BIO-SECURITY

Managing the pests and pathogens

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Bio-securing our woodland

Austin Brady, Head of Conservation at the Woodland Trust discusses the impacts of disease and pests on our woodlands, and how we can mitigate the risks...

It's now just over 1 year on from the day that the devastating disease ash dieback was confirmed within the 'wider environment' in the UK for the first time. Up until the discovery last October at sites in Suffolk, including the Woodland Trust's Pound Farm Woodland, it had only been found on recently planted trees. Interest and concern surrounding tree pests and diseases had been growing steadily for some time as their incidence within the UK in recent years has increased. The outbreak of ash dieback fungus, *Chalara fraxinea*, however has triggered a major step change. Tree health issues have regularly made national news over the past 12 months and the UK's Department for the Environment, Food and Rural Affairs (Defra) now classes this as one of its top 4 priorities.

The growing concern and resulting action around tree pests and diseases has also been a top priority for the Woodland Trust itself. As a major landowning conservation charity managing more than 1,100 woods covering 190 square kilometres, the threat posed by a plethora of tree pests and diseases is already having a direct impact. Nearly 350 of our sites contain ancient woodland of which 70% is semi-natural ancient woodland – land which has been under tree cover since at least 1600. It is the Woodland Trust's mission to protect and create more native woodland within the UK whilst restoring areas of ancient woodland damaged through either a lack of, or inappropriate management. Pests like the Asian Longhorn Beetle (*Anoplophora glabripennis*) and Emerald Ash Borer (*Agrilus planipennis*) together with devastating pathogens such as Plane Canker (*Ceratocystis platani*) and ash dieback therefore pose a huge threat to the Woodland Trust's own estate and its wider work with government, community groups and other landowners.

Upon the discovery of another pest or disease threatening our trees the first question is often what can we do?

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Ash dieback symptoms

Unfortunately the UK and wider European experience usually shows us that eradication is nearly always impossible. Containment or disease 'management' is often the best case scenario. Can we stop these pathogens arriving in our forests? is often the next question. The UK as an island nation finds itself in a more advantageous position than most in Europe here, but again this is virtually impossible when we consider the huge volumes of live plants and associated soil, timber, biofuel and packing material

being imported daily. In a globalised world where no one can afford, even if it were possible, to 'batten down the hatches' and close the border we need to recognise and accept the inherent risks of this trade and develop the most appropriate means of managing this risk. The European Union obviously has a large role to play here in regulating trade and setting industry standards. Its plant health regime is currently being reviewed and the proposals look very positive with an increased focus on surveillance, more stringent movement controls, greater prioritisation and a concerted effort to improve the collaboration and communication between official service, the private sector and the general public. However, the implementation of these new regulations is unlikely to happen before 2018 at the earliest. We must act now if our irreplaceable ancient woodland and relatively limited range of UK native species are to survive.

The Woodland Trust recognised the immediacy of these threats last year and swiftly implemented a three-point plan. The charity has always specified UK provenance seed for its woodland creation projects, but as of 2014 all trees will also be guaranteed to have been grown only in the UK. This immediately reduces the risk of introducing a pest or disease into the woodland as live imports of plants are one of the major 'risk pathways' identified by all government and stakeholder advisory groups charged with improving tree health.

An expert seminar on Tree Disease and Resilient Landscapes was hosted by the Woodland Trust and Defra in June this year. The seminar brought together 40 scientists, researchers, forest pathologists, woodland managers, professional bodies, government agencies and nature conservation NGOs to share experience and learning as well as to identify key gaps in knowledge and practice in relation to *Chalara fraxinea* and other threats. A summary of the seminar will shortly be published on the Woodland Trust website. As well as calls for better biosecurity at our borders and much better surveillance, detection and monitoring of pests and diseases that are current or anticipated threats, there was also much talk of improving our woodland's 'resilience'. Recognising the fact that we can never hope to keep out all threats and that some may arrive by natural processes the need to build resilience in our ancient and native woods is seen as the best way of safeguarding their conservation value in the long term. This will require different steps by many different parties but increasing the diversity of woodland structure, using a wider range of species and creating more genetic diversity within our woodlands will be key.

© Forestry Commission

Ash dieback close-up

The final point of the plan is a four-year partnership project involving the government Forest Research Agency, the Food and Environment Research Agency and a fellow charity, the National Trust. ObservaTREE is a LIFE+ funded project that will develop an early warning system for tree pests and diseases by engaging citizen scientists with leading tree health organisations to help detect and verify pests and diseases in order to avoid their spread and minimise woodland loss. Through the use of expert volunteers, trained by the Woodland Trust, the project will assist scientists with the investigation and filtering of tree health incidents reported by the public. This will enable tree health scientists to focus on the reports of greatest significance. The processes and experiences gained through this project will be shared with counterparts across Europe in an effort to ensure best practice is shared and the necessary international approach to tackling tree pests and disease is supported. This pan-European approach, shared with other initiatives such as FRAXBACK, will be essential if we are to learn from each other in order to ensure our forests can survive the current and future pest and disease threats.

Austin Brady
Head of Conservation
Woodland Trust
Tel: +44 (0)1476 581111
www.woodlandtrust.org.uk

The aliens killing our trees

In the last 30 years, there has been an unprecedented increase in pest and pathogen invasions into Europe, impacting on agriculture, horticulture and forestry. Numerous tree pests and diseases are spreading through the continent, with damaging organisms introduced from elsewhere in the world. Most of these species have been brought here through trade routes on plants and plant products, i.e. through human activities.

Once established, alien invasive pests and diseases of trees and plants lead to economic and ecological losses in the ecosystems affected, resulting in decreased yields and reduced timber quality, negative impacts on biodiversity at the species and ecosystem levels, and further effects on other benefits forests provide, including water catchment and soil protection, non-timber forest products, recreation and landscape values.

So precisely why have these problems increased so dramatically in recent years? Here I give examples of destructive alien invasive pests and pathogens of trees, expand on the reasons why they are becoming so problematic and suggest some methods that may help in mitigating their impacts. There is no simple 'fix': everyone must be involved, from EU and state governments through to the general public. Although, as will become clear, trade, particularly at an intercontinental scale, may be immediately responsible for the upsurge in alien invasions, in reality, everyone bears some responsibility for what is happening through demand for imports of plants and plant products.

Phytophthora cinnamomi rapidly kills trees of all ages

The first alien invasions

Dutch elm disease that began in the southern UK in the late 1960s and spread throughout Europe is often used as the classic example of an invading pathogen, the baseline from which to judge others. As important timber and landscape trees in Europe, the loss of elms had a highly significant impact. It quickly became clear, however, that once *Ophiostoma novo-ulmi*, the pathogen causing the epidemic had established, elms were a lost cause. As the pathogen is vectored on a local scale by elm bark beetles, which require declining trees for egg laying, the disease also led to a massive but temporary increase in the beetle population, which amplified the disease impact.

Dutch elm disease however, was not the first alien invasive problem affecting trees in Europe. Several *Phytophthora* species may have been introduced into Europe over 150-200 years ago. In the mid-19th Century, large plantations of North American 5-needle pines, particularly *Pinus strobus* died when white pine blister rust arrived in Central and Western Europe, on imports of infected European 5-needle pines from south-eastern Europe. This disease was then exported to North America on asymptomatic *P. strobus* seedlings, probably in the 1890s, resulting in massive epidemics in the 5-needle pines of North America.

The most commonly seen mildew of oak arrived in Europe from North America in the late 19th or early 20th Century, with major impacts on the health of oak species throughout the continent. Fireblight, caused by *Erwinia amylovora*, was first detected in Europe in southern England in the early 1950s, probably arrived on contaminated fruit or infected propagation materials from the east of North America. The disease affects woody rosaceous shrubs and trees, including apples and pears, but also cherry, including species in the forests. The Italian peninsula has suffered considerably as the first country in Europe where certain alien invasive pest and pathogen problems were found, notably sweet chestnut canker (causal agent: *Cryphonectria parasitica*), canker of *Cupressus spp*. (*Seiridium cardinale*) and wilt of *Platanus spp*. (causal agent: *Ceratocystis platani*).

The *Phytophthora* challenge

Many other examples of destructive invasive insect pests and micro-organisms exist, mostly from more recent introductions in Europe. One of the worst groups of pathogens for causing problems in plant populations is *Phytophthora*. In fact, it was one of the first such damaging agents recognized, as in the mid-1840s, one species, *Phytophthora infestans*, was responsible for the potato famine in the western regions of Europe at that time.

Phytophthora is now the most commonly intercepted genus of pathogens on the lists published by the European and Mediterranean Plant Protection Organisation, as many species spread internationally. In recent years, nearly 70% of 'fungal' interceptions were of *Phytophthora ramorum*, a species noted for the highly destructive diseases it causes on many tree species, particularly sudden oak death in California and Oregon and sudden death of Japanese larch in the UK and Ireland. The spread of *P. ramorum* in European trade, and invasion of landscape plantings and forests, is a major threat to ecosystems dominated by oak and rhododendron family plants, particularly in the humid oceanic climate of western Europe.

Phytophthora cinnamomi is one of the most destructive pathogens known, with a host range of over 950 plant species, and is arguably the most widespread invasive organism in the world. Several severe forest diebacks caused by *P. cinnamomi* are well-known, including Eucalyptus dieback in Western Australian and Victoria, Australia, ink disease of sweet chestnut in Europe, often in association with *P. cambivora*, and in the 'Dehesa', the evergreen oak forests of Spain and Portugal, where holm and cork oaks are killed. *P. cinnamomi* is probably the most frequent cause of death of hardy ornamental woody plants in horticulture too, a trade in which it has spread widely in Europe.

Tan oak killed by *Phytophthora ramorum*

The list of *Phytophthora* species causing problems in our forests through inadvertent transport in trade is long, but by no means exhaustive as yet. It is notable, however, that many of the highly destructive species in this genus were unknown to science prior to establishment in an exotic location, and the beginning of severe damage on attacked hosts.

Ceratocystis

There are many other important alien invasive pathogen threats. *Ceratocystis* includes many species, some of which are already present in Europe. Tree hosts recorded include Cocoa, Ficus, mango, coffee, and forestry species such as poplar, oak, plane, cherry and Eucalyptus, plus spruce, pine and larch. One notable species is *Ceratocystis platani*, which kills plane trees, both the hybrid plane

commonly planted in cities of Western Europe, and the eastern Mediterranean native oriental plane. Since the pathogen arrived from North America in Italy, probably in the mid-1930s, it has spread north and westwards. In France it was decided recently to fell all plane planted along the Canal du Midi, at an estimated cost of €200m. The pathogen spread into the native range of oriental plane in Greece in the late 1990s, where it is proving very virulent, killing all trees it infects.

European Pine threats

The most significant forest tree disease we are witnessing in Europe (and elsewhere in the world) currently is *Dothistroma* needle blight of pines. The massive problems in Europe over the last 15-20 years have possibly increased due to climate change. The various sub-species of black pine are badly affected, but recently, defoliation of Scots pine occurred in many northern European countries. Lodgepole pine (*Pinus contorta var. latifolia*), native to the Pacific Northwest and planted extensively in the northern region of the UK and in western Sweden, has been killed. Recently, massive damage to Turkish pine over an area of 5,000 hectares has been noted in Turkey.

Further major threats to the future of European pines in Europe include pitch canker, established in northern Spain, pine wood nematode now spreading from Portugal, and pine processionary moth, migrating northwards from its native range in the Mediterranean. Phytosanitary measures are helping to slow the advance of the pine wood nematode, but at great financial cost.

Ash dieback

Ash dieback of course, has received a lot of media attention in the last 5 years. In its native range in far eastern Asia, the causal organism lives benignly in the foliage of Asian ash species. Probably imported into Poland on ash plants in the late 1980s, it is pathogenic on two European ash species, the common ash and the narrow-leaved ash. The pathogen grows from the foliage into the shoots and main branches, killing the tissues and leading to severe dieback and death of infected trees. It would have been extremely difficult to predict this behaviour in the fungus, even if we had known long ago of its existence in Asia. The optimism that some European ash may be tolerant of

Ash dieback is killing ash trees throughout Northern Europe

H. pseudoalbidus, the pathogen, is somewhat misplaced however, as the emerald ash borer, a bark beetle also native to the far east of Asia, has spread into Europe causing huge damage to ash trees in Moscow. The insect has spread up to 450 km west of Moscow, and will soon invade the Ukraine. The range of common ash stretches from the Ural Mountains in the east, to the Atlantic coast of Northwestern Spain: there are no significant breaks in the ash population in that range: nothing stands in the way of the emerald ash borer spreading throughout the range of ash in Europe.

Invasive insects

Further invasive insect problems impacting on European forest ecosystems include the Asian long-horned beetles, *Anoplophora glabripennis* and *A. chinensis*, both of which

have been imported from Asia as larvae in wood packaging material, or on bonsai trees and nursery stock. *A. glabripennis* was apparently eradicated in south-east England in 2012, by destroying approximately 1200 trees around a compound where shipments of slate on wooden pallets from China were stored. One population of *A. chinensis* near Venice is now out of control, with thousands of trees and shrubs killed over 100 km². The chestnut gall wasp, *Dryocosmus kuriphilus*, a Chinese species damaging chestnut in Japan and, after introduction, North America was found in Italy in the 2000s and has spread rapidly to neighbouring countries, despite strict quarantine measures. A number of Siberian pest species, such as the Siberian moth and the larch gall midge, have crossed the Ural mountains aided by climate change, and will expand westwards where suitable host trees are present, climatic conditions are favourable and quarantine barriers limited within the EU.

Managing the pathways

Numerous routes (pathways) are known through which alien invasive organisms move from their native ranges to other parts of the world. The most damaging now is the 'plants for planting pathway', in which live plants are transported from a producing country to another country or continent. Many plants are in pots, complete with compost or soil, which includes billions of micro-organisms most of which are completely unknown to science; volumes of soil or compost can vary from a few hundreds of millilitres to thousands of litres, depending on the size of the plant.

Rather recently, a different pathway was substantially closed, with the introduction of International Standard for Phytosanitary Measures 15 (ISPM15) Regulation of Wood Packing Material in International Trade. A single treatment of wood, involving Pasteurization (heating to ~ 56ºC for 30 min in the core of the wood) kills all insect larvae and most micro-organisms in the wood. It is more difficult to apply a 'single intervention treats all' procedure to plants for planting pathway, where the desired export/import is living. Last year, ISPM 36 was published which proposes a series of processes to deal with this pathway. Time will tell if the procedures are workable in the trade and successful in reality.

If the billions of plants currently conveyed between continents is to continue, it is clear that much greater care must be taken to prevent invasions by damaging pests and pathogens. Producing nurseries must take steps to prevent the introduction of potentially problematic organisms into stock prior to export. Composts or soils must be clean, at least sterile in the horticultural sense. Foliage and shoots must be free of insect pests or pathogens. When entering the importing country, border security needs additional tools to help inspect the vast numbers of plants. Currently available molecular detection techniques are extremely sensitive and, when suitably targeted, can find many problems. Further help will come from adapting current chemical detection methods used in defence and anti-drugs trafficking which are incredibly sensitive to miniscule concentrations of certain chemicals, and could be adjusted to detect those produced by pests and pathogens.

Traceability is a key issue too: we need to be able to track where a problematic plant came from, not just within Europe, but to the producing nursery, even if in the wilds of China or Patagonia. Forest owners, workers and the public in general can be better informed, with educational programmes, and projects such as the Opal Initiative, in which they are trained to look for signs of problems on plants.

If we do not take these measures, we risk losing our forests, at least as we recognize them now. What price the environment?

Professor Steve Woodward is in the Institute of Biological and Environmental Sciences at the University of Aberdeen. He is coordinator of the EU-funded ISEFOR (KBBE 2009-3-245268) project focused on alien invasive pathogens of trees, and is a Trustee of the Scottish Forestry Trust.

For further information:

s.woodward@abdn.ac.uk
www.abdn.ac.uk/biologicalsci/staff/details/s.woodward
www.isefor.com

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