

Annual Report and Accounts 2007–2008



Forest Research

Annual Report and Accounts 2007–2008

Together with the Comptroller and Auditor General's Report on the Accounts

Presented to Parliament in pursuance of Section 45 of the Forestry Act 1967
and Section 5 of the Exchequer and Audit Departments Act 1921

Ordered by the House of Commons to be printed 17 July 2008

HC 717

Edinburgh: The Stationery Office
£18.55


Forest Research
The Research Agency of the Forestry Commission

Enquiries relating to this publication should be addressed to:

Forest Research
Alice Holt Lodge
Farnham
Surrey GU10 4LH

T: 01420 22255

E: research.info@forestry.gsi.gov.uk

Contact this address if you would like to request this document in large print or other format and for information on language translations.

© Crown Copyright 2008

The text in this document (excluding the Royal Arms and other departmental or agency logos) may be reproduced free of charge in any format or medium providing it is reproduced accurately and not used in a misleading context. The material must be acknowledged as Crown copyright and the title of the document specified.

Where we have identified any third party copyright material you will need to obtain permission from the copyright holders concerned.

For any other use of this material please write to Office of Public Sector Information, Information Policy Team, Kew, Richmond, Surrey TW9 4DU or e-mail: licensing@opsi.gov.uk

ISBN 978 010295211 7

Chief Executive's Introduction	4
About Forest Research	8
Advisory Committee on Forestry Research	10
National and international links, visitors and events	12
Our research	
Biometrics, Surveys and Statistics	18
The second National Inventory of Woodland and Trees	22
The temperature response of photosynthesis	23
Ecology	24
Climate change: impacts and adaptation in Scotland	28
Genetic fingerprinting of black poplar planting stock	29
Environmental and Human Sciences	30
The impact of forest management on forest recreational use	34
Ecological risk assessment	35
Forest Management	36
Managing wind risk to forests in northern Europe	40
Impact of whole-tree harvesting on the growth of Sitka spruce	41
Tree Health	42
New findings on the threat from Phytophthoras	46
Online management support system for <i>Hylobius</i>	47
Biomass Energy Centre	48
Publications	50
Forestry Commission technical publications	51
External publications	52
Research programmes and contracts	58
Major research programmes undertaken by Forest Research	59
Research contracts awarded by Forest Research	65
People	66
Accounts for the year ended 31 March 2008	74

Chief Executive's Introduction

I am proud to introduce the 2007–08 Annual Report for Forest Research (FR). This report illustrates some of the work undertaken by FR over the year, presents our achievement against the Key Performance Indicators (KPIs) and details FR's accounts for the year ending 31 March 2008.

FR provides the science and advice to underpin forestry policy and practice, principally in the UK and on behalf of the Forestry Commission. In addition, FR has a range of customers from other UK organisations and the Commission of the European Communities (CEC), and our research and development work is often linked with partners and collaborators worldwide. Indeed, one benefit provided by an applied forestry research organisation is informed access to wider science.



Chief Executive's Introduction

Forestry seeks to deliver economic, social and environmental objectives; objectives that are achieved through the application of sustainable forest management. Today, the delivery of these multiple objectives must be guided by a clear understanding of forestry's potential to contribute to the mitigation of climate change. There is a critical need for the forestry sector to adapt to climate change in order that adverse impacts are minimised and the multiple benefits of forestry continue to be provided. Much of the research presented in this report directly addresses detailed aspects of these main drivers.

The evidence base and strategies that are required to deliver forestry policy change rapidly and it is necessary for FR to be flexible in order to meet emerging research, guidance and advisory needs. FR published a **Development Strategy** in September 2006, which sets out key objectives as follows: to match FR's skills to emerging customer needs; to increase innovation, increase scientific and business excellence; to ensure a range of funding sources and improve the links with other research organisations. FR's Corporate Plan and KPIs for 2007-08 addressed the implementation of the Development Strategy and I am pleased to report that the year has seen good progress.

In the pages that follow, each of FR's five research divisions presents an overview of its achievements, followed by two technical highlights that focus in more detail on particular deliverables. **Biometrics, Surveys and Statistics Division** has highlighted the progress made on the National Inventory of Woodland and Trees and work on the determinants of photosynthesis, which forms the basis for process modelling. **Ecology Division** presents its work on climate change adaptation, which formed the basis of a publication launched by Michael Russell MSP, the Scottish Environment Minister, when he visited FR's Northern Research Station in January 2008, along with work on using molecular markers to look at genetic diversity in black poplar. The practical application of molecular biology has resulted in real progress in the identification of the pathogens responsible for damage to trees, and is also being applied in the conifer breeding programme TREENOMIX in partnership with the University of British Columbia. **Environmental and Human Sciences Division** has focused on the deliverables of the EU project EFORWOOD and on work done in the EPSRC-funded PuRE project. I am delighted that the skills of FR's **Social and Economic Research Group** of the Division continue to be in demand from a wide range of customers. The Group currently undertakes a number of projects co-funded by the FC and EU (RECOAL, SENSOR) and along with Ecology Division staff is also closely involved in the RELU programme. **Forest Management Division** has outlined one of FR's EU consortium projects, work on wind risk (STORMRISK), and also work on the impacts of whole-tree

harvesting. **Technical Development**, which is part of Forest Management Division and whose headquarters are in Ae, Dumfriesshire, celebrated its 50th birthday during the year. **Tree Health Division** has highlighted a new online management support system for *Hylobius*, the weevil that continues to be the most damaging insect pest in British forestry. The introduction and spread of new or newly introduced pathogens remains a real threat and Tree Health Division is pivotal to an understanding of problems associated with the spread of *Phytophthora ramorum* and *P. kernoviae*.

The new understanding and implications for policy and practice that arise from FR's work are published in FC publications, scientific journals, as well as being integrated in Decision Support Systems and through the internet. A significant element of staff time is also devoted to face-to-face communication. For example, during 2007-08 a programme of Research Update Seminars was provided, often in partnership with FC regional staff or at NRS and Alice Holt. I am pleased to report that during the year we have been able to return to our full complement of Research Liaison Officers and this has given FR the capacity for effective interaction with FC England, FC Scotland, FC Wales, the Confederation of Forest Industries (ConFor), the Arboricultural Association and a wide range of other industry stakeholders.

During 2007, the expertise and skills required to match emerging customer needs were examined by six Priority Area Working Groups. As a result of this analysis an **Urban Regeneration and Greenspace Centre** has been established to operate in a similar way to the established and successful **Biomass Energy Centre**. Since the creation of the Biomass Energy Centre we have seen an expansion of our work on woodfuel and an increased need for advice on related areas

Chief Executive's Introduction

such as whole-tree harvesting and stump removal. All FR's research addresses climate change directly or indirectly and co-ordination of climate change research is currently through a 'Research Hub' that links directly to the FC's **Climate Change Strategy Group**. Further development of FR's Climate Change Research Hub is an important objective during 2008-09.

FR's 2007-08 target for non-FC income was not met, with approximately £1.5 million of work being undertaken during the year against a target of £2.7 million. This outcome does not reflect a decline in the effort made to win external income or, in my view, a decline in the quality of applications. A significant amount of scoping and horizon scanning was undertaken by the six Priority Area Working Groups and this has provided strategic direction to the contract bidding that is currently under way. In the past few months, a large number of funding bids were made to the EU under Framework Programme 7 and to other customers, and I am confident that the 2007-08 external income can be exceeded during 2008-09.

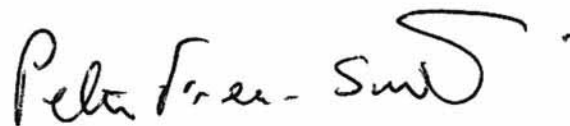
For the first time, FR is making real progress in its commercialisation activities. The year 2007-08 is the middle of three years of funding by the Department of Innovation, Universities and Skills under the Public Sector Research Exploitation Fund (PSRE). This has allowed us to introduce a process for development and management of the intellectual property (IP) generated by FR. We now employ an Intellectual Property Manager, have completed significant staff training on Innovation and established strong links with external professional advisors who work on IP management with other PSREs and universities.

The **Advisory Committee on Forestry Research** and the external Visiting Groups that it appoints provide independent assessment of the quality, balance and direction of FR's research programme. I would like to thank the members of the committee who, in addition to their usual role, have been directly involved in the implementation of the FR Development Strategy. I would also like to thank the members of FR's **Audit and Risk Committee** for their work in advising on the strategic processes for risk control and governance in FR.

During the year, the FC Programme Advisory Groups, which are responsible for linking FR's research programmes to FC research requirements, have been reorganised to give FC England, FC Scotland and FC Wales greater influence in the prioritisation and specification of research. This process has highlighted research requirements in the areas of climate change, woodfuel and forest resource assessment, and has resulted in major changes to FR's research programme in 2008-09.

I am delighted that Andy Moffat (Head of Environmental and Human Sciences Division) was awarded a Visiting Professorship at Reading University and that Bill Mason (Head of Forest Management Division) was awarded a Doctorate of Science based on his work on silvicultural research in support of multifunctional forest management. As already mentioned, FR has a number of strong and productive international links, and during the year new Memoranda of Understanding were signed with Scion Research in New Zealand and with the Finnish Forest Research Institute (METLA). Finally, it was a pleasure for FR staff to exhibit at the Royal Society's Summer Science Exhibition last July, together with Napier, Glasgow and Lavel Universities and FibreGen.

More details about FR's work during 2007-08 are given in the following pages. The key features of FR's continuing success in the provision of applied research, development and scientific services are: the quality and dedication of FR staff, our close working relationship with the FC and UK forestry, and our partnerships with other research organisations and universities in the UK, Europe and worldwide. I believe that our understanding of developing customer needs and our response to them are critical to our continued success. I would like to thank FR staff for their hard work in delivery to our customers and for their close involvement and work on implementation of the FR Development Strategy.



Professor Peter Freer-Smith
Acting Chief Executive

Chief Executive's Introduction

FR Corporate Plan Key Performance Indicators – Progress Report

Key Performance Indicator (KPI)	Commentary
<p>1. FR will establish Priority Area Working Groups (PAWGs) as mechanisms to develop business cases for six priority areas of research identified in the FR Development Strategy. PAWGs to report to FR CEO by June 2007. FREB to report on action to develop areas by September 2007. Implement new business targets by March 2008.</p>	<ul style="list-style-type: none"> • Groups reviewed the opportunities for expansion of FR's work in six priority areas and reported on target. • 'Biomass Energy' and 'Urban Regeneration and Greenspace' centres established. • Climate Change research is led by a newly appointed Head of Climate Change Research and is co-ordinated by a strengthened Programme Advisory Group linked to the FC Climate Change Strategy Group.
<p>2. FR will develop a clear framework setting out how FR intends to generate income by exploiting IP, R&D contracts, knowledge transfer and asset utilisation. To report to FR CEO by August 2007.</p>	<ul style="list-style-type: none"> • FR Business Development Plan was provided to the CEO during 2007. • FR Heads of Divisions, Research and Commercial Directors now meet monthly to co-ordinate responses to grant and contract calls, and to monitor progress with bids. • New business and income targets were set in FR's 2008–09 Business Plan.
<p>3. FR will agree with FC Wales geographic locations and partnership mechanisms to increase its presence in Wales, building on current strengths and opportunities for the future. A proposal and implementation plan will be put to the Wales National Committee by September 2007.</p>	<ul style="list-style-type: none"> • Proposal and implementation plan agreed by Wales National Committee in November 2007. • An FC-wide trawl to fill the post of Head of FR in Wales was unsuccessful; the post will now be advertised externally. • The location of FR staff in Aberystwyth is one of FR's KPIs for 2008–09.
<p>4. FR will undertake an audit of staff skills to provide details of business skills, flexibility and development needs to report to FR CEO. An action plan to achieve the required staff resources will be produced by March 2008.</p>	<ul style="list-style-type: none"> • Work force planning exercise, which will include the skills audit, is underway – to be completed by the end of August 2008. • Staff training put in place on IP, innovation and project management (PRINCE2), Essential Skills for Managers and Media Training.
<p>5. FR will review its finance system. A fit for purpose system will be recommended to the FR CEO by July 2007. This will be rolled out and in operational use by March 2008.</p>	<ul style="list-style-type: none"> • FR Financial and Project Management Systems reviewed and action plan agreed. • Much more work was required on the financial systems than had been anticipated. • Concluded that FC systems are the best primary data sources rather than a new system for FR; work under way to make better use of these. • New Finance Director appointed in January and tasked with major overhaul of systems. • Revised Programme Advisory Group (PAG) and Research Strategy Management Board (RSMB) structure now operating effectively. Gives increased country influence in the determination of the research programmes and specification of outputs, and greater transparency and responsiveness. • Closer working with FAS and James Pendlebury (as CFS Head of Research Purchasing) established and will be key to improved financial management.
<p>6. FR will grow its external income from £2.4 million in 2006–07 to £2.7m in 2007–08.</p>	<ul style="list-style-type: none"> • Not achieved; 2007–08 external income was approximately £1.5m.

About Forest Research

Forest Research is an agency of the Forestry Commission and is the leading UK organisation engaged in forestry and tree related research.



Aims and objectives

The aims and objectives of Forest Research (FR) are to assist the Forestry Commission (FC) in achieving its high-level objective.

On behalf of all three administrations, to take the lead in development and promotion of sustainable forest management and to support its achievement internationally.

FR's Aims

To support and enhance forestry and its role in sustainable development, by providing high-quality research and development in a well-run organisation.

FR's Objectives

- To inform and support forestry's contribution to the development and delivery of the policies of the UK government and the devolved administrations.
- To provide research, development and monitoring services relevant to UK forestry interests.
- To transfer knowledge actively and appropriately.

Research funding

Much of FR's work is funded by the FC with Corporate and Forestry Support acting as purchaser of research and other services in support of forestry in Britain, including the particular needs of England, Scotland and Wales. In addition, FC England, Scotland and Wales purchase research, development and surveys specifically related to the forest estate in each country. In recent years FR has successfully applied for external (non-FC) funding from government departments, the European Union, UK research councils, commercial organisations, private individuals and charities. Collaborative bids with other research providers and consortium funding have become increasingly important, placing emphasis on effective partnerships.

Activities

Research and development are essential components in delivery of the benefits of sustainable forestry in a multifunctional landscape. FR's research, surveys and related scientific services address the social, economic and environmental components of sustainability. There is a focus on providing new knowledge and practical solutions based on high-quality science. Our projects provide understanding, policy advice and guidelines on implementation of best practice (e.g. on

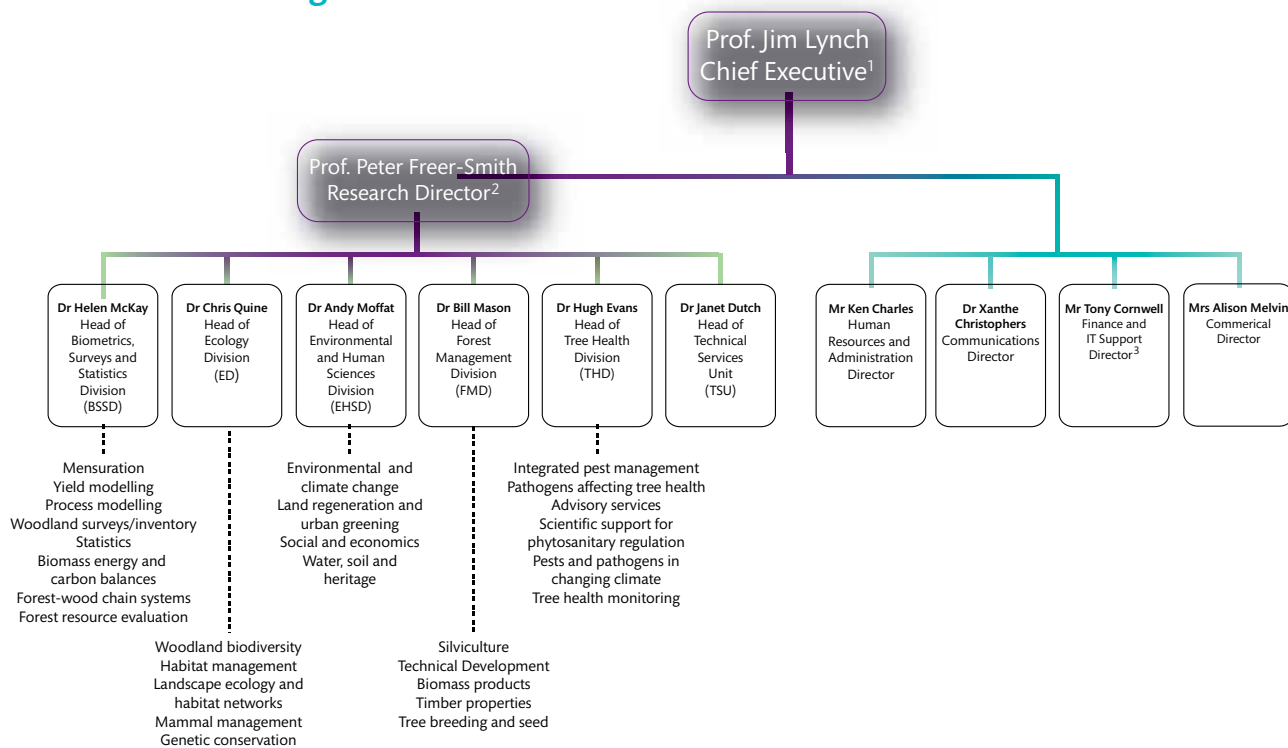
forest hydrology, continuous cover forestry, timber quality, land reclamation to woodland, and restoration of native woodlands). Much of the research is directed at increasing the biodiversity, landscape and recreational benefits of woodlands. Protection of GB woodlands from pests and diseases, and predicting the impacts of environmental change are also overarching themes. FR works closely with the FC, the Commission of the European Communities and other international organisations to ensure compliance with international agreements on the sustainable management of forests and related subjects. The Agency also carries out work on genetic conservation, tree improvement, seed testing, method studies, product evaluation, crop inventory, surveys (e.g. *The national inventory of woodland and trees*), and monitoring.

Resources

The Agency has two main research stations, Alice Holt Lodge in Hampshire and the Northern Research Station on the Bush Estate south of Edinburgh. The main office of Technical Development (part of Forest Management Division) is located at Ae in Dumfriesshire with subsidiary offices in the English Midlands and Wales. The Agency also has six field stations (the Technical Support Units) from which an extensive network of field trials, sample plots and monitoring sites is assessed. Contact information is given on the inside back cover. The Agency employs 275 staff, not including visiting scientists and sandwich course students. FR has published a Corporate Plan for the period 2008–11 and copies are available to download from www.forestresearch.gov.uk/corporateplans

About Forest Research

Forest Research organisation 2007–08



Advisory Committee on Forestry Research

Chairman

PROFESSOR SIR DAVID J. READ, FRS

Biological Secretary and Vice-President Royal Society and Professor of Plant Sciences, University of Sheffield

Secretary

PROFESSOR P. H. FREER-SMITH

Research Director and Acting Chief Executive from October 2007 Forest Research

Members

PROFESSOR C. WARD-THOMPSON

Director, OPENSpace Research Centre and Research Professor of Landscape Architecture
Edinburgh College of Art/
Heriot-Watt University

PROFESSOR D. EVANS

Consultant in the field of novel crop management solutions
Farnham, Surrey

PROFESSOR J. M. LYNCH

Chief Executive
Forest Research
(up to September 2007)

DR C. CAHALAN

School of Agricultural and Forest Sciences
University of Wales Bangor

PROFESSOR R. CLIFT, CBE

Professor of Environmental Technology,
Centre for Environmental Strategy
University of Surrey

PROFESSOR P. JARVIS, FRS

Emeritus Professor of Forestry and
Natural Resources
Institute of Atmospheric and
Environmental Sciences
School of GeoSciences
University of Edinburgh

MRS W. HARPER

Forestry Commission
Secretary to The Forestry Commissioners
and Head of Corporate and Forestry
Support

DR J. PENDLEBURY⁴

Forestry Commission
Corporate and Forestry Support

DR K. J. KIRBY

Forestry and Woodland Officer
Natural England
Peterborough

PROFESSOR C. A. GILLIGAN

Professor of Mathematical Biology and
Fellow
King's College
Department of Plant Sciences
University of Cambridge

PROFESSOR A. J. MOFFAT

Head of Environmental & Human
Sciences Division and Acting Research
Director from October 2007
Forest Research

¹ From October 2007 to March 2008, Peter Freer-Smith was Acting Chief Executive.

² From October 2007 to March 2008, Andy Moffat was Acting Research Director.

³ From January 2008 Sandra Smith was Finance and IT Support Director.

⁴ Dr James Pendlebury took up the post of FR Chief Executive in June 2008.

The Advisory Committee provides guidance for the Agency and the Forestry Commission on the quality and direction of FR's research. The Advisory Committee met in May 2007 for a tour of research work in East Anglia Forest District and in December 2007 at Alice Holt. Our thanks to Jim Lyon for hosting the Committee's visit to Thetford. These meetings allow Committee members to meet staff and keep up-to-date with FR's work; focus is usually on those research programmes to which Visiting Groups have been appointed in the year.

The Committee appointed and received a report from an external Visiting Group to Tree Health Division (chaired by Professor Michael Jeger, with Dr Chris Prior and Dr Hervé Jactel as members). The Visiting Group rated the research programmes of the Division on a four-point scale (A down to D) on the basis of science quality and overall relevance, delivery and progress. One programme (Phytophthora research) was rated at A for science quality, one (Scientific support for phytosanitary regulation) was B, three were at B/C and three at C. The significant amount of change in structure and management of Tree Health Division in recent years was acknowledged, and the group felt that the 'customer approach' constraints are likely to have prevented the Division from developing long-term, strategic and more innovative research. The Group commented that 'EU funding would provide the Division with degrees of freedom to broaden the scope of its research' and that 'there should be emphasis given to raising public, governmental (including internal FC) and private sector appreciation of the value of FR research outputs'. The international recognition of Tree Health Division, attested to by IUFRO and EU responsibilities and representational activities, was recognised. Five recommendations were made on the future development of programmes within the Division and across FR, and these recommendations are now being implemented. Presentation of these views to the Committee highlighted the need for a cross-divisional approach to be taken on climate change, and Committee members also emphasised the importance of high-quality peer-reviewed journal publications on which technical advice to practitioners should be based.

At its meeting of December 2007 the Committee also considered progress in implementation of FR's Development Strategy (2007-2012), and received a report on implementation of the recommendations made in the 2006 Visiting Group to Environmental and Human Sciences Division. Members of the Advisory Committee on Forestry Research are closely involved in the implementation of the FR Development Strategy through the provision of expertise on review groups and appointment and promotion boards.

National and international links, visitors and events

Forest Research is working at the forefront of forestry science, often alongside other research organisations and academic institutions both in the UK and worldwide. We are continually striving to build collaborative relationships with similar research bodies in order to share knowledge and expertise in the interests of furthering science. Our members of staff have taken part in many events and collaborations throughout the past year. Here we outline a small selection of highlights.



National and international links, visitors and events

Visitors

Alice Holt and the Northern Research Station (NRS) played hosts to a number of visitors, meetings and conferences this year. Lord Selborne, Chairman of the Board of Trustees of the Royal Botanic Gardens, Kew, visited Alice Holt in September 2007. His visit included a discussion with Richard Jinks on FC's tree collections, and a meeting with Joan Webber and Sandra Denman to talk about current disease epidemics affecting UK woodlands, plantations, and urban and garden trees. In November NRS welcomed MSP Rhona Brankin to look at FR's work in Scotland. Her visit included discussions on the Forestry for People project, decision support systems for management of insect pests such as *Hylobius*, timber quality research, and habitat networks for people and biodiversity.

In March, NRS hosted the Third Annual Conference on Timber Properties Research, jointly organised with Napier University and the University of Glasgow. Alice Holt also hosted a South East England Soils Discussion Group (SEESOIL) meeting to discuss forest soils and FR's current soil research. Several FR environmental scientists gave presentations and visitors enjoyed a field trip to observe soil-associated research in Alice Holt Forest.

Members of The Russian Federal Forestry Agency undertook a UK tour in March, which included meetings with the FC's Director General Tim Rollinson, before visiting Alice Holt. They received presentations on climate change from James Morison and FC's Mark Broadmeadow, and a tour of the Alice Holt Research Forest (see photo left), including FR's forest monitoring site, organised by Matt Wilkinson, Sirwan Yamulki and Nadia Barsoum.



Left to right: Professor Peter Freer-Smith, Lord John Selborne, Professor Jim Lynch and Professor Jeff Burley



International links

Throughout the year FR's staff have continued developing links across the globe. Continuing FR's strong links with China, Colin Edwards (pictured above on left) visited the Liaoning institute of Forest Management in Liaoning Province (between Beijing and North Korea). Colin's visit focused on helping researchers to develop alternatives to clearfell management systems for upland conifers. FR economist Gregory Valatin visited the US to look at payments schemes for ecosystem services, where landowners are paid to help provide benefits such as biodiversity conservation and carbon sequestration. Important schemes that were discussed included wetland conservation banking and carbon trading.

Further strengthening FR's ties with research institutes in New Zealand and Australia, Darren Kriticos from Scion Research in New Zealand visited FR's tree health researchers at Alice Holt in April and May 2007. He was particularly interested in biosecurity, contingency planning and the impacts of climate change, and his visit also provided an opportunity to discuss collaboration on future research projects.

Back in Europe, FR pathologist Sarah Green spent three weeks at the Norwegian Forest and Landscape Institute (FLI) in Ås, Norway,

National and international links, visitors and events

to learn the theory and techniques of real-time polymerase chain reaction (PCR) for detection of tree disease. During her visit, Sarah worked with laboratory staff to develop a real-time PCR method to detect the bacterium (*Pseudomonas syringae* pv. *aesculi*) that causes bleeding canker of horse chestnut in the UK. The visit also brought about ongoing collaboration between FR and the Norwegian FLI.

Events

During the year staff from most divisions took part in international conferences, seminars and meetings, taking FR's expertise and collaboration to different parts of the world.

In April 2007 Jim Lynch attended the European Forestry Institute (EFI) Board Meeting, which explored the advantages that could be generated by the development of regional offices around Europe. This could provide an important step forward for EFI and the forest research industry, owners and international forest-related organisations that it represents. Jim also discussed the role that FR might play in leading climate change activities with the EFI.

Later in April Jim joined participants from 51 different countries at the IUFRO 'Forest research management in an era of globalisation' meeting in Washington DC. This was a great opportunity to exchange views and experiences to improve management globally. Jim's lecture highlighted that 'scientists are increasingly enthusiastic to be involved in policy and can provide the essential evidence base for policy decisions... and wish now more than ever to be more involved in the creation of that policy'.

In May 2007, Peter Freer-Smith travelled to China with the Chairman, Lord Clark, the FC's Director General, Tim Rollinson, and Jonathan Taylor from International Policy to attend the first Working Group resulting from a Memorandum of Understanding between the Forestry Commission and China's State Forestry Administration. Discussions included specific research interests in silvicultural systems, plant health and protection, and climate change.

Kevin Watts, Darren Moseley and Amy Eycott represented FR at the International Association for Landscape Ecology (IALE) 25th birthday at the 7th World Congress in Wageningen, the Netherlands. Their presentations on climate change and habitat fragmentation, modelling techniques for reducing fragmentation, and applying forest habitat networks to target native woodland expansion made up part of a diverse range of topics covered.

In September Sirwan Yamulki took part in the 2nd International Workshop on 'Uncertainty in greenhouse gas inventories' in Laxenburg, Austria. Many countries produce these inventories, which estimate greenhouse gas levels from all sectors of the economy, but growing concerns about their accuracy has led to ongoing international collaboration to assess the issue of uncertainty.

Closer to home, in Bangor in September, Elena Vanguelova and Bruce Nicoll represented FR at the 4th international symposium on physiological processes in the roots of woody plants. Bruce ran a workshop on '3D architecture of coarse root systems - measurement and analysis', and Elena presented the results of a working group's research into bio-indicators of stress in fir tree roots.

The Offenders and Nature (O&N) Schemes, which enable offenders to work with nature conservation and forestry public agencies, benefiting participants and the environment, made further progress during the year. Claudia Carter, who is involved with research on these schemes, attended an O&N 'Dialogue Day' in London in July, and accepted on behalf of the FC a prestigious Outstanding Schemes award from the Howard League for Penal Reform in the Community (photo top right).

Between May and July, FR and the Regional FC England offices jointly organised a series of eight seminars for participants in the forestry and land-use sectors, focusing primarily on the implications of climate change for woodlands and their future management. Each seminar covered current Forest Research activity and the latest developments in forestry practice and science, and included presentations on topics of particular local interest. Questionnaires completed at the seminars were encouraging, with positive feedback and many enquiries about future events.

National and international links, visitors and events



Left to right: Nick Hazlitt (FC), Julian Dormady (FC), Claudia Carter (FR) and Baroness Linklater of Butterstone (Trustee of the Esmee Fairbairn Charitable Trust and Host of the Howard League Award Ceremony, July 2007)

Early in July, FR again exhibited at the Royal Society's Summer Exhibition in London. Barry Gardiner, Alexis Achim, Elspeth Macdonald and Dave Auty, along with colleagues from Napier, Glasgow and Laval Universities and FibreGen, created an exhibit entitled 'Listen to what the trees are saying'. This highly popular demonstration (pictured below) showed how the use of modern acoustic tools can determine the stiffness of standing trees and logs, and how this information can be used to allocate wood for a particular end use. This 'acoustic advantage' was also demonstrated later in the year to members of the forestry wood-chain industry at two seminars in Dunkeld in October and November.



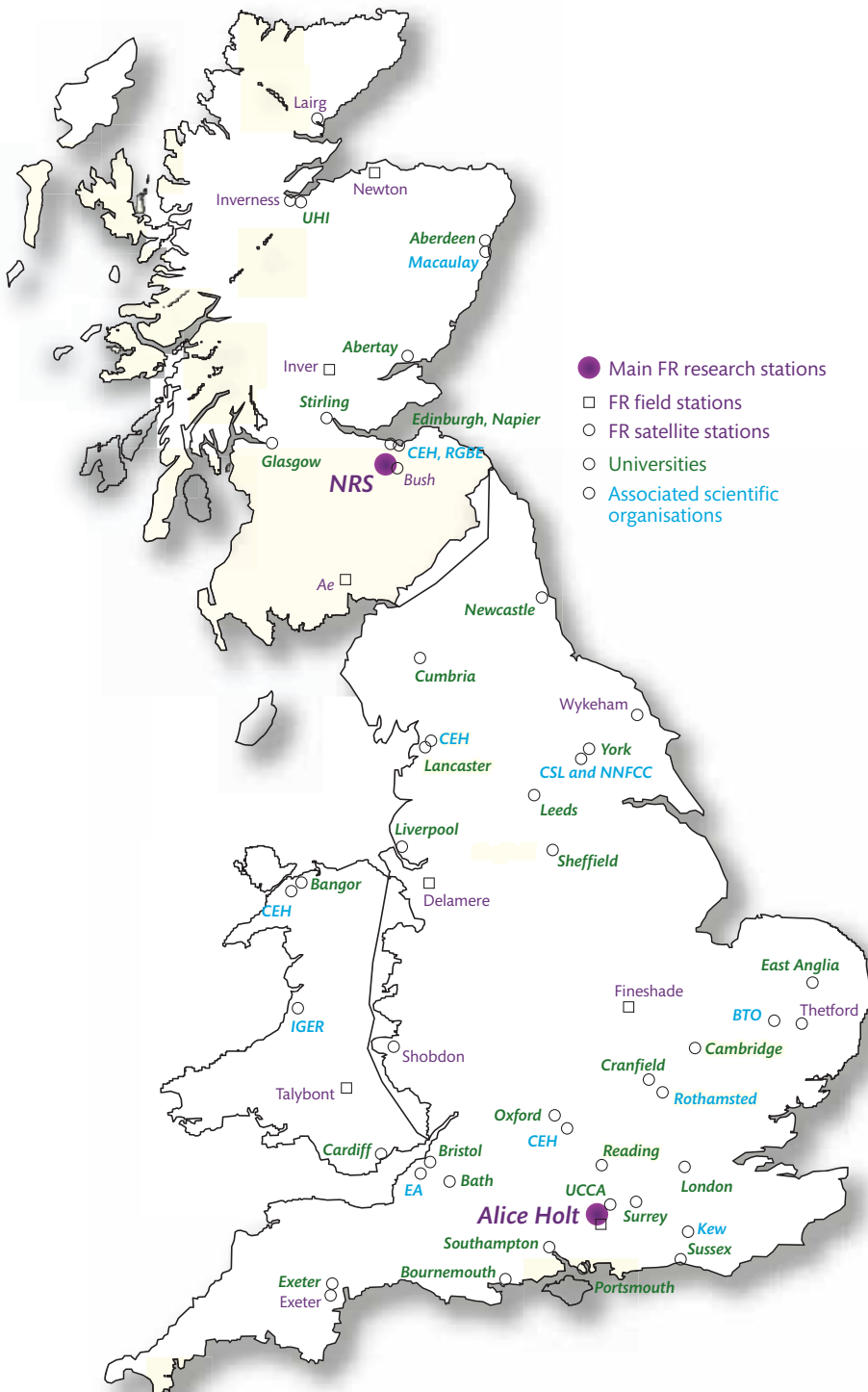
Even in Britain's damp climate, fire can be a threat to forests, heaths and moorland; last autumn, Ian Murgatroyd was one of the invited speakers at a group of seminars on fire suppression for fire consultants and rescue staff, organised by the Institution of Fire Engineers. Ian's presentation outlined studies into the water quantities used by different pumps and methods to suppress similar fires, and included a discussion of other fire suppression techniques used in the UK.

In December, Colin Edwards organised a one-day workshop in Grampian Region, Scotland, for foresters and conservationists to consider techniques for encouraging natural regeneration in native pinewoods, particularly in areas under deer pressure. Helen Armstrong described the effects of deer and cattle on Scots pine, Sarah Taylor talked about regeneration dynamics in pinewoods and Colin gave a presentation on 'Seventy-seven years of natural regeneration trials: results to date'. Lively discussion and site visits rounded off the day.

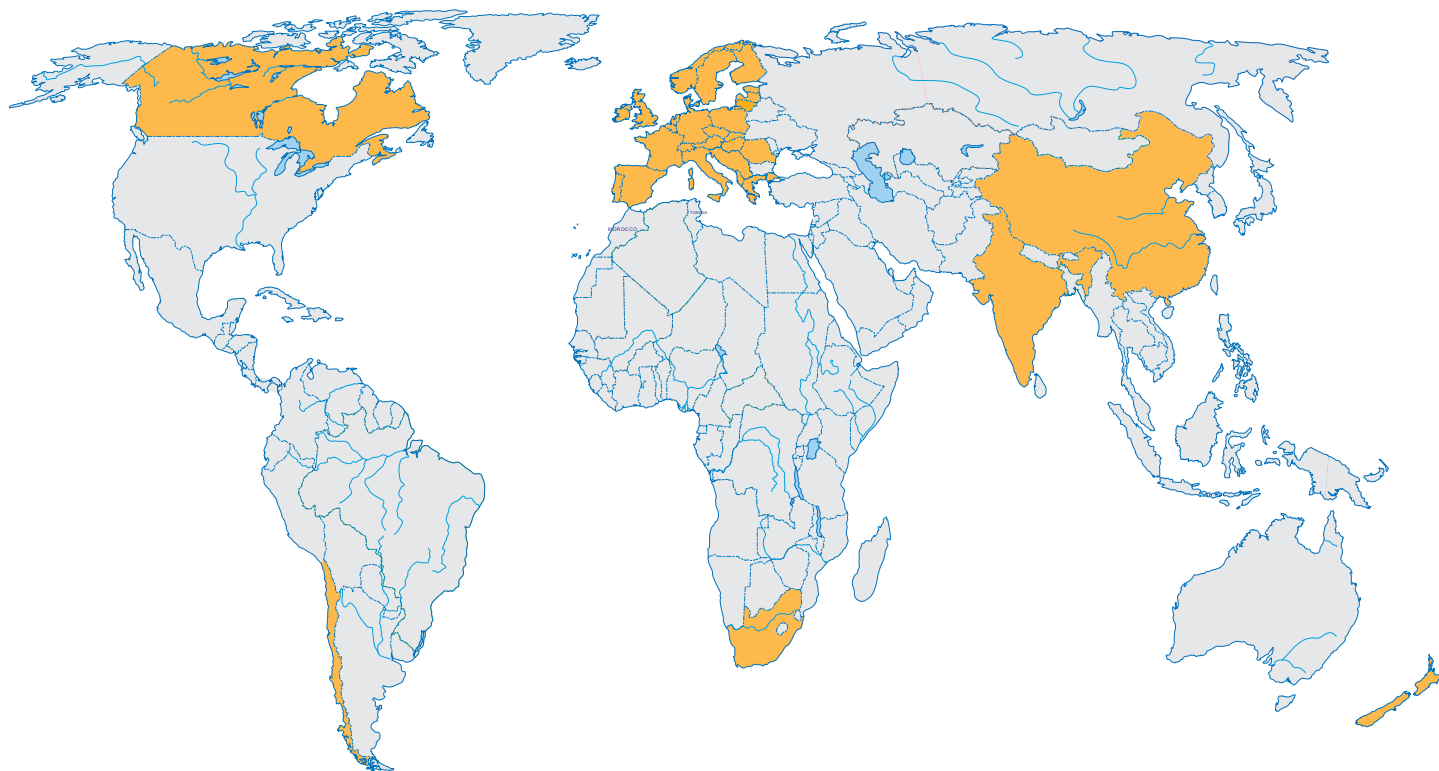
National and international links, visitors and events

National links

The national map to the left shows FR's links with an increasingly wide range of UK universities and associated scientific organisations. Many of our programmes, individual and collaborative, are funded by other government agencies, UK research councils and commercial organisations; these include Defra, SEEDA, BERR, DIUS, NERC, SNH, Natural England and the Environment Agency. We also collaborate with a wide range of universities countrywide, including: Aberdeen, Edinburgh, Napier, Stirling, Lancaster, Central Lancashire (Penrith), York,ffield, Leeds, Bangor, Cardiff, Cranfield,ord, Cambridge, Exeter, Bath, Bristol,smouth, Bournemouth, Reading, Surrey,thampton, Sussex and London universities.



National and international links, visitors and events



International links

The international map above shows our links worldwide. In addition to our extensive links across Europe, our wider global links are particularly strong with New Zealand, the US, Canada and China. FR has active collaborative links with all European member state countries, including:

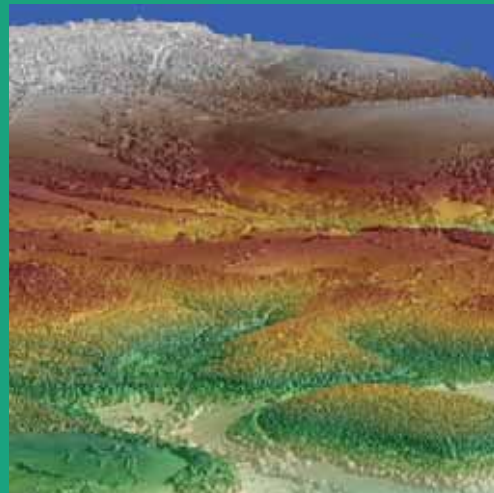
- INRA, France
- Brussels Free University, Belgium
- Plant Protection Service, The Netherlands
- PRI, The Netherlands
- BBA, Germany
- FVA, Germany
- INIA, Portugal
- University of Évora, Portugal
- EFN, Portugal
- Department of Forest Protection, Austria
- BOKU, Austria
- CSIC in Spain
- IMEDEA, Spain
- JRC in Italy
- METLA in Finland
- SLU, Sweden
- Skogforsk, Sweden
- FCBA, France
- FAO, Italy

Further across the globe we are working with:

- USDA in several areas of the US
- SCION in Rotorua, New Zealand
- Canadian Forest Service, e.g. Victoria, British Columbia
- Forest University Beijing, China
- Madeira National Park, Madeira
- INFOR, Chile
- Liaoning Institute of Forest Management, China
- Kerala Forest Research Institute, India
- FABI, South Africa

Biometrics, Surveys and Statistics

For Britain's woodlands to contribute effectively on today's key issues – climate change, biodiversity, economic viability and social value – we must know their size, location and properties. Our experts map and survey woodlands, develop models to predict their growth and potential commercial products, and write computer software for forest managers and policy-makers. We also provide essential help on statistics, database management, software development and geographic information systems.



Modelling rainfall interception

The leaves, branches and trunks of trees all catch rainfall. In heavy or prolonged rain this intercepted rainfall then falls off or runs down the trunk to the ground, whereas on showery days some of it may evaporate and never reach the ground. Rainfall interception influences many different processes and will become increasingly important as rainfall patterns alter due to climate change.

For example, more direct evaporation might worsen water shortages.

We compared ways of measuring and modelling canopy rainfall interception.

After collecting detailed data for one broadleaved and one conifer species, we adapted an existing computer model and used it to investigate different time periods.

For whole seasons, the model was very effective at estimating the different interception components for both species. However, at shorter timescales there was greater disparity between simulation and measurements;

further research is under way to evaluate the reasons for this and improve the model. For more

information, visit www.forestresearch.gov.uk/rainfallinterception



Developing tools for remote sensing

Remote sensing covers a range of techniques for obtaining information about forests without making measurements on the ground. Sensors are carried on planes or satellites and nowadays provide digital images rather than the photographs common just five years ago. Remote sensing in forestry is gaining acceptance as a way of providing information quickly and cheaply. Current applications include software to detect canopy changes (e.g. for monitoring illegal felling), and Light Detection and Ranging (LiDAR) to measure stands and produce thematic maps.

We recently used remote sensing to find aspen trees, a beautiful but rare feature of the Caledonian Forest. Aerial colour images were taken in late spring when most broadleaves were in leaf but aspen had yet to burst bud and was therefore more easily differentiated from surrounding species. Specialist software was then applied to the images (below), which identified and located 87% of the aspen. This technique is much faster and less expensive than field surveys, and we hope that further work will increase its accuracy.

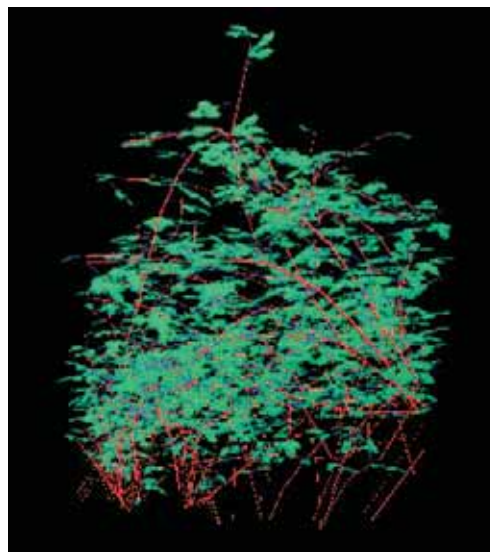


Photography by Caledonian Air Surveys Ltd

Assessing plant architecture

A plant's success depends on its ability to capture light through its leaves and convert it to biomass through photosynthesis. Therefore, the way the leaves are arranged within the crown of a tree will affect the tree's success. Forest Research has been using geometric models to investigate these architectural arrangements in order to improve understanding of how the crown functions.

Using a three-dimensional digitiser linked to tracing software, we constructed virtual images of forest species. In one example, we analysed bramble canopies (see right: virtual image and original). Once the structure could be described digitally, it was possible to work out how much light was available for the growth of each layer of plants, as well as the amount of light reaching the ground below. This research is particularly valuable as forest managers move towards regenerating woodlands using natural processes, where an understanding of canopy architecture is important for managing seedling regeneration in the face of other competing ground vegetation.



Applying statistics to research

How can you tell which results are significant, and which are most likely due to chance? Forest Research statisticians aim to help our researchers do this across a range of scales, from fungal fruiting bodies observed through a microscope, to sampling schemes for all British forests.

Our statisticians model data on damage by pine weevils and summarise information about who walks in our forests, and the activities of squirrels, deer and capercaillie. We analyse data on the growth and quality of trees, and the vegetation that grows under the trees.

Each of these varied applications requires a different approach that reflects the type and amount of data involved, as well as the research objectives and the science itself. This is achieved by selecting the right tools from the ever-expanding toolkit of modern statistical computer packages, modifying them when appropriate.

Making the most of our data

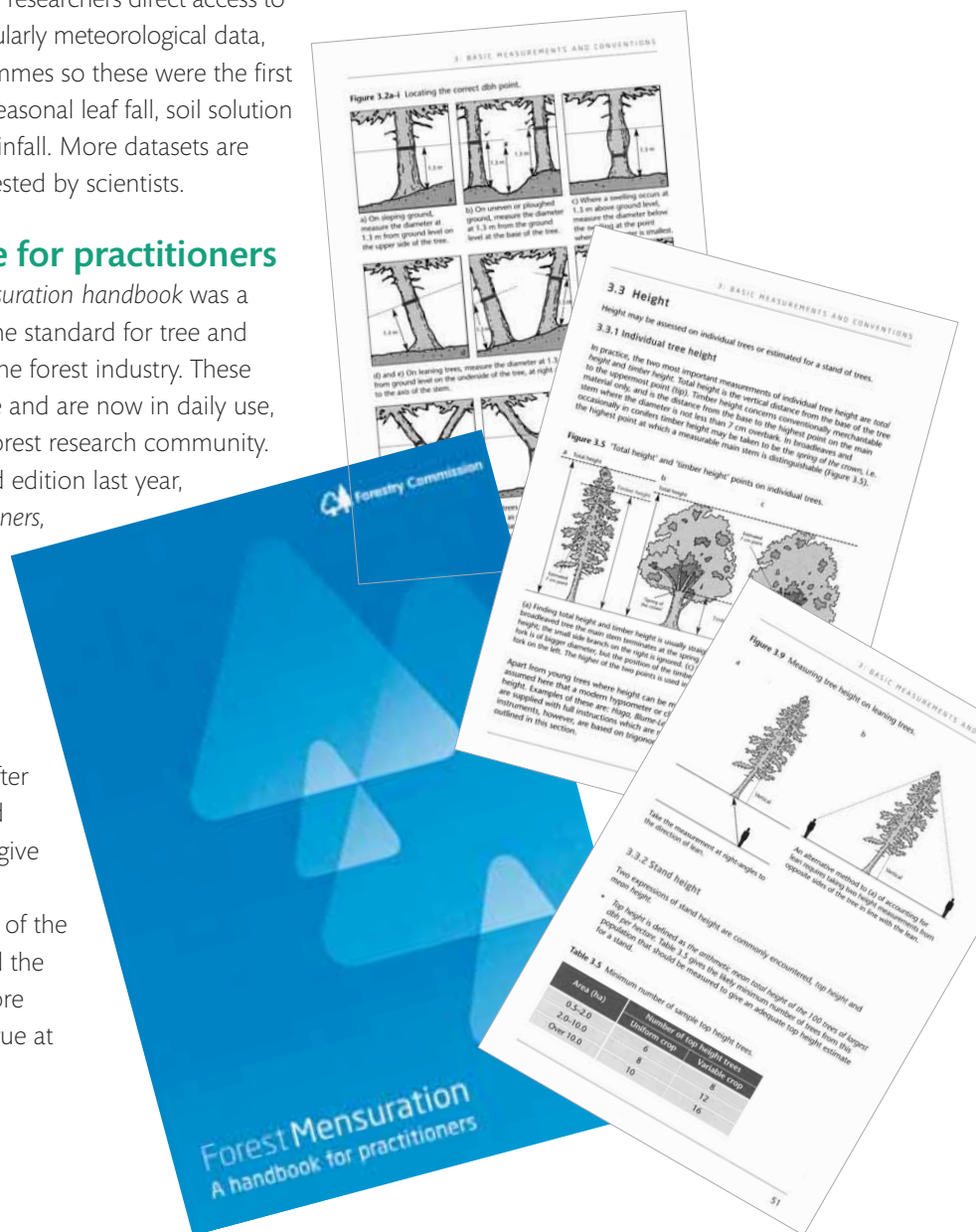
Knowledge-based organisations rely on good data management. Many of the programmes at Forest Research produce datasets of interest to other fields of research. For example, long-term monitoring projects and very intensively monitored plantation forests provide key datasets that allow us to investigate the effects of long-term environmental changes, including climate changes. Our main datasets are held in an Oracle database and managed by our central Data Centre.

To make this information more readily available to all our researchers, we are developing an intranet interface to allow researchers direct access to the Data Centre. Environmental data, particularly meteorological data, are most often requested by other programmes so these were the first to be made available, along with data on seasonal leaf fall, soil solution and deposition of chemical elements in rainfall. More datasets are being made available all the time, as requested by scientists.

Providing essential guidance for practitioners

The first publication in 1975 of *Forest mensuration handbook* was a landmark in British forestry. It literally set the standard for tree and timber measurement procedures used in the forest industry. These procedures gained widespread acceptance and are now in daily use, both in the timber trade and among the forest research community. Nearly 30 years on, we produced a second edition last year, *Forest mensuration: a handbook for practitioners*, which has proved so popular that it has already been reprinted this year.

The most notable changes in the second edition are on procedures for assessing standing volume of timber – i.e. judging how much usable timber a tree will give after felling. The section on assessment of wood quantity by weight has been expanded to give more prescriptive guidance. There are also many other improvements and the format of the book has been revised to help readers find the information they need more easily. For more details, see our online publications catalogue at www.forestry.gov.uk/publications



The second National Inventory of Woodland and Trees

Mark Lawrence and Helen McKay

Woodland is important to many types of user – the public, policy makers and the forest industry. Forest Research is responsible for collecting information on the amount, location and condition of British woodland and trees, by mapping and then surveying them.

In prehistoric times Britain was largely covered with woodland but, by the end of the 19th century, woodland had decreased to less than 5% of land area. The last major survey indicated that, by the end of the 20th century, woodland cover had increased to almost 12% (2.7 million hectares). The next major survey, the second National Inventory of Woodland and Trees (NIWT2), is now underway and has four elements.

First, the baseline map of main woodland blocks is being created. Main woodland is defined as woodland of half a hectare or more, with at least 20% canopy cover or the potential to achieve 20% cover. Woodland areas are divided into Interpreted Forest Types, such as Conifer, and Interpreted Open Areas, such as Grass (Figure 1). The mapping is being carried out by Infoterra and quality-assured by Forest Research; it should be completed by autumn 2009. Up to March 2008, almost one million hectares of woodland had been mapped and quality assured.

Second, a pilot survey will be carried out during 2008–09 to ascertain the timing and costs of measuring the field data required by Scotland, Wales and England, and for international reporting. This will allow Forest Research to finalise the list of woodland properties to be assessed, given the available budget. The pilot exercise will collect data on tree numbers and sizes, woodland structure and management, deadwood, soils, vegetation and veteran trees.

The third element is the full survey of main woodland, which it is estimated will take 6–8 years. Indicative results will be published at the halfway stage. It is envisaged that

some of the sample plots will be revisited regularly to update the NIWT dataset.

Finally, small woods (those of less than 0.5 ha), linear features and individual trees, which were first mapped in the late 1990s, will be remapped, and a proportion surveyed again. These woodlands are often especially important for wildlife, landscape and recreation.

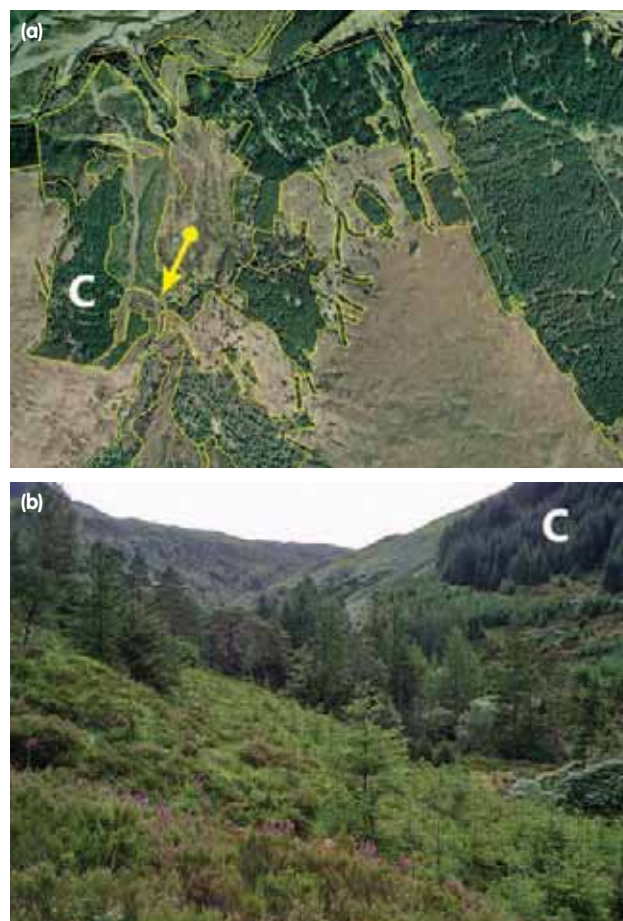


Figure 1 Scottish woodlands: aerial image and ground view. (a) Aerial image, 2005, with boundaries of NIWT2 Interpreted Forest Types.* (b) Ground view, 2006. C represents 'conifer'. The circle and arrow in (a) show the location and direction of the ground view in (b).

*Based upon Ordnance Survey imagery with the permission of the Controller of Her Majesty's Stationery Office; © Crown copyright – Forestry Commission Licence No: 0100021242

The temperature response of photosynthesis

Eric Casella

The concentration of carbon dioxide (CO₂) in the Earth's atmosphere has been rising over the past two hundred years, and rising much faster since the middle of the 20th century, as shown by direct measurements from atmospheric samples and ice cores. This increase in CO₂, and other greenhouse gases, is predicted to produce an increase in mean global temperatures of up to 5.5 °C by the end of the 21st century (Figure 1) unless very significant mitigation efforts are put in place. Temperature is one of the principal controls of the distribution and productivity of forest tree species, with large effects on physiological activity at all spatial and temporal scales. The central role of temperature in tree success was apparent to the earliest biologists and its influence on yield and tree fitness has led to extensive research on temperature effects throughout the modern history of plant biology.

Photosynthesis is the driving process here and is a key determinant of the rate of tree growth. In trees from temperate habitats, photosynthesis operates between 10 and 40 °C (Figure 2). It has an optimum temperature that roughly corresponds to the middle of this range, and

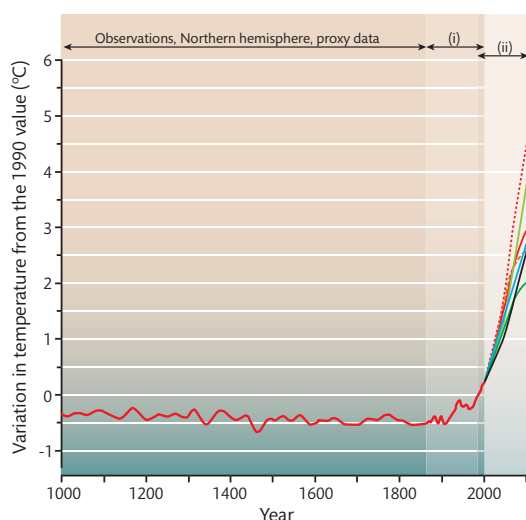


Figure 1 Predicted global averages of surface warming for contrasting climate-change scenarios*. (i) Direct temperature measurements; (ii) model predictions. Different colour lines show different model scenarios.

* Adapted from IPCC Climate change 2001

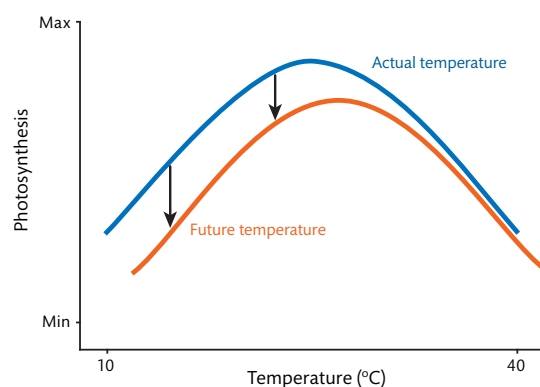


Figure 2 Typical pattern of thermal acclimation expected in temperate tree species.

photosynthesis declines as temperatures rise above or below this optimum. However, some forest plant species can acclimate, or adjust, to temperature changes, as indicated by shifts in the thermal response that will affect photosynthesis. Preliminary work over the past year has shown that the rate of photosynthesis of some poplar trees is adversely affected by an increase in temperature up to the current optimum, although most scientists would expect this to increase photosynthesis. This clearly illustrates that forest responses to increasing temperatures must not be assumed but should be checked experimentally.

Many different aspects of tree growth are affected by climate change, not just in response to temperature but also CO₂, water availability and wind. These responses are numerous and interlinked yet they can only be investigated gradually using experimentation. By adding our results together into mathematical models, we then get an indication of the effects of global warming on the overall function of forest ecosystems. With the predicted greenhouse-gas-induced rise in global surface temperature already under way, the effects of increasing temperature on tree growth and forest ecosystem function have become a major area of work for Forest Research. For more information on our research in this area, visit www.forestresearch.gov.uk/climatechange

Ecology

Our ecology teams work on a wide range of topics connected with the conservation and enhancement of biodiversity in Britain's woodlands and related landscapes. They bring ecological expertise to multi-disciplinary challenges in sustainable forest management and integrated land use. Here, we highlight some of our recent research.



Detecting gene flow and identifying species

Forensic science has demonstrated the powerful use of DNA matching, for example to link crime scenes and perpetrators, but this technique can also be applied to conservation of species and genes. Molecular markers can identify gene flow across landscapes and the concept of forest habitat networks supposes that the networks provide genetic connectivity for woodland species. We are testing this assumption using the wood cricket on the Isle of Wight.

Advances in molecular techniques permit the identification of species from minute traces of DNA. This can confirm the presence of rare species where direct observation is problematic, for example in distinguishing between the scats of pine marten and fox. We have now developed methods to distinguish the droppings of black grouse, red grouse and capercaillie. This will enable the Royal Society for the Protection of Birds to monitor the presence of these birds following habitat management in key reserves. For more information, visit www.forestresearch.gov.uk/geneticconservation



Conserving biodiversity through improved practice

Sustainable forest management, in policy and practice, requires the conservation of biodiversity and attention to the needs of a number of special species. Legal protection for European Protected Species has recently been strengthened by the 2007 amendments to The Conservation (Natural Habitats, &c.) Regulations 1994 and domestic legislation also identifies requirements. Consequently, Forest Research has been refining best-practice guidance for management activities.

The consequences of forest management are often poorly understood, and we target research to fill such knowledge gaps. For example, we are investigating with Plantlife Scotland whether timber extraction during thinning aids the vegetative spread of the twinflower, a rare pinewood plant. Similarly, in the West Midlands, we have been assessing the impact on dormouse populations of thinning, which can enhance shrub layers and thereby food supply.

Findings from this research will be added to the Habitats for Rare, Priority and Protected Species (HARPPS) database. This web-based tool for forest managers will come online later in 2008. For more information, see www.forestresearch.gov.uk/harpps



Understanding vegetation dynamics

Vegetation makes an important contribution to woodland biodiversity in its own right, but also underpins many food webs (i.e. sets of interconnected food chains). Vegetation composition in forests is dynamic and responds to a wide range of factors including tree growth, stand management and herbivory. By understanding the ecological consequences of habitat change, we can determine appropriate management activities.

We are currently working on planned change through the restoration of Plantations on Ancient Woodland Sites (PAWS). We are also investigating vegetation change following clearfelling, and assessing consequences for the conservation of black grouse. Studying natural stand dynamics can help determine how management might emulate or mimic such processes. We have recently resurveyed a number of sites in southeast England that were damaged in the storm of October 1987, looking especially at natural regeneration of trees, and whether the new woodlands are typical of local native woodlands. We hope that this will contribute to learning about how to achieve the conversion of conifer plantations to broadleaved or mixed forests. Further details are available at

www.forestresearch.gov.uk/storm1987

Researching wild herbivores: deer and boar

Wild herbivores produce a range of effects that can threaten the sustainable management and biodiversity of woodlands. However, these impacts are not entirely negative and in some cases it can be beneficial to introduce grazing for vegetation management.

Our ecologists are developing methods that will help make the management of herbivores in woodlands more effective. The impact of deer on vegetation character continues to be an important object of study. We are further refining our population model that enables managers to understand the extent to which deer populations may require management. Data from the Forestry Commission's deer-cull database have helped us to refine some of the population parameters, such as the recruitment rate. Knowledge gained through this work is also informing advice to forest managers about local decisions on the management of wild boar populations in southern England, including the use of culling and the technical specification of fencing. Visit www.forestresearch.gov.uk/herbivoreimpacts for more information on this topic. See also page 33 for details of related work on collaborative deer management.



© Alan Watson Featherstone/Trees for Life

Applying habitat networks to urban areas

Habitat networks link and expand individual habitats, and can reverse the effects of fragmentation on biodiversity. They can also deliver social and environmental benefits such as enhancement of local landscape and improved public access. There is growing interest in applying concepts derived in landscape ecology to planning and management of peri-urban and urban areas, and in particular to enhance the value of greenspaces within them.

We have recently conducted a study for the Scotland and Northern Ireland Forum for Environmental Research (SNIFFER) to explore the concept of urban networks for people and biodiversity. We considered whether it was possible to meet the multiple needs for public health, education, biodiversity and ecosystem functions in planning multi-functional green networks. The application of our least-cost approach, the Biological and Environmental Evaluation Tools for Landscape Ecology (BEETLE) model seemed particularly suitable – see www.forestresearch.gov.uk/beetletools. We are now progressing this work in collaboration with the Glasgow and Clyde Valley Green Network programme, with a view to improving the quality of greenspaces in that area.



Investigating communication on zoonotic diseases

How can we best warn countryside users about the potential for animal-related disease without scaring them away or spoiling their enjoyment? Surprisingly little is known about how best to encourage appropriate behaviour, even when the precautions are simple. We have recently begun a project to assess and communicate animal-disease risks for countryside users, with support from the Rural Economy and Land Use programme (RELU). We are working with the Universities of Oxford and Surrey, and the interdisciplinary team includes ecologists, psychologists and sociologists.

The project focuses on Lyme disease, caused by a bacterium *Borrelia burgdorferi* sensu lato (Bb) that is found in a number of wild animal hosts and which can be transferred to humans by infected ticks. This disease is being used as a model because it is relatively well understood, appears to be increasing in Britain, and there has been speculation that land use and climate change might make it more prevalent. We hope to help those involved in the countryside to understand how to deal with diseases such as Lyme disease, how to communicate the degree of risk effectively, and how to encourage appropriate precautionary behaviour while allowing the countryside to remain a source of pleasure and well-being for its users. For further details, visit

www.forestresearch.gov.uk/animaldiseaserisks

Climate change: impacts and adaptation in Scotland

Duncan Ray

Forest Research has recently completed work for Forestry Commission Scotland to help advise on the impacts of climate change on Scotland's forests, and suggest how the industry might adapt. The work includes new spatial modelling research using Ecological Site Classification to assess the impact of climate projections on changes in tree-species suitability, and preliminary suggestions to modify forest management. Although a more detailed analysis will follow, the findings provide important new insights, and a basis for strategic forest planning. Forestry is a long-term activity, and trees planted now must be suited to site and climatic conditions both now and in the future.

Key findings include:

- A warmer climate and increased atmospheric concentrations of CO₂ will improve tree growth throughout Scotland. Where water and nutrients are not limiting, annual growth could increase by 2–4 cubic metres per hectare for conifers.
- Southern and eastern Scotland will become more favourable for growing high-quality broadleaved trees on suitable deep and fertile soils.
- Droughty soils in eastern Scotland will become unfavourable for Sitka spruce and other drought-sensitive species (Figure 1).
- Changes in the seasonal distribution of rainfall will cause more frequent summer drought and winter flooding.
- There will be changes in the ecology of pests and diseases.

It is likely that low-impact silvicultural systems and the use of mixed species will spread risk and provide a basis for adaptation strategies. Patch-clearfell silviculture could be modified to include a wider range of tree species to increase stand resilience to climatic stress. Conditions are currently suited to many non-native tree species, and there may be a strong case for accepting the colonisation of beech and sycamore as a valid adaptation strategy in



Figure 1 Damage to a Sitka spruce following the dry summer of 2003. (a) Longitudinal lesions on the stem; (b) crack exposed after removing the bark.

some native woodlands. Changing rainfall patterns may require adjustments to operational practices to prevent site damage on wet soils, and forest nurseries will need to adapt to drier summers (e.g. more irrigation) and wetter winters (e.g. avoiding soil damage). Contingency plans should provide guidance for an effective response to increasing risks, such as fire, wind damage, and pest and disease damage.

Further research will assess impacts and adaptation strategies as new regional climate projections become available. For more information, please see www.forestresearch.gov.uk/climatechangescotland

Genetic fingerprinting of black poplar planting stock

Joan Cottrell and Sam Samuel

Native black poplar (*Populus nigra* var. *betulifolia*) is one of Britain's rarest native trees, with only 7000 specimens thought to remain. A long history of vegetative propagation, with transfer of cuttings over wide geographical areas, means that the number of clones present in the British population is much lower than the number of trees. Planting stock for woodland establishment falls under the control of the Forest Reproductive Material (FRM) Regulations (2002) which require marketing to be based on the clear identification of individual clones where vegetative propagation is used as the means of plant production. In the absence of any clear morphological or other features that can be ascribed to individual clones, molecular markers must be used to provide unequivocal identification.

Fourteen registered suppliers of commercial planting stock provided 83 samples of material from putative individual clones that they hold as sources of cuttings. A DNA fingerprint for each sample, based on six microsatellite markers, was established using a Licor sequencer (Figure 1). This revealed only 14 distinct clones among the 83 samples. A further molecular test indicated that one of these clones was in fact a hybrid between black poplar and another, non-native poplar species. Information on gender was available for some of the samples, and indicated a high proportion of male clones.

These findings reinforce earlier work and emphasise concerns about the genetic base of material being planted in Britain. The results will be used to rationalise current sources held by suppliers. They suggest that efforts to



Figure 1 Loading samples of amplified DNA from black poplar on to a gel in a Licor sequencer.

broaden the genetic base are unlikely to be successful without routine fingerprinting of all potential new trees selected for propagation work. This applies not only to commercial producers, but also to a range of local conservation initiatives. It is clear that a coordinated approach to widening the genetic constitution is necessary. The provisions of the FRM Regulations can be employed to certify individual clones being used, and to monitor progress in these objectives – more information on FRM Regulations can be found at

www.forestry.gov.uk/frm

Environmental and Human Sciences

Our environmental and human sciences research helps to ensure that evolving forestry policy and practice enhances the environment and people's lives, especially in response to global concerns such as climate change. It draws from expertise across the environmental, social and economic disciplines, and is increasingly multidisciplinary in approach. Our findings help to shape guidance for practitioners, as well as contributing to government policy.



Understanding the interaction of air pollution and forest functioning

Over the past 20 years, the UK has introduced policies to reduce pollution and lessen its effect on the environment. One way in which pollution most easily disperses into the environment is via rainfall. Our researchers have been evaluating the long-term trends in rainfall and dry deposition across the UK's intensive forest-monitoring network. Results have shown evidence of changes in important deposition chemistry, confirming the success of emission-reduction policies. Long-term trends at these sites also show definite, if slow, ecosystem response, with both chemical and biological recovery already observed.

Detailed analysis suggests that biological elements are an important influence on the forest chemical cycle. This is particularly significant as many insect pests may become more prevalent due to climate change, and more frequent and severe summer droughts will make trees increasingly susceptible to biotic agents. The integrated nature of intensive monitoring across the network enables the relationships between climate, pollutant exposure and chemical and biological response in forestry to be further explored. For more information visit www.forestresearch.gov.uk/l2trends



Protecting salmonid fish from climate warming

Some species of fish such as salmon and trout are very sensitive to water temperature, and so are believed to be at risk from climate warming. This is generating increasing interest in the role of riparian woodland in mitigating thermal stress. Forest Research is working with Southampton University in the New Forest to evaluate the influence of woodland shade on stream temperature and fish populations. Results show that water temperature in open grassland sections on hot summer days regularly exceeds the lethal limit of 25 °C for brown trout, increasing the risk of fish death. In contrast, maximum stream temperatures rarely rise above 20 °C in wooded sections.

This confirms the important role of riparian woodland in providing a cool-water refuge, protecting fish and other aquatic life from summer warming. These results are being used in modelling work to develop guidance on the optimum design and management of riparian woodland for mitigating climate warming. The guidance will cover species choice, woodland structure and woodland cover, for example. For more details, visit www.forestresearch.gov.uk/riparianshade

Mapping ozone injury to trees in Europe

Ozone is naturally present at ground level in low concentrations, but levels have been slowly increasing in recent years. Above a certain concentration, ozone can cause visible injury to the leaves of plants and trees. Forest Research has recently completed work on using biological monitors – or biomonitors – to map and monitor the effects of ozone by assessing visible injuries in commercial tree nurseries across four European countries. Tree stock in these nurseries is normally irrigated and therefore not subject to water stress, which can limit ozone uptake in woodland and forests. Meteorological and ozone-monitoring data from the sites were used to calculate cumulative ozone flux during the summer months when trees were monitored.

Ozone injury was observed in all countries, demonstrating that impacts are not restricted to Central and Southern Europe where higher ozone concentrations are experienced. In Northern Europe, longer day-length and higher moisture availability compensate for lower ozone concentrations with enhanced uptake. The highest ozone flux and the most extensive damage was found in Switzerland. The UK had the lowest fluxes and least injury, with damage here confined to late summer in the Southeast. However, ozone fluxes were lower than in previous years, so there may be more severe damage in future.



© Talliesin Communications

Evaluating social benefits of community woodland programmes

Forest Research is evaluating progress of Cydcoed*, a £16 million, seven-year community woodland programme, funded by Forestry Commission Wales (FCW) and the EU Objective One programme for West Wales and the South Wales Valleys. The programme aims to help community groups influence local decision-making, and its project groups have almost 8000 local members, with around 18,000 schoolchildren involved in activities. Forest Research is providing an independent assessment of the project, analysing the extent to which its longer-term desired outcomes are being achieved. These include:

- community groups being empowered to influence decisions about their locality
- woods providing long-term local social, economic and environmental benefits, and
- individuals playing a positive role in their community

We are evaluating the programme's effects on community networks, governance, and health and well-being within communities; economic analysis will provide information on the public benefit of the programme. We are also considering the Programme's contribution to wider FCW and Welsh Assembly objectives. FR's final report, due in August 2008, will help shape social forestry policy and programmes for FCW. For further information, visit

www.forestresearch.gov.uk/cydcoed

* Pronounced 'keed koyd'. From Welsh, Cydcoed literally translates as 'shared (cyd) wood (coed)' or 'woods for all'.

Researching collaborative deer management

Wild deer are highly mobile animals that interact with people in many ways, both good and bad. However, as wildlife is not 'owned' by anyone, no one has legal responsibility for the impacts or management of wild animals, yet clearly they need to be considered and, if necessary, any matters of concern need to be attended to by someone. This presents a complicated management challenge to landowners and land managers. To address this issue, Forest Research, in partnership with other institutions, is carrying out interdisciplinary research into collaborative approaches to land management.

Collaboration is widely used and studied in the natural resources field and brings a range of benefits, including an integrated management framework, resource efficiencies and the avoidance and resolution of conflict. Our research includes an analysis of stakeholder organisations and their collaboration at a national level, a review of the evolution of deer-management legislation and local case studies in Dorset and Herefordshire.

We have also investigated how different social groups perceive and describe woodlands, wish to see them managed and respond to scientific information about them. Early analysis suggests little difference between how separate groups prefer to see woodlands, but rather that they frequently describe these preferences using different terms and phrases. This indicates clear potential for successful collaborative management, once these differences are understood. For further information, visit www.forestresearch.gov.uk/reludeer; see also page 26 for details of related ecology research into herbivore management in woodlands.



The impact of forest management on forest recreational use

David Edwards and Mariella Marzano

The EU-funded project EFORWOOD is developing a computer-based tool to assess the sustainability of the European forestry-wood chain under a range of future scenarios. The project began in November 2005 and will run for four years. Forest Research is contributing to several elements of the project and is leading a team of researchers on the topic of 'social and cultural values'. The overall aim of this topic is to assess the impacts of changes to forest management on social and cultural values (SCVs) associated with forests in Europe.

Research began with a review of SCVs and indicators used for monitoring and evaluation within the forestry sector worldwide. A generic SCV indicator framework was developed, based on 9 themes, 42 sub-themes and 72 indicators. The review highlighted the difficulties of attempting to quantify and model SCVs, many of which are intangible and hard to separate from each other, for example 'quality of life' and 'well-being'. For this reason, the indicator 'recreational use' was chosen for further research, since it can be easily evaluated, for example as number of visits per hectare per year, and because it can also act as a proxy for the intangible benefits gained by the public from direct use of forests.

A comprehensive study is now being conducted to bring together existing knowledge of public preferences for visits to forests (Box 1) with different attributes in different parts of Europe. The attributes considered are both silvicultural, such as age, density and species, and non-silvicultural, such as recreational facilities and services. Workshops will then be run with European experts to help synthesise and refine the conclusions. A case study is also being carried out in Craik Forest in the Scottish Borders (Figure 1) to explore the preferences of local forest users. Through these methods, it should be possible to determine the direction, and approximate scale, of impact on visitor preferences caused by specific changes in forest management. In this way, the research seeks to develop 'recreational use' as a

qualitative indicator within the EFORWOOD impact-assessment tool. Further details of this work are available at www.forestresearch.gov.uk/eforwood

Box 1 Public preferences for forest characteristics

Public preferences for forest recreation tend to increase with the following changes to the silviculture of individual forest stands. These relationships are being examined, and where possible quantified, as part of this research.

Species:	More broadleaves, fewer conifers (in UK), more species
Age:	Increased stand age, older individual trees
Density:	Decreased stand density, more visual penetration, moderate thinning, less clearfelling and more natural regeneration
Ground cover:	Less slash, residue and products on-site; more ground vegetation – but not too much
Appearance:	Natural and semi-natural-looking, but not completely wild; 'park-like' in appearance



Figure 1 Craik Forest: what do local recreational users want?

Ecological risk assessment

Danielle Sinnett, Cécile De Munck and Tony Hutchings

Past industrialisation in the UK has resulted in a legacy of contaminated land. The Environmental Protection Act 1990 defines land as contaminated where it presents a significant harm or the risk of significant harm to any defined 'receptors'. Ecological harm is restricted to specified receptors such as Sites of Special Scientific Interest (SSSIs) or National or Marine Nature Reserves (NNRs and MNRs). An ecological risk assessment (ERA) should be conducted where contaminated sites are likely to affect these ecological receptors. An ERA may also be necessary where greenspace establishment is planned on contaminated sites, in order to ensure that there is no risk to the created habitats.

Environment Agency guidelines for conducting ERA on contaminated land recommend eco-toxicological tests, including assessments of plant germination and growth, soil-microbial function and health of soil invertebrates. Soil fauna tests are relatively simple, cheap and reliable. However, the vegetation tests primarily use food crops, which may not be ecologically relevant to greenspace created on contaminated land. In addition, no consideration is given to the transfer of pollutants through the food chain.

Forest Research is currently investigating the use of a number of plant species commonly found on urban greenspace in order to provide more relevant species for ERA. The accumulation of metal contaminants into stinging nettles (*Urtica dioica*) is also being studied, as is the resulting food-chain transfer into primary plant consumers. Results have demonstrated that stinging nettles are extremely tolerant of elevated concentrations of cadmium and zinc, and are able to accumulate significant concentrations within their above-ground biomass without any apparent toxicological effect (Figure 1). The cadmium and zinc within the plant tissues are subsequently transferred to aphids, snails (Figure 2)

and earthworms at levels that may be expected to present a risk to predators. Results are currently being used to develop a modelling platform to estimate the risk of metal food-chain transfer to higher organisms. This work is being conducted as part of the EPSRC-funded Pollutants in the Urban Environment (PUrE) research consortium. For more information on this subject, visit www.forestresearch.gov.uk/eiaurban



Figure 1 Stinging nettles growing in zinc solution.

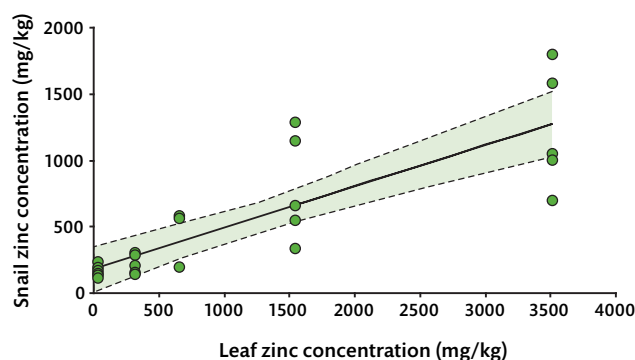


Figure 2 Concentration of zinc in snails as a function of zinc concentration in nettle leaves. Zinc-uptake model (solid line), with standard errors (dashed lines) and data (x) for snail soft tissue.

Forest Management

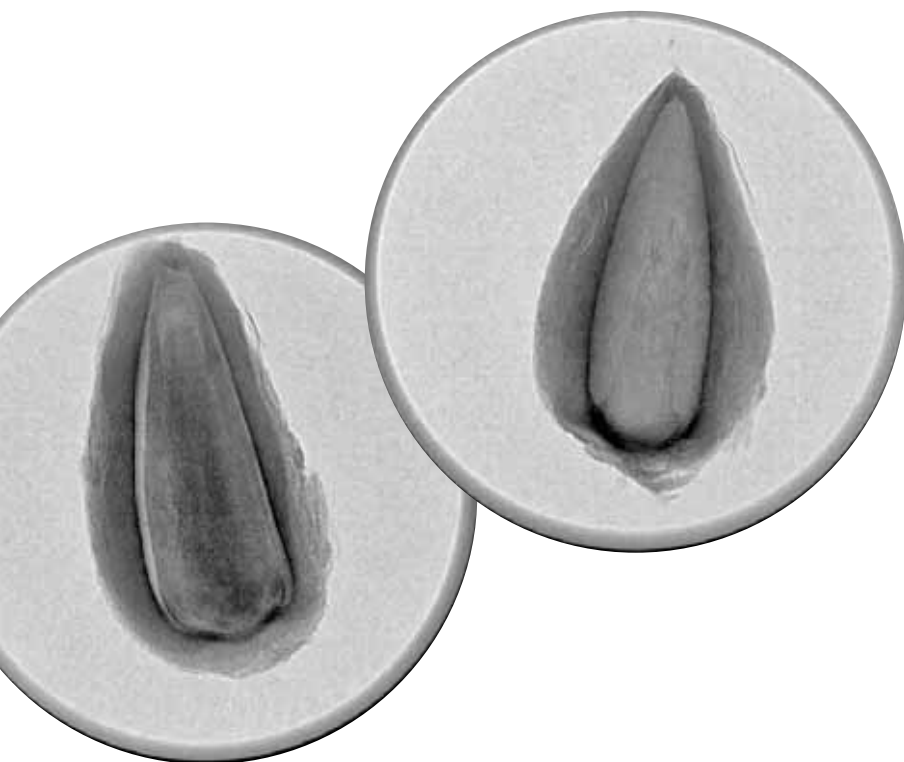
Our Forest Management research group carries out research and development covering all aspects of sustainable management of the forestry-wood chain, from seed or plant through to the wood products harvested from the forest. Here are some examples of our current work.



Conserving native trees – problems of seed viability

Attempts to conserve or propagate many British native trees are hampered by the absence of any quick or even reliable methods to screen seed quality. This results in empty or dead seeds being used alongside viable ones. Our seed scientists recently used X-rays to differentiate between 'filled' (see below left) and 'empty' (below right) seeds of juniper, one of three native conifer species. The seeds were then cut open to confirm whether they were filled or empty, and the filled seeds were stained with tetrazolium (TTZ), which distinguishes live seeds.

The X-ray and cut tests produced very similar results but, most excitingly, filled seeds were more often correctly identified by X-rays when the seeds were 'filled and live' than when they were 'filled and dead'. This suggests that the X-ray test could be used to identify viable seeds without destroying them. A non-destructive test for seed viability has long been sought, and may now be within sight for this species. For more information, see *Raising trees and shrubs from seed*, available at www.forestresearch.gov.uk/seedbiology



Investigating fallow strategies to control pine weevils

The large pine weevil, *Hylobius abietis* is the most significant insect pest in commercial forestry in Great Britain, feeding on young transplanted seedlings and causing heavy losses during restocking of forest sites. To reduce the use of pesticides, we are investigating alternatives to the chemical protection of plants. One option being assessed is to leave clearfelled sites fallow for up to five years until *Hylobius* populations have stabilised to naturally low levels. The success of this approach depends on the amount of weed growth during the fallow period, since heavy regrowth would require ground preparation and intensive herbicide application.

During summer 2007, we surveyed a range of sites felled between one and five years ago, each typical of upland Sitka spruce sites in northern and western Britain. Analysis of vegetation growth in relation to soil, climatic conditions and time since clearfelling is still in progress, but preliminary results suggest that most sites show appreciable vegetation regrowth by 3–4 years after felling. For more information, visit

www.forestresearch.gov.uk/hylobius

Predicting rhododendron colonisation

Rhododendron ponticum is an invasive, non-native shrub that has colonised a range of natural habitats since its introduction into Britain around 240 years ago. Controlling rhododendron can be expensive, and we are investigating strategic approaches to provide value for money. In a case study in mainland Argyll and Bute, western Scotland, we mapped known populations and used a landscape ecology habitat network analysis model (called BEETLE) to predict future expansion over 20 and 50 years.

The model identified habitats vulnerable to rhododendron colonisation and predicted expansion rates by both seed dispersal and shoot layering. Current populations will cost around £12.5 million to control, and costs could increase by 23% after 20 years and 58% after 50 years. In a worst-case scenario, populations could expand by up to 350%, placing an additional 15,000 hectares at risk of rhododendron colonisation. This information is being used to inform rhododendron control strategies in western Scotland. More details are available at www.forestresearch.gov.uk/rhododendroncontrol



Managing forests on steep ground

Practising forestry on steep ground can be expensive and technically difficult as slopes of more than 35% can hinder the working of forest machinery. Some forests on steep ground have been neglected over the past 20 years, especially while the timber market was poor. However, there is now increasing demand for timber from these forests, yet steep sites still require careful management to ensure conservation and landscape benefits while avoiding safety risks such as landslips.

Forest Research has contributed to developments in mechanised harvesting techniques that have enabled wheeled and tracked machines to move onto steeper areas traditionally worked by felling with chainsaws and cableway extraction systems. Consequently, production has risen, ergonomic working conditions have improved and costs have been reduced. However, equivalent development is still needed for ground-preparation systems for restocking on steep sites. We are now focusing on establishing an integrated approach to sustainably managing forests on steep ground.



Introducing continuous cover forestry – a long-term example

Continuous cover forestry (CCF) can provide visual and environmental continuity in sensitive landscapes and is being promoted in country forestry strategies. However, successful CCF requires long-term continuity of management. In 1952 a trial was started in Glentress forest, south of Edinburgh, to transform 120 hectares of plantation forest into an irregularly structured mix of Norway spruce, European silver fir and beech. The goal was to complete the transformation in 60 years by felling and replanting small gaps (0.01 to 0.02 ha), but over time, larger gaps (around 0.15 ha) have been adopted. Browsing damage by deer and sheep required a wider range of species to be planted, and since the 1980s there has been greater natural regeneration. We now estimate that the transformation will be complete by 2033, some 20 years later than initially planned.

Supported by the Scottish Forestry Trust, Forest Research is undertaking a new survey of the trial area to assess the changing structure of the forest. The results will contribute to future guidance on CCF management for forest managers throughout Britain. Visit www.forestresearch.gov.uk/ccf for more details.

Using acoustic tools to assess timber quality

Timber used in construction must meet specific requirements for mechanical properties. However, these properties can vary substantially between trees – and even within a single tree – so being able to assess them in standing trees and felled logs would greatly help in the allocation of material to specific end-uses. It would also help to avoid sending unsuitable wood to timber mills for processing, only for it to be downgraded later.

Portable acoustic instruments have recently been developed to measure *in-situ* wood properties. Working with partners in the wood-processing industry, we have been evaluating the use of these instruments with Sitka spruce and Scots pine. Trials show that acoustic tools can segregate wood effectively, and can be easily used on standing trees, logs at roadside or in the sawmill yard. These tools are now starting to be used commercially, and research is continuing to develop them further as a means of improving efficiency and profitability within the wood supply chain. More information is available at www.forestresearch.gov.uk/timberproperties



Managing wind risk to forests in northern Europe

Bruce Nicoll, Barry Gardiner, Juan Suarez and Stephen Bathgate

In January 2005, a catastrophic storm damaged 85 million cubic metres of timber across northern Europe – ten times the annual production of UK forests. The STORMRISK project, funded by the EU through the Interreg North Sea Programme, was established to gather knowledge of managing forest wind damage, and to make it accessible to forest owners, managers and planners. The project is a partnership of forestry companies and research organisations from Sweden, the UK, Germany and Denmark. Forest Research was invited to participate because of its experience in modelling and mitigating the effects of wind on forest stands.

A version of FR's successful ForestGALES wind risk model can now be applied in other countries bordering the North Sea. This system is accessed via the internet and calculates risk to forest stands based on local wind data and user-provided stand characteristics. Outputs include critical wind speeds expected to overturn trees, and the likely return period of such wind speeds.

During 2007, ForestGALES was applied at the landscape scale for a STORMRISK case study in Glen Affric, Scotland, using data from the Forestry Commission's sub-compartment database to predict current and future risk (Figure 1). This risk assessment has since been used in the local design planning process. To improve calculations of wind risk to stands with an uneven structure, and to develop a method of assessing risk using remote sensing data, Glen Affric has also been scanned using air-borne LiDAR (light detection and ranging). This technique uses laser pulses that can 'see' through forest canopy (Figure 2). The resulting data were analysed to provide the tree dimensions required by ForestGALES. Development of this link between remote sensing data and ForestGALES provides a method for detailed assessment of wind risk in complex forest structures.

Forest wind risk management must consider a changing climate. Predictions of climate change for northern Europe include an increased frequency of extreme wind events and

increased rainfall. Together these are expected to increase the risk of windthrow over the next fifty years. Advice on management of forests for wind risk in a changing climate, based on experiences from each participating country in STORMRISK, as well as the latest developments in wind-risk modelling, is available in an online toolbox (www.stormrisk.eu). For more information on the STORMRISK project visit www.forestresearch.gov.uk/stormrisk

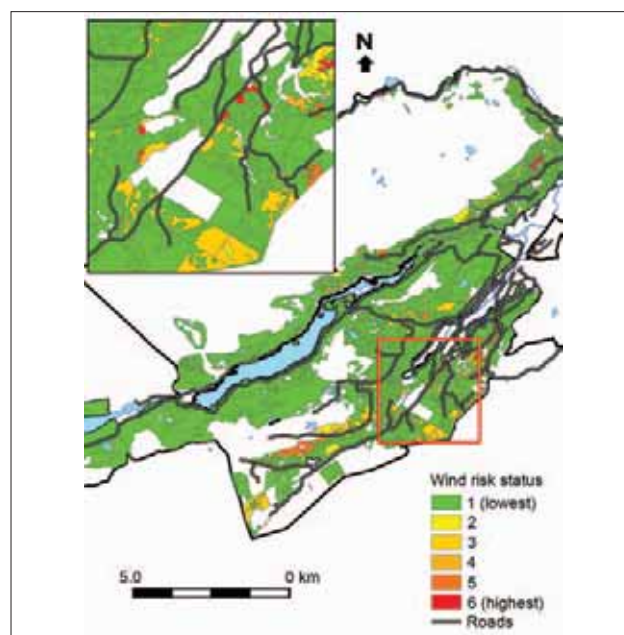


Figure 1 Geographic information system (GIS) map of wind risk in Glen Affric (areas of highest risk are shown in red).

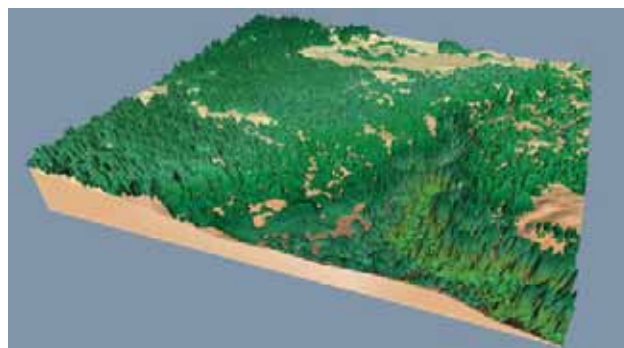


Figure 2 Three-dimensional view constructed from air-borne LiDAR data, showing a section of forest in Glen Affric.

Impact of whole-tree harvesting on the growth of Sitka spruce

Bill Mason and Helen McKay

Whole-tree harvesting (WTH) is the removal of most branches and needles ('brash') from a harvesting site, in addition to the stem wood removed in conventional harvesting. Government initiatives to increase the percentage of energy generated from renewable resources have enhanced awareness of the potential importance of various types of wood fuel, including brash, as energy sources. However, there is some concern that removing branches and needles is detrimental to soil sustainability on particular sites and reduces tree growth.

Further information on the effects of WTH on subsequent growth is provided by three experiments in Scotland established during the 1990s. These examine the impact of intensive residue removal after clearfelling on the growth of Sitka spruce, tree nutrition and ground vegetation, and the interaction of residue removal with applications of fertiliser and herbicide. The soil types in the experiments vary in fertility to cover the range of nutrient risk categories identified by existing WTH guidance; see www.forestresearch.gov.uk/brashremoval for guidance notes. Growth in these experiments has now been monitored for at least 10 years, which is the age when nutritional limitations become most obvious. At all sites, both brash retention and fertiliser application had significantly beneficial effects on tree growth, although the magnitude of these effects varied. Figures 1 and 2 show comparative results at Moray, the nutritionally poorest of the three sites. No effects of herbicide application were evident after 10 years.

These findings suggest that intensive brash removal has the potential to deplete soil nutrient capital and reduce subsequent tree growth at the majority of upland forest sites, with an ultimate loss in timber volume. This effect was found even on an upland brown earth soil, which would be considered a low-risk site under current guidance. Applying fertiliser boosted growth on all sites and there was a positive interaction between brash retention and fertiliser application. This suggests that it could be possible to offset the nutritionally detrimental impacts of WTH by fertilisation,

using either chemical fertilisers or possibly with wood ash. The compatibility of such remedial treatments with forest certification standards and the desire to reduce chemical inputs in forest management remains to be determined.



Figure 1 Sitka spruce growth 10 years after whole-tree harvesting at Moray, brash removed and no fertiliser applied: reduced growth.



Figure 2 Sitka spruce growth 10 years after whole-tree harvesting at Moray, brash retained and fertiliser applied: increased growth.

Tree Health

This year's research into tree health has included a number of topics on the general health of trees, as well as specific new research into aspects of climate change and alternative silviculture systems. It is notable that declining health in broadleaved trees frequently features the genus *Phytophthora**, reflecting the increasing impacts of existing and exotic representatives of this highly damaging pathogen. Here, we outline some of our recent work.



* The name *Phytophthora* derives from the Greek for 'plant destroyer', a particularly apt term in the context of our experience of this organism.

Investigating the causes of alder dieback

In northern Britain, alders can suffer from Phytophthora disease (caused by the pathogen *Phytophthora alni*) and from the less well-understood condition of alder dieback. While Phytophthora disease is relatively rare in this region, and has only been recorded in Scotland since 1999, severe and sometimes extensive dieback of alders has been happening for much longer in the north and west of the country. Forest Research has been monitoring several Scottish alder populations since 2000. We have found that alder dieback is episodic, with trees severely affected only in particular years.

Although one or several episodes of dieback can result in tree death, recovery is possible because the root systems usually remain alive. Death of the aerial parts of trees that succumb to dieback is rapid, however, and lesions on partially dead branches usually bear fruit bodies of the ascomycete fungus, *Valsa oxystoma*. Recent laboratory study has shown that *V. oxystoma* can be present within healthy alders, and we are investigating the conditions favouring its development in order to identify factors that may predispose alders to dieback.



Analysing trends in reports on oak decline

Over the past two years, more than 50 reports have been sent to the Forest Research Disease Diagnostic Advisory Service about a resurgence in oak decline. Affected trees show symptoms of dieback, and the worst affected often have copious bleeding on the trunk. As in the early 1990s, many reports comment on the acute and rapid nature



of the decline. In some areas, particularly central and southeast England, high proportions of trees are affected and many have died or had to be removed within just 3–5 years of the first foliar symptoms becoming apparent.

The exact reasons for the current episode of oak decline remain unclear, but reduced water availability in soils may have been an important trigger. Some of the highest mean annual temperatures ever recorded in Britain occurred during 2002–2007, and 2003 and 2006 were notable drought years. For more details, visit

www.forestryresearch.gov.uk/oakdecline

Protecting against oak processionary moth

Oak processionary moth (*Thaumetopoea processionea*) was found as feeding larvae in the UK for the first time in 2006. This pest has long been native in continental Europe, and its caterpillars can cause serious damage to oak and other broadleaved trees by feeding on the foliage. They are also a risk to animal and human health, as the hairs on the caterpillars cause severe irritation.

In 2007, Forest Research supported the Forestry Commission's new Outbreak Management Team, which was set up to aid co-ordination of a survey, control measures and the dissemination of information on the newly arrived pest. Analysis of the likely pathway of arrival of the moth in the UK suggests very strongly that this was live plants for planting. A formal Pest Risk Analysis was carried out in 2007 and used to support the setting up of the UK as a Protected Zone and designation of oak processionary moth as a regulated pest. For more information see www.forestresearch.gov.uk/oakprocessionarymoth



Developing strategies to control Phytophthoras

We are continuing work on the pathogens *Phytophthora ramorum* and *P. kernoviae* with new studies on trees in the Magnoliaceae family, including *Magnolia*, *Michelia* and *Liriodendron*, which are highly susceptible to the pathogens. These trees are valuable culturally, especially in heritage gardens, as well as being important horticultural and genetic resources. Chronic infection of mature magnolias causes blemishing, gradual defoliation and canopy thinning, sometimes leading to death of the tree.

As part of efforts to develop an integrated management strategy, we investigated the effect of injecting the fungicide phosphonate into tree stems before bud burst. This treatment aims to prevent reactivation of the pathogen in the growing season, and to bolster the plants' natural defence mechanisms against *Phytophthora* attacks in the spring. We found that the stem injection was very effective at delivering the chemical to the leaves but that it persisted there only briefly. Application of phosphonate by injection appears to offer the best potential for treatment, but we need to investigate further to confirm the efficacy and determine the optimum doses.

Assessing climate change effects on pests and pathogens

Increasing temperatures, changing rainfall patterns and increasing climatic variability are just some of the likely consequences of climate change in the UK. Such changes may alter the distribution, abundance and impacts of forest pests and pathogens over the coming decades, and so will influence how forestry adapts to a changing climate.

One effect of a warmer climate – in winter as well as summer – is that the growth and development rates of insects will increase. We have been investigating how this will affect insect lifecycles across the UK, an important first step in assessing future pest-risk profiles, allowing us to anticipate and therefore manage the impacts on trees and forests.

The main focus of our current research is the development of models of the rates of lifecycle development of pests (phenology models). Future research will include the study of climate impacts on pathogens and how the health of long-lived trees such as oak will be affected as the climate changes around them.



Monitoring pests under changing forest management

One of our new projects, Impact and Diversity of Insects in Alternative Management Systems, focuses on changes in the management and structure of Sitka spruce plantations, particularly conversion to continuous cover forestry (CCF) and other low-input systems. In particular, we hope to establish whether alternative systems will realise benefits in terms of increased invertebrate biodiversity and reduced damage from potential pest species.



During 2007, we carried out a full season of insect sampling at study plots in Clocaenog Forest and Cefn Llwyd in North Wales. The samples were dominated by high numbers of green spruce aphid (*Elatobium abietinum*) and leaf weevils (*Phyllobius* and *Polydrusus* spp.). These species were exceptionally abundant during the early part of the year and, although common throughout the study area, they were particularly numerous in the shelterwood plots, with natural regeneration below standing mature trees. For more information see

[www.forestresearch.gov.uk/
managementpestimpact](http://www.forestresearch.gov.uk/managementpestimpact)

New findings on the threat from Phytophthoras

Sandra Denman, Joan Webber, Anna Brown and Clive Brasier

The warm, wet summer of 2007 promoted disease caused by *Phytophthora ramorum* and *P. kernoviae*. Discovered 4–5 years ago, and considered recent introductions to the UK, these pathogens are a significant threat to woodland ecosystems. Both attack the foliage of shrub species such as *Rhododendron* and *Pieris*, where they produce zoospores (Figure 1). With heavy infestations of these foliar hosts, nearby trees become infected, resulting in extensive bark killing and even death of the trees. Beech is most at risk from both pathogens, but *P. ramorum* can cause potentially lethal cankers on various trees, including oak, southern beech and sweet chestnut (*Quercus cerris*, *Q. rubra* *Nothofagus obliqua*, and *Castanea sativa*).

Since 2003, over 150 *P. ramorum* outbreaks have been detected on shrubs in gardens and woodlands, mostly in England, but trees have only been infected at about eight sites. There have been about 50 *P. kernoviae* outbreaks, most in Cornwall with a few in Wales, but only ten have affected trees. Efforts at eradicating or containing the disease in woodland concentrate on destroying infected foliar hosts – mainly *R. ponticum*. However, Forest Research scientists have found that, even when foliar hosts are removed, both pathogens can persist for at least 1–3 years in soil and litter layers.

More recently, late in 2007, *P. kernoviae* was found infecting native bilberry plants (*Vaccinium myrtillus*) in Cornwall, in an ancient semi-natural woodland within a World Heritage Site. In early 2008, *P. kernoviae* was found for the first time on rhododendrons in gardens in Argyll and Arran, Scotland. In both instances, it is uncertain how disease spread to these new locations.

The plant trade is considered to be the most significant pathway for spread of these pathogens, and phytosanitary measures rely on visual inspections to detect infected plants. However, Forest Research has found that both Phytophthoras can infect foliage and even produce spores

without causing visible symptoms. Although more study is needed to understand the circumstances that allow pathogens to behave in this way, it raises the risk of inadvertently importing these organisms. Other studies have shown that Phytophthoras not only infect tree bark but also invade the underlying sapwood. Previously it was thought that Phytophthoras causing cankers and bark necrosis were restricted to the inner bark (phloem) which could be stripped, leaving the wood pathogen-free.

Both these discoveries have implications for phytosanitary measures and disease management. Further information can be found at

www.forestresearch.gov.uk/phytophthoraimpact



Figure 1 *Phytophthora ramorum* releasing zoospores, which cause disease on foliage and bark.

Online management support system for *Hylobius*

Roger Moore, Hugh Evans, Stephen Bathgate and Andrew Peace

Detailed research into population dynamics of the pine weevil, *Hylobius abietis*, has provided information relating population size to potential transplant damage on any given forest restocking site. For forestry practitioners, it is essential to know how weevil populations correspond to likely transplant damage in relation to different options for managing the restocking of a site. They can then select the management intensity and timing in relation to the level of risk from *Hylobius*, helping to reduce insecticide use, tree losses and hence restocking costs.

Forest Research has modelled the cumulative numbers of weevils per day on sites between mid-April and mid-October in each of the five years of potential weevil attack following colonisation. From this, a statistical measure of weevil feeding pressure called ‘weevil days’, based on population size and persistence, has been calculated for each site in each year studied, and related to levels of damage. A method for monitoring weevil populations in relation to feeding pressure and damage predictions has also been developed. This forms the basis of the *Hylobius* Management Support System (HMSS) (Figure 1) and employs a simple process of placing cut-conifer billets (pieces of small-diameter roundwood) on site for 28 days. The billets attract adult weevils (Figure 2) which are counted each week to indicate population size on site. This has been tested

extensively and now provides robust estimates of *Hylobius* population size when used with the HMSS.

To deliver this improved understanding of *Hylobius* impacts to forest managers, a practical web-based HMSS has been developed, incorporating the models described above and others, to help:

- plan future clearfell restocking strategies to minimise transplant damage by *Hylobius*
- reduce initial insecticide use and subsequent top-up applications to transplants, by identifying and targeting where insecticide is necessary
- reduce restock failure and the subsequent need to replace destroyed transplants
- meet operational goals for restocking, and satisfy requirements of the Forest Stewardship Council and UK Woodland Assurance Scheme
- reduce overall costs of restocking by helping managers to make informed, site-specific decisions
- indicate the impacts of using nematodes as biocontrol agents to reduce *Hylobius* populations

Further information is available at www.forestresearch.gov.uk/hylobiusmss

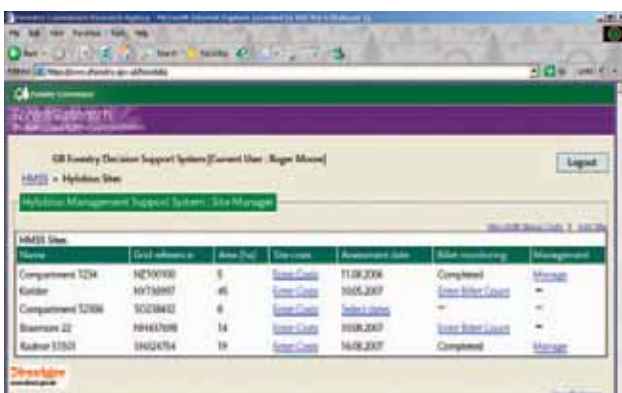


Figure 1 New HMSS software for site-specific management of *Hylobius*.



Figure 2 An adult pine weevil (*Hylobius abietis*).

Biomass Energy Centre

The Biomass Energy Centre (BEC) provides independent, up-to-date information to potential users and producers of biomass fuels. Launched in 2006, the BEC is managed by Forest Research on behalf of the Forestry Commission and the Department for Environment, Food and Rural Affairs (Defra).



The UK Biomass Strategy, published by the Government in May 2007, identified biomass as playing a 'central role' in meeting EU and UK targets for increased use of renewable energy and the reduction of carbon dioxide (CO₂) emissions. During 2007, the price of heating oil rose by around 50%. Using biomass to provide heat, and in some cases heat and power, is therefore becoming an increasingly viable alternative.

During 2007-08 most enquiries to the BEC were linked to the production or use of woodfuel. Burning biomass from woodlands that are regenerated and managed sustainably helps to prevent further rises in atmospheric CO₂ from burning fossil fuels. Also, producing woodfuel from woodlands not previously in active management can open new income streams for the woodland owner or manager, and have positive effects on biodiversity and timber quality within the woodland. For the end user, woodfuel can compete with oil and even gas in terms of price per kilowatt hour (see table). Biomass boilers are generally expensive to buy but this may be offset by national or regional grant schemes – the subject of another frequent enquiry.



Chipper producing fuel from slab wood



A satisfied woodfuel user

The BEC has also dealt with numerous enquiries from wood-processing companies trying to reduce costs of both waste management and energy by using sawdust and off-cuts to generate their own heat or to produce fuel pellets or briquettes for sale. In addition to providing information via the website and enquiries services, BEC works with Regional Development Agencies and the Forestry Commission's woodfuel officers at local and regional levels – attending shows, giving seminars and producing information sheets. BEC has already developed a strong reputation among other organisations, and has advised the Carbon Trust, the Renewable Energy Association, Defra, the Energy Saving Trust and regional woodfuel producer groups.

For more information, visit
www.biomassenergycentre.org.uk

Cost comparison of fuel types, March 2008 prices*

Fuel	Price	Price per kWh
Heating oil	50p per litre	4.9p
Mains gas	2.5p per kWh	2.5p
Woodchip (30% moisture content)	£70 per tonne	2.0p



* Updated regularly on the BEC website.

Publications

Forest Research publishes a wide range of material, from corporate reports and plans, to brochures, project summaries and technical reports. Many of these can be ordered through our online publications catalogue at www.forestry.gov.uk/publications

In addition, our researchers publish peer-reviewed articles in scientific journals and produce books through external publishing houses.



Forestry Commission technical publications

The following titles were published during the year ending 31 March 2008.

Published by Forest Research

Corporate publications

Forest Research annual report and accounts 2006–2007 (£18)

Forest Research corporate plan 2007–2010 (online publication, free)

Forest Research corporate plan 2008–2011 (online publication, free)

Newsletters, booklets and leaflets

FR Eye. Forest Research's newsletter, giving details of recent projects and developments (online publication, free)

www.forestresearch.gov.uk/freye

Ecotype. Biodiversity and conservation newsletter of Ecology Division (online publication, free)

www.forestresearch.gov.uk/ecotype

Growing places. Social and Economic Research Group newsletter from Environmental and Human Sciences Division (printed and online publication, free) www.forestresearch.gov.uk/growingplaces

Path News. Pathology bulletin of Tree Health Division (online publication, free) www.forestresearch.gov.uk/pathnews

Oak pinhole borer by Christine Tilbury. FR Tree Pest Advisory Note (free)

Methuselah: a monitoring and evaluation strategy for greenspace by Kieron Doick. Booklet (free)

Offenders and nature: helping people – helping nature by Claudia Carter. Booklet (free)

Published by the Forestry Commission

The publications listed below have been written by Forest Research staff for the Forestry Commission.

Bulletins

127 *Choice of Sitka spruce seed origins for use in British forests* by Sam Samuel, Alan Fletcher and Roger Lines (£21)

128 *Estimating deer abundance in woodlands: the combination plot technique* by Graeme Swanson*, Douglas Campbell* and Helen Armstrong (£17.50)

Field Guides

Roundwood and sawlog volume tables (£10)

Timber measurement by Ewan Mackie and Robert Matthews (£16)

Practice Guide

Raising trees and shrubs from seed by Peter Gosling (£5.50)

Inventory Report/Surveys

National inventory of woodland and trees 1995–1999 by Justin Gilbert (online only)

Forest condition survey 2005 (online only)

Information Notes (free)

86 *The role of forest genetic resources in helping British forests respond to climate change*
Jason Hubert and Joan Cottrell

87 *Resistance of young conifers to feeding damage by pine weevil*
David Wainhouse and Sara Brough

88 *Ten years of intensive environmental monitoring in British forests*
Elena Vanguelova, Nadia Barsoum, Suzanne Benham, Mark Broadmeadow, Andy Moffat, Tom Nisbet and Rona Pitman

89 *Evaluating biodiversity in fragmented landscapes: the use of focal species*
Amy Eycott, Kevin Watts, Darren Moseley and Duncan Ray

90 *Forests and wood ants in Scotland*
Jonathan Hughes and Alice Broome

91 *Greenspace establishment on brownfield land: the site selection and investigation process*
Kieron Doick and Tony Hutchings

Practice Note (free)

4 (revised) *Controlling grey squirrel damage to woodlands*
Brenda Mayle, Mark Ferryman and Harry Pepper

Research Note (free)

FCRN101 *Impacts of climate change on forestry in Scotland – a synopsis of spatial modelling research*
Duncan Ray

Technical Note (free)

17 *Cleaning mechanised pesticide spray equipment*
Bill J. Jones

* Authors outwith the Agency.

External publications

Printed Publications

- [Adams, P., De Leij, F.A.A.M.] and Lynch, J.M. (2007)
Trichoderma harzianum Rifai 1295-22 mediates growth promotion of crack willow (*Salix fragilis*) saplings in both clean and metal-contaminated soil. *Microbial Ecology* **54** (2), 306–313.
- A'Hara, S.W. and Cottrell, J.E. (2007)
Characterization of a suite of 40 EST-derived microsatellite markers for use in Sitka spruce (*Picea sitchensis* (Bong.) Carr). *Silvae Genetica* **56** (3–4), 138–141.
- [Al-Tabbaa, A., Smith, S.,] De Munck, C., [Dixon, T., Doak, J., Garvin, S. and Raco, M.] (2007)
Climate change, pollutant linkage and brownfield regeneration. In: *Sustainable brownfield regeneration: liveable places from problem spaces*, eds T. Dixon, M. Raco, P. Catney and D.N. Lerner. Blackwell Publishing, Oxford, 265–314.
- [Al-Tabbaa, A., Smith, S.E., Duru, U.E., Iyengar, S.R.,] De Munck, C., Moffat, A.J., Hutchings, T.R., [Dixon, T., Doak, J., Garvin, S.L., Ridal, J., Raco, M. and Henderson, S.] (2007)
Climate change, pollutant-linkage and brownfield regeneration. SUBR:IM Sustainable Urban Brownfield Regeneration: Integrated Management, Sheffield, SUBR:IM Bulletin SUB 3. CL:AIRE, London.
- [Andreu, V., Khuder, H., Mickovski, S.B., Spanos, I.A., Norris, J.E., Dorren, L.K.A.,] Nicoll, B.C., Achim, A., [Rubio, J.L., Jouneau, L. and Berger, F.] (2008)
Ecotechnological solutions for unstable slopes: ground bio- and eco-engineering techniques and strategies. In: *Slope stability and erosion control: ecotechnological solutions*, eds J.E. Norris, A. Stokes, S.B. Mickovski, E. Cammeraat, R. van Beek, B.C. Nicoll and A. Achim. Springer, Dordrecht, The Netherlands, 211–275.
- [ap Rheinalt, T., Craik, J.C.A., Daw, P.C., Furness, R.W.,] Petty, S.J. and [Wood, D.,] eds (2007)
Birds of Argyll. Argyll Bird Club, Lochgilphead, Argyllshire.
- [Balk, P.A., Brønnum, P.,] Perks, M., [Stattin, E., van der Geest, L.H.M. and van Wordragen, M.F.] (2006)
Innovative cold tolerance test for conifer seedlings. In: *National proceedings: forest and conservation nursery associations – 2006*, technical coordinators L.E. Riley, R.K. Dumroese and T.D. Landis. RMRS-P-50. USDA Forest Service, Rocky Mountain Research Station, Fort Collins, Colorado, 9–14.
- Barsoum, N. (2007)
Forest health – has acid rain made way for climate change? (And how will we know?). *Forestry and Timber News*, Issue 24, December 2007, 17–19.
- Biomass Energy Centre, Hogan, G. (2008)
Biomass – a renewable fuel source. International Society of Arborists, United Kingdom and Ireland Chapter. *treeline*, September 2007, 21–24.
- [Blackstock, K.L.] and Carter, C.E. (2007)
Operationalising sustainability science for a sustainability directive? Reflecting on three pilot projects. *The Geographical Journal* **173**, 343–357.
- [Bousquet, J., Isabel, N., Pelgas, B.,] Cottrell, J., [Rungis, D. and Ritland, K.] (2007)
Spruce. In: *Forest trees*, ed. C. Kole. Genome Mapping and Molecular Breeding in Plants 7. Springer, Berlin, 93–114.
- Brasier, C. (2007)
Phytophthora biodiversity: how many *Phytophthora* species are there? In: *Proceedings of 4th IUFRO Working Party 7.02.09 Meeting on Phytophthoras in forests and natural ecosystems, Monterey, California, 26–31 August 2007*, ed. E. Goheen. USDA, Forest Service (in press).
- Brasier, C. (2008)
Pramorum + Pkernoviae = International biosecurity failure. In: *Proceedings of the sudden oak death third science symposium*, co-ordinators S.J. Frankel, J.T. Kliejunas and K.M. Palmieri. General Technical Report PSW-GTR-214. Pacific Southwest Research Station, Forest Service, USDA, Albany, California, 133–139.
- Brasier, C., Brown, A., Rose, J. and Kirk, S. (2008)
Infection of tree stems by zoospores of *Phytophthora ramorum* and *Pkernoviae*. In: *Proceedings of the sudden oak death third science symposium*, co-ordinators S.J. Frankel, J.T. Kliejunas and K.M. Palmieri. General Technical Report PSW-GTR-214. Pacific Southwest Research Station, Forest Service, USDA, Albany, California, 167–168 (abstract).
- Broadmeadow, M.S.J. and [Carnus, J.-M.] (2007)
Response of the forestry sector. In: *Forestry and climate change*, eds P.H. Freer-Smith, M.S.J. Broadmeadow and J.M. Lynch. CAB International, Wallingford, Oxon, 218–225.
- Brown, A. and Brasier, C. (2008)
Invasion of xylem of mature tree stems by *Phytophthora ramorum* and *P. kernoviae*. In: *Proceedings of the sudden oak death third science symposium*, co-ordinators S.J. Frankel, J.T. Kliejunas and K.M. Palmieri. General Technical Report PSW-GTR-214. Pacific Southwest Research Station, Forest Service, USDA, Albany, California, 155 (abstract).
- Casella, E. and [Sinoquet, H.] (2007)
Botanical determinants of foliage clumping and light interception in two-year-old coppice poplar canopies: assessment from 3-D plant mock-ups. *Annals of Forest Science* **64** (4), 395–404.
- Castán Broto, V. and Carter, C. (2007)
Environmental policy in Bosnia and Herzegovina: post-socialism development and local governance – a dramatised interpretation in one act. In: *Beyond the global village: environmental challenges inspiring global citizenship*, eds R.C. Hillerbrand and R. Karlsson. Inter-Disciplinary Press, Oxford.
- Castán Broto, V., Tabbush, P., [Burningham, K., Elghali, L.] and Edwards, D. (2007)
Ash and risk: four social interpretations of a pollution landscape. *Landscape Research* **32** (4), 481–497.
- [Cochar, H.,] Casella, E. and [Mencuccini, M.] (2007)
Xylem vulnerability to cavitation varies among poplar and willow clones and correlates with yield. *Tree Physiology* **27** (12), 1761–1767.

Crow, P., Benham, S., [Devereux, B.J. and Amable, G.S.] (2007)

Woodland vegetation and its implications for archaeological survey using LiDAR. *Forestry* **80** (3), 241–252.

Denman, S. (2006)

Selected highlights on *Phytophthora ramorum*, *P. kernoviae* and other items of interest presented at the 2006 APS (American Phytopathological Society) meeting. British Society of Plant Pathology. *BSPSP News*, 25th anniversary edition, December 2006, <http://www.bspp.org.uk/bsppnews/bsppnewswinter2006.pdf>
Link to full-text 31–34.

Denman, S., Kirk, S.A. and Whybrow, A. (2007)

Investigating the potential of disease control practices for integrated management of *Phytophthora kernoviae* on mature magnolias in the UK (Abstract). In: *4th IUFRO Working Party 7.02.09 Meeting on Phytophthoras in forests and natural ecosystems, Monterey, California, 26–31 August 2007*. http://nature.berkeley.edu/IUFRO2007/phytophthora/abstracts/39_denman.pdf
Link to Abstract.

Denman, S., [Moralejo, E.], Kirk, S.A., Orton, E. and [Whybrow, A.] (2008)

Sporulation of *Phytophthora ramorum* and *P. kernoviae* on asymptomatic foliage. In: *Proceedings of the sudden oak death third science symposium*, co-ordinators S.J. Frankel, J.T. Kliejunas and K.M. Palmieri. General Technical Report PSW-GTR-214. Pacific Southwest Research Station, Forest Service, USDA, Albany, California, 201–207.

[Dolman, P.M., Hinsley, S.A., Bellamy, P.E.] and Watts, K. (2007)

Woodland birds in patchy landscapes: the evidence base for strategic networks. In: *Woodland birds: their ecology and management*, ed. K. Smith. *Ibis* **149** Supplement 2, 146–160.

[Eggleston, P., Beccaloni, G.] and Inward, D. (2007)

Response to Lo *et al.* *Biology Letters* **3** (5), 564–565.

Eycott, A.E., [Watkinson, A.R., Hemami, M.-R. and Dolman, P.M.] (2007)

The dispersal of vascular plants in a forest mosaic by a guild of mammalian herbivores. *Oecologia* **154** (1), 107–118.

Eycott, A.E. and Watts, K. (2007)

Using a consistent habitat network approach to reduce fragmentation at site to national scales. In: *25 years of landscape ecology: scientific principles in practice. Proceedings of the 7th IALE World Congress, Wageningen, The Netherlands, 8–12 July 2007, Book of abstracts, Part I*, eds R.G.H. Bunce, R.H.G. Jongman, L. Hojas and S. Weel. International Association for Landscape Ecology. IALE, Wageningen, The Netherlands.

[Fennessy, J.], Hubert, J. and Samuel, S. (2007)

Get your potential seed stands registered. *Woodland Heritage* **2007**, 54–55.

[Finér, L., Helmisaari, H.-S., Löhmus, K., 13 other authors] and Vanguelova, E. (2007)

Variation in fine root biomass of three European tree species: beech (*Fagus sylvatica* L.), Norway spruce (*Picea abies* L. Karst.) and Scots pine (*Pinus sylvestris* L.). *Plant Biosystems* **141** (3), 394–405.

Freer-Smith, P.H. (2007)

Environmental change and the sustainability of European forests. *Journal of Sustainable Forestry* **24** (2–3), 165–187.

Freer-Smith, P.H., Broadmeadow, M.S.J. and Lynch, J.M. (2007)

Forests and climate change: the knowledge-base for action. In: *Forestry and climate change*, eds P.H. Freer-Smith, M.S.J. Broadmeadow and J.M. Lynch. CAB International, Wallingford, Oxon, 7–14.

Freer-Smith, P.H., Broadmeadow, M.S.J. and Lynch, J.M., eds (2007)

Forestry and climate change. CAB International, Wallingford, Oxon.

[Fuller, R.J., Gaston, K.J.] and Quine, C.P. (2007)

Living on the edge: British and Irish woodland birds in a European context. In: *Woodland birds: their ecology and management*, ed. K. Smith. *Ibis* **149** Supplement 2, 53–63.

[Fuller, R.J., Smith, K.W., Grice, P.V., Currie, F.A.] and Quine, C.P. (2007)

Habitat change and woodland birds in Britain: implications for management and future research. In: *Woodland birds: their ecology and management*, ed. K. Smith. *Ibis* **149** Supplement 2, 261–268.

[Gale, S.], John, A., [Harding, K. and Benson, E.E.] (2008)

Developing cryopreservation for *Picea sitchensis* (Sitka spruce) somatic embryos: a comparison of vitrification protocols. *CryoLetters* **29** (2), 135–144.

[García, R.], Suárez, J.C. and [Patenaude, G.] (2007)

Delineation of individual tree crowns for LiDAR tree and stand parameter estimation in Scottish woodlands. In: *The European information society: leading the way with geo-information*, eds S. I. Fabrikant and M. Wachowicz. Lecture Notes in Geoinformation and Cartography. Springer, Berlin, 55–85.

Gill, R.M.A. and [Fuller, R.J.] (2007)

The effects of deer browsing on woodland structure and songbirds in lowland Britain. In: *Woodland birds: their ecology and management*, ed. K. Smith. *Ibis* **149** Supplement 2, 119–127.

Gill, R., [Saucedo Galvez, C., Aldridge, D.], Morgan, G. (2008)

Ranging behaviour of huemul in relation to habitat and landscape. *Journal of Zoology* **274** (3), 254–260.

[Glare, T.R., Reay, S.D., Nelson, T.L.] and Moore, R. (2008)

Beauvaria caledonica is a naturally occurring pathogen of forest beetles. *Mycological Research* **112** (3), 352–360.

[Groenewald, M., Barnes, I., Bradshaw, R.E.], Brown, A.V., [Dale, A., Groenewald, J.Z., Lewis, K.J., Wingfield, B.D., Wingfield, M.J. and Crous, P.W.] (2007)

Characterization and distribution of mating type genes in the *Dothistroma* needle blight pathogens. *Phytopathology* **97** (7), 825–834.

Hall, A. (2007)

Using woodfuel: the new fuel! *Quarterly Journal of Forestry* **101** (4), 293–295.

[Harbottle, M.J., Mantle, M.D., Johns, M.L.], van Herwijnen, R., [Al-Tabbaa, A.], Hutchings, T.R., Moffat, A.J. and [Ouki, S.K.] (2007)

Magnetic resonance imaging of the effect of zeolite on lithium uptake in poplar. *Environmental Science and Technology* **41** (10), 3444–3448.

Harmer, R. and Kiewitt, A. (2007)

Restoration of PAWS – testing some of the advice. *Quarterly Journal of Forestry* **101** (3), 213–218.

Harmer, R. and Morgan, G. (2007)

Development of *Quercus robur* advance regeneration following canopy reduction in an oak woodland. *Forestry* **80** (2), 137–149.

[Helming, K., Pérez-Soba, M.] and Tabbush, P. (eds) (2008)

Sustainability impact assessment of land use changes. Springer, Berlin.

[Helming, K., Tscherning, K., König, B., Sieber, S., Wiggering, H., Kuhlman, T., Wascher, D., Pérez-Soba, M., Smeets, P., Tabbush, P., Dilly, O., Hüttel, R. and Bach, H.] (2008)

Ex ante impact assessment of land use changes in European regions – the SENSOR approach. In: *Sustainability impact assessment of land use changes*, eds K. Helming, M. Pérez-Soba and P. Tabbush. Springer, Berlin, 77–105.

[Hemami, M.R., Watkinson, A.R.,] Gill, R.M.A. and [Dolman, P.M.] (2007)

Estimating abundance of introduced Chinese muntjac *Muntiacus reevesi* and native roe deer using portable thermal imaging equipment. *Mammal Review* **37** (3), 246–254.

[Holl, K.] and Smith, M. (2007)

Scottish upland forests: history lessons for the future. In: *Traditional knowledge, cultural heritage and sustainable forest management*. Selected edited papers from the IUFRO conference: Cultural heritage and sustainable forest management: the role of traditional knowledge, at Italian Academy of Forestry Science, Florence, Italy, 11–15 June 2006, eds J.A. Parotta and M. Agnoletti. Special issue *Forest Ecology and Management* **249** (1–2), 45–53.

Inward, D., [Beccaloni, G. and Eggleston, P.] (2007)

Death of an order: a comprehensive molecular phylogenetic study confirms that termites are eusocial cockroaches. *Biology Letters* **3** (3), 331–335.

Inward, D.J.G., [Vogler, A.P. and Eggleston, P.] (2007)

A comprehensive phylogenetic analysis of termites (Isoptera) illuminates key aspects of their evolutionary biology. *Molecular Phylogenetics and Evolution* **44** (3), 953–967.

Ireland, D. (2007)

Operational experience of continuous cover forestry (CCF). *Forestry and British Timber* **36** (12), December 2007, 11–14.

[Irvine, R.J.,] Broadmeadow, M., Gill, R.M.A. and [Albon, S.D.] (2007)

Deer and global warming. How will climate change affect deer populations? *Deer* **14** (5), Autumn 2007, 34–39.

John, A., [Gale, S. and Benson, E.] (2007)

Tissue culture and cryopreservation of Sitka. Allan John, Samantha Gale and Erica Benson explain how conserving Sitka spruce cells in cryobanks can help Forest Research's future clonal forestry programmes. *Forestry and British Timber* **36** (7), July 2007, 53–54, 56–58.

McCartan, S., Gosling, P.G. and Ives, L. (2007)

Seed fill determination in common juniper (*Juniperus communis* L.). In: *Proceedings of IUFRO tree seed symposium: Recent advances in seed physiology and technology, Fredericton, New Brunswick, Canada, 18–21 July 2006*, eds T.L. Beardmore and J.D. Simpson. IUFRO Fredericton, New Brunswick, 53.

[Mckenzie, A.J.,] Petty, S.J., [Toms, M.P. and Furness, R.W.] (2007)

Importance of Sitka spruce *Picea sitchensis* seed and garden bird-feeders for siskins *Carduelis spinus* and coal tits *Periparus ater*. *Bird Study* **54** (2), 236–247.

Mason, B., [Dedrick, S., Dittrich, F., Droste, C., Kennedy, S., Ni Dhubbain, A., Soalleiro, R.R., Skovsgaard, J.-P., Slodick, M., Spieker, H., Stahr, J., Stefanik, I. and Von Teuffel, K.] (2007)

Forest production: joint workshop. In: *Plantation or conversion – the debate! Ideas presented and discussed at a joint EFI Project Centre conference held 21–23 May 2006 in Freiburg, Germany*, eds S. Dedrick, H. Spieker, C. Orazio, M. Tomé and I. Martinez. EFI Discussion Paper 13. European Forest Institute, Joensuu, Finland, 33–36.

Mason, W.L. (2007)

Silviculture of Scottish forests at a time of change. *Journal of Sustainable Forestry* **24** (1), 41–57.

Mason, W.L. (2007)

Changes in the management of British forests between 1945 and 2000 and possible future trends. In: *Woodland birds: their ecology and management*, ed. K. Smith. *Ibis* **149** Supplement 2, 41–52.

Mason, W.L., Connolly, T., [Pommerening, A.] and Edwards, C. (2007)

Spatial structure of semi-natural and plantation stands of Scots pine (*Pinus sylvestris* L.) in northern Scotland. *Forestry* **80** (5), 567–586.

Matthews, R.W., [Robertson, K., Marland, G. and Marland, E.] (2007)

Carbon in wood products and product substitution. In: *Forestry and climate change*, eds P.H. Freer-Smith, M.S.J. Broadmeadow and J.M. Lynch. CAB International, Wallingford, Oxon, 91–104.

Mochan, S., [Moore, J. and Leslie, D.] (2007)

What's all the noise about? The use of acoustic tools for assessing timber quality in standing timber and logs. *Forestry and British Timber* **36** (10), October 2007, 22–24.

Moffat, A. and Hutchings, T. (2007)

Greening brownfield land. In: *Sustainable brownfield regeneration: liveable places from problem spaces*, eds T. Dixon, M. Raco, P. Catney and D.N. Lerner. Blackwell Publishing, Oxford, 143–176.

Moffat, A.J. and McKay, H.M. (2008)

The potential of British forests to recycle organic wastes. *Quarterly Journal of Forestry* **102** (1), 21–27.

[Monaghan, M.T.,] Inward, D.J.G., [Hunt, T. and Vogler, A.P.] (2007)

A molecular phylogenetic analysis of the Scarabaeinae (dung beetles). *Molecular Phylogenetics and Evolution* **45** (2), 674–692.

[Mooney, S.J.,] Foot, K., Hutchings, T.R. and Moffat, A.J. (2007)

Micromorphological investigations into root penetration in a landfill mineral cap, Hertfordshire, UK. *Waste Management* **27** (9), 1225–1232.

Morison, J.I.L., [Baker, N.R., Mullineaux, P.M. and Davies, W.J.] (2008)

Improving water use in crop production. *Philosophical Transactions of The Royal Society* **363**, 639–658.

Morris, J., [Camilleri, M. and Moncada, S.] (2008)

Key sustainability issues in European sensitive areas – a participatory approach. In: *Sustainability impact assessment of land use changes*, eds K. Helming, M. Pérez-Soba and P. Tabbush. Springer, Berlin, 451–470.

Moseley, D.G., [Worrell, R., Black, B.] and Ray, D. (2007)

A forest habitat network approach to directing native woodland restoration and expansion on the Argyll islands, Scotland. In: *25 years of landscape ecology: scientific principles in practice. Proceedings of the 7th IALE world congress, Wageningen, The Netherlands, 8–12 July 2007, Book of abstracts Part I*, eds R.G.H. Bunce, R.H.G. Jongman, L. Hojas and S. Weel. IALE, Wageningen, The Netherlands, 319–320.

Nisbet, T.R., [Orr, H.] and Broadmeadow, S.B. (2008)

Using woodland for soil protection and sediment control. In: *Land management in a changing environment. Proceedings of the SAC and SEPA biennial conference*, eds K. Crighton and R. Audsley. Scottish Agricultural College, Auchincruive, Ayr, 84–90.

[Norris, J.E., Di Iorio, A., Stokes, A., Nicoll, B.C. and Achim, A. (2008)

Species selection for soil reinforcement and protection. In: *Slope stability and erosion control: ecotechnological solutions*, eds J.E. Norris, A. Stokes, S.B. Mickovski, E. Cammeraat, R. van Beek, B.C. Nicoll and A. Achim. Springer, Dordrecht, The Netherlands, 167–210.

[Norris, J.E., Greenwood, J.R.,] Achim, A., Gardiner, B.A., Nicoll, B.C., [Cammeraat, E. and Mickovski, S.B.] (2008)

Hazard assessment of vegetated slopes. In: *Slope stability and erosion control: ecotechnological solutions*, eds J.E. Norris, A. Stokes, S.B. Mickovski, E. Cammeraat, R. van Beek, B.C. Nicoll and A. Achim. Springer, Dordrecht, The Netherlands, 119–166.

[Norris, J.E., Stokes, A., Mickovski, S.B., Cammeraat, E., van Beek, R.,] Nicoll, B.C. and Achim, A. (2008)

Slope stability and erosion control: ecotechnological solutions. Springer, Dordrecht, The Netherlands.

O'Brien, L., [Foot, K.] and Doick, K. (2007)

Evaluating the benefits of community greenspace creation on brownfield land. *Quarterly Journal of Forestry* **101** (2), 145–151.

O'Brien, L. and [Murray, R.] (2007)

Forest School and its impacts on young children: case studies in Britain. *Urban Forestry and Urban Greening* **6** (4), 249–265.

O'Brien, L. and [Snowdon, H.] (2007)

Health and well-being in woodlands: a case study of the Chopwell Wood Health Project. *Arboricultural Journal* **30** (1), 45–60.

O'Brien, L. and [Weldon, S.] (2007)

A place where the needs of every child matters: factors affecting the use of greenspace and woodlands for children and young people. Countryside Recreation Network (CRN). *Countryside Recreation* **15** (3), 6–9.

[Ostonen, I., Püttsepp, Ü., Biel, C., Alberton, O., Bakker, M.R., Löhmus, K., Majdi, H., Metcalfe, D., Olsthoorn, A.F.M., Pronk, A., Vanguelova, E., [Weih, M. and Brunner, I.] (2007)

Specific root length as an indicator of environmental change. *Plant Biosystems* **141** (3), 426–442.

[Ouki, S.,] van Herwijnen, R., [Harbottle, M.,] Hutchings, T., [Al-Tabbaa, A., Johns, M.] and Moffat, A. (2007)

Novel special-purpose composts for sustainable remediation. In: *Sustainable brownfield regeneration: liveable places from problem spaces*, eds T. Dixon, M. Raco, P. Catney and D.N. Lerner. Blackwell Publishing, Oxford, 177–202.

[Pei, M.H., Bayon, C., Ruiz, C.] and Tubby, I. (2007)

Population structure of poplar rust *Melampsora larici-populina* in the UK inferred from AFLP. *Plant Pathology* **56** (3), 472–479.

Petty, S.J. (2007)

Eurasian treecreeper *Certhia familiaris*. In: *Birds of Argyll*, eds T. ap Rheinallt, J.C.A. Craik, P.C. Daw, R.W. Furness, S.J. Petty and D. Wood. Argyll Bird Club, Lochgilphead, Argyllshire, 344–346.

Petty, S.J. (2007)

Great tit *Parus major*. In: *Birds of Argyll*, eds T. ap Rheinallt, J.C.A. Craik, P.C. Daw, R.W. Furness, S.J. Petty and D. Wood. Argyll Bird Club, Lochgilphead, Argyllshire, 338–340.

Petty, S.J. (2007)

Blue tit *Cyanistes caeruleus*. In: *Birds of Argyll*, eds T. ap Rheinallt, J.C.A. Craik, P.C. Daw, R.W. Furness, S.J. Petty and D. Wood. Argyll Bird Club, Lochgilphead, Argyllshire, 336–338.

Petty, S.J. (2007)

Long-tailed tit *Aegithalos caudatus*. In: *Birds of Argyll*, eds T. ap Rheinallt, J.C.A. Craik, P.C. Daw, R.W. Furness, S.J. Petty and D. Wood. Argyll Bird Club, Lochgilphead, Argyllshire, 335–336.

Petty, S.J. (2007)

Tawny owl *Strix aluco*. In: *Birds of Argyll*, eds T. ap Rheinallt, J.C.A. Craik, P.C. Daw, R.W. Furness, S.J. Petty and D. Wood. Argyll Bird Club, Lochgilphead, Argyllshire, 263–265.

Petty, S.J. (2007)

Common kestrel *Falco tinnunculus*. In: *Birds of Argyll*, eds T. ap Rheinallt, J.C.A. Craik, P.C. Daw, R.W. Furness, S.J. Petty and D. Wood. Argyll Bird Club, Lochgilphead, Argyllshire, 146–148.

Petty, S.J. (2007)

Eurasian sparrowhawk *Accipiter nisus*. In: *Birds of Argyll*, eds T. ap Rheinallt, J.C.A. Craik, P.C. Daw, R.W. Furness, S.J. Petty and D. Wood. Argyll Bird Club, Lochgilphead, Argyllshire, 139–140.

Petty, S.J. (2007)

Tawny owl *Strix aluco* (Linnaeus). In: *The birds of Scotland*, eds R. Forrester and I.J. Andrews. Scottish Ornithologists' Club, Aberlady, East Lothian, 917–920.

Petty, S.J. (2007)

Northern goshawk *Accipiter gentilis* (Linnaeus). In: *The birds of Scotland*, eds R. Forrester and I.J. Andrews. Scottish Ornithologists' Club, Aberlady, East Lothian, 468–471.

Petty, S.J. (2007)

An unsuccessful attempt to establish northern goshawks in Argyll. *Scottish Birds* **27**, 41–45.

Petty, S.J. and [Pennington, M.] (2007)

Lesser redpoll *Carduelis cabaret* (PL Statius Muller). In: *The birds of Scotland*, eds R. Forrester and I.J. Andrews. Scottish Ornithologists' Club, Aberlady, East Lothian, 1413–1416.

Quine, C.P., [Fuller, R.J., Smith, K.W. and Grice, P.V.] (2007)

Stand management: a threat or opportunity for birds in British woodland? In: *Woodland birds: their ecology and management*, ed. K. Smith. *Ibis* **149** Supplement 2, 161–174.

Quine, C.P. and Gardiner, B.A. (2007)

Understanding how the interaction of wind and trees results in windthrow, stem breakage, and canopy gap formation. In: *Plant disturbance ecology: the process and the response*, eds. E.A. Johnson and K. Miyanishi. Academic Press, Elsevier, Amsterdam, The Netherlands, 103–155.

Quine, C.P. and [Malcolm, D.C.] (2007)

Wind-driven gap development in Birkley Wood, a long-term retention of planted Sitka spruce in upland Britain. *Canadian Journal of Forest Research* **37** (10), 1787–1796.

Ray, D. (2008)

It's getting hotter. Duncan Ray summarises research into the effects of climate change in Scotland and the ways foresters will need to adapt in the future. Institute of Chartered Foresters. *The Chartered Forester* Spring 2008, 10–11.

Ray, D. (2008)

Climate change research. Forest Research: likely changes in Scotland's climate. *Bush Telegraph* No 61, January 2008, 9.

[Schepers, J.S.] and Lynch, J.M. (2007)

Soils and waste management: a challenge to climate change. In: *Forestry and climate change*, eds P.H. Freer-Smith, M.S.J. Broadmeadow and J.M. Lynch. CAB International, Wallingford, Oxon, 121–126.

[Scolobig, A.], Castán Broto, V. and [Zabala, A.] (2006)

Social actors' perspectives on flood mitigation in Malborghetto-Valbruna, northern Italy. Quarderni Programma Emergenza di Massa. ISIG 06-3. Istituto di Sociologia Internazionale, Gorizia, Italy.

[Semple, K.T.], Doick, K.J., [Wick, L.Y. and Harms, H.] (2007)

Microbial interactions with organic contaminants in soil: definitions, processes and measurement. *Environmental Pollution* **150** (1), 166–176.

[Solomon, A.M.] and Freer-Smith, P.H. (2007)

Forest responses to global change in North America: interacting forces define a research agenda. In: *Forestry and climate change*, eds P.H. Freer-Smith, M.S.J. Broadmeadow and J.M. Lynch. CAB International, Wallingford, Oxon, 151–159.

Straw, N.A., Green, G. and Williams, D.T. (2007)

Dieback and recovery in poplar and attack by the hornet clearwing moth, *Sesia apiformis* (Clerck) (Lepidoptera: Sesiidae). *Bulletin of Entomological Research* **97** (6), 555–567.

Suárez, J.C. and [Gould, M.] (2007)

Shaping the future of GI science in Europe (Guest editorial). Special issue *Transactions in GIS* **11** (6), 795–797.

Suárez, J.C. and [Gould, M.] (eds) (2007)

Shaping the future of GI science in Europe. Special issue *Transactions in GIS* **11** (6), 795–960.

Tabbush, P., [Frederiksen, P.] and Edwards D. (2008)

Impact assessment in the European Commission in relation to multifunctional land use. In: *Sustainability impact assessment of land use changes*, eds K. Helming, M. Pérez-Soba and P. Tabbush. Springer, Berlin, 35–54.

Thomas, H. and Nisbet, T.R.

An assessment of the impact of floodplain woodland on flood flows. *Water and Environment Journal* **21** (2), 83–164.

Thorpe, K. and [Day, K.] (2008)

Reproductive maturation in the large pine weevil *Hylobius abietis*: the relative importance of larval and adult diet. *Agricultural and Forest Entomology* **10** (1), 53–60.

Tilbury, C. (2008)

Pinhole borer threat grows. Oak pinhole borer, once considered a local problem for oak timber, is growing in importance. FR's Christine Tilbury explains. *Forestry and Timber News* Issue 25, February 2008, 18.

[Tobin, B., Cermák, J., Chiatante, D., Danjon, F., Di Iorio, A., Dupuy, L., Eshel, A., Jourdan, C., Kalliokoski, T., Laiho, R., Nadezhdina, N.], Nicoll, B., [Pagès, L., Silva, J. and Spanos, I.] (2007)

Towards developmental modelling of tree root systems. *Plant Biosystems* **141** (3), 481–501.

[Torr, P.], Heritage, S. and [Wilson, M.] (2007)

Steinernema kraussei, an indigenous nematode found in coniferous forests: efficacy and field persistence against *Hylobius abietis*. *Agricultural and Forest Entomology* **9** (3), 181–188.

Tubby, K. (2007)

Use of biological control against a forest pathogen in the UK. *Biocontrol News and Information* **28** (4), 74N–76N.

Tubby, K.V., Poole, J., Rose, D.R., Rose, J. Straw, N. and Tilbury, C. (2007)

The health of non-woodland trees in England in 2004. Arboriculture Research and Information Note 155-PATH-05. Tree Advice Trust, Arboricultural Advisory and Information Service, Office of the Deputy Prime Minister, Farnham, Surrey.

Tubby, K.V., [Scott, D.] and Webber, J.F. (2008)

Relationship between stump treatment coverage using the biological control product PG Suspension, and control of *Heterobasidion annosum* on Corsican pine, *Pinus nigra* ssp. *laricio*. *Forest Pathology* **38** (1), 37–46.

Valatin, G. (2008)

Ecopay. Jenna Coull of the Forestry Commission and Gregory Valatin of Forest Research, visited the USA to learn about the role of 'payments for ecosystem services' in environmental management and forest conservation. *Forestry Journal* **14** (3), March 2008, 36.

van Herwijnen, R., [Al-Tabbaa, A.], Hutchings, T.R., Moffat, A.J., [Ouki, S.K. and Johns, M.L.] (2007)

The impact of waste compost-based soil amendments on the leaching behavior of a heavy metal contaminated soil. *Environmental Engineering Science* **24** (7), 897–904.

van Herwijnen, R., Hutchings, T.R., [Al-Tabbaa, A.], Moffat, A.J., [Johns, M.L. and Ouki, S.K.] (2007)

Remediation of metal contaminated soil with mineral-amended composts. *Environmental Pollution* **150** (3), 347–354.

Vanguelova, E.I., [Hirano, Y., Eldhuset, T.D., Sas-Paszt, L., Bakker, M.R., Püttsepp, Ü., Brunner, I., Löhmus, K. and Godbold, D.] (2007)

Tree fine root Ca/Al molar ratio – indicator of Al and acidity stress. *Plant Biosystems* **141** (3), 460–480.

Vanguelova, E.I., [Nortcliff, S.], Moffat, A.J. and Kennedy, F. (2007)

Short-term effects of manipulated increase in acid deposition on soil, soil solution chemistry and fine roots in Scots pine (*Pinus sylvestris*) stand on a podzol. *Plant and Soil* **294** (1–2), 41–54.

[Vaughan, S.P.] Cottrell, J.E., [Moodley, D.J.], Connolly, T. and [Russell, K.] (2007)

Distribution and fine-scale spatial-genetic structure in British wild cherry (*Prunus avium* L.). *Heredity* **98** (5), 274–283.

[Vaughan, S.P.] Cottrell, J.E., [Moodley, D.J.], Connolly, T. and [Russell, K.] (2007)

Clonal structure and recruitment in British wild cherry (*Prunus avium* L.). *Forest Ecology and Management* **242** (2–3), 419–430.

Watts, K., Eycott, A.E., Broadmeadow, M., Ray, D., Sing, L. and [Latham, J.] (2007)

Climate change, habitat fragmentation and the resilience of ecological networks. In: *25 years of landscape ecology: scientific principles in practice. Proceedings of the 7th IALE world congress, Wageningen, The Netherlands, 8–12 July 2007, Book of abstracts Part II*, eds R.G.H. Bunce, R.H.G. Jongman, L. Hojas and S. Weel. IALE, Wageningen, The Netherlands, 913–914.

Webber, J. (2007)

Horse chestnut (*Aesculus hippocastanum*). The bleeding cankers and dying trees. *Woodland Heritage* **2007**, 56.

Webber, J. (2008)

Status of *Phytophthora ramorum* and *P. kernoviae* in Europe. In: *Proceedings of the sudden oak death third science symposium*, co-ordinators S.J. Frankel, J.T. Kliejunas and K.M. Palmieri. General Technical Report PSW-GTR-214. Pacific Southwest Research Station, Forest Service, USDA, Albany, California, 19–26.

Webber, J. and Rose, J. (2008)

Dissemination of aerial and soilborne *Phytophthoras* by human vectors. In: *Proceedings of the sudden oak death third science symposium*, co-ordinators S.J. Frankel, J.T. Kliejunas and K.M. Palmieri. General Technical Report PSW-GTR-214. Pacific Southwest Research Station, Forest Service, USDA, Albany, California, 195–198.

Willoughby, I., [Dixon, F.L., Clay, D.V.] and Jinks, R.L. (2007)

Tolerance of broadleaved tree and shrub seedlings to preemergence herbicides. *New Forests* **34** (1), 1–12.

Willoughby, I., Stokes, V., Poole, J., [White, J.E.] and Hodge, S.J. (2007)

The potential of 44 native and non-native tree species for woodland creation on a range of contrasting sites in lowland Britain. *Forestry* **80** (5), 531–553.

[Zondo, P.T.] Denman, S. and [Labuschagnè, I.F.] (2007)

Effect of season and aggressiveness of isolates on the response of two apple rootstocks to *Phytophthora cactorum* infection. *Australasian Plant Pathology* **36** (3), 240–244.

Online publications

[Al-Tabbaa, A., Smith, S.E., Duru, U.E., Iyengar, S.I.], de Munck, C., Hutchings, T.R., Moffat, A.J., [Garvin, S., Ridal, J., Dixon, T., Doak, J., Raco, M. and Henderson, S.] (2007)

Impact of and response to climate change in UK brownfield remediation. *Proceedings of the International Conference on Climate Change, ICCC 2007, Hong Kong, 29–31 May 2007*.

<http://www.hkie.org.hk/iccc2007/docs/PDF/Oral%20Papers/S05.PDF>

[Kitchen, K.], Moffat, A., Wilkinson, M. and Lafont, S. (2007)

Climate change and forest fires in the UK: possible impacts. Presentation at: Wildfire 2007, Dalby Forest, North Yorkshire, 5 and 6 June 2007. Met Office, Forestry Commission, Forest Research. Link to presentation, 45 screens:

http://www.wildfire2007.org.uk/presentations/karl_kitchen_andy_moffat.pdf

Link to Wildfire 2007 website:

<http://www.wildfire2007.org.uk/index.html> Wildfire 2007, Dalby, Yorks.

Lee, S.J. (2007)

Genetics – the way forward for high quality timber. The important role of selection and breeding. Presentation to the Institute of Wood Science Conference: The future begins with wood science: innovation into application, 21–22 November 2007, Edinburgh, 2007. 16 screens.

http://www.iwsc.org.uk/documents/conf2007/Steve%20Lee_files/frame.htm

Murgatroyd, I. and [Bruce, M.] (2007)

The performance of wildfire suppression systems. Presentation at: Wildfire 2007, Dalby Forest, North Yorkshire, 5 and 6 June 2007. Forestry Commission, Forest Research, Technical Development and Firebreak Services Ltd. Wildfire 2007, Dalby, Yorks. Link to presentation, 32 screens:

http://www.wildfire2007.org.uk/presentations/wildfire_suppression_systems.pdf

Link to Wildfire 2007 website:

<http://www.wildfire2007.org.uk/index.html>

Webber, J.F. and [Jones, B.] (2007)

Factors affecting the management of *Phytophthora kernoviae* and *P. ramorum* in South West England (abstract). In: *4th IUFRO Working Party 7.02.09 Meeting on Phytophthoras in forests and natural ecosystems, Monterey, California, 26–31 August 2007*.

Link to abstract, 1pp:

http://www.cnr.berkeley.edu/IUFRO2007/phytophthora/abstracts/30_webber.pdf

Research programmes and contracts

Forest Research carries out a wide range of research programmes, encompassing topics from across the spectrum of forestry and related environmental subjects. Our work aims to support and enhance forestry and its role in sustainable development. This year's programmes are listed as follows.



Major research programmes undertaken by Forest Research Programmes funded by the Forestry Commission

Project leaders' names are given for each programme.

Biometrics, Surveys and Statistics Division

Forest measurement, modelling and forecasting

Robert Matthews

Improve methods, models and systems for forecasting growth and yield of forests. Develop and promote systems and instruments for the efficient and accurate measurement of trees and timber to support industry and national/international standards. Develop and maintain the national network of permanent and temporary periodic growth and yield plots to support measurement, growth and yield studies.

Process modelling and data systems

Sebastien Lafont

Develop process-modelling systems, underpinned by integrated datasets, to forecast tree, stand and catchment dynamics under current and future environmental and management scenarios, to support and promote the implementation of multi-purpose sustainable forestry. Current focus: forested catchment-scale dynamics, growth and yield dynamics under climate change, and predicting pest impacts on host tree survival.

Woodland assessment surveys

Mark Lawrence

Undertake the Forestry Commission's National Inventory of Woodland and Trees, assessing woodland cover and providing national statistics on forest systems. Create the digital woodland map for Britain. Promote the use of GIS and remote sensing technology to provide spatially referenced data on the woodland cover of Britain and its changes.

Remote sensing

Juan Suarez

Evaluate and promote the potential of remote sensing technologies for operational use in the management of British forests.

Biomass Development

Andy Hall and Ian Tubby

This programme, which mainly involves staff from BSSD and FMD, covers all FR's research relevant to the greater use of woodfuel. Best practice guidance based on this research is made available to the public and industry, together with information on all aspects of biomass fuels and associated conversion technologies via the Biomass Energy Centre www.biomassenergycentre.org.uk

Ecology Division

Biodiversity indicators and monitoring

Jonathan Humphrey

Identify potential biodiversity indicators, develop and test monitoring methods and disseminate findings.

Priority species and their conservation

Alice Broome

Conduct research to support the protection and encouragement of woodland species identified as priorities within the UK Biodiversity Action Plan.

Rural and urban landscape ecology

Kevin Watts

Improve understanding of how biodiversity responds to management at the landscape scale, and translate this into practical management guidance for forest design.

Ecological site classification

Duncan Ray

Develop ecological site classification (ESC) to accommodate climate change projections and enable it to be implemented at a range of spatial scales.

Decision support for biodiversity

Duncan Ray

Develop decision-supporting tools for biodiversity and in particular produce a knowledge base for forest managers wishing to understand the significance of Habitats and Rare, Priority and Protected Species (HaRPPs).

Management of grey squirrels

Brenda Mayle

Develop cost-effective means of managing the impact of grey squirrels on timber production. Investigate the impact of grey squirrels on woodland biodiversity.

Impact of herbivores

Helen Armstrong and Robin Gill

Provide a sustainable basis for deer management in UK woodlands by investigating and developing new techniques and models of impacts and damage, population dynamics of deer, deer density assessment and grazing management.

Alien and invasive mammals

Roger Trout

Scope the potential for impact of alien and invasive vertebrates. Develop techniques and materials for cost effective protection of trees and woodlands from mammal damage.

Improvement of broadleaves

Jason Hubert

Undertake selection and testing at population, family and clonal level for a range of broadleaved species including oak, ash, sycamore, beech and birch.

Genetic conservation

Joan Cottrell and Jason Hubert

Study the genetic variation and gene flow in natural populations. Assess the level of adaptive variation in the field trials of populations of native species.

Research programmes and contracts

Scientific support for Forest Reproductive Material Regulations Sam Samuel

Devise methods for inspection of material proposed for registration. Maintain the National Register of Basic Material.

Management (and restoration) of Priority woodland habitats

Ralph Harmer and Richard Thompson

Examine methods for managing, restoring, regenerating and extending priority woodland habitats.

Management (and restoration) of Priority open habitats

Russell Anderson

Investigate and provide guidance on the restoration and management of open ground habitats.

Environmental and Human Sciences Division

Soil sustainability

Elena Vanguelova

Research to identify and evaluate the potential impacts of forest management, air pollution and climate change on soil status, functions and dynamics. Provide expert advice and develop guidance on best management practices for the protection of forest soil sustainability.

Urban regeneration network

Tony Hutchings

Improve establishment methods and management practices for woodland and other green uses in urban and on disturbed (brownfield) sites, taking into account changes in forestry and land-use policy, planting opportunity, environmental and socio-economic impacts, climate change, contamination, and waste minimisation and utilisation. Provide expert advice and develop best practice guidance on land regeneration issues.

Forest hydrology

Tom Nisbet

Study the impacts of forests and forestry management practices on water quality and quantity. Develop and assess guidance on best management practice for the protection of the freshwater environment within forests. Provide expert advice on forestry-water issues.

Environmental monitoring and evaluation of forest ecosystems

Nadia Barsoum

Determine the role of climate change and air pollution in forest condition and growth through long-term intensive environmental monitoring in forest ecosystems, in compliance with EC regulations. Provide data under the Convention on Transboundary Air Pollution for the calculation and mapping of critical loads.

Climate change impacts

Sirwan Yamulki

Monitor the effects of climate change and predict the likely future impacts through a combination of environmental monitoring (the Environmental Change Network), experimental manipulation and modelling studies. Identify interactions between forests, woodland management and the changing global environment, including a quantification of non-CO₂ greenhouse gas fluxes.

Forest carbon dynamics

Matthew Wilkinson

Develop a network for monitoring carbon stocks and stock changes of woodland in the UK. Maintain one of only three long-term carbon flux monitoring stations in woodland in the UK, measuring carbon fluxes and constructing a carbon budget for a stand of lowland broadleaf woodland. Research the contribution that wood (including bioenergy production) and wood products can make to climate change mitigation.

Cultural heritage and historic environment

Peter Crow

Develop methods, tools and guidance to aid the day-to-day management of historic environment features such as archaeological evidence, veteran trees and historic woodlands/landscapes.

Social Research

Anna Lawrence

Examine relationships between communities and woodlands in support of FC policies on sustainable forest management. Work concentrates on community involvement, publicly held values, health and well-being, sustainability indicators, impact assessment, recreation, access and rural development.

Economic Research

Gregory Valatin

Investigate the economics of sustainable forest management, including climate change mitigation and adaptation, and the potential for adopting economic instruments in forest policy. Provide economic advice to other research programmes.

Forest Management Division

Integrated establishment systems for the uplands

Mike Perks

Integrated studies of the effect of nursery practice, seedling physiology, plant handling methods, site preparation and maintenance upon tree establishment and subsequent growth.

Timber properties

Barry Gardiner

Investigate the impact of silvicultural practices on timber quality in conifers, especially spruce. Main emphasis is on impact of site factors (e.g. exposure, fertility) on quality.

Management of upland native woodlands

Colin Edwards

Research into the structure, dynamics and silviculture of native woodland ecosystems in northern and western Britain to support restoration and extension for ecological and economic benefits. Emphasis is on Scots pine forests, birchwoods and the Atlantic oakwoods.

Continuous cover silviculture

Gary Kerr

Evaluate canopy structure manipulation to promote suitable microclimates for seedling establishment and facilitate natural regeneration to enable wider use of alternative silvicultural systems to patch clearfelling (continuous cover forestry).

Tree stability and climate

Bruce Nicoll

Research to reduce wind damage to British forests using a GIS-based windthrow risk model for predicting the probability of windthrow in Sitka spruce forests. Carry out studies of root development and architecture in support of the model.

Integrated forest vegetation management

Ian Willoughby

Investigate alternatives to conventional vegetation management for new planting and regenerating existing woodlands, including reducing synthetic chemical inputs and direct seeding.

Seed and seedling biology

Peter Gosling and Richard Jinks

Improve tree seed quality and performance to reduce costs and increase reliability of direct seeding and natural regeneration.

Selection and testing of conifers

Steve Lee

Undertake plus-tree selection, progeny testing. Breeding/production populations. Demonstration of realised gain. Development of techniques for marker aided selection. Species: Sitka spruce, Scots pine, Corsican pine, Douglas fir, larch.

Long-term experiments

Alan Harrison

Retention of long-term forest experiments; include maintenance, assessment and provision of data.

Breeding and production of conifers

Steve Lee

Clonal archives: conservation, advanced breeding material. Improved seed: controlled pollination, seed orchards.

Modelling mixed stands

Sebastien Lafont

Evaluation of single tree growth models available in other countries that could be used to predict the growth of the mixed species and structure stands that are being created as a result of the greater use of Continuous Cover Forestry systems in British forestry. The work is carried out by a team comprising members of Biometrics and Forest Management Divisions.

Direct seeding

Ian Willoughby

Re-evaluation of the possibility of using direct seeding as a means of restocking forests in upland Britain at a lesser cost than conventional practice. Also considering the value of such systems to restore native woodlands in a more naturalistic manner.

Operational efficiency and safety in the forest wood chain

Ian Murgatroyd

This programme covers the investigation of operational issues and the provision of solutions that will contribute to improved efficiencies within the forestry sector. Four main areas of investigation are: forest establishment and maintenance; harvesting and transport; low impact silvicultural systems and ecosystem management; and safety and ergonomics.

Native woodland survey of Scotland

Alistair Macloed

Fieldwork is being carried out by Technical Services Unit (TSU) on behalf of Forestry Commission Scotland. First comprehensive survey of the extent, location and condition of all native woodlands in Scotland.

Tree Health Division

Pests and pathogens of phytosanitary concern

Hugh Evans

Research into the risks from indigenous and non-indigenous forest pests and pathogens. Co-ordination and implementation of surveys in relation to retention of EU Protected Zone status for named bark beetle pests. The use of Pest Risk Analysis techniques to determine risks from named non-indigenous pests and pathogens.

Impacts of pests under changing management

Nigel Straw

Investigate the implications of alternative silvicultural systems in relation to insect abundance and diversity, especially for key pest species. Study sites are located in several forests in Wales. This work builds on previous studies of quantitative relationships between insect populations and their impact on trees, particularly impact of green spruce aphid *Elatobium abietinum* on Sitka spruce.

Research programmes and contracts

Integrated Forest Management

Roger Moore

Building on studies of the population dynamics of *Hylobius abietis*, decision-support systems for management of the restocking problem are being developed. This enables the selective use of biological control to reduce populations of *H. abietis* to sub-economic levels through the managed application of insect parasitic nematodes for both the FC and private sectors.

Advice and scientific support for tree health

Joan Webber

Provide an advisory service to determine the causes of ill health in trees and provide advice and information on pest and pathogen identification, management and control. Disseminate the information to all interested parties through outreach activities such as Forest Health Days, workshops and seminars. Assess the impacts of horse chestnut leafminer and bleeding canker on the health of horse chestnut tree.

Tree health monitoring

Steven Hendry

Monitor the health of the nation's trees through the 350+ plots of the Forest Condition Survey, and raise awareness of tree health issues.

Non-chemical protection

Katherine Tubby

Research the potential for biological and non-chemical control of tree diseases, with special emphasis on root and butt rot of conifers caused by the fungal pathogen *Heterobasidion annosum*. Integrate this information into effective approaches to management and control of tree diseases.

Red band needle blight

Anna Brown

Research and survey the extent, severity and rate of spread of red band needle blight (caused by *Dothistroma pini*) in the UK with particular reference to East Anglia Forest District. Determine the impact that this could have on tree mortality and timber yields of Corsican pine and the suitability of the different control measures.

Quarantine pathogens – *Phytophthora ramorum* and *P. kernoviae*

Joan Webber

Investigate the biology and epidemiology of the two new quarantine tree pathogens, *Phytophthora ramorum* and *P. kernoviae*, which infect tree species within the Fagaceae. Use information generated from this research in Pest Risk Analysis to determine the extent of the risk these pathogens pose to trees in the UK, their impact and opportunities for eradication and control.

Pests and pathogens in a changing climate

David Wainhouse

New programme initially concentrating on three main strands. 1. The influence of voltinism in *Hylobius abietis* and its effect on geographical variation in pest status. This uses *H. abietis* as a model system to study the effects of climate change on insect pest generation time. 2. Interaction between drought stress and fungal disease of trees with particular reference to Sitka spruce in Scotland. 3. Investigate the influence of climate change on broadleaved pests and pathogens, using oak (*Quercus* spp) as a model system.

Programmes part-funded by the European Commission

Integrated information on tree breeding (TREEBREEDEX). Linking information on tree breeding programmes across major European countries.

Development of improved pest risk analysis techniques for quarantine pests, using pinewood nematode *Bursaphelenchus xylophilus* in Portugal as a model system (PHRAME).

Robinwood (INTERREG) projects: An examination of potential forest measures for mitigating hydrological instability and flood risk. Analysis of woodfuel management strategies and the impact of Continuous Cover Forestry on outputs from forests in various regions of Europe (Wales, Liguria, Murcia, Brandenburg and parts of the Czech republic).

Forests for water: Demonstration of opportunities on forest land to support the implementation of the Water Framework Directives.

Biosoil: The largest single soil monitoring exercise implemented so far at an EU scale, the main aim is to establish an improved common European baseline of forest soils for environmental applications – carbon stock assessment, acidification, eutrophication and impacts of climatic change.

GC EUFORGEN: Collaboration between European countries to promote conservation and sustainable use of forest genetic resources.

Risk analysis for *Phytophthora ramorum* (RAPRA).

Reintegration of coal ash disposal sites and mitigation of pollution in the West Balkan area.

Research programmes and contracts

EFORWOOD: Sustainability impact analysis of the European forestry wood chain under different scenarios and developing decision support tools to help evaluate changes in practice and market fluctuations.

SENSOR: Sustainability impact assessment: tools for environmental, social and economic effects of multifunctional land use in European regions.

STORMRISK: Development of STORM resistant landscapes through regional cooperation, adapted management and RISK communication. Working with partners in northern Europe to adapt existing decision support tools to help improve management practices.

COMFOR: Collective work science approach to solving the common problems of occupational health and performance in European forest operations SMEs.

INTERREG IIIA (Ireland-Wales): Sustainable Management of Forest Insect Pests.

Programmes funded by other organisations

BP Exploration Operating Co. Ltd
Scottish Forestry Alliance Biodiversity Group. Method development, data collection and analysis to provide biodiversity monitoring for new native woodlands established on Scottish Forestry Alliance sites.

Central Science Laboratory and Scottish Natural Heritage
Supporting a Defra-led project that aims to test and adapt fertility control agents for target species that have been developed in the US, and in particular work on the grey squirrel (*Sciurus carolinensis*).

Centre for Ecology and Hydrology (CEH)
Inventory and projections of UK emissions by sources and removals by sinks due to Land Use, Land-Use Change and Forestry (LULUCF).

COFORD
CLIMADAPT: Development of an Ecological Site Classification (ESC) for Ireland. Assessment of species suitability in Ireland, and the impact of IPCC climate change scenarios on forest stands and forest ecosystems using an ESC.

Deer Commission for Scotland
Management of Roe deer in peri-urban Scotland. Determine current attitudes of those who might manage peri-urban deer, i.e. private landowners and landholding organisations. Establish the distribution and scale of the peri-urban Roe deer population in the Central Belt.

Department for Business, Enterprise and Regulatory Reform (BERR) and Aspire Defence
The use of biologically enhanced charcoal for *in-situ* remediation of contaminated land.

Department for Environment, Food and Rural Affairs (Defra)
Biomass Centre – contributions towards continued development.

Flood and Coastal Erosion Risk Management Innovation Fund – Restoring Floodplain Woodland for Flood Alleviation.

Department for Innovation, Universities and Skills (DIUS)
Public Sector Research Exploitation Fund, third round. A three-year capacity building project commenced in April 2006 to assist Forest Research to develop its innovation and commercialisation activities.

Economic and Social Research Council (ESRC)/University of Leeds
Supergen: The production of different types of biomass and their behaviour in thermal conversion processes, with particular emphasis on the interaction and interface between production and conversion.

Engineering and Physical Sciences Research Council (EPSRC)/Sheffield
Novel compost.

EPSRC/University of Surrey
Pollutants in the urban environment.

ESRC/University of Sheffield
Rivers project.

Forestry Commission Scotland/Scottish Natural Heritage
Production of a toolbox of methods for assessing grazing impacts, including development of a qualitative method for assessing herbivore impacts on woodlands and monitoring of a pilot grazing grant scheme.

Forestry Commission Scotland/Perth and Argyll Council
Invasive weed control. Undertaking surveys of *Rhododendron ponticum* occurrence in sensitive woodlands, predicting potential for colonisation and developing cost-effective management strategies.

Research programmes and contracts

Gallagher Estates

Plant growing trials.

Highland and Islands Enterprise/FC Grampian Conservancy/Scottish Enterprise

Scots pine timber quality in North Scotland. Carrying out surveys of the Scots pine resource and assessing its quality for different markets.

Highland Birchwoods 'sourfelling'. Trials of various methods of preparing conifer timber for use as woodfuel.

Institute of Grassland and Environmental Research

Development of sustainable heat and power fuelled by biomass from short rotation coppice in Wales.

James Jones Ltd

Timber properties of Sitka spruce in south Scotland. Operational testing of acoustic tools for assessing timber quality in the forestry wood chain.

Natural Environment Research Council (NERC)

QUEST forestry demonstrator. Deliver the scientific basis for project verification methods and project design principles and guidelines that assure that forestry-based mitigation projects have maximum benefits for climate, social concerns and the environment, including biodiversity, water resources and soils.

Rural Economy and Land Use Programme (RELU)

A case study on integrated deer management.

Scotland and Northern Ireland Forum for Environmental Research (SNIFFER)

Urban networks for people and biodiversity: Review recent approaches to the identification and analysis of habitat networks and examine opportunities to apply these to urban areas. Identify other relevant social and environmental data-sets that could be linked to green network data to investigate the potential to create green networks with multiple functions.

Minard cattle grazing trial: Monitoring of cattle grazing as vegetation management to improve conditions for Black Grouse.

SNIFFER/British Trust for Ornithology (BTO)

Implications of land use and demographic change: Identifying the relationship between predicted environmental and demographic trends and biodiversity conservation in urban areas, and examining strategies to manage this relationship most effectively.

South East England Regional Development Agency (SEEDA)

Grant to assist the establishment of the Rural Research and Strategy Partnership. This Partnership aims to support and stimulate interdisciplinary research between Forest Research, the Universities of Reading, Surrey and Sussex and the University for the Creative Arts. It focuses on topics important for rural sustainability.

United States Department of Agriculture (USDA)

Studies on *Phytophthora ramorum*.

Research contracts awarded by Forest Research

Environment Agency (Wales)

Effects of forestry on surface water acidification.

Fountain Forestry

Water monitoring, Halladale.

Imperial College

Links between tree health and ectomycorrhizal (ECM) fungal communities under changing environmental conditions.

University of Bristol

Landscape history of Saverlake Forest.

University of Cardiff School of Engineering

Investigation of the hydraulic impact of floodplain woodland.

University of Edinburgh

Impacts of ultraviolet-B radiation on leaf decomposition in forest trees.

Physiological ecology of understorey trees in alternative management systems.

The biology of heartwood formation and its influence on conifer timber quality.

University of Essex

Impact of nitrogen deposition on microbial communities in relation to nitrogen/carbon cycling in forest soils.

University of Exeter

Soil microbial population dynamics and function associated with soil methane and CO₂ fluxes within forest systems as influenced by climate change.

University of Reading

Investigation into best practice for the design and management of successful engineered wetland habitat systems on brownfield land.

Investigating the flux of carbon dioxide from a lowland oak woodland.

University of Surrey

In-situ magnetic resonance of water distribution and movement in living trees.

University of Ulster

Impact of defoliating insects in a changing forest environment.

University of York

The role of biotic interactions in determining species' responses to climate warming.

People

Forest Research staff include many experts from a wide range of subject areas relating to forestry and the wider environment. These specialist science teams work at the forefront of research, aided by a network of support staff essential to the continued smooth running of our organisation.



Many FR staff have received awards and qualifications during the past year, reflecting national and international success and recognition.

Jim Lynch, FR Chief Executive from July 2003 to September 2007, received an OBE in June 2007, recognising particularly his 17 years as co-ordinator of the Organisation for Economic Co-operation and Development (OECD) programme on Biological Resource Management. Sam Evans also received an OBE (Military Division). Jim Lynch and Andy Moffat were both granted Visiting Professorships in the School of Human and Environmental Sciences at the University of Reading.

Mike Perks was awarded Honorary Fellow Status in the School of Geosciences at the University of Edinburgh, while Juan Suarez received a Fellowship from Glamorgan University. Bill Mason was awarded a Doctorate in Science from Bangor University for his work entitled 'Silvicultural research in support of multifunctional management of British conifer forests'.

Hugh Williams and Ian Willoughby were promoted to Fellows of the Institute of Chartered Foresters.

FR was pleased to welcome new staff in many areas of work and across most sites during 2007-08.

Biometrics, Surveys and Statistics Division (BSSD) welcomed Vera Correia and Stefania Pizzirani to work in the Woodland Surveys Unit at NRS. Dave Auty and John Fonweban joined Forest Management Division (FMD): Dave as a PhD student to work on developing a timber quality model for Scots pine with reference to forests undergoing transformation to irregular structures; and John as timber properties modeller working on the programme for Sitka spruce and the integration of modelling approaches. Rebecca Brassey joined Ecology Division (ED) at our Northern Research Station (NRS) as a project officer working to develop indicators of wild deer health and welfare on the open hills across Scotland.

Environmental and Human Sciences Division (EHSD) welcomed Anna Lawrence as the new Head of Social and Economic Research Group (SERG) at Alice Holt. Anna's role includes identifying and responding to the social research priorities related to the forest strategies of England, Scotland and Wales. Mariella Marzano joined as a project leader in SERG working on a literature review of forest management and recreation, and Vadims Sarajevs joined as an economist, based at NRS.

Also joining EHSD at Alice Holt is James Morison as Head of the Environmental Change Group where he is focusing on developing and co-ordinating FR research on the consequences and mitigation of climate (and the adaptation necessary). Jeremy Wingate joined the Land Regeneration and Urban Greening Research Group to work on a joint project on the *in situ* remediation of contaminated land.

Two new Research Liaison Officers (RLOs) joined Communications Group: Steve Penny as RLO for Scotland and Hugh Williams as RLO for England. Their wide-ranging roles include channelling FR research knowledge to FC Scotland and FC England and other stakeholders, providing feedback to FR.

Other new staff included Sandra Smith as Finance and IT Services Director, based at Alice Holt, and Sarah Jeffreys as a placement student in Human Resources and Administration. Also based at Alice Holt, but with a GB-wide role, Jane Devlin joined as Intellectual Property Manager to deliver FR's PSRE3 project and to support innovation and commercialisation across FR.

During 2007-08 we said goodbye to several staff, many after long and wide-ranging service with FR.

Allan John retired after 32 years working with Physiology Branch, Tree Improvement Branch and Forest Management Division. Allan's dedicated work focused on vegetative propagation of larch and Sitka spruce, initially with cuttings then at micro-level. He was also an active union member, representing FR on Whitley sub-committees and at 'Prospect' conferences.

People

Paul Tabbush retired after 34 years with FC/FR. His long and varied career began in the Forest of Dean and Kielder Forest before he began working as a silviculturist specialising in forest establishment at NRS, and later at Alice Holt where he was Head of Silviculture. His invaluable contribution to forestry research then moved in a different direction when he set up the Social Research Unit, actively developing research capacity and winning funding.

Sue Stiles' 21-year career with FR spanned a large range of secretarial work. In her last four years at Alice Holt she worked as personal secretary to Jim Lynch and Peter Freer-Smith, always providing vital and friendly support.

Dave West's 30 years as a forester started at Crychan Forest and he later became Head Forester at Thetford. During the past 15 years he worked with TSU at Santon Downham and Fineshade.

David Jones retired after 42 years, beginning as a forester in South Wales and Brecon Beacons before joining FC Technical Training at Rheola Training Centre. David was responsible for training all FC employees in mechanised harvesting. Moving to Technical Development, he then focused on small-scale harvesting and became an expert on woodfuel production systems.

Terry Gray, a leading research worker at TSU, Kielder, retired after 26 years.

Tony Cornwell retired as Finance and IT Director. During his nine years with FR, Tony centralised all financial information to the Finance Office at Alice Holt, transferred systems to PCs, and introduced the Government Procurement Card, popularly known as the GPC, to FR.

We also said farewell to **Jonathan Humphrey**. After 14 years of dedicated work on many aspects of ecology, including representing FR at conferences and editing proceedings, Jonathan left to retrain as a Church of Scotland Minister, starting with a degree in Divinity at Edinburgh University.

People and locations

Permanent and fixed-term staff as at 31 March 2008.

Acting Chief Executive

- Professor Peter Freer-Smith, BSc, PhD, DSc

Acting Research Director

- Professor Andy Moffat, BSc, PhD, DSc

Personal Secretaries

- Claire Holmes
- Helena Ladbury

Head of Northern Research Station

- Chris Quine, MA, MSc, FICFor, PhD

Quality Assurance Manager

- Carl Foster

Business and Innovation

- Alison Melvin, BA
- Jane Devlin, BSc

Human Resources and Administration

- Ken Charles, FMS, *HR and Administration Director*
- Wendy Groves
- Sarah Jeffreys
- Janet Lacey
- Andrew Phillips
- Heather Russell
- Mandy Sennett
- Sally Simpson
- Amanda Smith
- Mike Wheeler
- Mike Young
- Martin Abrahams, *Head of Administration at NRS*
- Gerry Cockerell
- Evelyn Hall
- Esther Ker

Finance and IT

- Sandra Smith, ACMA, *Finance and IT Director*
- Laura Cales
- Carol Knight
- Timothy Knight, BSc
- Carole Martin
- Paul Morris
- Corinne Russell
- Janet Turner
- Ann Williams
- Wayne Blackburn, BSc, *Head of IT Services*
- Alec Gaw, BSc

Communications

- Xanthe Christophers, BSc, MSc, PGCE, PhD, *Communications Director*
- Joanne Davies, BSc
- George Gate
- David Georgiou, BA
- Eleanor Harland, MA, DipLib
- Catherine Oldham, BA, MA, DipLib, MCLIP
- Sally Taylor
- Glenn Brearley
- Kirsten Hutchison, MA

Research Liaison Officers

- Hugh Williams (England), BA, MSc, PhD
- Steve Penny (Scotland), BSc, MSc
- Chris Jones (Wales), BSc

Biometrics, Surveys and Statistics Division

- Helen McKay, BSc, PhD, MICF, CEnv, *Head of Division*
- Professor Sam Evans, UDip, BA, MA, PGDip, PhD, PhD, FCMI (currently on secondment with Defra)
- Catia Arcangeli, MSc, PhD
- Eric Casella, MSc, PhD
- Joy Cornwell
- Ian Craig
- Paul Henshall, BSc
- Geoff Hogan, BSc, DPhil
- Makihiko Ikegami, BSc, MSc, PhD
- Sebastien Lafont, BSc, MSc, PhD
- Ewan Mackie, BSc, MSc
- Robert Matthews, BSc, MSc
- Geoff Morgan, BSc, MSc, PhD
- Lyn Pearce
- Tim Randle, BSc
- Marc Sayce
- Paul Taylor, MA, MSc, MPhil
- Ian Tubby, BSc
- Miriam White, HND, BSc, MSc
- Christopher Vials, BSc
- Stephen Bathgate, BSc, BSc, PGDip
- Christine Brown
- Graham Bull
- Shona Cameron
- Lynn Connolly
- Tom Connolly, BSc, PhD
- Vera Correia
- Fauzia Davidson, BSc, MSc
- Justin Gilbert, BSc
- Celia Igreja Dias
- Mark Lawrence, BSc, MSc
- Linda Legge
- Una McEvoy, BSc
- Andrew Peace, BSc
- Lynn Rooney
- Juan Suárez-Minguez, BSc, MSc
- Esther Whitton
- Adam Ward

FR employs 275 staff, some of whom work part time, giving a total staff number of 264 full-time equivalents at 31 March 2008.

KEY: ■ Alice Holt ■ Northern Research Station ● Technical Development Office ● Field Station

People

Ecology Division

- Chris Quine, MA, MSc, FICFor, PhD,
Head of Division
- Stuart A'Hara, BSc, MSc, PhD
- Russell Anderson, MSc
- Helen Armstrong, BSc, PhD
- Rebecca Brassey, BSc, MSc
- Alice Broome, BSc
- Robert Coope, BSc
- Joan Cottrell, BSc, PhD
- Jason Hubert, BSc, PhD
- Darren Moseley, BSc, PhD
- Liz Poulson, MSc
- Duncan Ray, BSc
- Sam Samuel, PhD
- Roz Shields
- Louise Sing, BA, MSc
- Mike Smith, BSc
- Shirley Spencer
(also with FMD and TSU)
- Tytti Vanhalla, BSc, MSc, PhD
- Georgios Xenakis BSc, MSc, PhD
- Amy Eycott, BSc, PhD
- Mark Ferryman
- Robin Gill, BSc, MSc, PhD
- Philip Handley, BSc, MSc
- Ralph Harmer, BSc, PhD
- Andrea Kiewitt, BSc, MSc
- Brenda Mayle, MSc
- Shirley Stephens
- Roger Trout, BA, PhD
- Kevin Watts, BSc, PhD

Environmental and Human Sciences Division

- Professor Andy Moffat, BSc, PhD, DSc,
Head of Division
- Lorraine Adams, BSc
- Nadia Barsoum, BSc, PhD
- Sue Benham, BSc
- François Bochereau, BSc, MSc
- Samantha Broadmeadow, BSc, MSc
- Andy Brunt
- Claudia Carter, BSc, MSc
- Sylvia Cowdry
- Peter Crow, BSc, MSc
- Norman Dandy, BSc, MA, PhD
- Cecile De Munck, BSc, MSc
- Kieron Doick, BSc, MRes, PhD
- Tony Hutchings, MSc
- Lynn Jordan
- Anna Lawrence, BA, MSc, PhD
- Vicki Lawrence
- Alberto Morales, BSc, PhD
- James Morison, BSc, PhD
- Jake Morris, MA, PhD
- Jacqui Neal
- Tom Nisbet, BSc, PhD
- Liz O'Brien, BSc, PhD
- Richard Pilgrim, BSc
- Rona Pitman, BSc, PhD
- Danielle Sinnett, BSc, MSc
- Elena Vangelova, BSc, MSc, PhD
- Christine Whitfield
- Matthew Wilkinson, BSc, MSc
- Jeremy Wingate, BSc, MSc
- Sirwan Yamulki, BSc, MSc, PhD
- David Edwards, BSc, MSc, MSc, PhD
- Mariella Marzano, BA, MA, PhD
- Vadims Sarajevs, MSc, MSc, PhD
- Gregory Valatin, MA, MPhil, PhD
- Roz Owen, BA, MA (Aberystwyth)
- Huw Thomas, BSc, MSc

Forest Management Division Incorporating Technical Development

- Bill Mason, BA, BSc, DSc, MICFor,
Head of Division
- Cathleen Baldwin
- Colin Edwards, BSc, MRes
- John Fonweban, BSc, MSc, PhD
- Professor Barry Gardiner,
BSc, PhD, FRMetS
- Sophie Hale, BSc, PhD
- Alan Harrison, BSc, MSc
- Madge Holmes
- Steve Lee, BSc, PhD, MICFor
- Elspeth MacDonald, BSc, MSc
- Colin McEvoy, BA
- Shaun Mochan, MSc
- Bruce Nicoll, BSc, PhD
- Margaret O'Donnell
- Steven Osborne, BSc (also with TSU)
- Mike Perks, BSc, MSc, PhD
- Stefania Pizzirani, BA, MSc
- Shirley Spencer
(also with ED and TSU)
- Rob Sykes
- Peter Gosling, BSc, PhD
- Richard Jinks, BSc, PhD
- Gary Kerr, BSc, PhD, FICFor
- Shelagh McCartan, BSc, MSc, PhD
- Matt Parratt, BSc
- Victoria Stokes, BSc, PhD
- Christine Woods, BA
- Ian Willoughby, BSc, MBA

Technical Development Ae, Scotland

- Andy Hall,
Head of Technical Development
- Duncan Ireland, BSc
- Bill J. Jones
- Ian Murgatroyd
- Joyce Rammell, BSc
- Colin Saunders
- Jean Saunders

Delamere

- Andy Hall (also at Ae)
- Paul Webster
- Stephanie Roux, MSc

Wales

- David Jones, EngTech, AMIAgrE
- Finlay McAllister, BA, BSc

KEY: ■ Alice Holt ■ Northern Research Station ● Technical Development Office ● Field Station

Tree Health Division

- Hugh Evans, BSc, DPhil, FRES,
Head of Division
- Elizabeth Beal, BSc, PhD
- Professor Clive Brasier,
BSc, PhD, DSc, Research Fellow
- Anna Brown, BSc, PhD
- Sandra Denman, BSc, MSc, PhD
- Daegan Inward, BSc, MSc, PhD
- Andrew Jeeves
- Martin Jukes, Cbiol, MIBiol
- Susan Kirk
- David Rose, BA
- Joan Rose
- Claire Sabin, BA
- Nigel Straw, BSc, PhD, FRES
- Christine Tilbury, BSc
- Kath Tubby, BA, MSc, DPhil
- David Wainhouse, MSc, PhD, FRES
- Joan Webber, BSc, PhD
- David Williams, BSc, PhD
- Sarah Green, BSc, PhD
- Steven Hendry, BSc, PhD
- Stuart Heritage, MBA, Cbiol, MIBiol
- Grace MacAskill
- Roger Moore, BSc, PhD
- Heather Steele, BSc

Field Stations

Technical Services Unit

- Janet Dutch, BSc, PhD,
Head of Unit

NRS Engineering Services

- David Brooks,
Head of Engineering Services
- James Nicholl
- John Strachan

Inver

- Nick Evans
- Andrew Kennedy, BSc
- Bill Rayner
- Pauline Simson, BSc

Ae and Bush Nursery

- Dave Watterson,
Head of Stations

Ae

- James Duff
- Martin Mackinnon, BSc
- Patrick Home Robertson, BSc
- Will Thompson, BSc
- Harry Watson
- James White

Bush Nursery

- David Clark, *Nursery Manager*
- John Armstrong
- Colin Gordon
- Hamish Howell

Newton and Lairg

- Alistair MacLeod, *Head of Stations*

Newton

- Hazel Andrew
- Sam Catchpole, BSc
- Julie Gardiner, BSc
- Philip James, BSc
- Fraser McBirnie
- Stuart McBirnie
- Stephen O'Kane
- Gary Servant, BSc
- Colin Smart

Lairg

- Alexander Bowran
- Calum Murray
- Duncan Williams

Alice Holt and Exeter

- Mark Oram, BSc, MSc, *Head of Station*
- Jamie Awdry
- Bob Bellis
- Sue Bellis
- Tony Bright
- Steve Coventry
- Kate Harris
- Ian Keywood
- Jim Page
- Bill Page

Alice Holt Workshop

- Jon Davey
- Clive Muller

Exeter

- Alan Ockenden
- Anthony Reeves
- Barnaby Wylder

Fineshade, Thetford and Wykeham

- Elizabeth Richardson, *Head of Stations*

Thetford

- John Lakey
- Paul Turner
- Alistair Whybrow, BSc
- Steven Whall

Wykeham

- Lee Cooper
- Nicola Corney
- Patricia Jackson
- William Riddick
- Jake Thompson, BSc

Shobdon and Talybont

- Nick Fielding, *Head of Stations*

Shobdon

- Sharon O'Hare
- Martin Page-Jones
- Andrew Price, BSc
- John Price

Talybont

- Lyn Ackroyd
- Justin Chappell
- Dai Evans
- Ben Griffin, BSc
- Steve Howells
- Richard Keddle
- Michal Maniakowski, BSc
- Tony Price
- Tyrone Waldron

PhD students linked with Forest Research as at 31 March 2008

Tom Adams

University of Edinburgh
Modelling complexity in native pinewoods

Sarah Archibald

Imperial College London
Classification of the UK population of *Dothistroma septosporum*

Dave Auty

University of Aberdeen
Scots pine timber quality in Scotland

Matt Aylott

University of Southampton
Modelling climate change impacts on the availability of short rotation coppice

Kate Beauchamp

University of Edinburgh
The biology of heartwood formation and its influence on timber quality

Sophie Bertin

University of Edinburgh
Physiological ecology of understorey trees in alternative management systems

Freia Bladon

University of Ulster
The impact of defoliating insects in a changing forest environment

Niels Brouwers

University of Bournemouth
Wood cricket movement on the Isle of Wight

Lois Canham

University of Stirling
Ecology of Capercaillie within a managed pine forest

Fiona Caryl

University of Stirling
Pine martins

Vanessa Castan Broto

University of Surrey
Lay perspectives in coal ash pollution

Jo Clark

University of Wales, Bangor
Provenance selection for climate change

Filipa Cox

Imperial College London
Are there links between tree health and ectomycorrhizal fungal communities under changing environmental conditions?

Julia Cox

University of Surrey
In-situ magnetic resonance of water distribution and movement in living trees

Cathy Dowling

University of Durham
Use of manganese oxide for land remediation

Helen Ellison

Imperial College London
Roundwood storage in the forest environment

Ruth Fitzgerald

University of Reading
Quantifying soil carbon exchange in lowland deciduous woodland

Priya Gadepalle

University of Surrey
Development of novel materials for land remediation

Rachel Gaulton

University of Edinburgh
Remote sensing for continuous cover forestry

Nicole Harris

University of Southampton
Differential gene expression in high and low wood density poplar and Sitka spruce trees

Theresa Huston

University of Exeter
Soil microbial population dynamics and function, and soil carbon fluxes within forest systems as influenced by climate change and increased atmospheric CO₂

Clare Jones

University of Liverpool
An investigation into Holocene stand-scale forest dynamics of British woodlands

Stuart Kennedy

University of Aberdeen
Determining the genetic heritability of wood properties of Sitka spruce critical to timber strength

Katherine King

University of Brighton
Understanding teenage leisure and woodlands

Laura Kruitbos

University of Aberdeen
The hitchhikers' guide to the forest

David Messenger

University of Edinburgh
Effect of UVB radiation on leaf litter decomposition

Helen Murray

University of Glasgow
The impact of the Whitelee Wind Farm development on the export of carbon and nutrients to catchment runoff

Jenny Owens

University of Stirling
Restock vegetation for Black Grouse

Philippa Reid

University of York
The role of biotic interactions in determining species' responses to climate warming

Sabrina Reignoux

University of Edinburgh
Molecular ecology of *Lophodermium* spp. on Scots pine

Matti Salmela

University of Edinburgh
Adaptive variation in natural populations of Scots pine in Scotland

Helen Sneath

University of Surrey
The sustainability of charcoal as an ameliorant in soil remediation

Juan Suárez-Minguez

University of Sheffield
LiDar analysis

Armand Tene

University of Dublin

Tree species adaptation to climate change

Emma Thorpe

University of Essex

Impact of nitrogen deposition on microbial diversity and function in relation to nitrogen/carbon cycling in different forest soils

Claire Twiddle

University of Exeter

Modelling the vegetation history of Inchriach Forest, Cairngorms

Leena Vihermaa

University of Glasgow

Tree growth influences on wood properties

Jeremy Wingate

University of Surrey

Use of charcoal for land remediation

Kirsten Wright

University of Reading

Investigation into best practice for the design and management of successful engineered wetland habitats on brownfield land

Patricia Xavier

University of Cardiff

Investigation of the hydraulic impact of floodplain woodland

Accounts for the year ended 31 March 2008



© Ben Smith, Dreamstime.com

Annual Report	76
Remuneration Report	82
Statement of Forestry Commission's and Chief Executive's Responsibilities	87
Statement on Internal Control	88
The Certificate and Report of the Comptroller and Auditor General to the House of Commons	93
Operating Cost Statement	95
Statement of Total Recognised Gains and Losses	95
Balance Sheet	96
Cash Flow Statement	97
Notes to the Accounts	98

Annual Report for the year ended 31 March 2008

1. Basis of accounts

These accounts are prepared in accordance with a direction given by HM Treasury in pursuance of section 7 of the Government Resources and Accounts Act 2000.

Management Commentary

2. Status

Forest Research became an Executive Agency of the Forestry Commission on 1 April 1997. It undertakes the major part of the Commission's research and development programmes as well as providing survey, monitoring and scientific services.

Forest Research remains part of the Forestry Commission, which is a cross border Government Department responsible for forestry throughout Great Britain. The relationship between Forest Research, the Forestry Commissioners and Forestry Ministers is described in the Framework Document, revised and published in September 2003.

Prior to April 1997, Forest Research was managed as a Division of the Forestry Commission and its assets and financial transactions were included in the departmental accounts presented in the Forestry Commission Annual Report and Accounts.

From 1 April 1997, the Agency assumed ownership of and responsibility for the assets and liabilities appropriate to the research activity, which were included in the Forestry Commission Statement of Assets and Liabilities as at 31 March 1997. It also assumed ownership of the building assets it occupies, which were previously owned and managed on behalf of the Forestry Commission by the Forest Enterprise agency, with appropriate intradepartmental charges made, and recorded on the Forest Enterprise balance sheet as at 31 March 1997.

Two organisational reviews took place during 2002 and 2003 that impacted on the Agency's status and operational arrangements.

In line with normal arrangements for agencies, Forest Research underwent a Quinquennial Review, stage one of which was completed in January 2002, whilst between May 2001 and August 2002 an interdepartmental group carried out a review of the Forestry Commission. This reviewed the devolution arrangements for delivering sustainable forestry policies in England, Scotland and Wales and the UK's international forestry commitments.

On conclusion of stage one of the Forest Research Quinquennial Review, Forestry Ministers decided that the Agency should retain its executive agency status for a further five years. The devolution review concluded that Forest Research should continue as a GB-wide agency of the Forestry Commission but new arrangements should be set up, with an enhanced role for the devolved administrations through the National Offices in England, Scotland and Wales in determining research priorities and specifying programmes.

The stage two report of the Agency's Quinquennial Review, which addressed the issues on implementing the outcomes of the stage one review and the devolution review, was approved by Ministers and a new Framework Document was put in place in September 2003.

Under the Framework Document, Forest Research is funded from the sale of its services to both the Forestry Commission and external customers. Any annual surplus or deficit is counted in the Forestry Commission's net funding requirement.

Forest Research has been designated a GB entity. For Resource Accounting purposes Forest Research is within the departmental boundary. Its accounts are consolidated into the Forestry Commission GB/England accounts.

3. Strategy

The strategic aims and objectives of the Agency have been set to assist the Forestry Commission achieve its GB objective to take the lead in development and promotion of sustainable forest management and to support its achievement nationally.

These are discussed in detail in the Agency's corporate plan, which is available on the Forestry Commission website and the Forest Research website.

4. Relationships with stakeholders

As most aspects of forestry are devolved activities, strong relationships between the wider Forestry Commission (FC) and the devolved administrations are critical. Summer 2005 saw the launch of FC's Science and Innovation Strategy, with an increased focus on the role of the FC National Offices and the Northern Irish Forestry Service to shape the research agenda and to disseminate results via the creation of Programme Advisory Groups involving country stakeholders. Consultations associated with this process involved the participation of many of our key stakeholders, focused around meetings held during the year. The Agency subsequently appointed three Research Liaison Officers, to support the process of research commissioning and dissemination on an ongoing basis.

As an applied research institute, the Agency's relationships with the forestry and land management industries are also of paramount importance. The Agency has recently strengthened its industrial links in a number of ways.

- The strengthening of its knowledge transfer expertise, through monies awarded by 'Public Sector Research Establishment 3' innovation capacity building fund, is enabling the Agency to take a more pro-active role in industry-led innovations.
- The Agency has become a member of the English Forest Industries Partnership, which has completed a sector mapping study.
- The Agency's close association with the Scottish Forest Industries Cluster has resulted in full involvement in the development of the European Forestry Technology Platform and its associated strategic research agenda, which is being taken forward in the Framework 7 programme during 2007-2013.

5. Aims and objectives

The aim of Forest Research is set out in the Framework Document. It is to support and enhance forestry and its role in sustainable development, by providing high quality research and development in a well-run organisation.

The objectives of Forest Research are listed on page 9 in the Annual Report.

Current and future development and performance

6. Operating review

The evidence base required to deliver forestry policies changes rapidly, requiring FR to be responsive in order to meet emerging customer needs for research, advice and scientific services. FR published a Development Strategy in September 2006 and the key objectives which it sets out are to match skills to customer needs, to provide innovation, to increase scientific and business excellence, to ensure a range of funding sources and to improve the links with other organisations.

During 2007–08 the system by which the FC specifies its research needs was updated by changing the structure and composition of the Programme Advisory Groups (PAGs) and by the introduction of Contract Proposals. FR staff provided contract proposals for all FC-funded programmes and these were reviewed and approved by the PAGs during the Autumn of 2007.

During the year the expertise and skills required to match the needs, particularly of non-FC customers, were reviewed by six Priority Area Working Groups. This has resulted in ongoing support of FR's Biomass Energy Centre and the establishment of a new Urban Regeneration and Greenspace Centre. In addition it has been recognised that much of FR's research addresses climate change, more or less directly, and climate change research within FR is now co-ordinated by a research hub linked to the FC's Climate Change Strategy Group.

The Social and Economic Research Group, Timber Quality Programme, Scottish Native Woodland Survey and second National Inventory of Woodland and Trees have also been areas of particular activity during the year. Demand for research and advice on silvicultural options, tree health, on biodiversity and habitat networks has remained strong. The 2007–08 year is the middle year of FR's Public Sector Research Exploitation project and this has allowed us to build our expertise and activity in commercialisation and management of intellectual property. We are now seeing the benefits of this approach in a number of specific areas.

7. Financial review

This is Forest Research's 11th year of operation as an Agency. Forest Research produced a net operating deficit of £887,000 on its Income and Expenditure Account, excluding the notional cost of capital. A comparison of income and expenditure with the previous year's results shows that:

- staff costs increased by £68,000 (0.7%)
- other management costs decreased by £65,000 (2.6%)
- materials and services costs increased by £406,000 (13.2%), primarily resulting from the employment of contractors to meet contractual commitments
- income from Forestry Commission customers decreased by £73,000 (0.6%)
- income from external customers decreased by £859,000 (36.0%). This confirmed the recommendations of a review which identified the need to improve financial and management information systems and reporting
- the notional cost of capital increased by £36,000 (7.6%)

The net deficit for the year after the cost of capital charge of £511,000 and depreciation was £1,398,000, representing a cost recovery rate of 91.3%, compared with 99.9% in 2006–07.

After adjusting the total deficit for items not involving the movement of cash and for capital expenditure, bank account movements and income, the net cash outflow for the year was £392,000, which was received from the Forestry Commission.

Additions to fixed assets in the year were £828,000.

8. Financial objective – Key Performance Indicators (KPIs)

Forest Research's primary financial objective set out in the Framework Document is to recover the full economic costs, including cost of capital, of its operations from the sale of services to customers. In 2007–08 the recovery rate was 91.3%.

Performance against other operational, scientific and financial KPIs is reported in the main body of the Annual Report and Accounts. FR achieved £1.5m of income from non-FC customers against the KPI target of £2.7m.

9. Events since the balance sheet date

There were no significant post-balance sheet events to record except the appointment of Dr James Pendlebury as Chief Executive and Agency Accounting Officer with effect from 16 June 2008.

10. The future

As the principal provider of research and science-base to the Forestry Commission and to UK forestry, FR is part of the wider science and technical development community, maintaining world class expertise and excellence in applied forest research. We have put arrangements in place to ensure that our work fully supports the forestry strategies in England, Scotland and Wales. Priorities during the coming year are:

- To maintain the progress made in implementing the recommendations of the Priority Area Working Groups and Finance Review which reported during 2007–08.
- To give close consideration to the co-ordination of climate change and forestry research and the integration of FR work with FC requirements on climate change.
- To maintain the progress being made with commercialisation and IP management, and in this area to develop joint work with other parts of the FC.

FR will continue to lead research on sustainable forestry and climate change which cut across its programmes of social, economic and environmental research. There will be an emphasis on customer care and we will also look closely at efficiency and delivery, participating fully in the FC's GreenerWays programme.

11. Supplier payment policy

Forest Research observes the principles of the Late Payment of Commercial Debts (Interest) Act 1998. Unless otherwise stated in the contract, we aim to pay within 30 days from the receipt of goods and services, or the presentation of a valid invoice, whichever is the later. An analysis for 2007–08 indicates that 100% of payments to suppliers, including those made using the Government Procurement Card, were paid within the due date. Arrangements for handling complaints on payment performance are notified to suppliers on orders. No interest was paid under the Late Payment of Commercial Debts (Interest) Act 1998.

12. Employment policies

Forest Research adheres to the Forestry Commission's employment policy and values and respects its staff by treating each member with respect and trust, and in doing so recognises that each person is different and can make a unique contribution to the work. The purpose of the Forestry Commission's employment policy is to demonstrate that it is an equal opportunity employer and the aim is to be fair to everybody. To do this the Forestry Commission ensures that no eligible job applicant or employee receives less favourable treatment on the grounds of their gender, or gender re-assignment, ethnic origin, disability, age, nationality, national origin, sexual orientation, marital status, religion and religious or philosophical belief, social class or offending background.

All employees, whether part-time, full-time or temporary, will be treated fairly and equally. Selection for employment, promotion or training or any other benefit will be on the basis of aptitude and ability. All employees will be helped and encouraged to develop their full potential and the talents and resources of the workforce will be fully utilised to maximise the efficiency of the organisation. No person shall be disadvantaged by conditions or requirements which cannot be shown to be justifiable.

The Forestry Commission also follows good employer practices aimed at ensuring that all staff work in an environment free from both illegal and unfair discrimination and harassment. Consolidated statements of the Commission's obligations with regard to equality of opportunity and diversity are shown in the Staff Handbook. Full details of these initiatives arising from our policies are also set out on the Human Resources intranet site.

The Forestry Commission will monitor the success of its policies by:

- Collecting and analysing data as appropriate.
- Regularly reviewing procedures (recruitment, performance management, promotion and pay) to ensure that they are free of unfair discrimination.
- Reporting the results of equality and diversity monitoring to the Human Resources Management Sub-Committee on an annual basis.
- Liaising closely with Cabinet Office and other Government Departments to ensure that we are keeping abreast of all changes in legislation and other developments.

Further information on the employment of persons with disabilities, the provision of information to, and consultation with, employees, and the promotion of equal opportunities is available on request from the Human Resources unit of the Forestry Commission.

13. Management

The Ministers who had responsibility for the Forestry Commission, including Forest Research, during the year were:

Rt. Hon. David Miliband MP	<i>Secretary of State, Department for Environment, Food and Rural Affairs (until 27 June 2007)</i>
Barry Gardiner MP	<i>Parliamentary Under-Secretary (Commons), Department for Environment, Food and Rural Affairs (until 27 June 2007)</i>
Rt. Hon. Hilary Benn MP	<i>Secretary of State, Department for Environment, Food and Rural Affairs (from 28 June 2007)</i>
Joan Ruddock MP	<i>Parliamentary Under-Secretary of State (Climate Change, Biodiversity and Waste), Department for Environment, Food and Rural Affairs (from 28 June 2007)</i>
Phil Woolas MP	<i>Minister of State, Department for Environment, Food and Rural Affairs (from 28 June 2007)</i>

Members of the Executive Board of Forest Research during the year were:

Jim Lynch	<i>Chief Executive (until 30 September 2007)</i>
Peter Freer-Smith	<i>Research Director (Acting Chief Executive from 1 October 2007)</i>
Ken Charles	<i>Head of Human Resources and Administration</i>
Tony Cornwell	<i>Finance Director (until 4 January 2008)</i>
Sandra Smith	<i>Finance Director (from 7 January 2008)</i>
Bill Mason	<i>Head of Forest Management Division</i>
Sam Evans	<i>Head of Biometrics, Surveys and Statistics Division (until 1 June 2007)</i>
Helen Mckay	<i>Acting Head of Biometrics, Surveys and Statistics Division (from 2 July 2007)</i>
Hugh Evans	<i>Head of Tree Health Division</i>
Chris Quine	<i>Head of Ecology Division</i>
Andy Moffat	<i>Head of Environmental and Human Sciences Division (and Acting Research Director from 1 October 2007)</i>
Xanthe Christophers	<i>Communications Director</i>
Janet Dutch	<i>Head of Technical Services Unit (from 1 October 2007)</i>
Alison Melvin	<i>Commercial Director (from 1 October 2007)</i>
Wilma Harper	<i>Head of Corporate and Forestry Support (from 1 October 2007)</i>

The Chief Executive is appointed following public advertising of the post. The term of the appointment, and provision for its termination, are governed by the Civil Service Commissioners' Recruitment Code.

Remuneration of board members who hold senior staff group posts is determined by the Forestry Commission's Senior Pay Committee in accordance with guidelines prescribed by the Cabinet Office. Other board members' remuneration is determined by the standard processes set out in the Forestry Commission's pay and grading system.

Further details on remuneration are set out in the Remuneration Report (page 82).

14. Pensions

Information on pensions is contained in the Remuneration Report and accounting policy note 1.14.

15. Personal data related incidents

There were no protected personal data related incidents reported for Forest Research in 2007-08 or previous financial years. Forest Research will continue to monitor and assess its information risks in order to identify and address any weaknesses and ensure continued improvement of its systems. Further information on the handling of information risk is contained in the Statement on Internal Control.

16. Auditors

These accounts are prepared in accordance with a direction given by the Treasury in pursuance of Section 7 of the Government Resources and Accounts Act 2000. They are audited by the Comptroller and Auditor General. The fee for statutory audit services in respect of these accounts was £25,000. No further assurance or other non-audit services were provided.

17. Disclosure of audit information to the auditors

So far as I am aware, there is no relevant audit information of which the Forest Research auditors are unaware. I have taken all the steps that I ought to have taken to make myself aware of any relevant audit information and to establish that the Forest Research auditors are aware of that information.

Dr James Pendlebury

Chief Executive and Agency Accounting Officer
9 July 2008

Remuneration Report

Remuneration policy

Remuneration of board members who hold senior staff group posts is determined by the Forestry Commission's Senior Pay Committee in accordance with guidelines prescribed by the Cabinet Office. Details of membership of the Pay Committee are provided in the Remuneration Report of FC Great Britain/England. Other board members' remuneration is determined by the standard processes set out in the Forestry Commission's pay and grading system.

Employment contracts

The Chief Executive is appointed following public advertising of the post. The term of the appointment, and provision for its termination, are governed by the Civil Service Commissioners' Recruitment Code. Jim Lynch was appointed Chief Executive on 1 July 2003 on a five-year contract (expiry date 30 June 2008) but stood down on 30 September 2007. Dr James Pendlebury was appointed as the new Chief Executive with effect from 16 June 2008.

Civil Service appointments are made in accordance with the Civil Service Commissioners' Recruitment Code, which requires appointment to be on merit on the basis of fair and open competition but also includes the circumstances when appointments may otherwise be made.

Other than Jim Lynch the senior staff covered in this report hold appointments which are open-ended until they reach the normal retiring age. Early termination, other than for misconduct, would result in the individual receiving compensation as set out in the Civil Service Compensation Scheme.

The performance of senior staff is monitored and reviewed through the appropriate Performance Management System (PMS) of the Forestry Commission. No element of remuneration is specifically subject to performance conditions although pay progression can be affected and performance bonuses, if awarded, are based on performance.

Further information about the work of the Civil Service Commissioners can be found at www.civilservicecommissioners.gov.uk

Salary and pension entitlements (information subject to audit)

The salary and pension entitlements of the members of the Forest Research Executive Board were as follows.

	2007-08		2006-07	
	Salary £000	Benefits in kind (to the nearest £100)	Salary £000	Benefits in kind (to the nearest £100)
Jim Lynch (up to 30 September 2007)	40-45 (full year equivalent 80-85)	-	80-85	-
Peter Freer-Smith	75-80	3,700	70-75	3,600
Ken Charles	45-50	-	45-50	-
Tony Cornwell (up to 4 January 2008)	45-40 (full year equivalent 45-50)	-	45-50	-
Sandra Smith (from 7 January 2008)	10-15 (full year equivalent 40-45)	-	00-00	-
Bill Mason	60-65	-	55-60	-
Sam Evans (until 1 June 2007) *	5-10 (full year equivalent 50-55)	-	45-50	-
Helen Mckay (from 2 July 2007)	50-55	-	00-00	-
Hugh Evans	60-65	1,500	55-60	1,500
Chris Quine	55-60	-	55-60	-
Andy Moffat	60-65	-	55-60	-
Xanthe Christophers	45-50	-	45-50	-
Janet Dutch (from 1 October 2007)	30-35	-	00-00	-
Alison Melvin (from 1 October 2007)	35-40	-	00-00	-

* On special unpaid leave from 1 June 2007. Seconded to Defra from 28 April 2008.

The salary and pension entitlements of Wilma Harper, an Executive Board member, are borne and disclosed in the Forestry Commission GB/England Annual Report and Accounts 2007-08 as she is Head of Forestry and Support Services, Forestry Commission.

Salary

'Salary' includes basic salary, performance pay or bonus, overtime and any allowances subject to UK taxation.

Benefits in kind

The monetary value of benefits in kind covers any benefits provided by the employer and treated by the HM Revenue and Customs as taxable income. They are in respect of the Car Provision for Employees Scheme.

Accounts

for the year ended 31 March 2008

Pension benefits 2007-08 (information subject to audit)

	Real increase in pension and related lump sum	Total accrued pension at age 60 at 31/3/08 and related lump sum	CETV @ 31/3/07	CETV @ 31/3/08	Real increase in CETV after adjustment for inflation and changes in market investment factors	Employer contribution to partnership pension account including risk benefit cover
	£000	£000	£000	£000	£000	nearest £100
Jim Lynch*	0-2.5	5-7.5	107	121	13	-
Peter Freer-Smith	0-2.5 plus 5.0-7.5 lump sum	22.5-25 plus 67.5-70 lump sum	363	462	45	-
Ken Charles	0-2.5 plus 0-2.5 lump sum	22.5-25 plus 67.5-70 lump sum	513	559	18	-
Tony Cornwell*	0-2.5	5-7.5	119	133	10	-
Bill Mason	0-2.5 plus 0-2.5 lump sum	20-22.5 plus 62.5-65 lump sum	466	538	12	-
Sam Evans	0-2.5 plus 0-2.5 lump sum	5-7.5 plus 20-22.5 lump sum	97	87	2	-
Hugh Evans	0-2.5 plus 0-2.5 lump sum	25-27.5 plus 77.5-80 lump sum	553	642	16	-
Chris Quine	0-2.5 plus 2-2.5 lump sum	17.5-20 plus 55-57.5 lump sum	279	336	13	-
Andy Moffat	0-2.5 plus 2.5-5.0 lump sum	20-22.5 plus 62.5-65 lump sum	375	459	30	-
Xanthe Christophers	0-2.5	2.5-5	23	39	10	-
Helen McKay	0-2.5 plus 5-7.5 lump sum	15-17.5 plus 50-52.5 lump sum	287	373	38	-
Sandra Smith	0-2.5	0-2.5	0	3	2	-
Janet Dutch	0-2.5 plus 0-2.5 lump sum	5-7.5 plus 20-22.5 lump sum	99	123	7	-
Alison Melvin	0-2.5 plus 0-2.5 lump sum	2.5-5 plus 7.5-10 lump sum	47	63	9	-

CETV: Cash Equivalent Transfer Value.

*Left during 2007-08.

Civil Service Pensions

Pension benefits are provided through the Civil Service pension arrangements. From 30 July 2007, civil servants may be in one of four defined benefit schemes: either a 'final salary' scheme (classic, premium or classic plus), or a 'whole career' scheme (nuvos). These statutory arrangements are unfunded with the cost of benefits met by monies voted by Parliament each year. Pensions payable under classic, premium, classic plus and nuvos are increased annually in line with changes in the Retail Prices Index (RPI). Members joining from October 2002 may opt for the appropriate defined benefit arrangement or a good quality 'money purchase' stakeholder arrangement with a significant employer contribution (partnership pension account).

Employee contributions are set at the rate of 1.5% of pensionable earnings for classic and 3.5% for premium, classic plus and nuvos. Benefits in classic accrue at the rate of 1/80th of final pensionable earnings for each year of service. In addition, a lump sum equivalent to three years' pension is payable on retirement. For premium, benefits accrue at the rate of 1/60th of final pensionable earnings for each year of service. Unlike classic, there is no automatic lump sum (but members may give up (commute) some of their pension to provide a lump sum). Classic plus is essentially a hybrid with benefits in respect of service before 1 October 2002 calculated broadly as for classic and benefits for service from October 2002 calculated as in premium. In nuvos a member builds up a pension based on his pensionable earnings during their period of scheme membership. At the end of the scheme year (31 March) the member's earned pension account is credited with 2.30% of their pensionable earnings in that scheme year and the accrued pension is uprated in line with RPI. In all cases members may opt to give up (commute) pension for lump sum up to the limits set by the Finance Act 2004.

The partnership pension account is a stakeholder pension arrangement. The employer makes a basic contribution of between 3% and 12.5% (depending on the age of the member) into a stakeholder pension product chosen by the employee from a panel of three providers. The employee does not have to contribute but where they do make contributions, the employer will match these up to a limit of 3% of pensionable salary (in addition to the employer's basic contribution). Employers also contribute a further 0.8% of pensionable salary to cover the cost of centrally provided risk benefit cover (death in service and ill health retirement).

The accrued pension quoted is the pension the member is entitled to receive when they reach pension age, or immediately on ceasing to be an active member of the scheme if they are already at or over pension age. Pension age is 60 for members of classic, premium and classic plus and 65 for members of nuvos.

Further details about the Principal Civil Service Pension Scheme can be found at the website

www.civilservice-pensions.gov.uk

Cash Equivalent Transfer Values

A Cash Equivalent Transfer Value (CETV) is the actuarially assessed capitalised value of the pension scheme benefits accrued by a member at a particular point in time. The benefits valued are the member's accrued benefits and any contingent spouse's pension payable from the scheme. A CETV is a payment made by a pension scheme or arrangement to secure pension benefits in another pension scheme or arrangement when the member leaves a scheme and chooses to transfer the benefits accrued in their former scheme. The pension figures shown relate to the benefits that the individual has accrued as a consequence of their total membership of the pension scheme, not just their service in a senior capacity to which disclosure applies. The figures include the value of any pension benefit in another scheme or arrangement which the individual has transferred to the Civil Service pension arrangements. They also include any additional pension benefit accrued

to the member as a result of their purchasing additional years of pension service in the scheme at their own cost. CETVs are calculated within the guidelines and framework prescribed by the Institute and Faculty of Actuaries.

Real increase in CETV

This reflects the increase in CETV effectively funded by the employer. It takes account of the increase in accrued pension due to inflation, contributions paid by the employee (including the value of any benefits transferred from another pension scheme or arrangement) and uses common market valuation factors for the start and end of the period.

Dr James Pendlebury

Chief Executive and Agency Accounting Officer
9 July 2008

Statement of Forestry Commission's and Chief Executive's Responsibilities

Under Section 7 of the Government Resources and Accounts Act 2000 the Treasury has directed the Forestry Commission to prepare a statement of accounts for Forest Research for each financial year in the form and on the basis set out in the accounts direction. The accounts are prepared on an accruals basis and must give a true and fair view of the Forest Research state of affairs at the year-end and of its income and expenditure, recognised gains and losses and cash flows for the financial year.

In preparing the accounts the Forestry Commission is required to comply with the requirements of the *Government financial reporting manual* and in particular to:

- observe the accounts direction, including the relevant accounting and disclosure requirements, and apply suitable accounting policies on a consistent basis;
- make judgements and estimates on a reasonable basis;
- state whether applicable accounting standards, as set out in the *Government financial reporting manual*, have been followed, and disclose and explain any material departures in the financial statements;
- prepare the financial statements on the going concern basis, unless it is inappropriate to assume that Forest Research will continue in operation.

The Director General of the Forestry Commission, as Principal Accounting Officer, has designated the Chief Executive of Forest Research as the Accounting Officer for the Agency. His relevant responsibilities as Agency Accounting Officer, including his responsibility for the propriety and regularity of the public finances and for the keeping of proper records, and for safeguarding the Agency's assets, are set out in the Accounting Officers' Memorandum, issued by the Treasury and published in *Managing public money* (The Stationery Office).

Statement on Internal Control

1. Scope of responsibility

I was appointed Agency Accounting Officer with effect from 16 June 2008. Prior to this date the Agency Accounting Officer was Prof Peter Freer-Smith. In making this statement I am reliant upon the commitment and discipline he exercised in carrying out the role of Accounting Officer during the financial year and in assurances that he has provided to me. As Agency Accounting Officer, I have responsibility for maintaining a sound system of internal control that supports the achievement of Forest Research policies, aims and objectives, whilst safeguarding the public funds and departmental assets for which I am personally responsible, in accordance with the responsibilities assigned to me in *Managing public money*.

The Director General is the Deputy Chairman of the Forestry Commissioners and the senior official in the Forestry Commission. In addition to his role as a Commissioner, he is the Principal Accounting Officer, formally responsible to Parliament for the financial affairs of the Forestry Commission, including the Agency. In practice, the Director General's role in relation to the Agency is delegated to the Chief Executive as Agency Accounting Officer.

The Chief Executive of the Agency is responsible, normally through the Director General, to the Forestry Commissioners for the management of the Agency. The Chief Executive has a right of access to the Commissioners, and to Forestry Ministers, and will meet them at least once a year. The Director General designates the Chief Executive as Agency Accounting Officer, responsible for the Agency's accounts and financial procedures, and for the proper, effective and efficient use of resources provided to the Agency within the terms of the Framework Document and in pursuit of the agreed Corporate Plan objectives and targets. The Chief Executive is a member of the Forestry Commission's Executive Board. In particular, the Chief Executive is responsible for:

- preparing the Agency's Corporate Plans and for achieving the targets set in them;
- appointment and organisation of the Agency's staff, and deployment of other resources to achieve the aims and objectives;
- maintaining financial and management information systems to assist in the monitoring and control of performance;
- preparing and submitting the Agency's Annual Report and Accounts;
- establishing and chairing an Agency Executive Board comprising senior managers within the Agency and the Head of Corporate and Forestry Support.

The Director General and Chief Executive are liable to be summoned to appear before the Public Accounts Committee to answer for their respective responsibilities. It will be for Ministers to decide who should represent them at other Parliamentary Committee hearings. In practice, where a Committee's interest is confined to the day-to-day operations of the Agency, Ministers will normally regard the Chief Executive as the person best placed to appear on their behalf.

2. The purpose of the system of internal control

The system of internal control is designed to manage risk to a reasonable level rather than to eliminate all risk of failure to achieve policies, aims and objectives; it can therefore only provide reasonable and not absolute assurance of effectiveness. The system of internal control is based on an ongoing process designed to identify and prioritise the risks to the achievement of the Agency's policies, aims and objectives, to evaluate the likelihood of those risks being realised and the impact should they be realised, and to manage

them efficiently, effectively and economically. The system of internal control has been in place in the Agency for the year ended 31 March 2008 and up to the date of approval of the Annual Report and Accounts, and accords with Treasury guidance.

3. Capacity to handle risk

The Agency has taken a positive approach to risk management, which it feels is entirely appropriate to its role and remit. Risk management is the responsibility of every member of staff in Forest Research. Everyone has a role to play in managing the risks within their own area of authority. Risk awareness and responsibility lies in parallel with the structure of Forest Research's objectives. At every level of objective there is an equivalent delegation of responsibility of associated risk.

The resources available for managing risk are finite and so the aim is to achieve an optimum response to risk, prioritised in accordance with the evaluation of risk. The system of internal control incorporates risk management. The system encompasses a number of elements that together facilitate an effective and efficient operation, enabling Forest Research to respond to a variety of operational, financial and commercial risks. These elements include:

- Policies set by the Board of Commissioners and the Forest Research Executive Board. Written procedures support the policies where appropriate.
- Comprehensive regular reporting to the Executive Board designed to monitor key risks and their controls. Decisions to rectify problems are made at their regular meetings.
- Planning and budgeting systems used to set objectives, agree action plans and allocate resources. Progress towards meeting plan objectives is monitored regularly.

The Forestry Commission has a departmental Risk Improvement Manager who chairs a Risk Management Group comprising a risk champion from each part of the organisation and an Internal Audit representative. During the year, the Finance Director of Forest Research has acted as risk champion for the Agency, including responsibility for maintenance and enhancement of the risk register.

4. The risk and control framework

Forest Research is committed to a process of continuous development and improvement: developing systems in response to any relevant reviews and developments in best practice in this area. In particular, in the period covering the year to 31 March 2008 and up to the signing of the accounts Forest Research has:

- Participated in the Commission-wide Risk Management Group (RMG), whose purpose is to ensure continued development of risk management within, and sharing of best practice across, the Commission. The RMG met on three occasions, in July and November 2007 and February 2008.
- Updated existing risk registers to reflect newly identified potential risks and appropriate control measures for agreement by Executive Board Members. This has included the further enhancement of the Risk Register methodology to clearly define inherent and residual risk.
- Continued to use and adapt the risk management software package working towards greater integration with Internal Audit and their planning.

An Internal Audit review in 2004–05 identified that the Forestry Commission needed fully developed contingency plans to effectively manage failure in key business systems. Responsibility for overseeing the wider approach has been co-ordinated by the Forestry Commission's Director of Finance via the RMG. It was recognised that a phased development would be required across the Forestry Commission and this has moved forward during the year. Business Continuity Plan templates for central shared services have been prepared, utilising the services of the Forestry Commission's external risk consultant, and are being implemented. In Forest

Research, some work had already taken place and specific plans were being incorporated into the risk register. Due to changes in management, and other competing priorities, work on this has been delayed and will now be taken forward in 2008–09.

During 2006–07 the Board of Commissioners reviewed the Forestry Commission's Audit Committee arrangements and recommended the setting up of separate Audit and Risk Committees (ARCs) in each of the three countries and in Forest Research. Interim arrangements were put in place for Forest Research using members of the existing Internal Control Committee (ICC) and representatives from Internal and External Audit, pending the resolution of membership and terms of reference. The interim Committee met in July 2007 and the full Committee in February 2008. Both meetings considered a range of reports from management and from internal and external audit.

The new ARC membership consists of two Non-Executives supported by the Agency Chief Executive and the Finance Director, the Head of Internal Audit and a National Audit Office representative. The Director General, as Principal Accounting Officer of the Forestry Commission, and his Director of Finance may attend any meeting. The ARC will advise the Agency Accounting Officer on:

- the strategic processes for risk, control and governance in the Agency;
- the Statement on Internal Control in the Agency;
- the accounting policies, the accounts and the annual report of the Agency, including the process for review of the accounts prior to submission for audit, levels of error identified, and management's letter(s) of representation to the external auditors;
- the planned activity and results of both internal and external audit;
- adequacy of management response to issues identified by audit activity, including internal audit reports and external audit's management letter;
- assurances relating to the corporate governance requirements for the Agency;
- anti-fraud policies and whistle-blowing processes.

The ARC will also periodically review its own effectiveness.

5. Data handling in Government

The Agency Accounting Officer needs comprehensive and reliable assurance from managers, internal audit and assurance providers that risks, including information risks, are being effectively managed.

In November 2007, the Government, in response to a number of high profile losses of personal information, launched a cross-government review of departments' procedures for the storage and use of data. The terms of reference for the work were to examine:

- the procedures in departments and agencies for the protection of data;
- their consistency with current government-wide policies and standards;
- the arrangements for ensuring that procedures are being fully and properly implemented, and to make recommendations on improvements that should be made.

The review reported in March 2008 and set out the mandatory process measures that all departments must put in place to ensure information risks are identified and managed. In line with the requirements, the Forestry Commission has taken the following steps to strengthen its handling of information risk and is developing its own action plan in line with revised guidance produced by the Cabinet Office and the Devolved Administrations.

- The Director General of the Forestry Commission has appointed his Finance Director, a member of the Forestry Commission's Executive Board, as the Senior Information Risk Owner (SIRO). The SIRO chairs an Information Systems Management Forum which meets on a formal and regular basis to co-ordinate the Forestry Commission's approach to information security and to monitor progress against an action plan. Regular updates will be provided to Forestry Commission Executive Board members.
- As a government department the Forestry Commission internally enforces the standards of the *Manual of protective security*. In addition, to meet Service Level Agreements with other government departments on whose behalf we carry out EU grant payments, we have a project under way to achieve compliance with ISO/IEC 27001, the standard for Information Security Management Systems. Compliance with the Standard will also ensure that we are in compliance with the Data Protection Act's Seventh principle that 'appropriate technical and organisational measures shall be taken against unauthorised or unlawful processing of personal data and against accidental loss or destruction of, or damage to, personal data.'

Information risk will be a standing agenda item for the ARC during 2008-09.

As reported in the Management Commentary, there were no protected personal data related incidents reported for Forest Research in 2007-08 or previous financial years.

6. Review of effectiveness

As Agency Accounting Officer, I have responsibility for reviewing the effectiveness of the system of internal control. My review of the effectiveness of the system of internal control is informed by the work of the internal auditors and the executive managers within the Agency who have responsibility for the development and maintenance of the internal control framework, and comments made by the external auditors in their management letter and other reports. I have been advised on the implications of the result of my review of the effectiveness of the system of internal control by the FR Executive Board and the Audit and Risk Committee. A plan to address weaknesses and ensure continuous improvement of the system is in place.

The Head of Internal Audit has prepared an annual report and assurance statement to me as the Agency Accounting Officer. The report includes an overall assessment of the adequacy and effectiveness of risk management, control and governance within the Agency. The Director General as Principal Accounting Officer has received a similar report and assurance statement including any comments specific to the Great Britain core responsibilities. The overall opinion is that internal control within Forest Research has continued to provide substantial assurance that material risks to the achievement of objectives are adequately managed, although some failings have been identified.

In September 2006 the Agency received the approval of the Forestry Commissioners for the implementation of a new Development Strategy. This concentrates on the achievement of sustainable growth and evolution in areas of high demand whilst continuing to deliver sound evidence-based research in support of FC policies.

A key element of the new strategy is the objective to deliver a 100% increase in non-Forestry Commission income by 2011-12 as a result of which external income is planned to increase to 27% of total income. Work on delivering this strategy continued apace during the year with the formation of groups to review opportunities in key research areas and a review of management information systems aimed at identifying the needs associated with the radical implications of the new strategy. However, the Agency's income from external customers fell by some 36% during 2007-08. I have been asked by the Director General to report on the cause of the fall in external income and the implications for achieving the longer term income target for the Agency.

Under present arrangements, I rely on the organisational structure for managing risk with clear responsibilities at every level supported by a Risk Management Group whose role is to assist in the development of good risk management practice throughout the Forestry Commission.

7. Significant internal control problems

None were identified during the year.

Dr James Pendlebury

Chief Executive and Agency Accounting Officer

9 July 2008

Forest Research Agency

The Certificate and Report of the Comptroller and Auditor General to the House of Commons

I certify that I have audited the financial statement of the Forest Research Agency for the year ended 31 March 2008 under the Government Resources and Accounts Act 2000. These comprise the Operating Cost Statement and Statement of Total Recognised Gains and Losses, the Balance Sheet, the Cashflow Statement and the related notes. These financial statements have been prepared under the accounting policies set out within them. I have also audited the information in the Remuneration Report that is described in that report as having been audited.

Respective responsibilities of the Agency, the Chief Executive and Auditor

The Agency and Chief Executive, as Agency Accounting Officer, are responsible for preparing the Annual Report, which includes the Remuneration Report, and the financial statements in accordance with the Government Resources and Accounts Act 2000 and HM Treasury directions made thereunder and for ensuring the regularity of financial transactions. These responsibilities are set out in the Statement of Accounting Officer's Responsibilities.

My responsibility is to audit the financial statements and the part of the Remuneration Report to be audited in accordance with relevant legal and regulatory requirements, and with International Standards on Auditing (UK and Ireland).

I report to you my opinion as to whether the financial statements give a true and fair view and whether the Financial Statements and the part of the Remuneration Report to be audited have been properly prepared in accordance with HM Treasury directions issued under the Government Resources and Accounts Act 2000. I report to you whether, in my opinion, certain information given in the Annual Report, which comprises a management commentary and a review of current and future development and performance, is consistent with the financial statements. I also report whether in all material respects the expenditure and income have been applied to the purposes intended by Parliament and the financial transactions conform to the authorities which govern them.

In addition, I report to you if the Agency has not kept proper accounting records, if I have not received all the information and explanations I require for my audit, or if information specified by HM Treasury regarding remuneration and other transactions is not disclosed.

I review whether the Statement on Internal Control reflects the Agency's compliance with HM Treasury's guidance, and I report if it does not. I am not required to consider whether this statement covers all risks and controls, or to form an opinion on the effectiveness of the Agency's corporate governance procedures or its risk and control procedures.

I read the other information contained in the Annual Report, which comprises the unaudited part of the Remuneration Report, and consider whether it is consistent with the audited financial statements. I consider the implications for my report if I become aware of any apparent misstatements or material inconsistencies with the financial statements. My responsibilities do not extend to any other information.

Basis of audit opinion

I conducted my audit in accordance with International Standards on Auditing (UK and Ireland) issued by the Auditing Practices Board. My audit includes examination, on a test basis, of evidence relevant to the amounts, disclosures and regularity of financial transactions included in the financial statements and the part of the Remuneration Report to be

audited. It also includes an assessment of the significant estimates and judgements made by the Agency and Chief Executive in the preparation of the financial statements, and of whether the accounting policies are most appropriate to the Agency's circumstances, consistently applied and adequately disclosed.

I planned and performed my audit so as to obtain all the information and explanations which I considered necessary in order to provide me with sufficient evidence to give reasonable assurance that the financial statements and the part of the Remuneration Report to be audited are free from material misstatement, whether caused by fraud or error and that, in all material respects, the expenditure and income have been applied to the purposes intended by Parliament and the financial transactions conform to the authorities which govern them. In forming my opinion I have also evaluated the overall adequacy of the presentation of information in the financial statements and the part of the Remuneration Report to be audited.

Opinions

Audit opinion

In my opinion:

- the financial statements give a true and fair view, in accordance with the Government Resources and Accounts Act 2000 and directions made thereunder by HM Treasury, of the state of the Agency's affairs as at 31 March 2008, and of the net operating cost, recognised gains and losses and cashflows for the year then ended;
- the financial statements and the part of the Remuneration Report to be audited have been properly prepared in accordance with HM Treasury directions issued under the Government Resources and Accounts Act 2000; and
- the information given within the Annual Report, which comprises management commentary and a review of current and future development and performance, is consistent with the financial statements.

Audit opinion on regularity

In my opinion, in all material respects, the expenditure and income have been applied to the purposes intended by Parliament and the financial transactions conform to the authorities which govern them.

I have no observations to make on these financial statements.

T.J. Burr

Comptroller and Auditor General
16 July 2008
National Audit Office
151 Buckingham Palace Road
Victoria
London SW1W 9SS

Operating Cost Statement for the year ended 31 March 2008

	Notes	2007-08 £000	2006-07 £000
Income			
Income from research, development and survey services			
Forestry Commission customers	2	13,092	13,165
Non-Forestry Commission Customers			
European Union		65	995
Other		1,465	1,394
Total income		14,622	15,554
Expenditure			
Staff costs	3	9,585	9,517
Other management costs	4	2,439	2,504
Materials and services	5	3,485	3,079
Total expenditure		15,509	15,100
Net operating surplus/(deficit)		(887)	454
Notional cost of capital	8	(511)	(475)
Net (deficit) for the year		(1,398)	(21)
Net (deficit) transferred to General Fund		(1,398)	(21)

Statement of Total Recognised Gains and Losses for the year ended 31 March 2008

	2007-08 £000	2006-07 £000
Net (deficit) for the year	(1,398)	(21)
Revaluation surplus for the year	1,206	1,333
Total recognised gains/(losses)	(192)	1,312

The notes on pages 98 to 112 form part of these accounts.

Accounts

for the year ended 31 March 2008

Balance Sheet as at 31 March 2008

	Notes	31 March 2008 £000	31 March 2007 £000
Fixed assets			
Tangible assets	6	14,152	12,802
Intangible assets	7	159	183
		14,311	12,985
Debtors falling due after more than one year	10	44	51
Current assets			
Stocks and Work in Progress	9	951	1,394
Debtors	10	924	658
Cash at banks and in hand	11	275	248
		2,150	2,300
Creditors – amounts falling due within one year	12	(1,185)	(660)
Net current assets		965	1,640
Total assets less current liabilities		15,320	14,676
Provisions for liabilities and charges	13	(103)	(170)
		15,217	14,506
Taxpayers' Equity			
General Fund	14	7,086	7,495
Revaluation Reserve	15	8,131	7,011
		15,217	14,506

Dr James Pendlebury

Chief Executive and Agency Accounting Officer

9 July 2008

The notes on pages 98 to 112 form part of these accounts.

Cash Flow Statement for the year ended 31 March 2008

		2007-08	2006-07
	Notes	£000	£000
Net cash inflow/(outflow) from operating activities	16a	463	958
Capital expenditure	16b	(828)	(580)
Net cash surplus/(deficit)		(365)	378
Financing – net cash transfer (to)/from Forestry Commission		392	(357)
(Decrease)/Increase in cash in the period		27	21

The notes on pages 98 to 112 form part of these accounts.

Notes to the Accounts

Note 1. Accounting Policies

1.1 Form of Accounts

In accordance with Section 7 of the Government Resources and Accounts Act 2000, the accounts are drawn up in a format agreed and approved by Treasury. They are prepared in accordance with the *Government financial reporting manual* (FReM) issued by HM Treasury for 2007–08 accounts, under the historical cost convention modified by the inclusion of the valuation of assets.

The accounting policies contained in the FReM follow UK Generally Accepted Accounting Practice for companies (UK GAAP) to the extent that it is meaningful and appropriate to the public sector. The particular accounting policies adopted by the Agency are described below. They have been applied consistently in dealing with items considered material in relation to the accounts.

1.2 Tangible Fixed Assets

Where the Agency is the principal beneficial user of assets of the Forestry Commission estate, they are treated as a fixed asset of the Agency although legal ownership is vested in the Forestry Ministers. Staff payroll costs and expenditure on materials and consumables related to systems development software, for general use within the Agency, are recognised as tangible fixed assets. There was no relevant in-house development activity in the year 2007–08.

The normal threshold for the capitalisation of assets is £1,500, but all IT equipment costing £250 or more is capitalised as a pooled asset.

1.3 Valuation of Assets

Professionally qualified staff employed by the Forestry Commission undertake a full revaluation of non-forest land at five-yearly intervals coinciding with that for the forest estate. They follow the principles set out in the RICS Red Book and value on the basis of Open Market Value, Existing Use Value, Depreciated Replacement Cost or Discounted Cash Flow as appropriate under the RICS guidance. Unequipped agricultural land indices provided by the District Valuer are used to restate values between full valuations. The next full valuation will take place as at 1 April 2008.

Professionally qualified staff employed by the Forestry Commission undertake a full revaluation of dwellings and other buildings following the principles set out in the RICS Red Book. Valuation is on the basis of Open Market Value or Existing Use Value as appropriate under the RICS guidance. Dwellings and other buildings were scheduled to be re-assessed as at 31 March 2005 in accordance with the three-yearly interval stated in the previous accounting policy. It has been decided, however, to bring the policy in line with UK GAAP and undertake a professional valuation of dwellings and other buildings on a five-yearly basis. The first five-yearly valuation will be undertaken at 1 April 2008 to coincide with the next full revaluation of the Forest Estate. Between full valuations, dwellings and other buildings are restated to current value using appropriate indices provided by the District Valuer.

Other tangible and intangible fixed assets are revalued annually using a range of appropriate indices as provided by the Office for National Statistics.

Any surplus on revaluation is credited to the Revaluation Reserve. A deficit on revaluation is debited to the Operating Cost Statement if the deficit exceeds the balance on the Revaluation Reserve.

1.4 Depreciation

In accordance with Forestry Commission policy, freehold land is not depreciated.

Depreciation is provided on all other tangible assets at rates calculated to write off the valuation, less estimated residual value, of each asset evenly over its expected useful life.

Freehold buildings – 20 to 80 years.

Scientific equipment – 6.5 to 20 years.

IT hardware – 3 to 10 years.

Other machinery and equipment – 10 to 20 years.

1.5 Intangible Fixed Assets

Purchases of software with an acquisition value of £1500 are recognised as intangible fixed assets and amortised over their expected useful lives to a maximum of seven years. Software purchases with an acquisition value of less than £1,500 are pooled and treated as intangible fixed assets, as the overall value is material.

1.6 Stocks and Work in Progress

Stocks of publications for resale are held and are valued at the lower of cost and net realisable value. Work in progress on long-term projects is valued at the cost of staff time and other direct costs plus attributable overheads based on the normal level of activity.

1.7 Provision for Bad and Doubtful Debts

Specific provision for bad and doubtful debts is set aside on the basis of a review of individual debts at the end of the year.

1.8 Research and Development

As a provider of research services, all income and expenditure on research and development is written off to the Operating Cost Statement.

1.9 Cost of Capital Charges

Charges, representing the cost of capital utilised by the Agency, are identified on the Income and Expenditure Account. The charge is calculated at the Government's standard rate of 3.5% in real terms on the average carrying amount of all assets, except for cash balances, less liabilities.

1.10 Corporation Tax

Forest Research is not subject to corporation tax.

1.11 Value Added Tax

The Forestry Commission is registered for Value Added Tax (VAT) and accounts for it on a Great Britain basis, including any Agency activity. Income and expenditure shown in the accounts is net of any recoverable VAT. Non-recoverable VAT is charged to the accounts in the year in which it is incurred.

1.12 Foreign Currencies

Transactions in foreign currencies are recorded at the rate ruling at the time of the transaction. Monetary assets and liabilities denominated in foreign currencies at the balance sheet date are translated at the rates ruling at that date. Translation differences are recorded in the Operating Cost Statement.

1.13 Insurance

In accordance with normal Government accounting practice, the Forestry Commission carries its own insurance risks.

1.14 Pensions

Past and present employees are covered by the provisions of the Principal Civil Service Pension Scheme (PCSPS), which is non-contributory and unfunded. The Forestry Commission recognises the expected cost of providing pensions on a systematic and rational basis over the period during which it accrues benefits from employees' services by payment to the PCSPS of amounts calculated on an accruing basis. Liability for payment of future benefits is a charge on the PCSPS. Further information on pensions is contained in the Remuneration Report and note 3 to the accounts.

1.15 Provisions

Forest Research provides for legal or constructive obligations which are of uncertain timing or amount at the balance sheet date on the basis of the best estimate or the expenditure required to settle the obligation. Where the effect of the time value of money is significant, the estimated risk-adjusted cash flows are discounted using the real rate set by HM Treasury (currently 2.2%).

1.16 Third Party Assets

Forest Research acts as co-ordinator for a number of projects partially funded by the European Commission. The duties of co-ordinators include receiving funds on behalf of partners for onward transmission once work programmes have been approved. These Third Party Assets, which neither the Agency or government more generally has a direct beneficial interest in, are not recognised in the accounts. The amount held at 31 March 2008 was £nil.

Note 2. Income from Forestry Commission and Forest Enterprise

- 2.1** The Agency undertakes a significant proportion of the Forestry Commission's overall annual research programme in the form of specifically commissioned projects to deliver agreed outputs. A separate annual charge is agreed for each project based on full cost recovery. These charges amounted to £10.2 million. Costs established in one year are used to determine project charges for future years. The Agency also provides research and survey services for Forest Enterprise and other parts of the Forestry Commission on a full cost recovery basis.

Income from Forestry Commission customers consisted of:

	2007-08	2006-07
	£000	£000
Research, development and other services to:		
Forestry Commission	11,906	11,778
Forest Enterprise	1,186	1,387
	13,092	13,165

Note 3. Staff Costs and Numbers

3.1 Employee costs during the year amounted to:

	2007-08			2006-07
	Permanent staff	Other staff	Total	
	£000	£000	£000	£000
Wages and Salaries	6,717	834	7,551	7,515
Social Security Costs	512	61	573	585
Employer's Superannuation Costs	1,312	114	1,426	1,390
Agency Staff Costs	-	35	35	27
	8,541	1,044	9,585	9,517

	2007-08	2006-07
Average number of employees (full-time equivalents)		
Permanent staff	233	251
Others	43	39
Total staff	276	290

Staff were covered by the Principal Civil Service Pension Scheme (PCSPS) which is an unfunded multi-employer defined benefit pension scheme but the Forestry Commission is unable to identify its share of the underlying assets and liabilities. The scheme actuary valued the scheme as at 31 March 2007. Details can be found in the resource accounts of the Cabinet Office: Civil Superannuation (www.civilservice-pensions.gov.uk).

For 2007-08, employers' contributions of £1,425,800 were payable to the PCSPS (2006-07: £1,389,458) at one of four rates in the range 17.1% to 25.5% (2006-07: 17.1% to 25.5%) of pensionable pay, based on salary bands. The scheme actuary reviews employer contributions every four years following a full scheme valuation. The contribution rates reflect benefits accruing during 2007-08 to be paid to the member when they retire and not the benefits paid during this period to existing pensioners.

Employees can opt to open a partnership pension account, a stakeholder pension with an employer contribution. No Agency staff have yet taken this option.

3.2 Benefits in kind are provided under the following schemes:

- (i) Advances of Salary for House Purchase
- (ii) Advances of Salary for purchase of Season Tickets and Bicycles
- (iii) Car Provision for Employees Scheme.

Each scheme is subject to conditions and financial limits.

The Advances of Salary for House Purchase scheme had loans with an outstanding balance of £2,500 or more to three individual members of staff at 31 March 2008. The total outstanding value of all loans was £50,742.

Note 4. Other Management Costs

Other management costs are stated after charging:

	2007-08	2006-07
	£000	£000
Auditors' remuneration	25	23
Travel and subsistence	558	586
Staff transfer expenses	68	62
Training	156	159
Building maintenance	457	430
Utilities	291	324
Computer supplies	89	92
Early retirement/departure costs	6	4
Depreciation of fixed assets	670	628
Loss on disposal of fixed assets	38	-
Other expenditure	81	196
	2,439	2,504

Included within other management costs are charges from the Forestry Commission and Forest Enterprise amounting in total to £121,000 (2006-07: £114,000).

Note 5. Materials and Services

Materials and services are stated after charging:

	2007-08	2006-07
	£000	£000
Materials and supplies	998	742
Central services from Forestry Commission	738	722
Vehicle lease charges from Forestry Commission	399	421
Contractors	859	636
Commissioned research	177	166
Publications	38	63
Protective clothing	19	23
Miscellaneous expenditure	257	306
	3,485	3,079

Included within materials and services are charges from the Forestry Commission and Forest Enterprise amounting in total to £1,134,000 (2006-07: £1,143,000).

Charges are made to Forest Research from the Forestry Commission and Forest Enterprise, as appropriate, for assistance with field experiments, hire of vehicles, machinery and equipment and for personnel, business management, financial and other support services at Silvan House, Edinburgh.

Note 6. Tangible Fixed Assets

	Freehold Land and Buildings	Scientific Equipment	IT Equipment	Other Machinery and Equipment Machinery	Total
	£000	£000	£000	£000	£000
Valuation:					
At 1 April 2007	12,314	2,003	945	697	15,959
Additions	46	450	101	194	791
Disposals	-	(402)	(377)	(105)	(884)
Revaluation to current prices	1,309	25	(19)	(2)	1,313
At 31 March 2008	13,669	2,076	650	784	17,179
Depreciation:					
At 1 April 2007	1,164	1,094	619	280	3,157
Provided in year	257	186	118	56	617
Disposals	-	(367)	375	(104)	(846)
Revaluation to current prices	97	9	(6)	(1)	99
At 31 March 2008	1,518	922	356	231	3,027
Net book value:					
At 31 March 2008	12,151	1,154	294	553	14,152
At 31 March 2007	11,150	909	326	417	12,802

Fixed assets were revalued as at 31 March 2008 in accordance with accounting policies. The valuation includes the principal research stations at Alice Holt Lodge near Farnham in Surrey and the Northern Research Station, Roslin near Edinburgh, with net book values of £6.9 million and £3.2 million respectively at 31 March 2008.

Note 7. Intangible Fixed Assets

	2007-08	2006-07
	£000	£000
Valuation		
Balance at 1 April	252	135
Additions	37	107
Revaluation	(10)	10
As at 31 March	279	252
Amortisation		
Opening balance	69	28
Depreciation in year	53	40
Revaluation	(2)	1
As at 31 March	120	69
Net book value	159	183

Intangible fixed assets relates wholly to purchased software.

Note 8. Cost of Capital

Notional cost of capital based on 3.5% of average total assets, excluding bank balances, less current liabilities employed in 2007-08 amounted to £510,986 (2006-07: £474,627).

Note 9. Stocks and Work in Progress

	2007-08	2006-07
	£000	£000
Stocks	3	-
Research work in progress	948	1,394
	951	1,394

Note 10. Debtors

10a. Analysis by type

	2007-08	2006-07
	£000	£000
Amounts falling due within one year		
EU debtors	295	242
Other Trade debtors	438	231
Other debtors	7	31
Prepayments	184	154
	924	658
Amounts falling due after one year		
House purchase loans	44	51
	968	709

10b. Intra-Government Balances

	2007-08	2006-07
	£000	£000
Balances with other central government bodies	255	267
Balances with local authorities	27	-
Intra-Government balances	282	267
Balances with bodies external to government		
Falling due within one year	642	391
Falling due after more than one year	44	51
	968	709

Note 11. Cash at bank and in hand

The following balances at 31 March are held at commercial banks and as cash in hand

	2007-08	2006-07
	£000	£000
Opening balance at 1 April	248	227
Net change in balances	27	21
Balance at 31 March	275	248

As part of its normal activities Forest Research maintains Sterling and Euro bank accounts primarily used for the receipt of income from non-Forestry Commission customers. These accounts are cleared to the Commission's main account on a regular basis. Sums held in these accounts on behalf of partners in European Commission projects are treated as third party assets and not included in the balances shown.

Note 12. Creditors: amounts falling due within one year

The following balances at 31 March are held at commercial banks and as cash in hand

	2007-08	2006-07
	£000	£000
Payments received on account	324	156
Trade creditors	848	492
Other creditors including taxation and social security costs	13	12
	1,185	660

All creditors are bodies external to central or local government. Funds held on behalf of partners in European Commission projects are treated as third party assets and not recorded on the face of the accounts (see note 1.16). At 31 March 2008 the amount held in Forest Research Bank accounts on behalf of partners was Nil (31 March 2007: £259,144 which was subsequently paid over).

Accounts

for the year ended 31 March 2008

Note 13. Provisions for Liabilities

	2007-08	2006-07
	£000	£000
Early departure costs		
Balance brought forward	170	443
Provided in year	4	146
Provision not required written back	-	(369)
Utilised in year	(76)	(43)
Unwinding of discount	5	(7)
Balance carried forward	103	170

Note 14. General Fund

	2007-08	2006-07
	£000	£000
Balance brought forward	7,495	7,345
Movement in year		
Backlog depreciation	86	68
Net (deficit) for year	(1,398)	(21)
Transfer of fixed assets to (-)/from other Forestry Bodies	-	(12)
Cash surplus to (-)/deficit from Forestry Commission	392	(357)
Non-cash inter-country transfers	-	(2)
Notional cost of capital	511	474
Balance carried forward	7,086	7,495

Note 15. Revaluation Reserve

	2007-08	2006-07
	£000	£000
Balance brought forward	7,011	5,746
Revaluation surplus/(deficit) for the year ended 31 March 2008		
Land and Buildings	1,212	1,335
Scientific equipment	16	(4)
IT	(13)	(24)
Other machinery and equipment	(1)	17
Intangible assets	(8)	9
	1,206	1,333
Transfer to general fund for backlog depreciation	(86)	(68)
Balance carried forward	8,131	7,011

Note 16. Note to the Cash Flow Statement

16a. Reconciliation of net deficit to net cash flow from operating activities

	2007-08	2006-07
	£000	£000
Net (deficit) for the year	(1,398)	(21)
Adjustments for non-cash transactions		
Depreciation – tangible fixed assets	617	588
Depreciation – intangible fixed assets	53	40
Non-cash inter-country transfers	-	(2)
(Profit) / loss on disposal of assets	38	-
Notional cost of capital	511	475
Provisions		
Provided in year	4	146
Provisions not required written back	-	(369)
Unwinding of discount	5	(7)
	(170)	850
Adjustments for working capital		
Decrease / (Increase) in stocks and work in progress	443	(107)
Decrease / (Increase) in debtors	(259)	41
Increase / (Decrease) in creditors	525	217
	709	151
Use of provisions	(76)	(43)
Net cash inflow/(outflow) from operations	463	958

16b. Analysis of capital expenditure

	2007-08	2006-07
	£000	£000
Tangible fixed assets	713	477
Intangible fixed assets	37	107
Total cash expenditure on fixed assets	750	584
Increase / (Decrease) in creditors	78	(4)
Capital expenditure	828	580

Note 17. Post Balance Sheet Events

There were no significant post-balance sheet events to record except the appointment of Dr James Pendlebury as Chief Executive and Agency Accounting Officer with effect from 16 June 2008.

These financial statements were authorised for issue on 16 July 2008 by the Agency Accounting Officer.

Note 18. Related Party Transactions

During the year, Forest Research has had a significant number of material transactions with the Forestry Commission and Forest Enterprise country agencies who are regarded as related parties. In addition, Forest Research has had various material transactions with other Government Departments and other central Government bodies. Most of these transactions have been with the Department for Environment, Food and Rural Affairs. Professor Jim Lynch, Chief Executive (until 30 September 2007), is Distinguished Professor of Life Sciences at the University of Surrey. The value of payments to the University for services provided in the year to 31 March 2008 was £64,000. Andy Moffat, Head of Environmental and Human Sciences Division, holds a visiting professorship at the University of Reading with which £3,000 was spent on research services. Other members of staff hold professorships at UK and foreign universities but no material financial transactions took place with these in 2007–08.

Note 19. Losses Statement

There were no losses (2006–07: £nil).

Note 20. Contingent Liabilities

There were three contingent liabilities at 31 March 2008 in respect of actions by ex-employees.

Note 21. Financial Instruments

FRS 13: Derivatives and other financial instruments require disclosure of the role which financial instruments have had during the period in creating or changing the risks an entity faces in undertaking its activities. Because of the way in which government departments are financed, the Agency is not exposed to the degree of financial risk faced by business entities. Moreover, financial instruments play a much more limited role in creating or changing risk than would be typical of the listed companies to which FRS 13 mainly applies. The Agency has no powers to borrow or invest surplus funds and financial assets and liabilities are generated by day-to-day operational activities and are held not to change the risks facing the Agency in undertaking its activities.

Liquidity risk

The Agency is not exposed to significant liquidity risks because its net revenue and capital resource requirements are financed by resources voted annually by the UK Parliament.

Interest rate risk

The Agency is not exposed to interest rate risk.

Foreign currency risk

The Agency has commercial relations with foreign customers and the European Commission, having dealings in foreign currencies and the Euro as well as Sterling. The treatment of gains and losses arising from transactions in foreign currencies is described at note 1.12 to the accounts. The Agency is therefore exposed to foreign currency risk, but the risk is not significant with income from these sources being no more than 9% of the Agency's total income.

Note 22. Financial Performance Measures

The Agency's net deficit was £1,398,000. Financial performance from normal operating activity resulted in an operating deficit of £887,000, which, after allowing for the cost of capital, and before exceptional items, represented a cost recovery of 91.3% (2006-07: 99.9%).

**Printed in the UK for The Stationery Office Limited
on behalf of the Controller of Her Majesty's Stationery Office 07/08**

Printed on paper containing 75% recycled fibre content minimum

Contact addresses

Forest Research

Alice Holt Lodge
Farnham
Surrey GU10 4LH
Tel: 01420 22255
Fax: 01420 23653
E-mail: research.info@forestry.gsi.gov.uk

Forest Research

Northern Research Station

Roslin, Midlothian EH25 9SY
Tel: 0131 445 2176
Fax: 0131 445 5124
E-mail: research.info@forestry.gsi.gov.uk

Technical Development

Forest Research
Ae Village, Dumfries
DG1 1QB
Tel: 01387 860264
Fax: 01387 860386
E-mail: research.info@forestry.gsi.gov.uk

www.forestresearch.gov.uk

Advisory services

Disease, Diagnosis and Advisory Service www.forestresearch.gov.uk/ddas

Plant Quality Testing www.forestresearch.gov.uk/pqt

Foliar Analysis/Fertiliser Prescription Service www.forestresearch.gov.uk/foliaranalysis

Library, Photographic and Information Services E-mail: library@forestry.gsi.gov.uk

Design and production: Colourgraphic Arts, Bordon, Hampshire GU35 9QE

Photographs: Forest Research Photo Library, Forest Life Picture Library and individual authors and photographers

Graphics: George Gate, Forest Research



Forest Research

Alice Holt Lodge

Farnham

Surrey GU10 4LH

Tel: 01420 22255

Fax: 01420 23653

www.forestresearch.gov.uk

Northern Research Station

Roslin

Midlothian EH25 9SY

Tel: 0131 445 2176

Fax: 0131 445 5124

Published by TSO (The Stationery Office) and available from:

Online

www.tsoshop.co.uk

Mail, Telephone Fax & E-Mail

TSO

PO Box 29, Norwich, NR3 1GN

Telephone orders/General enquiries 0870 600 5522

Order through the Parliamentary Hotline Lo-Call 0845 7 023474

Fax orders: 0870 600 5533

E-mail: customer.services@tso.co.uk

Textphone: 0870 240 3701

TSO Shops

16 Arthur Street, Belfast BT1 4GD

028 9023 8451 Fax 028 9023 5401

71 Lothian Road, Edinburgh EH3 9AZ

0870 606 5566 Fax 0870 606 5588

The Parliamentary Bookshop

12 Bridge Street, Parliament Square,

London SW1A 2JX

TSO@Blackwell and other Accredited Agents

£18.55

ISBN 978-0-10-295211-7



9 780102 952117