

Annual Report and Accounts 2006–2007



Cover photo: Female Sitka Spruce (*Picea sitchensis*) flowers and foliage.

Forest Research

Annual Report and Accounts 2006–2007

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

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Chief Executive's Introduction



I am delighted to share this *Annual Report* with our many friends, partners and stakeholders. The past year has been both demanding and exciting, with a number of new developments at Forest Research (FR). We have always adapted our research to answer the changing needs of our customers and the forestry and land-use sectors — over the past five years, 43 of our 56 programmes of research have changed significantly to meet changing requirements. However, over the past year, we have recognised that a step change is needed to ensure that FR continues to be responsive to the changing context of its customers and an attractive partner to work with. To achieve this, our new Development Strategy, which is in its early stages of implementation, guides our focus on topics that are a priority for our customers, so we can better answer their needs.

I was pleased that the FC Executive Board and Board of Forestry Commissioners approved the plans put forward in our Development Strategy in September 2006. At the heart of the Strategy is the understanding that FR must grow into a more sustainable organisation, with a more diverse range of funding sources in order to survive in a competitive world. Through the Strategy, we have set out to achieve this by increased innovation, improved links with other scientific and research organisations, increased scientific and business excellence, and strong governance.

The Development Strategy is being implemented as a sequence of actions that will carry forward into the future, and this year has seen good progress in its initiation. I have been greatly assisted in this by the appointment of Dr David Shannon, the former Chief Scientist of the Department for Environment, Food and Rural Affairs (Defra), to act as a facilitator on a consultancy basis. Our activities have also been supported by Dr David Evans, the former Research Director of Syngenta, who has been invaluable in advising on the financial and IP aspects of the development. And, last but not least, I have been particularly pleased to see the commitment of FR staff to implementing the new Strategy.

Highlights of 2006/07: The past year has seen many significant events and achievements.

- An international conference on **Forestry: a Sectoral Response to Climate Change**, jointly organised by FR, FC and the Organisation for Economic Co-operation and Development (OECD), took place in November at Wilton Park, the Foreign and Commonwealth Office's Conference Centre. To be published by CABI as *Forestry and Climate Change* (due in Autumn 2007), the book will share the most current ideas from key international experts on forest and climate change issues with a wider audience.
- In November 2006, we opened the **first UK Research Forest** at Alice Holt. Now other research organisations can access this very special research environment along with 50 years of environmental data.
- We successfully launched the **Biomass Energy Centre** (BEC) on behalf of Defra and the Department of Trade and Industry (Dti) as the British knowledge hub for biomass. So far, the BEC has responded to over one thousand enquiries, offering expert, impartial and up-to-date advice.
- Our research into **community use of woodlands** has continued to grow. New research is considering diversity amongst forest and woodland users, and the restorative powers of woodlands on schoolchildren, for example, with another study assessing the effects on offenders.
- Another key area of growth has been in **land regeneration**, with extensive research and consultancy advisory services to support FC activities across the UK on projects such as Jeskyns Farm, Thames Chase Community Forest, Newlands, Woods in and around towns (WIAT) and Cyd Coed.
- There was intense media attention on Horse Chestnut trees in autumn 2006, and we were able to respond immediately to the press and other concerned organisations with expert advice on Bleeding Canker and other **pests and diseases**.
- Environmental research is inherently international, so we were particularly pleased to welcome a group of **senior Chinese government officials** to learn about Forest Research's current research programmes and open the prospect of exchange visits.
- Following the award of PSRE-3 funding last year, we've made good progress in developing our **Intellectual Property** (IP) expertise, including the recruitment of an IP manager and establishment of an IP steering group with external members. We have implemented new internal procedures to assess and support innovation, and have developed a significant portfolio of development projects that have already generated significant business.
- We are proud of our research and so were delighted to welcome **FC Commissioners** to Alice Holt last autumn, including our two new Commissioners, Olutayo Adebawale and Calum MacDonald.
- Fellowships awarded by the OECD allowed us to **exchange researchers with Scion/Ensis** (New Zealand). Our two organisations now share a Memorandum of Understanding.
- Closer to home, we've set up initiatives to **reduce our carbon 'footprint'** – from small things like turning equipment off when not in use, to more video-conferencing to reduce travel between sites.



Finance

Income in the year increased by 8% compared to the previous year, with a 7% increase in payroll costs while other operating costs increased by 12%. The net deficit for the year from normal operations, after the cost of capital charge of £475,000 and depreciation, was £21,000, representing a cost recovery rate of 99.9%. Capital investment amounted to £580,000, covering a wide range of scientific and technical purchases, as well as office, laboratory and infrastructure refurbishments. In cash flow terms, the Agency generated a net surplus of £357,000.

This report demonstrates FR's very successful research and development activities. For these, we depend entirely on the expertise and hard work of our staff and I would like to thank all FR staff for their many and varied contributions at this particularly exciting and demanding time.

I hope this *Annual Report and Accounts* will give you a good overview of our research during the past year and how it may benefit us all. I encourage you to visit our website and sign up to our regular newsletter so we can continue to keep you informed.

A handwritten signature in black ink, which appears to read 'Jim Lynch'. The signature is fluid and cursive, with a large initial 'J' and 'L'.

Professor Jim Lynch
Chief Executive

Targets and achievements over the past six years

Performance measure		2001/02	2002/03	2003/04	2004/05	2005/06	
Customer satisfaction							
	Achieved	97%	98%	97%	97%	97%	–
To monitor and respond to customer satisfaction¹	–	–	–	–	–	–	Achieved via RSMB/CFS ² feedback
	–	–	–	–	–	–	
Peer-reviewed papers	Target	48	48	45	45	45	45
	Achieved	48	48	45	47	45	45
Identify FC priority areas for peer-reviewed papers¹	–	–	–	–	–	–	Achieved and agreed with CFS
	–	–	–	–	–	–	
Reports, FC publications³ and articles	Target	–	–	25	25	25	40
	Achieved	–	–	25+	25+	25+	40+
Increase number of hits on FR website	Target	–	–	–	–	15%	15%
	Achieved	–	–	–	–	Target exceeded	Target exceeded
Joint Code of Practice for Research Guidelines¹	Target	–	–	–	–	–	Comply
	Achieved	–	–	–	–	–	Achieved
External review of research programmes³	Target	–	–	Silviculture	Social Research	Biometrics	E&HS
	Achieved	–	–	Completed	Completed	Completed	Completed
Formal training (average number of days per member of staff)¹	Target	–	–	–	–	–	4
	Achieved	–	–	–	–	–	4
Review grading procedures¹	Target	–	–	–	–	–	Review procedures
	Achieved	–	–	–	–	–	Target met
Reduce sick leave to below FC average¹	Target	–	–	–	–	–	6.2
	Achieved	–	–	–	–	–	5.6
PSRE3 targets^{1, 4}	Target	–	–	–	–	–	Achieve targets ⁴
	Achieved	–	–	–	–	–	Targets met
Unit cost/ research day (unweighted) 98/99 =100	Target	94	92	90	88	86	84
	Achieved	81	79	78	75	72 ⁵	72
Unit cost of support services	Target	94	92	89	87	85	83
	Achieved	86	84	82	82	73 ⁵	73
Cost recovery	Target	99%	100%	100%	100%	100%	100%
	Achieved	100%	100%	100%	99.8%	100%	99.9%
Income from customers³ other than FC	Target	–	–	£1.5m	£1.5m	£1.9m	£2.1m
	Achieved	–	–	£1.65m	£2.11m	£2.01m	£2.4m

1 New targets set for 2006–07.

2 Research Strategy Management Board (RSMB); Corporate and Forestry Support (CFS).

3 New targets set following the Agency's first Quinquennial Review.

4 PSRE3 targets as agreed with the Office of Science and Innovation.

5 Efficiencies achieved during 2005–2006 following divisional reorganisation.

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. Forest Enterprise was responsible for managing the FC estate during 2006–07, and purchased research, development and surveys specifically related to this estate. 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.

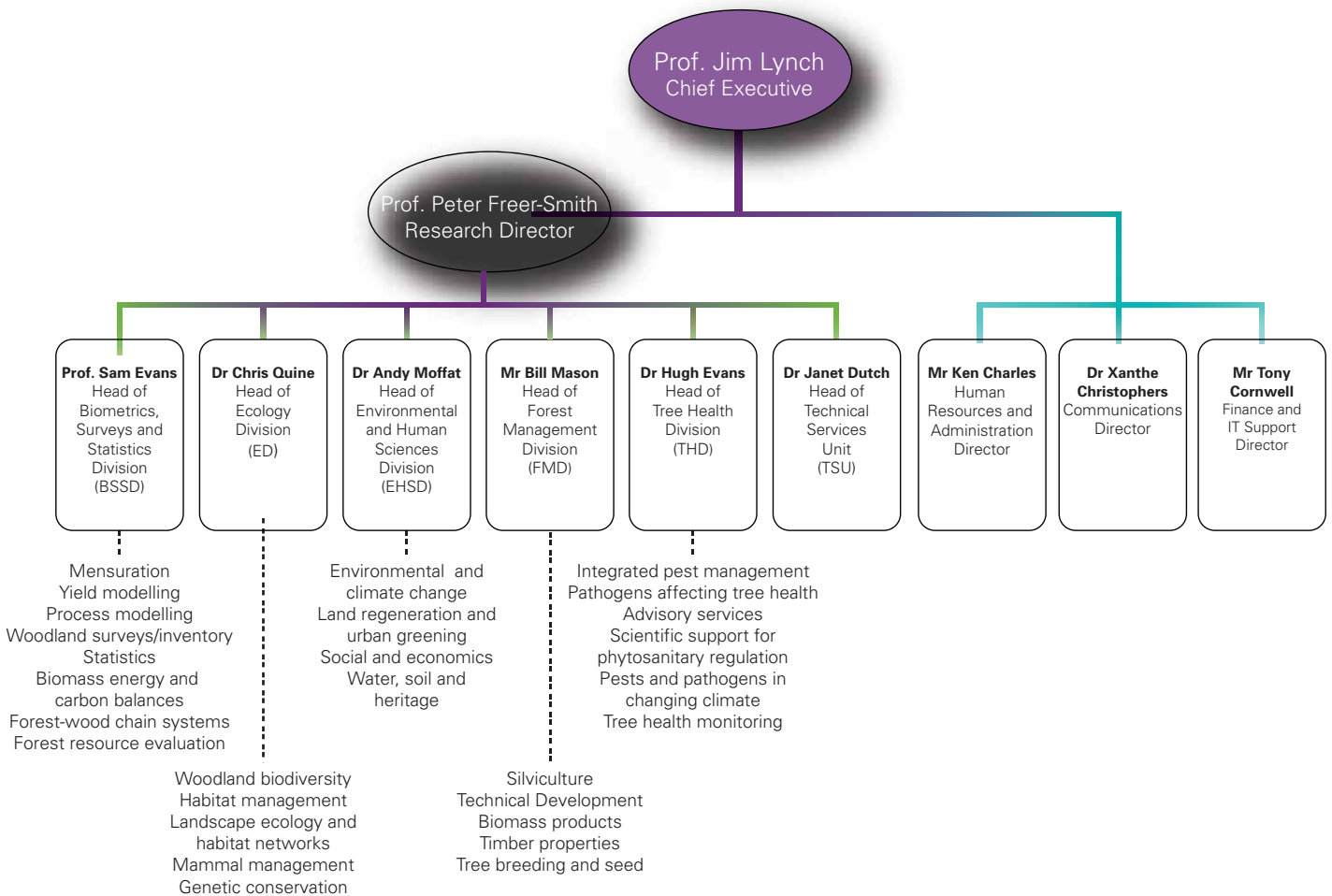
FR works closely with the FC, the Commission of the European Communities and other international organisations to ensure compliance with international agreements on the sustainable management of forests and related subjects. The Agency also carries out work on genetic conservation, tree improvement, 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 280 staff, not including visiting scientists and sandwich students. FR has published a Corporate Plan for the period 2006–2009 and copies are available to download from www.forestresearch.gov.uk/corporateplans

Forest Research Organisation 2006–07



Advisory Committee on Forestry Research

Chairman

PROFESSOR D. J. READ, FRS

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

Secretary

PROFESSOR P. H. FREER-SMITH

Research Director
Forest Research

Members

PROFESSOR C. WARD-THOMPSON

Director, OPENSspace 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

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

DR S. C. GREGORY

Forestry Commission
Corporate and Forestry Support
(up to February 2007)

DR J. PENDLEBURY

Forestry Commission
Corporate and Forestry Support
(from January 2007)

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

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 2006 for a tour of research work in The New Forest and in December 2006 at the Northern Research Station, Edinburgh. These meetings allow Committee members to meet staff and to 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 Environmental and Human Sciences Division (chaired by Professor Roland Clift, with Professors John Handley and James Curran as members). The Visiting Group rated the four research groups of the Division on a four-point scale (A down to D) on the basis of science

quality and overall relevance, delivery and progress. The evaluations were as follows:

- Water, Soil and Heritage Research: science quality A, overall delivery A
- Environmental Change Research: science quality A/B, overall delivery B/C
- Social and Economic Research: science quality A/B, overall delivery C
- Land Regeneration and Urban Greening: science quality A, overall delivery A

The Visiting Group gained an overall impression of 'an active research community, with some able and highly motivated staff and a good age structure'. The Group felt that there were tensions arising from FR's objective of broadening its research base and expertise beyond the immediate concerns of the FC, and from the need for FR to become more

actively engaged in influencing the policy process. In one of the four research groups in particular, the group detected a disproportionate effort spent on reporting research internally and in the 'grey literature'. The Visiting Group's final comment was that '...if a way can be found to resolve these tensions, we consider the Division overall to be in good shape, and well set to provide good service in future'.

In addition to the work outlined above, members of the Advisory Committee on Forestry Research are closely involved in the implementation of FR's Development Strategy. This has been through the provision of advice on the Strategy and of external expertise on appointment and promotion boards. We are also grateful to Professor David Evans for chairing the team that is currently reviewing FR's finance and management systems.

National and international links, visitors and events



Forest Research operates in the high-profile area of the environment and natural resources, alongside universities and other research organisations. We are keen to share knowledge with like-minded institutions and to continue to build collaborative links both at home and abroad. Over the past year, we have welcomed many visitors, including scientists and policy-makers from both the UK and the international community. Our staff have participated at a wide range of events, ensuring that FR is increasingly known for providing excellent research coupled with practice-based outputs both within and beyond the UK.

Forest Research's links with Scion/Ensis in New Zealand have been strengthened with exchange visits between scientists as part of a fellowship award from the Organisation for Economic Co-operation and Development (OECD). Scion/Ensis scientist Dr Nod Kay came to Alice Holt for seven weeks to work on aspects of island resource allocation in relation to colonisation of broadleaved trees by insect defoliators. In return, Dr David Wainhouse visited Scion/Ensis in New Zealand to study the potential pests of radiata pine. Other visitors from New Zealand included Dr Ross Beever, from Landcare Research NZ, and Dr Beccy Ganley from Scion/Ensis. Their visit was prompted by discovery of a pathogen in New Zealand which had been first identified by FR in Cornwall in 2003. The New Zealand researchers visited pathologists at Alice Holt to discuss their current research on the new species of invasive *Phytophthora*, *P. kernoviae*.

FR's Scientific Director, Peter Freer-Smith, undertook an OECD fellowship working with the French National Institute for Agricultural Research (INRA) in Bordeaux. During his visit, Peter carried out a review of sustainable management, certification and forest protection, which will be published in the journal *Ambio*.

Bill Mason, Chris Quine and Robin Gill delivered presentations at the British Ornithologist's Union discussion meeting on 'Woodland Birds: their ecology and management' at the University of Leicester, describing forest management, stand management and herbivore impacts.

In June, Liz O'Brien participated at the 12th International Symposium on Society and Resource management (ISSRM) in Canada, giving a presentation on 'Trees and woods in inner London: residents from two social housing estates and their perspectives on Peabody Hill Wood'. This annual meeting forms the largest gathering of social scientists and natural resource managers worldwide.

FR's stand at the Royal Welsh Show in Llanellwedd, Builth Wells, was extremely popular with visitors and provided the venue for a number of presentations throughout the event, showcasing recent publications including *Forest mensuration: a handbook for practitioners* and the *FC Technical Guide: Forest fencing*. It was also the first public presentation of FR's new biological control service using nematodes to reduce damage caused by weevils (*Hylobius abietis*).

FR's land regeneration experts joined a range of companies and organisations at the Environmental Technologies/ International Clean Up exhibition at the NEC in Birmingham in May. The event provided a good opportunity to inform industry visitors about the breadth of our research in this field and to show our extensive capabilities in the land regeneration and urban greening sectors.





In early July, FR collaborated with Edinburgh and Sheffield Universities to present a display on 'The Breathing Forest' at the Royal Society of Arts Summer Science Exhibition in London. The presentation proved very popular with visitors, and focused on the impact of forest carbon cycles on climate change models. Displays at the summer exhibition are awarded by competition so it reflects well on FR that we have been successful in the past few years — we will have a display again in 2007.

During the year, many members of staff attended International Union of Forest Research Organizations (IUFRO) meetings and other international events, representing a range of FR's expertise, advice and collaboration. In July, IUFRO held a seed physiology and technology research conference in Canada, where FR's Shelagh McCartan presented a well-received paper on 'Seed fill determination in juniper'. July also saw the inaugural meeting of a new working party on Alien Invasive Species and International Trade in Poland. Supported by IUFRO, and coordinated by Forest Research's

Clockwise from left: Tony Cooper, Paul Hill-Tout, Wilma Harper, Jim Lynch, Calum MacDonald and Olutayo Adebowale



Hugh Evans, the group aims to establish new measures to help reduce the spread of pests, diseases and pathogens.

In autumn, Alice Holt hosted a visit by two new FC Commissioners, Olutayo Adebowale and Calum MacDonald. Also attending were Commissioners Gareth Wardell and Tony Cooper, as well as Ian Forshaw

(FC Wales Chief Executive), Wilma Harper (FC Head of Corporate and Forestry Services), and Paul Hill-Tout (Director FC England).

The biennial International Forest Machinery exhibition organised by the Association of Professional Foresters (APF) took place in Warwickshire in September. Responding to the recent interest in woodfuel, the FC's Director General, Tim Rollinson, launched several new, key sources of information on using woodfuel as a sustainable, low-carbon source of energy and highlighted the prominent role of the Biomass Energy Centre. Forest Research supported these announcements by giving presentations outlining the latest work on woodfuel and providing information and advice for visitors.

FR hosted an international workshop on 'Forest storm risk management in the North Sea region' in Inverness as part of the STORMRISK project. The event was hosted by Mark Broadmeadow, Chris Quine, Barry Gardiner, Juan Suarez, Axel Wellpott and Bruce Nicoll. Forest managers and researchers from Sweden, Germany, Denmark, UK and Canada attended.

A key event for climate change was November's Wilton Park conference on 'Forestry: a Sectoral Response to Climate Change'. The international conference was jointly supported by Forest Research, the OECD and the Forestry Commission, and was attended by the Rt. Hon. Ian Pearson MP, the Rt. Hon. Lord Clark of Windermere, representatives of national forest services, and senior scientists and policy advisors from 19 countries. The event also saw the launch of Alice Holt Forest as an active 'Research Forest', opening it up to other scientific

and research organisations, along with access to over 50 years' environmental data. The conference was FR Chief Executive Jim Lynch's last event as Co-ordinator of the OECD Biological Resource Management, after 17 years' commitment.

Four scientists from the Chilean Institute of Forest Research (INFOR) spent six days at our Northern Research Station near Edinburgh last autumn to learn about FR's work on tree establishment under difficult weather conditions. Hosted by Bill Mason, Alan Harrison and Esther Ker, the visit offered an opportunity to share knowledge. Bill Raynor returned the visit to Chile to present a paper on 'Fifty years of research on establishing and growing trees in wind-exposed deforested areas of northern Scotland' at an IUFRO-organised conference.

Alice Holt hosted a visit by a group of senior Chinese government officials in early December. The delegates were keen to learn about the FC's forestry activities and FR's current research programmes, particularly since some of the guests were working towards setting the Chinese Forest Certification Standard. Another guest was New Zealand forest consultant Ian Barton, who met with Colin Edwards and Bill Mason to discuss the benefits of greater use of continuous cover forestry.

Matt Wilkinson, Danni Sinnott and Cécile de Munck represented FR at the Environment Agency's annual conference on 'Environmental Futures'. The event was an ideal opportunity to showcase FR's varied activities across many aspects of the environment and reach some of our newer audiences.



Darren Moseley participated at an FC Scotland seminar focusing on development and woodland biodiversity, as part of the Scottish Executive's Planning Development Programme. Darren explained how woodland data can be used to protect and enhance biodiversity. The event aimed to help unitary authority planning departments recognise the potential effects of development on woodland biodiversity and find ways to reduce this impact.

Jim Lynch attended an OECD meeting on bioenergy in Sweden this January and chaired the scientific sessions. The event included policy makers and scientists from 15 countries, with discussions on the need to establish a global carbon economy to mitigate climate change.



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, Dti, 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, Sheffield, Leeds, Bangor, Cardiff, Cranfield, Oxford, Cambridge, Exeter, Bath, Bristol, Portsmouth, Bournemouth, Reading, Surrey, Southampton, Sussex and London universities.



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

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

Our Research



This year, our *Annual Report and Accounts* includes new introductory overviews that briefly illustrate the breadth of research in each of our five working areas, outlining a selection of current projects and showing their impacts. Each overview is followed by two technical Highlight articles that delve into other projects in a little more detail.

Biometrics, Surveys and Statistics overview

Woodfuel and biomass energy

Simulating the impact of pinewood nematode

Ecology overview

Criteria for changing forest land use

Conservation measures for the Scottish capercaillie

Environmental and Human Sciences overview

Mapping unrecorded woodland heritage with LiDAR

Dendrochronology and climate change research

Forest Management overview

Sustainable management of the European forestry–wood chain

Creating new broadleaved woodlands by direct seeding

Tree Health overview

Bleeding canker of horse chestnut: a growing threat?

Gypsy moth and oak processionary moth in the UK

Further information on these topics is available from the Forest Research website – specific links are given where suitable.



Biometrics, Surveys and Statistics



Fully understanding the potential of our woodland resources requires an accurate picture of the size, location and composition of forests and woodlands. Our teams working on biometrics, surveys and statistics contribute a range of critical scientific approaches, from statistical analysis and data management to surveying and measurement, modelling and software engineering. Often working behind the scenes, they contribute to many of our research projects. This year, we've made significant progress across a range of diverse activities – here are a few examples.

Developing surveys and monitoring

Robust science relies on rigorous methodology. Our statisticians work alongside other researchers to design appropriate surveys and experiments for a broad range of projects. Over the past year, this has included designing social forestry questionnaires and surveys (page 33), and devising a suitable method to estimate the 'timber miles' travelled by Scottish wood (page 39).

Native Woodlands Survey for Scotland

On behalf of Forestry Commission Scotland, our surveyors are creating a high-resolution digital map for the Native Woodlands Survey for Scotland (NWSS). For the first time, the project will fully survey all native woodlands in Scotland, rather than using a plot- or sample-based survey. This will enable Forestry Commission Scotland to create a database of information on Scotland's native woodlands, to assess the condition of all native woods and pinpoint which areas may need changes in management. The survey programme will also increase understanding of the potential of Scottish woodlands and their likely survival in the longer term – two key considerations when devising management plans.

Remote sensing in surveys

Our survey researchers have been testing the capabilities of airborne laser scanning (ALS) for producing inventory data to support forest-management decisions at tactical and operational levels. This relatively new remote-sensing technique has proved its value as a cost-effective aid to inventory systems. ALS can detect tree height, canopy dimensions and

the spatial distribution of dominant tree types within a stand. This level of detail – never before achieved by any other sensor – improves our understanding of stand dynamics, how trees grow, their stability and timber potential.

Remote sensing used in models

International collaboration between Forest Research and other organisations is helping to advance knowledge about the allometric relationships (i.e. the different growth rates and proportions) of trees growing in close proximity. This is improving understanding of the spatial distribution of dominant types, and the effects this may have on both the growth dynamics of individual trees and the stability of stands of trees. For example, data generated by ALS were input to an adapted version of our wind-risk model ForestGALES. The results have increased understanding of the effect of stand structure on the likelihood of wind damage.

By highlighting the characteristics of those trees in a stand that are most vulnerable, we have been able to refine estimates of the probability of wind damage. Consequently, we can now make more-accurate predictions of wind damage than can be generated from stand information gathered in the field or from existing Forestry Commission woodland databases. Since this information can be obtained in a semi-automated manner, ALS can provide a cost-effective alternative to field data collection, and can increase the operational use of ForestGALES by forest practitioners. Further information is available from www.forestresearch.gov.uk/forestgales





Integrating forest monitoring systems

Forest Research has also contributed to the development of proposals for the Integrated Forest Monitoring project. This work will update and integrate four existing monitoring systems that collect a range of data, from photosynthesis to tree height, in order to better answer current and future needs. Future monitoring systems are likely to use stratified sampling based on woodland classification using species, management, soil and meteorological data. The integrated monitoring system will combine data from different sources to allow the estimation of quantities of interest using modelling techniques. Further details of our survey work is available at www.forestresearch.gov.uk/surveys

Modelling and data systems

Forest Research has been developing and improving an extensive collection of growth and yield models, several of which have recently been finalised and presented to their user communities for testing and feedback. For example, our modellers recently assisted the Department for Environment, Food and Rural Affairs (Defra) in creating 'opportunity maps' showing where short-rotation coppice can be most successfully grown. This involved using models based on data collected from the largest network of short-rotation coppice field trials in Europe. In addition, another model for predicting short-rotation coppice growth and yield under changing environmental conditions was presented to Defra and other stakeholders, including policy-makers and end-users. More details on the model can be found at www.forestresearch.gov.uk/src

The modelling team is also testing and refining a model that focuses on rainfall interception by tree canopies. Experiments at two different sites – Alice Holt in Surrey and Thetford in Suffolk – measure how much rain is intercepted at the canopy level. The model accurately simulates the rainfall interception at these sites, providing quantitative information on an important component of a forest's water balance. Work is underway to evaluate the model's suitability across Britain and to provide guidance and predictions for policy-makers on how forests may affect the amount of rainfall available for recharging groundwater levels under future management and climate scenarios.

Timber production forecasting for British forests

Our researchers work closely with the Forestry Commission to forecast the availability of annual timber volume from the national forest estate, both public- and private-sector. Potential timber production over 20 years is predicted by a set of models that are modified for different regions and forest types to reflect important variations in management practices. These include, for example, the wider adoption of continuous-cover forestry systems, which avoid clear felling. The published forecasts are used directly by the forest industry in decision-making for future investment, as well as in long-term planning of supply. They also form the basis of UK timber statistics, as reported to the United Nations. More details can be found at www.forestry.gov.uk/forestry/hcou-4u4jgx

Evaluating the carbon benefits of forestry

With the increasing importance of climate change, it has become necessary to estimate the value of climate-change mitigation by UK forests. This involves quantifying carbon dynamics of typical UK forests, considering the management techniques that maximise long-term carbon stocks, and evaluating what carbon emissions can be displaced by switching from fossil fuels to wood-based energy sources.

This year, Forest Research has been closely involved in research into the potential impacts of forest carbon management. This has included providing Forestry Commission England with forecasts of the carbon dynamics of woodlands under different management regimes to inform the development of a woodfuel strategy. We have also provided information on changes in forest carbon stocks, enabling economic analyses of the costs and benefits of forest carbon management.

Modelling the spread of diseases

As part of a recently completed EU project, our modellers have been working with experts in tree health on an experiment in Portugal to study pine wilt disease. This has included providing calibration and validation of the Forest Research ForestETP model – an ecological model adapted to simulate the impacts of the disease across Europe.



Woodfuel and biomass energy

Ian Tubby and Andy Hall

Forest Research has been studying and developing systems associated with the production, processing and end use of biomass and woodfuel for over two decades. This research experience, combined with a proven capability for technology transfer, ensured that FR was well placed to develop a 'national focus of knowledge and analysis on biomass energy', as recommended to government by the Biomass Task Force in October 2005. As part of government response to these recommendations, the Biomass Energy Centre (BEC) was launched in April 2006 to provide information on biomass-derived fuels and associated conversion technologies. Managed by Forest Research on behalf of the Forestry Commission and the Department for Environment, Food and Rural Affairs (Defra), the BEC has provided impartial and up-to-date advice and guidance in response to about a thousand enquiries and requests for information in its first year. Many of these enquires are received via the dedicated website www.biomassenergycentre.org.uk (Figure 1).

Throughout the year the BEC has played an important part in initiatives to develop a sustainable biomass sector, and is integral to the woodfuel strategy published by Forestry Commission England in March 2007. The BEC also works with Forestry Commission Scotland and with the Wood Energy Business Scheme in Wales. The Centre continues to develop links and information-delivery mechanisms with regional bodies and local organisations across the UK.

A significant number of responses to enquiries received by the BEC draw on results emerging from the Woodfuel Research Centre, home to Forest Research's growing portfolio of biomass-related investigations. A large proportion of this work is highly applied with direct relevance to industry, and is purchased centrally by the FC. Increasingly, projects are funded by other organisations such as Defra, the Institute for Grassland and Environmental Research, the EU and the Welsh Assembly. As well as enjoying good links with other research groups in the UK, the Woodfuel Research Centre contributes to international consortia such as the International Energy Agency Task 31: 'Biomass Production for Energy from Sustainable Forestry'. The Woodfuel Research Centre hopes to build on this sound start and to broaden knowledge and research experience in the coming year.

Figure 1

The website of the Biomass Energy Centre: www.biomassenergycentre.org.uk



Simulating the impact of pinewood nematode

Sam Evans, Makihiko Ikegami and Hugh Evans

Simulating the effects and impacts of a pest of pine trees is providing a new perspective on predicting pest risk. The pinewood nematode (*Bursaphelenchus xylophilus*) is an organism that usually lives on dead or dying pine trees. It is spread by longhorn beetles (genus *Monochamus*), which can introduce the organism into healthy trees without any apparent effects on plant activity. In some cases, however, and in a number of geographical regions, pinewood nematode has been found to cause the rapid death of mature pine trees. A body of evidence shows that the organism induces wilting of susceptible pine species (Figure 1), and is significantly affected by seasonal variation in water availability. Under certain environmental conditions the severity of wilting can result in death of the host plant. Pinewood nematode has been found in Portugal since 1999, so evaluating its potential risk to European pine species under a European climate is essential for devising appropriate management strategies to prevent its further expansion.

Forest Research has used current understanding of tree growth processes to develop a model describing and simulating what happens in cases of infestation with pinewood nematode. The model describes the physiological behaviour of the tree host and its interaction with the nematode to predict the likelihood of tree death. Simulations run for sites in the Iberian peninsula, including those where fatal infestation occur, indicate a high

likelihood of host death, both immediately and in the year following infestation with pinewood nematode. Within the model, the principal predictors of tree mortality are high temperature and low precipitation in summer, and medium temperature and high precipitation in autumn. Elsewhere, where environmental conditions do not result in significant tree stress, pinewood nematode does not result in wilting and host death. An ongoing observational experiment in Portugal, using *Pinus pinaster* trees infested with pinewood nematode, suggests a good correlation between simulated and observed results. It is proposed that, with further refinement and validation, this model may be suitable for developing a generic framework to predict the vulnerability of different hosts to pinewood nematode across a range of geographical regions.

Figure 1

Wilting in pine trees, caused by pinewood nematode



Ecology



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Our ecology teams carry out research into woodlands and forests using a number of different approaches. In particular, we're investigating methods to conserve biological resources, such as species and habitats; we're also researching how to safeguard and enhance woodland biodiversity, and examining the impact of animals on woodland ecosystems. Here, we highlight some of our recent research.

Implementing landscape ecology through habitat networks

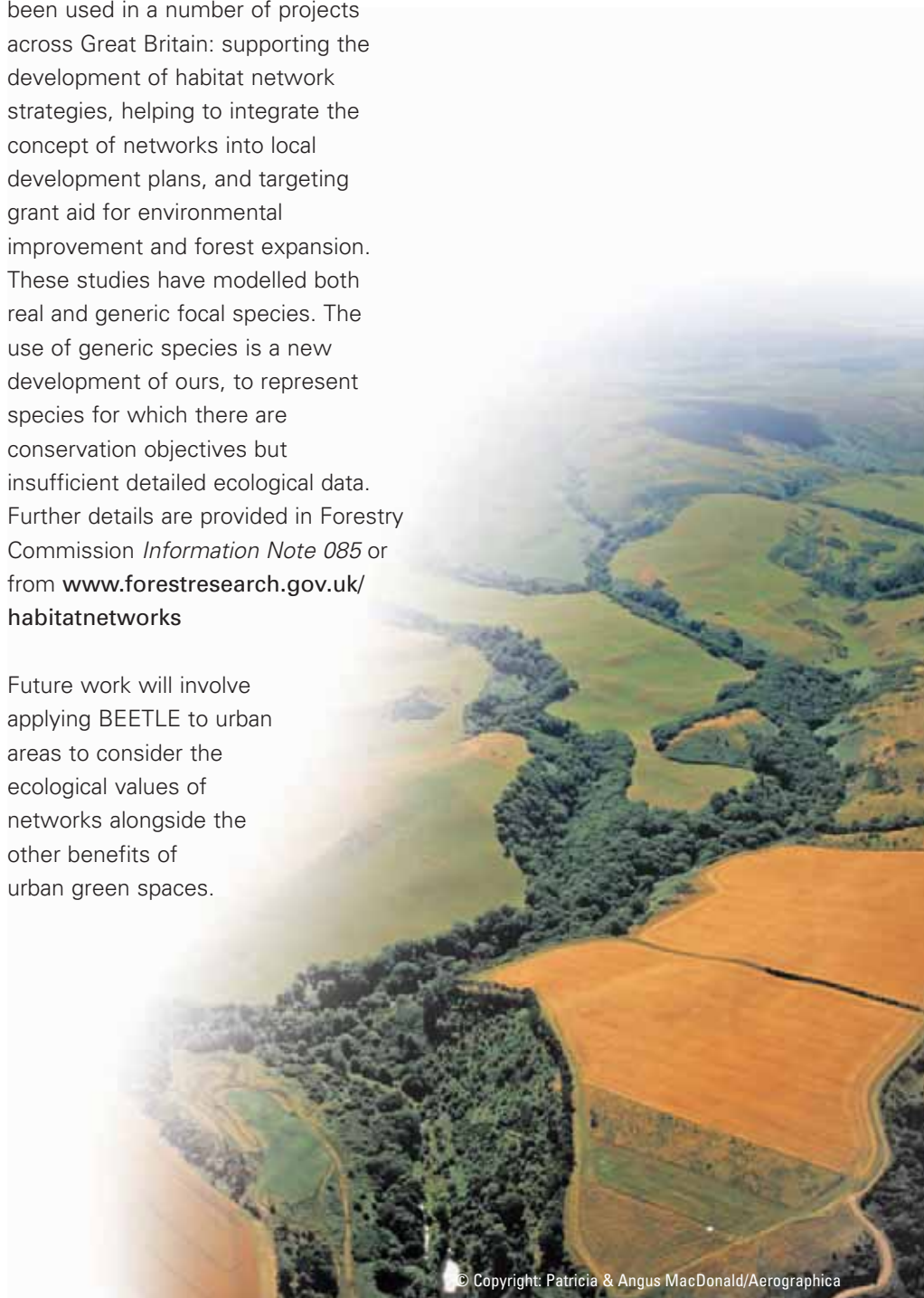
Despite considerable conservation efforts at different sites, research and monitoring has revealed a continuing decline in biodiversity. This is thought to be due to the effects of habitat fragmentation and a reduction in habitat quality, associated with intensive land management. These factors, combined with increased policy interest in changing land use, concern about the impact of climate change and developments in ecological theory, highlight the need for a more sophisticated approach to landscape ecology.

Our research into landscape ecology is increasing understanding of how biodiversity is affected by forest management practices at a landscape scale. This is highly relevant to the ecology and management of British forests, helping to inform forestry and landscape planning practices.

Recently, our work has focused on habitat networks, which link and expand habitats, making them capable of sustaining greater biodiversity. In the past, a structural approach considered only those habitats that are linked physically. Habitat networks consider the landscape from a more functional point of view, taking into account the ability of some organisms to move across surrounding land from one region of suitable habitat to the next. In this way, more sophisticated analyses of landscapes become possible. The landscape is no longer defined by areas of 'habitat' and 'non-habitat', but as an overall matrix that comprises various habitat areas of varying attractiveness, or hostility, to particular organisms. Our suite of Biological and

Environmental Evaluation Tools for Landscape Ecology (BEETLE) is now widely identified as the tool with which to assess habitat networks using Geographic Information Systems (GISs). As well as woodland, BEETLE can also help analyse other open ground habitats of concern. Over the past year, the suite of tools has been used in a number of projects across Great Britain: supporting the development of habitat network strategies, helping to integrate the concept of networks into local development plans, and targeting grant aid for environmental improvement and forest expansion. These studies have modelled both real and generic focal species. The use of generic species is a new development of ours, to represent species for which there are conservation objectives but insufficient detailed ecological data. Further details are provided in Forestry Commission *Information Note 085* or from www.forestresearch.gov.uk/habitatnetworks

Future work will involve applying BEETLE to urban areas to consider the ecological values of networks alongside the other benefits of urban green spaces.



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Assessing the impact of mammals on habitats

We are involved in an ambitious project to study the impacts of deer on habitats. Entitled 'Collaborative frameworks in land management – a case study of wild deer in Britain', the project is funded by the Rural Economy and Land Use programme (RELU) and brings together a multi-disciplinary group of scientists from a number of research centres. The project aims to improve understanding of both the impacts of deer on land and the attitudes towards these impacts among a range of stakeholders, including owners, managers and users of the countryside. Forest Research scientists are contributing both social and ecological expertise to this project.

Other work has developed a range of assessment methods to obtain greater insights into the problems encountered by land managers when grazing by deer and/or domestic stock causes damage to habitats or valuable crops. For example, a method has been developed to assess the degree of over-grazing in upland and lowland woods for the Department for Environment, Food and Rural Affairs (Defra). Another, more in-depth method has been devised to help Forestry Commission England monitor progress to encourage favourable conditions in 80 woodland Sites of Special Scientific Interest (SSSIs). Further details about our work on herbivore impacts is available at www.forestryresearch.gov.uk/reludeer



Disseminating knowledge on biodiversity

Assembling complex ecological information to be of practical use to managers of forests, woodlands and other priority habitats provides a particular challenge. Forest Research is working on decision-support tools to achieve this, and has been deeply involved in the organisation of knowledge to form new Forestry Commission Biodiversity Guidelines. These Guidelines support the UK Forestry Standard; they are supplemented by a wider range of Practice Notes and other detailed information that helps practitioners to implement policy and make site-specific decisions.

We are also exploring new ways of making information available. For example, a decision-support system for Habitats and Rare, Priority and Protected Species (HARPPS) will shortly be presented as a web-based tool. HARPPS will provide information for managers seeking to understand what they need to do to enhance the prospects for particular species or habitats, and how they might modify management activities to achieve this. We also disseminate knowledge informally, and regular updates on our ecology research are available from our online newsletter *ECOTYPE* at www.forestryresearch.gov.uk/ecotype

Researching molecular genetics

The detailed information held by systems such as HARPPS is underpinned by rigorous research. Our work continues to focus on a number of habitats and species of particular conservation interest (as introduced in the article by Broome and colleagues in Forest Research's *Annual Report and Accounts 2003–2004*). Increasingly, our investigations are carried out in collaboration with universities and other institutes through shared work or joint funding of higher degrees.

We are currently exploring the potential value that molecular genetics may add to these studies, in terms of both population structure (e.g. selecting the best strategy and most suitable species to expand native tree populations) and by providing insights into how landscape structure influences plant and animal populations. The recent acquisition of a real-time Polymerase Chain Reaction (PCR) machine has also opened up a new range of possibilities for ecological studies and molecular diagnostics. The machine facilitates rapid species identification from DNA, and enables new ways of examining genes.



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Criteria for changing forest land use

Duncan Ray, Chris Quine, Louise Sing, Max Hislop and Fauzia Davidson

Figure 1

Social scientist Max Hislop facilitating a meeting with Friends of Pembrey Forest, June 2006



Sustainable forest management balances the role of forests in providing goods and services for local and national economies, communities and the environment. In Wales, it has been recognised that some areas of conifer forest do not provide the required sustainable benefits. Forestry Commission Wales (FCW) and the Countryside Council for Wales (CCW) funded a study to examine the issues and develop

policy recommendations to guide the change of some forest to other land-use types, including the restoration of priority habitats.

A multi-disciplinary project team reviewed forest policy and drivers for land-use change in Wales, and used multi-criteria decision analysis (MCDA) as a framework for assessing the

need for change at two scales. At the national scale, all areas of coniferous woodland were assessed as candidates for change, within a geographical information system (GIS). At the local scale, more detailed data could be incorporated to evaluate particular candidate areas or other

forest areas of local concern not identified in the national MCDA.

Workshops with expert stakeholders identified criteria for the MCDA and appropriate measures for assessing the options. Community-group meetings based in Llanelli in the summer of 2006 (Figure 1) and a national survey of 1000 people in Wales provided information on the perceived importance of five issues:

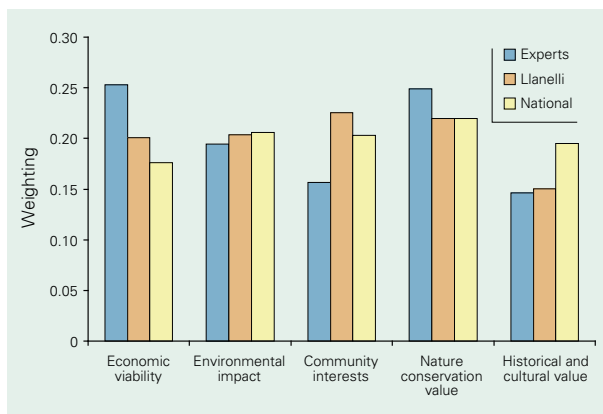
- economic viability
- environmental impact
- community interest
- nature-conservation value
- historical and cultural value

The weightings proposed by different stakeholders for the MCDA tool vary slightly (Figure 2). The expert stakeholder views were more polarised than those of other respondents, and favoured economic and nature-conservation issues over community interests and historical and cultural values.

This type of stakeholder and community involvement will play an important role in improving public participation in forest policy. The MCDA approach provides a structured, consistent, transparent and repeatable tool for supporting decisions. Moreover, the rigour of the approach ensures that a complete range of criteria pertinent to sustainable forest management, and often difficult to measure, can be included in the analysis and inform important decision-making.

Figure 2

Variation between interest groups in the weighting of five main issues



This Figure shows some of the results for the national MCDA analysis. If weightings were equally distributed, each issue would have a weighting of 0.2, as the sum of the weights equals 1.

Conservation measures for the Scottish capercaillie

Alice Broome, Liz Poulson, Chris Quine and Roger Trout

The capercaillie (*Tetrao urogallus*) is an iconic bird of the boreal forest and of Scottish pine forests. In Scotland the species became extinct in the 18th century, but was successfully reintroduced in the 19th century. However, numbers have declined again in the past 30 years, prompting concern about the risk of another extinction. The decline seems to be due to a range of factors, including less suitable spring weather, changes in habitat quality, and increased deaths from predation and collisions with fences.

Forest Research is taking part in an ambitious project on urgent conservation management for the Scottish capercaillie, in partnership with Highland Birchwoods, the Royal Society for the Protection of Birds, Cairngorms National Park Authority, Forestry Commission Scotland, Scottish Natural Heritage and co-financed by the LIFE financial instrument of the European Union. Forest Research has been monitoring elements of the project, including habitat enhancement and fence marking.

Different intensities of tree thinning have been carried out on three sites, with the aim of diversifying habitats while also improving the timber crop, and the vegetation response at each site has been monitored (Figure 1). A particular aim was to increase the amount of bilberry (*Vaccinium myrtillus*), which, together with associated caterpillars and other invertebrates, is an important food for capercaillie chicks. The monitoring has

shown slower-than-expected vegetation responses to changes in light availability, and important contributions of pre-existing vegetation cover. Excessive thinning of stands can lead to the expansion of competing species such as heather (*Calluna vulgaris*) and cowberry (*Vaccinium vitis idaea*) at the expense of bilberry (Figure 2), but lack of thinning also results in losses of bilberry.

Many unwanted deer fences have been removed in core capercaillie areas, but in some places fences are still required. Forest Research has developed various designs, tested their durability and monitored their efficacy in reducing collisions with woodland grouse. New designs have proved robust, and dramatic differences have been observed in the collision rate – for example, on a 14 km fence after marking there was a nine-fold reduction in strike rate of capercaillie and red grouse (*Lagopus lagopus*), and a six-fold reduction for black grouse (*Tetrao tetrix*).

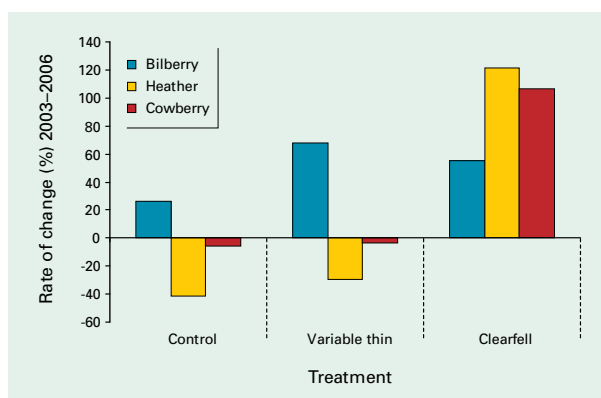
Figure 1

Variable-intensity thinning at Inschriach Forest



Figure 2

Vegetation responses to variable thinning, clearfell and no thinning control at Inschriach Forest



Environmental and Human Sciences



Our research into the environmental and human sciences draws on many elements of sustainable development, looking into environmental, social and economic links to forestry. While based on solid scientific foundations, research in this area is readily of use in practice and provides valuable advice for policy-makers and practitioners. Here, we outline six of our current projects, illustrating some important areas of research and showing the impacts that this work is achieving.

Measuring the benefits of forests to people

In April 2006, we began a two-year project on behalf of Forestry Commission Scotland, called Forestry for People. The project investigates how communities are affected by forestry and seeks to quantify benefits on a range of themes, establishing a monetary value for each, where possible. This is backed up by qualitative research in case-study areas. The themes considered are: livelihoods, education, health, recreation, amenity, culture and community capacity.

An interim report in February 2007 showed that the value of forest-related activities is much higher than expected. For example, 87% of people surveyed believe that woodlands are places to reduce stress and anxiety, 82% agree that Scotland's woodlands are good places in which to exercise and get fit, while 95% feel that woodlands play an important role in the outdoor learning experience of children and young people.

If we attribute economic values to physical and mental health, estimates show that the physical and mental health benefits of woodland recreation are worth up to £18m per year to Scotland's population. Similarly, visits to forests are worth around £40m per year, and having views of woodlands from homes and during daily activity is worth up to £39m per year. In addition, recreation and tourism in Scottish woods were found to support over 20,000 full-time-equivalent jobs.

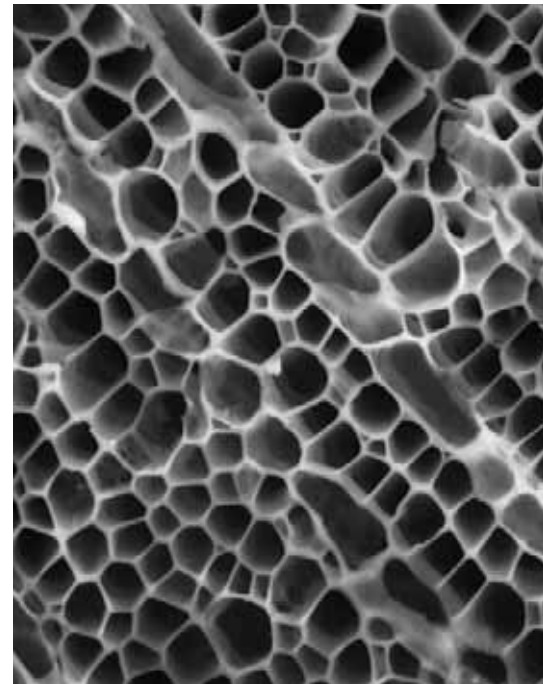
Work continues on this project, to survey community woodland activities and further explore the relationship

between different benefits of woodlands and their perceived values. More information is available at www.forestresearch.gov.uk/forestryforpeople

Using charcoal to treat contaminated land

The UK has an estimated 300,000 hectares of land contaminated with organic chemicals and heavy metals, mainly from previous industrial activities. As a result, this land is unsafe for direct redevelopment without first being treated or remediated. Unfortunately, conventional treatments for contaminated soil are becoming prohibitively expensive and labour-intensive, and often involve taking the soil away from the site to be either treated and returned or deposited elsewhere as landfill. As a further complication, different contaminants may require different treatment types.

Forest Research and the University of Surrey have recently patented a much cheaper and potentially more effective approach to soil remediation, using specially prepared and treated charcoals. Preliminary results show that the charcoals promote development of beneficial microbes that can degrade many organic contaminants through a process called bioremediation. Laboratory trials have shown that contaminants such as diesel are degraded up to 20 times faster when treated with the special charcoal materials. Contaminants that are not degraded are held strongly by the charcoal, making them environmentally benign; the charcoals have a strong ability to adsorb up to 20% of their own weight in metal contaminant.



In combination, these properties of bioremediation and chemical retention can help in the redevelopment of difficult sites. The charcoal is easy to apply and is simply incorporated into the contaminated soil. Forest Research and the University of Surrey have now also joined forces with Sheffield University and Aspire Defence Ltd to carry out field trials under a grant received from the Department of Trade and Industry's Programme for Contaminated Land Remediation Technologies. Further information on our research into contaminated land is available at www.forestresearch.gov.uk/landreclamation

Predicting soil erosion and pollution due to climate change

Future climate change will affect soil as well as vegetation. Recent research has examined how predicted changes in rainfall may increase the erosion of unprotected soils. In areas where soil is contaminated, this will increase the risk of water pollution.

Our researchers carried out case studies on two sites with a known high risk of water contamination through soil erosion and the subsequent transfer of heavy metals into surface waters. Predictive computer models were run for each site, using different climate-change scenarios.

The results showed a significant and gradual increase in rates of soil erosion with time as a consequence of climate change. However, modelling also showed that re-vegetation, including the establishment of woodland, could mitigate pollutant movement and reduce to well below existing levels the amount of metals transferred to the aquatic environment. Further research is investigating how land management practices could be developed to reduce the impact of climate change to an acceptable degree.

Promoting health through physical activity in forests

In support of the Department of Health campaign to encourage physical activity for all, one of our social research projects is investigating how active people are in the woodland environment, and what prevents increased activity. This research is supporting Active England, a programme run by Sport England, the government agency responsible for advising on, investing in and promoting community sport to create an active nation. The project is currently focusing on visitors to five different forest sites: Haldon (Devon), Bedgebury (Kent), Rosliston (Derbyshire), Greenwood (Nottinghamshire) and Great Western Community Forest (Wiltshire).



At each site, work is underway to monitor and evaluate the habits of users. New events – such as health walks, tai chi sessions and outreach work – have been introduced at some sites to help attract new visitors and encourage them to adopt healthier lifestyles. Researchers are carrying out yearly questionnaires with visitors, and are working to clarify the profile of the population within a 20-minute drive of each site. This will be followed by qualitative research in the surrounding communities amongst both users and non-users of the forest.

The project will particularly investigate key under-represented groups within the community, such as people on low incomes and young people under 16 years old, in order to identify what stops them from being more active, and to propose possible solutions. While still in its early stages, when completed, the Active England research will help forest managers to improve their understanding of the nature and needs of forest visitors. In turn, this will enable them to plan activities to increase the potential for forests to help deliver healthy lifestyles to those living in the area. For more information, visit www.forestresearch.gov.uk/activeengland



Mapping unrecorded woodland heritage with LiDAR

Peter Crow

Light detection and ranging (LiDAR) is a technique using laser pulses that can reveal landscape and archaeological features hidden beneath woodland canopies. In spring 2006, large-scale surveys were carried out in the Forests of Dean (Gloucestershire) and Savernake (Wiltshire), with exciting results. The survey in the Dean was the largest single heritage survey of a wooded landscape ever undertaken in the UK. Both surveys were commissioned to contribute to the discovery, mapping and management of historic environment features.

Continued research into the processing and visualisation of the survey data has enabled the production of modelled terrain images which, combined with targeted field survey and vegetation mapping, has increased confidence in their interpretation. These images have already resulted in the identification of hundreds of potentially new features of interest.

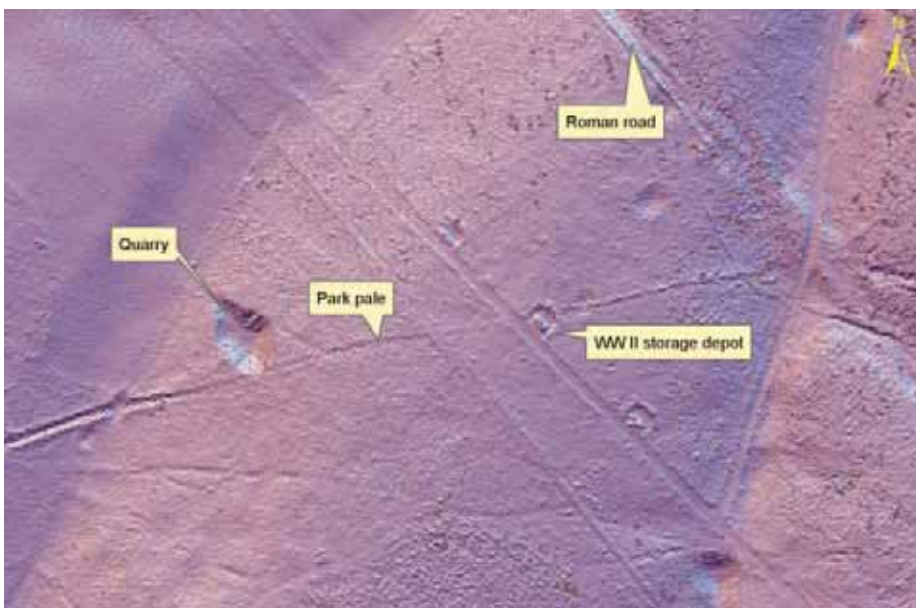
- The Forest of Dean has a landscape affected by mining and quarrying. Visible features include areas of mineral extraction (from small pits to extensive quarries), railways and trackways, spoil heaps and scowles (labyrinths of naturally occurring hollows in the ground that are special to the area). Extensive areas of charcoal production are also shown.
- The landscape at Savernake (Figure 1) is more varied, with quarries and pits for mineral extraction, but also Roman roads, a park pale (medieval boundary bank) and the remains of storage depots from the Second World War.

LiDAR will not work on every type of woodland, and not all the features identified in the data will be a significant part of the historic environment. However, results can be used to target areas for further investigation, and provide both professional archaeologists and local volunteers with maps for future fieldwork. The LiDAR models are being used to help forest planners and managers to refine and enhance plans for forest design, and to identify sensitive areas before the start of forest operations. LiDAR is continuing to generate considerable excitement in both the forest and heritage communities, and further surveys are being considered.

For more information on this application of LiDAR, please see: www.forestresearch.gov.uk/lidar

Figure 1

A LiDAR terrain model of the forest floor, Savernake



Dendrochronology and climate change research

Tanja Sanders, Mark Broadmeadow and Rona Pitman

There is an urgent need for guidance on how forests adapt to climate change, particularly with reference to choosing species for woodland creation and re-stocking. Applying knowledge gained from regions that have a climate similar to that predicted for a given site in the future will be increasingly valuable. Analysing the annual growth rings in tree trunks using dendrochronology is one method of assessing the impacts of extreme climatic events of the past.

Extreme events, particularly summer droughts, are likely to prove the principal limitation to tree growth and survival. Waterlogging of the soil in winter, leading to the death of fine roots, and late spring frosts, may also play a part. The effects of changing management practice, atmospheric nitrogen deposition and rising levels of atmospheric carbon dioxide also need to be considered.

To study the effects of climate on past tree growth, a pilot study has been conducted over the past two years at Alice Holt Forest in Surrey. Samples were taken from 20 oak trees (*Quercus robur*, Figure 1) planted in 1820. Preparation followed standard dendrochronological methods, and tree-ring width was measured to a precision of 0.01 mm. Data from individual trees were combined using standard techniques.

The chronology (Figure 2) shows clear annual variation in growth, for the period examined of 1822 to 2005.

Years of poor growth are evident and correspond with the recent drought events of 1976, 1983/84, 1989/90 and 2003. A downward trend in growth rate is apparent from 1998 and is the longest period of decline without recovery. Statistical analysis of the chronology indicates that mild spring temperatures and above-average rainfall in early summer result in increased growth, while below-average rainfall in July and August leads to reduced growth.

However, the strongest signal in the chronology is the dramatic increase in growth rate between the mid-1970s and 1998. The most likely factor to explain this is the rising atmospheric concentration of carbon dioxide. The decline in growth rate since 1998 is more difficult to interpret, and ongoing measurements will determine whether this is a short-term perturbation or a longer-term growth trend.

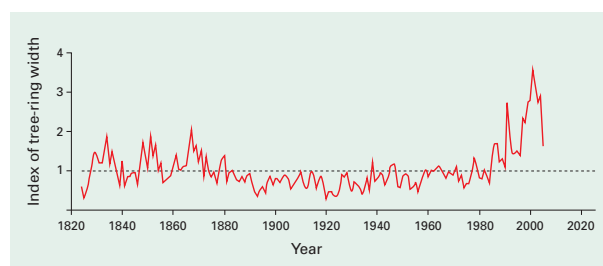
Figure 1

Increment cores of oak. The larger vessels indicate the start of the growing season for each year



Figure 2

Annual variation in tree-ring width of oak, 1820–2005



Forest Management



Our forest management researchers investigate a range of subjects relevant to the practical and sustainable management of forests and woodlands. Their work includes research into silvicultural systems (such as continuous cover forestry or low-impact silviculture), timber quality, conifer breeding and tree-seed biology. They also carry out technical development work to evaluate and develop forestry methods and machinery for use throughout the industry. Some of our more recent projects are briefly outlined [here](#) to illustrate the scope of our research.

Assessing timber miles

As part of its Scottish Climate Change Programme, the Scottish Executive has set targets for the forestry industry on carbon saving. One of the indicators used to measure this is 'timber miles' – the distance travelled relative to the tonnage of timber moved. This is similar to the concept of 'food miles' recently proposed by the Department for Environment, Food and Rural Affairs (Defra). Information on timber miles could be used to inform ongoing Scottish transport initiatives that aim to improve the sustainability of timber transport, making transportation more efficient and reducing the negative impacts of road haulage on communities.

In 2005/06, an initial scoping study found that the best source of information from which to calculate timber miles was the hauliers themselves. A subsequent study during 2006 identified the hauliers of Scottish timber and collected their mileage/tonnage information to make a first estimate of the current number of timber miles. Preliminary results suggest a very approximate annual total of 281 million timber miles for Scottish roundwood, with an average journey per lorry load of 51 miles. However, this is an initial estimate and further survey work is needed before we can establish accurate figures.

Surveying the structure and condition of native pinewoods

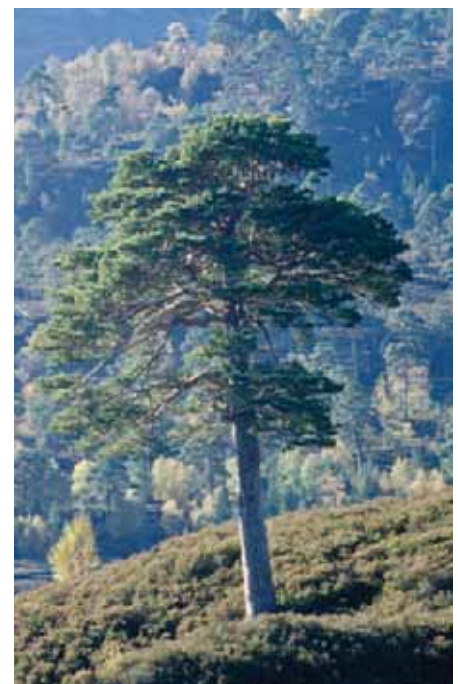
The European Union's directives on habitats and on birds together form a nature-conservation policy that aims to establish a network of protected areas where habitats and species are maintained or restored to favourable conservation condition. This network of

special areas of conservation is called Natura 2000. Forest Research was asked to develop a monitoring system to assess the woodland condition in native Scots pinewoods based on the use of stand structure as a surrogate measure of favourable condition. We developed a method that combines measurements of tree parameters (e.g. tree diameter at breast height (DBH) and age, density of trees, saplings and seedlings, percentage damaged, amount of standing deadwood) with site variables (e.g. protection, elevation, canopy cover), based on systematically located 0.05 ha plots. The results are compared to the known structural characteristics of forest developmental phases to establish which phases are present or absent. This indicates the potential future development of the forest without intervention. Those phases that are missing or under-represented (e.g. large mature trees) may require targeted management to ensure continuity of key habitats.

A modified version of this system is being used in a survey of the native pinewoods in Glen Affric. Plots are chosen in different developmental phases, as identified from interpretation of aerial photographs, and the same tree-based parameters are being measured. This will enable an interpretation of current structure and condition on the landscape scale.

Researching tree breeding and genetics

Our research into tree genetics aims to increase the quality of commercially grown trees and to ensure that forests are populated with stock of the most appropriate genetic origin for the specific regional and local geographic variations and predicted climate.



Over the past 40 years, genetic improvement of Sitka spruce has been progressing steadily, from the selection of plus trees (parent trees selected for their superior growth and form) and progeny testing, through the establishment of seed orchards, to the annual production of cuttings from family mixtures.

We have now developed a new addition to the suite of improved Sitka spruce planting stock, known as 'full-sibling families'. These are families with only one mother and one father, compared to previously available improved genotypes based on crosses between several parents. The full-sibling trees grow more vigorously, are straighter and have less variation from tree to tree than standard Sitka spruce. The new full-sibling stock will have significant financial benefits for forest managers by improving timber quality and wood volume, as well as stand uniformity. There is already considerable demand for the new full-sibling seed; commercial nurseries are producing rooted cuttings and the new stock has been available to forest managers all over the country since spring 2007. Further information on our tree-breeding research is available at www.forestresearch.gov.uk/treeimprovement

Supporting our national arboreta

Westonbirt Arboretum and Bedgebury Pinetum are among the finest tree collections in Britain. Each site is an important visitor attraction and a valuable resource for education, containing many species of woody plants that are rare or endangered in the wild. Forest Research provides scientific and technical support to the arboreta, most recently including

specialist propagation of rare species, support on plant-health issues, database support and audits of the management of the tree collection. Our scientists are also working with the Forestry Commission to coordinate the development of other important tree collections, such as at Kilmun and Brechfa. These activities directly support targets set out in the Global Strategy for Plant Conservation adopted by governments and other parties at The Hague in 2002.

One of our main projects, in collaboration with Bedgebury and the International Conifer Conservation Programme at the Royal Botanic Garden Edinburgh, is concerned with the *ex situ* conservation of populations of some of the world's most threatened conifers. The World Conservation Union (IUCN) lists nearly half of the world's 800 conifer species and sub-species as being of conservation concern. This project aims to establish a series of sponsored conservation plots at Bedgebury for breeding populations of selected threatened species. Some plots already exist at Kilmun. Other work includes developing a phenology-monitoring programme using species within the collections from different bioclimatic regions of the temperate zone.

Managing long-term field experiments

Over several decades, Forest Research has established an extensive network of field experiments of varying duration. In 2004 we began reviewing these ongoing experiments to cleanse and rationalise our experiment database and also to make the information more readily available both within



Forest Research and for the wider scientific community. As a result, we have identified a core of some 600 experiments for long-term retention, the oldest of which dates back to 1922. These are valuable not only for their original purposes but also as a unique and well-documented resource for future field-based research.

To achieve wider dissemination of our experimental information, it was decided that a web-based database would provide the best access. Such a system was already in use in Scandinavia for forest experiment data – the Nordic and Baltic database for long-term forest experiments, known as NOLTFOX. This online database covered many topics in common with ours, had a similar layout to that of our system, and concurred with our aim of using an open-access database to enable wider dissemination of experimental information. Therefore, we joined NOLTFOX in 2006 and our adapted Forest Research database was uploaded onto its site in December 2006. For more details, visit <http://noltfox.metla.fi>

Evaluating remote data capture

Remote data capture from tree-harvesting machinery provides a powerful tool for operators and managers. Many leading suppliers of harvesters and forwarders already use computers to aid machine-control functions, improve fault diagnosis and servicing, and assist in cutting the most profitable range of products from a tree (optimisation). Harvester computer systems have a number of benefits for operators, including increased cutting accuracy, ability to collect data about the stem profiles of the trees being harvested, facility to

transfer data via e-mail and GIS, and their useful location-tracking of machinery and products using GPS.

Our researchers are investigating the full potential of such remote systems. In one study, we evaluated a computerised optimiser and found that it gave a higher-value mix of products, so improving financial return. In a separate evaluation, we tested a number of methods for transferring harvester production data, such as by e-mail, disks and computer prints, telephone or handwritten sheets. E-mail was found to be the quickest way to transfer production data between machines or directly to sawmills and offices.

Using digital maps and transferring data electronically between machines can be of great benefit to operators and managers when planning and working on site. These tools help to clearly identify working areas and constraints and, with use of a 'distance calculation' package, enable the most efficient extraction routes to be identified. Our work is continuing to assess the benefits and limitations of remote data management.



Sustainable management of the European forestry–wood chain

Bill Mason, David Edwards, Barry Gardiner, Andy Hall, Jonathan Humphrey, Ian Murgatroyd, Bruce Nicoll and Mike Smith

‘EFORWOOD’ is a four-year project funded by the European Union, to develop a quantitative decision support tool for sustainability impact assessment of the European forestry–wood chain (FWC). Known as ToSIA, this tool should be applicable at both pan-European and country/regional levels, to provide information on many aspects of the FWC from forest management through primary and

secondary processing. The project is co-ordinated by Skogforsk in Sweden and involves researchers from 38 organisations including Forest Research.

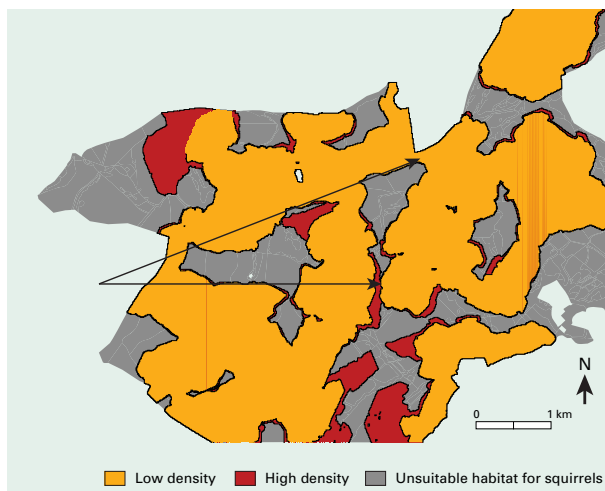
red squirrels and is used extensively by local communities for recreation. This enables study of the interaction between different intensities and types of management and the consequences for timber flows, biodiversity and social values.

All key information about this forest is digitised, making it possible to explore different scenarios over time using geographical information systems (GISs). The approach is based on an analysis of landscape, ecology and habitat networks, using estimates of functional connectivity. The concept of focal species has been adapted to identify services that represent the economic, environmental and social elements of the forest–wood chain (such as timber value, red squirrel numbers, visitor numbers). Early results suggest that the spatial pattern of harvesting could have a detrimental effect on red squirrel populations by creating areas no longer accessible for squirrels (Figure 1). Other early outputs from this work can be found on the project website:

www.forestresearch.gov.uk/eforwood

Figure 1

Red squirrels in west Craik, in relation to forest structure



The lines highlight points where felling could isolate squirrel populations.

secondary processing. The project is co-ordinated by Skogforsk in Sweden and involves researchers from 38 organisations including Forest Research.

Forest Research is working on the evaluation of different scenarios for forest-resource management, the implications for environmental and

social indicators, and on the interactions between forest and processing industries. The main British case study area is Craik Forest in Forestry Commission Scotland’s Scottish Borders Forest District, some 16 km west of Hawick. Craik was selected because over 50 per cent of the forest is Sitka spruce, so it typifies the conifer plantation forests established during the past 50 years which will be supplying increasing amounts of timber to the domestic market over the next 20 years. Craik also has an important population of

Creating new broadleaved woodlands by direct seeding

Ian Willoughby, Richard Jinks, Peter Gosling, Ralph Harmer and Matt Parratt

While there are references to direct seeding in Britain dating back to the 15th century, planting is usually regarded as a more reliable method of woodland regeneration. However, there has been renewed interest in using direct seeding as a cheaper method for establishing new broadleaved woodlands, particularly for mixtures of species (Figure 1), and there has been significant progress in overcoming some of the problems associated with the technique.

Under natural conditions, for example, the seeds of many temperate trees and shrubs are dormant when dispersed or collected. They may remain so for up to two years, leaving the sown seed highly vulnerable to damage and death before it can germinate naturally. Recent work at Forest Research has shown that sowing seed that has been artificially treated to break dormancy dramatically increases rates of seedling emergence and survival.

Because seedling emergence is controlled by soil moisture and temperature, choice of sowing date is the second important factor. In particular, seedling emergence of many species is sensitive to high soil temperatures, and sowing in autumn or winter usually gives better results than sowing in spring. Control of competing vegetation is essential, particularly in the first year after sowing, but can be very difficult to achieve among very small, irregularly

Figure 1

Direct-seeded, native woodland mixture after four growing seasons (2 m pole in foreground), showing variation in structure and naturally occurring open space



spaced tree seedlings. However, Forest Research has identified a series of techniques and herbicides that can be used safely to control weeds without damaging tree seedlings.

Detailed recommendations based on these and other factors, such as sowing rates, site preparation, seed handling, sowing depth, species choice and protection, are contained in a Forestry Commission Practice Guide (Figure 2). Using this guidance, direct seeding can now create new native woodlands in the lowlands that, compared to planting, can cost less, more rapidly create a woodland environment, produce better-quality, high-value hardwood timber, appear more natural, require the use of fewer herbicides, and use on-farm skills and machinery. Current research is also looking at how to use direct seeding for low-cost, high-quality restoration of native species on conifer plantation sites, as discussed in Forestry Commission Information Note 84: *Potential for Direct Seeding of Birch on Restock Sites*.

Figure 2

Direct seeding Practice Guide



Tree Health



Anoplophora Glabripennis

Our research on tree health focuses on assessing and maintaining the health of trees both nationally and internationally. We monitor established pests and diseases, design and investigate possible new methods of control, and work to assess and mitigate potential threats posed by new and exotic insects and pathogens. We also offer a diagnostic and advisory service to anyone requiring assistance or information. A number of our recent projects and developments are described here to demonstrate our work.

Investigating alien invasive species and international trade

While existing pests and pathogens in Britain remain a key component of our work, there is increasing emphasis on wider biosecurity issues, particularly in relation to the threats posed by non-native invasive species. Our researchers support the Forestry Commission's Plant Health service, using scientific study and tailored monitoring to provide guidance on protecting plants, and advice on managing the routes for potential import of pests. For example, we have been investigating the potential of residual bark on imported goods for harbouring bark- or wood-boring insects, even after standard phytosanitary treatments. This work supports the new International Standards on Phytosanitary Measures (ISPM15), which sets guidelines to address risks from wood packaging.

So far, the results of our UK studies show that the ISPM15 standard heat treatment does not prevent colonisation of bark, leaving insects able to invade the wood before export from the country of origin. In addition, one interesting finding has been that the mix of beetle species attacking treated wood has changed – this was also noted during similar studies in the US. Further work is ongoing to assess the actual threat posed by residual bark; the results are being considered by the International Forestry Quarantine Research Group.

International trade in live plants is another possible route for pests to travel between countries. This pathway is increasingly acknowledged as posing the greatest threat, particularly for pathogens that are

hard to detect or have not yet been recognised as threats. In 2006, the International Union of Forest Research Organisations (IUFRO) set up a working group on Invasive Alien Species and International Trade to address this issue. Our researchers are contributing to this group, and considerably more work is needed to address requirements for ensuring that imported plants are free from both known and as yet unrecognised pests. For more information on this topic, visit www.forestresearch.gov.uk/iufroinvasives

Managing pine weevils

We have made good progress nationally in developing an integrated system for the long-term management of pine weevil (*Hylobius abietis*), which causes extensive damage to the young trees used to re-stock clearfell sites. However, since this damage is often highly variable, routine use of insecticides is often either unnecessary or not fully effective.

Management support systems

Our approach is based around a *Hylobius* management support system (MSS) that helps forest managers assess if, when and to what extent insecticides are necessary for a particular site. Two different versions of the system are available: one for lowland re-stocking sites, and one for upland sites.

The lowland MSS has been developed in collaboration with East Anglia Forest District and uses a simple stump-monitoring system along with detailed knowledge of the time of felling. As a result, the use of chemical insecticides to protect young plants during re-stocking has reduced dramatically. In upland restocking

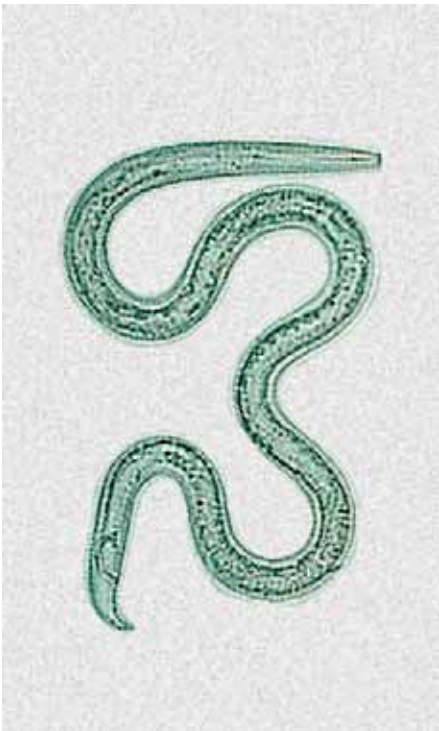


Hylobius abietis

sites, the extended lifecycle of the pine weevil requires a more sophisticated approach in order to monitor and predict its populations. Therefore, we have developed an online Hylobius MSS, available through the Forest Research website, which has a simple interactive interface where users can enter information such as site details, time of felling and preferred re-stocking option. The system requires on-site fieldwork to monitor levels of adult weevil presence, using counts of beetles on pine or spruce. It then predicts the level of plant losses for that site. This system is currently undergoing user trials.

Population control using nematodes

Although chemical insecticides are used in current protection strategies, they have no impact on weevil population size. To address this, we have recently launched Forest Biocontrol to provide biological control of *Hylobius abietis*. This offers forest managers the opportunity to reduce weevil populations overall within forest blocks and, over time, can reduce the need for insecticide treatment of re-stock sites. Over the past year, both the Forestry Commission and private-sector customers have used this nematode-application service, with a total of 120 hectares now having been treated successfully. The programme for 2007 is being finalised and we estimate that close to 600 hectares will be treated across Britain and Ireland. Further details are available from www.forestresearch.gov.uk/nematodes



Assessing the impact of forest management techniques on pests and diseases

Changes in the way plantation forests are managed are raising new questions and problems in relation to pests and diseases. The development of alternative approaches, particularly continuous cover forestry (CCF) and low-input silvicultural systems (LISS), looks likely to affect the impacts of traditional pest species, such as the pine weevil (*Hylobius abietis*) and green spruce aphid (*Elatobium abietinum*), due to changes in habitat structure and populations of predators and parasites. Forest stands using CCF and LISS are more structurally complex than even-aged forests and have an associated increase in biodiversity. This is considered likely to enhance the populations of insects' natural enemies, resulting in fewer pest problems. However, this hypothesis requires rigorous testing.

A new research programme was established during 2006/07 to compare insect diversity and abundance across forest stands of different types. The 24 study plots, in Mid- and North Wales, range from highly structured, mixed-age stands, typical of CCF systems, to traditional even-aged stands showing little variation between trees. All the plots are located in stands of Sitka spruce, to isolate the importance of structural complexity without the complication of mixing tree species. Insect populations in the plots will be sampled between April and October, using different traps and sampling techniques. An initial 14 plots will be sampled during 2007–09, with the remainder being sampled during 2008–10. The aim is to establish total

insect diversity, the abundance of potential pest species and the populations of natural enemies – and then to relate these factors to the variation in stand structure and tree age. Specific studies on aphids and weevils (*Curculionidae*) will provide more detailed information on these important insect groups. Further information is available from www.forestresearch.gov.uk/fr/infd-6xafdt

Researching the spread of red band needle blight

Since the late 1990s, the incidence of red band needle blight (*Dothistroma septosporum*) in Britain has increased very significantly. This disease was first reported in a single group of trees in East Anglia Forest District in 1999 and has now become a serious problem in the district. Annual monitoring has shown an increase in the percentage of Corsican pine (*Pinus nigra* ssp. *laricio*) crop affected from 61% in 2003 to 81% in 2006; the severity of infection has also risen sharply in the same three years.

To establish the geographical range of the disease on the Forestry Commission estate, all Corsican pine stands under 30 years old (excluding those in East Anglia) were checked for the disease in July 2006. Our results showed that of the 9,488 hectares checked, the disease was present in 70% of the stands, covering a total of 6,245 ha. If the data from East Anglia are included, the total area of infected Corsican pine under the age of 30 years is 14,665 ha. The disease was also reported on a further seven pine species during the survey, with lodgepole pine (*Pinus contorta* ssp. *latifolia*) being the most frequently infected species. Although no

lodgepole pine was found to be infected with red band needle blight in Scotland during the survey, the disease has since been confirmed in the Moray Forest District.

We set up an experiment to see whether changing current tree-thinning practices could help reduce levels of red band needle blight. Initial results have been promising – in July 2006, one year after thinning, we saw a significant decrease in the extent of crown infection among thinned trees, compared to those that were not thinned. And, further, those areas that were more heavily thinned showed an even greater reduction in crown infection levels. Further information on red band needle blight is available on the Forest research website at www.forestresearch.gov.uk/redbandneedleblight



Bleeding canker of horse chestnut: a growing threat?

Joan Webber

Figure 1

Bleeding canker on a horse chestnut



Over the past few years the incidence of a disease known as bleeding canker of horse chestnut (*Aesculus hippocastanum*) has risen markedly in the UK. Symptoms include rusty-brown or black gummy liquid seeping from the bark of affected trunks or branches (Figure 1). Sometimes, the bleeding cankers can be so extensive that infected tissue encircles branches or trunks, causing death of branches or even entire trees in just three or four years.

The first records of horse chestnut bleeding canker in the UK date from the 1960s, and the causal agents were found to be two species of *Phytophthora*, but the disorder was relatively uncommon and limited to southern England. However, between 2003 and 2006, more than 350 reports of bleeding canker on horse chestnut were notified to the Forest Research Disease Diagnostic Advisory Service, with records from England, Scotland and Wales.

Initially it was assumed that climatic changes might have encouraged more infection by *Phytophthora*. However, growing cultures from samples of infected trees usually yielded a different agent – a fluorescent form of the bacterium *Pseudomonas syringae*, which includes pathogens of important crops. In addition, some fluorescent *Pseudomonas* species have been shown to be responsible for several new and emerging diseases on plants.

Work with colleagues at the Central Science Laboratory, York, to sequence the gyrase B gene of *P. syringae* from horse chestnut and compare it with other pathovars of the bacterium, showed that a single strain of *P. syringae* was infecting horse chestnut trees throughout the UK. When the bacterium was inoculated into horse chestnut saplings, necrotic bark lesions gradually formed around the inoculation points, with some bleeding. This confirmed that *P. syringae* could cause bleeding canker of horse chestnut, and the current upsurge of the disease appears to be due to this bacterium and not species of *Phytophthora*.

The impact that *P. syringae* is now having on horse chestnut in the UK is widespread and damaging (see www.forestresearch.gov.uk/bleedingcanker for more details). A similar upsurge in bleeding canker has also been reported in the Netherlands, Belgium and France, apparently also due to the same bacterium.

Gypsy moth and oak processionary moth in the UK

Nigel Straw and Christine Tilbury

Gypsy moth (*Lymantria dispar*) and oak processionary moth (*Thaumetopoea processionea*) are native to central and southern parts of continental Europe, and are serious defoliators of oaks (*Quercus* spp.) and other broadleaved trees. Both species have hairy caterpillars (Figure 1), which, unusually for insects in the UK, can pose considerable problems for human health. Hairs from the caterpillars, particularly oak processionary, are extremely irritating to human skin and eyes. In some people, contact or inhalation of the caterpillar hairs leads to a severe asthmatic or allergic reaction.

Gypsy moth, and to a lesser extent oak processionary, have a long history of damaging woodland and urban trees in Europe. Gypsy moth is also a major defoliator of oaks and other trees in eastern North America, where it spread following accidental introduction in the late nineteenth century. Until recently, neither species occurred in the UK, but in 1995 a small population of gypsy moth was found in northeast London, and this population has persisted. A second, larger, outbreak of gypsy moth appeared in Aylesbury, Buckinghamshire in 2005. This population increased in 2006 (Figure 2), when several breeding colonies of oak processionary moth were also discovered in west London.

Forest Research has been closely involved with monitoring these moth populations using pheromone traps, and in developing management

strategies. The original outbreak of gypsy moth in London was thought to have started with moths or egg batches transported into the country on vehicles or goods from the continent. However, the more recent outbreaks appear to be associated with direct import of sapling trees from the continent. Trees of this size (2–8 metres tall) are extremely difficult to check and guarantee to be free of infestation and disease, and the arrival of gypsy and oak processionary moths in the UK highlights the potential dangers associated with this new and increasing trade in ‘plants for planting’. Higher spring and summer temperatures, most likely due to climate change, are expected to encourage further spread and an increase in population numbers.

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

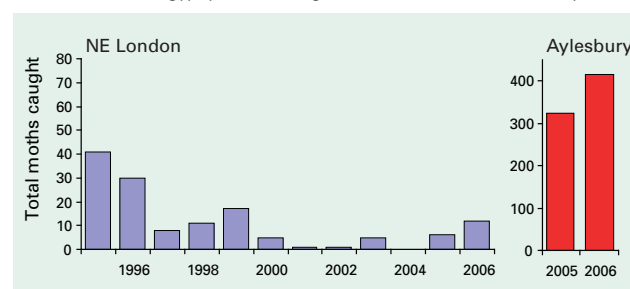
Figure 1

Oak processionary caterpillars on *Quercus robur*



Figure 2

Numbers of male gypsy moths caught in northeast London and Aylesbury



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 2007.

Published by Forest Research

Reports and plans

Forest Research annual report and accounts 2005–2006 (£20.60)

Forest Research corporate plan 2006–2009
(online publication, free)

Forest Research development strategy 2007–2012 (online publication, free)

Books, brochures and leaflets

A marvellous opportunity for children to learn: a participatory evaluation of Forest School in England and Wales by Liz O'Brien and Richard Murray* (£11)

Growing places: a study of social change in The National Forest. A Lancaster University Research Project with the National Forest Company and the Forestry Commission by Jake Morris and John Urry* (£11)

Leisure landscapes: exploring the role of forestry in tourism by Suzanne Martin (£10)

Knowledge•innovation•sustainability:
Forest Research brochure (free)

Alice Holt Research Forest
by Andy J. Moffat (free)

The quest for sustainable energy: woodfuel meets the challenge, revised and rewritten by Duncan Ireland, Jenny Claridge and Richard Pow* (free)

Oak processionary moth *Thaumetopoea processionea*. FR Tree Pest Advisory Note prepared by Tree Health Division, Forest Research (free)

Published by FC Corporate Services

The various series of technical publications listed below are published for the Forestry Commission by Corporate Forestry Services. New titles listed here are by Forest Research authors.

Books

Forest mensuration: a handbook for practitioners, 2nd edn
by Robert Matthews and Ewan Mackie (£24.00)

Wild harvests from Scottish woodland: social, cultural and economic values of contemporary non-timber forest products
by Marla Emery*, Suzanne Martin and Alison Dyke* (£12.50)

Practice Guide

17 *Managing and controlling invasive rhododendron*
by Colin Edwards (£6.50)

Technical Guide

2 *Forest fencing*
by Roger Trout and Harry Pepper (£7.50)

Information Notes (free)

80 *An update on nursery propagation and establishment best practice for larch in Britain*
Mike Perks, Alan Harrison, Helen McKay* and John Morgan*

81 *The principles of using woods for shelter*
Barry Gardiner, Harriet Palmer* and Max Hislop

82 *Choosing provenance in broadleaved trees*
Jason Hubert and Edward Cundall

83 *Managing mixed stands of conifers and broadleaves in upland forests in Britain*
Bill Mason

84 *The potential for direct seeding of birch on restock sites*
Ian Willoughby, Alan Harrison, Peter Gosling and Gary Kerr

85 *Evaluating biodiversity in fragmented landscapes: applications of landscape ecology tools*
Kevin Watts, Duncan Ray, Chris Quine, Jonathan Humphrey and Matthew Griffiths

Technical Notes

12 *Mechanised spraying systems for herbicide use in forestry*
Bill J. Jones

13 *Traction aids in forestry*
Duncan Ireland

14 *Planning and managing pesticide stores*
Bill J. Jones

15 *Selecting nozzles for hand-held applicators*
Bill J. Jones

16 *Using dye markers to reduce pesticide use*
Ian Willoughby

*Authors outwith the Agency.

External Publications

Printed publications

Achim, A., Gardiner, B., [Leban, J.-M. and Daquitaine, R.] (2006)

Predicting the branching properties of Sitka spruce grown in Great Britain. *New Zealand Journal of Forestry Science* **36** (2–3), 246–264.

Arcangeli, C., Matthews, R.W., [Knowles, L. and Kimberley, M.] (2006)

Modelling changes in stand stocking and production from thinnings under different silvicultural regimes. In: *Sustainable forestry in theory and practice: recent advances in inventory and monitoring, statistics and modeling, information and knowledge management, and policy science*, ed. K.Reynolds. USDA Forest Service, Pacific Northwest Research Station. General Technical Report PNW-GTR-688. USDA, Portland, Oregon. (CD-ROM)

Baldwin, M.E. and Matthews, R.W. (2006)

Integrating data for the construction of forest growth and yield models: an example based on even-aged stands of ash (*Fraxinus excelsior* L.). In: *Sustainable forestry in theory and practice: recent advances in inventory and monitoring, statistics and modeling, information and knowledge management, and policy science*, ed. K.Reynolds. USDA Forest Service, Pacific Northwest Research Station. General Technical Report PNW-GTR-688. USDA, Portland, Oregon. (CD-ROM)

Barsoum, N., Anderson, R., Broadmeadow, S., Bishop, H. and Nisbet, T. (2005)

Eco-hydrological guidelines for wet woodland – Phase I. English Nature Research Reports 619. English Nature, Peterborough.

Brasier, C. and [Jung, T.] (2006)

Recent developments in *Phytophthora* diseases of trees and natural ecosystems in Europe. In: *Progress in research on Phytophthora diseases of forest trees. Proceedings of the Third International IUFRO Working Party S07.02.09 meeting at Freising, Germany, 11–18 September 2004*, eds C.M.Brasier, T.Jung and W.Oßwald. Forest Research, Farnham, Surrey, 5–16.

Brasier, C., Denman, S., Webber, J. and Brown, A. (2006)

Sudden oak death: recent developments on trees in Europe. In: *Proceedings of the sudden oak death second science symposium: the state of our knowledge, Monterey, California, 18–21 January 2005*. USDA Forest Service, Pacific Southwest Research Station. General Technical Report GTR-PSW-196. USDA, Albany, California, 31–33.

Brasier, C., [Jung, T. and Oßwald, W.] (2006)

The growing *Phytophthora* threat to forests. In: *Progress in research on Phytophthora diseases of forest trees. Proceedings of the Third International IUFRO Working Party S07.02.09 meeting at Freising, Germany, 11–18 September 2004*, eds C.M.Brasier, T.Jung and W.Oßwald. Forest Research, Farnham, Surrey, 1–2.

Brasier, C.M., [Jung, T. and Oßwald, W.] eds (2006)

Progress in research on Phytophthora diseases of forest trees. Proceedings of the Third International IUFRO Working Party S07.02.09 meeting at Freising, Germany, 11–18 September 2004. Forest Research, Farnham, Surrey.

Brasier, C., Kirk, S. and Rose, J. (2006)

Adaptive differences between *Phytophthora ramorum* isolates from Europe and North America: evidence for separate subspecies? In: *Proceedings of the sudden oak death second science symposium: the state of our knowledge, Monterey, California, 18–21 January 2005*. USDA Forest Service, Pacific Southwest Research Station. General Technical Report GTR-PSW-196. USDA, Albany, California, 101–103.

Brasier, C.M., Kirk, S.A. and Rose, J. (2006)

Differences in phenotypic stability and adaptive variation between the main European and American lineages of *Phytophthora ramorum*. In: *Progress in research on Phytophthora diseases of forest trees. Proceedings of the Third International IUFRO Working Party S07.02.09 meeting at Freising, Germany, 11 to 18 September 2004*, eds C.M.Brasier, T.Jung and W.Oßwald. Forest Research, Farnham, Surrey, 166–173.

Brasier, C., Rose, J., Kirk, S., Denman, S. and Webber, J. (2006)

Comparative host range and aggressiveness of *Phytophthora ramorum* and *Phytophthora kernoviae* sp.nov. on North American and European trees. In: *Proceedings of the sudden oak death second science symposium: the state of our knowledge, Monterey, California, 18–21 January 2005*. USDA Forest Service, Pacific Southwest Research Station. General Technical Report GTR-PSW-196. USDA, Albany, California, 109–111.

[Bright, P., Morris, P. and Mitchell-Jones, T.] with Trout, R. (2006)

Habitat management. In: *The dormouse conservation handbook*, 2nd edn, by P.Bright, P.Morris and T.Mitchell-Jones. English Nature, Peterborough, 31–43.

[Britt, C., Cherrill, A., Le Duc, M., Marrs, R., Pywell, R., Sparks, T.] and Willoughby, I., eds (2007)

Vegetation management. [Conference at Studley Castle, Warwickshire, 25 and 26 January 2007]. Aspects of Applied Biology 82 2007. Association of Applied Biologists, c/o Horticulture Research International, Wellesbourne, Warwicks.

[Brixey, J.M.], Moore, R. and Milner, A.D. (2006)

Effect of entomopathogenic nematode (*Steinernema carpocapsae* Weiser) application technique on the efficacy and distribution of infection of the large pine weevil (*Hylobius abietis* L.) in stumps of Sitka spruce (*Picea sitchensis* Carr.) created at different times. *Forest Ecology and Management* **226** (1–3), 161–172.

Broadmeadow, M.S.J. (2007)

Forestry. In: *Preparing for a changing climate in Northern Ireland*, eds B.Arkell, G.Darch and P. McEntee. SNIFFER (Scotland and Northern Ireland Forum for Environmental Research). SNIFFER UKCC13. Atkins Limited, Belfast, 67–80.

Broome, A.C. (2007)

Management of butterfly habitat in north west Scotland: the effects of five years of cattle grazing. In: *Vegetation management. [Conference at] Studley Castle, Warwickshire, 25 and 26 January 2007*, eds C.Britt, A.Cherrill, M.Le Duc, R.Marrs, R.Pywell, T.Sparks and I.Willoughby. Aspects of Applied Biology 82 2007. Association of Applied Biologists, c/o Horticulture Research International, Wellesbourne, Warwicks, 199–212.

Broome, A. and Poulson, E. (2006)

Validation of Forest Condition Monitoring Programme (ICP-Forests, level I) cone index scores by measuring cone density using a field-of-view method. *Forestry* **79** (2), 159–166.

Broome, A., Hendry, S. and Peace, A. (2007)

Annual and spatial variation in coning shown by Forest Condition Monitoring programme data for Norway spruce, Sitka spruce and Scots pine in Britain. *Forestry* **80** (1), 17–28.

Brown, A., Brasier, C., Denman, S., Rose, J., Kirk, S. and Webber, J. (2006)

Distribution and etiology of aerial stem infections of *Phytophthora ramorum* and *Phytophthora kernoviae* at three woodland sites in the UK. In: *Proceedings of the sudden oak death second science symposium: the state of our knowledge, Monterey, California, 18–21 January 2005*. USDA Forest Service, Pacific Southwest Research Station. General Technical Report GTR-PSW-196. USDA, Albany, California, 105–108.

Brown, A.V. and Brasier, C.M. (2007)

Colonization of tree xylem by *Phytophthora ramorum*, *P. kernoviae* and other *Phytophthora* species. *Plant Pathology* **56** (2), 227–241.

Brown, A.V., Brasier, C.M., Denman, S., Rose, J., Kirk, S.A. and Webber, J.F. (2006)

Tree hosts of aerial *Phytophthora* infections with particular reference to *P.ramorum* and *P.kernoviae* at two UK survey sites. In: *Progress in research on Phytophthora diseases of forest trees. Proceedings of the Third International IUFRO Working Party S07.02.09 meeting at Freising, Germany, 11–18 September 2004*, eds C.M.Brasier, T.Jung and W.Oßwald. Forest Research, Farnham, Surrey, 122–125.

Brown, A.V., Brasier, C.M. and Webber, J.F. (2006)

Aetiology and distribution of *Phytophthora kernoviae* and *P.ramorum* stem lesions on European beech in southwest England. In: *Progress in research on Phytophthora diseases of forest trees. Proceedings of the Third International IUFRO Working Party S07.02.09 meeting at Freising, Germany, 11–18 September 2004*, eds C.M.Brasier, T.Jung and W.Oßwald. Forest Research, Farnham, Surrey, 139–141.

Brüchert, F. and Gardiner, B. (2006)

The effect of wind exposure on the tree aerial architecture and biomechanics of Sitka spruce (*Picea sitchensis*, Pinaceae). *American Journal of Botany* **93** (10), 1512–1521.

[Clay, D.V., Dixon, F.L.] and Willoughby, I. (2006)

Efficacy of graminicides on grass weed species of forestry. *Crop Protection* **25** (9), 1039–1050.

[Clay, D.V., Dixon, F.L.] and Willoughby, I. (2006)

The potential of safeners and protectants to increase tolerance of tree seeds to pre-emergence herbicides. *Quarterly Journal of Forestry* **100** (2), 107–114.

[Clay, D.V., Dixon, F.L.] and Willoughby, I. (2006)

Weed control in mist-propagated Sitka spruce (*Picea sitchensis* (Bong.) Carr.) cuttings. *Quarterly Journal of Forestry* **100** (3), 193–200.

Connolly, T., Cottrell, J.E., [Vaughan, S.P. and Russell, K.] (2006)

Determining paternity and gene flow from cherry microsatellite data. In: *Sustainable forestry in theory and practice: recent advances in inventory and monitoring, statistics and modeling, information and knowledge management, and policy science*, ed. K.Reynolds. USDA Forest Service, Pacific Northwest Research Station. General Technical Report PNW-GTR-688. USDA, Portland, Oregon.

Coudun, C. and [Gégout, J.-C.] (2006)

The derivation of species response curves with Gaussian logistic regression is sensitive to sampling intensity and curve characteristics. *Ecological Modelling* **199** (3), 164–175.

Coudun, C., [Gégout, J.-C., Piedallu, C. and Rameau, J.-C.] (2006)

Soil nutritional factors improve models of plant species distribution: an illustration with *Acer campestre* (L.) in France. *Journal of Biogeography* **33** (10), 1750–1763.

[De loanni, M.] and Gardiner, B. (2006)

Modelling the mechanics of oak trees growing on slopes. In: *Proceedings of the fifth plant biomechanics conference, Stockholm, Sweden, 28 August–1 September 2006*, ed. L.Salmén. STFI-Packforsk, Stockholm, 293–298.

Denman, S., Brasier, C.M., Brown, A.V., Kirk, S.A., Orton, E. and Webber, J.F. (2006)

Preliminary results of foliage susceptibility to *Phytophthora kernoviae* sp.nov.: a new pathogen of forest trees in the UK (Poster presentation). In: *Progress in research on Phytophthora diseases of forest trees. Proceedings of the Third International IUFRO Working Party S07.02.09 meeting at Freising, Germany, 11–18 September 2004*, eds C.M.Brasier, T.Jung and W.Oßwald. Forest Research, Farnham, Surrey.

Denman, S., Kirk, S., Whybrow, A., Orton, E. and Webber, J.F. (2006)

Phytophthora kernoviae and *P.ramorum*: host susceptibility and sporulation potential on foliage of susceptible trees. *OEPP Bulletin/EPPO Bulletin* **36** (2), 373–376.

Denman, S., [Moralejo, E.,] Kirk, S.A., Orton, E. and Webber, J. (2006)

Sporulation of *Phytophthora ramorum* and *P. kernoviae* on asymptomatic foliage. Abstract of paper presented at the APS CPS MSA Joint Meeting, Quebec City, Quebec, Canada, 29 July–2 August 2006. *Phytopathology* **96**, June 2006, S28.

Denman, S., Orton, E., Kirk, S.A. and Brasier, C.M. (2006)

Sporulation potential of *Phytophthora ramorum* on detached leaves of some susceptible UK trees *in vitro*. In: *Progress in research on Phytophthora diseases of forest trees. Proceedings of the Third International IUFRO Working Party S07.02.09 meeting at Freising, Germany, 11–18 September 2004*, eds C.M. Brasier, T.Jung and W. Oßwald. Forest Research, Farnham, Surrey, 75–78.

[Dick, M.A., Dobbie, K., Cooke, D.E.L.] and Brasier, C.M. (2006)

Phytophthora captiosa sp. nov. and *P.fallax* sp. nov. causing crown dieback of Eucalyptus in New Zealand. *Mycological Research* **110** (4), 393–404.

[Dixon, F.L., Clay, D.V.] and Willoughby, I. (2006)

Evaluation of the selectivity of herbicides as potential replacements for atrazine in forestry. *Scottish Forestry* **60** (3), 6–14.

[Doherty, M., Sanganee, K., Kozlakidis, Z., Coutts, R.H.A.,] Brasier, C.M. and [Buck, K.W.] (2007)

Molecular characterization of a totivirus and a partivirus from the genus *Ophiostoma*. *Journal of Phytopathology* **155** (3), 188–192.

Doick, K.J., [Burauel, P., Jones, K.C. and Semple, K.T.] (2005)

Effect of cyclodextrin and transformer oil amendments on the chemical extractability of aged [¹⁴C] polychlorinated biphenyl and [¹⁴C] polycyclic aromatic hydrocarbon residues in soil. *Environmental Toxicology and Chemistry* **24** (9), 2138–2144.

Doick, K.J., [Burauel, P., Jones, K.C. and Semple, K.T.] (2005)

Distribution of aged ¹⁴C-PCB and ¹⁴C-PAH residues in particle-size and humic fractions of an agricultural soil. *Environmental Science & Technology* **39** (17), 6575–6583.

Doick, K.J., [Clasper, P.J., Urmann, K. and Semple, K.T.] (2006)

Further validation of the HPCD-technique for the evaluation of PAH microbial availability in soil. *Environmental Pollution* **144** (1), 345–354.

Doick, K.J., [Dew, N.M. and Semple, K.T.] (2005)

Linking catabolism to cyclodextrin extractability: determination of the microbial availability of PAHs in soil. *Environmental Science & Technology* **39** (22), 8858–8864.

Doick, K.J., [Klingelmann, E., Burauel, P., Jones, K.C. and Semple, K.T.] (2005)

Long-term fate of polychlorinated biphenyls and polycyclic aromatic hydrocarbons in an agricultural soil. *Environmental Science & Technology* **39** (10), 3663–3670.

Doick, K.J., Sellers, G., Hutchings, T.R. and Moffat, A.J. (2006)

Brownfield sites turned green: realising sustainability in urban revival. In: *Brownfield sites III: prevention, assessment, rehabilitation and development of brownfield sites*, eds C.A. Brebbia and Ü. Mander. WIT Press, Southampton, UK and Boston, Massachusetts, USA, 131–140.

Edwards, C. and Mason, W.L. (2006)

Stand structure and dynamics of four native Scots pine (*Pinus sylvestris* L.) woodlands in northern Scotland. In: *Ecology and management of native pinewoods*, eds J.W. Humphrey, R. Tipping and H.O. Bishop. Special issue *Forestry* **79** (3), 261–277.

Edwards, C. and Rhodes, A. (2006)

The influence of ground disturbance on natural regeneration in a native pinewood: results after 60 years. *Scottish Forestry* **60** (2), 4–11.

Edwards, D. (2006)

Policy focus on bioenergy. European Forest Institute. *EFI News* **14** (1), 3–5.

Eycott, A.E., [Watkinson, A.R. and Dolman, P.M.] (2006)

The soil seedbank of a lowland conifer forest: the impacts of clear-fell management and implications for heathland restoration. *Forest Ecology and Management* **237** (1–3), 280–289.

Eycott, A.E., [Watkinson, A.R. and Dolman, P.M.] (2006)

Ecological patterns of plant diversity in a plantation forest managed by clearfelling. *Journal of Applied Ecology* **43** (6), 1160–1171.

[Forrester, N.L.,] Trout, R.C. and [Gould, E.A.] (2007)

Benign circulation of rabbit haemorrhagic disease virus on Lambay Island, Eire. *Virology* **358** (1), 18–22.

[Forrester, N.L.,] Trout, R.C., [Turner, S.L., Kelly, D., Boag, B., Moss, S. and Gould, E.A.] (2006)

Unravelling the paradox of rabbit haemorrhagic disease virus emergence, using phylogenetic analysis; possible implications for rabbit conservation strategies. *Biological Conservation* **131** (2), 296–306.

- [Gadepalle, V.P., Ouki, S.K.,] van Herwijnen, R. and Hutchings, T.R. (2006)**
Novel technique for sustainable brownfield remediation of arsenic contaminated soils. In: *The 22nd annual international conference on soils, sediments and water, University of Massachusetts, Amherst, 16–19 October 2006*. University of Massachusetts, Amherst, Massachusetts.
- [Gadepalle, V.P., Ouki, S.K.,] van Herwijnen, R. and Hutchings, T.R. (2006)**
Novel technique for sustainable brownfield remediation of arsenic contaminated soils. In: *Proceedings of 21st international conference on solid waste technology and management, Philadelphia, USA, 26–29 March 2006*. Widener University, Chester, Pennsylvania/University of Pennsylvania, Philadelphia, Pennsylvania.
- [Gadepalle, V.P., Ouki, S.K.,] van Herwijnen, R. and Hutchings, T.R. (2007)**
Immobilization of heavy metals in soil using natural and waste materials for vegetation establishment on contaminated sites. *Soil and Sediment Contamination* **16** (2), 233–251.
- [Gagkas, Z., Heal, K., Stuart, N.] and Nisbet, T. (2006)**
Forests and water guidelines: broadleaf woodlands and the protection of freshwaters from acidification. In: *Proceedings of the 9th British Hydrological Society national hydrology symposium: land management and the protection of the water environment: understanding the impact of new legislation, Durham University, 10–13 September 2006*, eds T.Burt and S.Lane. British Hydrology Society, Durham, 53–58.
- [Gathorne-Hardy, F.J., Syaokani] and Inward, D.J.G. (2006)**
Recovery of termite (Isoptera) assemblage structure from shifting cultivation in Barito Ulu, Kalimantan, Indonesia. *Journal of Tropical Ecology* **22** (5), 605–608.
- Gill, R.M.A. (2006)**
The influence of large herbivores on tree recruitment and forest dynamics. In: *Large herbivore ecology, ecosystem dynamics and conservation*, eds K.Danell, R.Bergstrom, P.Duncan and J.Pastor. Cambridge University Press, Cambridge, 170–202.
- Gosling, P.G. (2006)**
IDS [imbibition, drying, separation – to separate filled-live from filled-dead tree seeds]. In: *Encyclopedia of seeds: science, technology and uses*, eds M.Black, J.D.Bewley and P.Halmer. CABI, Wallingford, Oxon, 346.
- Gosling, P.G. (2006)**
PREVAC [pressure/vacuum treatment – to separate intact and mechanically damaged tree seeds]. In: *Encyclopedia of seeds: science, technology and uses*, eds M.Black, J.D.Bewley and P.Halmer. CABI, Wallingford, Oxon, 533.
- Gosling, P.G. (2006)**
Scarification [seed coat abrasion to stimulate germination]. In: *Encyclopedia of seeds: science, technology and uses*, eds M.Black, J.D.Bewley and P.Halmer. CABI, Wallingford, Oxon, 596–597.
- Gosling, P.G. (2006)**
Tree seeds. In: *Encyclopedia of seeds: science, technology and uses*, eds M.Black, J.D.Bewley and P.Halmer. CABI, Wallingford, Oxon, 725–731.
- Gosling, P.G. and McCartan, S. (2006)**
Seed dormancy in a nutshell! Canadian Tree Improvement Association, Tree Seed Working Group. *TSWG News Bulletin* **44**, 3–6.
- [Green, J.C., Reid, I., Calder, I.R.] and Nisbet, T.R. (2006)**
Four-year comparison of water contents beneath a grass ley and a deciduous oak wood overlying Triassic sandstone in lowland England. *Journal of Hydrology* **329** (1–2), 16–25.
- Green, S. and [Castlebury, L.A.] (2007)**
Connection of *Gnomonia intermedia* to *Discula betulina* and its relationship to other taxa in Gnomoniaceae. *Mycological Research* **111** (1), 62–69.
- Green, S. and MacAskill, G.A. (2007)**
Pathogenicity of *Marssonina betulae* and other fungi on birch. *Plant Pathology* **56** (2), 242–250.
- [Halsall, L.,] Gilbert, J., Matthews, R. and [Fairgrieve, M.] [Compilers] (2006)**
New forecast of softwood availability in the UK. *Forestry & British Timber* **35** (11), November 2006, 14,16,18–20,22–23.
- Harmer, R. and Willoughby, I. (2007)**
Controlling bramble within an oak woodland using herbicides. In: *Vegetation management. [Conference at] Studley Castle, Warwickshire, 25 and 26 January 2007*, eds C.Britt, A.Cherrill, M.Le Duc, R.Marrs, R.Pywell, T.Sparks and I.Willoughby. Aspects of Applied Biology 82. Association of Applied Biologists, c/o Horticulture Research International, Wellesbourne, Warwicks, 165–173.
- Hope, J.C.E., Humphrey, J.W. [and Stone, D.] (2006)**
Modelling the effects of forest landscape dynamics on focal species in Glen Affric, northern Scotland. In: *Ecology and management of native pinewoods*, eds J.W.Humphrey, R.Tipping and H.O.Bishop. Special issue *Forestry* **79** (3), 293–302.
- Humphrey, J.W. (2006)**
Ecology and management of native pinewoods: overview of special issue. In: *Ecology and management of native pinewoods*, eds J.W.Humphrey, R.Tipping and H.O.Bishop. Special issue *Forestry* **79** (3), 245–247.
- Humphrey, J.W. (2006)**
Reply to comment on ‘Benefits to biodiversity from developing old-growth conditions in British upland spruce plantations: a review and recommendations’ with reference to red squirrel conservation. *Forestry* **79** (2), 243.

Humphrey, J., Quine, C. and Watts, K. (2006)

The influence of forest and woodland management on biodiversity in Scotland: recent findings and future prospects. In: *Farming, forestry and the natural heritage: towards a more integrated future*, eds R.Davison and C.A.Galbraith. Scottish Natural Heritage. The Natural Heritage of Scotland 14. The Stationery Office, Edinburgh, 59–75.

Humphrey, J.W., [Tipping, R. and Bishop, H.O.], eds (2006)

Ecology and management of native pinewoods. Special issue *Forestry* **79** (3), 245–359.

Hutchings, T.R., Sinnett, D., Peace, A.J. and Moffat, A.J. (2006)

The effect of woodland growth on a containment landfill site in Hertfordshire, UK. *Urban Forestry & Urban Greening* **5**, 169–176.

Jinks, R.L., Willoughby, I. and [Baker, C.] (2006)

Direct seeding of ash (*Fraxinus excelsior* L.) and sycamore (*Acer pseudoplatanus* L.): the effects of sowing date, pre-emergent herbicides, cultivation, and protection on seedling emergence and survival. *Forest Ecology and Management* **237** (1–3), 373–386.

Jones, D.H. (2006)

Wyre forest: harvesting of wood fuel products. Annex F in: *Assessment and development of fuelwood uses for products from SSSI and ancient woodland conservation management at Wyre Forest, Worcestershire/Shropshire*, eds M. July and S. West. English Nature Research Reports 711. English Nature, Peterborough, 53–79.

[Joosen, R.V.L., Lammers, M., Balk, P.A., Brønnum, P., Konings, M.C.J.M., Perks, M., [Stattin, E., Van Wordragen, M.F. and Van Der Geest, A.H.M.] (2006)

Correlating gene expression to physiological parameters and environmental conditions during cold acclimation of *Pinus sylvestris*, identification of molecular markers using cDNA microarrays. *Tree Physiology* **26** (10), 1297–1313.

[Karlsson, P.E., Braun, S., Broadmeadow, M., [Elvira, S., Emberson, L., Gimeno, B.S., Le Thiec, D., Novak, K., Oksanen, E., Schaub, M., Uddling, J.] and Wilkinson, M. (2007)

Risk assessments for forest trees: the performance of the ozone flux versus the AOT concepts. In: *Critical levels for ozone effects on vegetation: further applying and developing the flux concept*, eds G.Wieser and M.Tausz. Special issue *Environmental Pollution* **146** (3), 608–616.

Kilbride, C., Poole, J. and Hutchings, T.R. (2006)

A comparison of Cu, Pb, As, Cd, Zn, Fe, Ni and Mn determined by acid extraction/ICP-OES and *ex situ* field portable X-ray fluorescence analyses. *Environmental Pollution* **143** (1), 16–23.

Lee, S.J. (2006)

It's a family affair. 'Full-sib' families are a new generation of improved Sitka spruce planting stock. *Forestry & British Timber* **35** (12), December 2006, 14–16.

Lee, S.J., [Woolliams, J.,] Samuel, C.J.A. and [Malcolm, D.C.] (2007)

A study of population variation and inheritance in Sitka spruce. IV: Correlated response in the progeny population based on selection in the parental population. *Silvae Genetica* **56** (1), 36–44.

[Little, K.M.,] Willoughby, I., [Wagner, R.G., Adams, P., Frochot, H., Gava, J., Gous, S., Lautenschlager, R.A., Ørlander, G., Sankaran, K.V. and Wei, R.P.] (2006)

Towards reduced herbicide use in forest vegetation management. *South African Forestry Journal* **207**, July 2006, 63–79.

[Lowe, A., Unsworth, C., Gerber, S., Davies, S., Munro, R., Kelleher, C., King, A., Brewer, S., White, A.] and Cottrell, J. (2005)

Route, speed and mode of oak postglacial colonisation across the British Isles: integrating molecular ecology, palaeoecology and modelling approaches. In: *Atlantic oakwoods: a Botanical Society of Scotland symposium at Oban, Argyll, 14–16 September 2005*, eds D.Malcolm, P.Cochrane, J.Cottrell and D.Chamberlain. *Botanical Journal of Scotland* **57** (1–2), 59–81.

[McInerney, D.] and Suárez, J.C. (2006)

Scottish forest inventory information derived from satellite imagery and field data. In: *Sustainable forestry in theory and practice: recent advances in inventory and monitoring, statistics and modeling, information and knowledge management, and policy science*, ed. K.Reynolds. USDA Forest Service, Pacific Northwest Research Station. General Technical Report PNW-GTR-688. USDA, Portland, Oregon.

[McKay, H.M.] and Nisbet, T.R. (2006)

Managing diffuse pollution from a forestry perspective. In: *Agriculture and the environment VI. Managing rural diffuse pollution: proceedings of the SAC and SEPA biennial conference, Edinburgh, 5–6 April 2006*, eds L.Gairns, K.Crighton and B.Jeffrey. Scottish Agricultural College/Scottish Environment Protection Agency, Edinburgh, 144–152.

Mackie, E. (2006)

The United Kingdom. In: *Forests and forestry in European Union countries: the guide to forests and forest issues*, English edn. Lasy Państwowe/The State Forests Information Centre/Forest Research Institute (IBL), Warsaw, Poland, 447–463.

[Malcolm, D.C., Cochrane, P.,] Cottrell, J. and [Chamberlain, D.] eds (2005)

Atlantic oakwoods: a Botanical Society of Scotland symposium at Oban, Argyll, 14–16 September 2005. *Botanical Journal of Scotland* **57** (1–2), 1–235.

Martin, S., [Emery, M. and Dyke, A.] (2006)

Wild harvests from Scottish woodlands: an exploration of the health and well-being benefits of non-timber forest product collection and use. *Scottish Forestry* **60** (3), 21–26.

[Matsubara, M.,] Lynch, J.M. and [De Leij, F.A.A.M.] (2006)

A simple screening procedure for selecting fungi with potential for use in the bioremediation of contaminated land. *Enzyme and Microbial Technology* **39** (7), 1365–1372.

Mochan, S. and Connolly, T. (2006)

The effect of windblow on timber quality in Sitka spruce. *Scottish Forestry* **60** (3), 15–20.

Moseley, D.G., Ray, D. and [Bryce, J.] (2005)

A Forest Habitat Network for the Atlantic oakwoods in Highland Region, Scotland. In: *Atlantic oakwoods: a Botanical Society of Scotland symposium at Oban, Argyll, 14–16 September 2005*, eds D.Malcolm, P.Cochrane, J.Cottrell and D.Chamberlain. *Botanical Journal of Scotland* **57** (1–2), 197–209.

Moseley, D.G., Ray, D. and Watts, K. (2007)

Improving forest habitat networks with new woodland planting schemes. *Forestry & British Timber* **36** (1), January 2007, 14, 16–18.

Nicoll, B.C. and Gardiner, B. (2006)

The effects of increased wind action on the radial growth of tree stems and structural roots. In: *Proceedings of the fifth plant biomechanics conference, Stockholm, Sweden, 28 August–1 September 2006*, ed. L.Salmén. STFI-Packforsk, Stockholm, 281–286.

Nicoll, B.C., Berthier, S., Achim, A., [Gouskou, K., Danjon, F. and van Beek, L.P.H.] (2006)

The architecture of *Picea sitchensis* structural root systems on horizontal and sloping terrain. *Trees: Structure and Function* **20** (6), 701–712.

Nicoll, B.C., Gardiner, B.A., Rayner, B. and Peace, A.J. (2006)

Anchorage of coniferous trees in relation to species, soil type, and rooting depth. *Canadian Journal of Forest Research* **36** (7), 1871–1883.

Nisbet, T.R. and Thomas, H. (2006)

The role of woodland in flood control – a landscape perspective. In: *Water and the landscape: the landscape ecology of freshwater systems. Proceedings of the fourteenth annual IALE(UK) conference, Oxford Brookes University, 5–8 September 2006*, eds B.Davies and S.Thompson. IALE(UK), Oxford, 118–125.

[Nuopponen, M.H., Birch, G.M.,] Sykes, R.J., Lee, S.J. [and Stewart, D.] (2006)

Estimation of wood density and chemical composition by means of diffuse reflectance mid-infrared Fourier transform (DRIFT-MIR) spectroscopy. *Journal of Agricultural and Food Chemistry* **54** (1), 34–40.

O'Brien, E. (2006)

Social housing and green space: a case study in Inner London. *Forestry* **79** (5), 535–549.

O'Brien, E.A. (2006)

A question of value: what do trees and forests mean to people in Vermont? *Landscape Research* **31** (3), 257–275.

O'Brien, L. (2006)

'Strengthening heart and mind': using woodlands to improve mental and physical well-being. *Unasyiva* **57** (224), 56–61.

O'Brien, L., [Greenland, M. and Snowdon, H.] (2006)

Using woodlands and woodland grants to promote public health and wellbeing. *Scottish Forestry* **60** (2), 18–24.

[Ogilvy, T.K., Legg, C.J.] and Humphrey, J.W. (2006)

Diversifying native pinewoods using artificial regeneration. In: *Ecology and management of native pinewoods*, eds J.W.Humphrey, R.Tipping and H.O.Bishop. *Special issue Forestry* **79** (3), 309–317.

[Pepper, H., Holland, M.] and Trout, R. (2006)

Wildlife fencing design guide. Highways Agency; Chris Blandford Associates; CIRIA. CIRIA C646. CIRIA, London.

Perks, M., Harrison, A. and Bathgate, S. (2006)

Tree establishment advice for UK uplands: promoting good silviculture via a decision support system. In: *Sustainable forestry in theory and practice: recent advances in inventory and monitoring, statistics and modeling, information and knowledge management, and policy science*, ed. K.Reynolds. USDA Forest Service, Pacific Northwest Research Station. General Technical Report PNW-GTR-688. USDA, Portland, Oregon.

Perks, M.P., Harrison, A.J. and Bathgate, S.J. (2007)

Establishment Management Information System (EMIS): delivering good practice advice on tree establishment in the uplands of Britain. In: *Sustainable forestry: from monitoring and modelling to knowledge management and policy science*, eds K.M.Reynolds, A.J.Thompson, M.Köhl, M.A.Shannon, D.Ray and K.Rennolls. CABI, Wallingford, Oxon, 412–424.

Pitman, R.M. (2006)

Wood ash use in forestry: a review of the environmental impacts. *Forestry* **79** (5), 563–588.

Pitman, R.M. and Barsoum, N. (2005)

Oak woodlands in the EU Long Term Forest Monitoring Programme. In: *Atlantic oakwoods: a Botanical Society of Scotland symposium at Oban, Argyll, 14–16 September 2005*, eds D.Malcolm, P.Cochrane, J.Cottrell and D.Chamberlain. Poster summary. *Botanical Journal of Scotland* **57** (1–2), 234.

Ray, D. and Broome, A.C. (2007)

An information retrieval system to support management of Habitats and Rare Priority and Protected Species (HaRPPS) in Britain. In: *Sustainable forestry: from monitoring and modelling to knowledge management and policy science*, eds K.M.Reynolds, A.J.Thompson, M.Köhl, M.A.Shannon, D.Ray and K.Rennolls. CABI, Wallingford, Oxon, 480–496.

Ray, D., Broome, A.C., Brunt, A., Brown, T., Mason, A. and Vials, C. (2006)

An information system to support the sustainable management of Habitats and Rare Priority and Protected Species (HaRPPS) in British forests. In: *Sustainable forestry in theory and practice: recent advances in inventory and monitoring, statistics and modeling, information and knowledge management, and policy science*, ed. K.Reynolds. USDA Forest Service, Pacific Northwest Research Station. General Technical Report PNW-GTR-688. USDA, Portland, Oregon.

[Reynolds, K.M., Thomson, A.J., Köhl, M., Shannon, M.A.,] Ray, D. [and Rennolls, K.], eds (2007)

Sustainable forestry: from monitoring and modelling to knowledge management and policy science. CABI, Wallingford, Oxon.

Rose, D.R. (2007)

Identificazione dei funghi lignivori su piante in piedi [Identification of wood-rotting fungi]. In: *Funghi che degradano il legno - Dinamiche di azione e conseguenze per gli alberi in ambiente forestale e urbano*, ed. P.Pietrobon. Editore Silvatika, Villorba, Italy, 119–127.

[Scholtz, C.H.,] Inward, D.J.G. and [Kerley, M.D.] (2007)

Description of a new Palaearctic *Trox* Fabricius species (Coleoptera: Trogidae) from Thailand, with a review of the *Trox opacotuberculatus* species-group and its biogeography. *Insect Systematics and Evolution* **38**, 93–103.

Sellers, G., Hutchings, T.R. and Moffat, A.J. (2006)

Learning from experience: creating sustainable urban greenspaces from brownfield sites. In: *Brownfield sites III: prevention, assessment, rehabilitation and development of brownfield sites*, eds C.A.Brebbia and Ü.Mander. WIT Press, Southampton, UK and Boston, Massachusetts, USA, 163–172.

[Semple, K.T., Dew, N.M.,] Doick, K.J. [and Rhodes, A.H.] (2006)

Can microbial mineralization be used to estimate microbial availability of organic contaminants in soil? *Environmental Pollution* **140** (1), 164–172.

Silverthorne, T. (2006)

What constitutes success in brownfield redevelopment? A review. In: *Brownfield sites III: prevention, assessment, rehabilitation and development of brownfield sites*, eds C.A.Brebbia and Ü.Mander. WIT Press, Southampton, UK and Boston, Massachusetts, USA, 39–46.

Sing, L., Peace, A., Ray, D. and Brown, T. (2006)

Modelling Sitka spruce yield in southern Scotland. In: *Sustainable forestry in theory and practice: recent advances in inventory and monitoring, statistics and modeling, information and knowledge management, and policy science*, ed. K.Reynolds. USDA Forest Service, Pacific Northwest Research Station. General Technical Report PNW-GTR-688. USDA, Portland, Oregon.

Sinnett, D., Poole, J. and Hutchings, T.R. (2006)

The efficacy of three techniques to alleviate soil compaction at a restored sand and gravel quarry. *Soil Use and Management* **22** (4), 362–371.

Sinnett, D., van Herwijnen, R., Kilbride, C. and Hutchings, T.R. (2006)

Comparing metal uptake by vegetation under different experimental conditions. In: *Brownfield sites III: prevention, assessment, rehabilitation and development of brownfield sites*, eds C.A.Brebbia and Ü.Mander. WIT Press, Southampton, UK and Boston, Massachusetts, USA, 75–84.

[Stewart, J., Rendell, S.,] Hubert, J. [and Boshier, D.] (2006)

Ash in Britain: translating research results into practical guidelines for sustainable use. *Quarterly Journal of Forestry* **100** (3), 201–208.

[Stokes, A., Salin, F., Kokutse, A.D.,] Berthier, S., [Jeannin, H.,] Mochan, S., [Dorren, L., Kokutse, N., Ghani, M.A. and Fourcaud, T.] (2005)

Mechanical resistance of different tree species to rockfall in the French Alps. In: *International conference: Eco-engineering: the use of vegetation to improve slope stability, Thessaloniki, Greece, 13–17 September 2004*, eds A.Stokes, I.Spanos, J.E.Norris and E.Cameraat. *Plant and Soil* **278** (1–2), 107–117.

Stokes, V. and Kerr, G. (2006)

Relationships between growth and leaf-scale physiological parameters in five Wildstar™ cherry clones (*Prunus avium* L.). *European Journal of Forest Research* **125** (4), 369–375.

Stokes, V.J. and Willoughby, I. (2007)

Tolerance of young trees to foliar acting herbicides. In: *Vegetation management. [Conference at] Studley Castle, Warwickshire, 25 and 26 January 2007*, eds C.Britt, A.Cherrill, M.Le Duc, R.Marrs, R.Pywell, T.Sparks and I.Willoughby. Aspects of Applied Biology 82. Association of Applied Biologists, c/o Horticulture Research International, Wellesbourne, Warwicks, 91–101.

Stokes, V.J., [Morecroft, M.D. and Morison, J.I.L.] (2006)

Boundary layer conductance for contrasting leaf shapes in a deciduous broadleaved forest canopy. *Agricultural and Forest Meteorology* **139** (1–2), 40–54.

Straw, N.A. and Tilbury, C.A. (2006)

Host plants of the horse-chestnut leaf-miner (*Cameraria ohridella*), and the rapid spread of the moth in the UK 2002–2005. *Arboricultural Journal* **29** (2), 83–99.

Straw, N., Fielding, N., Green, G. and Price, J. (2006)

Seasonal changes in the distribution of green spruce aphid *Elatobium abietinum* (Walker) (Homoptera: Aphididae) in the canopy of Sitka spruce. *Agricultural and Forest Entomology* **8** (2), 139–154.

Suárez, J.C. and [Markus, B.], eds (2006)

AGILE 2006. *Shaping the future of geographic information science in Europe: 9th AGILE international conference on geographic information science, Visegrád, Hungary, 20–22 April 2006*. University of West Hungary, College of Geoinformatics, Székesfehérvár, Hungary.

Thompson, R.N. (2005)

Thinning Atlantic oakwoods – options at the stand scale. In: *Atlantic oakwoods: a Botanical Society of Scotland symposium at Oban, Argyll, 14–16 September 2005*, eds D.Malcolm, P.Cochrane, J.Cottrell and D.Chamberlain. Poster summary. *Botanical Journal of Scotland* **57** (1–2), 235.

Thompson, R.N. and Hope, J.C.E. (2005)

Restoring Planted Ancient Woodland Sites – assessment, silviculture and monitoring. In: *Atlantic oakwoods: a Botanical Society of Scotland symposium at Oban, Argyll, 14–16 September 2005*, eds D.Malcolm, P.Cochrane, J.Cottrell and D.Chamberlain. *Botanical Journal of Scotland* **57** (1–2), 211–227.

Tilbury, C. and Jukes, M. (2006)

Ophelimus ?maskelli: a new gall-causing eulophid wasp (Hymenoptera: Chalcidoidea) on Eucalyptus in London. *Cecidology* **21** (2), 90–91.

[Torr, P., Wilson, M.J.] and Heritage, S. (2005)

Forestry applications. In: *Nematodes as biological control agents*, eds P.S.Grewel, R.Ehlers and D.I.Shapiro-Ilan. CABI, Wallingford, Oxon, 281–293.

Trout, R. (2006)

Dormice in Planted Ancient Woodland Sites. *The Dormouse Monitor: Newsletter of the National Dormouse Monitoring Programme*, Spring 2006, 4–5.

[Vanden Broeck, A.], Cottrell, J., [Quataert, P., Breyne, P., Storme, V., Boerjan, W. and Van Slycken, J.] (2006)

Paternity analysis of *Populus nigra* L. offspring in a Belgian plantation of native and exotic poplars. *Annals of Forest Science* **63** (7), 783–790.

[Vanderklein, D., Martínez-Vilalta, J.], Lee, S. and [Mencuccini, M.] (2007)

Plant size, not age, regulates growth and gas exchange in grafted Scots pine trees. *Tree Physiology* **27** (1), 71–79.

Vanguelova, E., Moffat, A. and Lynch, J. (2006)

Impact of forestry on soil quality in the UK. In: *Expert workshop on definition of best indicators for biodiversity and soil quality for life cycle assessment (LCA). Proceedings and conclusions, Guildford (UK), 12–13 June 2006*, eds L.Milà i Canals, L.Basson, R.Clift, R.Müller-Wenk, C.Bauer, Y.Hansen and M.Brandão. CES Working Paper 02/06. Centre for Environmental Strategy, University of Surrey, Guildford, 24–27.

van Herwijnen, R., [Gadepalle, V.P.], Hutchings, T.R., [Al-Tabbaa, A.], Moffat, A.J., [Johns, M.L. and Ouki, S.K.] (2006)

How to remediate heavy metal contaminated sites with amended composts. In: *2nd SUBR:IM conference in association with CL:AIRE: Overcoming the barriers to brownfield regeneration, Imperial College, London, 29 March 2006*. SUBR:IM Sustainable Urban Brownfield Regeneration: Integrated Management, Sheffield.

van Herwijnen, R., [Joffe, B., Ryngaert, A., Hausner, M., Springael, D., Govers, H.A.J., Wuertz, S. and Parsons, J.R.] (2006)

Effect of bioaugmentation and supplementary carbon sources on degradation of polycyclic aromatic hydrocarbons by a soil-derived culture. *FEMS Microbial Ecology* **55** (1), 122–135.

van Herwijnen, R., [Laverye, T., Ouki, S.K., Al-Tabbaa, A., Hodson, M.E.] and Hutchings, T.R. (2006)

The effect of composts on the leaching of metals from contaminated soils. In: *Brownfield sites III: prevention, assessment, rehabilitation and development of brownfield sites*, eds C.A.Brebbia and Ü.Mander. WIT Press, Southampton, UK and Boston, Massachusetts, USA, 99–108.

van Herwijnen, R., [Ouki, S.K., Gadepalle, V.P.], Hutchings, T.R., [Al-Tabbaa, A.], Moffat, A.J. and [Johns, M.L.] (2006)

Mineral enriched composts for the remediation of heavy metal contaminated sites. *The 22nd annual international conference on soils, sediments and water, University of Massachusetts, Amherst, 16–19 October 2006*. University of Massachusetts, Amherst, Massachusetts.

van Herwijnen, R., [Ouki, S.K., Gadepalle, V.P.], Hutchings, T.R., Moffat, A.J., [Al-Tabbaa, A. and Johns, M.L.] (2006)

Testing of two mineral amended composts for remediation of heavy metal contaminated soil: metal immobilization and performance of ryegrass. In: *Proceedings of 21st international conference on solid waste technology and management, Philadelphia, USA, 26–29 March 2006*. Widener University, Chester, Pennsylvania/University of Pennsylvania, Philadelphia, Pennsylvania.

[Villella, J.], Sellers, G., Moffat, A.J. and Hutchings, T.R. (2006)

From contaminated site to premier urban greenspace: investigating the success of Thames Barrier Park, London. In: *Brownfield sites III: prevention, assessment, rehabilitation and development of brownfield sites*, eds C.A.Brebbia and Ü.Mander. WIT Press, Southampton, UK and Boston, Massachusetts, USA, 153–162.

[Wallington, E.D.] and Suárez, J.C. (2006)

Airborne LiDAR and SAR estimation of forest top height. In: *Sustainable forestry in theory and practice: recent advances in inventory and monitoring, statistics and modeling, information and knowledge management, and policy science*, eds K.Reynolds. USDA Forest Service, Pacific Northwest Research Station. General Technical Report PNW-GTR-688. USDA, Portland, Oregon.

[Wallington, E.D.] and Suárez, J.C. (2007)

Evaluation of commercial airborne LiDAR and SAR products to estimate top height and associated parameters in production forests in Britain. In: *Sustainable forestry: from monitoring and modelling to knowledge management and policy science*, eds K.M.Reynolds, A.J.Thompson, M.Köhl, M.A.Shannon, D.Ray and K.Rennolls. CABI, Wallingford, Oxon, 298–313.

[Waterton, C., Norton, L.] and Morris, J. (2006)

Understanding Loweswater: interdisciplinary research in practice. *Journal of Agricultural Economics* **57** (2), 277–293.

Watts, K. (2006)

British forest landscapes: the legacy of woodland fragmentation. *Quarterly Journal of Forestry* **100** (4), 273–279.

Webber, J.F. (2006)

Risk analysis for *Phytophthora ramorum*, a pathogen threat to Europe (Poster presentation). In: *Progress in research on Phytophthora diseases of forest trees. Proceedings of the Third International IUFRO Working Party S07.02.09 meeting at Freising, Germany, 11–18 September 2004*, eds C.M.Brasier, T.Jung and W.Oßwald. Forest Research, Farnham, Surrey.

Webber, J.F. and Gibbs, J.N. (2006)

Phytophthora disease of alder in the UK (Poster presentation). In: *Progress in research on Phytophthora diseases of forest trees. Proceedings of the Third International IUFRO Working Party S07.02.09 meeting at Freising, Germany, 11–18 September 2004*, eds C.M.Brasier, T.Jung and W.Oßwald. Forest Research, Farnham, Surrey.

Webber, J.F., Rose, J. and Denman, S. (2006)

Bleeding canker of horse chestnut. In: *Progress in research on Phytophthora diseases of forest trees. Proceedings of the Third International IUFRO Working Party S07.02.09 meeting at Freising, Germany, 11–18 September 2004*, eds C.M.Brasier, T.Jung and W.Oßwald. Forest Research, Farnham, Surrey, 119–121.

Wellpott, A. and Gardiner, B. (2006)

Wind loading on trees in a mature Sitka spruce forest. In: *Proceedings of the fifth plant biomechanics conference, Stockholm, Sweden, 28 August–1 September 2006*, ed. L.Salmén. STFI-Packforsk, Stockholm, 323–328.

Williams, D.T. and Evans, H.F. (2007)

A preliminary investigation into the potential use of a hydrocyclone to concentrate entomopathogenic nematodes from suspension. *Biocontrol Science and Technology* **17** (2), 155–169.

Willoughby, I., [Clay, D.V., Dixon, F.L.] and Morgan, G.W. (2006)

The effect of competition from different weed species on the growth of *Betula pendula* seedlings. *Canadian Journal of Forest Research* **36** (8), 1900–1912.

Willoughby, I., Jinks, R.L. and Stokes, V. (2006)

The tolerance of newly emerged broadleaved tree seedlings to the herbicides clopyralid, cycloxydim and metazachlor. *Forestry* **79** (5), 599–608.

[Woods, C.M., Woodward, S., Pinard, M.A.] and Redfern, D.B. (2006)

Colonization of Sitka spruce stumps by decay-causing hymenomycetes in paired inoculations. *Mycological Research* **110** (7), 854–868.

[Worrall, F., Harriman, R., Evans, C.D., Watts, C.D., Adamson, J., Neal, C., Tipping, E., Burt, T., Grieve, I., Montieth, D., Naden, P.S.,] Nisbet, T., [Reynolds, B. and Stevens, P.] (2004)

Trends in dissolved organic carbon in UK rivers and lakes. *Biogeochemistry* **69**1, 1–34.

[Wright, K.A.L., Johnes, P.J.,] Nisbet, T.R. and Sellars, G. (2006)

Investigation into best practice for the design and management of successfully engineered wetland habitat systems on brownfield land. In: *Water and the landscape: the landscape ecology of freshwater systems. Proceedings of the fourteenth annual IALE(UK) conference at Oxford Brookes University, 5–8 September 2006*, eds B.Davies and S.Thompson. IALE(UK), Oxford, 248–255.

FR electronic publications on FR/FC internet sites

Ecotype articles can be accessed at:
www.forestresearch.gov.uk/ecotype

Broome, A. (2006)

Survey of Welsh small-leaved lime woods for the scarce lime bark beetle *Ernoporus tiliae*.

Ecotype No 34, May 2006, 6–7.

Cottrell, J. and A'Hara, S. (2006)

The use of microsatellites to assess the degree of clonal duplication of black poplar in Ireland.

Ecotype No 34, May 2006, 1–2.

Eycott, A. (2006)

A GIS method for targeting PAWS restoration management.

Ecotype No 35, July 2006, 2–3.

Hubert, J. (2006)

Native rowan experiment established.

Ecotype No 34, May 2006, 3–4.

Hubert, J. (2006)

Climate change and forest genetic diversity: implications to sustainable forest management.

Ecotype No 34, May 2006, 2–3.

Humphrey, J. and Smith, M. (2006)

Developing Lowland Habitat Networks in Scotland (short item).

Ecotype No 35, July 2006, 5–6.

Kiewitt, A. (2007)

Kinnoul Hill and Drummond Hill forests, Perthshire.

Ecotype No 36, March 2007, 7–8.

Moseley, D. (2006)

Improving forest habitat networks for high quality woodland specialists.

Ecotype No 35, July 2006, 3–5.

Poulsom, L. (2006)

Red squirrel conservation in Scotland.

Ecotype No 34, May 2006, 4.

Webber, J. (2006)

Bleeding canker of horse chestnut.

www.forestresearch.gov.uk/bleedingcanker

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

Biometrics, Surveys and Statistics Division

Forest measurement, modelling and forecasting

Robert Matthews, Alan Brewer, Ewan Mackie and Ian Craig

Improve methods and models for forecasting growth and yield of forests. Current focus: development of interactive stand-level yield models and software. 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. Current focus: contemporary silvicultural practice, uneven-aged planting mixtures, modern planting and harvesting systems, long-term environmental change monitoring. Develop and promote the FC production forecasting system, with a specific emphasis on the private sector forecast.

Modelling and data systems

Sebastien Lafont and Paul Taylor

Development of 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.

National Inventory of Woodland and Trees

Mark Lawrence and Graham Bull

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.

Woodfuel research and the Biomass Energy Centre

Ian Tubby

In conjunction with other research programmes within BSSD and FMD, investigate the environmental performance of energy coppice and woodfuel systems. 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

Lowland native woods

Ralph Harmer

Examine methods for managing, restoring, regenerating and extending lowland native woodlands.

Biodiversity evaluation and indicator development

Jonathan Humphrey

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

Management for habitat quality

Jonathan Humphrey and Russell Anderson

Investigate and provide guidance on the management of habitats forests for biodiversity, including the development of old growth stands, and the restoration and management of open ground habitats.

Species Action Plans

Alice Broome, Roger Trout, Chris Quine and Brenda Mayle

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

Ecology of upland native woods

Richard Thompson

Develop methods for restoring and managing native woods in the uplands.

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 and decision support for biodiversity

Duncan Ray

Develop decision-making tools for ecological site classification and for habitat and species management (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

Robin Gill, Helen Armstrong and Brenda Mayle

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.

Protection of woodland ecosystems against mammals

Roger Trout

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.

Forest Reproductive Material Regulations

Sam Samuel

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

Environmental and Human Sciences Division

Soil sustainability

Elena Vanguelova and Rona Pitman

Research to identify and evaluate the potential impacts of both forest management and air pollution on soil status and dynamics. Develop and advise upon sustainable practices.

Land Regeneration and Urban Greening

Tony Hutchings, Kieron Doick, Danielle Sinnett, Andy Moffat and René van Herwijnen

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, Huw Thomas and Samantha Broadmeadow

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 and Andy Moffat

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

Mark Broadmeadow, Sue Benham, Rona Pitman, Sirwan Yamulki, Matthew Wilkinson and Duncan Ray

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. Interpret published climate change scenarios and develop guidance on future species suitability, both for production forestry and native woodland restoration. Identify interactions between forests, woodland management and the changing global environment, including a quantification of non-CO₂ greenhouse gas fluxes.

Forest carbon dynamics

Mark Broadmeadow, Robert Matthews, Sirwan Yamulki and 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

Paul Tabbush, Elizabeth O'Brien, Max Hislop, Suzanne Martin, David Edwards and Jake Morris

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, Alan Harrison and Colin McEvoy

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

Silvicultural effects on timber quality

Barry Gardiner, Elspeth Macdonald, Shaun Mochan and Alexis Achim

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.

Silviculture of upland native woodlands

Colin Edwards and Bill Mason

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.

Transformation and continuous cover silviculture

Gary Kerr, Colin Edwards, Sophie Hale, Victoria Stokes and Bill Mason

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).

Stability of stands

Bruce Nicoll and Barry Gardiner

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 and Richard Jinks

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 and Joan Cottrell

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, Richard Jinks and Bill Mason

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

Breeding and production of conifers

Steve Lee and Rob Sykes

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

In vitro propagation and phase-change biotechnologies

Allan John

Investigate tissue culture systems for multiplication of Sitka spruce.

Technical Development Group

Large-scale forestry harvesting

Colin Saunders

Evaluate machinery and equipment, produce output guidance and investigate operational techniques relevant to large-scale forestry work in harvesting.

Large-scale ground preparation, seed sowing and planting

Ian Murgatroyd and Finlay McAllister

Evaluate machinery and equipment, produce output guidance and investigate operational techniques relevant to large-scale forestry work in ground preparation and planting.

Continuous cover and small-scale silviculture/harvesting

Duncan Ireland

Develop methods and assess equipment with low environmental impact suitable for use in small, generally broadleaved woodlands, and suitable for use by farmers and small contracting firms.

Wood for energy

Andy Hall, Stephanie Roux and Paul Webster

Develop methods for using short rotation coppice, single-stemmed short rotation forestry, forestry residues and existing undermanaged woodlands for small-scale heating and small- or large-scale electricity generation.

Chemical weeding

Bill J. Jones

Evaluate equipment, application techniques and safety.

Reduction in the use of chemicals

Ian Murgatroyd and Finlay McAllister

Examine equipment and methods that offer opportunities for non-chemical weed control.

Health and safety

Colin Saunders

Review techniques and procedures for management of health and safety of machine operators.

Tree Health Division

Pests and pathogens of phytosanitary concern

Hugh Evans, Joan Webber and Christine Tilbury

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. Research into pinewood nematode as a model for improved risk analysis (part EU-funded).

Impact of insects on tree growth

Nigel Straw

Investigate quantitative relationships between insect population pressure and the growth of trees attacked by those insects. An important aim is to separate the direct effects of damage from other biotic and abiotic variables that might mask the impacts of pest insects. The target species is green spruce aphid, *Elatobium abietinum*, which severely defoliates Norway and Sitka spruces. A new programme, impacts of pests under changing management, started during the year and extends this approach to study the implications of different forms of forest management on associated insect fauna.

Integrated Forest Management

David Wainhouse, Roger Moore, Stuart Heritage and Hugh Evans

Develop the concepts and science of Integrated Forest Management (IFM) to underpin sustainable forestry with particular emphasis on reductions in chemical pesticides. Study the population dynamics of *Hylobius abietis* and use the data to develop decision support systems for management of the restocking problem. Develop the 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. Investigate mechanisms of resistance of young conifers to the pine weevil. Determine the relative importance of genetic and environmental factors in resistance expression as factors in the IFM approach to control of pine weevil. Research into effective use of chemical pesticides in relation to protection of transplants from pine weevil attack.

Advice and scientific support for tree health

Joan Webber, David Rose, Christine Tilbury and Sarah Green

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

Joan Webber

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 pinii*) 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.

Dieback of birch

Sarah Green

Investigate the causes of shoot dieback that are frequently found in birch planted as part of 'new native woodlands' in Scotland. Aim to establish if fungal pathogens cause the disorder and to advise forestry practitioners and the Forestry Commission on whether they are a serious, primary factor in birch dieback and, if so, how they may be managed.

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

Joan Webber, Sandra Denman and Clive Brasier

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 and Sarah Green

New programme initially concentrating on two 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.

Programmes part-funded by the European Commission

Integrated information on tree breeding (TREEBREDEX).

An examination of potential forest measures for mitigating hydrological instability and flood risk.

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

Forest condition surveys.

Forest Focus review.

Robinwood (INTERREG) projects.

Demonstration of opportunities on forest land to support the implementation of the Water Framework Directives.

Urgent conservation management for Scottish capercaillie.

Risk analysis for *Phytophthora ramorum*.

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

Fellowship: Quality of Life and Management of Living Resources.

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

Sustainable management of forest insect pests.

Development of generic 'on site' molecular diagnostics for EU quarantine pests and pathogens.

EFORWOOD: Sustainability of the forestry woodchain.

STORMRISK: Development of STORM resistant landscapes through regional co-operation, adapted management and RISK communication.

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

Urgent measures for the recovery of Fea's Petrel [Zino's Petrel], *Pterodroma feae*, and its habitat.

ELAV: Enhancing local activity and values from forest land through community-led strategic planning.

Programmes funded by individual organisations

AEA Technology plc

Acid deposition monitoring at High Muffles.

Aspire Defence

The use of biologically enhanced charcoal for *in-situ* remediation of contaminated land.

BP Exploration Operating Co. Ltd

Scottish Forestry Alliance Biodiversity Group.

CCW/FCW

Woodland habitat network strategy for Wales.

Centre for Ecology and Hydrology

Water monitoring at Llangorse Lake.

Central Science Laboratory and SNH

Develop cost-effective systems to deliver fertility control agents to target species (grey squirrel).

Chimac – Agriphar

Efficacy and phytotoxicity trials.

Contaminated Land: Applications in Real Environments (CL:AIRE)

Development of an Indicator Methodology to determine the plant availability of potentially toxic elements.

DAFF – Isle of Man

Full plantation crop surveys.

Department for Environment, Food and Rural Affairs (Defra)

Biomass Centre – contributions towards continued development.

Assessment of current overgrazing methodology in semi-natural lowland woodland habitats, including proposals for method amendments.

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

Inventory and projections of UK emissions by sources and removals by sinks due to LULUCF.

An assessment of chemical treatment as part of a disease management strategy against *P. kernoviae* infections on magnolias.

Species boundaries on *Phytophthora*.

Yield models for energy coppice of poplar and willow.

Investigation of eradication and control strategies for *Phytophthora kernoviae* in natural environments.

Renewable industrial material from the hills: adding value to trees.

Condition survey of non-woodland amenity trees.

Department of Trade and Industry

Development of a novel soil remediation technique.

Environment Agency

Monitoring the impact of floodplain woodland in River Parrett catchment.

EPSRC/Sheffield

Urban greening.

Novel compost.

Climate change.

EPSRC/University of Surrey

Pollutants in the urban environment.

FCS

Scottish Native Woodlands Survey.

Climate Change Report.

Potential FR Timber Quality Group.

FC Wales

Wales Deforestation Policy.

Highland and Islands Enterprise/FC Grampian Conservancy/Scottish Enterprise

Scots pine timber quality in North Scotland.

Institute of Grassland and Environmental Research

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

James Jones

Timber properties of Sitka spruce in south Scotland.

Macaulay Land Use Research Institute

A case study on integrated deer management – RELU.

Maelor Forest Nurseries

Supply of seeds.

Manchester University/EPSRC

Pollutants in the urban environment.

Midlothian Council

Forest Habitat Network for Edinburgh and Lothian.

Natural Environment Research Council/Sheffield University

Terrestrial carbon dynamics.

Natural Resources International

Use of baculovirus control agents within an integrated pest management strategy against teak defoliator, *Hyblaea puera*, in India.

NERC

UK emissions by sources and removals due to land use and land-use change policy.

Terrestrial umbrella – eutrophication and acidification ecosystems in the UK.

Perth & Kinross - Quality of Life Trust

Small cow-wheat species recovery project.

Plantlife Scotland

Trials for *Juniperus communis* subsp. *communis*.

Scottish Environment Protection Agency

Review of research priorities for woody debris in streams.

Scottish Executive

Development of lowland habitat networks.

Scottish Forestry Trust

Distribution and biology of *Anisogramma virgultorum* on birch in Scotland.

Scottish Natural Heritage

Development of lowland habitat networks.

Forest habitat networks in Scotland.

Minard cattle grazing trial.

Sheffield University

Centre for Terrestrial Carbon Dynamics: data management.

Southampton University

Short rotation coppice (poplar).

Open top chamber experiment.

Tree Advice Trust

Non-woodland amenity trees.

USDA

Phytophthora ramorum.

Bark infecting Phytophthoras.

Woodland Trust

The role of native woodland in water management.

Research contracts awarded by Forest Research

Avon Vegetation Research

Forestry herbicide evaluation.

Butterfly Conservation

Study of small pearl-bordered fritillary populations in Clocaenog Forest.

Cranfield University, BHR Group

Development and production of prototype systems to separate insect parasitic nematodes from rearing media.

Environment Agency (Wales)

Effects of forestry on surface water acidification.

Fountain Forestry

Water monitoring, Halladale.

Imperial College, London

Control of decay in utility poles.

Development of a biological control agent for Dutch elm disease.

Conservation of *Xylophagous* beetles and their parasitoids in Britain's woodlands.

University of Abertay, Dundee

Cryopresentation of Sitka spruce tissues.

University of Birmingham

Woody debris in forest aquatic habitats.

University of Bristol

Use of landscape features and habitats by lesser horseshoe bats: management implications.

University of Cardiff

Investigation of the hydraulic impact of floodplain woodland.

University of Leeds

Atmospheric boundary layer over forests.

Chemical transport in forests.

University of Reading

Soil quality indicators in forestry.

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

University of Southampton

Molecular studies of quantitative traits in Sitka spruce.

University of Stirling

Habitat use of working forest by capercaillie.

Paleoecology of Glen Affric.

Identification and analysis of spider samples obtained from Forest Research's Biodiversity Assessment plots.

University of Sussex

Biochemical mechanisms for plants to act as sinks for atmospheric pollutants.

Drought tolerance in poplars.

University of Ulster

Feeding ecology of the large pine weevil.

Impact of defoliating insects on forests.

University of York

Carbon stocks in UK soils and their vulnerability to climate change.

People



Forest Research staff hold a wide range of roles across many specialisms. Our research teams include experts from an increasingly varied range of subjects, reflecting FR's wider environmental remit and readiness to adapt, while vital support roles also contribute to the development of the Agency, both at home and abroad.

FR staff followed the pattern of previous years in receiving a range of awards and qualifications, reflecting national and international success and recognition.

Bruce Nicoll was awarded a PhD from the University of Edinburgh and Alexis Achim a PhD from Université Laval, Quebec. Russell Anderson, Alan Harrison and Max Hislop were all awarded an MSc from the University of Edinburgh and Colin Edwards gained an MRes, while Robert Coope received a BSc from King's College London. Kevin Watts was joint winner of the Royal Forestry Society's 2006 James Cup for his article: 'British forest landscapes – the legacy of woodland fragmentation', which can be found from www.forestresearch.gov.uk/landscapeecology

Ian Murgatroyd received the Royal Scottish Forestry Society's Sir George Campbell Memorial Trophy for best article: 'Extreme botany', published in the journal *Scottish Forestry*, volume 59. Mike Perks was invited to chair the Carbon Working Group for the Scottish Forest Alliance. Chris Quine became a trustee of the Scottish Forestry Trust in January 2007, replacing Bill Mason who served as trustee for 10 years.

During 2006–07 FR was pleased to welcome new staff in all areas of work and across most sites.

Ecology Division welcomed Philip Handley as a GIS and spatial ecology analyst to work on the BEETLE project, and Tytti Vanhala to work in the molecular genetics group. Gregory Valatin, Norman Dandy, Claudia Carter and Roz Wornell joined the Social and Economic Research Group within

Environmental and Human Sciences Division (EHSD): Gregory as senior economist, Norman to work primarily on the RELU-sponsored deer management project, Claudia as leader on the EC-funded RECOAL project, and Roz on the evaluation of the Cyd Coed project, which encourages community use of woodland. Also joining them in EHSD are Cecile de Munck as environmental modeller and Sirwan Yamulki as climate change and greenhouse gas project leader.

Sebastien Lafont joined Biometrics, Surveys and Statistics Division (BSSD) to work as a process modeller and programme manager, along with Adam Ward and Fauzia Davidson who are working with the GIS unit. Tree Health Division welcomed Daegan Inward to work on plant–insect interactions and Elizabeth Beal (née Young) as a research scientist working on red band needle blight and Phytophthora. Stephanie Roux joined Forest Management Division as team leader (south) in Technical Development.

Other new staff included Paul Morris as computing officer at Alice Holt, Joanne Davies as editor and publications manager, Neil Bowering as intellectual property manager, Helena Ladbury as Personal Secretary to the Chief Executive and Research Director, Andrew Phillips in Central Services and Sandie Cowley as our new restaurant manager. In Technical Services Unit (TSU), Mark Oram joined as field station manager at Alice Holt and Jake Thompson as research survey worker at Wykeham.

This year we also said goodbye to several staff, some after many years of service.

Norman Day retired as deputy head of TSU, after a long career with FC, including field surveys at Santon Downham and Alice Holt, and working as Forest District Manager at Weald Forest. Lorelie Ives' 45 years of dedicated TSU and seed-lab work included raising thousands of plants for countless experiments by hundreds of researchers, and contributing enormously to seed testing and seed research. Again with exceptional dedication, she acted as Alice Holt's 'Met. Observer' for 40 years. Jenny Claridge retired as editor and publications manager after 14 years of freelance and full-time work on a wide range of FR/FC publications, always to the highest standard and with helpful support to authors. She continues working freelance. After 18 years of varied work in Office Services, Finance, Publications and the Library, Thelma Smalley retired, but aims to keep in contact with FR through Butterfly Conservation Work.

Carol Foden retired from BSSD having provided valuable data entry work for 20 years; and Jane Poole also left BSSD having worked as statistician across all divisions. We also said goodbye to Catherine Butcher after 10 years of excellent catering at Alice Holt, including many memorable Christmas lunches.

People and locations

Staff as at 31 March 2007, in Divisions and Technical Services based at:

- **Alice Holt**
- **Northern Research Station**
- **TSU Field Station / ● Field staff locations**
- **Technical Development Office**



Chief Executive

- Professor Jim Lynch, BTech, PhD, DSc, CSci, CChem, FRSC, CBiol, FIBiol, FIBiotech, FRSA

Research Director

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

Personal Secretaries

- Claire Holmes
- Helena Ladbury
- Sue Stiles

Head of Northern Research Station

- Chris Quine, MA, MSc, FICFor, PhD

Quality Assurance Manager

- Carl Foster

Human Resources and Administration

- Ken Charles, FMS, *HR and Administration Director*
- Alastair Bell
- Wendy Groves
- Emma Hewitt
- 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
- Madge Holmes
- Esther Ker
- Linda Legge
- Roz Shields

Finance and IT

- Tony Cornwell, FCMA, *Finance and IT Director*
- Laura Caless
- Carol Knight
- Timothy Knight, BSc
- Carole Martin
- Paul Morris
- Corinne Russell
- Janet Turner
- Wayne Blackburn, BSc, *Head of IT Services*
- Alec Gaw, BSc

Communications

- Xanthe Christophers, BSc, PhD, *Communications Director*
- Joanne Davies, BSc
- George Gate
- David Georghiou, BA
- Eleanor Harland, MA, DipLib
- Alison Melvin, BA
- Catherine Oldham, BA, MA, DipLib, MCLIP
- Sally Taylor
- Neil Bowering BSc, PhD
- Glenn Brearley
- Kirsten Hutchison, MA

FR employs 285 staff, some of whom work part time, giving a total staff number of 271 full-time equivalents at 31 March 2007.

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

Research Liaison Officers

- Susannah Kable, BSc (England)
- Kate Fielding (Scotland)
- Chris Jones (Wales)

Biometrics, Surveys and Statistics Division

- Professor Sam Evans, UDip, BA, MA, PGDip, PhD, PhD, FCMI, *Head of Division*
- Catia Arcangeli, MSc, PhD
- Miriam Baldwin, HND, BSc, MSc
- Alan Brewer, BSc, MSc, MSc, PhD
- Eric Casella, MSc, PhD
- Joy Cornwell
- Ian Craig
- Paul Henshall, BSc
- 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
- John Proudfoot
- Tim Randle, BSc
- Marc Sayce
- Paul Taylor, MA, MSc, MPhil
- Ian Tubby, BSc
- Christopher Vials, BSc
- Stephen Bathgate, BSc, BSc, PGDip
- Christine Brown
- Graham Bull
- Shona Cameron
- Lynn Connolly
- Tom Connolly, BSc, PhD
- Fauzia Davidson, BSc, MSc
- Justin Gilbert, BSc
- Mark Lawrence, BSc, MSc
- Una McEvoy, BSc
- Andrew Peace, BSc
- Lynn Rooney
- Juan Suárez-Minguez, BSc, MSc
- Esther Whitton
- Adam Ward

Ecology Division

- Chris Quine, MA, MSc, FICFor, PhD, *Head of Division*
- Stuart A'Hara, BSc, MSc, PhD
- Russell Anderson, MSc
- Helen Armstrong, BSc, PhD
- Alice Broome, BSc
- Robert Coope, BSc
- Joan Cottrell, BSc, PhD
- Jason Hubert, BSc, PhD
- Jonathan Humphrey, BSc, PhD
- Darren Moseley, BSc, PhD
- Liz Poulson, MSc
- Steve Petty, PhD, Research Fellow
- Duncan Ray, BSc
- Louise Sing, BA, MSc
- Mike Smith, BSc
- Shirley Spencer (also with FMD and TSU)
- Richard Thompson
- 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
- Roger Trout, BA, PhD
- Tytti Vanhalla, BSc, MSc, PhD
- Kevin Watts, BSc, PhD

Environmental and Human Sciences Division

- Andy Moffat, BSc, PhD, DSc, *Head of Division*
- Lorraine Adams, BSc
- Nadia Barsoum, BSc, PhD
- Sue Benham, BSc
- François Bochereau, BSc, MSc
- Mark Broadmeadow, BSc, PhD
- 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
- Alberto Morales, BSc, PhD
- Jake Morris, MA, PhD
- Jacqui Neal
- Tom Nisbet, BSc, PhD
- Liz O'Brien, BSc, PhD
- Christopher Peachey, BSc, MSc
- Richard Pilgrim, BSc
- James Pitman, BSc
- Rona Pitman, BSc, PhD
- Olga Rodrigues, BSc, PhD
- Danielle Sinnott, BSc, MSc
- Paul Tabbush, BSc, MSc, FICFor
- Huw Thomas, BSc, MSc
- Rene van Herwijnen, MSc, PhD
- Elena Vanguelova, BSc, MSc, PhD
- Christine Whitfield
- Matthew Wilkinson, BSc, MSc
- Matthew Williams, BSc
- Tanja Wohleber, BSc, MSc
- Sirwan Yamulki, BSc, MSc, PhD
- David Edwards, BSc, MSc, MSc, PhD
- Anna Elliot, BSc
- Max Hislop, MSc, MICFor
- Suzanne Martin, BSc, PhD
- Gregory Valatin, MA, MPhil, PhD

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

Forest Management Division Incorporating Technical Development

- Bill Mason, BA, BSc, MICFor,
Head of Division
- Alexis Achim, BSc, PhD
- Cathleen Baldwin
- Christopher Duncan
- Colin Edwards, BSc, MRes
- Professor Barry Gardiner,
BSc, PhD, FRMetS
- Sophie Hale, BSc, PhD
- Alan Harrison, BSc, MSc
- Allan John, BSc, PhD
- Steve Lee, BSc, PhD, MICFor
- Elspeth MacDonald, BSc, MSc
- Shaun Mochan, MSc
- Bruce Nicoll, BSc, PhD
- Margaret O'Donnell
- Mike Perks, BSc, MSc, PhD
- Shirley Spencer
(also with ED and TSU)
- Rob Sykes
- Colin McEvoy, BA
- 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

Delamere

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

Wales

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

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
- Gillian Green, BSc
- Daegan Inward, BSc, MSc, PhD
- Andrew Jeeves
- Martin Jukes, Cbiol, MIBiol
- Susan Kirk
- Elizabeth Orton, BA, MSc
- David Rose, BA
- Joan Rose
- Shirley Stephens
- 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
- Corinne Russell
- Heather Steele, BSc

Field Stations

Technical Services Unit

- Janet Dutch, BSc, PhD,
Head of Unit

North

Engineering Services

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

Inver

- Nick Evans, *Head of Station*
- Bill Rayner

Ae, Kielder and Bush

- Dave Watterson,
Head of Stations

Ae

- James Duff
- Joanna McGregor
- Harry Watson
- James White

Kielder

- Terry Gray

Bush

- Colin Gordon
- Hamish Howell
- Steven Osborne, BSc

Bush Nursery

- David Clark, *Nursery Manager*
- John Armstrong

Newton and Lairg

- Alistair MacLeod, *Head of Stations*
- Pauline Simson, BSc

People

Newton

- Hazel Andrew
- Allison Cowie
- Julie Gardiner, BSc
- Philip James, BSc
- Andrew Kennedy, BSc
- Fraser McBirnie
- Stuart McBirnie
- Hugh MacKay, BSc
- Stephen O’Kane
- Philip Sansum
- Colin Smart

Lairg

- Alexander Bowran
- Calum Murray
- Duncan Williams

South

Alice Holt

- Jamie Awdry
- Bob Bellis
- Sue Bellis
- Tony Bright
- Rory Cobb
- Steve Coventry
- Kate Harris
- Ian Keywood
- Vicki Lawrence
- Mark Oram, BSc, MSc
- Jim Page
- Bill Page

Alice Holt Workshop

- Jon Davey
- Clive Muller

Exeter

- Alan Ockenden
- Anthony Reeves
- Barnaby Wylder

Fineshade and Thetford

- Elizabeth Richardson,
Head of Stations
- Dave West

Thetford

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

Shobdon and Talybont

- Nick Fielding, *Head of Stations*

Shobdon

- Sharon O’Hare
- Martin Page-Jones
- John Price
- Jonathan Tetley

Talybont

- Chris Jones, BSc
- Lyn Ackroyd
- Sam Catchpole, BSc
- Justin Chappell
- Dai Evans
- Ben Griffin, BSc
- Steve Howells
- Richard Keddle
- Andrew Price
- Tony Price
- Jake Thompson
- Tyrone Waldron
- Ken Williams

Wykeham

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

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

PhD Students linked with Forest Research

Sarah Archibald (Imperial College London)	Priya Gadepalle (University of Surrey)	Helen Sneath (University of Surrey)
Miriam Baldwin (Wageningen University, NL)	Zisis Gagkas (University of Edinburgh)	Danni Sinnett (Reading University)
Eligiusz Baumgart (Imperial College London)	Samantha Gale (Abertay University)	Juan Suárez-Minguez (University of Sheffield)
David Beattie (Imperial College London)	Rachel Gaulton (University of Edinburgh)	Suzanne Swanwick (Cranfield University)
Sophie Bertin (University of Edinburgh)	Nicole Harris (Southampton University)	Louise Timms (Imperial College London)
Freia Bladon (University of Ulster)	Katherine King (University of Brighton)	Alessandra Timarco (Reading University)
Niels Brouwers (University of Bournemouth)	Laura Kruitbos (Aberdeen University)	Akshatha Veerendra Kumar (University of Edinburgh)
Wendy Bryan (Paisley University)	Tessa Knight (University of Bristol)	Axel Wellpot (University of Edinburgh)
Lois Canham (University of Stirling)	Bruce Lamond (University of Edinburgh)	Jeremy Wingate (University of Surrey)
Fiona Caryl (University of Stirling)	Lucy Marchant (Reading University)	Kirsten Wright (Reading University)
Vanesa Castan-Broto (University of Surrey)	Paul McLean (University of Glasgow)	Patricia Xavier (University of Cardiff)
Jo Clark (University of Wales, Bangor)	David Messenger (University of Edinburgh)	Georgios Xenakis (University of Edinburgh)
Julia Cox (University of Surrey)	Jo Mortimer (Reading University)	
Richard Curtis (University of Gloucester)	Gloria Olaya (University of Edinburgh)	
Monica De Ioanni (University of Molise)	Martin Price (University of Wales, Bangor)	
Heike De Silva (University of Aberdeen)	Philippa Reid (University of York)	
Cathy Dowding (University of Durham)	Sabrina Reignoux (University of Edinburgh)	
Helen Ellison (Imperial College London)	Jennifer Seaman (University of Sheffield)	
Ruth Fitzgerald (Reading University)	Tim Silverthorne (University of Surrey)	

Accounts

for the year ended 31 March 2007

Year ended 31 March 2007

Balance Sheet as at 31 March 2007

	Notes	2006-07 £000	2005-06 £000
Fixed assets			
Tangible assets	6	12,802	11,607
Intangible assets	7	183	107
		12,971	11,714
Creditors falling due after more than one year	10	51	
Current assets			
Stocks and Work in Progress			
Debtors			
Cash at banks and in hand			

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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 intra-departmental 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 England/GB 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 will be 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. 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 Regional 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 just 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 year proved to be one requiring continuing flexibility in deployment of resources as requirements for work on key areas such as Phytophthora developed during the year; and work on forest condition monitoring, funded by the EC through the Forest Focus programme, drew towards completion.

The year saw the Agency's continuing involvement in the Scottish Native Woodland Survey and it is expected that this pilot work will lead to a substantial programme of activity over the coming years.

In line with policy to increase the value of and expand the range of involvement in non-FC funded research, the development of initiatives in sustainability forestry such as woodfuel and biomass energy, as well as land regeneration and remediation, continue to progress apace. These are confidently expected to bear fruit in future years.

The successful bid for PSRE funding in 2005–06, which yielded £495,000 over a three-year period, is enabling the Agency to accelerate the construction of its commercialisation and innovation skill base in order to pursue the government agenda for exploitation of science.

Changing requirements for fieldwork and traditional experiments have led to a steady and increasing downturn in the financial performance of the Technical Support Unit (TSU). A thorough study concluded that the TSU was no longer sustainable in its present size or organisation but remained a valuable asset to the Agency and the Commission as a whole. Accordingly restructuring plans were prepared, involving a number of early retirements and redundancies, and these were implemented during 2006–07. The costs were met from the Agency's own resources.

7. Financial review

This is Forest Research's tenth year of operation as an Agency. Forest Research produced a net operating surplus of £454,000 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 £602,000 (6.8%)
- other management costs by £206,000 (9.0%)
- materials and services costs increased by £391,000 (14.5%)
- income from Forestry Commission customers increased by £817,000 (6.6%)
- income from external customers increased by £376,000 (18.9%)
- the notional cost of capital increased by £34,000 (7.7%).

The net deficit for the year after the cost of capital charge of £475,000 and depreciation was £21,000, representing a cost recovery rate of 99.9%.

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 inflow for the year was £357,000, which was handed over to the Forestry Commission.

Additions to fixed assets in the year were £580,000.

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 2006–07 the recovery rate was 99.9%.

Performance against other operational, scientific and financial KPIs is reported in the main body of the Annual Report and Accounts. The KPI to achieve £2.1m from income from non-FC customers was exceeded by £0.3m. There are two other financial KPIs relating to the overall cost per chargeable research day and the cost of support services per chargeable research day. Compared with 2005–06, efficiency savings have been achieved against both of these KPIs with the overall cost measure reducing by 3% and support services reducing by 8%. These calculations are derived from a detailed analysis of staff time records which cover 100% of the time of all Agency staff.

9. Events since the balance sheet date

There were no material events since the balance sheet.

10. Future events

As a science-based government agency, FR staff are part of the wider science and technical development community maintaining world class expertise and excellence in applied forest research. Three of the key priorities for FR in the coming year will be:

- to increase our partnerships with other research establishments, across the UK, Europe and worldwide – linking with programmes of research, development, monitoring, resource evaluation and scientific services;
- to establish relationships with users of research outputs including industry, policymakers and other stakeholders in order to understand their needs;
- to monitor bodies that fund research in order to be responsive to changing needs.

FR will continue to lead research in areas of sustainable forestry which increasingly cut across its programmes and which include social, economic and environmental components. FR continues to grow as an internationally recognised centre of excellence in the traditional area of advancing the scientific understanding of sustainable forest management. However, it is also extending this reputation in areas which include research into all aspects of the environment pertaining to trees, woodlands, forests and on their value to society.

There will be continued emphasis on knowledge transfer. There will be increasing analysis of the existing routes for knowledge transfer including further development of the website. The three Research Liaison Officers (RLOs) in England, Scotland and Wales take the lead in establishing and maintaining channels of communication with stakeholders and in developing new initiatives for improving knowledge transfer.

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 2006–07 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 in 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. Margaret Beckett MP	<i>Secretary of State for the Department for Environment, Food and Rural Affairs (until 5 May 2006)</i>
Rt. Hon. David Miliband MP	<i>Secretary of State, Department for Environment, Food and Rural Affairs (from 5 May 2006)</i>
Jim Knight MP	<i>Parliamentary Under-Secretary (Commons), Department for Environment, Food and Rural Affairs (until 5 May 2006)</i>
Barry Gardiner MP	<i>Parliamentary Under-Secretary (Commons), Department for Environment, Food and Rural Affairs (from 5 May 2006)</i>

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

Jim Lynch	<i>Chief Executive</i>
Peter Freer-Smith	<i>Research Director</i>
Ken Charles	<i>Head of Human Resources and Administration</i>
Tony Cornwell	<i>Finance Director</i>
Bill Mason	<i>Head of Forest Management Division</i>
Sam Evans	<i>Head of Biometrics, Surveys and Statistics Division</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</i>
Xanthe Christophers	<i>Communications Director</i>

The Chief Executive is appointed on a fixed-term basis 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 86).

14. Pensions

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

15. 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 £23,000. No further assurance or other non-audit services were provided.

16. 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.

Professor J.M. Lynch

Chief Executive and Agency Accounting Officer

11 July 2007

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 on a fixed-term basis 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 which expires on 30 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 the Chief Executive 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 remuneration.

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

Salary and pension entitlements

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

	2006-07		2005-06	
	Salary £000	Benefits in kind (to the nearest £100)	Salary £000	Benefits in kind (to the nearest £100)
Jim Lynch	80-85	-	80-85	-
Peter Freer Smith	70-75	3,600	65-70	2,000
Ken Charles	45-50	-	45-50	-
Tony Cornwell	45-50	-	45-50	-
Bill Mason	55-60	-	50-55	-
Sam Evans	45-50	-	45-50	-
Hugh Evans	55-60	1,500	55-60	1,300
Chris Quine	55-60	-	50-55	-
Andy Moffat	55-60	-	55-60	-
Xanthe Christophers	45-50	-	40-45	-

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.

Pension benefits

Name	Real increase in pension and related lump sum	Total accrued pension at age 60 at 31/3/07 and related lump sum	CETV @ 31/3/06	CETV @ 31/3/07	Real increase in CETV after adjustment for inflation and changes in market investment factors	Employer contribution to partnership pension account including risk benefit cover
2006-07	£000	£000	£000	£000	£000	nearest £100
Jim Lynch	0-2.5	2.5-5	76	76	25	-
Peter Freer-Smith	0-2.5 plus 2.5-5.0 lump sum	17.5-20 plus 57.5-60 lump sum	340	362	14	-
Ken Charles	0-2.5 plus 0-2.5 lump sum	20-22.5 62.5-65 lump sum	483	485	7	-
Tony Cornwell	0-2.5	5-7.5	100	112	12	-
Bill Mason	0-2.5 plus 0-2.5 lump sum	20-22.5 plus 60-62.5 lump sum	430	467	17	-
Sam Evans	0-2.5 plus 0-2.5 lump sum	5-7.5 plus 17.5-20 lump sum	86	97	9	-
Hugh Evans	0-2.5 plus 2.5-5 lump sum	22.5-25 plus 72.5-75 lump sum	512	554	23	-
Chris Quine	0-2.5 plus 2.5-5.0 lump sum	15-17.5 plus 50-52.5 lump sum	261	279	13	-
Andy Moffat	0-2.5 plus 2.5-5.0 lump sum	17.5-20 plus 57.5-60 lump sum	329	356	16	-
Xanthe Christophers	0-2.5	0-2.5	13	23	8	-

CETV: Cash Equivalent Transfer Value.

Civil Service Pensions

Pension benefits are provided through the Principal Civil Service Pension Scheme. From 1 October 2002, civil servants may be in one of three statutory based 'final salary' defined benefit schemes (classic, premium and classic plus). The schemes are unfunded with the cost of benefits met by monies voted by Parliament each year. Pensions payable under classic, premium and classic plus are increased annually in line with changes in the Retail Prices Index. New entrants after 1 October 2002 may choose between membership of premium or joining 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 and classic plus. Benefits in classic accrue at the rate of 1/80th of pensionable salary 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 variation of premium, but with benefits in respect of service before 1 October 2002 calculated broadly as for classic.

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 selection of approved products. 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).

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 CETV figures, and from 2003-04 the other pension details, include the value of any pension benefit in another scheme or arrangement which the individual has transferred to the Principal Civil Service Pension Scheme and for which the CS Vote has received a transfer payment commensurate with the additional pension liabilities being assumed. 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.

Professor J.M. Lynch

Chief Executive and Agency Accounting Officer

11 July 2007

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 Government accounting (The Stationery Office).

Statement on Internal Control

1. Scope of responsibility

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 *Government accounting*.

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.

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 2007 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 system 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 2007 and up to the signing of the accounts Forest Research has:

- Organised risk management workshops conducted by a private sector expert.
- 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.
- Updated existing risk registers to reflect newly identified potential risks and appropriate control measures for agreement by management 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. The RMG has now identified a prioritised list of plans with a view to starting work on these in 2007–08. This will require investment of an internal and external resource in order to ensure completion during the next financial year.

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 Committees met in June 2006 and March 2007. Both meetings considered a range of reports from management and from internal and external audit. At the March 2007 meeting the membership of the ARC was agreed.

The new ARC membership will consist 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 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. 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 continues to provide substantial assurance that material risks to the achievement of objectives are adequately managed.

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 this external income will increase from 15% 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 the launch of a review of management information systems aimed at identifying the needs associated with the radical implications of the new strategy.

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.

6. Significant internal control problems

None were identified during the year.

Professor J.M. Lynch

Chief Executive and Agency Accounting Officer

11 July 2007

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 2007 under the Government Resources and Accounts Act 2000. These comprise the Operating Cost Statement and Statement of 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 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 2007, 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.

John Bourn

Comptroller and Auditor General

July 2007

National Audit Office

157–197 Buckingham Palace Road

Victoria

London SW1W 9SP

Operating Cost Statement for the year ended 31 March 2007

	Notes	2006-07 £000	2005-06 £000
Income			
Income from research, development and survey services			
Forestry Commission customers	2	13,165	12,348
Non-Forestry Commission Customers			
European Union		995	998
Other		1,394	1,015
Total income		15,554	14,361
Expenditure			
Staff costs	3	9,517	8,915
Other management costs	4	2,504	2,298
Materials and services	5	3,079	2,688
Total expenditure		15,100	13,901
Net operating surplus/(deficit)		454	460
Exceptional item – provision for restructuring costs		–	(369)
Notional cost of capital	8	475	(441)
Net (deficit) for the year		(21)	(350)
Net (deficit) transferred to General Fund		(21)	(350)

Statement of Total Recognised Gains and Losses for the year ended 31 March 2007

	2006-07 £000	2005-06 £000
Net (deficit) for the year	(21)	(350)
Revaluation surplus for the year	1,333	744
Total recognised gains/(losses)	1,312	394

The notes on pages 100 to 112 form part of these accounts.

Balance Sheet as at 31 March 2007

	Notes	31 March 2007 £000	31 March 2006 £000
Fixed assets			
Tangible assets	6	12,802	11,607
Intangible assets	7	183	107
		12,985	11,714
Debtors falling due after more than one year	10	51	32
Current assets			
Stocks and Work in Progress	9	1,394	1,286
Debtors	10	658	718
Cash at banks and in hand	11	248	227
		2,300	2,231
Creditors – amounts falling due within one year	12	(660)	(443)
Net current assets		1,640	1,820
Total assets less current liabilities		14,676	13,534
Provisions for liabilities and charges	13	(170)	(443)
		14,506	13,091
Taxpayers' Equity			
General Fund	14	7,495	7,345
Revaluation Reserve	15	7,011	5,746
		14,506	13,091

Professor J.M. Lynch

Chief Executive and Agency Accounting Officer

11 July 2007

The notes on pages 100 to 112 form part of these accounts.

Cash Flow Statement for the year ended 31 March 2007

	Notes	2006-07 £000	2005-06 £000
Net cash inflow/(outflow) from operating activities	16	958	706
Capital expenditure (additions to fixed assets)	16b	(580)	(489)
Net cash surplus		378	217
Financing - net cash transfer (to)/from Forestry Commission		(357)	(538)
(Decrease)/ Increase in cash in the period		21	(321)

The notes on pages 100 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 2005–06 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, consumables, etc., of 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 2006–07.

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

In accordance with UK GAAP, professional valuation of non-forest land and buildings shall be undertaken on a five-yearly basis with a formal review in the third year. The first five-yearly valuation shall be undertaken at 31 March 2008.

In 2004–05, professionally qualified staff employed by the Commission carried out a review into the use of the indices provided by the District Valuer. The review concluded that the use of the indices provided a reasonable restatement of the current value of non-forest land and buildings. The indices were therefore used to restate values as at 31 March 2007 and shall be used in each year until the professional valuation at 31 March 2008.

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 also treated as intangible fixed assets, on a pooled asset basis, the amount being material.

1.6 Stocks and Work in Progress

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 Income and Expenditure Account.

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 Income and Expenditure account.

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 2007 was £381,488, which was paid over to partners on 19 April 2007.

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 £10.6 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:

	2006-07	2005-06
	£000	£000
Research, development and other services to:		
Forestry Commission	11,778	11,185
Forest Enterprise	1,387	1,163
	13,165	12,348

Note 3. Staff Costs and Numbers

3.1 Employee costs during the year amounted to:

	2006-07			2005-06
	Permanent staff	Other staff	Total	
	£000	£000	£000	£000
Wages and Salaries	6,893	622	7,515	7,090
Social Security Costs	540	45	585	547
Employer's Superannuation Costs	1,292	98	1,390	1,277
Agency Staff Costs	–	27	27	1
	8,725	792	9,517	8,915

	2006-07	2005-06
Average number of employees (full time equivalents)		
Permanent staff	251	253
Others	39	34
Total staff	290	287

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 2003. Details can be found in the resource accounts of the Cabinet Office: Civil Superannuation (www.civilservice-pensions.gov.uk).

For 2006-07, employers contributions of £1,389,458 were payable to the PCSPS (2005-06: £1,277,000) at one of four rates in the range 17.1% to 25.5% (2005-06: 16.2% to 24.6%) 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 2006-07 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 2007. The total outstanding value of all loans was £58,386.

Note 4. Other Management Costs

Other management costs are stated after charging:

	2006–07	2005–06
	£000	£000
Auditors' remuneration	23	22
Travel and subsistence	586	533
Staff transfer expenses	62	71
Training	159	153
Building maintenance	430	394
Utilities	324	325
Computer supplies	92	92
Early retirement/departure costs	4	25
Employer liability provisions and payments	–	–
Depreciation of fixed assets	628	571
Loss on disposal of fixed assets	–	11
Other expenditure	196	101
	2,504	2,298

Included within other management costs are charges from the Forestry Commission and Forest Enterprise amounting in total to £114,000 (2005–06: £118,000).

Note 5. Materials and Services

Materials and services are stated after charging:

	2006–07	2005–06
	£000	£000
Materials and supplies	742	784
Central services from Forestry Commission	722	697
Vehicle lease charges from Forestry Commission	421	418
Contractors	636	368
Commissioned research	166	182
Publications	63	29
Protective clothing	23	25
Miscellaneous expenditure	306	185
	3,079	2,688

Included within materials and services are charges from the Forestry Commission and Forest Enterprise amounting in total to £1,143,000 (2005–06: £1,115,000).

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	Total
	£000	£000	£000	£000	£000
Valuation:					
At 1 April 2006	10,863	1,761	828	649	14,101
Additions	22	122	110	219	473
Disposals	–	–	(3)	(18)	(21)
Transfers (note 14)	(16)	128	49	(177)	(16)
Revaluation to current prices	1,445	(8)	(39)	24	1,422
At 31 March 2007	12,314	2,003	945	697	15,959
Depreciation: At 1 April 2006					
	812	954	504	224	2,494
Provided in year	244	155	135	54	588
Disposals	–	–	(3)	(17)	(20)
Transfers (note 14)	(3)	(11)	(2)	13	(3)
Revaluation to current prices	111	(4)	(15)	6	98
At 31 March 2007	1,164	1,094	619	280	3,157
Net book value:					
At 31 March 2007	11,150	909	326	417	12,802
At 31 March 2006	10,051	807	324	425	11,607

Fixed assets were revalued as at 31 March 2007 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 £7.6 million and £3.1 million respectively at 31 March 2007.

Note 7. Intangible Fixed Assets

	2006-07	2005-06
	£000	£000
Valuation		
Balance at 1 April	135	59
Additions	107	84
Revaluation	10	(8)
As at 31 March	252	135
Amortisation		
Opening balance	28	9
Depreciation in year	40	19
Revaluation	1	
As at 31 March	69	28
Net book value	183	107

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 2006-07 amounted to £474,627 (2005-06: £441,147).

Note 9. Stocks and Work in Progress

	2006-07	2005-06
	£000	£000
Research work in progress	1,394	1,286
	1,394	1,286

Note 10. Debtors

10a. Analysis by type

	2006-07	2005-06
	£000	£000
Amounts falling due within one year		
EU debtors	242	297
Other Trade debtors	231	228
Other debtors	31	23
Prepayments	154	170
	658	718
Amounts falling due after one year		
House purchase loans	51	32
	709	750

10b. Intra-Government Balances

	2006-07	2005-06
	£000	£000
Balances with other central government bodies	267	108
Balances with local authorities	-	14
Intra-Government balances	267	122
Balances with bodies external to government		
Falling due within one year	391	596
Falling due after more than one year	51	32
	709	750

Note 11. Cash at bank and in hand

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

	2006-07	2005-06
	£000	£000
Opening balance at 1 April	227	548
Net change in balances	21	(321)
Balance at 31 March	248	227

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

	2006-07	2005-06
	£000	£000
Payments received on account	156	50
Trade creditors	492	382
Other creditors including taxation and social security costs	12	11
	660	443

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 2007 the amount held in Forest Research Bank accounts on behalf of partners was £259,144 which was subsequently paid over (31 March 2006: £26,500.81).

Note 13. Provisions for Liabilities

	2006-07	2005-06
	£000	£000
Early departure costs		
Balance brought forward	443	78
Provided in year	146	379
Provision not required written back	(369)	
Utilised in year	(43)	(19)
Unwinding of discount	(7)	5
Balance carried forward	170	443

Note 14. General Fund

	2006-07	2005-06
	£000	£000
Balance brought forward	7,345	7,852
Movement in year		
Retained surplus	68	39
Net (deficit) for year	(21)	(350)
Transfer of fixed assets to (-)/from other Forestry Bodies	(13)	(106)
Cash surplus to (-)/ deficit from Forestry Commission	(357)	(538)
Non-cash inter-country transfers	(2)	7
Notional cost of capital	474	441
Balance carried forward	7,495	7,345

Note 15. Revaluation Reserve

	2006-07	2005-06
	£000	£000
Balance brought forward	5,746	5,041
Revaluation surplus/(deficit) for the year ended 31 March 2007		
Land and Buildings	1,335	771
Scientific equipment	(4)	2
IT	(24)	(21)
Other machinery and equipment	17	-
Intangible assets	9	(8)
	1,333	744
Transfer to general fund for backlog depreciation	(68)	(39)
Balance carried forward	7,011	5,746

Note 16. Note to the Cash Flow Statement

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

	2006-07	2005-06
	£000	£000
Net (deficit) for the year	(21)	(350)
Adjustments for non-cash transactions		
Depreciation – tangible fixed assets	588	552
Depreciation – intangible fixed assets	40	19
Non-cash inter-country transfers	(2)	7
(Profit) / loss on disposal of assets	–	11
Notional cost of capital	475	441
Provisions		
Provided in year	146	379
Provisions not required written back	(369)	–
Unwinding of discount	(7)	5
	850	1,064
Adjustments for working capital		
Decrease / (Increase) in stocks and work in progress	(107)	(825)
Decrease / (Increase) in debtors	41	655
Increase / (Decrease) in creditors	217	(169)
	151	(339)
Use of provisions	(43)	(19)
Net cash inflow/(outflow) from operations	958	706

16b. Analysis of capital expenditure

	2006-07	2005-06
	£000	£000
Tangible fixed assets	477	405
Intangible fixed assets	107	84
Total cash expenditure on fixed assets	584	489

Note 17. Post Balance Sheet Events

These financial statements were authorised for issue on 10 July 2007 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 of Trade and Industry and the Department for Environment, Food and Rural Affairs.

Professor Jim Lynch, Chief Executive, 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 2007 was £61,036. Sam Evans, Head of Biometrics Division, holds a visiting professorship at the University of Sheffield with which £18,744 was spent on research services. Other members of staff hold professorships at UK and foreign universities but no financial transactions took place with these in 2006–07.

Note 19. Losses Statement

There were no losses (2005–06: £4,000 from 1 case).

Note 20. Contingent Liabilities

There was a contingent liability at 31 March 2007 in respect of a personal injury action by an ex-employee.

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 £21,000. Financial performance from normal operating activity achieved an operating surplus of £454,000, which, after allowing for the cost of capital, and before exceptional items, represented a cost recovery of 99.9% (2005–06: 100.1%).

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