

Invasive Tree Pests and Diseases



The risk to UK trees from invasive diseases and pests is growing with the expansion of international trade and travel and transport of live trees and timber products, along with environmental changes. This POSTnote summarises the difficulties in regulating the threat of imported pests and diseases, and for managing them if they become established in the UK.

Background

Woodland covers about 12% of the UK (2.84 million ha), below the European average of 37%, with two main types of habitat:¹

- coniferous woodland, with more than 80% of the canopy being conifer species, accounts for 48% of UK woodlands. Scots pine is the only coniferous species of 66 UK native tree and shrubs.²
- woodland with more than 20% of the canopy dominated by non-coniferous tree species is classified as broadleaf, mixed and yew woodland. This accounts for the remaining 52% of UK woodland habitat.²

Diseases and pests harmful to trees are important elements in woodland ecosystems. Rotting wood is a habitat and a food source for many species and is a key component for nutrient cycling. Dying trees also open up gaps in woodland canopies, with beneficial effects for ground flora.³ However, severe tree disease or pest epidemics can occur, as with the 1960s/70s Dutch elm disease (*Ophiostoma novo-ulmi*) outbreak that killed some 30 million trees. Such epidemics can alter landscapes,⁴ and affect the provision of multiple economic, social and environmental benefits, including:

- the significant contribution to the UK economy from the forestry and wood processing sectors (POSTnote 275)

Overview

- Tree diseases and pests from outside or already spreading within, Europe, have the potential to damage or kill large numbers of trees in the UK's country and urban landscapes.
- Detecting pests or pathogens in imported trees and timber products is challenging, as is the development of effective and affordable measures to control them.
- Widespread tree loss, especially oaks, would have major effects on semi-natural woodland habitats in the UK.
- UK commercial forestry is heavily reliant on four coniferous species, some of which are already affected by diseases.
- There is low public awareness of tree health threats, although the cost of managing them, such as quarantine tree felling, falls on owners of affected land.

- potential wood biomass provision for the energy sector
- visits to gardens in Britain, generating £300 million in direct spending annually, with 12 million visitors each year to the National Trust's 220 historical gardens
- the 'urban green infrastructure' of urban trees and gardens (gardens containing about 28.7 million trees)⁵
- environmental benefits such as carbon sequestration, valued at £115 million, biodiversity, valued at £476 million and recreation valued at £484 million annually.²

Regulating Tree Health Risks

A major aim of international plant health regulation is to prevent the introduction and spread of harmful disease or pests, but actions undertaken should not be a barrier to trade. The international regulatory system for plant health consists of:

- the World Trade Organisation Agreement on the Application of Sanitary and Phytosanitary Measures (WTO/SPS Agreement)
- under this agreement the Codex Alimentarius Commission, the 1951 International Plant Protection Convention (IPPC) and the World Organization for Animal Health (OIE) set reference standards.

The EU Plant Health Regime (Box 1) regulates the trade of plants and plant products in accordance with the IPPC and

WTO international plant health standards and obligations, as set out in the EU Plant Health Directive 2000/29/EC. Import of some species is prohibited due to the level of risk. Other high risk material, which includes all plants for planting (including trees), must be accompanied by a phytosanitary certificate. However, processes in non-EU countries can be flawed.⁶ For example, a trade in live maple trees, certificated as pest free by Chinese authorities, led to outbreaks of Asian Longhorned Beetles in EU countries (Box 2). Any plant material not regulated by the directive can be imported into member states without certification.

Box 1. EU Common Plant Health Regime

The basic structure of the regime was set up in 1977 by Council Directive 77/93/EEC, which provided a framework governing import into the EU and intra-EU trade. Harmful organisms were listed in annexes to the directive. Since the 2000 codification, the basic legal framework is Council Directive 2000/29/EC. Under this, each member state is required to notify immediately the Commission and the other EU member states of the presence in its territory of any of the harmful organisms listed in the relevant annex, or other "harmful" organisms which are not listed. Member states are required to take all necessary measures to eradicate or, if that is impossible, inhibit, the spread of the harmful organisms concerned and to inform the EU Commission and the other member states of the measures taken. Member states have the right to introduce national legislation if there is a specific threat that is not controlled effectively through EU legislation. The EU Plant Health Regime is being extensively revised, with a new directive proposed for 2014/15. It is hoped that this will lead to more timely decisions, better target risks and an increase in co-ordination between national plant health inspectorates.

Plants and plant products that have been imported into, or produced within, EU countries can be moved freely between member states, unless it is plant material that can carry the most serious 'quarantine' pests and diseases. This requires a 'plant passport' for movement within and between member states. Plant passports are issued only by growers and traders registered and authorised to do so after inspection of the premises by plant health authorities.

Box 2. Asian Longhorned Beetle

The Asian Longhorned Beetle (*Anoplophora glabripennis* and *Anoplophora chinensis*) is native to eastern Asia. It infests a range of different tree and shrub species, including maple, poplar, willow and elm. The beetle larvae feed on the wood inside the plant stem for 1 to 3 years, until they reach a critical weight, after which they pupate before emerging. Larvae or pupae can thus be imported in live trees, which show no apparent symptoms of infestation. Imported wood packaging/products may also contain the larvae. Trade in live Japanese maple trees from China has been suspended since 2010 and wood packaging must be treated to eliminate infection. York University and the Food and Environment Research Agency (FERA) are developing acoustic tools to detect the sound of larvae feeding in live trees or in wood products.

Regulation in England

The Plant Health Act 1967 provides powers to prevent the introduction and spread of forestry pests and diseases. The Plant Health (Forestry) Order 2005 (SI 2005 No. 2517) is the principal instrument for implementing plant health requirements for forestry material. It and related orders allow for restrictions to control the entry of certain plants and plant materials into the UK. The act also identifies the Forestry Commissioners as the competent authority in Great Britain for the protection of "forest trees" and timber. The Forestry Commission (FC) is also the lead partner for UK Biodiversity

Action Plans (BAP) for priority woodland habitats. In 2009, the FC set up a Biosecurity Programme Board to ensure national co-ordination of the management of tree pests and diseases. It is leading on these matters on behalf of the 'devolved' FC in England, Scotland and Wales and the Forest Service Northern Ireland. The Department for Environment, Food and Rural Affairs (Defra) and FC launched a UK "Action Plan for Tree Health and Plant Biosecurity" in October 2011.⁷

Controlling Import of Tree Health Risks

The international trade in trees and timber products means that no system of regulation can be totally secure. Any system of assessing, managing and mitigating the risks arising needs to be proportionate and affordable. For example, the high volume of the plant trade means that 100% visual inspection of plant movements is not feasible. Such inspection may also be of limited effectiveness, as infection or infestation may not be apparent (latent infection), plants may not have foliage, or may have been sprayed with fungicides to suppress disease symptoms.⁶

Pest Risk Analysis

The principle of assessing tree health threats through Pest Risk Analysis (PRA) is prescribed in international standards, and such analyses provide the information on an organism to develop proportionate regulation. Once evidence emerges of a pest or pathogen likely to cause problems, it is added to the European and Mediterranean Plant Protection Organisation (EPPO) alert list. EPPO is the organisation responsible for cooperation in plant protection in the European and Mediterranean region, covering 50 countries. The EPPO maintains several lists, including the:

- quarantine list of organisms recommended for regulation that have undergone PRA. This is split into pests that are absent or present from the EPPO region.
- action list of priority pests for regulation that have undergone PRA
- alert list of pests prioritised for PRA.

The PRA can range from rapid and short assessments, using expert judgement, to more detailed and longer scientific assessment of risk. Development of the PRA requires extensive knowledge of host specificity, extent of damage and biology of the pest or pathogen. It aims to:

- determine the likelihood of introduction, establishment and spread
- assess likely environmental and economic impacts
- provide a basis for decisions on quarantine pest status and risk management options.

PRAs are undertaken by EU member states, the EPPO or the European Food and Safety Authority, the official risk assessor to the EU. Any species incorporated into, or removed from, the list of harmful organisms in the annex to the EU Plant Health Directive should have a PRA (Box 1).

Challenges for PRA

Under a list-based system (rather than total prohibition), only known threats are listed for regulation. However, many were completely new to science when introduced into the EU.⁶, such as Ramorum disease (Box 3). Many microbial and invertebrate species remain undescribed. For example, it has been estimated up to 90% of fungal species are probably unknown.⁸ New pathogens can also arise from hybridisation

between closely related species. For instance, alder dieback, is a hybrid pathogen that may have originated in a European horticultural nursery.⁹

Box 3. Ramorum Disease

The pathogen *Phytophthora ramorum* is thought to have spread from south east Asia via trade in horticultural plants. By 2000, it was established as a significant disease affecting North American oak species, with an epidemic taking hold in California and Oregon. *P. ramorum* was formally named as a new species in 2001 and listed as a quarantine pest by the EU in 2002. It is thought to have arrived in the UK as a single introduction to a nursery in Cornwall in 2002, probably on infected nursery stock originating within the EU. By 2009, over 500 nurseries had had outbreaks despite annual surveys of nursery stock and the destruction of all infected plants found within 2km radius of an outbreak.⁴ Defra initiated a £23 million programme in 2009 to address the threat posed to semi-natural woodland, commercial forestry, historical gardens and heathland by this pathogen and another introduced *Phytophthora* species (*P. kernoviae*). Ramorum disease poses a threat to UK BAP priority habitats, including native pinewoods, upland moorland and lowland heathland and UK BAP priority species such as blueberry and heather.

The principal agent of long distance spread is believed to be movement of infected plants. The main host species in Britain is rhododendron, which are now subject to an extensive programme of clearance, but the disease can infect at least 100 species of trees and shrubs. It spreads via fungal-like spores, the rate being determined by the number and location of spores produced. A source of spores located high in a mature tree can be dispersed longer distances. Until 2009, relatively few UK trees were seriously affected. Significant numbers of Japanese Larch trees have since died, with over 2,200 hectares in England, Wales and Northern Ireland currently being felled as a quarantine measure. All three larch species grown in the UK can be infected. These comprise almost 10% of the conifer growing area of Britain (134,000ha). Due to weather patterns of dry springs and cold wet summers in the last few years, the level of annual spread of infection was much lower than initial estimates. However, outliers of infection have recently been found in previously disease free areas of Derbyshire, Lancashire and Cumbria. Outbreaks on larch have also occurred in Northern Ireland and Scotland.

At present, import trade pathways can develop with little scrutiny and it is only after problems become manifest that control measures are instigated. Certain parts of the world, notably East Asia, are a disproportionate source of emerging risks. The EU-funded PRATIQUE project addressed many of the challenges for PRA, including the identification of emerging threats. Non-native European trees in botanic gardens and natural habitats are being monitored in East Asia to see which pests and pathogens affect them. The tests have found over 30 pests and pathogens threatening these trees that had not been previously been identified. The review of the EU Plant Health Regime is considering whether new trade pathways in plant material, particularly live plants, should undergo a risk assessment before importation is permitted. Any problems identified through the risk assessment would trigger a PRA, leading to tighter controls on importers. However, any such system cannot infringe WTO rules and it is not clear who would pay for the risk assessments.

A British Standard Code of Practice for Trees from Nursery to Independence in the Landscape (BS 8545), is being discussed by the Horticultural Trades Association, the National Association of Tree Officers and the Royal Botanic Gardens, Kew.¹⁰ It may involve imported trees being put into a holding facility for inspection before they can be traded. The conditions in the facility and how long the trees are

detained will be critical for effective detection of pests and pathogens.

Managing Tree Health Risks

Observations of the biology of invasive organisms suggest that only about 10% of those introduced become established.¹¹ Of these, only a few of will become highly damaging pests and pathogens, but the factors associated with this are not always well understood. The range of some pests and pathogens may also be extended across the UK if climate change results in warmer winters.¹² Once established, effective management of such tree diseases and pests can be problematic and expensive. For example, the capability of the Dutch elm disease fungus to infect and kill elm trees, combined with its widespread dispersal by the elm bark beetle, rendered belated control actions ineffective. The unpredictable characteristics of Ramorum disease (Box 3), including its ability to infect new host species, indicates similar challenges.⁴ Defra and the Research Councils are currently discussing funding priorities for research in response to concerns about maintaining adequate capability to address the increasing level of risk.

Concerns for Commercial Forestry

Although increasingly broadleaf species such as oak, beech, ash and cherry are grown commercially, forestry in the UK remains largely reliant on four coniferous species (Sitka spruce, Douglas fir, Scots pine and larch). The first covers over 60% of the UK conifer growing area and although it is not significantly affected at present by pests or diseases, there are concerns about the future impacts of the green spruce aphid. Ramorum disease is already affecting larch (Box 3), while pine species are being infected by red band needle blight, a fungal disease (Box 4). Corsican pine is particularly affected. It had been identified as one of the future options for commercial forestry to cope with expected changes in climate over the next few decades.¹³ Pine species in the UK may also be affected by pinewood nematode (the cause of pine wilt syndrome, Box 5), if it spreads from other European countries.

Box 4. Red Band Needle Blight

The disease of pines known as Dothistroma Needle Blight (DNB), or Red Band Needle Blight, is caused by the fungus *Dothistroma septosporum*. Initial symptoms include red banding on needles, which are then shed prematurely. Extensive year-on-year defoliation weakens trees, resulting in low or no growth rates and, in some cases, death. The pathogen can infect a wide range of pine species, but the susceptibility of the host appears to depend on a range of factors including where a pine species originated, as well as site and climatic conditions. Severe episodes of the disease appear to be correlated with wet springs and higher than average rainfall at the time of infection. Pine comprises almost 30% of the conifer growing area of Britain (409,000 ha). Since 2000, infection rates have increased to the extent that Corsican pine is no longer commercially viable in the UK.

Concerns for Nature Conservation

Major changes in woodland composition due to species loss in woodlands designated under conservation legislation, such as the Habitats Directive, could lead to issues for the conservation agencies.³ For example, oak, which is being affected by acute oak decline (Box 6), is the dominant species in some types of woodland and there are relatively few native species to take its place.

Box 5. Pine Wilt Syndrome

The pinewood nematode (*Bursaphelenchus xylophilus*) is largely unable to travel outside of the wood by itself; in order to reach another host tree (living or dead) it must be carried by an insect vector. These include wood boring beetles widely referred to as "pine sawyers" (such as *Monochamus galloprovincialis*). The nematode is now present in the EU (Portugal), infecting commercially grown Maritime pines. There are no means of treating nematode infestation, so pine wilt syndrome is managed through measures to limit its spread. However, the establishment of large quarantine zones, precautionary felling and the heat treatment of susceptible wood products in response to EU Action Plan requirements has failed to control its spread thus far.

This iconic tree has a wide variety of species associated with it and is prevalent as a "veteran" tree (of value culturally, in the landscape or for wildlife, due to age, size or condition). Focussing resources to protect commercial forestry from disease threats could affect forest management for other environmental benefits, such as biodiversity. Loss of commercial forestry plantations may increase pressure to maintain plantations growing on unsuitable habitats, such as lowland heathland, as Environmental Impact Assessment (EIA) regulations do not apply to replanting existing sites.

Box 6. Acute Oak Decline

Oak covers 23% of the total broadleaf area in Britain (223,000 ha). Over the past 3-4 years, there have been increasing reports of a disorder known as Acute Oak Decline affecting both UK native species of oak (pedunculate oak and sessile oak), usually mature trees in excess of 50 years old. Typical symptoms include extensive stem bleeding where fluid exudes from bark cracks and stains the tree trunk. Trees with advanced levels of bleeding also have crown symptoms (dieback and yellow, thinning foliage). The cause of the bleeds appears to be several species of pathogenic bacteria, but some of the trees affected are also infested with the wood-boring larvae of the buprestid beetle. Many trees die within four to five years of the onset of symptoms. AOD is most prevalent in the midlands and south east of England, with over 150 sites recorded and an average 25% of trees at each site showing symptoms. The impact and spread of the disease has been well characterised at a limited number of sites, but the wider disease epidemiology is not well understood.

Measures to Control Pests and Diseases

Implementing biosecurity control measures for tree diseases and pests is complex, requiring plant health authorities to work closely with private sector bodies. The range of those that can be affected - gardeners, the horticultural trade, foresters, local authorities and nature conservation bodies, etc - poses significant challenges to plant health authorities. Statutory powers are available to allow access to property and enforce control measures where necessary. However, unlike livestock disease outbreaks, the cost of dealing with tree disease outbreaks falls on owners, who must pay for measures, such as felling trees and destroying material that could spread the disease. Felling that may disturb wildlife protected under the Wildlife and Countryside Act, such as birds during the breeding season, requires an EIA.

Public Awareness

At present, there is low public awareness of the role of humans in the dispersal of tree pests and diseases, despite initiatives to encourage reporting.¹⁴ Bodies such as the National Trust now undertake basic biosecurity measures, such as regular cleaning of boots, tools and vehicles between sites. Raising awareness by landowners may ensure that disease outbreaks are reported promptly,

reducing the risk of disease transfer between sites.

Implementation of biosecurity measures would need to be developed and promoted in conjunction with a range of different stakeholders, including the horticultural trade, to promote trust among affected parties and ensure wider information exchange.¹⁵ A high percentage of UK woodlands have public access, creating difficulties in enforcing biosecurity measures. Any such measures would need to take account of burdens placed on woodland owners.

Biological Controls

Some pests and diseases have been successfully controlled through the use of organisms that are their predators, parasites, or are pathogens (Box 7). Such controls often require lengthy and expensive development. All relevant organisms need to be screened to identify biocontrol agents. Specialised facilities are then needed for rearing, with a lengthy approval process prior to release. For example, it took decades to develop the biocontrol agent (*Phlebiopsis gigantea*) to inhibit infection of conifers by the airborne spores of the root and butt-rotting basidiomycete fungus (*Heterobasidion annosum*). This is effective only in newly planted sites as the pathogen persists in woody debris in the soil, infecting young trees when the roots make contact.

Long-term Resilience to Tree Health Threats

New non-native pests and diseases of pine, oak, alder, horse chestnut, ash and larch now in Europe, along with climate change, mean that the species composition in woodlands will inevitably change. Improving the ecological condition of woodland habitats through expanding and linking existing woodlands is seen as critical for biodiversity to adapt to climate change,⁵ but strategies are also needed to increase resilience to plant health threats, such as increasing the genetic and species diversity of woodland. A mixture of tree species at a site, as well as genetic diversity within species, may increase the chance of a woodland habitat of some type surviving a pest or disease threat at that site. Commercial forestry may need to be supported through major investment in long term programmes, such as the breeding of disease-resistant trees. The potential for new commercial species, such as Eucalyptus, could also be explored, as could use of GM technologies (POSTnote 386), although the risks to other benefits for which woodland is managed, such as biodiversity, would need to be assessed.¹⁶

Endnotes

- 1 Jackson, D, 2000, *Guidance on the Interpretation of the Biodiversity Broad Habitat Classification (Terrestrial and Freshwater Types): definitions and the relationship with other classifications*, JNCC Report 307
- 2 Quine, C, *et al*, Chapter 8: *Woodlands*, UK National Ecosystem Assessment
- 3 Kirby, K, *et al*, 2010, *Quarterly Journal of Forestry*, 104, 77-84
- 4 Potter, C, *et al*, 2011, *Phil. Trans. R. Soc. B*, 366, 1966-1974
- 5 Defra, 2011, *The Natural Choice: securing the value of nature*. CM8082
- 6 Brasier, C, 2008, *Plant. Pathol.*, 57, 792-808
- 7 <http://www.defra.gov.uk/food-farm/crops/tree-health/>
- 8 Hawksworth, D, 2001, *Mycol. Res.*, 105, 1422-1432
- 9 Brasier, C, 2000, *Nature* 405, 134-135.
- 10 BS 8545 <http://standardsdevelopment.bsigroup.com/Home/Project/201001092>
- 11 Jeschke, J, and Strayer, D., 2005, *PNAS* 102(20):7198-202
- 12 Broadmeadow, *et al*, 2009, An assessment of the likely future impacts of climate change on UK forests, in: *Combating Climate Change – a role for UK forests*, Read, D, *et al*, eds p67-98. TSO
- 13 <http://www.forestry.gov.uk/forestry/INFD-7L6E57>
- 14 <http://sylva.org.uk/treewatch/>
- 15 Mills, P, *et al*, 2011, *Phil. Trans. R. Soc. B*, 366, 2035-2044
- 16 LTS International, 2006, *A Review of Potential Impacts of Short Rotation Forestry*.