

# Research highlight

## People, trees and woods

Paul Tabbush and Andy Moffat

*Links between trees and woodland and the environmental, economic and social aspects of our lives are wide-ranging. Woods can contribute to human well-being by providing natural restorative spaces.*



Children in Littlewood (Liverpool) involved in a community woodland event.

- **Social forestry research**
- **Woodland history and heritage**
- **Woodland soils and archaeology**

### Social forestry research

During 2002, consultation days, focusing on the relationship between forests and health and well-being, were held in England, Scotland and Wales. These 'expert consultations' linked health and environmental professionals and culminated in the publication of *Health and well-being: trees, woodland and natural spaces*.

Investigation of values and meanings in relation to woodlands, originally conducted in northwest and southeast England by Liz O'Brien, was extended to Vermont, USA with a three-month study tour. Suzanne Martin and Paul Tabbush visited each of the FC National Offices to develop research on forest recreation. Action research on community involvement in forestry decision-making (Max Hislop) was extended to three Forest Enterprise districts.

### The historic environment in woodlands

FR's historic environment research programme first began in 1999 by examining the issues and knowledge relating to the management of the archaeological resource in wooded landscapes. This involved extensive consultation with archaeologists in the form of a discussion document. Following this work, a significant part of 2002–03 was spent designing and producing a website on the Forestry Commission intranet to assist sustainable forest practice by the dissemination of information, research findings and advice.

The site also provides a forum to exchange ideas, with examples of FC-wide surveys and projects. A database was designed and incorporated into the website to enable information about ancient trees on FC land to be collected and mapped.



*Grimes Graves: an English Heritage managed site in the heart of Thetford Forest. Many other archaeological features exist in the surrounding landscapes and require informed management by the FC.*

The new information presented on this website significantly increases the ability of the FC to manage FE woodlands while fulfilling its commitment to preserve important heritage features. Many aspects of the internal website will be transferred to the wider FR internet during 2004 and thus will be accessible to the wider forest industry.

## Woodland soils and archaeology

Woodland soils vary greatly in their chemistry and this in turn influences the longevity of different buried archaeological materials. In 1997, seven reference minerals were buried in 10 forest soils to examine weathering rates. During 2002–03, these were re-examined and further analysed to form part of a study into the longevity of archaeological materials in woodland soil environments. A simple method of determining preservation based on soil solution chemistry is being developed.

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# Research highlight

## Woodland biodiversity

Chris Quine

*Conserving biodiversity has become one of the most important objectives of sustainable forest management.*



Pearl-bordered fritillary butterfly

- **Developing guidance on HARPPS**
- **Biodiversity planning at landscape scale**
- **Technology transfer**

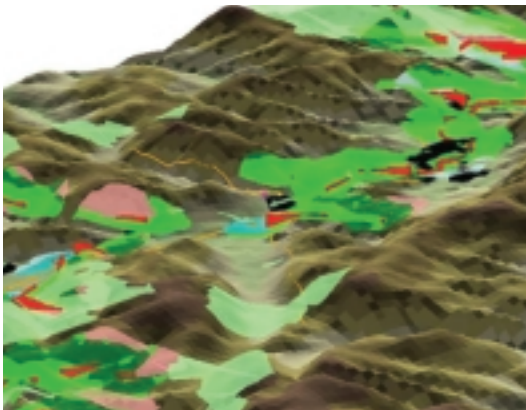
### Development of a HARPPS pilot trial

First steps have been taken to develop a decision support system giving guidance on Habitats and Rare, Priority and Protected Species (HARPPS). A steering group representing main users has agreed the scope of the project and the development of a pilot trial. The system is being developed as a source of ecological advice for forest managers concerned with the requirements of particularly important species found within British forests. HARPPS will provide a source of general knowledge about the ecology of the species, their known distribution and habitat requirements, and their sensitivity to forest management. Managers will be able to use the information to assess the impact of particular operations and, conversely, to plan specific enhancement measures. HARPPS is being developed as computer software for possible access via the World Wide Web, and we would also like to establish direct linkage to information within the National Biodiversity Network.

HARPPS will ultimately provide a repository for the knowledge gained within a number of the other biodiversity programmes, including the projects relating to the Species Action Plans. For example, recent work in this area has included topics on juniper, twinflower, small cow-wheat, dormouse, red squirrel, capercaillie, the lime bark beetle, the chequered skipper and pearl-bordered fritillary, and a number of moths of coppice woodlands.

## Biodiversity planning at landscape scale

A number of research strands are now tackling the broader scale of biodiversity planning – often termed the landscape scale. The Ecological Site Classification (ESC) has been developed in GIS form to link with the ArcView ‘Forester’ system and is being tested as a ‘beta version’ prior to general release. One of the difficulties of working at this scale is the acquisition of suitable data, and digital soils data of an appropriate resolution is particularly scarce. We have been exploring ways of predicting ESC soil variables (soil moisture regime and soil nutrient regime) from coarse resolution lithological and soil maps using relationships with topographic variables such as slope, aspect and convexity. In the first phase of the Landscape Ecology project, we explored the use of a number of summary landscape metrics.



Visualisation of native woodland expansion (green) and existing woodland (red).

Although the approach has promise, it is difficult to establish an ecological interpretation for the indices. The metric approach is now being complemented by a species-based approach. A prototype GIS-based Decision Support System (BEETLE – *Biological & Environmental Evaluation Tools for Landscape Ecology*) has been developed, which addresses the landscape requirements of a range of focal species. This will enable an analysis of landscapes with respect to the needs of particular representative (or focal) species and in time should provide a means of incorporating landscape ecology into the forest design planning process.

## Technology transfer

There has been a substantial commitment to a wide variety of technology transfer activities, but two initiatives have required particular involvement. A series of training courses have been run supporting the publication of a guide to the provision and conservation of deadwood in forests, and there has been continuing demand for training in ESC.

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# Research highlight

## Protecting trees, woodlands and forests

Hugh Evans, Joan Webber and Chris Quine

The management of woodlands to provide a wide range of public benefits places even greater priority on their protection. Risks to trees and woodlands need to be properly understood and in many instances new threats need to be excluded or established pests and pathogens managed.



Horse chestnut leaf miner moth, *Cameraria ohridella*.  
(photo: P. Roose)

- Predicting potential threats
- Developing contingency plans
- Impacts of the grey squirrel

### Potential threats: predicting and planning

There is often a fine line between our perception of woodland organisms as innocuous or beneficial and, at the other extreme, as damaging pests. Pest outbreaks have always occurred and it has been the aim of Forest Research to understand the reasons behind them and to develop ways of managing the problems they cause. There is considerable success in doing this but additional and increasing threats to our woodlands and forests are being noted as a result of the enormous expansion in international trade of woody and non-woody plant stock, of wood as a product in its own right and as packaging material associated with other products. Vigilance, both to predict potential threats and to develop contingency plans to manage incursions and establishments, is therefore essential. This is well illustrated by two recent threats, horse chestnut leaf miner moth and *Phytophthora ramorum* (the causal agent of sudden oak death) which were publicised through Exotic Pest Alerts and which have subsequently arrived in Britain.

Research into the implications of these recent incursions is progressing and there is no doubt that additional threats will continue to occupy our attention. FR also works closely with Forest Health Group and Defra's Plant Health Branch to take effective action when incursions occur.

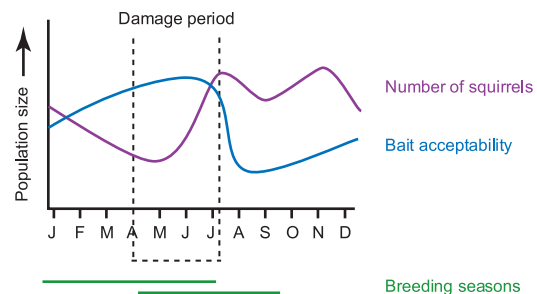
## Grey squirrel impacts

The introduced North American grey squirrel and native and introduced deer species can cause very substantial damage in British woodlands; the latter featured in an article in last year’s Annual Report. The focus of squirrel research has switched to field methods of reducing impacts, following the decision to stop field trials of immuno-contraception methods until further fundamental development work has been carried out.

A study tour to North America was undertaken by Brenda Mayle (FR) and Charles Critchley (FE) to liaise with researchers studying the squirrel in its native habitat and to consider whether there were new insights into the problem of managing squirrels in Britain. A number of useful contacts were made. There is increasing concern that grey squirrels may be impacting a wide range of woodland biodiversity, and not just trees (and timber quality). We are collaborating with the British Trust for Ornithology (BTO) to review the published evidence for such impacts – for example in affecting the breeding success of woodland birds. A new investigation has commenced to consider the prospects for targeting control efforts by index trapping. This method will distinguish years in which the overwinter survival of juvenile grey squirrels has been high, and damage is very likely, from those years in which damage is unlikely and control less necessary.



Grey squirrel (*Sciurus carolinensis*).



Tree seed availability influences grey squirrel population size and breeding success. Assessing seed availability and whether animals can be drawn to traps in early January (index trapping), followed by assessment of damage levels to vulnerable trees in late summer, will allow better prediction of damage risk in future years.

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# Research highlight

## Woodlands and forests in their wider environment

Andy Moffat and Sam Evans

*Climate change, pollutant depositions and other anthropogenic factors can have a major influence on forest condition and thus on terrestrial and aquatic ecosystems. The merits of effective, co-ordinated monitoring and research have become clear.*



Rock sampling is part of the investigation of the effect of Corsican pine woodland on nitrate concentrations in groundwater.

- **Forest ecosystem monitoring**
- **Trees and drought**
- **Forest riparian management**
- **Climate change**
- **Forest carbon dynamics**

### Forest ecosystem monitoring and evaluation

The Level II intensive monitoring programme and the Environmental Change Network (ECN) have become highly valued sources of data. During the year, the number of Level II sites has been extended to 20, and now covers five species (Sitka spruce, Scots pine, Norway spruce, oak and beech). Ambient air quality is now measured using passive samplers at 13 plots. A rolling programme of intensive monitoring of air quality is providing data which will enable canopy exposure to ozone and other pollutants to be estimated from the passive sampler data. Litterfall measurements are undertaken at seven of the sites, and with chemical data these have been used as inputs to dynamic models for the prediction of critical loads and their exceedance for acidity and nitrogen.

At the Alice Holt ECN site, 2002–03 saw intensive vegetation monitoring (vascular plants, bryophytes, mosses and lichens) in 1750 quadrat plots. These data have been collated and will be evaluated in relation to forestry practices.

### Hydrological research

There were some significant outputs from the hydrological research programme in 2002–03. The Final Report of the Trees and Drought Project on Lowland England (TaDPoLE), produced in association with the Universities of Newcastle and Loughborough, and ADAS,

suggested that change of land use from grass to oak or pine woodland on the Sherwood sandstone aquifer will reduce groundwater recharge. The study also revealed higher nitrate concentrations under pine than was previously recognised and indicated that the establishment of pine woodland would exacerbate groundwater concentrations.

The effect of riparian forest management on the freshwater environment was reviewed for SNIFFER (Scotland and Northern Ireland Forum for Environmental Research). The Final Report of the project included an assessment of the impact of clearance of conifer crops from stream banksides on salmonid fish and/or benthic invertebrate populations at three study sites in Scotland and Wales, and made proposals for best management practice for riparian buffer areas.

## Climate change research

Predictions of the effect of climate change on both production and suitability for native woodland have been made by incorporating the UK Climate Impacts Programme (UKCIP) 2002 climatic scenarios as the underlying dataset of ESC (Ecological Site Classification). For oak, commercial productivity is predicted by 2050s to fall significantly in the south and east of the UK, but to increase in parts of northern England and eastern Scotland.

Forest Research is in the process of establishing three phenology gardens, at Alice Holt, and Westonbirt and Bedgebury arboreta, as part of the International Phenology Garden (IPG) network. These will improve climate change monitoring significantly. A phenology garden which operated at Headley Nursery, near Alice Holt, between 1968 and 1981 provided valuable data for the calibration of the Forest Research oak budburst model, which has been further validated in 2002–03 using two new datasets.

## Forest carbon dynamics

The role of trees and forests in carbon cycling is crucial to our understanding of how forests can help to mitigate climate change and how forest management practices can influence carbon dynamics. A new research programme: Forest Carbon Dynamics, jointly operated by Environmental Research and Mensuration Branches, was established in April 2002. At the Straits Enclosure carbon flux station in Alice Holt Forest, the carbon flux for 2002 was lower than preceding years, which may be the result of poor canopy development during a period of cold weather in late spring, as was also suggested by the low leaf litterfall.

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# Research highlight

## Sustainable forest and woodland management

Bill Mason, Paul Tabbush, Steve Smith,  
Bill Jones and Sam Evans

*The current emphasis on continuous cover forestry, native woodland and natural regeneration have called for new approaches to woodland establishment and management.*



Continuous cover forestry in the Knightwood Inclosure, New Forest, Hampshire.

- **Continuous cover forestry**
- **Native woodlands surveys**
- **Alternative establishment systems**
- **Sustainable forestry and technical development**

### Advisory support for CCF initiatives

We continued to provide substantial advisory support to the range of continuous cover forestry (CCF) initiatives being developed throughout Great Britain. Much of this activity is concentrated upon the 12 demonstration sites identified by Forest Enterprise, and in conjunction with Forestry Training Services training courses on the principles of CCF management were run at Wykeham, Clocaenog, Glentress and Inshriach. Two seminars for the private sector were organised at Newton St Boswells in the Scottish Borders and at Evanton on the Black Isle.

Our close involvement with these initiatives has helped to identify where our current understanding is limited and research is necessary to provide improved knowledge. At Clocaenog Forest, for example, where we have joint plots with the School of Agricultural and Forest Sciences, Bangor, analysis of the 50-year-old Sitka spruce stands showed that these appear substantially more wind stable than would be predicted by the wind risk model ForestGALES. The reasons appear to be a combination of past thinning giving more resistant stand structures and some differences in wind climate, but we plan to test these assumptions in 2003–04.

### New native woodland schemes: surveys to improve guidance

Since the early 1990s, there has been extensive new planting of native broadleaves and Scots

pine as part of a policy of creating 'New Native Woodlands' in the uplands of Scotland. In both 2000 and 2001, a substantial number of advisory queries arose as a result of establishment failures in some of the schemes. To get a better idea of the extent of this issue and of the possible causes, a pilot survey of 10 Native Woodland Schemes in northern Scotland was carried out in late summer and early autumn 2002. The team included establishment specialists, a pathologist and a soil surveyor.

Findings indicated that the larger schemes tended to be on impoverished (ESC soil nutrient status of 'very poor') and moist site types with moderate to severe exposure. Such sites can require intensive management if satisfactory establishment is to be achieved. Problems of poor growth and unsatisfactory survival seemed to be most serious where wet microsites had not been adequately cultivated and/or inappropriate fertiliser regimes had been used. In some cases, there were also indications that the abiotic effects were being compounded by interactions with fungal pathogens. Preliminary survey results were presented to FC staff in December 2002 and further work during 2003 will provide improved guidance to woodland officers and other interested parties.

## Monitoring, establishment and natural regeneration

The programme on Native Woodlands completed work on native coppice with the publication of *The silviculture and management of coppice woodlands*. A sampling system for monitoring the transformation of even-aged stands to continuous cover was developed and published in the journal *Forestry*. At the 4th International Vegetation Management Conference, papers were presented on Alternative Establishment Systems, the use of dye markers to reduce pesticide use, natural product herbicides, and the development (with the Canadian Forest Service) of a prototype web-based herbicide selection expert system .

Knowledge of seed biology and seed predation studies are being applied to the problem of obtaining reliable natural regeneration of the main broadleaved species and Corsican pine.

## Sustainable forestry and technical development

Technical Development carries out research on operational methods, techniques and machinery, evaluating performance in terms of the quality of the work, environmental protection, economics of the operation and health and safety. Ongoing project work includes:

- *Ground preparation on restock sites.* Uniform and effective mounding with excavators can be difficult to achieve on restock sites due to brash residues and the difficulties operators can have in achieving consistent accurate spacing. Evaluation of different methods of dealing with brash has identified a reliable means of obtaining consistent mound production, with good soil to soil contact and regular spacing across the whole site. In addition, techniques to develop operator skill in mound spacing have been tested. A problem in soils such as clays and peats has been the difficulty of the spoil sticking in the bucket, causing delay and discomfort for the operator as the machine vibrates when shaking the bucket to release the spoil. We have designed and tested a bucket, which shows considerable promise in dealing with these problems – increasing output and improving the working conditions for the operator.
- *Other research programmes.* Alternatives to the use of herbicides (in partnership with the Woodland Trust); machine operator ergonomics (with EU partners); continuous cover forestry operations; woodfuel harvesting and supply; skyline operations; small scale forestry equipment; brash mat construction during harvesting.

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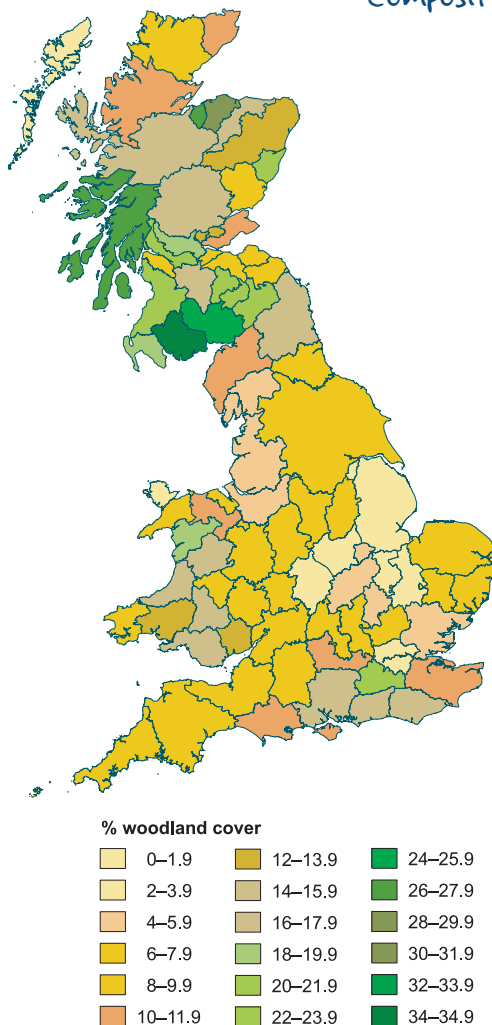
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# Research highlight

## Collecting information about our forests and woodlands

Steve Smith and Sam Evans

*A key requirement in monitoring the sustainable management of our forests and woodlands is to have up to date information on their extent, location and composition.*



Woodland cover by county in 1998.

- **National woodland inventory**
- **Potential woodfuel availability**
- **Modelling and evaluating our woodland resources**

## National Inventory of Woodland and Trees

The analysis of the primary data collected in the last round of the National Inventory was completed, and all remaining national, regional and county reports published. There were official launches for the three national inventory reports for England, Scotland and Wales.

- The England report was launched in November 2001, with Forestry Minister Elliot Morley claiming that it was the most accurate picture of England's forests and woodlands since the Domesday Book (1086).
- The Scotland report was launched by Forestry Minister Alan Wilson in April 2002. The message was that Scotland now has more trees than at any time since Robert the Bruce (early 14th century), with over 16% woodland cover.
- The launch of the Wales report followed in October 2002, by Rural Development Minister Michael German. Continuing the theme that woodland is in a period of expansion, the Welsh used the reign of the Prince of Wales, Owain Glyndwr, 600 years ago to compare when there was last this much woodland in Wales. Over the last 50 years alone, woodland cover has doubled to around 14%.

A Forestry Commission survey showed that over 60% of the public believes that GB woodland area is decreasing. This is clearly not the case, and inventory reports were used

locally to try to dispel this impression. For example, in Essex, where woodland cover has increased by 27% since 1980, the local FC Conservancy put out the press release: ‘When fact is better than fiction – woodland report explodes rural myth in Essex’.

**Woodfuel availability.** The data from the National Inventory of Woodland and Trees (NIWT) formed the basis of a variety of other studies. One example was the major project launched to estimate the size of the woodfuel resource available from British forests. The NIWT provided the basic dataset for the Private Sector, while Woodland Survey’s Private Sector Timber Forecast System was adapted to forecast whole tree biomass. Results from this study are due to be published in 2004.

A major international conference, ForestSAT, on the use of remote sensing in forestry, was organised in Edinburgh in August 2002. Speakers from around the world gave presentations on operational systems and research projects covering the range from forest inventory to disease monitoring. The conference served to stimulate interest in the use of these technologies in British forestry.

Since work on data collection for the last round of the inventory finished, there have been several initiatives which will require different data in the future. For example, the development of national country forestry strategies, and the publication of the *UK indicators of sustainable forestry*. Work has begun on possible changes to the field data to be collected in the next round of the National Inventory, for example the need for more data on native woodlands and timber quality. Proposals will be put out for consultation next year.

## Modelling and evaluating our woodland resources

Forest mensuration is the research discipline that develops and evaluates the theoretical basis and practical application of measurement systems which assess the growth and yield of

trees and forest stands. Forest inventory techniques are underpinned by research on methods and approaches that process measurements to summarise current and future yield. Quantitative measurements provide the basis for standard procedures and conventions used by the forest industry.

- The *Forest mensuration handbook* has been extensively revised and will be published in spring 2004. Current research is developing standardised measurement conventions on 3-dimensional log scans to optimise wood processing in the forest industry.
- The sample plots research programme that characterises and quantifies UK growth trends of managed stands has been reviewed to provide new data to model the relationships between potential stand yield and site factors. By focusing on a larger number of single species or mixture sites to encompass the observed growth variability and range of management practice, the programme aims to achieve representation of the majority of forest conditions within 15 years.
- The interactive Sitka spruce yield model (ForestYield) will be released in spring 2004. As well as developing novel approaches to quantifying biomass, the model develops new single stand yield and volume curves for single species and mixtures representative of different management practices. Its structure provides the benchmark for future empirical models.
- Collaborative FC, EU and NERC projects have developed and validated process models of forest structure, growth and yield that can be used to simulate unobserved conditions. Models describing the water and carbon cycles in forest stands have been integrated with a catchment hydrology model to simulate the potential impacts of afforestation and management practice. This approach is being used to simulate the potential growth and quality of timber under scenarios of climate change.

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# Research highlight

## Land reclamation and urban greening

Andy Moffat

*Woodland can provide a wide range of socio-economic, health and environmental benefits, including amenity, recreation and economic regeneration of deprived areas.*



Promotional leaflet describing the expertise and capabilities of the Land Reclamation and Urban Greening Team.

- **Site investigation of brownfield sites**
- **Assessing site fitness for woodland**
- **New soil cultivation technologies**

### Brownfield sites

Work activity has focused on meeting the expanding needs of colleagues in the Forestry Commission, especially the Land Regeneration Unit and those involved in the Northwest Development Agency Newlands Project and the Capital Modernisation Fund project in Thames Chase Community Woodland. Considerable effort has been spent in developing the methodology and formal specification for site investigation of brownfield sites. The Stage 1 (Preliminary Investigation) specification has been completed, and good progress has been made on Stage 2 (Reconnaissance Intrusive Survey). These methodologies have been adopted for the Newlands Project, and will be further developed for use across the portfolio of Forestry Commission brownfield sites where woodland establishment is sought.

### Opportunities for woodland on contaminated land

During 2002, the Forestry Commission published guidance on the opportunities for woodland on contaminated land. Research continues to provide a sound scientific understanding on how trees grow on, and interact with, contaminated soil materials. In particular, an ecotoxicological, biomonitoring method for assessing site fitness for woodland establishment using cuttings of poplar and willow has been tested. Preliminary results demonstrate the potential of this method, and it will be further developed with support from CLAIRE (Contaminated Land: Applications In Real Environments).

## Evaluation of new soil cultivation technologies

Research on the evaluation of new soil cultivation technologies has continued with assessments of tree response and soil condition in an important replicated experiment at Bramshill Forest. New ripping equipment, recently designed at Cranfield University, has been tested against conventional tackle and cultivation using a 360 degree excavator. The research has been set up to allow the modernisation of guidance on cultivation of restored substrates.

Work continues on the study of tree growth on containment landfill sites. A detailed examination of tree rooting was undertaken at the Waterford site, Hertfordshire. Results suggest that previous guidance on the need for an adequate thickness (>1.5 metres) of rootable soil material over a compacted mineral cap are well founded.

### Strategic research issues in land reclamation and urban greening and how they are translated into research activities, and then presented in appropriate publications.

Research issue	Research activity	Recent publications <sup>a</sup>
<b>Assessing land suitability for woodland establishment</b>	Development of site investigation protocols for woodland establishment.	Foot <i>et al.</i> (2002) Report
	Reviewing issues relating to establishing trees on contaminated land.	Hutchings (2002) Information Note
	Assessing the plant availability and impacts of potentially toxic elements.	Hutchings (2003) Journal paper
<b>Improving land restoration practice</b>	Alleviation of soil compaction on restoration sites.	Foot (2002) Unpublished report Foot & Spoor (2003) Journal article
	Assessing the effects of incorporating soil forming materials on tree survival and growth.	Foot <i>et al.</i> (2003) Book chapter
	Assessing the effects of mycorrhizal inoculation on tree survival and growth.	Moffat (2002) Journal paper
<b>Assessing the performance and implications of woodland planting</b>	Woodland establishment on landfill sites.	Hutchings <i>et al.</i> (2001) Journal paper Foot (2002) Unpublished report
	Meeting ecological and environmental standards when planting woodland in urban areas.	Moffat (2001) Journal paper

<sup>a</sup> For further details of these publications, please contact [andy.moffat@forestry.gsi.gov.uk](mailto:andy.moffat@forestry.gsi.gov.uk)

# Research highlight

## Enhancing economic value of forest and woodland resources

Andy Hall, Bill Mason and Sam Samuel

*There is a wide range of ways in which research, particularly in partnership with the forest industry, can increase the competitiveness of British-grown forest products and their contribution to wealth creation.*



'Woodfuel meets the Challenge' leaflet produced in conjunction with Forest Research/Forestry Commission woodfuel exhibition.

- **Biomass crops**
- **Assessing the risk of wind damage**
- **Marker-aided selection**

### Biomass crops

Biomass is not new and comes in many forms. For many centuries, man has been using it in one form or another to heat his dwelling places. Over time, as new technologies have developed, interest in wood has been rekindled, but this resurgence of interest has often been misplaced and many opportunities for progress have come to nothing. However, today, reducing the use of fossil fuels to help mitigate the effects of climate change, present a very real social and economic opportunity for biomass, woods and forests to make a difference. The UK forest industry is being inundated with requests for information on woodfuel supply and we are already playing an essential role in the UK in support of this new and developing market sector.

#### Specific recent projects include:

- **Woodfuel strategy review.** This was primarily aimed at informing, supporting and prioritising future work within the woodfuel project area, as sponsored by the FC's Forestry Group and the forest industry. This work will benefit the industry and should help inform other market sectors which have an interest in wood beyond that as a fuel.
- **Investigations into methods for achieving woodfuel specifications.** These aim to identify the numerous factors affecting the sustainable development of a woodfuel supply industry in the UK.

- **Seminars and presentations on woodfuel production.** These have involved a significant amount of research which provided a unique overall characterisation of the woodfuel market and allowed us to establish ourselves as the ‘honest broker’ to the industry.

#### Ongoing projects include:

- **Woodfuel factsheets.** In conjunction with FE, this series of factsheets covers a wide range of information from the science of burning wood through to plumbing in wood burning systems. Written and presented with FC/FE forester staff in mind, they are also suitable for the wider audience.
- **Haulage and drying trials.** Bulk transport issues in relation to wood chip haulage, and long-term drying trials for short roundwood.

## Assessing the risks of wind damage

In 2000 we released ForestGALES, a predictive model for assessing the risk of wind damage to forest stands. This is a Windows based package that can be used to calculate the risks to uniform conifer plantations anywhere in Britain. Several hundred copies of the model have been sold to end-users, many of whom have been trained in the use of the model in courses designed in collaboration with Forestry Training Services.

We have now made further improvements to the batch processing capability of the model and to the wind climate generator as a result of further analysis of anemometer datasets from forests throughout Britain. A beta version of the upgrade was released to the industry in late summer and the final version is due for release in late 2003. We have also developed an ArcView extension to the model so that it can be used with the GIS management systems

being introduced to the private sector and Forest Enterprise. This is currently undergoing trials in a Forest District. The next steps proposed are to enhance our ability to use the model to predict the risks of damage in the irregular and mixed species stands which will be favoured under Continuous Cover Forestry regimes. This will be one consequence of the studies to be carried out at Clocaenog Forest previously mentioned, in ‘Sustainable forest and woodland management’.

## Marker-aided selection

In tree-breeding programmes, progeny testing is a vital part of assessing the genetic potential of trees to be selected for breeding. The problem for breeders is that the necessary field trials are expensive and need to be assessed over a number of years before conclusive information is available. A possible solution could be to employ the techniques available from molecular genetics to detect desirable characteristics in breeding material at an early age in the laboratory. Making the link between characteristics in the field and markers in the laboratory needs the most appropriate plant material to be established in the field.

Through vegetative propagation, Tree Breeders from Forest Research have now established clonal material of 1500 individuals within each of 3 full-sib families of Sitka spruce and plan to plant this in field trials on 3 different sites in 2005. Over the next 20 years this material will be assessed for a very wide range of characters relating to aspects such as growth and timber quality. Laboratory work has already begun to find molecular markers with which to construct a molecular map of the species. During later stages of this work, quantitative traits measured in the field trials will be linked to these markers. This will enable rapid early selection of superior genotypes in the laboratory.

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