

Centre for Forestry and Climate Change

We investigate and provide guidance on the complex interaction between climate change and forests, particularly the growing effects of climate change on pest and pathogen behaviour. Our work provides scientific evidence to inform policies on the role of woods and forests in mitigating the effects of increased greenhouse gases. We offer information for those working with trees and woodlands to adapt their management practices sustainably. Our research also helps in the development of green infrastructure in towns and cities. Here are four examples of current projects.

Changing behaviour of *Phytophthora ramorum*

Before 2009, the recently introduced 'sudden oak death' pathogen, *Phytophthora ramorum*, had infected fewer than a hundred trees in Britain, most of which were beech (*Fagus*), southern beech (*Nothofagus*) and non-native oak (*Quercus*). However, in August 2009, we found that stands of mature Japanese larch (*Larix kaempferi*) in south-west England that had developed extensive dieback were infected with *P. ramorum* (see photo above). The affected trees were ~30–100 km east of previous tree-infected sites and symptoms included extensive resin bleeding on trunks and branches, causing dieback and death.



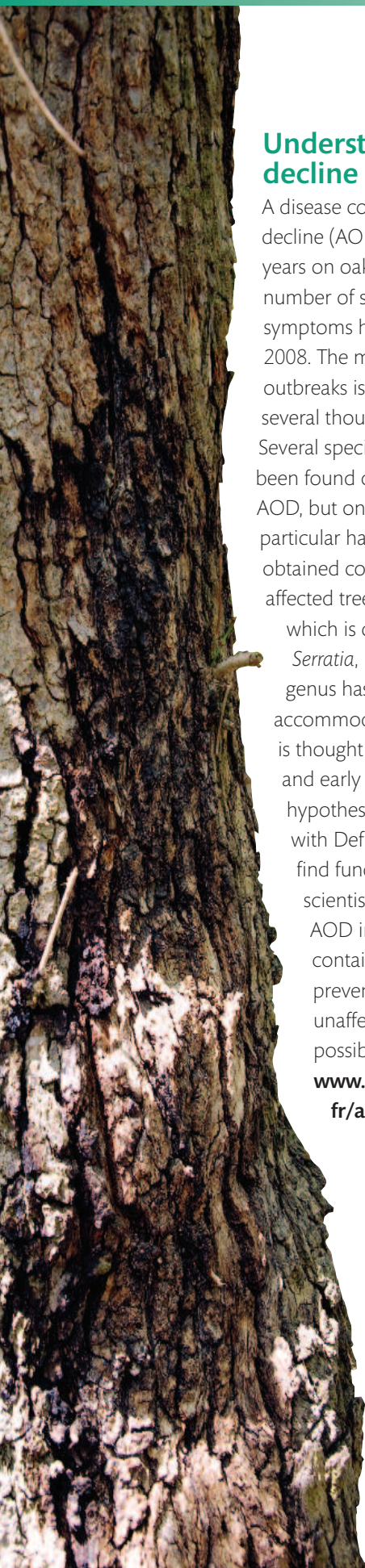
Significantly, we found that infected larch needles can generate huge numbers of spores, fuelling the rapid and widespread infection of larch and also threatening other tree species. To reduce this risk, ten thousand symptomatic larch were felled during the winter and surveys are underway to detect other affected locations. This is the first time *P. ramorum* has had a serious impact on a conifer host and emphasises that much remains to be learned about the threat it poses to trees. For more information visit www.forestry.gov.uk/pramorumsweengland

Slowing flood flows at Pickering

A new project at Pickering in North Yorkshire is looking at how changes in land use and land management could help to reduce the risk of flooding in the town. Pickering has a long history of flooding and, in common with many other affected communities across the country, is at risk of more frequent flooding in the future due to climate change. This two-year demonstration project is funded by the Department for Environment, Food and Rural Affairs (Defra) and led by Forest Research, in partnership with the Environment Agency, the Forestry Commission, Durham University, North York Moors National Park Authority, Natural England and other local partners.

The project involves, among other measures, planting more trees, especially along streambanks and in the floodplain, and restoring dams formed by large pieces of woody debris, to help slow down and reduce flood flows. For further details about the project, see www.forestry.gov.uk/fr/slowingtheflow





Understanding acute oak decline

A disease condition called acute oak decline (AOD) has appeared in recent years on oaks in Britain and the number of sites with trees showing symptoms has grown rapidly since 2008. The main focus of AOD outbreaks is the Midlands, where several thousand trees are affected. Several species of bacteria have been found on trees with AOD, but one species in particular has been obtained consistently from affected trees. This bacterium, which is closely related to the genus *Serratia*, is new to science and a new genus has been proposed to accommodate it. The new bacterium is thought to have a key role in AOD, and early trial results support this hypothesis. Forest Research is working with Defra and other stakeholders to find funding mechanisms to enable scientists to determine the extent of AOD in Britain, develop methods to contain the current outbreak, prevent further spread, and protect unaffected areas as quickly as possible. For more information, visit www.forestry.gov.uk/fr/acuteoakdecline



Adapting forestry and woodlands to climate change

Climate change is arguably a greater concern in forestry than other land uses, because of the much longer timescales involved in tree growth and planning forests and woodlands. Measures to adapt forestry to climate change therefore need to be introduced early, anticipating the future and involving specific adaptations rather than being reactive. Adaptation must also allow for future unknowns and uncertainties.

Forest Research has started to analyse the latest climate projections for the UK (UKCP09), which include probability ratings to indicate their levels of certainty. This will enable us to assess the risk of key climate-related events such as droughts, waterlogging, early or late frosts and windthrow, and how these vary geographically and are likely to change in future decades. We are producing publications and holding seminars on adaptation to inform the forestry sector and support the recommendations in the new UK Forestry Standard Climate Change Guidelines. For more information, visit www.forestry.gov.uk/fr/ccadaptation

Centre for Forest Resources and Management

We work to make British forests cost-effective, safe, sustainable and beneficial to society overall. Our objective is to understand and advise on scientific and technical aspects of measuring and managing British forests – from creation to maturity and regeneration. This year, our research has focused increasingly on questions of climate change. How can we adapt forest management to minimise risks from climate change? How can forests best contribute to the uptake of carbon dioxide? Here, we outline four current projects.

Growing trees for energy

Short rotation forestry, using fast-growing tree species, may contribute to climate change mitigation by providing biomass to replace fossil fuels. Provided woodland is managed sustainably, woodfuel is a renewable energy source, unlike fossil fuels, and on burning releases much less carbon dioxide than coal, oil or gas. With funding from the Department of Energy and Climate Change and Forestry Commission Scotland, Forest Research has selected 13 sites in Britain to create a network of trials where 11 promising species will be planted. Using the same species (and origins) on all sites allows a direct comparison across sites and species. We have also collected data from suitable existing woodlands planted without research in mind. The third main activity on this



project this year has been reviewing and collating information about the impacts and performance of these promising tree species. We have reviewed both published literature and our own past experiments investigating growth for timber rather than biomass. These complementary sources of information will form an evidence base for policy and operational decisions on short rotation forestry. For more details on woodfuel and bio-energy visit www.forestry.gov.uk/woodfuelscotland

Silvicultural systems to mitigate climate change

Continuous Cover Forestry (CCF) promotes the mixing of trees of different ages and species. It is often cited as a possible solution to the threats posed by climate change to forestry, but few studies have examined this and there is little evidence available. Forest Research has carried out an in-depth review of the scientific literature to answer the question, 'What evidence exists to support the use of CCF to help Scotland's forests adapt to the risks of climate change?'

We rated the potential impact of a range of hazards to Scottish forests and made an evidence-based judgement about whether CCF could help. We also rated the evidence base on which the judgement was made. Through this analysis, we concluded that CCF has *potential* to help Scotland's forests adapt to *some* of the risks of climate change. However, the benefits are highly site-specific. The full report can be downloaded from www.forestry.gov.uk/fr/ccf

Carbon FAQs

Demand continues to grow for estimates of carbon within existing and potential forested areas. This interest has increased since the publication of the Read report, *Combating climate change – a role for UK forests*, in November 2009, which advocates an increase in forests. This year for example, Forest Research drew on its extensive information to answer two frequently asked questions: 'How much carbon is stored in wood in the form of timber?' and 'If we reduce our carbon dioxide footprint, how much wood does that represent?'

The answers depend on the tree species, but, taking Sitka spruce as an example, one cubic metre of timber equates to the emissions from running a typical petrol car for a year (11,000 miles). A 5-cm cube contains carbon equivalent to that emitted in generating national-grid electricity to boil a kettle of water, watch a 32" LCD TV for just under an hour, or fuel a moped for 1 mile. For more details, visit

www.forestry.gov.uk/carboninwood



Developing clonal technologies

Cloning can improve the propagation and growth rates of desirable tree species. Working with conifers, Forest Research has been developing tissue-culture systems to increase stocks of scarce, high-quality tree material. We have cultured (grown) embryogenic tissue from a seed, and then used this culture to produce many more genetic copies or 'somatic embryos'. We are applying this technology to material selected by our breeding programme for Sitka spruce, to create many new tested, improved clones for mass planting.

During the past year, the production of somatic embryos has gone well and plantlets grown from somatic embryos should be ready for field trials by autumn 2011. Our future work on this project will focus on improving the success of transferring plantlets from sterile conditions to growing in soil, and on storing embryogenic tissue by freezing it in liquid nitrogen to prevent deterioration while field testing takes place. Information on these technologies and their development worldwide is summarised in reports from our international meeting on clonal forestry – see www.forestry.gov.uk/clonalforestryworkshop

Centre for Human and Ecological Sciences

We aim to research and develop the role of trees, woodlands and forests in society and within integrated sustainable landscapes. Our researchers achieve this by applying a broad range of skills from a proverbial A-to-Z of disciplines – from anthropology to zoology. Our inter-disciplinary capability provides a strong base for collaborations within Forest Research and with a broad cross-section of other research organisations and those working on land use. Here is a snapshot of four current projects.

Public attitudes to forests

What do people value about forests? In 2009, Forest Research investigated public perceptions and expectations of the 258,000-hectare English Public Forest Estate (PFE), on behalf of Forestry Commission England (FCE). The research consisted of a review of existing data, a national survey of 1775 adults, and ten group discussions.

We found that people value public forests and woods most highly for access, recreation, facilities and wildlife, while rating benefits of timber, soil, and water less highly. Many people expressed a profound sense of connection with trees and woodlands, and valued a wide range of forest types. There was widespread concern about perceived forest loss, and many people wanted to see the creation of new woodlands. Few people considered that



private ownership would improve woodland management; most wished to maintain and increase woodlands in public ownership. For more information, visit www.forestry.gov.uk/fr/pfesocialstudy

Green networks and people

There is increasing policy interest in both greater integration of land uses and developing green infrastructure. Forest Research has pioneered the use of spatial analysis techniques for biodiversity conservation. In particular, our landscape ecologists are expert in using habitat networks as a focus for restoring and expanding habitats. By combining landscape ecology with social science this year, we have extended our approach to aid the planning and management of multi-functional green networks in urban and peri-urban situations.

Green networks can support not just biodiversity conservation but also increased participation in outdoor recreation for a range of social groups, the creation of health-promoting environments, and sustainable patterns

Courtesy Patricia and Angus MacDonald/Aerographica



of travel. This year, we have contributed to initiatives in these areas by applying our research to the practical planning of habitats and greenspace, through mapping, awareness-raising seminars, guidance materials and a customised spatial modelling approach to suit both master-planning and local development plans. For more details, go to www.forestry.gov.uk/fr/greennetworks

Management of wild boar

Wild boar populations have become established in British woodlands in the past decade, generating several management challenges. Meeting these requires better understanding of the boar populations, including how to monitor changes in range and numbers and how to assess impacts on woodland biodiversity. Forest Research ecologists are working on this in collaboration with The Food and Environment Research Agency (Fera), funded by the Department for Environment, Food and Rural Affairs (Defra) and the Forestry Commission.

We have collated information on the presence of wild boar through a network of forest managers and also developed the use of thermal imaging to estimate boar

numbers. To improve population estimates, we have combined thermal-imaging results with GPS data on boar movements to test whether the boar are avoiding forest rides and roads. We have piloted methods of assessing impacts of boar behaviour, such as rooting, on ground layer vegetation, plant biodiversity, invertebrates and small mammal numbers. More information is available at www.forestry.gov.uk/fr/mammaldamage



Using scenarios in rural land-use planning

While people generally benefit from countryside activities, there are some associated risks, such as diseases transmitted from wild animals (e.g. Lyme Disease). As part of a Rural Economy and Land Use (RELU) programme, we are investigating how to assess and communicate these risks. We talked to land-based organisations to identify the types of outdoor activities that might occur on their land both now and in the future.

We developed four scenarios reflecting extensification or intensification of land use, and whether future recreation is likely to be dispersed or concentrated. We used the scenarios to consider possible changes in visitor use and management, vegetation and wildlife, in three different landscape settings ranging from peri-urban to remote rural locations. We will now use this information to examine the effect of media information, and the potential impact of a new disease. For more information, see

www.forestry.gov.uk/fr/animaldiseaserisks

