

## Supplementary material. Boxes

Black and Bartlett: Biosecurity frameworks for cross-border movement of invasive alien species

### **Box 1: Regulated Pests**

**Regulated pests** are those pests on which regulatory action (phytosanitary measures) may be taken. This concept is further explored by understanding the two categories of regulated pests (quarantine pests and regulated non-quarantine pests recognized in the International Plant Protection Convention [IPPC]).

**Quarantine pest** (IPPC definition, Article II): "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."

The consequences of the adoption of this definition are:

- (i) that quarantine pests must be declared/listed for each national territory at risk;
- (ii) that a pest is only a quarantine pest when (a) there is a risk of economic impact of its introduction and establishment in that territory, and (b) its categorization as a quarantine pest is justified by its distribution; and
- (iii) that quarantine pests are justified by pest risk analysis (PRA) and further that PRA is necessary to determine and justify phytosanitary import requirements on the basis of a specified pest risk.

**Regulated non-quarantine pest** (IPPC definition, Article II): 'a non-quarantine pest whose presence in plants for planting affects the intended use of those plants with an economically unacceptable impact and which is therefore regulated within the territory of the importing contracting party'

This type of pest is already present and widely distributed in the national territory but they are subject to phytosanitary measures because they will affect the growth of the plants or affect the quality of harvested products. Regulated non-quarantine pests are invariably plant pathogens (fungi, bacteria, viruses/viroids, and phytoplasmas) or nematodes. Regulated non-quarantine pests must also be justified by PRA (ISPM 21).

Source: *International Plant Protection Convention* Article II.

[https://www.ippc.int/static/media/files/publications/en/2013/06/06/1329129099\\_ippc\\_2011-12-01\\_reformatted.pdf](https://www.ippc.int/static/media/files/publications/en/2013/06/06/1329129099_ippc_2011-12-01_reformatted.pdf)

## **Box 2. Annex 4, ISPM11**

ISPM 11 'also includes details regarding the analysis of risks of plant pests to the environment and biological diversity, including those risks affecting uncultivated/unmanaged plants, wild flora, habitats and ecosystems contained in the PRA area.' It [also] 'includes guidance on evaluating potential phytosanitary risks to plants and plant products posed by [living modified organisms/genetically modified organisms]'. Additionally, the important concept of 'plants as pests' as elaborated in Annex 4 of ISPM 11.

The number and diversity of plants being moved between and within countries is increasing as opportunities for trade increase and markets develop for new plants. Movements of plants may imply two types of pest risk: the plant (as a pathway) may carry pests, the plant itself may be a pest, or the growing medium could harbour pests or seeds/other propagating material of invasive species. The risk of introducing pests with plants as a pathway has long been recognized and widely regulated. However, pest risk posed by plants as pests requires specific consideration.

### **Plants as pests**

Plants as pests may affect other plants through competition for space and resources, such as light, nutrients and water, or through parasitism or allelopathy. Plants introduced to a new area may also become pests by hybridizing with cultivated plants or wild plants.

Thus, the protection of plants as pursued through the IPPC may include considering certain plants as pests and taking phytosanitary measures to prevent their introduction and spread. Determining which plants are pests is context-specific and may vary with geography, habitat, land use, time and the perceived value of the natural resources in the endangered area. Another factor is changing environmental conditions resulting from, for example, climate change, although this may be more relevant for horizon scanning. PRA should form the basis of such a determination and subsequent decisions regarding possible regulation of the plant species as a quarantine pest. It should be noted that plants having undergone such analysis may also require assessment of their potential to be pathways for other pests.

The IPPC has recognized the importance of plants as pests by underscoring that the definition of "pest" includes weeds (ICPM, 2001), and by specifically including "plants that are invasive alien species" in a range of recommendations for action for those invasive alien species that are pests of plants (ICPM, 2005).

The IPPC is concerned with pests injurious to cultivated and wild plants ..., and therefore weeds and invasive plants that are injurious to other plants should be considered pests in the IPPC context. Henceforth ..., the terms "weed" and "invasive plants" are not used, but only the single term "plants as pests" (FAO 2017).

FAO. 2017. International Standards for Phytosanitary Measures. ISPM 11. Pest risk analysis for quarantine pests. Food and Agricultural Organisation of the United Nations. International Plant Protection Convention.

[https://www.ippc.int/static/media/files/publication/en/2017/05/ISPM\\_11\\_2013\\_En\\_2017-05-25\\_PostCPM12\\_InkAm.pdf](https://www.ippc.int/static/media/files/publication/en/2017/05/ISPM_11_2013_En_2017-05-25_PostCPM12_InkAm.pdf)

ICPM. 2001. Report of the Third Interim Commission on Phytosanitary Measures, Rome, 2–6 April 2001. Rome, IPPC, FAO.

ICPM. 2005. Report of the Seventh Interim Commission on Phytosanitary Measures, Rome, 4–7 April 2005. Rome, IPPC, FAO. A strategy for dealing with invasive species in Australia. <https://invasives.org.au/strategy-invasive-species-australia/> (accessed 12 August 2019)

### **Box 3. Deliberate plant introductions – when things go wrong**

Introductions of plants from different countries has been important for agriculture and horticulture for centuries and our gardens would be very different without this ongoing trade. The unintended consequence of garden escapes can cause long term problems, not only in outcompeting natives, but in the case of giant hogweed (*Heracleum mantegazzianum*) considered an imposing, architectural plant by Victorian gardeners in England, can pose a very real health hazard. Non-native, Spanish bluebells (*Hyacinthoides hispanica*) are hybridising with the native woodland *H. non-scripta* leading to concerns and *Rhododendron ponticum*, is a major, costly, issue for forestry (Edwards, 2006).

Hulme *et al.* (2018) acknowledged this issue in their paper on the potential for integrating invasive species policies across ornamental horticulture supply chains as a mechanism to prevent plant invasions. These authors reviewed four policy instruments that can be used in this context: pre-border import restrictions, post-border bans, industry codes of conduct and consumer education. They concluded that these elements need to be better integrated and that tracking, labelling and monitoring of plant imports should link more closely with national plant health regulations.

There are many examples of deliberate plant introductions as practical, biological, solutions to environmental ‘problems’. These include strategies to stabilise soil and prevent erosion. A plant now considered a problem in many countries is mesquite, (*Prosopis juliflora*) originating in south America but now widespread across Africa and Asia. This plant was considered useful as it has an extensive root system, is drought and salinity tolerant and

establishes – and spreads – quickly. In north west India seed was sown from the air to prevent deserts expanding but is now a significant problem for farmers (Bartlett *et al.* 2017). It is unlikely that this approach would now be considered; great caution and extensive risk assessment would be essential.

Bartlett, D., Gomez-Martin, E., Milliken, S. and Parmar, D. 2017. Using landscape character assessment and the ecosystem approach to evaluate the role of the invasive plant *Prosopis juliflora* in rural livelihoods of Kachchh, Gujarat, India. *Landscape Urban Plan.* 167, 257–266. <http://dx.doi.org/10.1016/j.landurbplan.2017.06.013>

Edwards, C. 2006. Managing and controlling invasive rhododendron. Forestry Commission Practice Guide [https://www.forestry.gov.uk/pdf/fcpg017.pdf/\\$file/fcpg017.pdf](https://www.forestry.gov.uk/pdf/fcpg017.pdf/$file/fcpg017.pdf) (accessed 10 September 2019)

Hulme, P.E., Brundu, G., Carboni, M., Dehnen-Schmutz, K., Dullinger, S., Early, R., Essl, F., González-Moreno, P., Groom, Q.J., Kueffer, C., Kühn, I., Maurel, N., Novoa, A., Pergl, J., Pyšek, P., Seebens, H., Tanner, R., Touza, J.M., van Kleunen, M., and Verbrugge, L.N.H. 2018. Integrating invasive species policies across ornamental horticulture supply chains to prevent plant invasions. *J. Appl. Ecology* 55, 92–98. <https://doi.org/10.1111/1365-2664.12953>

#### **Box 4 Pests and diseases of trees in the UK**

In the UK trees represent a particularly interesting group of both commercial and recreational/aesthetic value. These are increasingly considered at risk from invasive pests and diseases (POST, 2011), particularly in the South East of England where proximity to continental Europe facilitates spread of air-borne organisms.

Sweet chestnut (*Castanea sativa*), native to southern Europe and Turkey and the Caucasus, and considered to have been introduced to more northern parts of Europe 2000 years ago is now suffering from oriental chestnut gall wasp (*Dryocosmus kuriphilus*) (Forestry Commission 2017a) and at risk from chestnut blight which is widespread in continental Europe (Forestry Commission 2017b). This tree is of significant commercial value in south east England so efforts to identify routes of entry and to control these pests was treated as a priority. In both cases rapid response strategies were implemented, setting up quarantine zones with movement restrictions and destroying affected trees, but the route of entry had not been ascertained limiting legislative control options. However, the gall wasp, first reported in

2015, spread so rapidly that, after initial sanitary felling at the first site intended to destroy the organism, no further official action has taken apart from monitoring.

The non-native fungus *Chalara fraxinea* causing ash dieback disease on the native ash (*Fraxinus excelsior*) is of concern for both commercial, biodiversity and aesthetic reasons (Mitchell *et al.* 2014). The disease was first confirmed in February 2012 and spread rapidly with concern about the effect on associated animal and plant species, the landscape (5% of Britain's woodland comprises ash trees) and on public safety as dead trees became brittle and fell. It quickly became clear that containment was not an option although attempts were made to reduce spread by disinfecting footwear and vehicle tyres. The risk had been highlighted back in 2009 when the Horticultural Trades Association had requested a ban on importing ash but this was not implemented until late October 2012, by which time the disease had become established (<https://www.gov.uk/government/news/government-bans-imports-of-ash-trees>).

Horse chestnut (*Aesculus hippocastanum*) is affected with horse chestnut leaf miner (*Cameraria ohridella*) which causes the leaves to go brown and to fall early (Forestry Commission 2017c). First noticed in 2002 this is now widespread and many of these non-native trees, widely planted as street trees or ornamental/park land specimens, are rendered unsightly. No long-term effect on the health of the trees has been established.

Forestry Commission. 2017a. Oriental chestnut gall wasp (*Dryocosmus kuriphilus*). <https://www.forestry.gov.uk/gallwasphttps://www.forestryresearch.gov.uk/tools-and-resources/pest-and-disease-resources/oriental-chestnut-gall-wasp-dryocosmus-kuriphilus/> (accessed 1 August 2019.)

Forestry Commission. 2017b. Sweet chestnut blight (*Cryphonectria parasitica*). <https://www.forestry.gov.uk/chestnutblight> (as updated 19 December 2017).

Forestry Commission. 2017c. Horse chestnut leaf miner *Cameraria ohridella*. <https://www.forestry.gov.uk/horsechestnutleafminer> (as updated 19 December 2017).

Mitchell, R.J., Bellamy, P.E., Beaton, J. and Woodward, S. 2014. Ash dieback in the UK: A review of the ecological and conservation implications and potential management options. *Biol. Conserv.* 175, 95–109. <https://doi.org/10.1016/j.biocon.2014.04.019>

### **Box 5. Freshwater environments**

Invasive alien aquatic plants (IAAPs) can have very serious impacts not only competing with natives but also causing blockages in water flow and interfering with drainage systems, resulting in localised flooding and restricting navigation, necessitating costly interventions.

The aquarium trade has been established as the route for the introduction of non-native and invasive fish species into both America and Europe (Maceda-Veiga *et al.* 2013) and this, combined with the rising interest in water gardens, is also the route for the spread of invasive plants into freshwater ecosystems (Maki and Galatowitsch 2004). While sale of some water plants is prohibited there are problems with misidentifications and, as most of the ‘problem’ species are very efficient at propagation from tiny fragments, these can be inadvertently included with legitimately traded water plants or spread in mud adhering to the feet of birds.

Maki and Galatowitsch (2004) established that hydrilla (*Hydrilla verticillata*) was introduced to California through a single contaminated shipment of waterlilies and found a high diversity of unintentionally included organisms in their study of aquatic plant orders in Minnesota, USA. They concluded that this pathway of plant movement required greater consideration in the development of regulations and policies to prevent the spread of invasives.

Flowing water provides a highly effective distribution mechanism for freshwater aquatic organisms and this, combined with transportation by hitching a ride on visiting animals, makes this group particularly difficult to control. Initiatives such as ‘Check. Clean. Dry.’ in New Zealand raises awareness about the potential impact of both local and international tourism activities, such as fishing and kayaking, to encourage participants to take personal responsibility to prevent spread of plants that, if established, could negatively impact on their enjoyment (Anderson *et al.* 2015; NNSS, 2019).

Hussner *et al.* (2017) carried out an extensive review of the literature and best practices from Europe, the USA and New Zealand resulting in guidelines for improving the management of IAAPs. While preventing the introduction of IAAPs is the most cost-effective management

option early detection and rapid response is essential if they are to be eradicated before they become established. However, if these steps fail, then weed control management becomes the only feasible option with the management goal of containment, reduction or nuisance control and eradication, depending on the situation and resource available. The methods reviewed include biological, chemical and mechanical control, sometimes in combination.

Anderson, L.G., Roccliffe, S., Haddaway, N.R. and Dunn, A.M. 2015. The role of tourism and recreation in the spread of non-native species: A systematic review and meta-Analysis. PLOS ONE 10 (10), e0140833. <https://doi.org/10.1371/journal.pone.0140833>

Hussner, A., Stiers I., Verhofstadd, J.J.M., Bakker, E.S, Grutters, B.M.C, Haurye, J. van Valkenburgf, J.L.C.H, Brundug, G., Newmanh, J., Claytoni, J.S., Andersonj, L.W.J. and Hofstrai, D. 2017. Management and control methods of invasive alien freshwater aquatic plants: A review. *Aquat. Bot.* 136, 112–137.

[http://hpkx.cnjournals.com/config/hpkx/news\\_category/2017-05-02/1-s2.0-S0304377016300924-main.pdf](http://hpkx.cnjournals.com/config/hpkx/news_category/2017-05-02/1-s2.0-S0304377016300924-main.pdf) (accessed 1 August 2019)

Maceda-Veiga A., Escribano-Alacid J., de Sostoa A., and García-Berthou, E. 2013. The aquarium trade as a potential source of fish introductions in southwestern Europe. *Biol. Invasions* 15, 2707–2716. <https://doi.org/10.1007/s10530-013-0485-0>

Maki, K. and Galatowitsch, S. 2004. Movement of invasive aquatic plants into Minnesota (USA) through horticultural trade. *Biol. Conserv.* 118, 389–396.

NNSS. 2019. Help stop the spread of invasive plants and animals in our waters! GB Non-native species secretariat. <http://www.nonnativespecies.org/checkcleandry/>

### Supplementary material. Legislation

Black and Bartlett: Biosecurity frameworks for cross-border movement of invasive alien species

## EU legislation

Identifier	Descriptor	OJ	Link to EURlex
Council Directive 2000/29/EC	on protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community	L 169 10.7.2000	<a href="http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32000L0029">http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A32000L0029</a>
Regulation (EU) 1143/2014	on the prevention and management of the introduction and spread of invasive alien species	L 137/35 4.11.2014	<a href="http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014R1143">http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014R1143</a>
Regulation (EU) 2016/2031	on protective measures against pests of plants	L 317/4 23/11.2016	<a href="http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32016R2031">http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32016R2031</a>
Commission Implementing Regulation (EU) 2016/873	amending Regulation (EC) No 690/2008 recognising protected zones exposed to particular plant health risks in the Community	L 145/10 2.6.2016	<a href="https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32016R0873">https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32016R0873</a>

## Acts of the UK Parliament

Title	Year, Chapter	Official source
Plant Health Act	1967, c.8	<a href="http://www.legislation.gov.uk/ukpga/1967/8/contents">http://www.legislation.gov.uk/ukpga/1967/8/contents</a>
Plant Health (Northern Ireland) Act	1967, c. 28	<a href="http://www.legislation.gov.uk/apni/1967/28/contents">http://www.legislation.gov.uk/apni/1967/28/contents</a>
European Communities Act	1972, c. 68	<a href="http://www.legislation.gov.uk/ukpga/1972/68/contents">http://www.legislation.gov.uk/ukpga/1972/68/contents</a>
Wildlife and Countryside Act	1981, c. 69	<a href="http://www.legislation.gov.uk/ukpga/1981/69/contents">http://www.legislation.gov.uk/ukpga/1981/69/contents</a>

## Legislation of the Eurasian Economic Union

Title	Date published or notified to WTO	Source
"Decision of the Customs Union No. 318 on Assurance of Customs Union"	18 June 2010	<a href="https://www.wto.org/english/df">https://www.wto.org/english/df</a>
"The Common Rules and Standards to Ensure Plant Quarantine on the customs territory of the Eurasian Economic Union"	30 November 2016	<a href="https://gain.fas.usda.gov/Rec/Rec%20on%20EAEU%20Com%20an%20Federation_4-13-2017.pdf">https://gain.fas.usda.gov/Rec/Rec%20on%20EAEU%20Com%20an%20Federation_4-13-2017.pdf</a>
"The Common Quarantine Phytosanitary Requirements of the Eurasian Economic Union"	30 November 2016	<a href="https://gain.fas.usda.gov/Rec/Rec%20on%20EAEU%20Phyt%20an%20Federation_4-6-2017.pdf">https://gain.fas.usda.gov/Rec/Rec%20on%20EAEU%20Phyt%20an%20Federation_4-6-2017.pdf</a>
Draft Amendments to "The		



Common Quarantine Phytosanitary Requirements of the Eurasian Economic Union"	3 April 2017	
"The Common List of Plant Quarantine Objects of the Eurasian Economic Union"	30 November 2106	<a href="https://www.tarim.gov.tr/eri/bitki_bitkisel_urun/faal_AEK_Kararnamesi.pdf">https://www.tarim.gov.tr/eri/bitki_bitkisel_urun/faal_AEK_Kararnamesi.pdf</a>
Draft Amendments to "The Common List of Plant Quarantine Objects of the Eurasian Economic Union"	3 April 2017	

From ADB, 2018.

### Australian legislation

<b>Title</b>	<b>Act No, year</b>	<b>Official source</b>
Environmental Protection and Biological Conservation Act 1999	No. 91, 1999	<a href="https://www.legislation.gov.au/Details/C2016C00777">https://www.legislation.gov.au/Details/C2016C00777</a>