be dispersed, and also of the risk of spread by human assistance, through movement of soil, irrigation waters, footwear, used machinery, etc. The possibility

of containing the plant is also considered, since herbicide treatments may easily contain a plant even if it has established.

16.5.2.6 Potential Economic Consequences (Including Environmental Impacts)

In the case of introduced plants, establishment and spread do not necessarily imply that there is a negative impact. Introduced species may even increase biological diversity (the Mediterranean flora contains about 20% of exotic species). So it is necessary to evaluate further whether there are potential negative economic impacts (including environmental and social impacts). Any such effects are documented and evaluated for the current area of distribution of the plant, and estimated for the PRA area. This may be done in monetary terms, especially for control costs. For example, in the EPPO PRA for *Crassula helmsii*: “one recent estimate puts the cost of control of *C. helmsii* at between 1.45 and 3 million euros based on the treatment of 500 sites over a period of 2–3 years in the British Isles” (Leach and Dawson 1999).

For invasive alien plants, it is particularly important to evaluate environmental impacts such as reduction of keystone species; reduction of species that are major components of ecosystems, and of endangered species; significant reduction, displacement or elimination of other species; indirect effects on plant communities (species richness, biodiversity); significant change in ecological processes, and the structure, stability of an ecosystem (including further effects on plant species), etc. are evaluated. For example, in the assessment of the environmental impact of *Crassula helmsii*, part of the information provided in the PRA is: “[...]. The rare starfruit *Damasonium alisma*, one of the rarest plants in UK, is thought to be threatened by *C. helmsii* (Watson 2001). Moreover, Leach and Dawson (1999) state that in an artificially managed lake (Priors Down Lake, Stalbridge, Dorset), evidence suggests changes in floral dominance, *C. helmsii* excluding *Ludwigia palustris* and *Galium debile* (Dawson and Warman 1987) [...].”

Invasive alien plants may also have social impacts, which can be taken into account as they would be for any other kind of pest. For example, these social impacts could include damaging the livelihood of a proportion of the human population and affecting human activities (e.g. water quality, recreational uses, tourism, animal grazing, hunting and fishing). Some of these effects, such as those on human or animal health, the water table or tourism, might have also to be considered, as appropriate, by other agencies/authorities. Information provided for *Crassula helmsii* was: “The mats formed by the plant choke ponds and drainage ditches. Strongly invaded waters lose their attractiveness for recreation and flooding may be caused. The mats can be dangerous to pets, livestock and children who mistake them for dry land”.

Whether for entry, establishment or economic effects, the areas and degree of uncertainty should be noted. They ensure transparency of the process (according to the SPS Agreement principle of transparency) and may orientate additional research to complete the PRA or give it more accuracy.

The overall conclusion of the pest risk assessment is to decide whether the pest qualifies as a quarantine pest, on the basis of the answers given. If so, PRA continues

with the selection of risk management options, provided the risk identified is considered unacceptable.

16.5.3 Pest Risk Management

This part of the analysis identifies measures to prevent entry, establishment or spread of the pest. It explores options that can be implemented: (1) at origin or in the exporting country, (2) at the point of entry or (3) within the importing country or invaded area. The options are structured so that, as far as possible, the least stringent options are considered before the most expensive/disruptive ones, and are consistent with the SPS-Agreement and Plant Health principles (described in ISPM no. 1).

The methods whereby risk management options are selected for invasive alien plants differ according to whether the introduction is intentional or unintentional, whether the organism is absent or already present in the PRA area and the type of entry pathway. Different measures will apply for these different categories.

If the invasive alien plant is to be intentionally imported, the possible measures will generally be either to prohibit import (e.g. in the case of *Pueraria lobata*) or to take action only within the importing country. An EPPO Standard PM/3 67 on *Guidelines for the management of invasive alien plants or potentially invasive alien plants which are intended for import or have been intentionally imported* has been adopted in 2006 (<http://www.blackwell-synergy.com/doi/abs/10.1111/j.1365-2338.2006.01031.x>. Accessed on 1 February 2008). These measures can be used either nationally or within specified endangered areas and include the following:

- Publicity (existing regulations and lists of invasive or potentially invasive plants, information about threats and pathways should be publicized to raise awareness among all the persons concerned, e.g. horticultural industry, botanical gardens, gardeners)
- Labelling or marking of plants explaining the risks and appropriate actions/uses
- Surveillance
- Control plan
- Restrictions or codes of conduct on sale
- Restrictions or codes of conduct on holding
- Restrictions or codes of conduct on movement (e.g. prevention of movement to specified areas)
- Restrictions or codes of conduct for importers (including notification before import, limitation of quantities)
- Import restricted to specified non-invasive cultivars or clones
- Restrictions or code of conduct on planting (including authorization to plant in intended habitats, prohibition of planting in unintended habitats, required growing conditions for plants).

If the invasive alien plant is likely to be unintentionally introduced as a contaminant, classical plant health measures are appropriate, including prohibition of

certain consignments, detection in consignments, removal from consignments, exclusion from consignments or prevention of natural spread. Pre-entry measures are preferred to post-entry measures since they are considered more efficient in preventing introduction. For some invasive plants, it will be possible to prevent the contamination of the pathway by treatment of the crop or consignment, or by other phytosanitary procedures, in the exporting country, under the responsibility of the NPPO. For example, the crop can be treated with herbicides, or grown in a specified way, or the consignment can be cleaned. Consignments can be required to originate in a crop free from the invasive plant, or in place of production, or area free from that plant (according to the capacity of the plant for local spread).

If entry with travellers and their luggage is a significant pathway, possible measures are inspection, publicity to enhance public awareness of pest risks, fines or incentives. For example, EPPO recommends its members to promote public awareness of pest risks due to the unintentional movement of seeds or rhizomes of *Solanum elaeagnifolium* with travellers. Contaminated machinery or means of transport may be cleaned or disinfected.

Finally, measures applied when the commodity has entered the country may also be envisaged, such as prevention of establishment by limiting the use of the consignment, or import under special licence/permit and specified restrictions.

16.6 Other Relevant EPPO Standards

Although preventive measures are considered the most effective tool to tackle the problem of invasive alien plants, conducting PRA on many individual species is likely to take time, and other approaches may be taken.

16.6.1 National Regulatory Control Systems

National measures such as monitoring, eradication, containment and/or control may be implemented by countries. EPPO provides such information with Standards in the series PM 9 "National regulatory control systems". So far, drafts are being prepared for *Ambrosia artemisiifolia* and *Heracleum* spp.

16.6.2 Codes of Conduct

Codes of conduct for plant producers, sellers and users may be an effective tool for the management of invasive alien plants, if regulation is too complex and costly. Partnerships with the nursery industry and elaboration of codes of conduct have already been undertaken within the EPPO region (United Kingdom), and have

given fruitful results and a better understanding of the problem. Such initiative is undertaken by EPPO in partnership with the Bern Convention at the European and Mediterranean level. Such codes should provide technical information to professionals in order to allow them to manage the problem themselves.

16.7 Further Improvements

Despite these advances, a recent study predicts that the number of plant pests establishing in Europe will increase significantly in the next 10 years, based on current trends (Waage et al. 2005). PRA must therefore be made even more effective. As noted earlier, performing PRA on individual species takes time and it is important that the use of the international and regional standards for PRA is enhanced at the national level. Better coordination and synergy is needed between relevant bodies at the national level (Ministries of Agriculture and Environment, traders, producers). EPPO plans to provide basic training on PRA and to improve its information systems for PRA, while EPPO countries plan to operate more effective international systems for PRA. At the present time, management of invasive alien plants in Europe remains a national or even a sub-national concern, but the systems exist that will allow the European countries to agree on common policies for preventing the introduction and spread of invasive alien plants in the framework of the IPPC.

16.8 PRATIQUE: A Project Within the Seventh European Union Framework Programme

The EPPO Decision-support scheme is widely used by EPPO countries for their internal purposes, but is confronted by the fact that the application of phytosanitary measures in 27 of those countries requires decisions at the EU level. PRA at the EU level is still under development. The data required to make accurate analyses of the risks throughout the EU are often lacking. The existing systems in the EU respond slowly to new developments, and are very complex to operate with full participation of the member states. PRATIQUE (Enhancements of PRA Techniques), a project within the seventh framework programme of the European Union has the objective to develop more efficient risk analysis techniques for pests and pathogens of phytosanitary concern.

Between 2008 and 2011, a consortium of 15 bodies will work in order to do the following:

- Provide data sets valid for PRAs concerning the whole of the EU, with appropriate information on trade, on new pests, etc.
- Conduct multi-disciplinary research to enhance the techniques used in PRA for the assessment of impacts, standardizing and summarizing risks, pathway analysis, etc.
- Ensure that the PRA scheme is fit for its purpose and user-friendly.

16.9 Conclusion

Experience in the EPPO region as well as in other parts of the world shows the essential and successful role of PRA, in the IPPC framework, as a basis for phytosanitary import regulations.

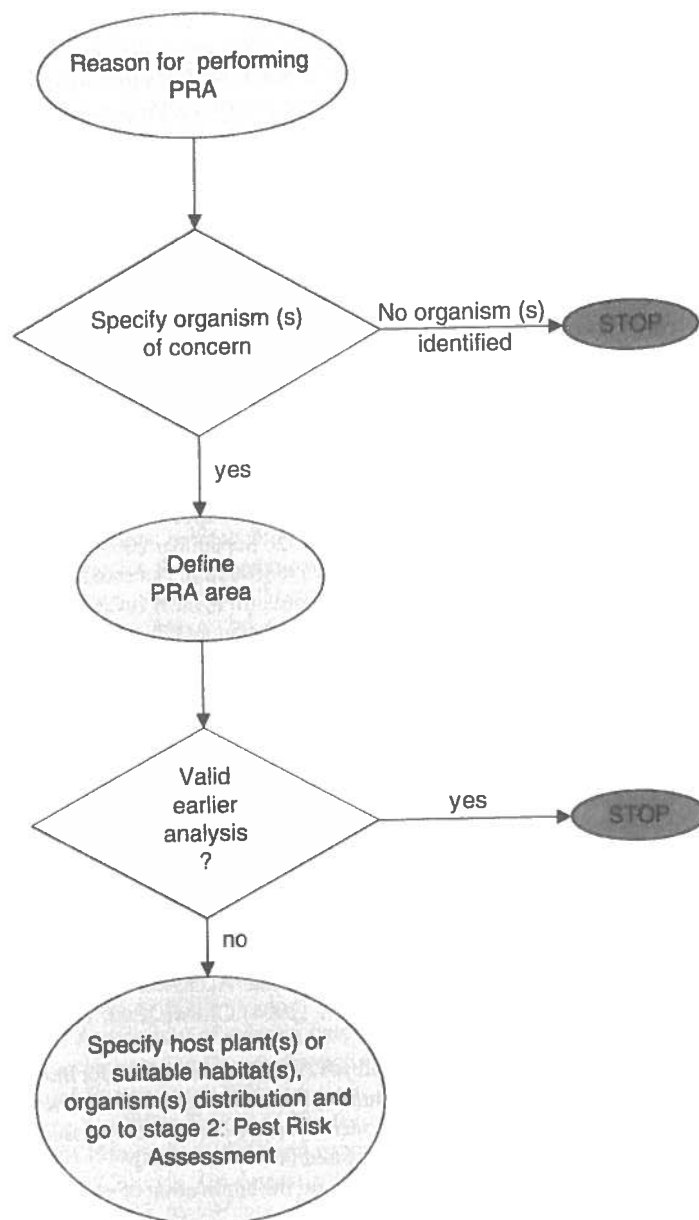
EPPO has made its Decision-support scheme for PRA evolve so that invasive alien plants can be assessed. Consequently appropriate tools exist in the IPPC framework to address risks presented by invasive alien plants. These tools now need to be promoted and used by countries, and collaboration should be established between the different sectors involved.

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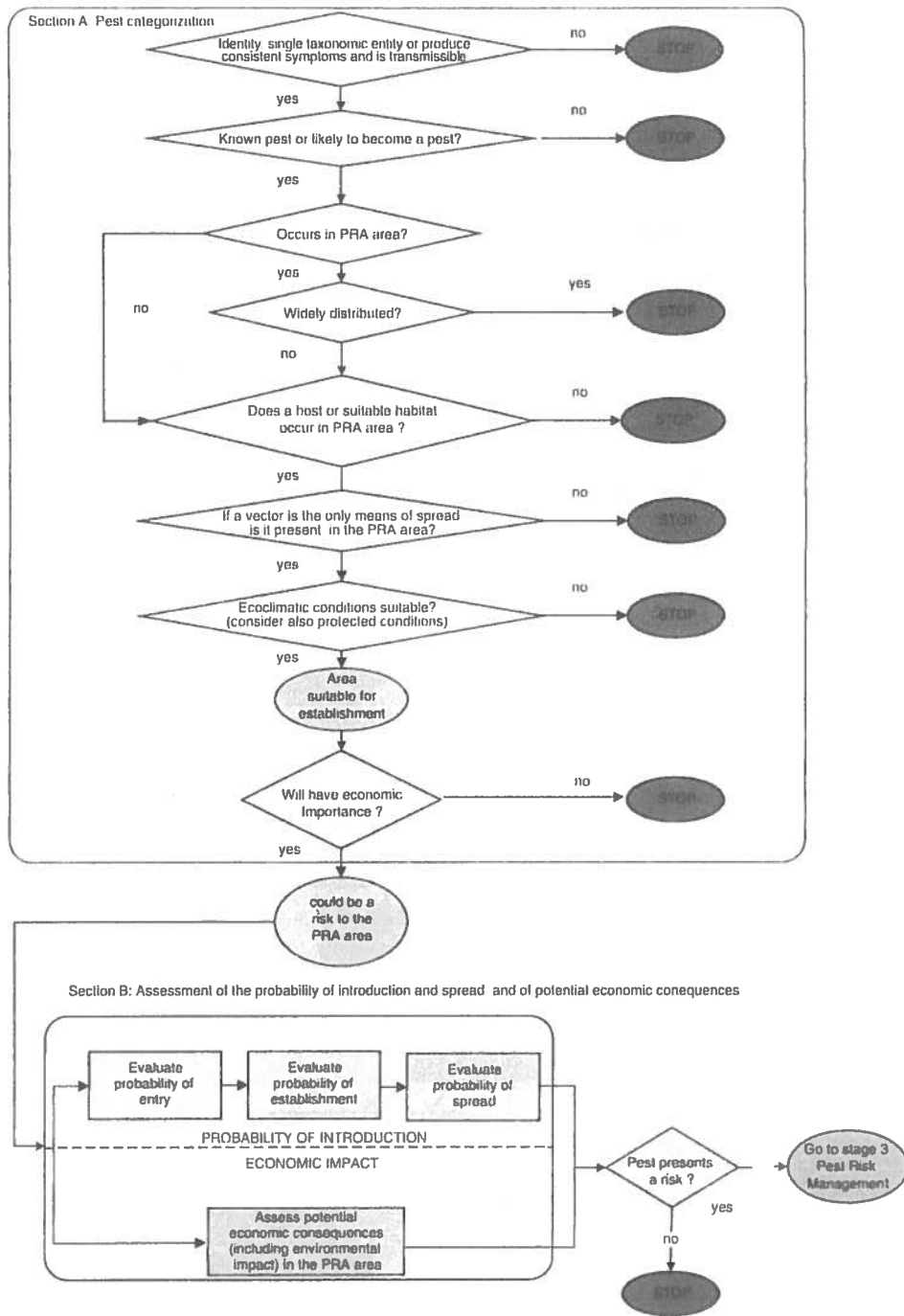
Appendix 1 Initiation of the EPPO Decision-Support Scheme for PRA



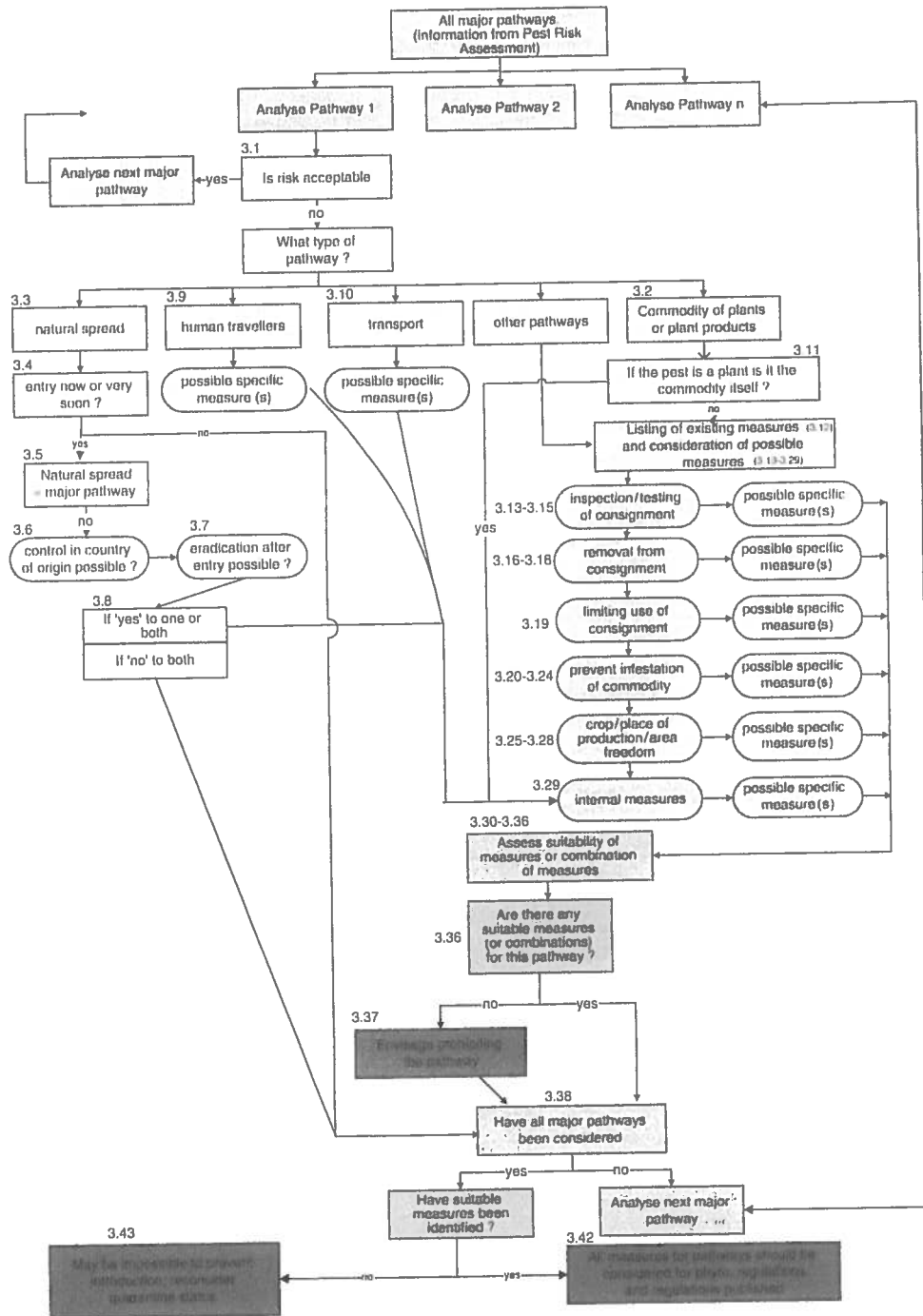
Appendix 2

Decision-Support Scheme For Quarantine Pests.

Stage 2: Pest Risk Assessment



Appendix 3 Decision-Support Scheme for Quarantine Pests. Stage 3: Pest Risk Management



In the framework of the IPPC, PRAs are initiated by importing countries in order to develop appropriate phytosanitary measures to prevent the introduction and spread of quarantine pests, and to justify these measures to trading partners. The measures usually concern the unintentional movement of pests with traded commodities. Under the IPPC, exporting countries should, if requested, provide adequate information in support of the PRAs of importing countries. This model does fit invasive alien plants in some circumstances.

However, many potentially invasive plants are intentionally imported, as such, for agricultural, horticultural or other purposes. CBD Guiding Principle 10 on intentional introduction states that the “the burden of proof that a proposed introduction is unlikely to threaten biological diversity should be with the proposer of the introduction or be assigned as appropriate by the recipient State”. As already explained, there is in Europe no general measure restricting the import of plants from other continents. Exporters and importers agree on what is traded. The IPPC framework makes no provision for PRA to be conducted by exporters or importers, so in fact only the NPPO of the importing country can in practice perform PRAs for invasive alien plants, and besides has the systems in place to do so.

When is a PRA initiated? The EPPO scheme provides many possible scenarios appropriate for other plant pests. For invasive alien plants, the situation is relatively simple: an established infestation may exist or be discovered in the PRA area, a plant may be reported to be an invasive alien in some other part of the world, or a new plant may be intentionally imported.