

Centre for Forestry and Climate Change



Our research into climate change aims to help all those involved in managing trees and woodlands to adapt their management practices so that our current and future woodlands and forests are better able to cope with the changing climate and play a part in mitigating its effects.

We coordinate the many strands of climate-related work at Forest Research in order to consolidate information and advice on sustainable forest management. We also work on existing and potential new threats to tree health. The following examples illustrate the range of our activities this year.

Detecting and tracing disease patterns

A devastating bleeding canker disease of horse chestnut is caused by the bacterial pathogen, *Pseudomonas syringae* pv. *aesculi* (*Pae*), which is believed to have originated in India and been introduced into Britain very recently. This year, Forest Research has been investigating the infection processes of *Pae* and its pathways of spread throughout Europe. *Pae* infects woody branches of horse chestnut directly via lenticels, leaf scars and other discontinuities in the bark (see image, top). An ongoing series of experiments has demonstrated that *Pae* can survive and remain viable for extended periods in soil.

Our scientists, alongside colleagues from the University of Edinburgh, recently completed work to generate the *Pae* genome sequence and are now

deciphering the genetic pathways by which *Pae* and other bacterial pathogens have evolved to attack trees. Early results suggest multiple evolutionary shifts onto woody hosts, requiring the acquisition of specific genes. More information on our *Pae* research can be found at:

www.forestry.gov.uk/fr/pae

Monitoring caterpillar risk to Scots pine

Caterpillars of the pine-tree lappet moth, *Dendrolimus pini*, are major defoliators of Scots pine in Europe.

Scientists at Forest Research confirmed that the moths were breeding near Inverness in 2009. Since this discovery, timber movements have been restricted, and our work has focused on determining population size, extent, origin and likelihood of outbreak now and in the future.

Monitoring, partly carried out in collaboration with Butterfly conservation Scotland, shows that *D. pini* is currently rare and very restricted in its distribution in Scotland, although climate modelling suggests



Lappet moth image courtesy of John Knowler

an increasing risk of outbreak in the future. DNA work has revealed that the moths are most likely to have come from Southern Europe and are unlikely to have colonised Scotland naturally. In 2010, there was a slight increase in moth dispersal and the extent of the breeding area, but no captures outside the 'movement control area'. This year's findings will be analysed to assess the need for eradication or control. For more information visit www.forestry.gov.uk/fr/pinetreelappet

Modelling the forest carbon cycle

Growing concern about climate change has led to an expansion of our research on carbon and greenhouse gas balances. UK trees, woodlands and forests are major carbon stocks, and increasing forest areas would contribute to reducing net UK emissions of greenhouse gases. A large research programme is linking detailed measurements of carbon stocks and greenhouse-gas exchanges in forests with models at various scales from stand to country.

At stand scale, Forest Research is assessing how carbon stocks change,

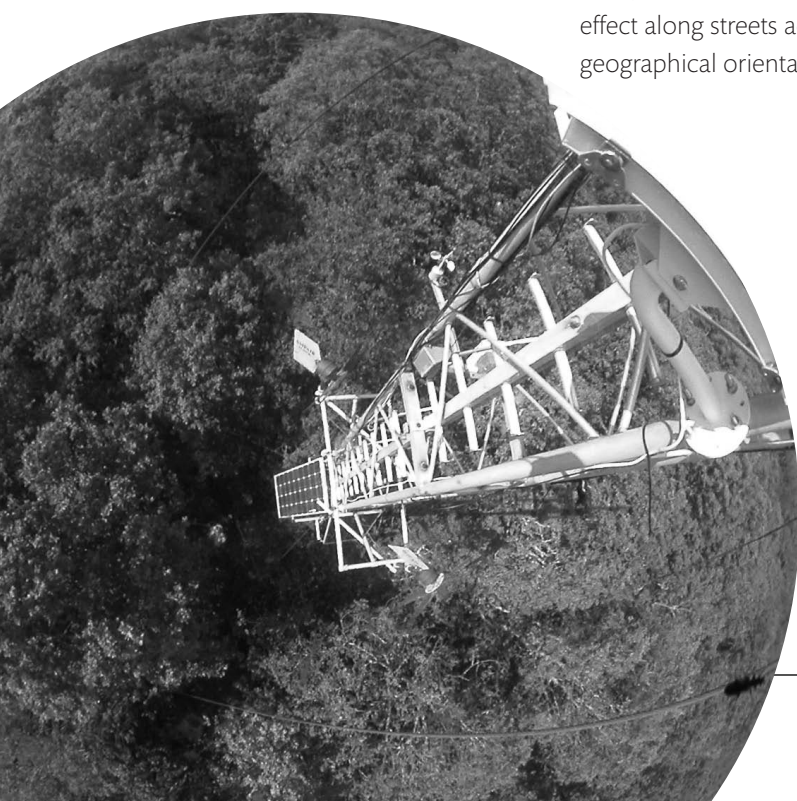
in relation to environment and management, in an 80-year-old stand of oaks (aerial photo, bottom). Eleven years of almost continuous measurements of the net uptake of carbon dioxide help to quantify daily, seasonal and annual carbon cycling.

At country scale, computer models have been used with details of forest areas, types and stand ages to predict future carbon uptake by Welsh forests. For more information visit www.forestry.gov.uk/fr/ccmitigation

The cooling effect of urban trees

Another area of increasing interest is the possible impact of climate change on urban trees and greenspaces and how green areas may in turn ameliorate the effects of climate change. As a consequence, we are working with a number of partners to look at measuring the cooling effects of greenspaces on local temperatures and have just completed a pilot project in and around Kensington Gardens, London. Our initial results have shown a cooling effect that was more apparent on warmer days but less so on cooler ones, with a difference in the cooling effect along streets according to their geographical orientation.

We plan to look at these effects in combination with local meteorological data, and to repeat the pilot study from Spring 2011, monitoring temperatures over a longer period. We will use data from these studies in developing a model of the local cooling effects of urban greenspaces. The model in turn will contribute to an investigation of health implications for local vulnerable populations. For more details, see www.forestry.gov.uk/fr/urbanclimate



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Centre for Forest Resources and Management



Our research investigates and provides guidance on sustainable forest management. As well as measuring today's forest resources, we forecast what is likely to be available in the future.

In particular, we undertake research to recommend cost-effective and environmentally sustainable ways to manage forests to provide a whole range of ecosystem services from timber to biodiversity and recreation. Key issues in the past year have been management for carbon and responses to disease threats. Here are four examples of our current work.

University of Surrey, we are investigating improved methods for clearing infected plants and alternative herbicides and bio-herbicides for preventing regrowth. We are also researching accelerated decomposition, charcoal production, and novel anti-microbial compounds for reducing re-infection from cut material. For more information see www.forestry.gov.uk/fr/rhododendron

Fighting *Phytophthora*

If left unchecked, the highly damaging disease organisms *Phytophthora ramorum* and *Phytophthora kernoviae* could kill large numbers of trees in Britain. Rhododendrons and larch growing in woodland can help to spread the disease, as once infected they produce large quantities of spores. For this reason, the Forestry Commission, Defra and the Scottish and Welsh Governments, alongside affected landowners, have been destroying infected plants.

Defra has contracted Forest Research to develop improved methods for controlling *Rhododendron ponticum* and to minimise re-infection after clearance. Working with the Centre for Agricultural Bioscience International (CABI) and the

Surveying for the Native Woodland Survey of Scotland

This year, our field workers have surveyed over 69,000 hectares of woodland for Forestry Commission Scotland (FCS) as part of the Native

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Woodland Survey of Scotland. This unique survey covers all Scotland's native, near native and ancient woodland sites down to half a hectare.

Skilled field staff capture data on woodland location, type, structure and



condition. The team works all year round – this year's severe winter weather was a challenge but did not stop the surveying, although some rescheduling was necessary and work focused on the western mainland areas and islands until the snow melted.

The survey is due to finish in 2013, when all of the data on Scotland's native woodlands will be available online. The results will be of use to landowners making management decisions and policy-makers developing regional and national policy. More information is available at www.forestry.gov.uk/nwss

Predicting timber properties before felling

To be competitive in a global market, it is important to direct timber to the most appropriate and cost-effective end market. At the same time, forests are growing in a changing climate, which affects tree growth and the properties of wood. How can we improve assessment of the timber quality of our forests, now and in future? Working closely with the forestry and wood processing sector and collaborating with colleagues at Edinburgh Napier University and the University of Glasgow, we have been testing field methods: visual assessment, laser scanning and orthogonal photography for measuring the form of standing trees, and acoustic tools for measuring wood stiffness (a good indication of quality). We are also developing computer simulations to predict tree growth and important wood properties of key species. So far, we have developed models for Sitka spruce and Scots pine, to estimate the impact of silviculture, tree breeding and a changing climate. We are currently extending this work to Douglas fir and larch. For more information visit www.forestry.gov.uk/fr/timberproperties

Increasing tree species diversity for the future

British forests are dominated by just a few tree species (notably Sitka spruce, Scots pine, oak and beech) and considering a wider range is a prudent strategy to adapt our forests and woodlands to projected climate change. This will also help if a favoured species should prove vulnerable to a pest or disease – such as red band needle blight, which has damaged both Corsican and lodgepole pine.

We have created a new set of web pages carrying summary information on 60 species that could be grown for timber in British forests (see www.forestry.gov.uk/fr/treespecies). We are re-examining our existing

species trials, arboreta and forest gardens, such as Kilmun (pictured below), which has over 160 species in separate plots.

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We have also collaborated with colleagues from other European countries in the Interreg project REINFFORCE (www.forestry.gov.uk/fr/reinfforce) to agree a list of species for experimental planting on sites throughout Western Europe. These are now growing in nurseries for planting from Spring 2012 onwards.



Centre for Human and Ecological Sciences



We focus on the links between people and forests, investigating the role of trees, woodlands and forests in society and within integrated sustainable landscapes.

Our researchers contribute diverse skills from the social and ecological sciences and are committed to inter-disciplinary working. We work with colleagues on aspects of ecosystem services, society and biodiversity, and also work collaboratively on a range of joint initiatives both locally and globally. Here, we highlight four examples of current projects.

National Ecosystem Assessment

The National Ecosystem Assessment (NEA), published on 2 June 2011, is the first analysis of the UK's natural environment in terms of the benefits it provides to society and our continuing economic prosperity, building on the pioneering global Millennium Ecosystem Assessment. The project has produced an independent and peer-reviewed assessment of the state and value of the UK's natural environment and ecosystem services, identifying what has driven change observed in the natural environment and the services it has provided over the last 60 years, and what may drive change in the future. It includes an investigation into the monetary and non-monetary value to the economy, society and individuals

from various ecosystem services, including how some of these may change in future.

Forest Research coordinated the woodlands element of the NEA, with input from the Macaulay Land Use Research Institute, the University of Bangor and Natural England; our researchers also contributed to the process of economic and non-economic valuation of ecosystems. The NEA provides clear evidence of the value of woodlands in delivering multiple benefits and how the forest sector can and does support multiple

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services through sustainable forest management. More information is available at <http://uknea.unep-wcmc.org/>

Helping to restore forests worldwide

In many countries, degraded environments are increasingly seen as landscapes of opportunity. The Global Partnership on Forest Landscape Restoration (GPFLR) is a collaborative



project uniting governments, organisations, communities and individuals in a network to share examples of successful restoration. Forests can play a major role in restoring degraded lands and providing multiple benefits for human societies.

Forest Research is contributing to the GPFLR by working with our counterparts, Forest Research India, supported by Defra and the Department for International Development (DFID). The aim is to develop a better understanding of the link between forest restoration and ecosystem services, including their contribution to climate change mitigation, biodiversity and human well-being. Initial activities include a review of recent restoration projects in India and the UK, assessing successes and the reasons for them. This has involved exchange visits between forestry professionals in Scotland and the Indian states of Madhya Pradesh, Orissa and Uttarakhand. For more information, see www.ideastransformlandscapes.org

Organising knowledge for forest professionals

A challenge for many land managers is to access and understand the complex information necessary to make informed decisions while both the natural and policy environments are changing. The extent of recent and likely changes means that the past is no longer an adequate basis on which to form views for the future. In response, our researchers have developed innovative decision support systems (DSS) to help with policy, planning and management of forests and land use. While many DSS are now scientifically excellent, some are not widely used by forest managers. To find out why, Forest Research has been undertaking social research

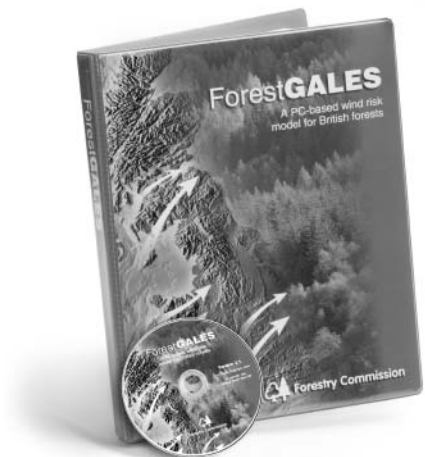
to identify what it is that constrains the uptake of DSS, most recently concentrating on the private sector, including Confederation of Forest Industries (Confor) members.

Our findings indicate that scientists, and those who commission the development of DSS, need to focus more on engaging with stakeholders and not just the technical challenges of DSS development. This places greater emphasis on the decision making contexts, ongoing dialogue between developers and users to build trust and credibility, and clarifying how the codified knowledge can best support decisions by different users. For more information, visit www.forestry.gov.uk/fr/dssuptake and for examples of DSS visit www.forestry.gov.uk/fr/planningtools

Woodland Grazing Toolbox

There is growing interest in woodland grazing as a way of obtaining income from the multiple use of land while contributing to the protection of biodiversity. Woodlands can provide shelter for livestock, and the grazing process can benefit woodland structure and a wide range of plants and animals. However, the benefits depend on appropriate choice of the type and density of domestic animals. This choice should reflect the site quality, presence of wild herbivores, and the owner's objectives for the site.

The Woodland Grazing Toolbox is our web-based collection of the information necessary to underpin



a woodland grazing management plan and was developed in collaboration with Scottish Natural Heritage, Scottish Agricultural College and many land managers. It provides detailed guidance on how to assess the initial condition of the woodland and how to monitor changes over time. The Toolbox is already in use in developing woodland grazing within the Scottish Rural Development Programme. For more information, go to www.forestry.gov.uk/woodlandgrazingtoolbox

