COFORD ANNUAL REPORT 2008

Chairman's Report

In presenting this report on COFORD's activities in 2008, in what has been a difficult year for the processing sector of the forest industry, I would like to highlight a number of new developments in COFORD's operations and role.

In line with placing increased emphasis on the developmental role of COFORD, we have established three council development groups to:

- support the continuation and expansion of the afforestation programme,
- develop and provide improved forecasting of roundwood availability on the island of Ireland, and
- estimate future demand for roundwood, from the energy sector and the sawmilling and board milling sectors.

Good progress has been made. A series of papers has been developed arguing the economic, environmental and societal benefits of the afforestation programme. Continued capital investment by the state and land owners is essential to building an indigenous forest resource, which gives rates of return to the owner of the order of 5-10%, and which is essential to land-based mitigation of climate change and renewable energy provision.

New wood supply and demand estimates are also well advanced. Production forecasts for privately owned forests will be available in mid 2009 and will be augmented by data from Coillte and the Northern Ireland Forest Service. By late 2009 a full production forecast from all forests will be available in the public domain. Capital investment and future planning will greatly benefit from the new forecast, and from estimates of future raw material demand.

As well as the work of the council groups, the executive has continued to play an important role in providing policy advice, input to national and international processes and information on wood supply, processing and trade. For example, during the year COFORD completed a wood flow model for the island of Ireland, which quantifies how wood harvested on the island is processed and moves through the sawmilling, boardmilling and energy sectors. Such information is vital to assessing current market dynamics, and enables better decision making.

In common with a number of other government agencies, COFORD's status was changed in 2008, with the announcement in the Budget that the organisation is to be merged with the Department of Agriculture, Fisheries and Food. This, however, will not impact on the operation or effectiveness of the organisation. The COFORD council is to be retained as a conduit for feedback from the forestry sector on the scope and direction of COFORD's funded research programme. COFORD's role, together with the Forest Service, in providing a permanent platform to advance sector wide development issues, will also continue. We look forward to continuing engagement with industry and government departments and agencies.

Despite the unprecedented market conditions and the very serious reduction in government income, investment in research and development, and its use as a tool to drive innovation and improved cost effectiveness, is now more important than ever before. In these extremely difficult times for all sectors of the industry, when prices for sawn timber and related products have fallen to unsustainable levels, companies and the state need to aggressively explore new opportunities provided by the growth in the use of wood for energy generation and the move to more sustainable building levels and practices. Land-based mitigation of climate change though forestry needs to be brought into a market-based framework, and linked to national polices and measures in the agriculture sector and beyond. Systems to provide cost efficiencies in the procurement, handling and transport of roundwood, a number of which have been signaled in previous COFORD research, need to be implemented now as profit margins are being squeezed as never before. These developments will not happen without a focused and strategic approach at state and industry level. COFORD is addressing these issues, but a greater engagement by both state and industry is needed to bring about change.

Michael Lynn, Chairman

Director's Report

COFORD's activities in R&D funding, information transfer and service provision aim to contribute to the national economy, the environment and society. They support national afforestation policy, utilisation of forest products, and a range of other policies and measures, including climate change mitigation, water quality and biodiversity conservation and enhancement.

Knowing the forest sector and its dynamic is essential, in our view, for national R&D investment to make a difference. For example, renewable energy policies and targets have been set by government to substantially increase the use of forest biomass in the heat and power sectors, over the period leading up to 2020. Ten to 20-fold increases in annual wood energy supplies will be needed to meet the targets. While the resource base has increased substantially over the last decade, due to continued state and private investment in the afforestation programme, increasing wood energy supply to the levels envisaged requires a focus on four interlinked areas: policy development, capital investment, supply chain innovation and fuel quality.

Forest energy policy is being addressed by the Renewable Energy Development Group of the Department of Communications, Energy and Natural Resources, and its Biomass Working Group, of which COFORD is a member.

Direct capital investment support in the forest sector has been made available through the Wood Biomass Harvesting Machinery Grant Scheme of the Forest Service. COFORD has also advocated for improvement in the price offer for biomass-derived combined heat and power (CHP), to stimulate capital investment; and this is now reflected in the price tariffs offered under the REFIT scheme.

Innovation in the supply chain from forest to final combustion is being supported by the COFORD-funded ForestEnergy R&D programme, underway since 2006, which has been led by Waterford Institute of Technology in partnership with the Danish Forestry Extension Service. The programme has championed innovative and cost-effective harvesting systems, and ways to store and dry energy wood. Allied to the R&D programme, demonstration events have been held since 2006, in close collaboration with Teagasc; and the programme has led to the woodenergy.ie advisory service, as well as a workshop programme on wood energy.

Fuel quality is critical to the development of wood energy in Ireland - the ForestEnergy programme has established a reference data set of physical and chemical wood fuel quality parameters, and how these are influenced by species and harvesting method – and the team has input to the development of EU-wide CEN wood fuel specifications, through the National Standards Authority of Ireland. This work has been complemented by a COFORD/SEI register of wood fuel testing laboratories, set up in early 2008.

The forest energy example illustrates the need to link policy goals, R&D and the related innovation framework, to deliver required outcomes. Similar linkages have been developed in the other COFORD programmes, and are outlined by the programme leaders in their reports under the thematic areas.

Research programmes also need to be periodically updated and realigned to new policy and practice needs. To that end COFORD issued calls for proposals in silviculture and forest energy in September. The aim is to develop longer term work in broadleaf silviculture and in research related to the forest biomass supply chain, as well as to address specific information gaps.

During the year we published the report on the BOGFOR research programme, which examined the forestry potential of cutaway Midland peats. Included in the report are comprehensive guidelines to enable successful afforestation of cutaway peatlands. These have now been taken forward by Bord na Móna and Coillte, and a new afforestation programme is underway.

COFORD's other information activities continued with a series of indoor and outdoor workshops, as well as a highly successful conference on site classification and forestry. Nineteen new COFORD

Connects notes were published and disseminated to the forestry sector and beyond.

Despite the severe downturn in building activity, use of woodspec.ie, the timber specification and innovation website, which is hosted by COFORD, increased significantly during 2008. We attribute much of the increase to the site update which was completed at the end of 2007.

COFORD staff serviced a number of national and international processes during the year, including the forestry aspects of the UN Framework Convention on Climate Change, the national catalogue of seed stands, the British and Irish Hardwoods Improvement Programme and EUFORGEN (European Forest Genetic Resources Programme). We also undertook the Joint Forest Sector Questionnaire which compiles wood harvest, use and trade data, on behalf of EUROSTAT and other bodies, and the Joint Wood Energy Enquiry on behalf of the UNECE/FAO Timber Section. Both data sets are essential to build long-term wood harvest and utilisation trends, and to determine the impact of policies and measures in areas such as renewable energy and wood processing.

Eugene Hendrick, Director

COFORD EXECUTIVE

Dr Eugene Hendrick
Director
Email: eugene.hendrick@coford.ie

Alistair Pfeifer
Research Programme Manager
Email: alistair.pfeifer@coford.ie

John Fennessy
Research Manager: Tree Improvement and Non-wood Forest Products
Email: john.fennessy@coford.ie

Lauren MacLennan
Technology Transfer Co-ordinator
Email: lauren.maclennan@coford.ie

Haze Zhang
Financial Administrator
Email: haze.zhang@coford.ie

Moira Rycraft
Office Administrator
Email: admin@coford.ie

Services and Technology Transfer

COFORD STAFF-DELIVERED SERVICES

Advice and input on economic and environmental matters

COFORD staff provided advice to the Forest Service and the Department of Agriculture, Fisheries and Food on:

- valuation of state investment in afforestation;
- water quality and forestry;
- forest inventory;
- climate change and forestry and other land uses;
- forest biodiversity.

Broadleaf silviculture

The increasing importance of managing broadleaved forests for roundwood production and wood energy is reflected in an ongoing programme of thinning demonstrations organised by COFORD with the support of Teagasc (BROADFORM project). In 2007 COFORD co-ordinated the first in a series of hands-on workshops on the early thinning of young ash stands with Teagasc and the Forest Service. This programme was continued in 2008 with two similar workshops at Crooked Wood, Co Westmeath, in April and at Cappamore, Co Limerick, in September. In 2008 COFORD commissioned a review of the performance of broadleaf/conifer mixtures. As a result of this work, a COFORD Connects note on mixtures is in preparation. COFORD provided advice to the Forest Service on the design of tending and thinning systems for broadleaves. Outcomes from this work include:

- development of tending and thinning systems for broadleaf crops;
- development of systems for managing broadleaf/conifer mixtures;
- support in the development of a draft grant scheme for thinning broadleaves.

Climate change and forests

COFORD's work in climate change includes the CLI-MIT research programme, reporting on carbon stock changes in Irish forests to national and international processes, provision of forecasts of Kyoto-eligible carbon sequestration, input to the implementation of forestry aspects of the National Climate Change Strategy, input to climate change aspects of national forest policy, COFORD staff involvement in international negotiations under the United Nations Framework Convention on Climate Change, and provision of information on climate change aspects of forests to the agriculture and forestry sectors, government departments and agencies and to the public. Outputs in 2008 included:

- further quantification and valuation of forest carbon sequestration and the potential role of different forest sector measures to mitigate climate change;
- a number of publications related to forests and climate change (see *Forests, Carbon and Climate Change - Local and International Perspectives.* Proceedings of the COFORD conference held at the Glenview Hotel, Co Wicklow on 19 September 2007. Editors: Eugene Hendrick and Kevin G. Black; *Climate change and Irish forestry.* COFORD Connects note – Forestry and the Environment No. 9).

Forest statistics

Forest statistics, compiled on a consistent basis and over a number of years, are vital to benchmarking the performance of the forest sector, and in guiding state and private sector investment. COFORD is responsible for the compilation of national wood harvest and forest product trade statistics. Through the forest economics and policy research programme, FORPOLEC, COFORD is estimating the macro economic contribution of the forest sector, in both tradable goods and services, and in public goods. The main outputs in 2008 were:

- compilation of national roundwood harvest, wood product production and trade statistics for 2007 as part of the Joint Forest Sector Questionnaire compiled by EUROSTAT/Food and Agriculture Organisation/United Nations Economic Commission for Europe (UNECE)/International Tropical Timber Organisation and quantification of wood product flows within Ireland;
- compilation of 2007 wood energy harvest and use statistics for the Joint Wood Energy Enquiry (http://www.unece.org/timber/mis/energy/JWEE.htm), compiled on behalf of the UNECE/International Energy Agency, in collaboration with Sustainable Energy Ireland.

Reproductive material

In 2007 the Forest Genetic Resources Working Group concluded its task with the publication of *Sustaining and developing Ireland's forest genetic resources – An outline strategy*. Covering the period 2007 to 2013, it was developed as a result of extensive consultation and examination of genetic resource issues over a 2-year period. Work continued on the implementation of some of the findings of this report during 2008.

A working group to establish the research needs of the nursery sector was established by COFORD in 2007. Its work continued in 2008 with a workshop on *Chemicals in the*

Nursery Sector. Following feedback from the workshop, a process to register chemicals for use in the nursery sector was initiated. In co-operation with the Pesticides Control Service, Department of Agriculture, Fisheries and Food, this process has begun and will be concluded in 2009.

Work on reproductive material includes monitoring, compilation and updating of the national catalogue of seed stands on an annual basis (required under EC regulation, including advice on felling licence applications in respect of each stand), on behalf of the Forest Service. COFORD staff also provide Irish input to international gene conservation and tree improvement processes (particularly EUFORGEN), and co-ordinate the Irish element of the British and Irish Hardwoods Improvement Programme (BIHIP). Work also includes input to the Department of Agriculture, Fisheries and Food Advisory Committee on Genetic Resources for Food and Agriculture. Outputs from the work include:

- review and updating of the annual national catalogue of seed stands;
- development of co-operative clone banks, seedling seed orchards and seed source field trials with UK partners in BIHIP;
- outline strategy for sustaining and developing Ireland's forest genetic resources.

Wood energy

The wood energy portfolio covers the COFORD-funded ForestEnergy R&D and demonstration programme, advice on wood energy supply chain development and related matters through woodenergy.ie, joint hosting (with SEI) of the register of wood fuel quality testing laboratories, wood energy workshops (organised jointly by Waterford Institute of Technology (Forestry) and Danish Forestry Extension) and input to national renewable energy policies and measures through SEI and the Department of Communications, Energy and Natural Resources. Outcomes attributable to the work of COFORD, in conjunction with industry, Forest Service and other agencies included:

- continued expansion of the wood energy heating market and the growth of supply of woodchip, graded firewood, pellets and briquettes;
- increased levels of early harvest in privately owned plantations (adding value to existing crops);
- increased use of wood energy in the power generation sector;
- increased levels of expertise and knowledge in the management of energy wood supply chains.

WEB-DELIVERED ADVISORY SERVICES

A revamp of the COFORD web site was completed in 2008, to enable better accessibility and navigation. There were 61,366 unique visitors to the COFORD website in 2008 - a 30% increase in traffic compared to 2007. The total number of hits on the site was 1,462,653.

Web-facilitated and delivered advisory services available at the COFORD web site currently comprise:

- CLIMIT - forests and climate change;
- GROWFOR – forest growth and yield modelling for the main conifer species in Ireland, and financial appraisal of crop management;
- WINDTHROW – estimating windthrow probability in forest plantations in Ireland;
- woodenergy.ie – advice on all aspects on the wood energy supply chain
- woodspec.ie – advice on specifying wood products based on the Woodspec manual.

GROWFOR now comprises 90 licence holders, spread across the forestry sector. Queries generated in 2008 (41) are shown in Figure 1. Registered GROWFOR users have web access to the latest versions of the software as new species and functionality are added. Up to date standing roundwood prices are also provided to registered users.

During 2007 woodenergy.ie had 22,437 unique visitors (310,114 hits), while woodspec.ie attracted 39,968 users (a 10-fold increase over 2007 usage), with 1,066,731 hits. The breakdown of the queries generated in 2008 is given in Figures 2 and 3.

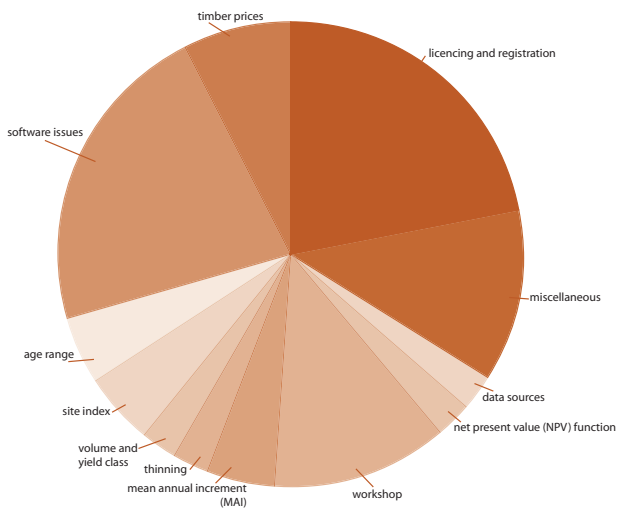


Figure 1: Query categories at GROWFOR on www.coford.ie during 2008.

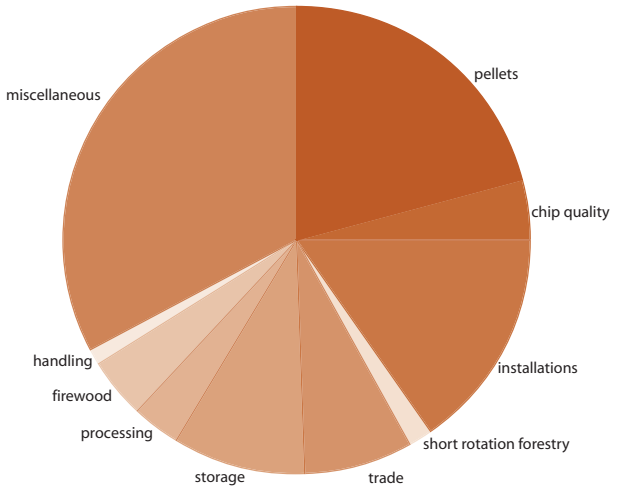


Figure 2: Query categories at www.woodenergy.ie during 2008.

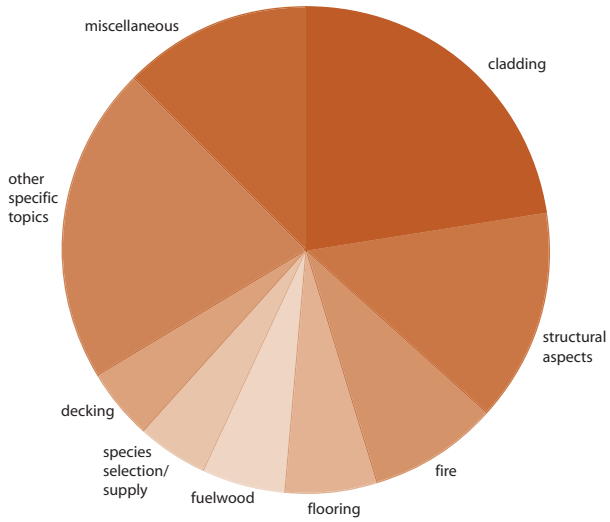


Figure 3: Query categories at www.woodspec.ie during 2008.

NETWORKING AND KNOWLEDGE TRANSFER

Support was given during 2008 to facilitate travel and mobility, seminars and workshops and working visits through the Networking and Knowledge Transfer Support Initiative. Nine travel and mobility grants, four working visit grants and three seminar grants were awarded. Reports on the visits and events are available on the COFORD website.

Events

COFORD was involved in the organisation and hosting of conferences and workshops in 2008 as listed below. Presentations made at these events are available on www.coford.ie.

- Technical workshop: Developing cost-effective systems for wood procurement, harvesting and transport (2 February 2008).
- National forestry conference: New forestry initiatives – opportunities for the sector (7 March 2008).
- Ash field days: Crookedwood, Co Westmeath 9 April 2008 and Cappamore, Co Limerick 7 September 2008.
- The role of site classification in forest productivity and management (4 June 2008).
- Bioenergy plus wood energy conference: Teagasc Mellows Centre, Athenry (19-20 June 2008).
- Chemicals in the nursery sector (2 July 2008).
- Wood energy workshops: Roganstown, Swords, Co Dublin 25-26 August, Killarney 15-16 September 2008.
- Wood energy – fuelling your future: Westport, 10 September 2008.
- GROWFOR workshop: 26 September 2008, Roscrea, Co Tipperary.
- Securing wood chip for out wintering pads, demonstration held in conjunction with Teagasc, Moore Park, Fermoy, Co Cork, 4 November 2008.

Publications

- Annual report 2007.
- Developing a forest resource on industrial cutaway peatland. The BOGFOR programme.
- Forests, carbon and climate change - Local and international perspectives.
- Forest fungi in Ireland.

COFORD Connects

- A handy stand for sharpening your chainsaw.
- An overview of the Irish wood-based biomass sector.
- Assessment of wild edible fungal production in Irish woodlands.
- Cladding.
- Climate change and Irish forestry (pre-publication draft).
- Controlling the large pine weevil, *Hylobius abietis*, using natural enemies.
- Crossing drains.
- Dispelling myths: the true extent of recent peatland afforestation in Ireland.
- Estimated woodflow for the Republic of Ireland for 2006.
- Estimated woodflow for the Republic of Ireland in 2007.
- Eucalyptus as a potential biomass species for Ireland.
- Gasifier-type firewood fuelled boilers.
- Guidelines for designing a wood pellet storage facility.
- Impact of forest industry on the Irish economy and society (pre-publication draft).
- Lifting and handling stresses can cause shoot dieback in oak.
- Roundwood supply, wood energy and related issues in the UNECE region.
- Seed source significantly influences growth, form and silvicultural management of oak.

- Social impacts of forestry: A case study approach.
- The economic impact of the forestry and wood products sectors in Ireland.

E-Newsletter

The monthly email newsletter Forestry and Wood Update continued to be compiled and circulated. The new COFORD website facilitates online subscription, with the number of subscribers now standing at over 1,800.

COFORD INVOLVEMENT IN NATIONAL AND INTERNATIONAL ORGANISATIONS AND PROCESSES

Dr Eugene Hendrick is the Irish representative on the EU forest sink experts group in the international climate change process, and a member of the Heads of National Forest Research Institutes. He is the national correspondent for the UNECE/FAO/EUROSTAT/ITTO Joint Forest Sector Questionnaire, and the Irish representative on the International Council of the International Union of Forest Research Organisations (IUFRO).

Alistair Pfeifer is the national representative on the COST Domain Committee for Forests, their Products and Services. He also is a member of the Forests and Water Steering Group that is developing a Programme of Measures for Forestry under the Water Framework Directive.

John Fennessy represents COFORD on the British and Irish Hardwood Improvement Programme (BIHIP) and is national co-ordinator on European Forest Genetic Resources Network (EUFORGEN). He is also the Irish representative on the Stand-forming Broadleaves Network of EUFORGEN and is a member of the Advisory Committee on Genetic Resources for Food, Agriculture and Forestry of the Department of Agriculture, Fisheries and Food.

Lauren MacLennan is a member of the IUFRO Extension Working Group, IUFRO Technology Transfer Working Group, and the Forest Communicators Network (FAO/ECE).

Papers and presentations

- Hendrick. E. 2008. Forests and the UNFCCC process - an overview. In Forestry, Carbon and Climate Change - Local and International Perspectives. Conference proceedings. COFORD.
- Grêt-Regamey, A., Hendrick, E., Hetsch, S., Pingoud, K., and Rüter, S. 2008. Challenges and Opportunities of Accounting for Harvested Wood Products. Workshop on Harvested Wood Products in the Context of Climate Change Policies. Swiss Federal Office for the Environment (FOEN), UNECE/FAO and MCPFE <http://www.unece.org/timber/workshops/2008/hwp/documents.htm#top>.
- Presentations at Teagasc conference on land use and climate change, and conference *The European Forest-Based Sector : Bio-Responses to Address New Climate and Energy Challenges*, 6-8 November 2008, Nancy, France <http://www.gipecofor.org/docs/nancy2008/ppt_des_presentations_orales/van_orshoven_session_2.0.pdf>.

Research Programme Thematic Areas and Projects 2008

COFORD's research programme can be broadly grouped into three main thematic areas: establishing and growing forests, harvesting and products; and policy and public goods. Each of these areas is addressed by a number programmes and projects, as outlined below.

ESTABLISHING AND GROWING FORESTS 11

ESTABLISHING AND GROWING FORESTS

Establishing and growing forests are core activities of forest management. Central to these activities is the concept of sustainability which is changing the way in which we live our lives today. Sustainability in forestry finds its expression in sustainable forest management (SFM) which is the underlying principle by which forest management is being practiced in many countries throughout the world. Since the concept as first introduced in 1992 at the Earth Summit in Rio, SFM has revolutionised the way in which we manage forests and has been a key driver in forest research and development programmes for the last two decades. SFM has required us to re-examine the value of forests and the goods and services they provide; also to rebalance the economic, environmental and social aspects of forest management for a more sustainable future.

The projects outlined in this section are concerned with making forest management more sustainable in Ireland. For example:

- rebalancing the species composition of the forest estate towards broadleaves and mixed species stands to create greater diversity in both timber products and enhancement of biodiversity;
- having a better understanding of the timber yields from private forests so that sustained yield can be achieved;
- sustaining an experimental infrastructure from which we derive much of our scientific knowledge that underpins policy and management decisions;
- developing new technologies for multi-resource inventories;
- developing planning tools for redesigning forest plantations established on environmentally sensitive sites to make them more sustainable;
- Seeking new methods to reduce chemical usage in forest establishment thereby sustaining the health of the forest ecosystem.

These outputs will provide us with the necessary guidance and methodologies which will ensure that practices are appropriate for the sustainability of forests and to ensure that they are in harmony with other land uses and the wider landscape.

FOREST REPRODUCTIVE MATERIAL

OVERVIEW

The original objective of the national afforestation programme was to create a resource that would yield a sustainable supply of timber to satisfy the country's needs and reduce dependence on imports. Initially this led to the establishment of plantations of several fast growing exotic conifers from many parts of the world, especially from western North America. However, recent years have seen a rapid rise in the use of native species, particularly broadleaved species, in both commercial afforestation and in the Native Woodland Scheme. Whichever species is used it is important that planting stock should be well adapted and genetically suited to the site on which it is planted. Attempts to rectify the planting of unsuitable or poorly adapted forest reproductive material is expensive and the returns on such crops will be far below expectations. Forest owners and managers recognize that the costs associated with utilizing the most appropriate and proven forest reproductive material are small compared to the costs of forest establishment and management. Securing forest reproductive material that is well adapted to Irish climatic and edaphic conditions is fundamental to maintaining the sustainability of the forest resource. COFORD is playing a key role in monitoring, testing and evaluating Irish forest reproductive material through a number of important national and international projects as listed below.

National forest reproductive material (FRM) projects:

- **ASHGEN** – Identifying the scale of suspected introduced hybrid ash (*F. excelsior* x *F. angustifolia*) in Ireland and its potential for genetic pollution of indigenous ash germplasm
- **ASHQUAL** – Comparison of untested Irish ash seed sources from across the country and with European controls
- **BEECHQUAL** – Testing of stands of Irish beech with European controls
- **BIRCH/ALDER** – Selection and improvement of Irish birch (in association with an alder improvement project)
- **OAKPROV** – Establishment of Irish oak seed stands and progeny trials with European controls
- **QUALIBROAD** – Improving the uniformity and quality of broadleaf planting stock
- **XMASFIR** – Field trials to test the suitability of improved Danish noble fir Christmas tree sources in Ireland
- **SEEDSTANDS** – Reviewing and managing the national catalogue of seed stands

International FRM projects:

- **BIHIP** - Co-ordination and participation in the British and Irish Hardwoods Improvement Programme
- **EUFORGEN** – National co-ordination in co-operation with the Forest Service, of the European Forest Genetic Resources Programme

ASHGEN

Identifying the scale of suspected hybrid ash in Ireland and its potential for genetic pollution of indigenous ash germplasm

PROJECT TEAM

Dr Gerry Douglas, Teagasc*
John Mc Namara, Teagasc
Dr Juan Fernandez, University of Paris
Dr Nathalie Frascaria, University of Paris
Dr Trevor Hodkinson, Trinity College Dublin
Muriel Thomasset, Trinity College Dublin and Teagasc

* Email: gerry.douglas@teagasc.ie

COMPLETION DATE: June 2010

BACKGROUND

Ash plants imported from 1993 to 2000 have produced poorly growing plantations in a substantial number of cases. This project investigates whether the planting stock was true common ash (*Fraxinus excelsior*) or natural hybrid material involving another continental species (*F. angustifolia*). These plantations are now seeding. The project is investigating the origin of the imported trees and their interbreeding capacity because the dispersal of hybrid seed into the landscape may give rise to a wild population that would interbreed with native stock, resulting in genetic pollution of native ash germplasm.

OBJECTIVES

The overall objective of this research is to provide a set of tests that can confirm the hybrid nature of ash that is present at suspect sites in Ireland and the potential of these plantations to interbreed with indigenous ash.

The specific objectives are:

- to examine suspect material in Ireland using known morphological criteria;
- to examine suspect material in Ireland using known molecular criteria;
- to assess the potential threat of the confirmed hybrid material to further introgress with native stocks of ash.

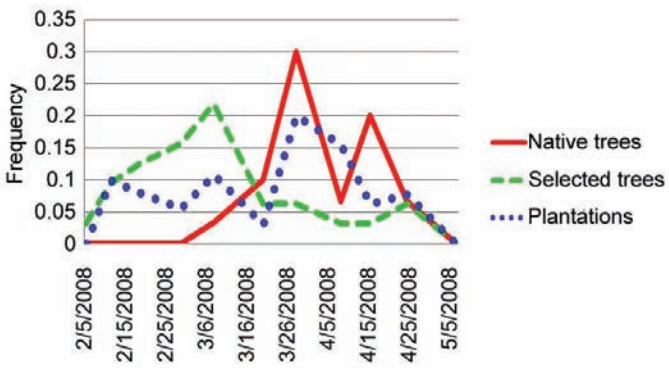
PROGRESS

Fourteen suspect plantations were examined and four of these were intensively sampled to study morphology and molecular markers in Meath, Wicklow, Kerry and Dublin, as well as material from control populations in France.

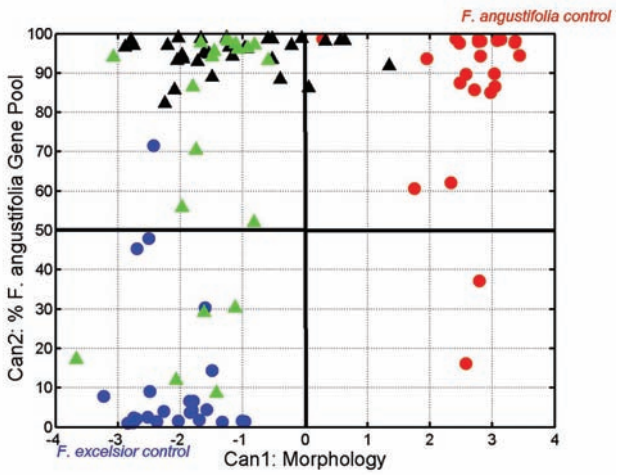
Morphological features of the leaves from three sites did not fit well with the set of characters that were found in pure control populations of either *F. excelsior* or *F. angustifolia*. The lack of significant clustering of the Irish plantation ash with either control population from France may indicate that these controls may not be the most appropriate to use. Hybridisation of ash is known in several regions of France and control populations from other areas may give more useful information. Furthermore, the results showed that material in two of the plantations share more characters with each other than with either species. This suggests that the source of the plantation ash may be from the same or nearby regions of provenance.

Molecular analysis of single gene markers were equivocal but indicated a strong component of *F. angustifolia*. Several features including 11 morphological and 13 molecular markers were examined using multivariate statistics. For the Irish samples it showed that most of the trees indicated a hybrid nature (Meath and Kerry) while those in Wicklow were very close to *F. angustifolia*. However, morphological characters of *F. angustifolia* were only apparent in certain individuals, suggesting the cryptic hybrid nature of many trees.

At each plantation site the onset of flowering was earlier among the plantation trees compared to native surrounding trees. This is more characteristic of *F. angustifolia* and it may be a useful practical indicator of hybridity. Over 60% of the



Time of flowering in plantation 'hybrid' trees and native ash in Wicklow: open flower frequency, stage 2.5.



Joint morphological (X axis) and genetic (Y axis) evaluation of the ' hybrid' ash plantation trees from Wicklow (black triangles) and Meath (green triangles) together with control material of *F. excelsior* (blue dots) and *F. angustifolia* (red dots).

Lateral buds of *F. angustifolia* and 'hybrids' may have three buds in one plane (*F. excelsior* has two) and the terminal bud may have three axes of symmetry as illustrated.

plantation trees at two sites produced some flower buds and we found an overlap in the flowering periods of plantation trees with native trees that leaves the possibility of hybridisation and gene flow from plantations to native trees and visa versa.

ACTIVITIES PLANNED

- Complete the genetic fingerprinting (genotyping) of chloroplast markers for two plantations.
- Genotyping of 96 trees from Clonee with 12 nuclear and chloroplast microsatellite markers and of the progeny (seeds) to determine the sources of pollen (from within the plantation or from outside).
- Complete the morphological analysis of Irish plantation material to compare with putative hybrid zone material from France.
- Cloning and sequencing of more trees to produce specific primers for the ETS to provide a potential 'bar code approach' to identification.
- Determine the viability of seeds from Irish hybrid plantations.

OUTPUTS

Muriel Thomasset wrote a paper on *Hybridisation, introgression and climate change: a case study in the tree genus* Fraxinus, for a book published by the Systematics Association and Cambridge University Press.

Posters

Muriel Thomasset, Gerry Douglas, Trevor Hodkinson. 2008. *Hybrid alien ash in Ireland and its potential for interbreeding with native ash.* Postgraduate Ecology Forum conference 10-12 March 2008, Trinity College Dublin. Conference book p40.

Juan F. Fernández-M., Muriel Thomasset, Trevor R. Hodkinson, Nathalie Frascaria-Lacoste, Gerry C. Douglas. 2008. *Identifying the scale of suspected hybrid ash* (F. excelsior × F. angustifolia) *in Ireland and its potential for genetic pollution of indigenous ash.* Climate Change and Systematics, 1-3 September 2008, Trinity College Dublin. Conference book p24.

Muriel Thomasset, Gerry Douglas, Trevor Hodkinson. 2008. *Hybrid alien ash:* F. excelsior × F. angustifolia *and its potential for interbreeding with native ash under current and future climatic conditions.* Climate Change and Systematics, 1-3 September 2008, Trinity College Dublin. Conference book p29.

Juan F. Fernández-M., Muriel Thomasset, Trevor R. Hodkinson, Nathalie Frascaria-Lacoste, Gerry C. Douglas. 2008. *Identifying the scale of suspected hybrid ash* (F. excelsior × F. angustifolia) *in Ireland and its potential for genetic pollution of indigenous ash.* Agricultural Biotechnology International Conference, 24-28 August 2008, University College Cork. Poster 1.18 Book of abstracts p8.

Communications

Douglas, G. Keeping Irish ash pure. 2008. *Science Spin* No. 31 p10.

Thomasset, M. *Hybrid alien ash in Ireland and its potential for interbreeding with native ash*. Seminar day for first year postgraduates at Trinity College Dublin, 25 March 2008.

Conference presentations

Postgraduate Ecology Forum conference, 10-12 March 2008, Trinity College Dublin.

Ecological Genetics Group (EGG) conference, 1-3 April 2008, University of Sheffield, England.

Climate Change and Systematics, 1-3 September 2008, Trinity College Dublin.

ASHQUAL

Comparison of Irish ash seed sources

PROJECT TEAM

Dr David Thompson, Coillte*
Pat Doody, Coillte
Derek Felton, Woodstock Seeds Ltd.

* Email: david.thompson@coillte.ie

COMPLETION DATE: October 2008

BACKGROUND

Ash (*Fraxinus excelsior*) is an important native Irish broadleaf species that has received much attention under the current grant-aided Forest Service broadleaf planting scheme. The stem form quality of many resulting ash stands is quite variable, but whether this is due to genetic differences in seed source is not known. Currently most of the ash planted in this country originates from hedgerow and parkland trees because there are very few ash stands available as seed stands and ash plantations may not consist of local material. A seed orchard of phenotypically selected individuals has recently been established but is not yet in production.

OBJECTIVE

The objective is to establish a series of trials comparing the growth and stem form of a range of seed sources, including Irish roadside trees, Irish seed stands and several continental seed sources.

PROGRESS

Ash seed was obtained from 18 sources including eleven from Ireland, one from the Netherlands and two each from Denmark, Germany and the UK. Seed was stratified and sown in March 2008 in containers in a heated glasshouse. In July the plants were moved outside to continue their growth. Due to close spacing in the containers, some plants overtopped others resulting in a wide range of plant sizes at the end of the growing season. One trial was planted in Camolin forest in Co Wicklow in December 2008.

ACTIVITIES PLANNED

One additional trial will be planted in early 2009 and the remaining plants will be lined out in a nursery bed and grown during 2009 to produce material for planting the remaining trial in the autumn/winter of 2009/10.

Ash, beech and oak trial planted at Camolin forest at the end of 2008.

BEECHQUAL

Testing seed stands of Irish beech

PROJECT TEAM

Dr David Thompson, Coillte*
Pat Doody, Coillte
Derek Felton, Woodstock Seeds Ltd.

* Email: david.thompson@coillte.ie

COMPLETION DATE: March 2009

BACKGROUND

Beech (*Fagus sylvatica*), although not a native broadleaf species, has been planted in this country since the 1600s and plays a role in broadleaf forestry in Ireland. In the past, seed price rather than suitability to Irish climatic conditions determined the source of most imported seed which resulted in low survival and poor quality stands.

OBJECTIVE

The objective of this project is to establish a series of beech field trials comparing the growth and stem form of selected home-grown seed sources with continental seed sources.

PROGRESS

Seed from 17 sources, including 12 home-collected as well as one source each from the Netherlands, Denmark, Belgium, Germany and the UK was included. Seed was sown in containers in a heated glasshouse in March 2007. Plants were removed from the containers and lined out in a nursery bed due to difficulties with sites combined with the lateness of the season. In December 2008 one trial in Camolin forest, Co Wicklow, was planted with this material.

ACTIVITIES PLANNED

A second trial will be planted in early 2009 and the remaining plants will be lined out in a nursery bed for planting of an additional trial in the autumn/winter 2009/10.

BIHIP

British and Irish Hardwoods Improvement Programme

PROJECT TEAM

Irish members of the species groups:
Michael Carey, Forestry consultant - Chairman of Sycamore Group
Pat Doody, Coillte – Vice Chairman of Ash Group
Gerry Douglas, Teagasc – Member of Sycamore Group
John Fennessy, COFORD – Chairman of Oak Group*
Derek Felton, Forestry consultant – Member of Oak Group
Ted Horgan, Coillte – Member of Spanish Chestnut Group
Elaine O'Connor, Teagasc – Member of Birch Group

* Email: john.fennessy@coford.ie

COMPLETION DATE: These long term broadleaf improvement programmes will continue for the foreseeable future.

BACKGROUND

The British and Irish Hardwoods Improvement Programme was established as a result of the Royal Forestry Society's symposium on *Tree Breeding and Improvement*, at Edgbaston, UK, 1991. At this meeting a small group including John Davis (private nursery owner), Peter Savill and Peter Kanowski (both of Oxford Forestry Institute) decided to initiate work on improving ash. This led to the formation of the British Hardwoods Improvement Programme (BHIP). Ireland joined the group in 1998 and at the 1999 Annual General Meeting a new constitution was adopted establishing the British and Irish Hardwoods Improvement Programme (BIHIP).

OBJECTIVE

The programme operates through individual species working groups with a central executive. There are seven individual species groups: oak, ash, birch, sycamore, cherry, Spanish chestnut and walnut. The objective of the programme is to improve the quality and productivity of these important broadleaved species in Britain and Ireland.

PROGRESS

Progress is continuing with all aspects of the BIHIP programme. Plus tree selections are continuing in a number of species, particularly sycamore, ash and sweet chestnut. Earlier progeny/breeding seedling seed orchards in oak, cherry and ash are being monitored and assessed at regular intervals. The first series of oak seedling seed orchards was measured during 2007/8 and results published. Limited seed production has commenced in the ash breeding seedling seed orchards and these are now due for rouging. The birch indoor clonal orchards are producing adequate seed to supply the demand in Scotland after a very short time. Similar indoor orchards are being developed at Kinsealy by Teagasc. A limited quantity of cherry seed will be available from the BIHIP programme in 2009. Collection of sweet chestnut selected clonal material for establishing seed orchards will be completed in 2009.

The BIHIP website was upgraded and made more user-friendly. New management plans are being developed for a number of the species groups. During 2008 a fundraising trust – the British and Irish Hardwoods Trust - was established in Ireland. A similar trust has been in existence in Britain for a number of years. The purpose of the trusts is to raise funds to finance the full development of the British and Irish Hardwoods Improvement Programme in the future. During 2008 a part-time genetics advisor attached to the Oxford Forestry Institute was appointed to the programme as research co-ordinator and to assist in the development of breeding strategies for each species.

ACTIVITIES PLANNED

Broadleaved tree improvement is long term and the sourcing of funds to support the ongoing work is critical to the continuation of the programmes. The spring meeting will take place in April 2009 at Kinsealy Research Centre and the annual general meeting will be held in the UK in the autumn. The species groups have now produced performance plans and targets and the next stage is to implement these and to review and update breeding strategies during 2009.

OUTPUTS

Plans are well advanced for a new database on all BIHIP plus trees and field trials. This unique database will give the details and numbers of all the plus trees identified in the species, their locations, quality, sex, dimensions, owners etc. It will be added to as new plus trees are identified across the species range as the programme progresses.

BIRCH/ALDER

Selection and improvement of Irish birch and alder

PROJECT TEAM

Dr Ellen O' Connor, University College Dublin/Teagasc*
Dr Martin Steer, University College Dublin
Dr Nuala Ni Fhlatharta, Teagasc
Jerry Campian, Teagasc
Toddy Radford, Teagasc

* Email: elaine.oconnor@teagasc.ie

COMPLETION DATE: December 2009

BACKGROUND

Demand for native species has increased in recent years. This project continues the work of the birch (*Betula pendula* and *B. pubescens*) improvement project that began in 1998. Improvement of alder (*Alnus glutinosa*) was initiated in 2005.

OBJECTIVES

The overall objective of this research is to provide a secure source of improved planting stock of these native species for the Irish forestry sector. The improvement path for all three species includes:

- Locating the best examples of mature trees (plus trees) of these species on which to base the improvement programme;
- Collecting scion wood and establishing seed orchards;
- Establishing clone banks to preserve the genotypes;
- Collecting seed and establishing progeny trials to assess the value of the trees as parents.

PROGRESS

Grafts of selected birch trees were bulked up and grown on for inclusion in an indoor seed orchard. Two birch trials established in 2001 were measured at planting and after one, two, four and six years. The plantations are approaching the stage where thinning will be required. Field assessments, begun in autumn 2008, will assess the trees after eight growing seasons and provide pre-thinning data to compare with post-thinning data. Growth and quality will be assessed.

Grafts of alder plus trees were bulked up and grown on for the development of a seed orchard and to provide material for an alder clone bank in Kilmacurragh. Three alder progeny trials were established in 2008 using seed from selected alder plus trees. The seedlots were planted in blocks of nine trees (3 x 3) with spacing of 2 x 2m and three replicates per site. Planting heights and diameters were measured to provide baseline data. Sites will be assessed over the years to compare growth, quality and health of the seedlots.


Eight year old birch trial at Ballyredmond, Co Carlow.

A polytunnel has been prepared to house the birch and alder seed orchards. More plus trees of birch and alder have been identified.

ACTIVITIES PLANNED

- Completion of indoor seed orchards for birch and alder at Teagasc, Kinsealy.
- Increase of the alder collection number towards the target number of 200.
- Establishment of a third alder progeny trial.
- Completion of the assessment of the 8-year old birch trials.
- Collation, analysis and summary of birch breeding work to date.

OUTPUTS

Co-operation in COST E42 led to participation in two publications:

Skovsgaard, J.P., O'Connor, E., Graversgaard, H.C., Hochbichler, E., Mohni, C., Nicolescu, N., Niemistö, P., Pelleri, F., Spiecker, H., Stefancik, I. and Övergaard, R. 2006. *Procedures for forest experiments and demonstration plots*. http://www.valbro.uni-freiburg.de/

Hemery, G., Clark, J., Aldinger, E., Claessens, H, Malvolti, M., O'Connor, E., Raftoynnis, Y., Savill, P. and Brus, R. Growing scattered broadleaved tree species in a changing climate – risks and opportunities. *Forestry* (submitted).

EUFORGEN

European Forest Genetic Resources Network

PROJECT TEAM

National co-ordinator – John Fennessy, COFORD*
Species networks national representatives:
Conifers – Alistair Pfeifer, COFORD
Scattered Broadleaves – Dr Ellen O'Connor, University College Dublin/Teagasc
Stand-forming Broadleaves – John Fennessy, COFORD
Thematic Networks (Forest Management) – Noel Foley, Forest Service
National Focal Point (EUFGIS Project) – Cathal Ryan, Forest Service

* Email: john.fennessy@coford.ie

COMPLETION DATE: This is an ongoing programme on gene conservation at European level with Phase III scheduled to end on 31 December 2009.

OBJECTIVES

In 1994, the European Forest Genetic Resources Programme (EUFORGEN) was established as an implementation mechanism for Resolution S2 (Conservation of forest genetic resources) adopted by the first Ministerial Conference on the Protection of Forests in Europe (MCPFE) in 1990. EUFORGEN is co-ordinated by Bioversity International and has participants from over 30 European countries. The programme operates through networks in which policy makers, scientists and managers from participating countries agree work programmes, exchange information and identify needs and priorities to enhance pan-European collaboration on forest genetic resources. In Ireland the programme is serviced by COFORD working in close co-operation with the Forest Service.

PROGRESS

The EUFORGEN Networks are currently developing common action plans for target tree species to strengthen gene conservation efforts on a pan-European basis. The common action plans aim at sharing of responsibility for forest genetic resources conservation among European countries. During 2007 the EUFGIS (Establishment of a European Information System on Forest Genetic Resources) project, co-ordinated by Bioversity International and co-funded by the European Commission under the Council Regulation (No 870/2004), on genetic resources in agriculture initiated the development of an information system for dynamic gene conservation units of forest trees in Europe and work in this area is continuing.

ACTIVITIES PLANNED

- Third Stand-Forming network meeting in Turkey, March-April 2009.
- Phase III of EUFORGEN steering committee meeting in Thessalonica, Greece, June 2009, to discuss outcomes from the current phase and develop future plans for EUFORGEN.

OUTPUTS

During 2008 the Scattered Broadleaves network meeting (Skiphelle, Norway, 20–22 May) progressed the common action plans and reported on the development of common action plans in a number of member countries. Progress on the work programme for Phase III was evaluated and tasks to be completed before the end of the phase were highlighted.

The Conifers network meeting (Sopron, Hungary, 10–12 June) continued work on the development of common action plans for conifers. Four categories were considered: (1) stand-forming widespread conifers, (2) scattered widespread conifers, (3) rare and threatened conifers and (4) exotic conifers. Development of technical guidelines was reported for a number of new conifer species. The meeting included a seminar on the use of forest genetic resources in Hungary.

The Forest Management network meeting (Louven, Belgium, November 2008) reported on developments in forest management issues in Europe and how these impacted on forest genetic resources, and provided updates on relevant European programmes. It agreed to finalise working plans for the completion of the programme in Phase III of EUFORGEN with:

- the publication of guidelines on genetic aspects of forest management,
- the summary report to be developed by all networks and published at the conclusion of Phase III will include a chapter on policies and practices related to gene conservation and forest management and a chapter on policy tools to promote the use of high quality forest reproductive material.

It was also agreed that the network would review climate change strategies in European countries with a view to developing a comprehensive set of recommendations for the use of forest genetic resources in Europe.

OAKPROV

Establishment of Irish oak seed stand and progeny trials

PROJECT TEAM

Dr David Thompson, Coillte*
Pat Doody, Coillte
Derek Felton, Woodstock Seeds Ltd.

* Email: david.thompson@coillte.ie

COMPLETION DATE: The nursery stage of this project was completed in June 2007 and the field trials are being established in 2008 and 2009.

BACKGROUND

Oak (*Quercus petraea* and *Q. robur*) are important native broadleaf species that occupy a significant proportion of the current broadleaf planting programme in Ireland. While it is Forest Service policy to use home-collected seed, there are good and poor native sources. For this reason it is necessary to identify good seed sources, but perhaps more importantly to identify sources that should be avoided.

OBJECTIVE

The objective of this project is to establish a series of field trials to test the productivity and quality of a range of both registered Irish oak seed stands and 'source identified' Irish seed sources.

PROGRESS

Seed from 11 registered Irish seed stands and 10 'source identified' stands were sown in containers in a heated glasshouse in the spring of 2008. Plants were moved out of the glasshouse in July and hardened off.

As with the ash material grown for the ASHQUAL project, the close spacing of the cells in the trays resulted in the more vigorous plants overtopping the less vigorous individuals, resulting in a wide range of different sized plants. In December 2008 one trial was planted in Camolin Forest in Co Wicklow.

ACTIVITIES PLANNED

A second trial will be planted in early 2009. It is proposed to line out all plants in a nursery bed and grow them for establishment of a third field trial in autumn/winter 2009/10.

QUALIBROAD

Improving the uniformity and quality of broadleaf planting stock

PROJECT TEAM

Dr Conor O'Reilly, University College Dublin*
Colin Doody, University College Dublin
Ruairi Manktelow, University College Dublin
Farhana Afroze, University College Dublin
Sarah Ryan, University College Dublin
Pat Long, Coillte
Pat Doody, Coillte
Dermot O'Leary, Coillte
Prof. Anders Mattsson, Dalarna University, Sweden
Prof. Douglass Jacobs, Purdue University, USA
Justin Schmal, Purdue University, USA

* Email: conor.oreilly@ucd.ie

COMPLETION DATE: December 2009

BACKGROUND

The planting of broadleaf species in Ireland has increased in recent years, with broadleaves now accounting for more than 30% of the current planting programme. Consequently, there has been a renewed focus on improving the yield and quality of broadleaf planting stock in the nursery. The main focus of the QUALIBROAD project was to address these issues for broadleaf species of importance in the forestry programme in Ireland. The development of new seed pretreatments and seed storage protocols, and the effects of post germination aspects (cloches, fertilization, mini-plugs) of nursery culture on seedling growth, yield and quality were examined over several years. The seed research element of the project conducted in previous years at the laboratory in University College Dublin focussed on common alder (*Alnus glutinosa* Gaertn.), birch (*Betula pendula* Roth. and *Betula pubescens* Ehrh.), ash (*Fraxinus excelsior* L.) and pedunculate oak (*Quercus robur* L.). Most of this research was completed in 2007. In 2008, research on ash seeds was continued and new research commenced on the seeds of spindle tree (*Euonymus europaeus* L.), rowan (*Sorbus aucuparia* L.) and Guelder rose (*Viburnum opulus* L.).

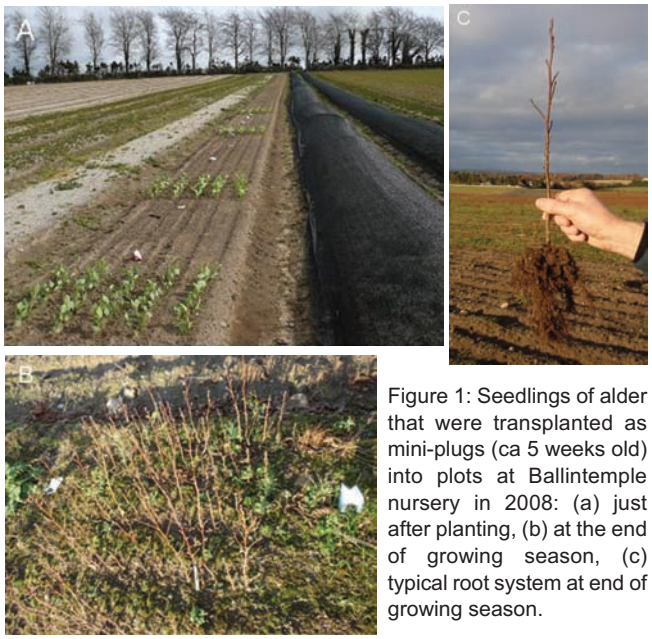


Figure 1: Seedlings of alder that were transplanted as mini-plugs (ca 5 weeks old) into plots at Ballintemple nursery in 2008: (a) just after planting, (b) at the end of growing season, (c) typical root system at end of growing season.

OBJECTIVES

- To improve seed germination in ash, spindle tree, rowan and Guelder rose;
- To evaluate the potential for transplanting alder plants as miniplugs;
- To grow oak seedlings to plantable size in a single season using the exponential fertilization method.

PROGRESS

Seed research on spindle tree, rowan and Guelder rose commenced in 2008. Since the seeds of these species require very lengthy pretreatment periods (including a warm phase) to break dormancy, only preliminary work could be completed in 2008. In addition, problems were encountered in conducting seed tests on spindle tree seeds, which delayed progress further. The work in ash focussed on (i) germination temperature responses of pretreated (non-dormant) seeds, and (ii) the impact on the post-storage germination of pretreated seeds.

New research in the area of mini-plug transplanting was completed, in collaboration with Prof. Anders Mattsson of Dalarna University. The mini-plug seedlings were grown in Sweden (using seed supplied by Coillte) and then transplanted into the nursery in early April and early May. The seedlings planted in May performed very well, but those planted in April performed poorly due to the unseasonably cold and windy weather that prevailed soon after planting. Despite these problems, the results were very promising, indicating that alder seedlings could be produced in a single growing season using the mini-plug system (Figure 1).

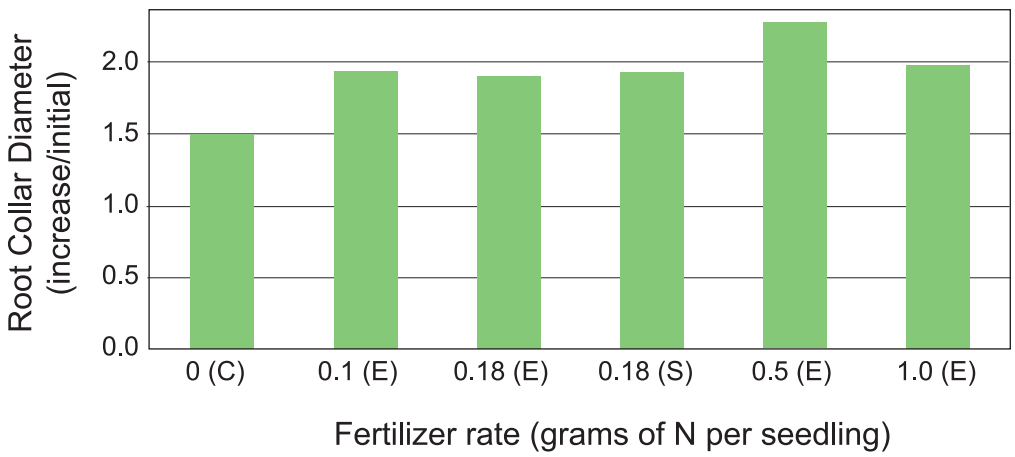


Figure 2: Diameter growth relative to initial diameter in oak seedlings in response to fertilizer treatments. Treatments: C = no fertilizer; S = standard level (as currently used operationally); E = exponential fertilization.

In another study in collaboration with Prof. Douglass Jacobs of Purdue University, the use of exponential nutrient loading to improve the quality of pedunculate oak seedlings and leaching dynamics in a trial laid down at Ballintemple nursery was investigated. The preliminary results from this study are promising (Figure 2), although all the sampling and data analysis has not been completed yet. In particular, there was evidence that the exponential method reduced nutrient leaching, with consequent environmental benefits.

ACTIVITIES PLANNED

Continue the seed research element and fertilization study in oak (in collaboration with Purdue University).

OUTPUTS

Doody, C. and O'Reilly, C. 2008. Drying and soaking pretreatments affect germination in pedunculate oak. *Annals Forest Science* 65: 509 p1-7.

Doody, C. and O'Reilly, C. 2008. *Long periods of warm pretreatment improve germination in ash seeds.* Poster presented at the 9th ISSS Conference on Seed Biology, 6-11 July 2008, Olsztyn, Poland.

O'Reilly, C. *The New Forests of Ireland.* Invited seminar presentation. Purdue University, Indiana, 22 April 2008.

O'Reilly, C. and Cabral, R., 2008. *Lifting and handling stresses can cause shoot dieback in oak.* COFORD, Dublin.

Schmal, J., Jacobs, D.F. and O'Reilly, C. 2008. *Exponential fertilization of pedunculate oak* (Quercus robur L.) *seedlings: quality assessment, nutrient budgeting, and leaching dynamics.* Poster presented at the Society of America Foresters Convention, 5-9 November 2008, Reno, NV, USA.

SEEDSTANDS

The national catalogue of seed stands

PROJECT TEAM

John Fennessy, COFORD*
Derek Felton, Woodstock Seeds Ltd.
Gerard Cahalane, Forest Service

* Email: john.fennessy@coford.ie

COMPLETION DATE: The national and EU seed stand listings are reviewed and updated at the end of every calendar year. The next review will take place during 2009 and an updated list will be published at the end of December 2009.

BACKGROUND

On becoming a member of the European Union in 1973, Ireland was obliged to comply with a number of directives on the marketing of forest reproductive material. These directives were updated in 1999 with new regulations coming into force across all EU states from 1 January 2003. In compliance with the regulation, the Irish State is required to *draw up a national register of the basic material of the various species approved on its territory*. This is the responsibility of the regulatory authority, the Forest Service, who, with COFORD, carries out the annual update of the national catalogue of seed stands and fulfils an important role in the identification, categorisation, management and evaluation of progeny of seed stands selected under national and European regulation.

High quality beech seed stand in the Forêt de Soigne, Belgium, suitable for supplying reproductive material for Ireland.

OBJECTIVE

To comply with the EU Directive on the marketing of forest reproductive material as well as to satisfy the national forest reproductive material (FRM) requirements, where possible, from best adapted most productive and most suitable forest reproductive material from home sources. Where home sources are not available the national needs are satisfied from suitable overseas material.

PROGRESS

The main progress during 2008 was the identification of stands for the production of forest reproductive material to meet the demands of the main commercial conifer species, especially Sitka spruce, lodgepole pine and to a lesser extent Norway spruce. In recent years, supply of forest reproductive material for lodgepole pine was provided from seed orchards; however, these orchards are now in decline and production of seed in these orchards is low. As an interim measure and until new orchards are established, suitable stands of known origin will be selected and used as seed sources for lodgepole pine.

A significant area of broadleaved seed orchards has been established since 2000. These include ash, alder, birch, oak and sycamore of both clonal and seedling selected material. Part of this work is in co-operation with the British and Irish Hardwoods Improvement Programme (BIHIP). It should be noted that 2008 was a particularly bad year for tree seed production in Ireland especially in most of the broadleaved species apart from ash, birch and alder.

An active Sitka spruce breeding programme has been ongoing since the 1970s and from an original selection of over 550 plus trees, 86 have been proven in field trials to have superior growth and quality characteristics. The parents of this material, retained at Kilmacurra, are the basis for selected

Sitka spruce now available and are classified as 'tested' material. Over the last few years a number of hedge orchards have been established in Aughrim nursery for the purpose of commercial production of this improved material and these were added to the 2007 list. A further new hedge orchard was added to the list in 2008.

ACTIVITIES PLANNED

Continue review and updating of the national catalogue in line with current demands and related requirements.

OUTPUTS

Completed the 2008 national and EU listing. The current area of seed stands is shown in Table 1.

Table 1: Current area of seed stands as at 31 December 2008.

SCIENTIFIC NAME	COMMON NAME	AREA (ha)
Acer pseudoplatanus	Sycamore	7.0
Alnus glutinosa	Common alder	113.3
Betula pubescens	Common birch	26.0
Castanea sativa	Spanish chestnut	8.6
Fagus sylvatica	Beech	80.3
Fraxinus excelsior	Ash	155.8
Quercus petraea	Sessile oak	1381.3
Quercus robur	Pedunculate oak	737.9
Chamaecyparis lawsoniana	Lawson cypress	3.3
Larix decidua	European larch	19.7
Larix x eurolepis	Hybrid larch	2.9
Larix kaempferi	Japanese larch	50.1
Picea abies	Norway spruce	379.7
Picea sitchensis	Sitka spruce	603.2
Pinus contorta	Lodgepole pine (North coastal)	13.0
Pinus contorta	Lodgepole pine (South coastal)	112.0
P. nigra var. maritima	Corsican pine	63.1
Pinus radiata	Monterey pine	21.7
Pinus sylvestris	Scots pine	159.6
Pseudotsuga menziesii	Douglas fir	123.3
Abies procera	Noble fir	57.4
Thuja plicata	Western red cedar	8.9
Taxus baccata	Yew	33.1
	Mixed species	36.0
	TOTAL	**4129.5**

SILVICULTURE

OVERVIEW

Forest policy changes made in the 1980s to diversify the species composition of the forest estate resulted in a significant expansion in the area of broadleaved tree species. From a very low base 20 years ago broadleaves have now reached almost 30% of the annual afforestation programme. This has presented Irish foresters with a challenging situation as broadleaves are more demanding in terms of site requirements; and are more costly in terms of establishment, maintenance and subsequent management than the conifer species which have formed the greater part of the afforestation effort to date. Issues such as matching of species to site types, planting pure or mixed crops, compatibility of species, shaping, tending and more recently thinning have tested foresters silvicultural skills for some time. Much has been learned from practical experience: however, research has helped and the **BROADFORM** and **GBREVIEW** projects, both of which combine a scientific and practical approach, have greatly assisted in providing much needed guidance for forest managers and owners. All of the experience and experimentation to date with broadleaves in Ireland is currently being reviewed in the **GBREVIEW** project. The findings will update our knowledge on the silviculture of broadleaves and will be published in a book which will replace *Growing Broadleaves* first published in 1998.

Another area that requires a high level of silvicultural skill is the management of forestS under continuous cover. These less intensive alternativeS to clearfell silvicultural systems, that are practised in many European countries have the potential to deliver multifunctional outputs from forests, particularly for sensitive sites. However, these systems are new to Ireland and have evolved in a forest environment that is very different to that experienced in this country. The **CONTINUCOVER** project is evaluating the potential of these systems in Ireland.

Good timber properties and the ability to survive and grow on difficult sites have led to the widespread planting of the Sitka spruce. Sometimes, however, the species has been extended to sites of low nutrient status where it cannot develop into a merchantable crop without additional application of fertilisers. Aerial fertilisation is no longer an option in many of these areas and alternative application methods are required. **GROWCHECK** is a development project that seeks to find practical solutions to this problem.

BROADFORM

Silviculture of new broadleaved species: shaping and thinning

PROJECT TEAM

Dr Ian Short, Teagasc*
Toddy Radford, Teagasc

* Email: ijshort@hotmail.com

COMPLETION DATE: December 2008

BACKGROUND

Whilst final crop volume of timber is important for broadleaves, quality is also important due to the different end uses for the timber. Concern has been expressed about the quality and ongoing management of broadleaf afforestation sites as some broadleaf crops have been planted on marginal sites and many areas are neglected after year four. Current broadleaf silvicultural knowledge in Ireland is in its infancy. This project aimed to augment the current silvicultural knowledge of the management of young broadleaf plantations with the aim of producing high quality, valuable timber. Pruning of ash, beech and oak, and tending of ash, has been investigated.

OBJECTIVES

Develop treatment protocols for the early management of broadleaved species to include:

- Shaping methods to control early stem form in the 1 to 3 m range;
- Development of tending practice to favour the best quality stems.

PROGRESS

Two demonstration days were held during 2008 at privately-owned sites in Co Westmeath and Co Limerick to demonstrate the tending of ash. Tom Kent (WIT, ForestEnergy programme) demonstrated extraction by quad bike and timber arch and also small-scale firewood processing at one of the demonstration days. An important aspect of the demonstration involves the identification by participants of Potential Crop Trees (PCTs) and trees to be removed during a tending operation. The demonstration days illustrated that, after minimal practical training, the majority of participants can successfully select the correct trees as PCTs and also those to be removed. In addition, Dr Ian Short and Toddy Radford presented the tending of ash at an ITGA/SIF field day held at Johnstown Castle, Co Wexford.

Dr Ian Short participated in the T10Q workshop, held at Oxford University, which had the objective of identifying the top 10 priority questions for forest research. The results of the workshop, however, may not be fully applicable to Ireland as, of the 51 people that participated, only four were from Ireland and therefore there may be priority questions in an Irish context that have not been captured by the voting process.

Dr Ian Short and Toddy Radford attended the *Growing Valuable Broadleaves* conference at the University of Freiburg. Dr Ian Short also attended the final meeting of COST E42.

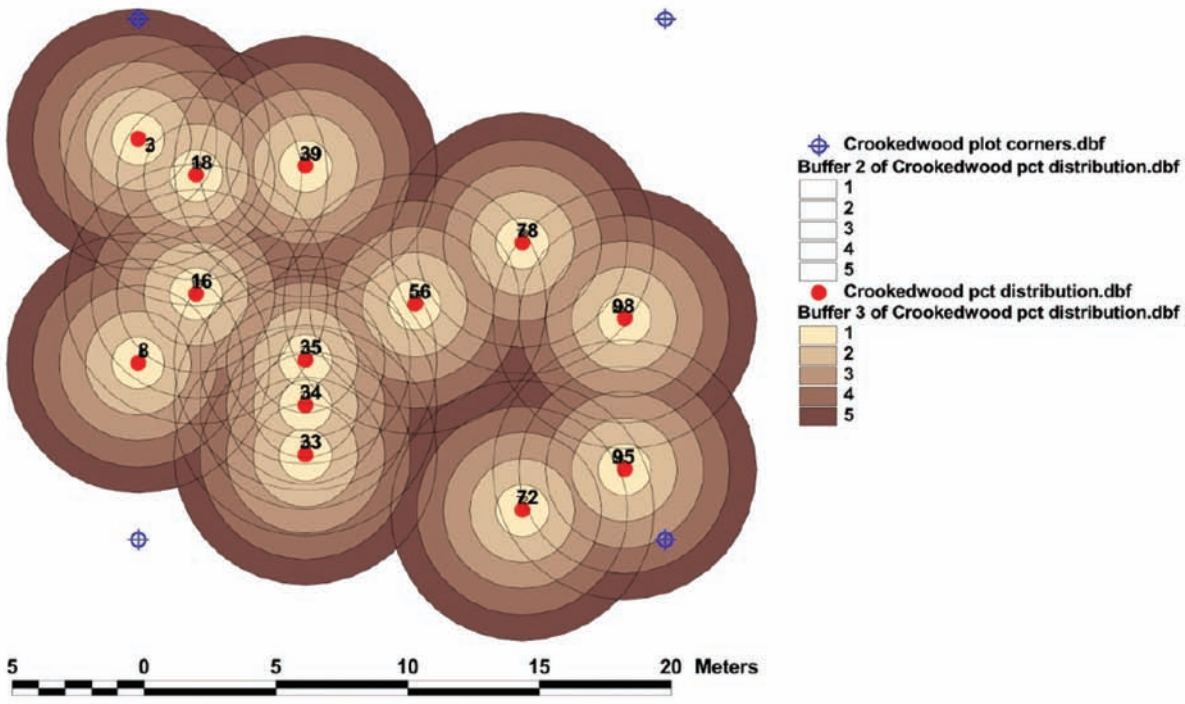
The final measurements of the COFORD-funded poplar trials located at Teagasc Kinsealy, Ballyhaise and Kildalton centres were completed during the year.

An alder tending trial is in the process of being established. The trial site has been laid out and potential crop trees and their competitors have been selected. Baseline measurements have been recorded and the site now requires tending and monitoring.

ACTIVITIES PLANNED

Dr Ian Short and Toddy Radford will continue to provide input to the COFORD broadleaf silviculture programme and the review of *Growing Broadleaves*. A number of broadleaf tending demonstration days are planned for 2009.

Participants selecting Potential Crop Trees (PCTs) at the Crookedwood ash tending demonstration day.



Distribution of Potential Crop Trees (PCTs) within a 20 x 20 m plot, Crookedwood demonstration day.

OUTPUTS

Ash tending demonstration days: 9 April, Crookedwood, Co Westmeath; 17 September, Moroe, Co Limerick; 18 April, Johnstown Castle, Co Wexford. ITGA/SIF field day.

The BROADFORM project was presented on 20 June at FarmFest 2008.

Following consultation with Teagasc Forestry Development Officers and industry, Dr Ian Short and Toddy Radford have written guidelines for the tending and thinning of broadleaves. The BROADFORM project has also had input to the review of the *Growing Broadleaves* book to be published by COFORD.

Short, I., Bulfin, M. and Radford, T. 2008. COST E42 *Growing valuable broadleaves silviculture matrix: An Irish example.* Poster presented at the Growing Valuable Broadleaves conference, University of Freiburg, Germany. 5-9 October 2008.

Short, I. and Radford, T. In Press. *Silvicultural guidelines for the tending and thinning of broadleaves. Recommendations for the tending and thinning of ash, sycamore, Norway maple, alder, oak (pure), oak with conifer nurse, beech (pure) and beech with conifer nurse.* Teagasc.

CONTINUCOVER

An evaluation of continuous cover forestry in Ireland

PROJECT TEAM

Dr Áine Ní Dhubháin, University College Dublin*
Prof. Tom Bolger, University College Dublin
Nuala Freeman, University College Dublin
Denis Coghlan, University College Dublin
Seamus Kennedy, University College Dublin
Dr Michael Keane, Coillte
Donal O'Hare, Field forester
Tottenham family, Forest owners

* Email: aine.nidhubhain@ucd.ie

COMPLETION DATE: December 2009

BACKGROUND

Continuous cover forestry (CCF) includes all silvicultural systems that involve the continuous and uninterrupted maintenance of the forest. While the practice of CCF is not new, interest in this approach to forest management increased in Europe in the early 1980s. The vast majority of forests in Ireland are managed using the clearfell system, but this has increasingly been criticised. This study set out to explore means by which stands managed under the clearfell system can be transformed so as to be managed under alternative systems. A key element of the transformation process is the ability to develop an understorey below an existing canopy using natural regeneration or underplanting.

OBJECTIVES

- To assess the survival and growth of a number of tree species under various levels of canopy cover;
- To monitor throughfall, temperature, and rate of nutrient turnover (C and N) under these canopies;
- To establish plots to demonstrate the implementation of alternative silvicultural systems to clearcutting.

PROGRESS

Experiments investigating the survival and growth of a number of tree species under various levels of canopy cover shade were completed during previous reporting periods and the objectives outlined above have been achieved. The main focus during this reporting period was to set up additional demonstrations sites. The first stage of the work to establish Mount Callan forest as a demonstration forest for continuous cover forestry is finished, with the completion of an inventory. Prescriptions for the management of sections of this forest under CCF systems are currently being drawn up. Different thinning systems will be used to demonstrate the initial stages of the transformation process to CCF.

ACTIVITIES PLANNED

The following tasks will commence in 2009:

- Complete the set up of Mount Callan as a demonstration site;
- Host an international conference on Continuous Cover Forestry in Europe in conjunction with CONFOREST, a European Forest Institute regional project centre concerned with the process of converting stands to CCF;
- Establish an AFI* site in Mount Callan;
- Establish an additional marteloscope site;
- Complete and submit the final project report.

OUTPUTS

Seamus Kennedy was awarded a PhD in April 2008 for his thesis *The impact of shade on the morphology, physiology and photochemistry of* Picea sitchensis, Larix x eurolepis *and* Thuja plicata.

Denis Coghlan was awarded an M.Agr.Sc in April 2008 for his thesis *Survival and growth of five commercial tree species planted under various levels of canopy cover in a 40 year-old Sitka spruce stand.*

* The AFI (Association Futaie Irrégulière) is an association registered by French law, setup in 1991 by a group of private forestry consultants in order to promote the management of irregular stands. It aims to share technical information and is founded on the principles advanced by ProSilva. These two associations remain quite distinct, although they each share a certain number of common objectives. Much of the effort in the organisation has been directed toward irregular management of broadleaved stands. The AFI has put in place a network of "reference" stands to demonstrate how managers were working and what was successful. A key principle of the network is that there is no overall prescribed management: the network observes and records the operations of experienced practitioners in well–structured forests owned by a range of private forest owners across a range of sites type. At the start of December 2004 there were 61 reference stands.

GBREVIEW

Review of *Growing Broadleaves*

PROJECT TEAM

Editorial committee:
Prof. Juergen Huss, University of Freiburg, Germany
Prof. Padraic Joyce, University College Dublin
John Fennessy, COFORD*

Working group:
Dr Ian Short, Teagasc
Dr Nuala Ni Fhlatharta, Teagasc
Eugene Curran, Forest Service
Alistair Pfeifer, COFORD
Joe Barry, Farmer
Ted Horgan, Coillte
Dr Richard McCarthy, Coillte

* Email: john.fennessy@coford.ie

COMPLETION DATE: December 2009

BACKGROUND

COFORD published *Growing Broadleaves* in 1998 with the intention of providing foresters, landowners and students with silvicultural guidelines for the establishment and management of broadleaves in Ireland. In the interim period, much experience and knowledge has been acquired on the performance of broadleaves. In order to capture changes as well as to extend the range of species, it was decided to undertake a full review of the original publication.

OBJECTIVES

The main objective is to review and update the original COFORD publication *Growing Broadleaves* based on practical experience gained with the establishment and management of broadleaves in Ireland since its publication in 1998. Other objectives include extending the range of species covered in the original document from five of the major species to all broadleaved species encountered in Irish forestry today including most of the minor broadleaved species.

PROGRESS

Several meetings of the editorial committee took place during 2008 and agreement was reached on the new structure of the book. Final drafts are ready for distribution to members of the working group. Many studies and evaluations have been undertaken in 2008 in relation to material for the book combined with field visits to successful and problematic sites during the year.

OUTPUTS

As part of the review, an Irish student from the Albert-Ludwigs University in Freiburg, completed a masters degree in forest ecology and management in 2007 on *Quantifying the development of oak/Scots pine and oak/European larch stands in Ireland.* A draft COFORD Connects Note based on the study will be published in 2009.

ACTIVITIES PLANNED

It is anticipated that the new publication will be launched at the end of 2009 as part of an international conference on broadleaved silviculture.

GROWCHECK

The application of fertilizer using ground-based machines in checked forest stands

PROJECT TEAM

Dr Dermot Tiernan, Coillte*
Michael Flannery, Coillte

* Email: dermot.tiernan@coillte.ie

COMPLETION DATE: December 2008

BACKGROUND

Coillte owns approximately 6,000 ha of checked Sitka spruce plantations in Galway and Mayo. These plantations are deficient in both P and N and occur mostly on peatlands. In order to bring these crops to maturity it is expected that on average two fertilizer applications will be required for most stands. Based on research from the 1980s it is reasonable to assume that most checked stands will respond to fertilizer applications, assuming that poor drainage and exposure are not limiting factors. Analysis by previous researchers suggests that spreading fertilizer using a helicopter is cost effective when it covers large areas. However, in recent years, due to stakeholders' requests, this option has not been used. As a result, there is a need to explore ground-based machines as a potential alternative to the use of helicopters for spreading fertilizer. The machine trial outlined in this report demonstrated the potential of using a ground-based machine to apply fertilizer in typical checked stands.

OBJECTIVE

To explore the practicality, feasibility and cost of applying fertilizer using ground-based machines in checked forest stands.

PROGRESS

The trial was completed in October 2008 in a typical west of Ireland checked stand of Sitka spruce on peatland and a detailed report was compiled. Analysis of the cost of using ground-based machines for fertilizing suggests that it is financially viable to fertilize these areas, based on current costs and revenues, if they can be taken out of check to a suitably high yield class. The trial also indicated that spreading fertilizer using a ground-based machine is technically possible but more work will be needed to adapt the machine used in this trial if it is to be effective. These adaptations include, investigating the possibility of using a machine with a smaller effective width, ensuring calibration of spreader is correct, further investigation into the rate and variation of the spread rate of the fertilizer, improvements to the limiter function and the use of more sophisticated GPS guidance systems. Of these, the most critical from a cost perspective is the effective width of the machine. The majority of areas in check will at some point require fertilizer when the crop is at pre-thicket stage. For access reasons, the adoption of the machine used in this trial requires one line in seven to be felled to waste, with brashing along the adjoining line of trees to facilitate fertilizer ingress into the forest. This manual element has a significant cost implication on the overall financial viability and it is recommended that further investigation on machines with smaller effective widths be evaluated.

Spreading scenarios: left) open canopy; right) pre-thicket.

ACTIVITIES PLANNED

The trial and final report are complete.

OUTPUTS

Tiernan, D. and Flannery, M. 2008. GROWCHECK (Fertilizer machine trial). Coillte, Newtownmountkennedy, Co Wicklow, Ireland. Unpublished.

FOREST PLANNING AND MANAGEMENT

OVERVIEW

PLANSFM:

The planning and implementation of sustainable forest management

Programme leader: Prof. Maarten Nieuwenhuis

Programme manager: Charles Harper

The management of forests in Ireland is evolving into an increasingly complex process. Two significant factors have contributed to this change. The first was the publication of the Irish National Forest Standard*. This document introduced Sustainable Forest Management (SFM) as the national standard and it requires that all management decisions are based on an evaluation of economic, social and environmental indicators. This standard requires the availability of a very wide range of data and the systems to collect, analyse and incorporate the information in management (planning) decision-making procedures. It has also introduced a need to widen the range of silvicultural and management practices, including the use of mixtures, diverse species, continuous cover systems and retention, while the range of potential products has widened to include biomass and bioenergy, carbon sequestration and biodiversity. The second change has been the expansion of private forestry. As a result, but also as a consequence of Coillte's diversification of management, the simple situation where one company with its standardised practices determines the status of the national forest estate, the forecasted (timber and non-timber) outputs, and the future development and make-up of the estate, has gone. There is now a need for private and public owners and management companies to have access to tools to collect, store, analyse and use the information necessary for the sustainable management of their estates.

The motivation for the projects that comprise the PLANSFM programme originates in these two major changes. The programme addresses the need for improved access to information and decision support systems required for the sustainable management of the national forest estate, both private and state-owned, in Ireland.

The main objective of the PLANSFM programme is to improve access to better quality information about the forest through the development of new inventory and analysis tools and improved software to support sustainable forest management decisions. The key issues addressed are focussed on improvements in private and state forestry: multi-resource inventory protocols, decision support tools, improved modelling

* Anon. 2000. Irish National Forest Standard. Forest Service, Department of the Marine and Natural Resources. ISBN 0-9538874-0-5.

of forest growth and yield, improved forest volume assessment, and identifying and quantifying forest resources to maximise potential markets. In addition, the programme addresses the need for access to the results of previous forestry research trials and experiments, bringing added value to the existing data and ensuring the continued maintenance and assessment of existing, relevant experimental sites.

The long-term goals of the PLANSFM programme are to support the forest industry through the provision of improved tools to support sustainable forest management. These include:

- Improved volume and yield models for a wider range of tree species (and mixtures) than is currently available.
- Improved tools for carrying out, analysing, recording and reporting of multi-resource forest inventories and the timber and non-timber forecasts associated with the management plans developed using the inventory data.
- The provision of decision support tools for forestry on sensitive sites, including the western peatland forests.
- The evaluation and further development of new technology and data analysis procedures for multi-resource inventories, including terrestrial laser scanning and equipment for upper stem and crown measurements.

The key benefit the PLANSFM programme is bringing to Irish forestry is in the provision of better quality information about the forest, the best options for sustainable management of the forest using this information, and the provision of forecasts of timber and non-timber outputs at local and regional levels. This extends from the shape of individual tree stems, the yield of timber and non-timber outputs of the forest, the optimal conversion of trees to forest products, the provision of timber production forecasts based on actual inventory and management information, to giving scientists access to data from completed and ongoing forestry trials and experiments. The PLANSFM programme will result in new methods for timber measurement using laser scanning devices, new tools for modelling volume at tree and yield at stand level, the introduction of multi-resource inventory and forest management software in the forest industry, the production of local and regional timber and non-timber production forecasts, and, though an online database, improved access to the data produced by previous forestry research in Ireland.

PLANSFM

FORESTSCAN

Terrestrial laser scanning technology for multi-resource forest inventories

PROJECT TEAM

Prof. Maarten Nieuwenhuis, University College Dublin*
Martin van Leeuwen, University College Dublin
Mark Tarleton, PTR Ltd.
Enda Keane, TreeMetrics Ltd.
Garret Mullooly, TreeMetrics Ltd.
Taye Mengesha, University College Dublin

* Email: maarten.nieuwenhuis@ucd.ie

COMPLETION DATE: December 2011

BACKGROUND

Ireland is a high cost economy, which is reflected in the delivered-in price of wood. Research and development aimed at reducing costs and thereby increasing competitiveness in roundwood production is the key driver behind this project. Effective planning and decision-making in modern multi-purpose and sustainable forest management requires up to date and accurate data in order to evaluate the range of potential options for the future management and utilisation of a forest.

OBJECTIVES

The three main objectives of the study are:

- An investigation of the basic principles of terrestrial laser scanning technology and its applicability to (multi-resource) forest inventories;
- An evaluation of existing data analysis software and the development of new software, for a range of forestry applications;
- A cost-benefit analysis for the introduction and use of this technology over a range of potential inventory applications.

PROGRESS

An investigation of the state of the art of laser scanning has been conducted and the report is currently being written. The investigation includes terrestrial (Figure 1), aerial and space-borne LIDAR techniques, and their relative advantages and potential to support each other. It is understood that the combined application of these three techniques could enhance conducting forest inventories both on a local and global scale.

A survey has been completed and highlighted the data analysis software for terrestrial laser scanning data from forests. Other work includes the development of branch detection algorithms (Figure 2). This will be included in written work resulting from the development of a new software algorithm that is designed to detect and map a tree's branching structure.

Following the measurement of the first 19 plots, PTR and TreeMetrics have submitted their independently compiled data sets to University College Dublin for processing and comparative analysis.

Figure 1: Data collected from the scanning device (foreground) can be checked using a laptop computer before completing the plot scan.

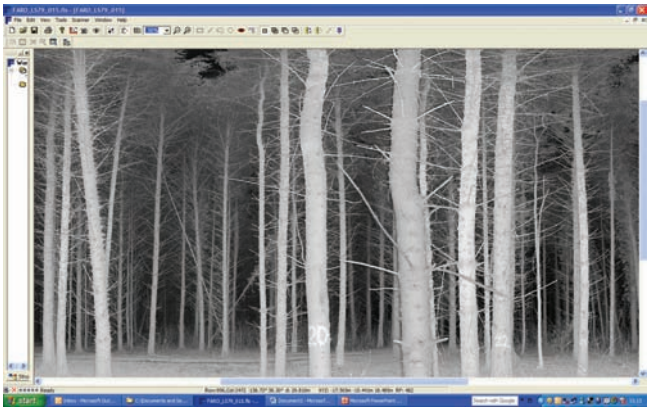


Figure 2: A point cloud derived from a laser scan. Part of the project aims to develop software that will recognise branching.

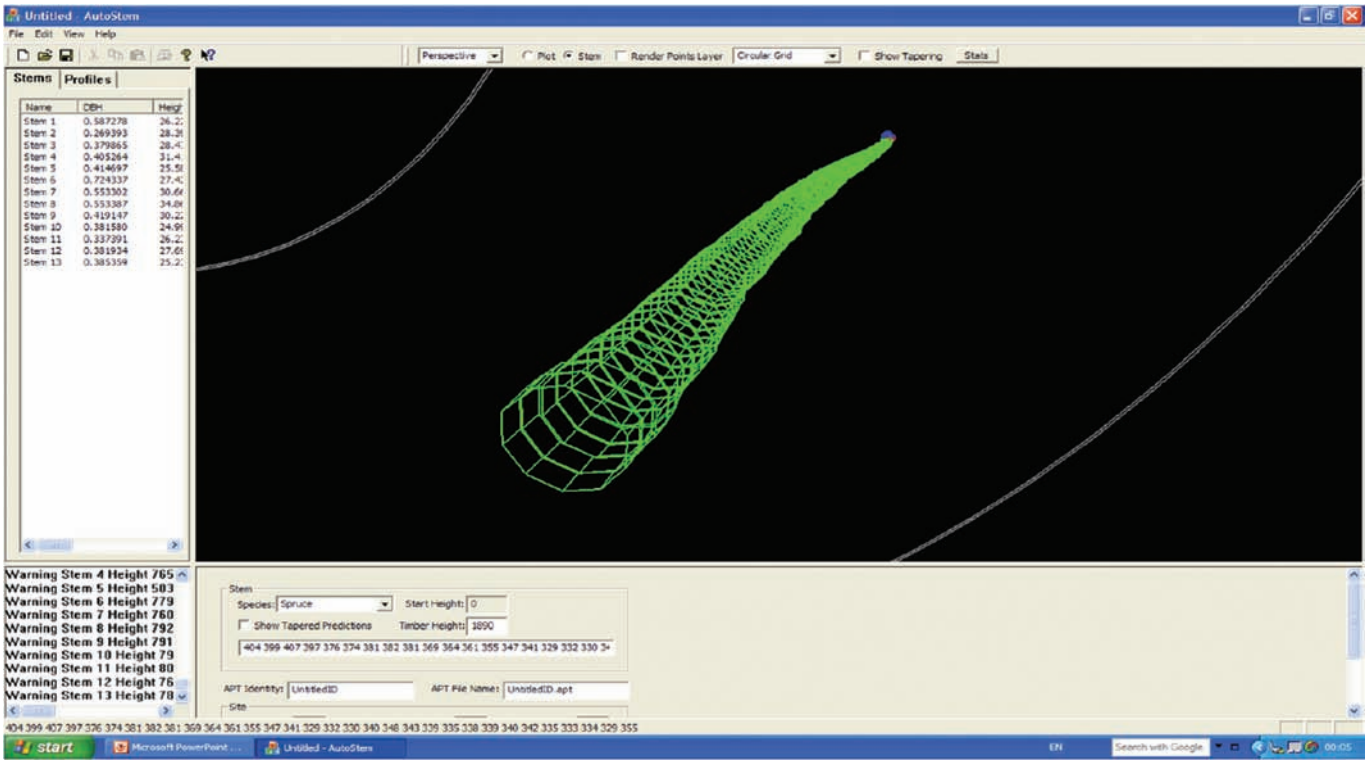


Figure 3: Autostem software interface during analysis of collected scan data.

ACTIVITIES PLANNED

- The data collected from the 19 plots will be analysed (Figure 3).
- Based on the results of the analysed data and manually measured parameters in the 19 plots, other sites will be selected by including various species of forests at different ages.
- The terrestrial scanning and measurement of sample trees by callipers will be carried out together with TreeMetrics and PTR.
- Work will commence on improving the reported weakness of the Autostem software together with the software developers from Dresden University and TreeMetrics.
- A research paper will be prepared on the results of the first data analysis.
- A second phase of field work will commence in spring 2009.

OUTPUTS

Nieuwenhuis, M. 2008. FORESTSCAN – Terrestrial laser scanning technology for multi-resource inventories. *Irish Timber and Forestry* 17(3): p 32 - 35.

PLANSFM

NATFOREX

Establishing a national resource of field trials and a database for forest research and demonstration

PROJECT TEAM

Prof. Maarten Nieuwenhuis, University College Dublin*
Clare Cullinan, University College Dublin
Ted Lynch, Coillte
Donal O Hare, University College Dublin

* Email: maarten.nieuwenhuis@ucd.ie

COMPLETION DATE: October 2013

BACKGROUND

Years of forestry research have resulted in an extensive network of experimental trials on many aspects of silviculture and forest management. These trials have provided scientific data to assist in developing best forest practice and have also acted as demonstration areas for communicating research results. The NATFOREX project aims to create a national database of trials established to date. The project will give a useful inventory of the resources available and silvicultural and management treatments tested. It will also facilitate reviews of knowledge gained to date and help to show areas where new trials may be required.

OBJECTIVES

To maintain and manage a national network of field trials for the study of silvicultural and forest management treatments. Specifically to:

- evaluate the relevance of existing trials in the Coillte experimental plot network and in the research sections of other organisations;
- decide on the feasibility of analysing existing data and on the benefits of further data collection;
- decide on the need to establish new trials;
- carry out necessary maintenance on field trials;
- collect new data in trials where required;
- integrate the findings and data from the trials into a public online database.

PROGRESS

In the last year the focus has been on developing methods on how the project data are collected. A list of 1,500 field trials established by state forestry and other organisations has been compiled. This list is the basis for all investigations in the project. A secure intranet site has been set up to store metadata about the field experiments. A project management group has been established to advise on the retention of field trials and inclusion in the database. An advisory group met during the year and contributed to the longer-term direction of the project.

Part of the intranet development includes an early warning system that will alert the project to potential loss of trial sites. A number of sites were found to be part of the forest stands offered for sale as thinnings or clearfell areas under Coillte's marketing system. This risk was highlighted in the database communicated to Coillte's Forest Information System. A

NATFOREX project team, management group and advisory group.

Tablet computer used to report on field trials by creating high resolution digital maps.

number of site visits were carried out to establish a practical reporting system to be used in deciding the status of experiments. One site was visited by the project management group so that they could appreciate the difficulties encountered by the project team in assessing a site. To date, in excess of 100 trials have been reviewed and reports on these are being compiled. Up to 500 trials have been documented in the NATFOREX database.

A new tablet computer is used to report on field trials by creating high resolution digital maps. This work has been supported by Coillte IT. The company provided shape files: these are geospatial vector data, consisting of different layers of information about a field site, such as forest roads, forest compartments and experiment plot layers. Data recovery was completed during the year. Old computers and storage media have been checked for data, many were damaged and about a third of the corrupt disks were recovered.

ACTIVITIES PLANNED

The design of the NATFOREX internet site including an online database will be completed and populated with experiment records. A number of trials will be approved by the project management group for retention and the associated raw data will be entered into the database. Other (non-Coillte) stakeholders will be invited to contribute to the project. A statistician will be appointed to provide advice on the design of trials and quality of available data. Field reports on remaining intact Coillte trials will continue to be submitted to the project management group and an outline of research areas where retention of trials is recommended will be drawn up.

OUTPUTS

Harper, C. 2008. *NATFOREX - establish a national resource of field trials and a database for forest research and demonstration.* University College Dublin. NATFOREX Brochure.

Nieuwenhuis, M. 2007. NATFOREX – a national data base of forest experiments and research. *Irish Timber and Forestry* 16 (4):20-24.

Liaison with the R&E section of Coillte for IT requirements was carried out in 2008, to set the process in motion to have trials retained under the NATFOREX project recognised in Coillte's GIS.

Nieuwenhuis, M. 2008. NATFOREX – Establishing a national resource of field trials and a database for forest research and demonstration. C*OFORD Forestry and Wood Update* 8(12): 2-3.

Cullinan, C. and Nieuwenhuis, M. 2008. NATFOREX – *Establishing a national resource of field trials and a database for forest research and demonstration in Ireland*. In: Karlsson, K. (Ed.) Proceedings of the NoLTFoX meeting, Edinburgh, Scotland (5 – 6 June 2008). http://www.metla.fi/julkaisut/workingpapers/2008/mwp105.pdf

Current Internet Presence

http://coillteconnect/sites/natforex/default.aspx

www.ucd.ie/research/publications/20062007/lifesciences/schoolofbiologyenvironmentalscience/

http://www.coford.ie/iopen24/pub/defaultarticle.php?cArticlePath=196_421_425_453

http://www.coford.ie/iopen24/pub/defaultarticle.php?cArticlePath=141_483 (NATFOREX mentioned in the Silviculture scoping paper)

http://www.ucd.ie/forestry website describing NATFOREX in the context of the PLANSFM research programme (due for launch in March 2009).

PLANSFM

PRACTISFM II

PractiSFM: Implementation, communication and optimisation

PROJECT TEAM

Prof. Maarten Nieuwenhuis, University College Dublin*
Marie Doyle, University College Dublin
Paddy Purser, PTR Ltd.
Daragh Little, Forest Enterprises Ltd.
John O'Reilly, Green Belt Ltd.
Frank Barrett, Forest Service

* Email: maarten.nieuwenhuis@ucd.ie

COMPLETION DATE: December 2013

BACKGROUND

The Irish National Forest Standard, published in 2000, applies to all forest in Ireland. Since its implementation, private forest owners and managers are required to evaluate forests for economic, social and environmental sustainability through the quantification and qualification of multiple resources. Such requirements place additional demands on data collection methods, beyond the traditional, timber-orientated forest inventory. For private woodland owners in Ireland, the lack of reliable, up to date and affordable forest inventory data providing information related to their own properties represents a considerable obstacle in the assessment, monitoring and implementation of Sustainable Forest Management (SFM). The original PractiSFM project resulted in a prototype multi-resource inventory protocol and decision support system (Figure 1), and the PractiSFM2 project will build on this success to implement the system and enhance its usefulness in terms of improved forest management and the provision of a reporting capacity to provide the forestry sector with up to date information on planned outputs from private woodlands.

OBJECTIVES

- Field testing and validation of the PractiSFM system with the help of management companies;
- Further development of the existing system in co-operation with management companies;
- The development of a communication system enabling the uploading of PractiSFM management plan information into a central database;

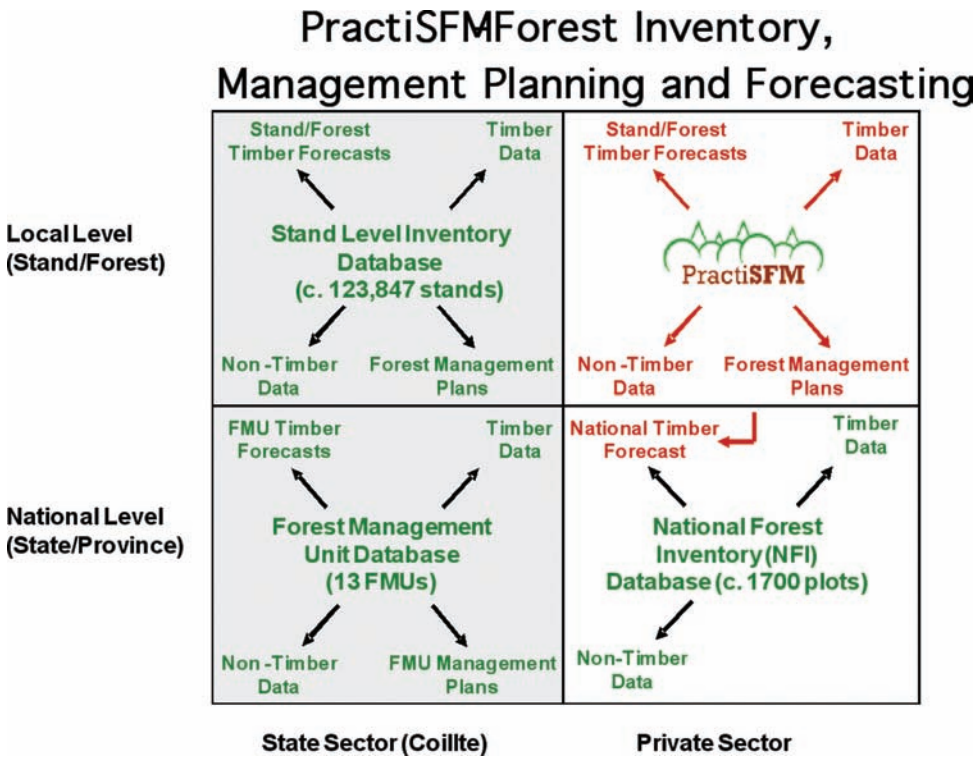


Figure 1: The role of PractiSFM positioned in the private forestry sector for forest planning and management.

- The introduction of a wider range of management options that move towards flexible, user-defined management strategies;
- Development of an optimisation component to the PractiSFM system;
- Implementation of the completed system in the private forest management sector.

PROGRESS

Following on from the PractiSFM project, a number of publications and presentations were produced which deal with the potential of PractiSFM to act as a template for the reporting of forest inventory, management and timber forecast information that incorporates owners' objectives.

ACTIVITIES PLANNED

A revised plan will be drawn up and PractiSFM will be introduced to a number of management companies and, based on their feedback, modifications and additions will be made to the inventory protocol and the data analysis and decision support system. At the same time, the development of a reporting and communication system to enable the uploading of PractiSFM management plan information into a central database will be initiated. This will be done in consultation with the Forest Service. The development of an optimisation module will commence by investigating methods to capture stakeholders' preferences and translation of these into optimisation goals and weights (Figure 2).

OUTPUTS

Barrett, F., Somers, M. and Nieuwenhuis, M. 2007. *PractiSFM – an operational multi-resource inventory protocol for sustainable forest management.* In: Sustainable Forestry: from Monitoring and Modelling to Knowledge Management and Policy Science. (Editors: Reynolds et al.) CABI publishing. Pp 224 – 237.

Barrett, F. and Nieuwenhuis, M. 2008. *A decision support system linking forest policy with sustainable forest management planning in private forests in Ireland*. In: Forest Management. Nova Science Publishers, NY, USA (in press).

Barrett, F. and Nieuwenhuis, M. PractiSFM – multi-resource inventory protocol and decision support system: a model to address the private forest resource information gap in Ireland. *Irish Forestry* (in press).

Nieuwenhuis, M. 2008. PractiSFM II – a link between the inventory and management needs of the private forestry sector and the need for production forecasts. Presented at the COFORD technical workshop *Forest growth modelling and wood production forecasting*. Portlaoise, Ireland (12 May 2008).
http://www.coford.ie/iopen24/pub/120508practisfmii.pdf

Current Internet Presence

http://www.ucd.ie/forestry website describing PractiSFM2 in the context of the PLANSFM research programme (due for launch in March 2009).

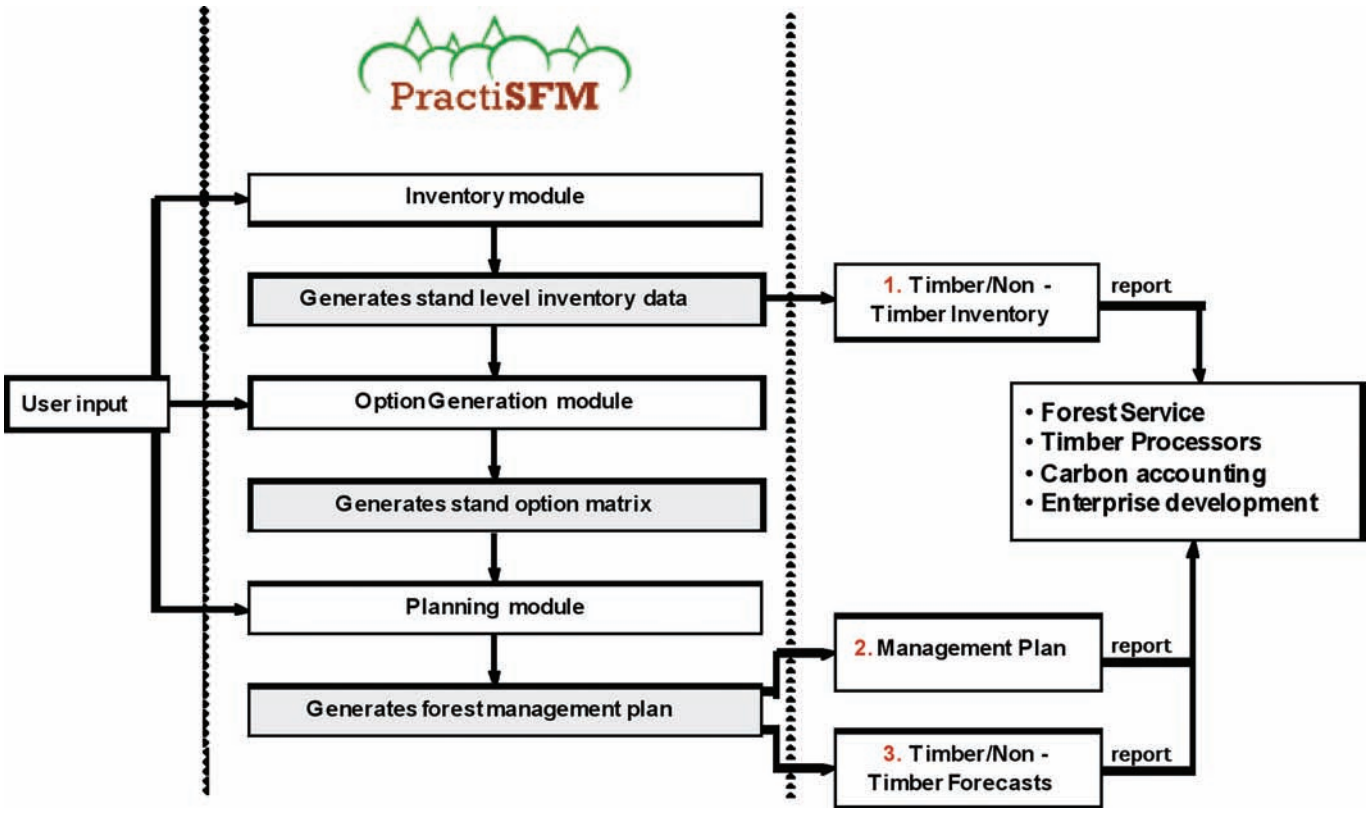


Figure 2: PractiSFM – The link with information needs of the forestry sector.

PLANSFM

STANDMODEL

Development of dynamic yield models for conifers, broadleaves and mixtures

PROJECT TEAM

Prof. Maarten Nieuwenhuis, University College Dublin*
Ross Buchanan, University College Dublin
Paddy Purser, PTR Ltd.
Ted Lynch, Coillte
Dr Lance Broad (consultant)

* Email: maarten.nieuwenhuis@ucd.ie

COMPLETION DATE: December 2012

BACKGROUND

Better resource information is one of the key requirements for investment decisions. Growth and yield models, including those developed under the DYNAMIC YIELD project, are a key component of any decision-making framework. Models developed to date cover Sitka spruce, lodgepole pine, Norway spruce, Douglas fir and Scots pine. These models have an operational interface called GROWFOR (Figure 1), which is licensed by COFORD and which is now in use by Irish foresters. The models are also incorporated into Coillte's volume forecasting systems. Given the increase in the use of both broadleaves and mixtures under grant-aided afforestation, further models need to be developed. The STANDMODEL project is currently developing new dynamic yield models for ash and Japanese larch and is examining ways in which mixtures can be modelled using the dynamic approach.

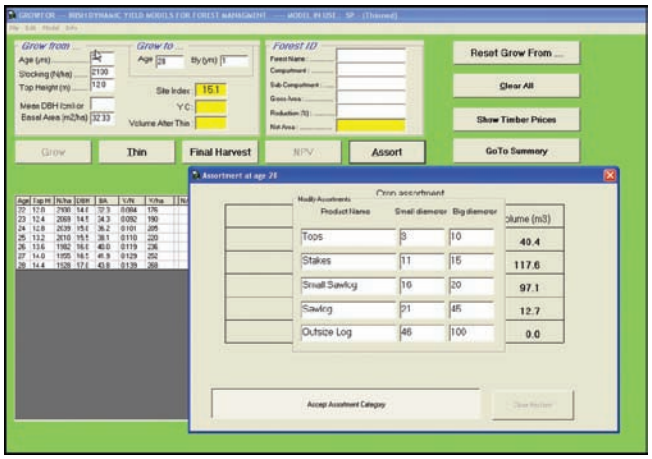


Figure 1: GROWFOR software interface. Models developed for ash and Japanese larch will be included in GROWFOR.

OBJECTIVES

This project is aiming to achieve the following objectives:

- Produce new dynamic yield models for Japanese larch (thinned and unthinned) and ash (thinned) and integrate these into the existing Irish Dynamic Yield Model User Interface.
- Investigate the potential for generating growth forecasts for species mixtures using existing model combinations.
- Investigate the potential for utilising National Forest Inventory plot data in validating and strengthening existing dynamic yield models and in generating new ones.
- Develop additional functionality for the Irish Dynamic Yield Model User Interface in the form of:
  - User defined assortments;
  - Optimisation/goal seeking capability;
  - Facility for mixtures.

PROGRESS

Collection of Japanese larch data: The felling of sample trees and plot measurement was completed in 2008 and the data were added to the national forest measurement database managed by Coillte.

Collection of ash data: Sample plot establishment, measurement, volume sample felling and thinning of ash were carried out in 2008. There are 100 such plots located nationwide (Figure 2) and these are stratified by age and region. Eighty plots are located in Coillte forests while 20 are located in private forests. Annual DBH increment data for all 100 plots are currently being collected.

User-defined assortments have been developed for Scots pine. The process involved for this species may not be replicable for other species but further work in this area is continuing.

ACTIVITIES PLANNED

- Annual measurement of ash sample plots with updates on DBH and plot maintenance.
- A series of temporary plots will be established in Japanese larch and validation data collected for future use in validating the proposed Japanese larch dynamic model.

- There will be continued work on the user-defined assortments.

OUTPUTS

Current Internet Presence

http://www.ucd.ie/forestry website describing STANDMODEL in the context of the PLANSFM research programme (due for launch in March 2009).

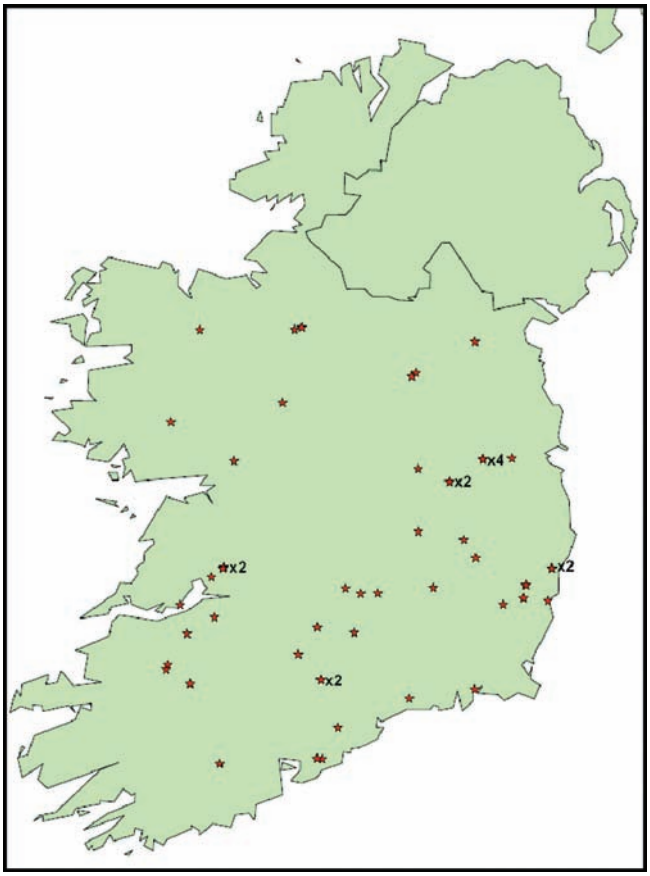


Figure 2: Map of Ireland showing the location of the ash sample plots in the STANDMODEL project.

PLANSFM

TREEMODEL

Development of single tree volume models and stem profile models

PROJECT TEAM

Prof. Maarten Nieuwenhuis, University College Dublin*
John Redmond, University College Dublin
Ted Lynch, Coillte
Paddy Purser, PTR Ltd.
Dr Martin Cerney, IFER

* Email: maarten.nieuwenhuis@ucd.ie

COMPLETION DATE: December 2010

BACKGROUND

The National Forest Inventory has collected detailed tree and stand measurement data at over 1,800 permanent sample plots across the country. Investigations to determine the suitability of these data for updating dynamic yield models are required. Work associated with the National Forest Inventory has derived very accurate Sitka spruce tree volume equations that have an application not only in deriving stand volume estimates, but as a cost-effective mensuration tool. Further work is required in this area, extending to other species, as is research on deriving wood supply indications from the national inventory and other data sources.

OBJECTIVES

- Produce stem profile models for ash, Douglas fir, Japanese larch, lodgepole pine, Norway spruce, Scots pine and Sitka spruce.
- Validate these models with newly collected stem data.
- Describe the different inventory tools available for collecting necessary data for stem profile models.
- Develop recommendations for the integration of stem profile models into everyday private sector inventory and management practice.

PROGRESS

Stem data provided from the Coillte measurement database are available in several databases for all species relevant to this project with the exception of ash. At first, these data were checked for inconsistency and missing or incorrect values were recalculated. Then all the databases were put together, restructured and converted into the FieldMap database to be available for the StemProfiler software. As FieldMap enables visualization of stem profiles, data were also checked visually. This database is now complete and is part of the Field Map program. FieldMap is used as an interface between the large dataset and the user, allowing summarisation of data both numerically and graphically per tree, plot, year, treatment and species. A querying facility has been developed. The database has also been transformed to the commonly accessible MS Access format.

The parameterisation of the Douglas fir, lodgepole pine, Norway spruce, Scots pine and Sitka spruce models has been completed by IFER. A model for ash has yet to be completed. The data of the 19 sample plots collected in 2007 have been verified and are available in a MS Access database for processing. The Sitka spruce model has been tested and validated.

A paper detailing the methods used in model parameterisation will be completed in 2009. Ash data from 100 sample plots from the STANDMODEL project are currently being reviewed in advance of the development of a similar single tree volume model for this species.

ACTIVITIES PLANNED

- A paper detailing the methods used in model parameterisation and stem profile modelling will be completed and submitted for publication.
- The integration of the new single models into practical inventory systems will be advanced. This will involve consultative workshops with the industry.
- There will be further work on the development of a measurement equipment database (Figure 1).

Figure 1: The Masser RC3H in use, a basal area calculator for productive inventory and planning work. This forms part of the measurement equipment database developed during the TREEMODEL project.

OUTPUTS

- The validated Sitka spruce stem profile model has been produced (Figure 2).
- Stem profile models for Douglas fir, lodgepole pine, Norway spruce and Scots pine have also been produced.
- A fully cleaned MS Access database of all stem data has been produced.
- A rudimentary querying system for the above models has been produced.

Current Internet Presence

http://www.ucd.ie/forestry website describing TREEMODEL in the context of the PLANSFM research programme (due for launch in March 2009).

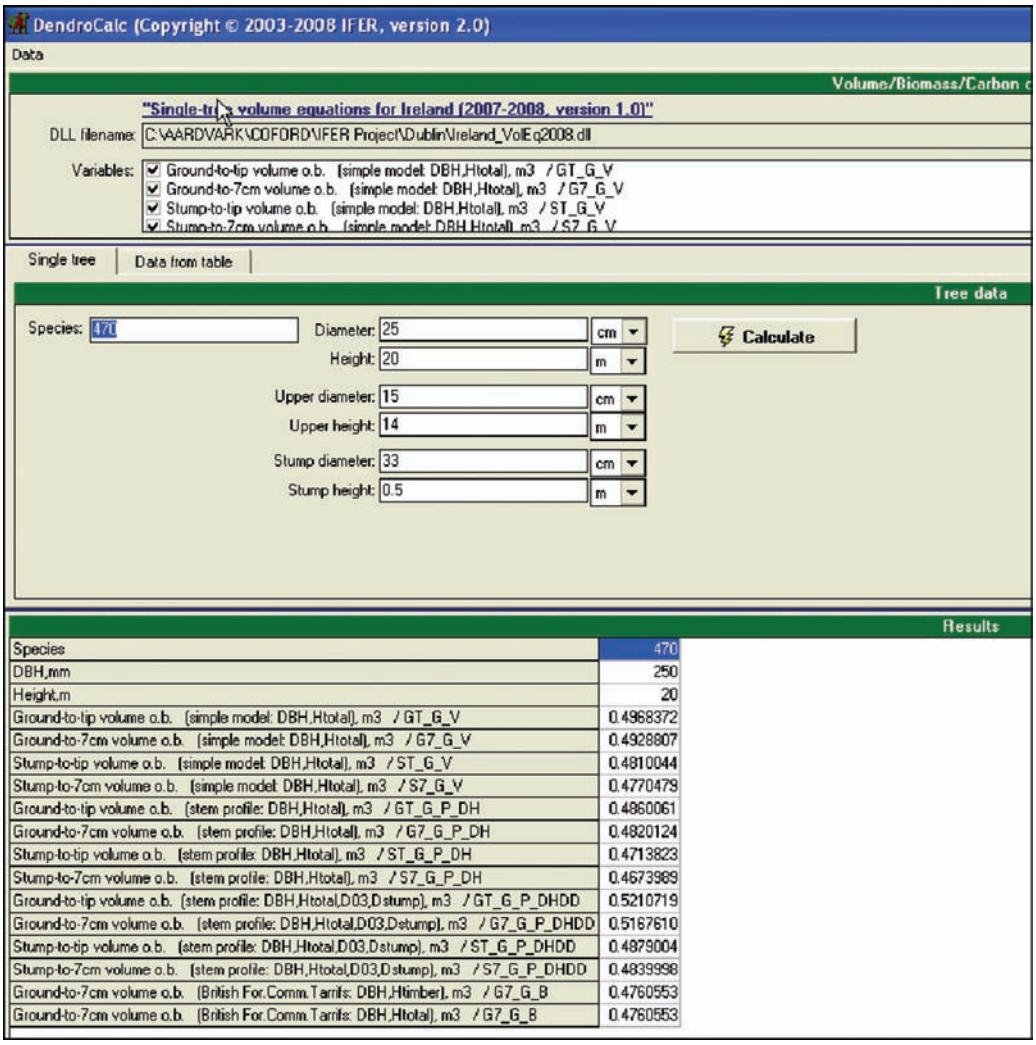


Figure 2: Validated Sitka spruce stem profile data are now included in the DendroCalc software.

PLANSFM

WESTFOREST

A GIS-based multi-objective decision support system for the optimal management of forests on sensitive sites

PROJECT TEAM

Prof. Maarten Nieuwenhuis, University College Dublin*
Dr Dermot Tiernan, Coillte
Stephen Clifford, University College Dublin

* Email: maarten.nieuwenhuis@ucd.ie

COMPLETION DATE: December 2011

BACKGROUND

Many forests have been planted on the western peatlands of Ireland and their sustainable management is a complex problem. The range of critical environmental and social constraints that needs to be taken into account, as well as the age distribution of the stands, add to the factors to consider in making decisions about the future options for these forests. Decision support tools to facilitate the management of stands, based on, among others, catchment sensitivity, soil type, National Heritage Areas, amenity provision, economic potential and social acceptability merit investigation. This applies particularly to forests established on peatlands and other environmentally sensitive areas, where felling and reforestation decisions need to take into account a wide range of economic, environmental and social factors.

OBJECTIVES

The project aims to develop:

- a GIS system that contains spatial, contextual and qualitative information on restrictions applicable to the western peatland forests (WPFs).
- a matrix of the known impacts and restrictions associated with the range of potential forest management practices and land use changes.
- a decision support system (DSS) for the sustainable management and redesign of WPFs.
- an optimisation module for the DSS, for the production of alternative plans.
- a forest management plan for the WPFs, based on the optimal DSS prescriptions, drawn up in the context of arrangements with the Forest Service, and compatible with an integrated, shared land use policy.

PROGRESS

- Investigated GIS DSSs available within the industry.
- Various topics within forest planning were studied, including forest management and water quality, the biomass market, the forest industry in Ireland, employment within forestry, and the history of the western peatland forests.
- Reviewed the DSS produced by Coillte for the western peatland area as part of a previous project.
- Initial research into restrictions and limitations of forest planning in the western peatlands area.
- Field visits to western Ireland were conducted to look at various issues associated with forestry in the area, such as the general physical conditions on the sites, incentives for conversion from farming to forestry, forest management issues on sensitive sites, and to review Sitka spruce field spacing trials in western Ireland.
- Established contact with researchers in western Canada who are developing forest management models based on Cellular Automata and agent-based modelling.

ACTIVITIES PLANNED

- Compare different decision support systems used in forestry.
- Assess the potential of cellular automata in decision support systems, e.g. Moland.
- Develop methodology for a decision support system. Potential methodologies include Cellular Automata and agent-based modelling.
- Develop and populate the forest management and land use change impact matrix.

OUTPUTS

Nieuwenhuis, M. and Tiernan, D. 2007. WESTFOREST – a GIS-based multi-objective decision support system for the sustainable management of forests on sensitive sites. *Irish Timber and Forestry* 16(6): 20 - 22.

Current Internet Presence

http://www.ucd.ie/forestry website describing WESTFOREST in the context of the PLANSFM research programme (due for launch in March 2009).

CLUSTER

A cluster-based approach for identifying farm forest resources to maximise potential markets

PROJECT TEAM

Niall Farrelly, Teagasc*
Brian Clifford, Teagasc
Stuart Green, Teagasc

* Email: niall.farrelly@teagasc.ie

COMPLETION DATE: August 2009

BACKGROUND

While we have a general picture of the area of forest approaching first thinning age, there is very little information at a local level on exactly where the resource is located and which plantations are suitable for thinning in the next 5 to 10 years. In addition, there are few structures in place to quantify, locate or market the timber for owners and there is a danger that the resource will be overlooked if the potential is not fully recognised. This research aims to address these issues by developing an optimal methodology for quantifying the material from farm forests.

OBJECTIVES

- Development of methods to quantify the forest resource and produce a timber forecast at a local level.
- Development of cluster groups where forestry operations can be performed together to minimise cost.
- Development of cluster groups to facilitate combined sale of forest products from many farms.
- Scheduling harvesting to coincide with adjacent harvesting in similar locations based on demand for selected products.

PROGRESS

The collation of locations of all private grant-aided forests from Forest Service databases has been completed and high forest density areas identified nationally. A high forest density area in the north west of Ireland has been selected as a study area (Figures 1a and 1b). Forests contained within this area were stratified for suitability for field visit using aerial photography and Forest Service planting records. Landowner notification was issued and field visits were arranged with the

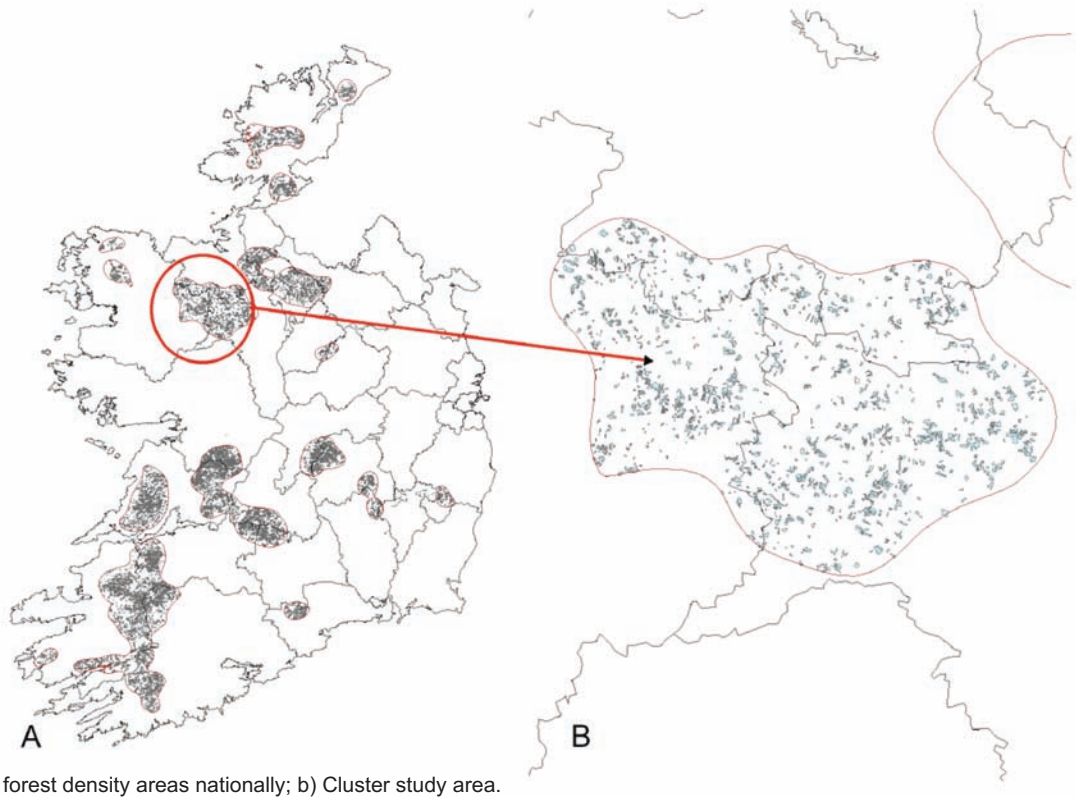


Figure 1: a) High forest density areas nationally; b) Cluster study area.

INDEX	PYEAR	ALTITUDE	NOTES	AREA	OrthoStag	Species	Ground	NYC	Thin	LandClass
745	1995	92	Site Visit	1.6	PT	LP	Deep Peat	12	No Thin	Unclosed
746	1990	91	Site Visit	3.4	T	SS/LP		0	No Thin	Unclosed
749	1991	92		5.1	T			0		Enclosed
750	1991	92		2.2	T			0		Enclosed
752	1995	92	Site Visit	0.9	T	SS/LP		0	No Thin	Unclosed
757	1995	92	Site Visit	0.9	T	SS/LP		0	No Thin	Unclosed
758	1995	92	Site Visit	1.3	T	LP	Deep Peat	12	No Thin	Unclosed
765	1994	96		0.6	T	LP	Deep Peat	12	No Thin	unenclose
766	1994	97		1.0	T	LP	Deep Peat	12	No Thin	unenclose
767	1993	0		10.0	T	SS/LP	Peaty Gley	16	2012	Enclosed
768	1994	96		0.3	T	LP	Deep Peat	12	No Thin	unenclose
769	1994	97		3.7	T	SS/LP	Soft Miner	24	2012	Enclosed
771	1994	0		16.7	T			0		unenclose
774	1994	91	Site Visit	7.1	T	SS	Soft Miner	24	2012	Enclosed
784	1994	95		2.2	T	LP	Deep Peat	10	No Thin	unenclose
825	1994	0		6.0	T	SS	Deep Peat	24	2012	Enclosed
828	1994	95		2.9	T	SS	Soft Miner	24	2012	Enclosed
836	1994	85		6.6	T	SS/LP	Peaty Gley	16		Enclosed
837	1994	0		0.1	T	SS/LP	Peaty Gley	16		unenclose
838	1994	0		0.1	T	SS/LP	Peaty Gley	16		unenclose
839	1994	0		0.2	T	SS/LP	Peaty Gley	16		unenclose
840	1994	85		0.3	T	SS/LP	Peaty Gley	16		unenclose
841	1994	86		1.4	T	SS	Soft Miner	24		Enclosed
842	1994	86		0.4	T	SS	Soft Miner	24		Enclosed
843	1994	86		0.8	T	SS	Soft Miner	24		Enclosed
845	1994	86		1.2	T	SS	Soft Miner	24		Enclosed
857	1994	86		0.4	T	SS	Soft Miner	24		Enclosed
2058	2001	93		11.0	NV	SS	Soft Miner	0		Enclosed
2106	1999	94		2.6	PT	SS	Soft Miner	24		Enclosed
2108	1999	84		6.4	GP	NS/AS	Soft Miner	24		Enclosed
2109	2002	88		1.9	NV	SS	Soft Miner	24		Enclosed
2110	2002	86		0.8	NV	SS	Soft Miner	24		Enclosed
3030	1999	96		19.6	GP	SS/LP	Peaty Gley	16		unenclose
3038	1999	93		0.1	P			0		unenclose
751	1998	90		4.2	PT	NS/SS	Soft Miner	24		unenclose
710	1998	99		14.5	PT	SS/LP	Peaty Gley	16		Enclosed
3137	1989	0	Site Visit	12.6	P	LP	Deep Peat	12	No Thin	unenclose
764	1989	0	Site Visit	12.6	P	SS	Soft Miner	24	2008	Enclosed
835	1989	0	Site Visit	7.0	P	SS	Soft Miner	24	2008	Enclosed
785	1989	0	Site Visit	16.5	P	SS	Soft Miner	24	2008	Enclosed
3138	0	0		16.5	P	LP	Deep Peat	12	No Thin	unenclose
770	1993	91		6.6	T	LP	Deep Peat	12	2012	Enclosed
770	1993	91	Site Visit	6.6	T	SS	Soft Miner	24	2012	Enclosed

Figure 2: Field database indicating areas suitable for thinning in close proximity.

selected landowners. An assessment of timber quality and volume was performed using standard forest mensuration techniques. These field visits are near completion and the compilation of field data and the creation of a field database has started (Figure 2).

Part of this research programme involves an investigation into remote sensing options for obtaining forest information. In this context the suitability of EO data for assessing the small scale, fragmented farm forest holdings in Ireland is being examined. Aerial photography, high resolution satellite imagery, LIDAR and RADAR datasets have been obtained and are currently being investigated.

ACTIVITIES PLANNED

Field work will be completed in early 2009. The remainder of the reporting period will consist of the compilation of results, analysis and preparation of main findings for publication and presentation in the final report.

OUTPUTS

Farrelly, N., Clifford, B. and Green, S. 2008. Unlocking farm forest potential. *TResearch* 3 (1): 22-25.

Farrelly, N., Clifford, B. and Green, S. 2008. Using GIS cluster analysis to quantify timber production from farm forestry plantations. *Irish Timber and Forestry* 17 (5) 30-33.

Farrelly, N., Clifford, B. and Green, S. 2008. *Cluster – A cluster-based approach for identifying farm forest resources to maximise potential markets.* Forest growth modelling and wood production forecasting workshop, 12 May 2008, Killeshin Hotel, Portlaoise. Available at http://www.coford.ie/iopen24/pub/120508cluster.pdf

Farrelly, N., Clifford, B. and Green, S. 2008. *The private forest resource – its potential for wood energy and barriers and solutions to access.* Bioenergy conference 2008, 19 June 2008, Teagasc, Athenry, Co Galway.

Farrelly, N. 2008. *Fuelling your future – the growing forest resource*. Proceedings from the Teagasc/COFORD/SEI Wood Energy Conference, Westport 10 September 2008.

Clifford, B., Green, S. and Farrelly, N. 2008. *A cluster based approach for the identification of private forest resources.* 2nd Annual Irish Earth Observation Symposium, Opportunities for Earth Observation in Ireland, 6-7 November 2008, pp14.

Farrelly, N., Clifford, B. and Green, S. 2008. *Using cluster analysis to identify forest resources*. Poster presentation, Farmfest, Teagasc, Athenry, Co Galway, 2008.

Farrelly, N., Clifford, B. and Green, S. 2008. Forest focus unlocking farm forestry. *Irish Farmers Monthly* July 2008. p42-44.

FORECAST

Geospatial forecasts of private sector timber supply

PROJECT TEAM

Dr Máirtín Mac Siúrtáin, University College Dublin*
John Redmond, Forest Service
Henry Phillips, Forest Solutions
Dr Eoin O'Mongain, Spectral Signatures Ltd.

* Email: mms@ucd.ie

COMPLETION DATE: March 2012

BACKGROUND

Since the 1980s there has been a rapid expansion of grant aided private forests, which now comprise 45% of the total forest estate. However, no overall production forecast is available for the full national estate, including state and private forests.

The Irish government is committed to increasing the national area of forest to 12% by 2030 and to increasing the utilisation of wood, particularly for the generation of energy from renewable and sustainable sources. Development is constrained, however, by the lack of consolidated roundwood supply forecasts for energy and other traditional assortments. There is therefore a compelling requirement for a GIS forecast model to generate national, regional and catchment production forecasts.

A desktop study, published in 2001, was the first step towards quantifying the full production potential of the forest resource of the island of Ireland. One of main recommendations of the study was that a continuous multi-attribute forest inventory for both state and private forests is needed to more accurately forecast production and monitor growth.

The Forest Service commenced the National Forest Inventory (NFI) of state and private forests in 2004; this has been completed and published (Forest Service 2007-1, 2007-2, 2007-3). It is timely to evaluate the data requirements for national production forecasting from both state and private forests.

This project is specifically designed to produce reliable national, regional and catchment geospatial forecasts of private sector timber supply using existing Forestry Commission static and national dynamic yield models.

OBJECTIVES

The short term objectives are to develop an interim GIS forecast on a national and catchment basis for privately owned forests (2009-2028) to replace the current private sector forecast; and to publish an interim private sector timber supply forecast within 12 months after consultation with interested parties.

In the long term, the objectives are:

- To analyse the possibility of generating a reliable forecast of production from privately owned forests using the existing National Forest Inventory (NFI) plot data;
- To compare plot versus stand based methods for forecasting future timber production from privately owned forests;
- To develop an internet interface for the provision of national and catchment forecasts through an easy to use client browser, which is fully compatible with iFORIS and ESRI products, using industry standard licence free GIS software.

PROGRESS

A number of requirements to forecast volumes from the private sector are missing, e.g. forecast rules, management regime, site productivity etc. The initial focus of the project has been to address these gaps. Forecast rules have been developed for: rotation length; thinning; volume reduction factors; species and default yield models; and harvest losses.

An initial review of available private forest datasets was undertaken. The Premium Dataset received from the Forest Service is being reviewed and evaluated for completeness and reliability of spatial information.

A number of forest companies have expressed their willingness to co-operate with the project in terms of validating management regimes.

COFORD has established a roundwood supply group with industry representation. The project has given a presentation to the group and will act as Secretary.

Joint meetings with the CLUSTER project have identified areas for mutual collaboration.

The NFI data contain no information on top height or yield class. The data were analysed to determine whether it would be possible to apply a surrogate top height based on mean heights collected. Robust relationships between mean height

and top height have been developed for the main coniferous species based on permanent sample plot data provided by Coillte. Models were also developed to predict the upper and lower prediction intervals. These mean height top height models allow the NFI plot data to be populated with top height, yield class with the precision of the estimates quantified.

Code for the GROWFOR growth model has been modified to allow forecast estimates to be generated for any number of input vectors for both thinned and unthinned Sitka spruce stands. This capacity will be extended for all coniferous species for which GROWFOR models exist.

ACTIVITIES PLANNED

- Analyse the possibility of generating a reliable forecast of production from privately owned forests using the existing National Forest Inventory (NFI) plot data.
- Compare plot versus stand based methods for forecasting future timber production from privately owned forests.
- Develop an internet interface for the provision of national and catchment forecasts through an easy to use client browser, which is fully compatible with iFORIS and ESRI products, using industry standard licence free GIS software.

OUTPUTS

The FORECAST project has made the following presentations:

- COFORD Growth Modelling and Forecasting Workshop, Portlaoise, May 2008.
- COFORD Council, Portlaoise, June 2008.
- COFORD Roundwood Supply Group, Portlaoise, September 2008.
- GIS Ireland 2008, The Guinness Storehouse, Dublin, October 2008.
- Forestry Commission, Silvan House, Edinburgh, October 2008.
- SEI BWG SUB-GROUP - RESOURCE, SEI Glasnevin, October 2008.
- COFORD Roundwood Supply Group, Portlaoise, November 2008.

FOREST HEALTH AND PROTECTION

OVERVIEW

The large pine weevil continues to be the most devastating insect pest species in Irish forestry. The impact of the species is primarily seen on restock sites where the adults feeding on the bark of newly established trees can cause very high mortalities, which in turn, can significantly increase establishment costs. Satisfactory protection can be achieved through the application of an insecticide, but attempts to provide protection through physical means have proven to be costly or largely ineffective.

Forest certification requires the reduction in the use of chemicals in forests. This is an extremely challenging situation for forest managers as to date there were few effective means of protecting young trees against pine weevil attack, other than through the use of chemicals. The requirements of certification, however, have given the necessary impetus to find non-chemical means of protection and alternative means of avoiding weevil damage are being investigated. The use of biological control agents in the form of parasitic nematodes is, however, showing promise. Significant progress has been made with the research into the use of these host specific nematodes and is now at the point where large scale field testing is underway. An exciting development is the discovery of an indigenous nematode that appears to be significantly more effective than the non-native species that is currently available for operational use.

ABATE

Integrated reduced-chemical control of *Hylobius abietis* in Sitka spruce

PROJECT TEAM

Dr Christine Griffin, NUI Maynooth*
Dr Aoife Dillon, NUI Maynooth/Coillte
Aileen Foster, NUI Maynooth
Prof. Martin Downes, NUI Maynooth
Dr Patrick Walsh, Galway-Mayo IT
Michael Moran, Galway-Mayo IT
Martine Blaix, Galway-Mayo IT

* Email: christine.griffin@nuim.ie

COMPLETION DATE: December 2008

BACKGROUND

The large pine weevil, *Hylobius abietis*, is a major obstacle to reforestation of coniferous plantations in northern Europe. Female weevils lay their eggs in recently cut stumps, where development takes place. The emerging adults feed on the bark of young seedlings, killing 60-100% of plants if they are not protected. Currently, seedlings are protected by chemical insecticide (cypermethrin), either by dipping before planting or by spraying immediately afterwards. Maintaining forest health in accordance with the principles of sustainability involves favouring preventative and biological pest management options over chemical insecticides.

OBJECTIVES

The objective of the ABATE project is to reduce reliance on chemical insecticides in reforested sites by developing biological control measures for the large pine weevil (*Hylobius abietis*). The overall aim is to suppress numbers of weevils emerging from stumps. Agents investigated include insect-killing nematodes, stump-colonising fungi, and parasitoids. The main objective for 2008 was to bring nematodes closer to operational level in Ireland, specifically:

- assess the success of large-scale application of nematodes in Coillte forests;
- assess the quality of fermenter-produced *Heterorhabditis downesi*;
- monitor effects of nematodes on non-target insects.

PROGRESS

Following on from successful small-scale field trials conducted as part of this project, Coillte treated 150 hectares of their estate with nematodes (*Steinernema carpocapsae*) in 2007 and a further 71 hectares in 2008. The ABATE team monitored the success of the application on a total of eleven sites and showed that nematodes can suppress the number of weevils emerging from treated stumps for at least two years after application. This was done by comparing numbers of adult weevils emerging into insect traps erected over nematode-treated and untreated (control) stumps on each site. Seedlings were planted on treated sites in the winter following the 2007 nematode application, and these were monitored for damage throughout the weevil feeding period in 2008. Little feeding damage was recorded on four of five replanted sites, but one site suffered unacceptable damage. This site had exceptionally high populations of weevils emerging in both 2007 and 2008. Since nematodes typically kill only a proportion (up to 80%) of the weevil population, treated sites with very high populations will still have enough weevils left alive to devastate a crop, and so an alternative pest management approach is required for such sites.

The large-scale field application employed *Steinernema carpocapsae*, as this species was already available commercially. Another nematode, *Heterorhabditis downesi*, has consistently out-performed *S. carpocapsae* in our trials, but was not available in large enough quantities to treat whole sites. It has recently been brought into production by a biocontrol company, and enough fermenter product was available for small-scale field testing this year. Fermenter produced *H. downesi* was more effective than *S. carpocapsae* produced and shipped under similar conditions, confirming that this nematode is promising for use in forest protection.

Nematodes are generally regarded as safe to humans and the environment; nevertheless, in order to detect any impact of nematodes on non-target insects in clearfell forests, beetles collected from emergence traps were identified. Forty-six species of beetle, other than *H. abietis*, were recovered from the traps. Beetle abundance and biodiversity appear to be influenced by site factors rather than treatment (nematode versus no nematode).

Stumps on a clearfell site are sprayed with insect-killing nematodes to reduce the numbers of emerging pine weevil adults. Newly planted seedlings are thus protected from feeding damage by this pest. The spray rig was developed by Forest Research UK.

Photo: Aoife Dillon.

OUTPUTS

Dillon, A.B. and Griffin, C.T. 2008. *Controlling the large pine weevil,* Hylobius abietis, *using natural enemies*. COFORD Connects, Silviculture/Management No. 15.

Dillon, A.B., Moore, C.P., Downes, M.J. and Griffin, C.T. 2008. Evict or Infect? Managing populations of the large pine weevil, *Hylobius abietis* – a bottom-up versus top down approach. *Forest Ecology and Management* 255, 2634-2642.

Dillon, A.B., Rolston, A.N., Meade, C.V., Downes, M.J. and Griffin, C.T. 2008. Establishment, persistence and introgression of exotic entomopathogenic nematodes in a forest ecosystem. *Ecological Applications* 18, 735-747.

Everard, A., Griffin, C.T. and Dillon, A.B. 2008. Competition and intraguild predation between the braconid parasitoid *Bracon hylobii* and the entomopathogenic nematodes *Heterorhabditis downesi*, natural enemies of the large pine weevil, *Hylobius abietis*. *Bulletin of Entomological Research*. doi:10.1017/S0007485308006287

HARVESTING AND PRODUCTS

From the earliest times forests have been used as a resource to sustain human existence. They have provided food, fuel and materials to build shelter and provide a safe environment in which to live. While our circumstances have changed from those early days, we still benefit from products that forests continue to provide.

The development of new technologies and changing circumstances (e.g. climate change) are providing us with opportunities for more cost effective and efficient production and harvesting of what are often regarded as traditional forest products; and also for using these in a different way. Lifestyle changes have made us aware of other non-timber products that forests can provide such as decorative foliage, wild foods and also intangible benefits such as the enhancement of our environment for recreation, biodiversity etc.

The research projects described in this section are concerned with the tangible products from forests. They deal with the adaptation of new technologies (GPS) to transport wood more efficiently to the mills; also the harvesting and processing of wood fuel, not a new product by any means, but a traditional forest product that is being used for the new purpose of providing carbon neutral renewable energy. Similarly, the potential for the commercial production of edible fungi, a traditional forest product in central Europe, is also being investigated as a possible new product from Irish forests.

FOREST HARVESTING AND TRANSPORT

OVERVIEW

WOODTRANS

Programme leader: Dr Ger Devlin

One of the main drivers of this programme was the potential to use GPS technology to improve transport logistics and reduce operating costs in the forest sector. The GPSTRACK project is a significant step in the overall integration of information technology into the Irish forest industry. The work was carried out in collaboration with industry and the Forest Industry Transport Group (FITG) and assessed the potential of vehicle tracking devices and engine diagnostic sensors and made recommendations regarding their use in timber haulage.

There are approximately 320 Coillte-contracted timber haulage trucks in operation in the country. The overloading that occurred in the past has been significantly reduced, making the sector one of the most compliant across the entire haulage industry. As a result, payloads are smaller, but haulage costs have increased, mainly due to the unpredictable cost of road diesel. Furthermore, as the maximum gross vehicle weight (g.v.w) for 5 axle trucks is due to revert from the current 42 tonnes to 40 tonnes, possibly in 2009, this will also impact on revenue per kilometre. Taking these factors into account it is imperative that maximum legal payloads are hauled 100% of the travelling time in order to maintain and build competitiveness in a sector that impacts significantly on the delivered-in price of roundwood. The basis for the **LOADSENSOR** project was therefore to develop and test the most appropriate, affordable and accurate on-board weight systems for optimising payload weights for in-forest loading and remote load monitoring.

GPSTRACK and **LOADSENSOR** are projects that have arisen as a result of recommendations in the FITG *Code of Practice for Timber Haulage*:

Potential benefits and outcomes of this programme include:

- Increased profits and reduced running costs;
- Ability to identify the best drivers through driver performance information;
- Remote monitoring of fuel usage and avert incidents of siphoning diesel;
- Option for cross-checking time sheets with GPS recorded vehicle activity, reducing false claims of overtime;
- Distances and routes travelled can be checked against GPS recorded vehicle data;
- Elimination of overweight fines;
- Reduction of loading/adjusting time;
- Reduction of maintenance costs and increased vehicle life;
- Increased safety;
- Reduced liability exposure for overweight vehicles.

WOODTRANS

GPSTRACK

Assessment of GPS tracking devices and associated software suitable for real time monitoring of timber haulage trucks

PROJECT TEAM

Dr Kevin McDonnell, University College Dublin*
Dr Ger Devlin, University College Dublin
John Lyons, Coillte
Fionan Russell, Forest Industry Transport Group
Donal Mortimer, Shredwood Ltd.

*Email: kevin.mcdonnell@ucd.ie

COMPLETION DATE: October 2008

BACKGROUND

This project arises as a result of the recommendation in the *Code of Practice for Timber Haulage* launched in December 2004: *Encourage closer co-operation between consignors and hauliers to plan routes in a manner which optimises the economic returns within a legal framework.*

Initial research was carried out by the Forest Industry Transport Group (FITG) in 2002. Results showed that a substantial number of trucks (58-80%) are currently not adhering to the legal load restrictions. The enforcement of legal loading (44 t) will have a negative impact on revenue earned by hauliers (3-11%). Moving to a 40 tonne restriction will have a significant negative impact on the haulier's revenue (17-25%). The distance travelled unloaded (50%) is very high in many cases. Technology in the area of in-vehicle tracking systems has developed further since this initial research and such systems are now more economically viable and easier to access than before.

OBJECTIVES

- To study of the suitability, accuracy and efficiency of real-time GPS tracking of two timber haulage trucks travelling on public and forest roads. The GPS data will also be analysed in terms of its horizontal accuracy on the forest roads through the GIS.
- Results will be analysed and recommendations made to the haulage sector to determine whether GPS and GIS technology can be incorporated in a cost effective manner to help optimise the movements of timber trucks across Irish roads and within internal forest roads in terms of locating timber stockpiles.

PROGRESS

During the four week study period 10,669 data points were recorded for truck 1 and 9,500 data points recorded for truck 2. FMS engine diagnostic data were filtered from both data sets as it is not relevant to calculating GPS accuracy. After filtering, the amount of workable data to determine HRMS accuracy* were 8,360 and 5,049 data points for truck 1 and 2 respectively (Figures 1 and 2).

Figure 1: Public and forest road GPS tracklog created in GIS for Truck 1.

Figure 2: Public and forest road GPS tracklog created in GIS for Truck 2.

Table 1 and Figure 3 show that the HRMS 63% accuracy on the forest roads increases to as much as 41 m for truck 1 data and approximately 27 m for truck 2. The data for the public roads proves much more favourable with accuracy values of 2.55 m for truck 1 and 2.47 m calculated for truck 2. Results show that while the GPS accuracy vary considerably between public road data and forest road data (thus emphasising the effects of forest canopy) the tracking systems still work adequately to the point where the user can still monitor the movements of the trucks in real-time without the loss of much GPS and GPRS signal within the boundaries of the forests. The reasons for the difference are related to the position of the GPS receiver, but more importantly, due to the varying increased canopy of the forest from which truck 2 was transporting timber. Forest canopy has been well documented

* Horizontal Root Mean Square (HRMS) accuracy is a calculation for determining the accuracy of GPS points to an underlying road network. Values at the confidence level of 63% mean that 63% of the values are within a specified distance.

Table 1: HRMS 63% accuracy of public and forest road.

ROUTES	POSITIONAL ACCURACY STANDARD DEVIATION	MEAN	MAX	MIN	$(mean)^2 + (sd)^2$	HRMS (63%)
Truck 1 forest road < 100 m	21.28	17.11	100.00	0.03	745.47	27.30
Truck 1 forest road < 50 m	12.17	11.58	50.00	0.03	282.26	16.80
Truck 2 public road < 10 m	2.61	3.54	10.00	0.01	19.36	4.40
Truck 2 public road < 5 m	1.42	2.13	5.00	0.01	6.54	2.56
Truck 2 forest road < 100 m	28.00	29.95	100.00	0.28	1681.11	41.00
Truck 2 forest road < 50 m	13.79	17.64	50.00	0.28	501.12	22.39
Truck 2 public road < 10 m	2.80	3.75	10.00	0.01	21.94	4.68
Truck 2 public road < 5 m	1.40	2.05	5.00	0.01	6.15	2.48

to affect GPS performance and accuracy but for this project the authors are not attempting to define a correlation between density of forest canopy and GPS accuracy. The assumption of signal degradation is based on visual inspection within the forest.

For an articulated truck driving an average distance of 100,000 km/annum:

Average mileage from system = 7.5 mpg = 2.66 km/L

(1 mpg = 0.3540062 km/L)

7.5 mpg = 12.07 kmpg (2.66 * 4.54609)

100,000 km/12.07 kmpg = 8,285.00 gallons

==> 8,285.00 * 4.54609 = 37,664 litres

==> 37,664 litres * 0.8 €/litre = €30,131.20

==> CO_2 emissions = 37,664 L * 2.67 kg = 100,562.88 kg = 100.56 tonnes

For increase in fuel mileage to approximately 8.5 mpg (reduction in fuel consumption)

Average mileage from system = 8.5 mpg = 3.01 km/L

(1 mpg = 0.3540062 km/L)

8.5 mpg = 13.68 kmpg (kilometres per gallon)

(3.01 * 4.54609)

100,000 km/13.68 kmpg = 7,309.94 gallons

==> 7,309.94 * 4.54609 = 33,231.65 litres

==> 33,231.65 * 0.8 €/litre = €26,583.32

==> CO_2 emissions = 33,231.65 L * 2.67kg/L = 88,728.51 kg = 88.73 tonnes

==> Financial saving = €30.131.20 - €26,583.32 = €3,547.88

==> CO_2 emission saving = 100.56 T – 88.73 T = 11.73 tonnes

==> SAVING approximately €3,500/annum/truck on diesel fuel and 11.73 tonnes of CO_2 emissions simply by decreasing fuel consumption by 1 mpg due to increased driver performance.

ACTIVITIES PLANNED

This project is almost complete. Final activities include completing the final report, presentation of findings to FITG, publication of the papers and presentation of the research at Forest Engineering Group (FEG) on 10 March 2009.

Results of the study will be published in COFORD Connect notes and published on the COFORD website through the annual report. Similar reports will be circulated to members of the FITG (Forest Industry Transport Group).

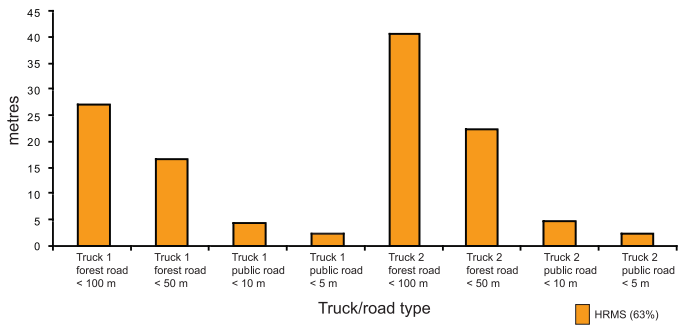


Figure 3: Graph of HRMS 63% accuracy for public and forest roads for trucks 1 and 2.

OUTPUTS

Presentation to the FITG meetings on 14 May and 16 October 2008 at Killeshin Hotel, Portlaoise, Co Laois.

Developing cost effective systems for wood procurement, harvesting and transport presented at the COFORD Technical Workshop on 22 February 2008, Killeshin Hotel, Portlaoise, Co Laois.

Presentation at the Agriculture Engineering Technology (AET) workshop in Brussels, on 31 October 2008

Devlin, G. J. and McDonnell, K. 2008. Performance accuracy of real-time GPS asset tracking systems for articulated trucks travelling on both internal forest road network and public road network. *International Journal of Forest Engineering* (in review).

Devlin, G. J. and McDonnell, K. 2008. Real time GPS asset tracking – Fuel for thought. *Journal of Transport Geography* (in review).

WOODTRANS

LOADSENSOR

Evaluation of airbag pressure sensors/gauges as load weighing devices for use on timber haulage trucks

PROJECT TEAM

Dr Kevin McDonnell, University College Dublin *
Dr Ger Devlin, University College Dublin
John Lyons, Coillte
Fionan Russell, Forest Industry Transport Group

* Email: kevin.mcdonnell@ucd.ie

COMPLETITION DATE: April 2009

BACKGROUND

This project proposal arises as a result of a recommendation in the Forest Industry Transport Group (FITG) *Code of Practice for Timber Haulage*, launched in December 2004: *COFORD in collaboration with the forest industry to undertake research and evaluation of load cells and mobile weighing devices*. This issue was further discussed in 2005 at FITG meetings.

OBJECTIVE

To test the cost-effectiveness and accuracy of using load-weighing devices fitted to the truck air suspension system.

PROGRESS

To date, one vendor has been sourced to retrofit the on-board weigh systems to both tractor unit and trailer. The idea was to develop a new piece of technology from an air suspension approach or indeed load cell perspective but after review, it seemed that this technology already exists. However, in addition to monitoring payload weights on site, it is important to be able to monitor weights in transit and remotely in real time. This angle connects well with the previous project, GPSTRACK, where the real-time GPS tracking of articulated trucks was assessed.

General Packet Radio Service (GPRS) is a packet-based, wireless communication service for passing data over the mobile phone network. It has become known as 'always-on data connection' for GSM mobile phones. It sends packets of data collected by the equipment on the truck, back to base in 'real time'. It can also be used for voice communications between the vehicle and base. Thus, by simply incorporating the GPRS network for data transfer, the technology can be developed so that trucks can be monitored in real-time and any discrepancies in loading, unloading, and indeed overloading, can be established and marshalled correctly. This work has been part of the early review stage of the project.

Research has shown that for payload control, the high quality AirWeigh system incorporates a unique air sensor principle that measures the load in the trailer's air suspension system. This works in conjunction with fifth wheel load cells for even greater precision weighing results (Figure 1). The AirWeigh system can be fitted easily and installed within one working day. The system can measure to within ± 1.5% which implies optimising the full revenue per payload weight. For in-cab monitoring, the indicator is fixed in place (Figure 2). For out of the vehicle and on site weighing, the wireless pad can also be used (Figure 3).

The team is proposing a working and research relationship with the GPS vendors from the GPSTRACK-funded project to develop the on-board payload real-time information with their R COM tracker.

If this software can be developed (planning stages), then both COFORD-funded projects will connect very well to provide an overall packaged answer to real time GPS tracking and onboard weigh systems for the haulage industry.

Figure 1: Jost fifth wheel load cell.

Figure 2: In cab indicator.

Figure 3: Freeweigh wireless pad.

ACTIVITIES PLANNED

Planned activities include final analysis of the results from the trial period and writing the final report, presentation and circulation of findings to FITG, and presentation of research at Forest Engineering Group (FEG) meeting in March 2009.

WOOD ENERGY

OVERVIEW

Diminishing supplies of fossil fuel, allied to the urgent need to drastically reduce emissions of greenhouse gases, are driving a world-world move to renewable energy sources. At the end of 2008 the EU agreed the Climate and Renewable Energy Package, which sets legally binding targets to be achieved by 2020, to cut greenhouse gas emissions by 20%, to establish a 20% share for renewable energy, and to improve energy efficiency by 20%. At national level a series of renewable energy policies and targets in heat, power and CHP will result in solid biomass demand of over 4 million tonnes by 2020. Further policy development is taking place under the Renewable Energy Development Group of the Department of Communications, Marine and Natural Resources.

Forestry has a central role to play in meeting future demand for solid biomass. Over 200,000 ha of new forests have been established since 1985, many of which have already entered the thinning stage, and are already being harvested for wood energy.

Developing a wood fuel energy supply from Irish forests needs a concerted long term programme of research, development and demonstration, focussed on matching wood fuel supply and quality to end-user demands; for example, heating needs wood with a moisture content below 40%, with well graded chips, while large scale power generation can accept higher moisture contents and a wider range of fuels from sawdust to chip. COFORD has funded a national programme of R&D and demonstration in the wood energy area – **FORESTENERGY** – since 2006.

The project in this thematic area is:

- **FORESTENERGY**: Harvesting and processing forest biomass for energy production in Ireland

FORESTENERGY

Harvesting and processing forest biomass for energy production in Ireland

PROJECT TEAM

Tom Kent, Waterford Institute of Technology*
Pieter Kofman, Danish Forestry Extension
Dr Eleanor Owens, Waterford Institute of Technology
Dr Dmitri Botvich, Waterford Institute of Technology
Enda Coates, Waterford Institute of Technology
Sarah Cooley, Waterford Institute of Technology
Sean Kelly, Waterford Institute of Technology
Meabh Kenneally, Waterford Institute of Technology
Cathy Walsh, Waterford Institute of Technology
Dan O'Mahony, Waterford Institute of Technology
Nicholas Mockler, Waterford Institute of Technology
Damien O'Donovan, Waterford Institute of Technology
Tom O'Dwyer, Waterford Institute of Technology
Alastair Dunnett, Waterford Institute of Technology
Seamus Forde, Waterford Institute of Technology

* Email: tkent@wit.ie

COMPLETION DATE: February 2009

BACKGROUND

Concerns over climate change, security of energy supplies and sustainable forest management have directed international policy supporting the development of renewable energy from wood fuel. The EU plans to produce 20% of energy requirements from renewable sources. It is expected that almost 65% of that goal is to come from biomass and most of that biomass would be in the form of wood.

The Irish Energy White Paper and Bioenergy Action Plan for Ireland set out the framework for meeting these targets in Ireland. Sustainable Energy Ireland has mounted a successful campaign to encourage private individuals and commercial firms to install wood fuel boilers, thus creating a demand for wood fuel in the form of wood pellets and dry wood chip. Three peat-fired power stations are gearing up to fulfill their obligation to co-fire 30% biomass with peat by the year 2015. The Forest Service has had two calls for grants for companies to buy relevant wood chipping equipment. These initiatives have created a supply and demand situation.

Wood for energy is a relatively new assortment in Irish forestry and much knowledge remains to be gained. Ireland has a ready-made wood fuel resource in the large areas of farm forests planted over the last 25 years, which now require thinning to achieve production potential. Forest ownership is fragmented and knowledge of harvesting and storing wood for energy limited. The ForestEnergy project, commenced in 2006, and renewed annually, aims to develop cost-effective supply chains by adapting commercially used methods from Europe to Irish conditions.

OBJECTIVES

The main project objective was to secure marketable wood fuel of acceptable moisture content for sale from Irish first thinnings of softwoods and hardwoods.

Specific objectives were to:

- Demonstrate harvesting, extraction and wood fuel processing equipment on softwood and hardwood sites, representative of regional and site variation in Ireland;
- Produce and assess the quality of both wood chip and firewood products;
- Assess optimum storage systems to promote maximum seasoning at lowest cost;
- Investigate moisture content/climate relationships with the view to developing a moisture content reduction model based on simple climatic indicators;
- Analyse chemical composition of wood samples collected during the harvesting trials across the country, and subsequently analyse the change in chemical composition of wood fuel assortments during storage;
- Organise dissemination activities including public demonstrations, articles, workshops, presentation of results and display of wood fuel sample materials.

PROGRESS

Forest harvesting and wood fuel processing trials

Between 2006 and 2008, nine softwood sites, totalling 130 ha, received first thinning treatments. A further 35 ha of first thinning was carried out over five hardwood sites. Harvesting and chipping trials were also carried out on forest plots on Bord na Móna cut-over peat. Figure 1 presents the location of all trial sites. A range of methods was used for harvesting, extraction and chipping. All machinery and methods were studied to develop productive time per unit output for the range of site types and tree sizes encountered.

The whole tree method was the lowest cost method of

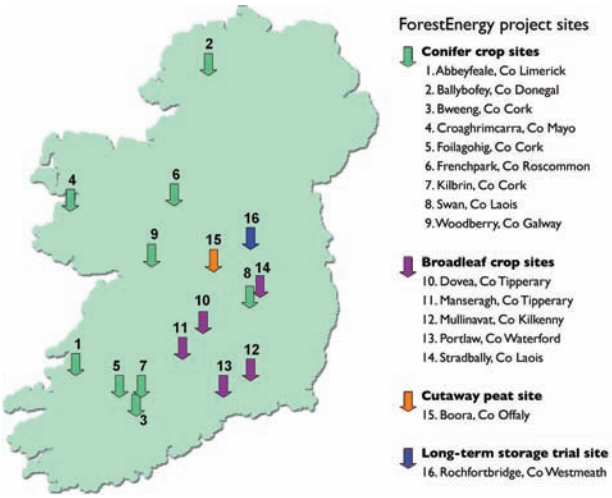


Figure 1: Location of ForestEnergy trials.

producing woodchip from first thinnings in softwoods: the trees were felled by chainsaw in a line thinning, seasoned in the extraction rack and chipped by a Silvatec terrain chipper and extracted to roadside by a chips forwarder. Figure 2 shows the Silvatec terrain chipper used on eight softwood sites, three hardwood sites and one cut-over peat site during the ForestEnergy project. On eight sites over three years, the average production cost by this method was in the range of €2.03 to €4.28/GJ. The next cheapest method, at €2.80/GJ, was also a whole tree method where a feller-buncher carried out a selective thinning and bunched the trees in the rack, for post-seasoning terrain chipping. Disadvantages of the whole tree terrain chipping system were no distinct brash mat and no machine infrastructure available in Ireland to efficiently transfer chips from the chip forwarder to a road transportation system.

In comparison, the production cost of wood chip using standard harvester and forwarder roundwood line and selective thinning, with logs stacked in the forest to season and chipped at roadside, was in the range of €6.53 to €7.59/GJ. A variation of this standard thinning system was to replace the pulp assortment with an energy wood assortment, with no minimum top diameter and branches only loosely delimbed leaving stubs, cut to a variable length up to 4.5 m.

Figure 2: The Silvatec terrain chipper.

The production cost of chip with this energy wood system was between €5.82 and €6.81/GJ.

The substantial difference in production costs can be attributed to three main factors: harvesting whole trees yielded on average 50% more biomass and the energy wood assortment yielded 15% additional biomass per hectare in comparison to the round wood methods. Also, the whole tree harvesting operation is faster and cheaper as there is no delimbing and cross-cutting to length. Finally whole trees dried more in the stand compared to logs stacked at roadside in first thinnings.

In hardwoods, time studies were carried out on marking stands prior to thinning, in addition to studying various systems for thinning to produce wood chip and firewood assortments. Marking the crop, in accordance to the Forest Service/Teagasc guidelines, averaged 1 ha per man day. There was little variation between personnel studied or between sites.

As in the softwood trials, the lowest cost method of producing woodfuel was terrain chipping whole trees. Production costs ranged from €2.82/GJ for a line thinning only by chainsaw, to €7.09/GJ when the thinning included selection between lines. Using the feller buncher for line and selection thinning in hardwoods gave a production cost of €3.37 - €4.07/GJ.

Wood fuel storage trials

Softwood storage trials were carried out in the forests and were carried out at an open, exposed depot site for comparison. Hardwood trials were carried out in the forest and storage trials of 3 m length logs and firewood products stored under a variety of conditions were also carried out. All material was harvesting between March and June and all chipping was carried out in August – September to benefit from summer seasoning. Sites harvested in 2006 were chipped after one summer only. Sites harvested in 2007 were partially chipped after one summer and the remainder chipped after two summers seasoning. In the forest, whole trees were seasoned in the extraction rack; roundwood and energy wood assortments were stacked at roadside. Some stacks were covered and some left uncovered. Moisture content was

Figure 3: Whole ash trees, stored under plastic cover at roadside over summer 2006, chipped with a Jenz 700 towed chipper into walking floor lorry.

sampled at time of harvest and again post seasoning as the material was chipped.

Freshly felled Sitka spruce at first thinning varied in moisture content between sites and assortments but averaged 60% moisture content. There was a large variation between years, between sites and between assortments in the rate of drying. The hardwood results were interesting, in that ash had a mean initial moisture content of 40%. On the other hand, the ash assortments stored in the forest did not dry to any great extent. Table 1 details the change in moisture content between harvesting and after storage in the forest.

General conclusions from the in-forest storage trials were that the forest environment at first thinning stage is not conducive to rapid, even, predictable drying of stored wood. Whole tree assortments generally performed better than roundwood and energy wood assortments. Covered stacks dried better than uncovered stacks, however the covers used degraded substantially in the second year and were not effective. Wood fuel stored in the forest did not dry sufficiently for use in commercial boilers requiring fuel of less than 35% moisture content. In-forest storage may be used to dry wood fuel to 45-50% moisture content.

A storage trial was constructed near Rochfortbridge on an open, exposed Bord na Mona site to assess drying potential of logs moved from the forest to a depot. Eight steel bins were constructed, placed on load cells and c. 25 tonnes of logs were placed in each to assess the loss of weight over time. The assumption was made that any loss of weight would represent a loss of moisture. Moisture content and other parameters were sampled intensively at the beginning and end of the trial. Bins were filled with freshly felled material in April, June, September and December 2007 to assess the variation in drying seasonally. All bins were emptied in August 2008.

All log stacks achieved an end moisture content in the range of 18-22%. The mean time length to achieve a 30% moisture content required for commercial wood fuel boilers was 19 weeks, for material stored in April this was 16 weeks, whereas material stored in December required 26 weeks. On average, the stacks lost 47% of the initial total weight, and 63% of initial total moisture. The energy content of the wood fuel increased on average by 17% over the storage period. Figure 4 shows a summary of the variation in seasonal moisture content reduction over the storage period.

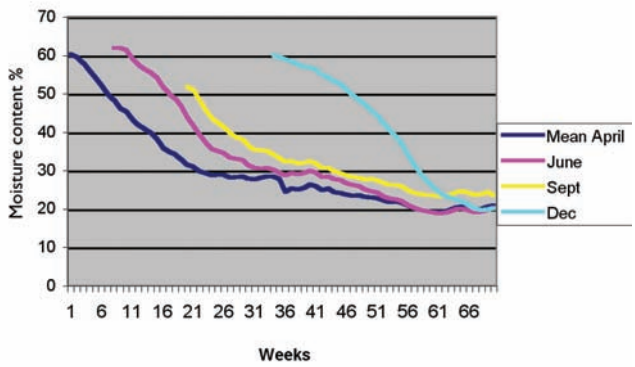


Figure 4: Seasonal variation in moisture content reduction of logs stored at the Rochfortbridge trial.

General conclusions from the storage trials were that logs and trees stored in the forest will not achieve a moisture content of less than 30% over either one or two summer seasons, due to the shelter effect and humid micro climate found. Covered stacks will dry 10% in one summer and an additional 5% in two summers. Uncovered stacks are not recommended. Seasoning roundwood to less than 30% moisture content is possible in ambient Irish climate in an open exposed depot. Logs that begin seasoning in spring will dry fastest, while logs beginning seasoning in winter will dry slowest. Covering stacks in an open depot will both aid faster drying and ensure more uniform moisture content in the stack.

ACTIVITIES PLANNED

The final project report is in preparation. Twenty-one COFORD Connects Notes covering all harvesting, storage, fuel quality and tree moisture content outputs are being written at present. Dissemination of project outputs is continuing through the woodenergy.ie website. A number of research papers are in preparation.

OUTPUTS

Presentations

Kent, T. *Wood Energy – From Forest to Market.* Presentation made at National Forestry Conference: New forestry initiatives - opportunities for the sector. 7 March 2008, Enfield, Co Meath.

Table 1: Mean moisture content changes pre- and post-seasoning for assortments stored in the forest. All moisture contents are after one summer season only unless stated.

Species	Assortment	Mean Moisture Content%			
		At harvest	Post-seasoning		
			2006	2007	2008
Sitka spruce	Pulpwood uncovered	61	63	54	47 (2 summers)
Sitka spruce	Pulpwood covered	62	55	48	45 (2 summers)
Sitka spruce	Energywood uncovered	62	62		
Sitka spruce	Energywood covered	60	57	53	48 (2 summers)
Sitka spruce	Whole trees	57	50	50	47 (2 summers)
Sitka spruce	Whole trees (chemical thinning)	58	52	39	
Sitka spruce	Whole trees (felled standing)	54		44	
Ash	Whole trees	42	36		37
Ash	Roundwood	37			31

Kofman, P. *Fuelling your Boiler the Right Way – Feedstock Quality for Commercial Boilers.* Presentation made at Bioenergy 2008 Conference: A Growing Opportunity for Energy and the Environment. 19 June 2008, Teagasc Mellows Centre, Athenry, Co Galway.

Kent, T. *Wood Fuel Quality Parameter Testing – Summary of Current Activities*. Presentation to NSAI CEN Solid Biofuel Mirror Group Meeting, 25 June 2008, Waterford Institute of Technology.

Kofman, P. *Developing Quality Wood Fuel from Irish Forests, Avoiding the Pitfalls.* Presentation made at SEI Wood Energy Conference: Fuelling Your Future. 10 September 2008, Westport, Co Mayo.

Kent, T. *COFORD Forest Energy Programme Overview.* Presentation to Inter-Departmental Bioenergy Working Group, hosted by Sustainable Energy Ireland, 11 September 2008, Dublin.

Kent, T. *Development of Wood Energy Supply Chains*. Presentation made at Forest Service Seminar - Wood Fuel: The Energy Solution for Kerry. 19 September 2008, Killarney, Co Kerry.

Kent, T. *Producing Wood Chip for Energy – Experiences from the COFORD Forest Energy Programme*. Presentation to the Wicklow Uplands Private Forest Owners Group Seminar. 12 November 2008, Co Wicklow.

Kent, T. and Kofman, P. *Moisture Content Management - The key to wood fuel quality. A result of COFORD Forest Energy Programme.* Irish Bioenergy Association Wood Energy Information Day. 19 November 2008, Enniskillen Co Fermanagh.

Field days

Kent, T. and S. Kelly. Forest Energy Project: results and conclusions of the COFORD funded research programme. Society of Irish Foresters/Irish Timber Growers Association/Irish Farmers Association Field Day 23 May 2008, Ballybofey, Co Donegal.

Coates, E., Cooley, S., Kelly, S., Kent, T. Mockler, N. and Owens, E. Woodfuel Quality Testing Demonstrations and Talks and Wood Energy Assortment and Machinery Demonstrations and Talks. COFORD/SEI/Teagasc Bioenergy 2008, Teagasc, Athenry, Co Galway.

Coates, E., Kent, T., Kelly, S. and Kofman, P. Wood fuel supply chain and quality assessment on softwood first thinning site, Croaghrimcarra, Co Mayo. Public demonstration arranged for at SEI Wood Energy Conference: Fuelling Your Future. 10 September 2008, Westport, Co Mayo.

Coates, E. and Kent, T. Wood chipping methods and costs and wood chip quality demonstration and talk. Teagasc Out-wintering Pad Public Demonstration Day, 19 November, Moorepark Research Centre, Co Cork.

NON-WOOD PRODUCTS

OVERVIEW

Until relatively recently, forests were mainly viewed in the context of the quantity of wood produced. However, today forests are seen more as multifunctional, sometimes with a higher value placed on the non-wood elements. This is particularly true for certain parts of the world where there are strong forestry traditions and where the practices of utilising the non-wood products from the forests have long been practiced; for example, the Scandinavian countries where the practice of collecting fruits, berries and fungi is well established and citizens have traditional rights to collect these products from the forests.

In Ireland the opportunities created by our forests for amenity, recreation and nature are among the main criteria by which most people judge the value and benefits of the national forestry development programme. There is a substantial and growing interest by the public generally and a by a wide variety of interest groups in the use of forests for many different activities including recreation, education and general well-being. Economic growth, development of efficient transportation networks, and increasing disposable incomes have led to a dramatic increase in demands for open space and the recreation associated with forested land. However, there are other products of value in the forests such as foliage, fruit, fungi and berries and these may also have an important economic value for the forest owner.

Ireland's forests are predominantly plantations, mainly grown for wood. However, they are also providers of many other goods and services. As the country becomes more urbanised, the significance of these services is likely to continue to grow. With the expansion of farm forestry, the need to develop income sources from these forests are of the highest priority and developing the full potential of the other products apart from wood production is paramount.

In 2004 COFORD carried out a review of the market possibilities for non-wood forest products in Ireland and explored the opportunity of creating markets for some of these non-wood goods and services. While the non-wood sector in Ireland is not developed to the same extent as in other countries, there are areas such as the production of Christmas trees and foliage that are now important economic activities. Forest recreation and other outdoor activities are steadily growing in our forests and are promoted by the following COFORD projects that are contributing to the development of the non-wood forest products sector in Ireland.

- **FARMFUNGI** - Production of edible fungi in the farm forest.
- **FORESTFUNGI** – An assessment of wild edible fungal production in selected forest sites, and an evaluation of the commercial potential of harvesting.
- **WILDFUNGI** in Ireland – A publication exploring the range of species of fungi recorded in Irish forests.

FARMFUNGI

Production of edible fungi in the farm forest

PROJECT TEAM

Dr Tom Harrington, University of Limerick*
Maria Cullen, University of Limerick
John O'Connell, Private forest owner

* Email: thomas.harrington@ul.ie

COMPLETION DATE: December 2010

BACKGROUND

Oyster mushrooms (*Pleurotus ostreatus*) and shiitake mushrooms (*Lentinula edodes*) are produced on a commercial scale in a number of countries. Production by traditional methods (i.e. on logs) has the potential to be integrated into farm forest enterprises, and to contribute to the financial returns from these enterprises. This is because capitalisation costs are low and there is an availability of raw material for inoculation from thinnings. With careful management, logs may continue to produce crops for up to six years after inoculation, further reducing costs. The rationale behind this project is to assess the feasibility of this production method in a farm forest scenario in Ireland.

OBJECTIVES

- To determine whether inoculation of cut stumps and sawn logs and incubation in the forest will yield marketable quantities of oyster mushrooms and shiitake.
- To determine the influence of stump size and type, log type, size, and moisture content on mushroom yield.
- To develop a protocol for cultivation of mushrooms on logs derived from thinnings that will be applicable in farm forest enterprises.
- To determine whether a plantation of *Tuber aestivum*-inoculated host trees that will yield commercially viable quantities of truffles can be established on a previously unforested site in Ireland.

PROGRESS

A field trial, replicated in three different farm forests in Co Limerick, was set up in spring 2008 to assess production of oyster mushrooms (*Pleurotus ostreatus*) and shiitake (*Lentinula edodes*) on logs cut from forest thinnings. On each farm the trial comprised 720 logs (500 logs are considered the minimum that would give a commercial return). The trial tested one strain each of oyster mushroom and shiitake on 1 m logs of variable diameter of a range of hardwood timber types (Table 1). Ash, sycamore and beech are being assessed at all three farms, oak at two farms and alder at one farm. Inoculation of cut stumps of ash, sycamore and beech is being carried out at one farm.

Inoculated logs were arranged in four standing stacks, one stack for each timber type. There were 45 logs in each stack, comprising four diameter classes.

The logs are now being monitored on a monthly basis for moisture content, mycelium development, production of fruiting bodies, and contaminant fungi. Continuous environmental monitoring is also being carried out (air and soil temperatures, rainfall).

Moisture content remained between 25-35% just prior to (April) and after inoculation (Figure 1), which should have ensured adequate moisture for the colonization of logs.

The contaminant fungus *Trichoderma viride* spread extensively on most logs (except ash) in all the sites after inoculation. This was successfully counterd by restacking and the onset of drier weather.

Table 1: Details of inoculations.

Plantation	Dates of inoculation	Type of timber inoculated with oyster and shiitake	Total number of logs inoculated	Total number of stumps inoculated
Blossomhill Kilcornan	27/05/08-20/06/08	Alder, ash, beech, oak and sycamore	850	180
Springfield Dromcolliher	09/06/08-23/06/08	Ash, beech, oak and sycamore	775	100
Askeaton	24/06/08-07/07/08	Alder, ash, and sycamore	540	27

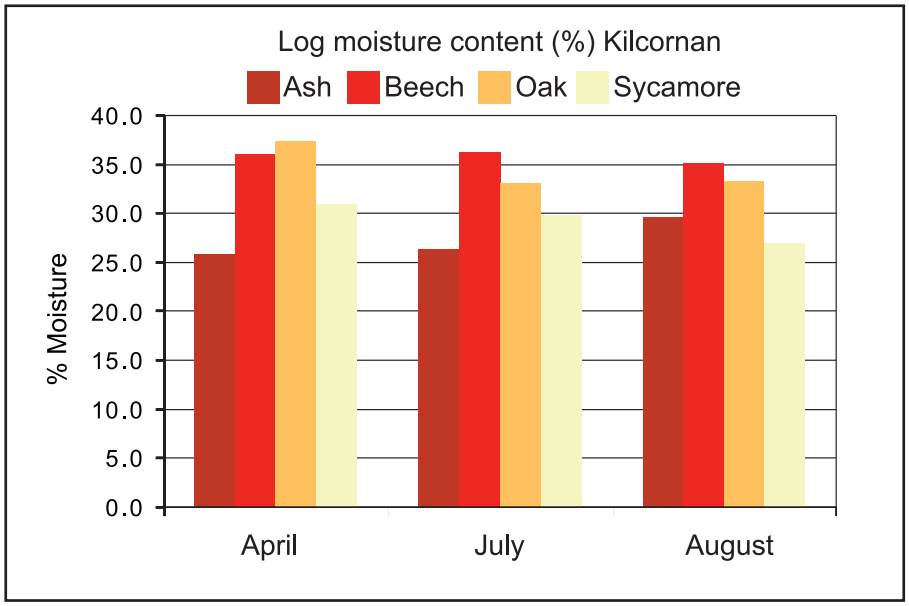


Figure 1: Moisture content in logs of different timber types inoculated with oyster mushroom.

Preliminary internal inspection of a number of logs indicated that the inoculae of oyster and shiitake are colonizing the timber. Fruiting bodies have appeared on a number of the smaller diameter beech logs and also on a number of stumps, a hopeful sign for the success of the inoculation.

Soil cores were collected from the oak and hazel truffle orchard and attempts were made to assess the density of Tuber mycorrhizae on roots of inoculated oak and hazel samplings. Tuber mycorrhizae appear to be present on roots of both species.

ACTIVITIES PLANNED

- Continuous monitoring of the weight and moisture content of the inoculated logs and fungal development on these logs.
- Monitoring environmental conditions in each plantation.
- Establishment of a second trial in spring 2009 to investigate variables such as different strains of oyster and shiitake mushrooms, the use of home-grown inoculum, suitability of conifer timber, and continuous (i.e. year-round) inoculation.
- Analysis of how variables (such as log type, log diameter, log moisture content) influence the yield of shiitake and oyster mushrooms.
- Analysis on the influence of stump size, type and location on yields of oyster mushrooms.

OUTPUTS

A short piece on the project was included in the *Ear to the Ground* television programme broadcast by RTÉ on 6 November 2008.

FORESTFUNGI

Assessment of wild edible fungal production in selected Irish forest sites, and an evaluation of the commercial potential of harvesting

PROJECT TEAM

Dr Tom Harrington, University of Limerick*
Maria Cullen, University of Limerick
John O'Connell
Jonathan Spazzi
Kieran Connolly
David Fallon
Bill O'Dea

* Email: thomas.harrington@ul.ie

COMPLETION DATE: August 2010

BACKGROUND

At least 1,100 species of wild fungi are collected worldwide for culinary or medicinal use. In Europe, the most highly valued commercially collected fungi are truffles (*Tuber* species), ceps (*Boletus edulis* and related species) and chanterelle (*Cantharellus cibarius*), but many more species may actually be collected for consumption depending on regional preferences.

Harvesting of edible fungi in Irish forests was traditionally rather insignificant, but interest in collecting edible fungi for culinary use has increased greatly in recent years. Information is needed on the potential of edible fungi as a secondary forest product in Ireland. Such information is at present sparse, anecdotal and unpublished, in contrast to the situation in many other European countries where collecting wild edible mushrooms is popular. The aim of this project is to obtain this information, which will provide an objective basis for assessing the commercial and recreational potential of edible fungal harvesting in Irish forests.

Cantharellus cibarius. Photo: Louis Smith

OBJECTIVES

- To obtain quantitative information on the production of wild edible fungi in forest study sites that are representative of larger areas of forest in Ireland.
- To establish a framework for long term monitoring of the selected sites beyond the lifetime of the project.
- To extrapolate production from the study sites to larger areas of similar forest in Ireland.
- To assess year to year variation in fungal production.
- To correlate fungal production with environmental and habitat variables.

PROGRESS

In 2007, 53 forest sites were selected for surveying in counties Limerick, Clare, Cork, Kerry, Waterford, Tipperary, Wexford, Wicklow, Dublin, Westmeath, Mayo, Galway, Roscommon, Sligo, Leitrim, Cavan, Offaly, Laois and Donegal. The sites comprised replicate stands of the following range of tree types, generally in single-species, mature stands: beech, birch, Douglas fir, hazel, lodgepole pine, Norway spruce, noble fir, oak (*Q. robur* and *Q. petraea*) and Sitka spruce. In 2007 each site was visited and surveyed between three and four times during the period the first week of September and the last week in November.

In the run up to the 2008 season, the sites sampled in 2007 were re-evaluated for their suitability for long term monitoring. This resulted in the exclusion of approximately 10% of the 2007 sites and their replacement with potentially more suitable sites. The retained sites were resampled and additional sites were also sampled, commencing in mid-August and finishing at the end of November. Each site was sampled at least four times.

Levels of production recorded in the 2008 season were similar to the 2007 season. Both seasons were poor compared to the last productive season in 2006. Hedgehog fungus (*Hydnum repandum*) and different species of chanterelle (*Cantharellus* species) were again the most abundant edible types, and were present at some sites in commercial quantities. Summer truffles (*Tuber aestivum*) were found for the first time in the project, located in a woodland site in the Midlands. Collection of environmental and habitat variables (soil and vegetation) continues, and work has commenced on relating fruit body production and distribution patterns to environmental variables.

Boletus edulis. *Photo: Pat McClelland*

Progress was made towards establishing a framework for a long term monitoring of edible woodland fungi. In relation to this also, the website is nearing completion.

ACTIVITIES PLANNED

- The third round of sampling for fruit body production will be carried out commencing in August 2009. A small number of sites will be sampled earlier in the year, to check for production of morels, St George's mushroom and early-fruiting ceps (*Boletus edulis*).
- Sampling for summer truffles will be carried out on a more systematic basis in the 2009 season.
- Collection of environmental data from the sites will be completed.
- Preliminary multivariate analysis of factors influencing edible fungal production will commence in January 2009.

OUTPUTS

Maria Cullen took part in the *Mooney Goes Wild* programme on RTÉ Radio 1 in October 2008 describing the project, and she and John O'Connell appeared in the *Ear to the Ground* television programme broadcast by RTÉ on 6 November 2008.

WILDFUNGI

Wild fungi of Ireland

PROJECT TEAM

Dr Paul Dowding, Trinity College Dublin
Louis Smith, Galway Mayo Institute of Technology
John Fennessy, COFORD*

* Email: john.fennessy@coford.ie

COMPLETION DATE: August 2008

OBJECTIVES

To publish a book aimed at all those with an interest in Irish fungi, designed to highlight and promote edible Irish forest fungi and linked to FORESTFUNGI and FARMFUNGI.

PROGRESS

The publication has been finalised.

ACTIVITIES PLANNED

The book will be launched in early 2009.

POLICY AND PUBLIC GOODS

While timber production was the original objective at the outset of the afforestation programme, today it is generally recognised that forests provide more than simply economic benefits to society. Social and environmental benefits, often known as public goods, have assumed an important role in the sustainable management of our forests. Through their existence, forests provide services such as employment, carbon sequestration, biodiversity, water protection and wild spaces for outdoor recreation but this contribution is often not taken into account when the economics of a forest enterprise is assessed. While we may be aware of these contributions, our understanding of these benefits, and the underlying mechanisms by which they operate, are in many cases not fully understood or quantified. The projects reported in this section are providing deeper insights into the value of forests to society and ways to account for these externalities, in addition to providing guidance for their enhancement and future development.

FOREST ECONOMICS AND POLICY

OVERVIEW

FORPOLEC

Programme leader: Dr Áine Ní Dhubháin

The policy arena in which forestry operates is changing rapidly. The multi-functional model of forestry, delivering economic, environmental, social and cultural benefits, which has been evolving throughout Europe, represents the new paradigm. Forestry is increasingly expected to deliver public benefits including recreation, landscape, water quality, biodiversity and carbon sequestration. Furthermore, the range of tradable goods and services generated in the forestry sector has expanded beyond timber production in Ireland to include, *inter alia*, cut foliage and marketed recreational activities. Alongside this, the ongoing reform of the Common Agricultural Policy, leading to the introduction of the Single Payment Scheme and the emergence of a new Rural Development Strategy, the ongoing review of the National Climate Change Strategy, and an overall downturn in the economy will have significant implications for the future of forestry in Ireland.

Key drivers behind the initiation of this programme included:

- The need for accurate information on the economic impacts of forestry for informed decision-making. Information is needed not only on the direct impacts of forestry at national level but also on the indirect impacts. Information on the regional and local economic impacts of forestry is also required. There is limited information on the values of the public goods provided by Irish forests, especially in relation to how these values differ under different management approaches.
- The need to identify the factors that influence afforestation levels in Ireland and to identify means by which these can be increased. It is an objective of government policy to increase the forest estate, the success of which is dependent on landowners' willingness to convert land to forestry. These afforestation targets are not being met so there is a need to explore the context in which decisions to afforest are made and to determine what steps can be taken to influence the afforestation decision.

The objectives of the programme are to determine:

- How policy changes are likely to affect afforestation levels and planting objectives of farmers.
- What is the value of public goods under different management scenarios?
- What is the impact of forestry on the national, regional and local economies?

This programme will:

- Provide an estimate of the value of all of the tradable goods of forestry. The direct and indirect contribution of these tradable goods and services to the national, regional and local economies will also be estimated.
- Address the valuation of the market and non-market functions of forestry, including timber, game hunting, marketed recreational activities, carbon sequestration, water quality, landscape and biodiversity impacts, as well as the non-marketed recreational activities. The valuations will, where possible, be associated with types of forest as differentiated on the following criteria, i.e. ownership, location, scale, management and species mix. This will yield strategic information by indicating the relative benefits of different types of forest as compared to other land uses.
- Identify strategies to encourage afforestation by farmers in the context of the changing policy environment.

FORPOLEC

FIRMEC

Modelling the economics of forestry in Ireland

PROJECT TEAM

Mary Ryan, Teagasc*
James Breen, Teagasc
John Cullinan, Teagasc
Trevor Donnellan, Teagasc
Niall Farrelly, Teagasc
Dr Kevin Hanrahan, Teagasc
Dr Stephen Hynes, Teagasc
Dr Cathal O'Donoghue, Teagasc

*Email: mary.ryan@teagasc.ie

COMPLETION DATE: December 2010

BACKGROUND

Forestry has an important and ever evolving role to play in the Irish economy. There is an increasing emphasis on the role of forestry as an alternative energy source, its potential to sequester carbon and the provision of non-tradable goods such as forest recreation. However, despite the presence of generous forest premium payments and the decoupling of direct payments, the afforestation rate is in decline. Given the importance of forestry, a better understanding of the relationship between policy and afforestation rates is therefore required.

OBJECTIVES

This project assesses the actual and potential contribution of forestry to the national, regional and local economy, in terms of both tradable goods and services and in terms of public goods as well as building up the capacity to assess the impact of policy reforms on the sector and assess the impact of the forest sector on the wider economy:

- To measure the impact on farm afforestation rates on the wider economy, competing sectors in terms of land use and the external policy environment;
- To assess the impact of forestry on the regional and local economy;
- To estimate the non-market (i.e. recreational, scenic etc.) value of forests.

PROGRESS

The task of updating the FAPRI-Ireland Forestry model has required substantial changes to the model structure due to changes in Central Statistics Office data. Previously the model was used to estimate afforestation rates for five regions; however, with the change to the NUTS III regions this requires the modelling of afforestation over seven regions. Current model specifications are being examined in order to improve the fit of the model.

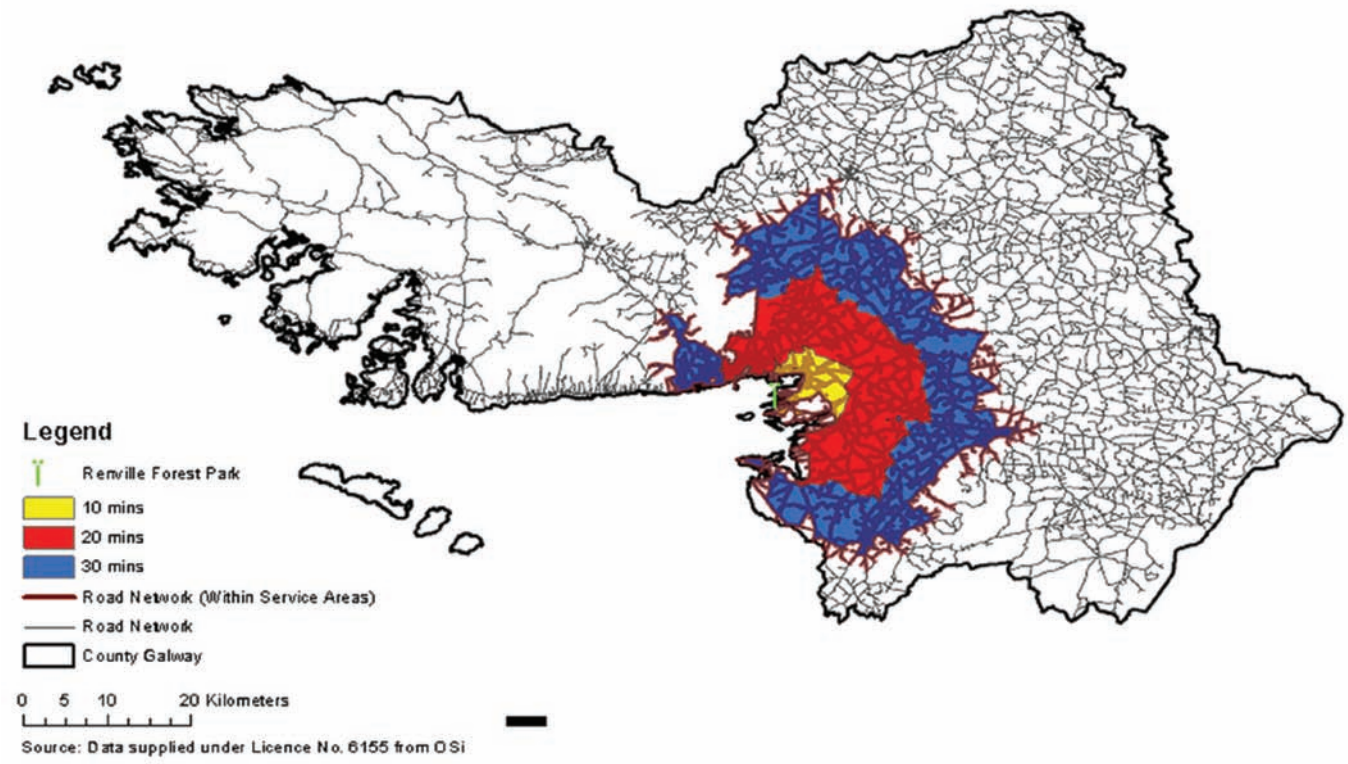
A paper on the Situation and Outlook for Forestry 08/09, produced for the 2008 Situation and Outlook Conference, examined the characteristics of those farmers who currently have or intend to plant forests, as well as the state of timber markets and the consequences for afforestation rates.

A review of the literature has also been conducted where the patterns of use and economic demand for recreational activities in farm forests in Ireland have been examined. Particular emphasis in the review was given to examining previous valuation exercises that have been conducted in Ireland in relation to recreation in Irish forests.

A multi-stage modelling approach for simultaneously estimating the total number and aggregate value of recreation-related visits to small-scale community forest sites in the west of Ireland was also carried out. Simulated spatially-referenced individuals from a spatial microsimulation model for Ireland (SMILE) who reside within the forests' catchment area were identified using GIS techniques. A travel cost model was estimated for a sample of visitors to the sites and transferred across each individual in the simulated population, using SMILE and GIS-based network analysis to derive the appropriate values for the dependent variables. The results of the modelling approach were used to derive aggregate visits and consumer surplus estimates.

ACTIVITIES PLANNED

- Completion of the re-estimation of the FAPRI-Ireland Forestry Model.
- Inclusion of forestry in the farm-level greenhouse gas emissions model.
- Derive aggregate visits and economic value estimates for potential farm forestry recreational sites.



Estimated catchment population of a forest recreation site in Co Galway.

OUTPUTS

Breen, J.P., Donnellan, T., Hanrahan, K. and Ryan, M. 2008. *Projecting future Irish farm afforestation levels.* Paper presented at the Figures for Forests Workshop, Freiburg, Germany.

Breen, J.P. and Ryan, M. 2008. *Situation and outlook for forestry 2008/09.* Paper presented at the Situation and Outlook 2008/09 Conference, Tullamore.

Cullinan. J., Hynes, S. and O' Donoghue, C. 2008. Estimating catchment area population indicators for outdoor recreation sites in Ireland. *Irish Geography* 41: 279-294.

Cullinan, J., Hynes, S. and O'Donoghue, C. 2008. *Using spatial microsimulation to estimate aggregate consumer surplus values in travel cost modelling*. Presented at the 16th annual meeting of the European Association of Environmental and Natural Resource Economists in Gothenburg, Sweden (25-28 June 2008).

Cullinan, J., Hynes, S. and O'Donoghue, C. 2008. *Aggregating consumer surplus values in travel cost modelling using spatial microsimulation and GIS techniques*. Teagasc Working Paper No. 08wpre07.

FORPOLEC

FORECON

An economic evaluation of the market and non-market functions of forestry

PROJECT TEAM

Dr Áine Ní Dhubháin, University College Dublin*
Dr Deirdre O'Connor, University College Dublin
Dr Craig Bullock, University College Dublin
Vincent Upton, University College Dublin

*Email: aine.nidhubhain@ucd.ie.

COMPLETION DATE: June 2011

BACKGROUND

Good policy decision-making in forestry needs to be well informed. This implies, amongst other things, that up to date information on the economic contribution of forestry to the national, regional and to local economies is collated. Furthermore, given that the multi-functional model of forestry, delivering economic, environmental, social and cultural benefits, is the new paradigm, this economic evaluation should include an assessment of the value of the public goods that forestry delivers, including:

- climate change mitigation;
- biodiversity conservation and enhancement;
- water quality protection and enhancement;
- recreation;
- landscape value.

It is likely that different approaches to forest management deliver different public benefits, thus it is important that the economic valuation associated with types of forest be assessed as differentiated on the following criteria: ownership, location, scale, management and species mix. This will yield strategic information by indicating the relative benefits of different types of forest.

OBJECTIVES

- Provide strategic information by indicating the relative benefits of forest management practice respectively directed at the outputs of recreation, biodiversity, landscape, water quality and carbon sequestration;
- Estimate the relative public benefits of public forestry and private forestry, including farm forestry;
- Determine the direct and indirect contribution of the tradable goods and services of forestry, including timber, game hunting, a small number of marketed leisure activities, cut foliage and forest food (i.e. berries and mushrooms) to the national, regional and local economies;
- Demonstrate the net public benefit of forestry in comparison with other land uses;
- Examine those factors that determine public benefits and determine if benefit transfer estimates from abroad would be applicable to Ireland;
- Place values in a public cost-benefit framework by comparing policy cost with the social benefits and combining this information with the private costs and benefits motivating forestry uptake over time.

PROGRESS

The current emphasis of the project is on examining the relative benefits of different forest management approaches to non-market forest benefits (NMFB) and in identifying Irish and international studies from which it may be possible to acquire relevant benefit transfer figures. To date an extensive literature review has been carried out, which has included a wide range of environmental valuation methods and case studies related directly to NMFB. This has facilitated the identification of the most suitable valuation methods for use in the project and how they may be applied following best practice. Data from previous studies have been collected and examined; however, NMFB valuation studies directly related to Ireland are limited.

Previous Irish valuation studies have placed emphasis on direct use benefits, such as recreation, and as a result information on indirect benefits, such as biodiversity, is lacking. Biodiversity value is a particularly difficult benefit to capture given that its primary value is often one of existence. Stated preference environmental valuation methods such as

contingent valuation and choice experiments employ surveys to quantify the value of a particular environmental change. As these methods are not reliant on an existing market they have the capacity to capture non-use values such as those related to biodiversity. A choice experiment examining the value of different forest management approaches is expected to be the primary valuation technique employed in the household survey for this project.

Data collected in the household survey will be combined with forest spatial data in a GIS to investigate how existing forests influence people's attitudes to and value for forests and forest management. Spatial data related to Irish forests and households have been identified for use in this analysis.

Design of the household survey and the choice experiment has commenced. The survey design will first be examined in a focus group situation and pre-tested before being carried out as a household survey of a sample of the general population.

ACTIVITIES PLANNED

- Survey design will continue, following best practice;
- Focus groups will be organised to finalise and analyse the survey questions to ensure they are comprehensible and realistic to the general public;
- A household survey will be carried out to examine the public's use of and attitudes towards forests and forest management;
- A series of in-forest surveys will be undertaken and work has begun to identify relevant forests for inclusion in these studies;
- Work on input-output analysis will commence.

OUTPUTS

A presentation of the project status was given at the Teagasc Forest Economics workshop held in Athlone on 15 October 2008.

FORPOLEC

POLFOR

Forestry in a changing policy environment

PROJECT TEAM

Dr Áine Ní Dhubháin, University College Dublin *
Dr Deirdre O'Connor, University College Dublin
Stefanie Duesberg, University College Dublin

*Email: aine.nidhubhain@ucd.ie.

COMPLETION DATE: June 2011

BACKGROUND

The government's forest strategy, *Growing for the future* (DAFF 1996), laid out afforestation targets of 25,000 ha per annum to the year 2000 and 20,000 ha per annum thereafter, with the ratio of private to public planting to be 70:30. These targets have not been met and planting rates have fallen since 1996, reaching only 10,000 in 2005. Since its publication a number of reviews of the success of the strategy have been carried out (e.g. Clinch 1999; Bacon and Associates 2004; Malone 2008) and the policy environment in which forestry operates has changed substantially. Continued reforms of the Common Agricultural Policy (CAP) resulting in the introduction of the Single Payment Scheme, changes in rural development policy and climate change measures, all influence afforestation policy and practices. There is a need therefore to explore the influences of these policy measures for forestry as well as a need to understand better the decision-making environment of farmers and more specifically to influence it.

OBJECTIVES

- Compare the relative returns from forestry and a number of different agricultural systems in the light of the introduction of the Single Payment Scheme (SPS) and analyse the impact at the level of the individual farmer and the wider economy;
- Examine the implications of the forestry-related measures to be introduced under the Rural Development Regulation (RDR) in Ireland for both the sector itself (including Coillte) and the wider economy, including, *inter alia*, the impact of revised payment rates for afforestation and the introduction of more specific 'forest-environment' payments;
- Explore the factors influencing a farmer's decision to plant using a combination of quantitative and qualitative research methods;
- Determine the impact of these reforms and farmers attitudes on land availability for forestry;
- Identify strategies to encourage afforestation by farmers in the context of the changing policy environment.

PROGRESS

Much of the work of the initial phase of the project has been to undertake an extensive review of:

- policies that influence land use, but specifically forestry, including the Rural Development Programme, the Single Payment Scheme and related EU policies;
- the literature relating to decision-making by landowners regarding the use of their land.

Reviewing the literature revealed that two groups of decision-makers operating in Irish forestry can be separated: farmers on the one hand and the public forest sector and forest companies on the other. They can be distinguished by the different policy framework they are operating in and other factors prevailing in their decision-making process. Therefore in the further progress of the project the influential policy framework and the factors influencing the decision-making of these two groups will be examined separately.

In order to explore the financial arena in which Irish farmers make decisions regarding afforestation, a net present value (NPV) exercise was undertaken to compare the relative returns from a number of agricultural systems and a forestry enterprise taking account of the introduction of the Single

Payment Scheme (SPS). This work will be extended to examine the gross margins from various agricultural systems and the cash flows from forestry enterprises and will account for changes arising from the introduction of the SPS, the Rural Development Strategy and other policy developments.

ACTIVITIES PLANNED

- *Examine farmers' decision-making processes.* Using a qualitative method, for example semi-structured interviews, farmers shall be asked about the reasons for their land use decisions with regard to forestry. Farmers with and without forests will be approached as will farmers of different farming enterprises;
- *Explore the impact of these factors.* Using the results of the interviews, a questionnaire will be designed and issued to farmers of all farming enterprises and to farmers with and without forests. With the help of this quantitative study, structural patterns underlying the decision-making process of farmers can also be revealed;
- *Examine the decision-making process of state forestry bodies and forestry companies and the factors influencing the process.* Hold discussion group meetings comprising a cross-section of decision-makers in state bodies and companies.

OUTPUTS

Duesberg, Stefanie. 2008. *Trees, beef or sheep? A comparison of the profitability of forestry and two agricultural land use systems in Ireland by their Net Present Values of bare land.* Unpublished working paper. Available from stefanie.duesberg@ucd.ie.

Presentation of the project status at the Teagasc Forest Economics workshop in Athlone, 15 October 2008.

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FORESTS AND CLIMATE CHANGE

OVERVIEW

CLI-MIT
Climate change mitigation and adaptation in Irish forests

Programme manager: Dr Kevin Black

There is now convincing scientific evidence that global climate change is occurring rapidly as a result of human activities, such as fossil fuel burning and deforestation. Global and regional climate change will create many challenges and opportunities for Irish forestry. Because of their long life cycles, trees are expected to be more sensitive to large and fast shifts in climate patterns, much faster than those experienced in the past. Forests interact with both the climate and atmosphere: on the one hand, they are vulnerable to climate change but, on the other hand, they are likely to contribute to emissions reductions and carbon sinks. In fact it is difficult to discuss adaptation to climate change with a forest decision maker without any comment about carbon sequestration and mitigation of greenhouse effect. Similarly, mitigation cannot be planned without any hypotheses about the future forest vulnerability. The key objective of the CLI-MIT programme is to provide stakeholders with the required tools and knowledge for formulating and achieving effective mitigation and adaptation policies. This requires a good knowledge of the impact of climate change, international and EU policy, carbon reporting mechanisms, and issues relating to forest carbon sinks.

Mitigation

The EU is committed to reducing its overall emissions to at least 20% below 1990 levels by 2020, and is ready to scale up this reduction to as much as 30% under a new global climate change agreement when other developed countries make comparable efforts. At a national level, this puts more emphasis on emission reduction rather than mitigation by forest sinks because of technical and institutional barriers such as land availability, and the ability to finance forestry projects will reduce the potential to a fraction of the stated amount. The National Climate Change Strategy sets out a series of measures that are designed to meet Ireland's greenhouse gas emission target over the period to the end of 2012. Forest sinks (afforestation since 1990 – the Kyoto forest) is by far the largest measure identified. The contribution is estimated at 2.08 million tonnes of carbon dioxide in 2008. The reporting and accounting guidelines under the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto agreement demand a transparent, compliant and representative estimation of the changes carbon stocks in Irish forests. These estimates are subject to a high degree of spatial and temporal uncertainty. The scientific background

and reporting procedures are being developed in the programme under the **CARBWARE, CARBiFOR II, FORESTSOILC** and **WOODCARB** projects.

Adaptation

A new set of modelled climate predictions for Ireland have been downscaled in a regional climate model (RCM) and tested by the Community Climate Change Consortium for Ireland (C4I). The RCM predictions provide more detail on the likely changes in Ireland's climate throughout this century.

The change in Ireland's climate in terms of warmth and climatic droughtiness, which are both important for tree growth and survival, has been predicted from C4I data. The spatial and temporal changes in the mean climate indicate increasing warmth and droughtiness in the south and east of Ireland. The decadal frequency of extreme climatic events will increase. Drought frequency is predicted to increase to 3-4 droughts per decade over large parts of central and southern Ireland by 2050, increasing to more than 7 droughts per decade towards the end of the century.

Given the rapid change in the predicted climate in Ireland over the next century and the relatively long periods between establishment and final harvest, it is likely that some species may not be suited to the future climate within one or two rotation cycles. Clearly, the suitability of currently used forest species under the future climate and consequent changes in growth and ecology of forests and their pests and diseases requires consideration now. The aim of the **CLIMADAPT** project is to develop a GIS decision support system for species selection and productivity based on the current climate, site attributes and soil types. These productivity models will be further developed to assess the sustainability of current forest species and suggest the introduction of new species or management strategies under future climate change scenarios. The sequestration potential of forests under future climate change scenarios will also be investigated and incorporated into the **CARBWARE** model.

Potential benefits and outcomes from this programme include:

- Delivery of an International Panel for Climate Change (IPCC) compatible and compliant carbon accounting system for Irish forestry;
- Support policy makers and national climate change negotiators with background information including scenario analysis and projections of forest sinks;
- Provide guidelines to stakeholders so that the technical potential for mitigation options can be maximised (e.g. wood substitution and forest management options);
- Provision of good basic research to support the national reporting obligations;
- Ongoing monitoring of the impacts of climate change so that adaptive and mitigation options can be considered in a holistic way;
- Developing tools to aid in the selection of species best suited to site type and future climate scenarios;
- Climate change risk assessment so that adaptation options and policy can be implemented in a timely manner;
- Education and dissemination of information on forests and climate change by publication, media and web sites (see www.coford.ie/iopen24/defaultarticle.php?cArticlePath=420_395).

CLI-MIT

CARBIFOR II

Carbon sequestration by Irish forest ecosystems

PROJECT TEAM

Prof. Maarten Nieuwenhuis, University College Dublin*
Dr Brian Tobin, University College Dublin
Paul Gardiner, University College Dublin
Samuel Olajuyigbe, University College Dublin
Prof. Bruce Osborne, University College Dublin
Dr Matt Saunders, University College Dublin
Guiseppe Benanti, University College Dublin
Prof. Thomas Bolger, University College Dublin
Dr Brian Reidy, University College Dublin
Catriona Duffy, University College Dublin

* Email: maarten.nieuwenhuis@ucd.ie

COMPLETION DATE: April 2012

BACKGROUND

The overall objective of CARBiFOR II is to provide information for quantifying the influence of disturbance, land use change, soil type and forest age on carbon budgets that are relevant to the Land Use, Land Use Change and Forestry (LULUCF) reporting requirements under the Kyoto Protocol of the Climate Change Convention. The CARBiFOR II project builds directly on the achievements of CARBiFOR, by extending the time span of flux measurements to include an analysis of stand age, as well as the influence of disturbance caused by afforestation and thinning operations. The project will also attempt to characterise changes in biomass, decomposition, CO_2 and non-CO_2 greenhouse gas (GHG) flux associated with different soils and tree species, providing a more comprehensive assessment of the total greenhouse gas budget of Irish forest ecosystems. The project intends to study four chronosequences (a series of sites representing the development of forest plantations):

Chronosequence 1: Sitka spruce growing in a mineral soil;

Chronosequence 2: Sitka spruce growing in a peat soil;

Chronosequence 3: Ash growing in a mineral soil;

Chronosequence 4: Oak growing in a mineral soil.

OBJECTIVES

- Biomass allocation and stock measurements;
- Above- and below-ground coarse-wood decomposition study;
- Using ground penetrating radar to estimate below-ground biomass.
- Measuring the surface exchange of CO_2, H_2O and turbulent energy over several forest age classes using permanent and mobile eddy covariance towers;
- Estimation of C losses associated with thinning, associated vegetation and land use change;
- Measurement of non-CO_2 greenhouse gas emissions associated with land use change and forest stand age;
- Assessment of C stock changes associated with afforestation;
- Project chronosequence soil characterisation and C stocks;
- Soil sampling of national forest inventory plots and chronosequence sites;
- C inputs and parameters for CENW model.

PROGRESS

Sampling has begun and has included both nursery and forest stock assessments. Nursery stock is being sampled to create a baseline or starting point for estimating growth curves and biomass expansion factors (BEFs). The nursery species sampled include alder, ash, Douglas fir, lodgepole pine, oak, Scots pine and Sitka spruce. Alder and larch have also been sampled from 6-year-old forest sites.

To examine the effect of thinning, a final survey at the end of the 2008 growing season will complete a series of surveys covering growth over four years and two thinning events (first and second).

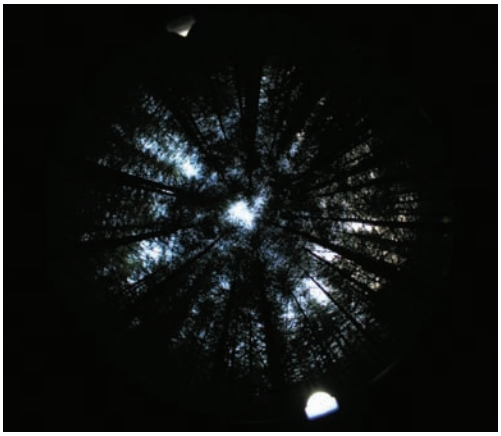


Figure 1: Hemispherical photographs will be used to analyse changes in stand canopy structure before and after thinning events.

Figure 2: CO_2 and trace gas measurements being measured using a photo-acoustic analyser on brash lines after the second thinning at Dooary (20-year-old stand).

A series of replicated trenched experiments have been set up at the main eddy covariance (EC) site at Dooary to examine below-ground decomposition of coarse roots. The results of the first sampling are being analysed. Sampling of coarse wood debris (CWD) has also begun. Respiration measurements from brash have begun and will encompass a period before and after the second thinning at Dooary.

EC measurements are being made over a range of forest age classes, and a semi-natural grassland (prior to afforestation), through to a 20-year-old stand. The permanent tower is located at a 20-year-old stand and has been operational since 2003; this site has also undergone two thinning events. A mobile EC tower is being used to investigate both the impact of land use change and forest age on carbon fluxes. The mobile tower moves on a weekly basis between a semi-natural grassland, and a 6- and 14-year-old Sitka spruce stand.

In association with the EC flux towers, measurements of soil respiration and non-CO_2 greenhouse gas fluxes (methane and nitrous oxide) are being made using static chambers at the chronosequence sites.

Litter inputs, litter decomposition and fine root turnover are being measured.

The definitive selection of sites will be ongoing as it requires site visits to ensure the availability of appropriate paired plots. Where sites have not been appropriate, backup sites were selected from a reserve list. Initially the sampling of mineral and peaty mineral soils was prioritised over peat soils until a detailed sampling protocol was agreed with University College Cork in December (2008). Peat sampling equipment has been purchased in conjunction with University College Cork with a view to sharing this equipment for analyses in the coming months.

ACTIVITIES PLANNED

- Complete identification of chronosequences 2-4;
- Sampling of above- and below-ground CWD decomposition;
- Resurvey of the thinning experiment (following the second thinning);
- Continue litter collection, biomass surveys and sampling, and brash respiration measurements;
- Continue roving the mobile EC tower between all chronosequence 1 sites at Dooary forest;
- Continuous soil respiration and canopy profile CO_2 measurements;
- Decomposition, litterfall and fine root turnover experiments will be continued;
- Continue measurements of N_2O and CH_4;
- Continuation of NFI paired plot sampling and processing;
- Commencement of analysis of samples.

OUTPUTS

Meetings/conference attendance:

Olajuyigbe, S., Gardiner, P., Tobin, B. and Nieuwenhuis, M. 2008. *Stump survival in commercial plantations in Ireland.* Poster presented at COST Action E38, Woody roots and Ecosystem services, 16 to 20 May 2008, Lisbon, Portugal.

COFORD Conference on Proceedings of Site Classification in Ireland, June 2008, Tullamore: Participation in the presentation on CLIMADAPT.

Tene, A., Tobin, B., Black, K., Ray, D., and Nieuwenhuis, M. 2008. *Adaptation of forest species to climate change.* Poster presented at Dendro-ecology fieldweek, Birmensdorf Switzerland, 14 to 20 September 2008.

IMECC Annual Meeting, 3-5 March 2008, Jena, Germany.

Irish Plant Scientists Meeting, 26-28 March 2008, NUI Maynooth. Oral presentation.

COST Action 639, Greenhouse gas budget of soils under changing climate and land use (BurnOut), 27-29 April 2008, Rostock, Germany. Poster Presentation.

EPSO (European Plant Science Organisation) meeting, 22 – 26 June 2008, Toulon, France. Invited speaker.

Trends in Plant Ecophysiology and Ecosystem Ecology Research conference, 23 – 27 June 2008, Palermo, Italy. Poster Presentation.

CarboEurope-IP Trace gas chamber calibration workshop, 21-28 September 2008, University of Helsinki, Forestry Research Station, Hyttiala, Finland.

6th Annual CarboEurope-IP Project Meeting, 29 September – 3 October 2008, Jena, Germany. Oral and poster presentation.

1st Expert Meeting on Data for the IPCC Database on Greenhouse Gas Emission Factors. 17-19 November 2008, Buenos Aires, Argentina.

Tene, A., Tobin, B., Black, K., Ray, D. and Nieuwenhuis, M. 2008. *Adaptation of forest species to climate change.* Poster presentation at the Nancy 2008 International Scientific Conference. The European Forest-Based Sector: Bio-Responses to Address New Climate and Energy Challenges? 6-8 November 2008, Nancy, France.

CLI-MIT

CARBWARE

Development of tools and systems for reporting on forest carbon stocks and stock change under the Kyoto protocol and the UNFCCC

PROJECT TEAM

Dr Kevin Black, FERS Ltd.*
Dr Gerhardt Gallagher, University College Dublin
Prof. J. Connelly, University College Dublin
Dr M. Hawkins, University College Dublin
Mark Tarleton, PTR Ltd.
Jacques Hamel, PTR Ltd.

* Email: kevin.black@ucd.ie

COMPLETION DATE: December 2011

BACKGROUND

Newly planted forests (post-1990), in particular, offer the potential to offset CO_2 emissions by taking up and storing carbon in forest biomass and soils. The sequestration potential of these forest sinks has been substantially enhanced by the establishment of more than 260,000 ha since 1990 following the introduction of afforestation grant schemes. Under the agreed terms of the Kyoto Protocol, Ireland is committed to reduce greenhouse gas (GHG) emissions by 13% above the 1990-base year level. Current estimates (1990-2004) suggest that GHG emission levels are 23% above the 1990 level. Assuming a business as usual scenario, it is estimated that the contribution of national forests, under Article 3.3, may offset ca. 16% of the required GHG emissions for the first commitment period. However, estimation of the extent to which forests sequester carbon in the mid to long term is hindered by a high degree of uncertainty due to spatial heterogeneity and temporal variability.

The Irish carbon reporting system (CARBWARE) was initially implemented in 2004 to meet reporting requirements to the United Nations Framework Convention on Climate Change (UNFCCC) on all national forest sources and sinks. Whilst this model indicates the likely contribution of forests to the national C storage (sink) potential, the system has relied on the use of generalised stand growth models to describe changes in forest carbon stocks because of the lack of national forest inventory (NFI) data. The availability of detailed NFI data and new research information now provides the opportunity to develop CARBWARE and improve estimates of national forest carbon stock changes. Experimental and observational research information, carried out by the CARBiFOR II and FORESTSOILC projects, is aimed at supporting and developing the CARBWARE reporting system.

OBJECTIVES

The overall objective is to report C stock and stock changes in Irish forests using the agreed UNFCCC format for land use, land use change and forestry (LULUCF) and the International Panel for Climate Change (IPCC) good practice guidance on LULUCF and Kyoto reporting.

Specific targets are:

- Analysis of NFI and iFORIS data streams to extract relevant information in a format compatible with CARBWARE;
- Refinement and redevelopment of CARBWARE to include species and yield class specific biomass models;
- Statistical sensitivity analyses to select a GPG-LULUCF complaint reporting procedure with the smallest uncertainty and error;
- The implementation of a database of input data to allow for QA/QC of input data and formatting input data for mathematical operations in CARBWARE computations;
- Development of a Windows-based software interface based on the CARBWARE model and with compatible LULUCF, UNFCCC reporting table and Kyoto output files. This software should be able to run different scenarios and incorporate uncertainty analysis;
- Incorporation of a Harvested Wood Product (HWP) C-store reporting procedure into CARBWARE;
- Independent peer review of reporting mechanism, prior to final submissions and redevelopment if required;
- The publication of a LULUCF and Kyoto reporting manual, which complies with GPG requirements, for Irish forests;
- Implications of climate change on potential sequestration by Irish forests using an Ecological Site Classification (ESC), yield-based model, under different climate change scenarios.

PROGRESS

UNFCCC reporting

The CARBWARE project is responsible for providing the EPA with LULUCF reports on an annual basis. Significant refinements to the reporting system in 2008 included:

- Implementation of a national system to capture deforestation based on national forest inventory, Coillte inventory and felling licence information;
- The inclusion of nitrous oxide (N_2O) emission estimates for drained forest soils for LULUCF reporting.

National strategy, policy and negotiation support

A large proportion of CARBWARE's resources were aimed at providing strategic support for international burden sharing and climate change negotiations. A range of forest sink projections up to 2020 were compiled to clarify both the Irish and EU options in the negotiation process (Figure 1). Major considerations to be addressed in the next Conference of Parties (COP 15) meeting in Copenhagen are:

- Agreement on accounting rules for the period 2012 to 2020;
- Inclusion of land use activities post the first commitment period. CARBWARE provided estimates of sink/emission for all afforestation and deforestation activity since 1990 (i.e. Article 3.3 forests) and for all other managed forest land planted before 1990 (i.e. Article 3.4 forests).

Ireland did not previously elect Article 3.4 activities for the first commitment period due to uncertainty associated with the models and incomplete accounting for litter, deadwood and soil carbon pools. However, it is possible that the reporting and accounting for all forest land could become mandatory after the first commitment period (i.e. after 2012). Most recent projections using CARBWARE suggest that the managed forest may represent a small sink between 2012 to 2020 (Figure 1b) if forests are managed in a sustainable manner. Therefore, it would be a small advantage to account for Article 3.4 forests in the future. The extent and magnitude of the emission or sink for 3.4 forests would depend on:

- current annual increment;
- timber removal from harvest and disturbances.

Growth modelling

A single tree model for Sitka spruce has been parameterised and optimised using Coillte permanent sample plot data. The models have been designed to specifically cope with data from the NFI, which does not provide sufficient information to utilise stand-based models such as GROWFOR. The unique features of these models are:

- Single tree models can be applied to semi-natural, mixed species and uneven aged stands;
- The model includes a competition factor that can cope with different mortality and competition effects within one species cohort. So, for example, one model can be used for thinned and non-thinned stands of different planting densities;
- The model is dynamic since it can account for the spatial and state transitions that represent stand development.

CARBWARE projections

The national forest estate can be divided into two categories for Kyoto accounting purposes: Article 3.3 forest (afforested and deforested areas since 1990) and article 3.4 forests (all managed forest land afforested before 1990).

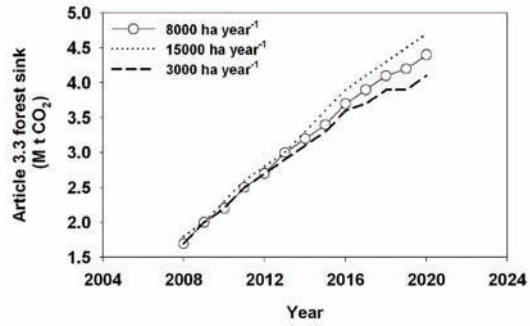


Figure 1a: CO_2 sink (uptake) by Article 3.3 forests based on three different afforestation rates.

Article 3.3 forests are likely to sequester 2 to 4.5 M t CO_2 per year between 2009 and 2020 based on the current afforestation rates (ca. 8000 ha year^{-1}). This potential may vary slightly in the short term depending on future afforestation rates. This projection suggests that the maximum technical potential for mitigation under this option is primarily limited by the afforestation rate due to socio-economic factors such as land price and competing agricultural policy.

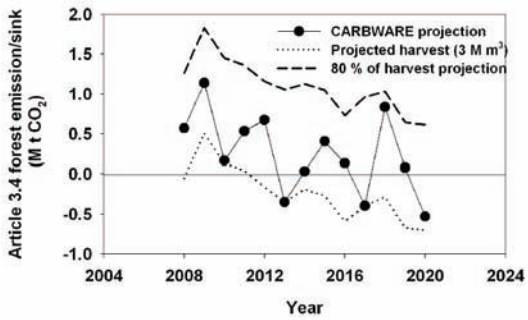


Figure 1b: Emission/sink projections for the article 3.4 forests (negative values represent a net loss or emission for any given year). The broken line represents different harvest scenarios. The projected harvest of 3 million m^3 is based on projections for Coillte lands (Gallagher and O'Carroll 2001), which represents 92% of the article 3.4 forest area. The CARBWARE projection forecasts a harvest of 2.7 million m^3.

Negative values indicate where harvest is greater than increment. The maximum technical potential for mitigation using this option is largely determined by management. For example, the downward future trend (net emission) for the 3.4 forest may be due to factors such as harvesting before rotation age is reached (i.e. before maximum mean annual increment) or a proportional increase in timber demand from the same area with a decreasing standing volume.

Software specification

The software code for the CARBWARE package has been specified and designed. Source code for the growth component of the model is currently being programmed in Visual Basic. The software will contain four modules:

1: *Pre-processing and growth simulation:* contains NFI data processing functions and growth model source codes for major species.

2: *Stand modification:* the module will interact with the growth simulator to account for the following four factors: a) mortality, b) harvest, c) fire and d) deforestation.

3: *Biomass allocation*: this module will process carbon stock changes in the biomass, litter, deadwood and soil pools.

4: *Reporting*: this module will scale up the simulated data based on NFI, research information and models to produce user defined reports specifically designed for LULUCF and Kyoto reporting.

ACTIVITIES PLANNED

- Development of five more cohort models.
- Development of harvest and growth modifier module in software.
- Development of biomass allocation module.
- Completion of reporting module.
- Uncertainty analysis and scoping of Monte Carlo system for software development.
- QA/QC of data inputs to the CARBWARE software.
- Implementation of felling sampling system.
- Assist FORESTSOILC and CARBiFOR II with statistical analysis of paired plots data for detection soil carbon stock changes.
- Submission of National LULUCF and Kyoto report 2008 including deforestation, fire activities.

OUTPUTS

Black, K., Gallagher, G., O' Brien, P., Redmond, J., Barrett F. and Twomey, M. 2008. *Dispelling myths: the real extent of peatland afforestation in Ireland* COFORD Connects, Environment No. 8, COFORD, Dublin.

Black, K. 2008. *Ireland's forest carbon reporting system*. In: Hendrick, E. and Black, K.G. (Eds). Proceedings of COFORD conference Forestry, Carbon and Climate Change - local and international perspectives, p 14-20.

Hawkins, M.J., Black, K. and Connolly, J. 2008. *Missing values in Sitka spruce growth model covariate*s. XXIV International Biometrics Conference, 13-18 July, Dublin.

Hawkins, M.J., Black, K. and Connolly, J. 2008. *Modelling changes in Irish forest carbon stocks*. In: Eilers, P.H.C. et al. (eds.). 23rd International Workshop on Statistical Modelling. 7-11 July, Utrecht, Netherlands.

Hendrick, E. and Black K. 2008. *Climate change and Irish forestry*. COFORD Connects, Environment No 9, COFORD Dublin.

Ray, D., Xenakis, G., Semmler, T, and Black, K. 2008. *The impact of climate change on forests in Ireland and some options for adaptation.* Proceedings of COFORD conference Forestry, Carbon and Climate Change - local and international perspectives, COFORD, p 27-34.

Ray D., Xenakis G., Tene, A. and Black, K. 2008. *Developing a site classification system to assess the impact of climate change on species selection in Ireland*. COFORD Workshop The role of site classification in forest productivity and management. Tullamore Court Hotel, June 2008.

Collaborations and Committees

- Management committee member of ECHOES: Cost FP0703 (Expected Climate Change and Options for European Silviculture).
- Member of National Steering Group on climate change impact and adaptation.
- Member of National Steering Group on Climate change mitigation.
- Participation in workshops on LULUCF reporting issues.
- UNFCCC reviewer on LULUCF.

CLI-MIT

CLIMADAPT

The use of Ecological Site Classification in adapting forests and their management to climate change

PROJECT TEAM

Duncan Ray, Forest Research, UK*
Dr Georgios Xenakis, Forest Research, UK
Dr Kevin Black, FERS Ltd.
Prof. Maarten Nieuwenhuis, University College Dublin
Dr Brian Tobin, University College Dublin
Armand Tene, University College Dublin
Andrew Mason, Environ-IT, UK

* Email: duncan.ray@forestry.gsi.gov.uk

COMPLETION DATE: May 2009

BACKGROUND

The project was initiated to improve forest species site selection in Ireland. This is a fundamental requirement for implementing sustainable forest management. Climate change will also impact on species selection and CLIMADAPT will provide guidance on suitability for future climate scenario projections.

OBJECTIVES

- Design a forest classification system for tree species selection and yield potential in Ireland, based on the interpretation of six biophysical factors.
- Develop a knowledge-base of climate change adaptation strategies including species choice and silvicultural modifications from an interpretation of the likelihood of abiotic and biotic impacts resulting from climate change scenario projections.
- Validate knowledge-based yield models for Sitka spruce and other species if data availability permits.
- Develop a web-based combined stand-scale and spatial-scale decision support tool.

PROGRESS

CLIMADAPT is a forest classification system based upon ESC (Pyatt et al. 2001) for Great Britain. Six biophysical variables have been used to specify site conditions based on: climatic warmth, climatic wetness/droughtiness, wind exposure, continentality, soil wetness and soil fertility.

Spatial data representing the six biophysical variables have been completed for Ireland. In addition, spatial climatic variables based on future climate change projections based on the IPCC A2 and B1 emissions scenarios have been calculated for Ireland. This will allow CLIMADAPT to check tree species suitability in future climate scenarios, providing an initial assessment of likely climate impacts and adaptation strategies for particular species-site type–climate impact combinations.

Knowledge-based suitability models have been described for 21 tree species. Models use information from a Delphi group meeting held in Dublin, in July 2007, and from the results of an expert group that discussed tree species suitability for Britain in 2001. The models describe the suitability response of a species against each of the six biophysical variables. Suitability is defined by the most limiting factor for a particular site type.

An initial validation of the knowledge-based yield predictions for Sitka spruce has been designed using Bayesian and Monte Carlo methods. Initial investigation showed that validation data must be improved, this work is currently being undertaken.

The core model of web-application has been completed and tested. This uses java script and ajax (asynchronous java and xml) technologies, and also links to Google™ maps and satellite imagery.

The user interface was discussed at a user group meeting in 2008. A mock-up of the system was tested by users, who provided feed back on amendments and additional functionality that was required. The user interface will be completed and tested by May 2009.

A pilot study (part of a PhD at UCD), to assess several species of tree for moisture stress across a west-east transect through Ireland and the UK, has been completed. The pilot study tested the sampling and analysis techniques to be used in the main project. The project will measure stable isotopes of carbon and oxygen in the early wood and late wood of specific tree rings, taken from dominant trees within permanent sample plots on freely draining soils. In Figure 1 the moisture deficit anomaly from three meteorological stations in eastern and southern Ireland records the synchronous occurrence of particularly dry summers in 1959, 1976, 1984, 1989 and 1990. The study will determine whether narrow tree rings associated with dry summers show isotope signals associated with closed stomata – caused by drought conditions. Figure 2 shows a core being taken from a tree in Avoca forest.

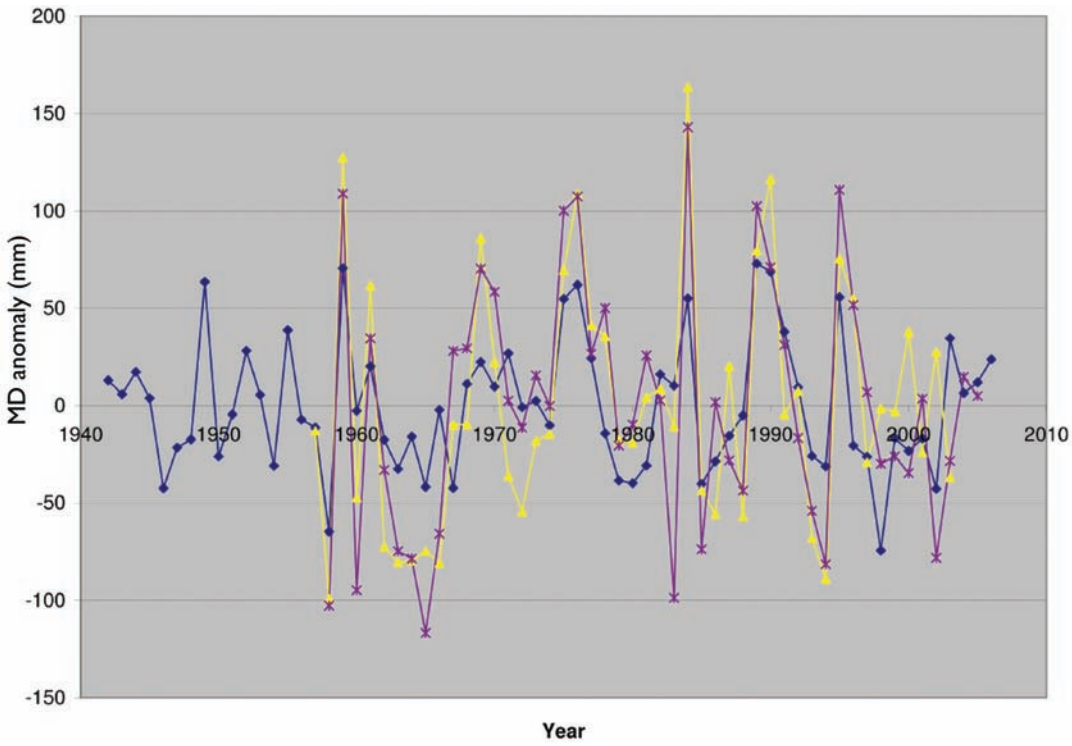


Figure 1: Moisture deficit (MD) anomaly for three meteorological stations in Ireland (Dublin ◊, Rosslare Δ, and Kilkenny x), showing synchrony between dry summers (positive anomaly) and wet summers (negative anomaly).

ACTIVITIES PLANNED

- Complete a CLIMADAPT yield validation for Sitka spruce,
- Complete the user interface of the web-application,
- Test the application with the user group in Ireland,
- Hold workshops in Ireland to demonstrate the CLIMADAPT web-application,
- Complete the first field season of tree coring and analysis for the main dendroclimatology study.
- Complete and submit two papers.

OUTPUTS

Papers published

Ray, D., Xenakis, G., Semmler, T. and Black, K. 2008. The impact of climate change on forests in Ireland and some options for adaptation. In: E. Hendrick and K.G. Black (Eds). Forests, Carbon and Climate Change - Local and International Perspectives. COFORD, Dublin, Glenview Hotel, Dublin, Ireland, p 27-33.

Papers submitted

Ray, D., Xenakis, G., Tene, A. and Black, K. Submitted. Developing a site classification system to assess the impact of climate change on species selection in Ireland. *Journal of Irish Forestry.*

Conferences attended

Site Classification Conference, Tullamore, Ireland, June 2008 - presentation.

Figure 2: Taking a tree core in a 50-year-old permanent sample plot at Avoca.

International Conference on climate change, Nancy, France - poster.

Dendro-ecology conference, Birmensdorf, Switzerland - poster.

Reference

Pyatt, D.G., Ray, D. and Fletcher, J. 2001. *An Ecological Site Classification for Forestry in Great Britain*. Bulletin 124. Forestry Commission, Edinburgh.

CLI-MIT

FORESTSOILC

Soil carbon stock changes and greenhouse gas fluxes in Irish forests

PROJECT TEAM

Prof. Gerard Kiely, University College Cork*
Michael Wellock, University College Cork
Christina LaPerle, University College Cork
Nelius Foley, University College Cork
Dr Kevin Black, FERS Ltd.

* Email: g.kiely@ucc.ie

COMPLETION DATE: May 2011

BACKGROUND

The Kyoto Protocol includes mechanisms such as Article 3.3 for parties to use C sequestration in forests to meet emission targets. Article 3.3 allows changes in C stocks due to afforestation, reforestation, and deforestation since 1990 to be used to offset emissions. Due to the rapid rate of afforestation in Ireland since 1990 Article 3.3 offers a great potential for Ireland to offset emissions from other sources. In order to meet international reporting obligations, Ireland must collect nationally specific data to increase the accuracy and reduce the uncertainty of the estimation of the greenhouse gas emissions offset by afforestation.

OBJECTIVES

- To investigate the effect of afforestation on soil C stocks at 40 forest sites and to estimate forest soil carbon stocks.
- To determine the effect of afforestation and deforestation on CO_2 and CH_4 dynamics in peat soils and to develop emission factors for afforested and deforested blanket peat.
- To determine the effect of broadleaf afforestation of mineral soils on soil C stocks.
- To investigate the effect of afforestation of grassland on CO_2 and N_2O fluxes.

PROGRESS

Work on developing a quantitative assessment of the carbon (C) stocks in Irish forest soils commenced in July 2007. Following the development of sampling and laboratory protocols and some preliminary field work, it was agreed that 21 mineral soil sites (i.e. 21 pairs to include one forest site plus a nearby non-forest site), 8 peaty mineral soil sites and 10 peat soil sites are to be sampled. The paired concept grew out of review work in New Zealand.

The mineral soil sites have been divided into eight sampling groups based on soil type (brown earths, podzols, brown podzolics, and gleys) and forest type (coniferous, mixed, or broadleaf). The mineral soil forest sites are paired with a site representative of pre-afforestation site conditions.

The peat and peaty mineral (peaty gley and peaty podzol) sites will not be paired due to the level of variability in peat depth within a site.

Figure 1 shows the sites sampled to date. Nineteen of the 21 mineral paired sites, two of the 8 peaty mineral sites and none of the peat sites have been field sampled to date. It is planned to complete the mineral site sampling by the end of February 2009 and the peat sites by May 2009. The laboratory analysis of soils is ongoing. Figures 2 and 3 show some preliminary results for the group conifer brown earth.

With regard to the aim to assess the impact of afforesting grassland on the fluxes of CO_2, N_2O and CH_4 from the soil, the selected site was recently afforested (2005) ~10 ha grassland site at Dripsey, Co Cork. The eddy covariance flux tower was installed in the summer of 2008. The instrumentation on the 2 m scaffold tower (Figure 4) includes:

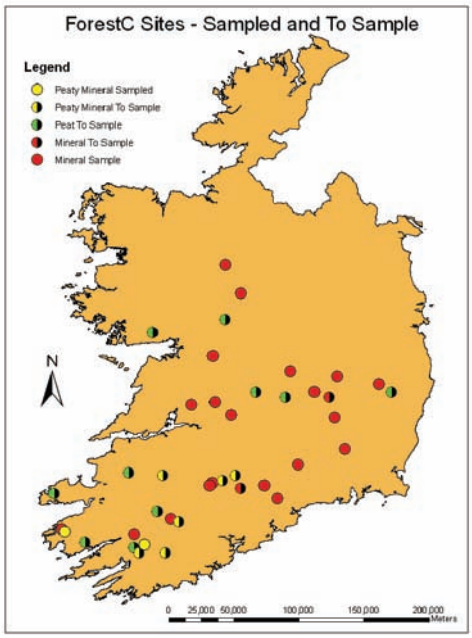


Figure 1: ForestC sites that have been sampled and those that will be sampled during next period.

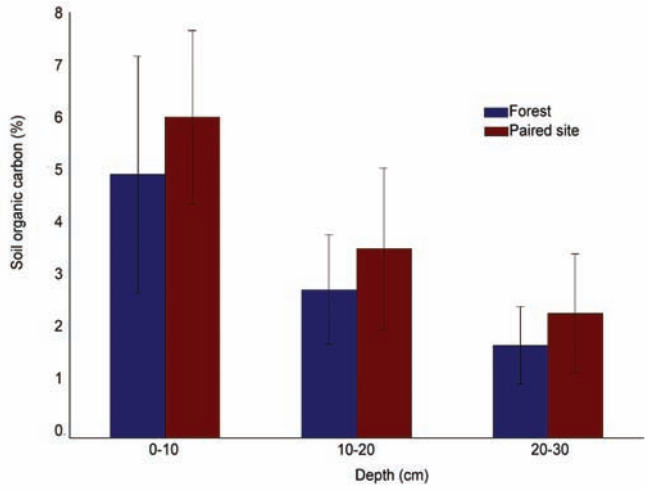


Figure 2: The average of 3 sites: all conifer brown earth for SOC% with depth (cm). Sites included in averages are Loughrea (Site 6659), Clonmel (Site 12048), and Baltinglass (Site 15894).

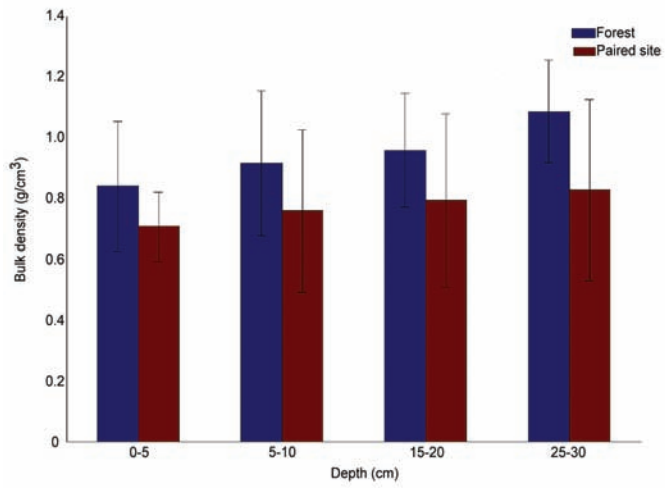


Figure 3: The average of 3 sites: all conifer brown earth for bulk density with depth (cm). Sites included in averages are Loughrea (Site 6659), Clonmel (Site 12048), and Baltinglass (Site 15894).

radiation and PAR sensors; air temperature and humidity sensors; a LICOR 7500 sensor for 10Hz CO_2 and H_2O concentrations; a 3D sonic anemometer; soil temperature and moisture. Data collection on the flux tower began in September 2008, and included meteorological and flux data.

At the same site, sixteen permanent collars (along with soil moisture and temperature probes) have been placed at the soil surface in 2 transects to measure the N_2O and CH_4 fluxes. The N_2O fluxes will be measured monthly during the winter and weekly during the growing season.

ACTIVITIES PLANNED

National scale soil C stocks: All field and laboratory work should be complete by July 2009, and estimation of SOC stocks will begin.

C dynamics in organic soils: Begin work on project in February 2009 and have initial results for July 2009.

C stock changes in mineral soils: Begin work on this after completion of work on national scale soil C stocks.

CO_2 and N_2O fluxes in recently afforested grassland: Begin N_2O data collection after the installation of the soil temperature and moisture probes.

Figure 4: Tower looking north-west. Note: The new forest height is ~ 1.5 m (November 2008).

FOREST BIODIVERSITY

OVERVIEW

PLANFORBIO

Programme leader: Prof. John O'Halloran

Programme manager: Dr Sandra Irwin

The knowledge base on forest biodiversity in Ireland remains relatively restricted to certain forest types and taxonomic groups, although progress has been made in recent years through state funding of the National Survey of Native Woods and the BIOFOREST project. PLANFORBIO will build upon these efforts, expanding the number of forest types in which biodiversity is understood and drafting management and monitoring guidelines for these habitats. There will be a focus on particular elements of diversity and aspects of management that are important to Irish forest policy through large-scale studies of forest biodiversity. In addition, special studies will be made of two species that are of great interest to Irish and European conservation and diversity: the Hen Harrier, one of Ireland's raptors associated with forested habitats, and the invasive alien plant *Rhododendron ponticum*.

A primary aim of the programme is to address forest diversity and management, focusing on forest types that are currently being encouraged through state policies and financial incentives. These are the Irish forests of the future, and little is currently known about their capacity for biodiversity conservation. The aim of the Hen Harrier and Rhododendron studies is to develop decision-making tools about forest planning and management draft action plans for species conservation or control. These will be achieved through four discrete research projects with over-arching objectives and outputs:

FORESTBIO: Managing for biodiversity in a range of Irish forest types.

RHODO: Achieving effective Rhododendron control.

HENHARRIER: Optimum scenarios for Hen Harrier conservation in Ireland.

BIOPLAN: Implementation of an assessment and monitoring programme for forest biodiversity.

The PLANFORBIO programme will support decision-making through the provision of information on forest biodiversity in the form of user-friendly databases, peer reviewed scientific papers and stakeholder focussed workshops. In addition, the four projects will contribute policy relevant recommendations for sustainable forest management and conservation. This programme will have an emphasis on outreach and information dissemination through workshops and seminars with target audiences such as forestry contractors and managers. PLANFORBIO also supports national strategic objectives of increasing the

number of post-graduate students being trained in Ireland and will ultimately build research capacity that underpins an important sustainable national industry.

Further information can be found on the programme website at www.ucc.ie/en/planforbio

A separate but related project to the PLANFORBIO programme is **FUNCTIONALBIO**. This project examines the functional aspects of forest ecosystems, particularly the fungi and soil fauna which play an important role in decomposition and nutrient cycling within forests. Among the aims of the project are to assess the below-ground faunal biodiversity of forests, compile a macrofungal inventory of selected woodland sites, determine the mycorrhizal diversity on forest trees and develop methodologies to assess and enhance biodiversity in forests.

PLANFORBIO

FORESTBIO

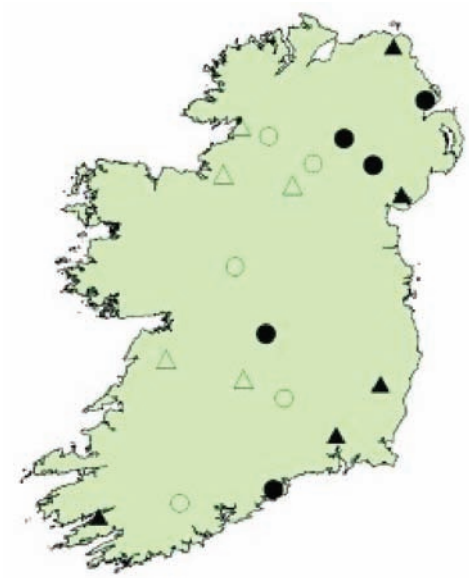
Managing for biodiversity in a range of Irish forest types

PROJECT TEAM

Prof. John O'Halloran, University College Cork
Dr Sandra Irwin, University College Cork*
Dr Daniel Kelly Trinity College Dublin
Dr Tom Kelly, University College Cork
Dr Fraser Mitchell, Trinity College Dublin
Dr Michael Keane, Coillte
Dr Mark Wilson, University College Cork
Dr Anne Oxbrough, University College Cork
Dr Linda Coote, Trinity College Dublin
Pat Neville, Coillte
Howard Fox, Trinity College Dublin
Veronica French, University College Cork
Rebecca Martin, University College Cork
Karen Moore, Trinity College Dublin
Oisín Sweeney, University College Cork
Kathrin Kopke, University College Cork
Dr Fidelma Butler, University College Cork

* Email: s.irwin@ucc.ie

COMPLETION DATE: December 2010



Locations of study sites for 2008 biodiversity surveys (● Norway Spruce:Oak plantation, ○ Norway Spruce:Scots Pine plantation, ▲ Native Oak Woodland, Δ Native Ash Woodland).

BACKGROUND

The COFORD/EPA funded BIOFOREST project was an integral part of the emerging body of knowledge on forest biodiversity in Ireland following a period of intensive afforestation and associated landscape changes during the latter part of the twentieth century. Although expansion of the forest estate remains a priority for government, the character of Ireland's forests is undergoing considerable change. An increasing proportion of existing conifer forests are being harvested and restocked, and a high proportion of plantings now consist of a mix of conifer and broadleaved species. FORESTBIO seeks to address gaps in the knowledge of forest biodiversity in three forest types (second rotation conifer plantations, mixed tree species plantations and native woodlands) through surveys of plants, birds and invertebrates.

OBJECTIVES

- Assess the biodiversity of native woodlands, second rotation plantations and mixed species plantations.
- Conduct inter-forest type comparisons and comparisons with data from BIOFOREST to build a picture of the variety of forests in Ireland today.
- Identify indicators of biodiversity for different forest types and describe long term monitoring techniques.
- Identify measures to enhance the biodiversity of the different forest types.

PROGRESS

This project will sample 60 forest sites in total, 20 each of the three forest types. The following target taxonomic groups are being examined:

- Epiphytes;
- Ground-dwelling plants;
- Ground-dwelling invertebrates;
- Canopy-dwelling invertebrates;
- Lepidoptera;
- Birds.

The intention was to complete the majority of fieldwork during the first two years to allow sufficient time for subsequent laboratory identification of specimens and for data analysis. To this end 30 sites (20 second rotation

plantation, five oak native woodland and five ash native woodland) were selected for survey during 2007 and thirty (20 mixed tree species plantation, five oak native woodland and five ash native woodland) during 2008. Much of the project fieldwork has now been completed and specimen identification is well underway. In addition to the flora and fauna surveys conducted during 2007, dedicated Lepidoptera surveys were conducted during the summer of 2008, and a subset of sites selected for autumn Lepidoptera surveys. Similarly, a subset of sites was selected for winter bird surveys.

Analysis of data collected thus far has commenced and team members are working towards interpretation and dissemination of results. Construction of the project database will bring together the many disciplines and add value to the results generated by each group, while making the data accessible to stakeholders in a user-friendly format.

During the summer of 2008 the canopy fogging surveys uncovered a new species of spider to Ireland. One male and one female of *Entelecara acuminata* (Wider 1834) were captured at Brownstown Wood in Co Kilkenny. This species is rare in England and has occasionally been recorded in Scotland, but never before in Ireland. Although a labour intensive and often difficult method for surveying forest canopy invertebrates, thermal fogging offers a unique tool in the assessment of fauna in our forest canopies, and has been directly responsible for the discovery of this species in Ireland.

Male of *Entelecara acuminata*, a new spider species to Ireland found in 2008 using the thermal canopy fogging technique.

ACTIVITIES PLANNED

Much of the fieldwork on FORESTBIO is now complete; however, Lepidoptera and canopy invertebrate sampling will continue through the next reporting period.

Sorting and identification of plant and invertebrate samples collected during 2007 and 2008 fieldwork will be completed.

Detailed statistical analysis of data will be a priority with a view to the production of manuscripts for submission to international journals.

Lilac Beauty (*Apeira syringaria*), a member of the 'Thorn' family found in woodland and heathland and classified as 'rare' by the Moths Ireland website. During 2008 lepidoptera surveys this species was found in a pure Norway spruce forest, Norway spruce forests mixed with both oak and Scots pine and a native oak woodland.

Preliminary data will be presented at conferences and workshops, nationally and internationally.

OUTPUTS

Popular articles

Moore, K. 2008. *Plant communities after clearfelling.* Irish Tree Society Winter Newsletter.

Peer-reviewed papers

Martin, R. In Press. *Entelecara acuminata* (Wider 1834) at Brownstown Wood, Co Kilkenny, new to Ireland. *The Irish Naturalists Journal.*

Presentations at workshops and conferences (including posters)

Coote, L., Kelly, D.L., Kelly, T., Mitchell, F., Irwin, S., Oxbrough, A., Wilson, M.W., Martin, R., French, V., Fox, H., Sweeney, O., Moore, K., Neville, P., Keane, M. and O'Halloran, J. 2008. *FORESTBIO*. Irish Plant Scientists Association meeting 2008. NUI Maynooth.

Fox, H. and Kelly, D.L. 2008. *Epiphyte diversity in native and plantation forests.* ENVIRON 2008 DkIT.

Irwin, S., Kelly, D. L., Kelly, T., McCarthy, N., Mitchell, F., Coote, L., Oxbrough, A., Wilson, M., Martin, R., French, V., Fox, H., Sweeney, O., Moore, K. and O'Halloran, J. 2008. *Planning and management tools for biodiversity in a range of Irish forests.* (Poster presentation). ENVIRON 2008, DkIT.

Martin, R., Kelly, T., Oxbrough, A., Wilson, M., Irwin, S. and O'Halloran, J. 2008. *Assessing the biodiversity of canopy arthropods in a range of forest types*. (Poster presentation). ENVIRON 2008, DkIT.

Martin, R., Kelly, T., Oxbrough, A., Wilson, M., Irwin, S. and O'Halloran, J. 2008. *Assessing the biodiversity of canopy arthropods in a range of forest types.* Postgraduate Ecology Forum 2008, Trinity College Dublin.

Moore, K., Coote, L., Fox, H., Vézeau, C., Mitchell, F. and Kelly, D. L. 2008. *Ground flora diversity of Sitka spruce reforestation plantations in comparison with afforestation plantations in Ireland*. ENVIRON 2008 DkIT, Postgraduate Ecology Forum 2008 TCD and Irish Plant Scientists Association Meeting 2008 NUI Maynooth.

O'Halloran, J., Kelly, D. K., Kelly, T., Mitchell, F., Giller, P. S., Iremonger, S. and Irwin, S. 2008. *BIOFOREST and Biodiversity (BIOFOREST and PLANFORBIO)*. Environmental Research Conference 2008, Royal Hospital Kilmainham, Environmental Protection Agency.

Oxbrough, A., Kelly, T., Irwin, S., and O'Halloran, J. 2008. *Biodiversity indicators of ground-dwelling spiders in Irish plantation forests and native woodlands.* Biodiversity in Forest Ecosystems and Landscapes' (IUFRO) conference, Thompson Rivers University, Canada.

Sweeney, O., Kelly, T., Wilson, M., Irwin, S. and O'Halloran, J. 2008. *What affects bird diversity in native and plantation woodlands?* (Poster presentation). ENVIRON 2008, Dundalk Institute of Technology.

Sweeney, O., Wilson, M., Irwin, S., Kelly, T. C. and O'Halloran, J. 2008. *Bird diversity of Irish Woodlands.* Postgraduate Ecology Forum 2008, Trinity College Dublin.

Sweeney, O., Wilson, M., Kelly, T. C., Irwin, S. and O'Halloran, J. 2008. *Bird diversity and abundance in different stages of the forest cycle in first and second rotation plantation forests*. Cork Ornithology Research Conference, University College Cork, November 2008.

Theses

Chauvigne, C. 2008. *The ground-dwelling invertebrate communities of native oak woodlands (*Quercus *sp.), pure plantation forests (Norway spruce (*Picea abies*)) and mixed plantation forests (Norway spruce and oak).* MSc Thesis, Ecole Superieure d'Agriculture d'Angers.

Daly, O.H. 2008. *An investigation of the ground flora diversity of mixed forests.* MSc Thesis, Trinity College Dublin.

Inputs to curriculum development and teaching

O'Halloran, J. 2008. *Biodiversity of birds in Irish woodlands.* Seminar Series Hilary Term, TCD.

Anne Oxbrough and Mark Wilson have lectured to the MSc Ecosystem Conservation and Landscape Management run by the ZEPS department, University College Cork.

Oisín Sweeney, Mark Wilson and John O'Halloran gave lectures on the Biodiversity Components of Forestry course at UCC.

Project website

http://www.ucc.ie/en/planforbio/Projects/FORESTBIO/

PLANFORBIO

HENHARRIER

Optimum scenarios for Hen Harrier conservation in Ireland

PROJECT TEAM

Prof. John O'Halloran, University College Cork
Dr Sandra Irwin, University College Cork *
Dr Tom Kelly, University College Cork
Dr Mark Wilson, University College Cork
Barry O'Mahony, University College Cork
Chris Cullen, University College Cork
Barry O'Donoghue, University College Cork/National Parks and Wildlife Service
Steven O'Connell, University College Cork
Geoff Oliver, National Parks and Wildlife Service

* Email: s.irwin@ucc.ie

COMPLETION DATE: December 2012

BACKGROUND

Hen Harriers can be adequately provided for within Irish SPAs only when detailed data on their habitat requirements are available. A greater understanding of foraging behaviour and success of Hen Harriers will enable investigation of the importance of within-habitat variation in determining the value of land to foraging Hen Harriers. This project specifically addresses the issue of land use designation and habitat preferences of the Hen Harrier. Although a species of great conservation concern, previous research in Ireland has focussed almost exclusively on population size and this project is the first large-scale study of Hen Harrier breeding ecology and habitat requirements.

Male Hen Harrier caught in the Slieve Aughtys in 2008 using a stuffed eagle owl as a decoy.

OBJECTIVES

- Increase knowledge of Hen Harrier ecology and foraging behaviour.
- Determine the value to Hen Harriers of the main habitats in the SPAs.
- Improve understanding of Hen Harrier habitat requirements at the landscape level, and revise recommendations accordingly, incorporating these into an Indicative Strategy for Hen Harrier management in the SPAs.
- Compile a GIS database of land use and habitat types within the SPAs.

PROGRESS

2008 was the second successful year of data collection on this project. Fieldwork was conducted with assistance from additional fieldworkers supported financially by the National Parks and Wildlife Service (NPWS). Four field researchers spent the summer months gathering breeding biology data at 60 Hen Harrier nests and ringing and wing-tagging the young chicks. This work resulted in the accrual of a significant volume of data on breeding biology including information on timing of breeding, basic breeding biology, nest site selection, habitat requirements and breeding season outcomes in four research areas (Kerry, West Clare, Ballyhouras and Slieve Aughtys). These data will ultimately contribute to the long term study of Hen Harrier breeding on this project, but preliminary findings based on the first two years of data have been published in *Irish Birds* in an effort to raise awareness for this work, and to provide those involved with Harrier conservation and members of the public with some basic information on the breeding ecology of Hen Harriers in Ireland. Fieldwork experiences to date have been positive and strong working links have been established with NPWS and IRSG staff and data on breeding success and foraging ecology will continue to be collected until 2012.

This year also saw the first deployment of nest cameras to observe the parenting behaviour of birds and also the first captures of adult harriers with a view to GPS tracking in 2009. This is the first time that these technologies have been employed with Hen Harriers in Ireland and significant progress was made towards developing protocols for their use on this project during 2009. Although some technical difficulties were experienced with the nest cameras deployed,

these were efficiently resolved in most cases and much useful data were obtained. While no GPS tags were deployed during 2008 the capture method was tested and the protocol refined in collaboration with NPWS ahead of the 2009 season when the first GPS tracking of Hen Harriers will be conducted.

ACTIVITIES PLANNED

- Third full season of breeding biology collection, including deployment of nest cameras.
- GPS tracking of Hen Harriers in Ireland.
- Update habitat database for Hen Harriers areas (SPAs and areas previously identified as Indicative Areas by NPWS).
- Dissemination of project findings at international conferences.

OUTPUTS

Peer-reviewed papers

Irwin, S., Wilson, M., Kelly, T.C., O'Donoghue, B., O'Mahony, B., Oliver, G., Cullen, C., O'Donoghue, T. and O'Halloran, J. 2008. Aspects of the breeding biology of Hen Harriers Circus cyaneus in Ireland. Irish Birds. Vol 8(3): 331-334.

O'Halloran, J., Kelly, T.C., Irwin, S. and Newton, S. 2008. Current Ornithological Research in Ireland: 5th Ornithological Research Conference, UCC November 2008. Irish Birds. Vol 8(3): 441-488.

Wilson, M., Irwin, S., Norriss, D., Newton, S., Collins, K., Kelly, T. and O'Halloran, J. In Review. Nest site selection by Hen Harriers Circus cyaneus in Ireland. Ibis.

Popular articles

O'Donoghue, B. 2008. In Search of the Sky Dancer. Wings magazine (Summer 2008).

Presentations at conferences

Irwin, S., Kelly, D. L., Kelly, T., McCarthy, N., Mitchell, F., Coote, L., Oxbrough, A., Wilson, M., Martin, R., French, V., Fox, H., Sweeney, O., Moore, K. and O'Halloran, J. 2008. Planning and management tools for biodiversity in a range of Irish forests. (Poster presentation). ENVIRON 2008, DkIT.

O'Donoghue, B. 2007. The Irish Hen Harrier - an illustrated talk. Presented at Sligo Institute of Technology, November 9th 2007; Fort Dunree, Irishwomen, Co Donegal, November 16th 2007; Presented at BurrenLife, County Council Chambers, Ennis, Co Clare, February 13th 2008; Presented at Killarney National Park Spring Week, International Hotel, Killarney, Co Kerry, 26 April 2008.

Wilson, M. 2008. Habitat requirements of Hen Harriers in Ireland. Irish Wildlife Trust - Slieve Felim group. Glenstal Abbey Library, October 2008.

Inputs to curriculum development and teaching

Mark Wilson lecture to 'Early Start' class in Zoology Department, UCC, September 2008: Habitat requirements of Hen Harriers in Ireland.

Databases and data management

2007-2008 breeding locations, reproductive biology and nesting success of Hen Harriers in Ballyhouras, North Kerry, Slieve Aughtys and West Clare (complete).

Habitat classification of Hen Harrier SPAs and Indicative Areas (complete, requires updating).

2007-2008 detailed habitat within 2 km of Hen Harrier nest (ongoing).

Internet presence

The Hen Harrier was featured as 'Species of the month' on the noticenature.ie website in July 2008.

Project website:
www.ucc.ie/en/planforbio/Projects/HENHARRIER/

Still shots taken using nest camera at a Hen Harrier Nest at Derryvokeel in the Slieve Aughtys in June 2008.

PLANFORBIO

RHODO

Achieving effective Rhododendron control

PROJECT TEAM

Prof. John O'Halloran, University College Cork
Dr Sandra Irwin, University College Cork*
Dr Nick McCarthy, Waterford Institute of Technology
Eddie Daly, Waterford Institute of Technology
Dr Daniel Kelly, Trinity College Dublin

* Email: s.irwin@ucc.ie

COMPLETION DATE: October 2011

BACKGROUND

Humans have introduced a large number of alien plant and animal species into local habitats. In many cases conditions permit these species to become invasive and impact on the habitat's integrity. Foremost among alien invasive species in Ireland in terms of area covered, density and resulting sterilising effect is *Rhododendron ponticum* L. Rhododendron invades several Annex 1 habitats in Ireland and direct control is required to maintain these habitats in 'favourable conservation status'. This project aims to develop tools for the planning of landscape level control programmes and to transfer the experience gained to other practitioners and environments. It also aims to develop cost-effective methods for reduction or elimination of herbicides, particularly in conservation areas.

OBJECTIVES

- Increase knowledge of rhododendron invasion.
- Ascertain the effectiveness of reducing rhododendron natural regeneration post-clearance.
- Survey and collect any indigenous pathogens adversely affecting rhododendron in Ireland.
- Isolate these pathogens and test them under laboratory conditions with a view to using them in the future as bioherbicides.
- Run workshops during and at the end of the project on rhododendron control.
- Produce national policy recommendations based on the findings of the project.

PROGRESS

Key research questions have been identified and experimental protocols are being devised to answer them. Following extensive literature searches five research areas were selected for detailed investigation during this project:

- Investigate the development of a bio-control for rhododendron;
- Development of an aging key for rhododendron;
- Reducing rhododendron reinvasion post-clearance;
- Calorific value of rhododendron;
- Seed longevity and viability.

Two sites have been selected for the reinvasion experiment to give as much vegetation type variation as possible. Castlelands in Lismore, Co Waterford, has been chosen as one site. This is an 8 ha broadleaf forest consisting of mature oak with an understorey of rhododendron, *Prunus laurocerasus* and some *Ilex aquifolium*. The second site selected is Nephin forest (Coillte-owned forest) outside Newport, Co Mayo. At the request of the Marine Institute (who have a research facility adjoining the property), the site was not replanted following harvesting 10 years ago and rhododendron has since invaded the site. Nephin forest is a peatland site.

The RHODO team will also collaborate with CABI (Centre for Agricultural Bioscience International) UK to isolate some of the fungi that may have potential for future use as a mycoherbicide. The investigation into innovative fungal isolates on rhododendron to inform the development of bioherbicide agents for its control will be carried out in two phases. The first will be the survey and collection of pathogens affecting rhododendron and subsequent isolation of the pathogens in the laboratory. The second stage will be concerned with the inoculation of young rhododendron plants with some of these fungal isolates under laboratory conditions to study their effects and ascertain whether there is potential for use as bioherbicides.

Rhododendron ponticum in flower.

ACTIVITIES PLANNED

Collaboration with CABI on the identification of fungi with potential for use as mycoherbicides will commence in January 2009 when a member of CABI UK will visit WIT to work with the team.

Experimental protocols will be finalised and work will begin with seed viability tests and growth rate measurements when they ripen in early 2009.

Calorific value, moisture content and bulk density of rhododendron biomass will be ascertained during the first half of 2009.

Work on establishing the re-invasion sites will be conducted between January and April.

Outreach will commence with presentations at national and international meetings.

OUTPUTS

Irwin, S., Kelly, D. L., Kelly, T., McCarthy, N., Mitchell, F., Coote, L., Oxbrough, A., Wilson, M., Martin, R., French, V., Fox, H., Sweeney, O., Moore, K. and O'Halloran, J. 2008. Planning and management tools for biodiversity in a range of Irish forests. (Poster presentation). ENVIRON 2008, DkIT.

Project website:
http://www.ucc.ie/en/planforbio/Projects/RHODO/

FUNCTIONALBIO

Functional biodiversity in forests: diversity of soil decomposers and predatory and parasitic arthropods

PROJECT TEAM
Prof. Thomas Bolger, University College Dublin*
Dr Julio Arroyo, University College Dublin
Dr Annette Anderson, University College Dublin
Dr Aidan Keith, University College Dublin
Dr Alvin Helden, University College Dublin
Joan Kenny, University College Dublin
Dr Tom Harrington, University of Limerick
Richard Hanlon, University of Limerick

* Email: tom.bolger@ucd.ie

COMPLETION DATE: December 2009

BACKGROUND

In forests, growth and decomposition are the two most important ecosystem functions. Plants supply the majority of growth within the ecosystem, while fungi and soil fauna are the main drivers of decomposition. Soil arthropods play a major role in decomposition and nutrient cycling within forests, and also help inoculate roots with mycorrhizae. Mycorrhizae are important within forest ecosystems as the associations they form with the roots of many tree species assist in the assimilation of nutrients. Within the forest system, there is far greater biodiversity below-ground than above-ground, for example there are approximately 1000 species of soil invertebrates in a single square metre of a beech forest. Also the biodiversity of macrofauna are of considerable importance in soil systems.

The taxa selected for study (fungi, soil microarthropods, parasitoid wasps, bugs (Hemiptera), and nematodes) were chosen specifically because of their potential usefulness as indicators in forest systems, and because they are additional taxa that significantly broaden the ecological scope of the assessment of biodiversity in Irish forests.

OBJECTIVES

The objectives of this research project are to:

- assess the biodiversity of mites, Collembola, bugs and parasitic wasps in canopies;
- assess the below ground animal biodiversity;
- compile an inventory of macrofungal basidiomycetes and ascomycetes;
- assess abundance of fruiting bodies of edible forest fungi;
- relate diversity to forest type;
- relate the efficiency of fungal biodiversity indicators to other biodiversity indicators in Irish forests;
- develop methodologies to assess biodiversity in forests;
- draw up recommendations to enhance biodiversity in plantation forests.

PROGRESS

Canopy sampling by tree climbing trees is now complete and has yielded a large number of species.

The samples processed thus far have yielded three species new to science. These come from the genus *Zercon*. The descriptions have been accepted for publication and will appear in early 2009. These findings are of a great ecological and faunistic importance because *Zercon* species are not commonly found in arboreal habitats, suggesting a sharp distinction between arboreal and soil species.

The genus *Licneremaeus* (Acari: Oribatida) has been recorded for first time in Ireland and Scanning Electron Microscopy (SEM) was used to confirm the identifications of *Xenylla brevicauda*, and its presence in Ireland which has been disputed. Discussions with taxonomists are ongoing.

A literature review of the Acari and Collembola species found in Irish forests is ongoing. This will be the basis for the biodiversity inventory.

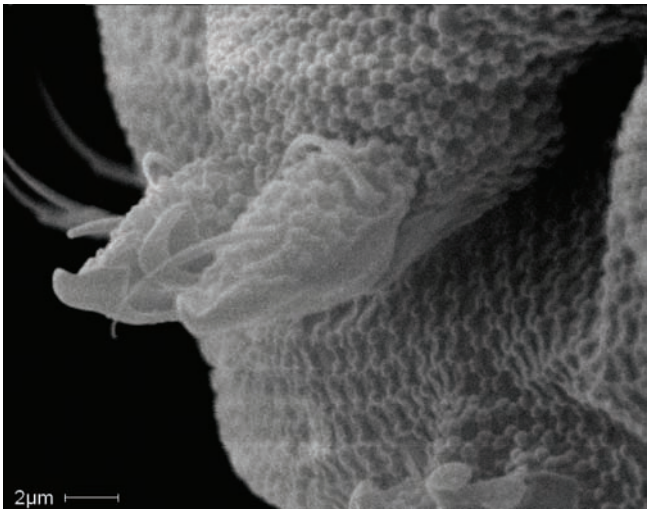
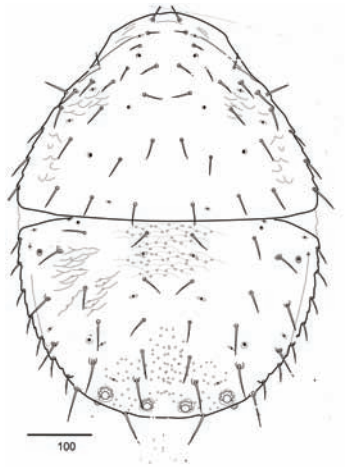
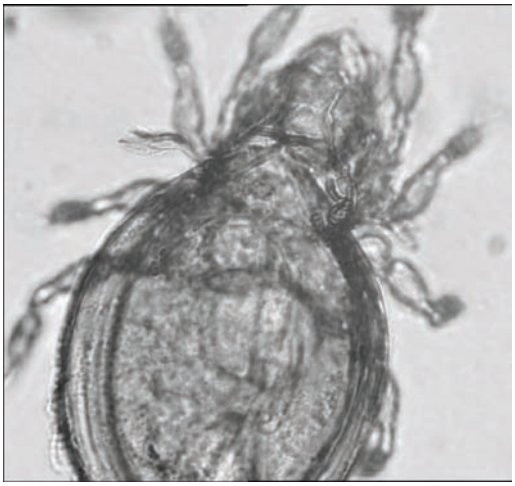


Image of the springing organ of the Collembola species *Xenylla brevicauda* taken using SEM.



Zercon hibernia Moraza, Arroyo and Bolger, sp. nov. (from Moraza, Arroyo and Bolger 2009) collected in Kinnity Oak Forest in 2007.



Licneremaeus sp.

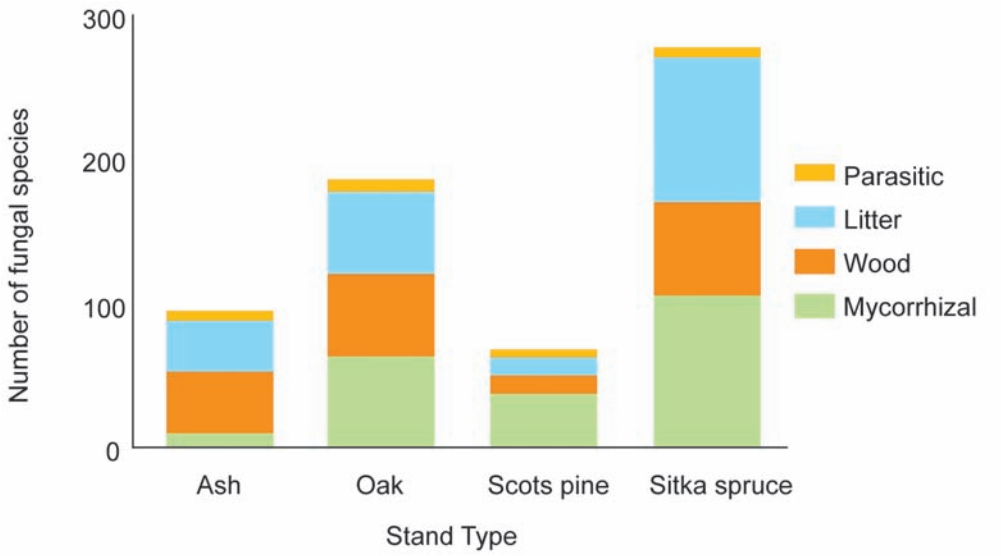


Figure 1: Fungal functional group breakdown in forest stands of different type.

Four study sites were fogged in August 2007. Three study sites were fogged in August and September 2008. The remaining 18 study sites will be fogged in summer 2009 and completed by end July 2009.

Soil cores were collected in 2007 and 2008 and a number have been processed for mite and collembolan species. A subset has been processed for nematodes.

From a total of 3,544 fruit bodies counted 354 species of fungi have been identified. The data from two year's sampling indicate that:

- the mycoflora differ between stands of different type. Ash sites were found to a very different and impoverished assemblage of macrofungi compared to that of the other tree species (Figure 1);
- oak sites had the most diverse macrofungal assemblages on average, but more species were found on Sitka spruce sites. This may be due to more Sitka spruce sites being investigated.

ACTIVITIES PLANNED

Activities planned for 2009 include nematode fieldwork, fogging fieldwork, and laboratory work for samples. Literature review for all Acari and Collembola species found in research projects and theses is ongoing. Verification of species identities in difficult groups will be necessary.

Analysis of mycorrhizal populations in forest sites will be analysed and the PCR protocol will be refined. The remaining site variables will be collected, such as vegetation data, photosynthetic active radiation (PAR), and the soils of each site will be classified according to their physical and chemical attributes.

Another sampling for fungi will take place in summer and autumn 2009.

OUTPUTS

Moraza, M.L., Arroyo, J. and Bolger, T. 2008. Three new species of mites (Acari: Zerconidae) from canopy habitats in Irish forests. *Zootaxa* (in press).

Arroyo, J. and Bolger, T. An overview at the Oribatid mite fauna (Arachnida, Acari) inhabiting the canopy of a young Sitka spruce plantation in Ireland. Environ 2008 Dundalk IT.

A commentary on the project appeared in Science Spin (Issue 23).

FORESTS AND WATER

OVERVIEW

The Water Framework Directive (2000/60/EEC) requires EU member states to achieve good ecological and chemical status for all waters within river basin districts by 2015. The characterisation study which was undertaken to identify the anthropogenic pressures on water bodies identified forestry as one of the land use activities posing a potential risk in terms of diffuse pollution. Among the pressures highlighted were increased acidification from plantations in acid-sensitive catchments, sedimentation from harvesting operations, road construction and erosion on steep catchments and eutrophication from fertilization on steep catchments and from harvesting on peat soils.

Our knowledge of these pressures arises from scientific studies carried out since the early 1990s on the interactions between forests and surface water quality. These have given us a deeper understanding of the underlying natural processes that give rise to these interactions and have led to the introduction of Forest Service guidelines on forest operations and water quality. However, many gaps in our knowledge remain and the projects described below are building on previous research to further our insights into these interactions while also investigating practical mitigation measures to address the pressures that water bodies may experience from forests and forestry operations.

HYDROFOR is a multidisciplinary 5 year project that brings together the key scientists and institutions concerned with the environmental aspects of water quality, to investigate the impacts of forests and forestry operations on Ireland's aquatic ecology. The project, co-funded by COFORD and the EPA, builds in part on a previous study, FORWAT, that highlighted the complexities of forest-water interactions – complexities related to both the ecological sensitivities of forested catchments and the nature and extent of the forestry operations ongoing in these catchments. Results from the project will help to refine codes of practice on the sizing of clearfells, design guidelines for riparian woodland, buffer zones and possibly acidity buffering to protect biota in receiving waters from any adverse damage from soil and nutrient releases resulting from harvesting operations.

SANIFAC is also a project that extends the work undertaken in a previous study, SILTATION, which has provided valuable insights into the pattern and extent of sediment and phosphorous release following clearfelling in a peatland catchment. Study sites in the new project will be confined to three acid sensitive catchments in Co Mayo where the effects of clearfelling on the hydrology, chemistry and biology of the receiving waters will be monitored pre and post clearfelling. This work will be continued under the umbrella of the **HYDROFOR** project when the current funding being provided under the STIMULUS programme is utilised.

FORFLUX

Biogeochemistry of Irish forests

PROJECT TEAM

Dr Thomas Cummins, University College Dublin*
Prof. Ted Farrell, University College Dublin
Prof. Christoph Muller, University College Dublin
Prof. Julian Aherne, Trent University
James Johnson, Trent University
Alison Hyland, University College Dublin
Pat Neville, Coillte
Fiona Harrington, Coillte

* Email: thomas.cummins@ucd.ie

COMPLETION DATE: November 2010

BACKGROUND

The Irish landscape has undergone a unique transition from being virtually treeless to supporting a highly productive, intensively managed forestry sector during the last six decades. These plantation forests are distinctly different from the naturally regenerated and long-established managed forests of most of Europe and North America. Understanding ecosystem processes in plantation forests is a key to sustainable forest management. In recent decades, we have become more aware of the interaction of the forest with the atmosphere, the soil and surface waters. The need now is to understand the long term implications of these interactions.

OBJECTIVES

- Quantify major nutrient pools and fluxes at Irish forest monitoring plots.
- Develop tools supporting sustainable forest management assessment.
- Quantify concentrations and long term trends of atmospheric ammonia and solutes in deposition, throughfall and soil water.
- Model soil water percolation, nutrient nitrogen and mineral weathering rates.

PROGRESS

The principal activities during the reporting period have focused on the development of monitoring capacity, collection of field samples (soils) and the collation of historic data. Ambient trace-gas monitoring stations have been established for NH_3, SO_2 and NO_x at the three intensive forest monitoring plots. Data loggers have been installed for soil water and temperature. Additional soil sampling has been carried out at ten Level 1 forest monitoring sites.

A database of forest biogeochemistry is being developed and will be used in the time-series analysis of forest biogeochemistry. In addition, data have been collected for soil water percolation modelling and the determination of nutrient pools.

The first meeting of the project advisory group was held in May. In conjunction with the project, an MSc project was carried out at UCD and a PhD research position was establishment at Trent University.

ACTIVITIES PLANNED

- Installation of field equipment (for monitoring of deposition chemistry, persistent organic pollutants and soil nutrient contents). Collection of additional soil and vegetation.
- Ongoing ambient-trace-gas monitoring for NH_3, SO_2 and NO.
- Testing of forest biogeochemistry database and completion of time series analysis of forest biogeochemistry (preparation for publication).
- Second meeting of the advisory group. Attendance and research presentation at the BIOGEOMON and LSW conferences.

OUTPUTS

Huber, C., Aherne, J., Weis, W., Cummins, T., Farrell, E.P. and Göttlein, A. *Seepage water quality before and after clear cutting of Norway spruce stands at Ballyhooly (Ireland) and Höglwald (Germany) under high sea salt and nitrogen deposition.* EUROSOIL, Vienna, Austria, 25–29 August 2008.

Hyland, Alison. *Investigating the Predictive Capacity of Pedotransfer Functions for Estimating Bulk Density and Soil Organic Carbon of Irish Forest and Moorland Soils.* MSc Thesis. Masters in Environmental Resource Management, UCD, 2008.

Input to curriculum development and teaching: case study on forest biogeochemistry planned for new UCD course Soil Science Applications, utilising Level 2 site Ballinastoe and real-time datasets.

Shared file server for Project group, hosted by UCD.

HYDROFOR

Assessment of the impacts of forest operations on the ecological quality of water

PROJECT TEAM

Steering committee

Prof. Ted Farrell, University College Dublin
Noel Foley, Forest Service
Dr Paddy Kavanagh, ESB International
Dr Tom Nisbet, Forestry Commission (UK)
Prof. Steve Ormerod, Cardiff University
Alistair Pfeifer, COFORD
Dr Alice Wemaere, Environmental Protection Agency

Principal investigators

Prof. Michael Bruen, University College Dublin
Dr Mary Kelly-Quinn, University College Dublin

Co-investigators

Reilly Dibner, National University of Ireland - Galway
Tom Drinan, University College Cork
Hugh Feeley, University College Dublin
Prof. John O'Halloran, University College Cork
Dr Simon Harrison, University College Cork
Dr Mark Healy, National University of Ireland - Galway
John Regan, National University of Ireland - Galway
Dr Michael Rogers, National University of Ireland - Galway

Advisors

Dr Julian Aherne, Trent University
Dr Thomas Cummins, University College Dublin
Dr Elvira de Eyto, Marine Institute
Dr Philip O'Dea, Coillte
Dr Russell Poole, Marine Institute
Liz Ryder, Marine Institute

Project manager

Sean Blacklocke, University College Dublin *

* Email: sean.blacklocke@ucd.ie

COMPLETION DATE: June 2013

BACKGROUND

HYDROFOR is a multi-disciplinary, multi-sector co-operative project to investigate the effects of forestry enterprises on Ireland's aquatic ecology and assess measures such as buffer strips to efficiently mitigate those effects. HYDROFOR will investigate the full range of forestry operations (i.e. planning and planting, maintenance, harvesting) and assess key associated mitigation measures to address acidification, sedimentation, eutrophication and hydromorphological impacts. Impacts will be analysed in selected catchments exhibiting high-risk pollutant source-receptor pathway conditions (e.g. peaty soils, high rainfall, steep slopes, etc.).

OBJECTIVES

- Review the literature on forestry impacts on hydrochemistry, hydrology and ecology;
- Publish a review of this literature in an international forum;
- Assemble a database of relevant Irish data on forest surface water interactions;
- Collect hydrochemical, hydromorphological and ecological data from six catchments;
- Analyse data to establish controls and influences on impacts;
- Develop modelling tools to predict impacts and design control measures;
- Predict the future impact of forestry on hydro-ecology.

PROGRESS

All relevant literature and datasets (numeric and GIS) were collected, reviewed and organised into structured, query-friendly online databases.

Draft literature review(s) were undertaken on the full range of relevant topics, including:

- Operations inherent to planting, maintenance and harvesting;
- Impacts including acidification, eutrophication, sedimentation and hydromorphological changes;
- Indicators of impacts, including various biological metrics (e.g. macroinvertebrate counts) and physico-chemical parameters (e.g. nitrate concentration measurements);
- High risk pollutant pathways, such as peaty soils, steep slopes and catchments with high precipitation levels;
- Measures to address these impacts, such as riparian buffers, forest restructuring and re-engineered drainage.

ACTIVITIES PLANNED

- Complete literature review(s) and online literature portal.
- Document final detailed scope of work and schedule execution of work packages 2-7.
- Initiate field sampling and monitoring strategy.
- Establish and maintain the project web site (http://www.ucd.ie/hydrofor/home.htm)

SANIFAC

Assessment and mitigation of soil and nutrient losses from acid-sensitive forest catchments

PROJECT TEAM

Dr Michael Rodgers, National University of Ireland - Galway
Dr Liwen Xiao, National University of Ireland - Galway
Mark O'Connor, National University of Ireland - Galway
Connie O'Driscoll, National University of Ireland - Galway
Zaki-ul-zaman Asam, National University of Ireland - Galway

* Email: michael.rodgers@nuigalway.ie

COMPLETION DATE: October 2010

BACKGROUND

From the 1960s to the 1980s a substantial increase in afforestation occurred in Ireland, particularly on blanket peat. This first rotation crop is now being harvested, or is due for harvesting over the coming years. However, it is well known that forest harvesting has the potential to cause releases of solids, nutrient and acidic substrates from soils, causing damage, including eutrophication and acidification, to receiving waters. This project is particularly relevant to the Forest Water Relations Themes in: (a) examining the effectiveness of buffer zones in the protection of the water quality of receiving waters from forest activities and (b) quantifying the particulate and soluble loads and fluxes in an acid-sensitive forest environment, pre- and post-clearfelling.

OBJECTIVES

- Develop guidelines for the selection of sustainable clearfell sizes in acid-sensitive catchments based on comprehensive quantitative and qualitative experimental data, including dilution and buffer zone capacities in the catchment.
- Review design guidelines and develop soil and nutrient mitigation rates for riparian woodlands and buffer zones based on comprehensive field data.
- Investigate the mechanisms of erosion on five Irish soils in novel laboratory flume studies and establish numerical erodibility indices for disturbed and undisturbed soils.
- Investigate the mechanisms of soil nutrient release from peats and forest residues to surface runoff in laboratory-simulated overland flow tests on soil layers taken from the study site.

PROGRESS

Literature relevant to the research area is being reviewed. Studies carried out in Ireland, the UK and globally on releases of nutrients and sediments, changes in acidity, and changes in biota associated with forestry activities on blanket peats have been reviewed. Four project meetings were held to ensure focused execution of the project objectives.

The Srahrevagh River study catchment has been instrumented. The instrumentation in Glenamong study catchment is ongoing. Three 3 x 20 m buffer plots have been constructed in Srahrevagh River study catchment. The buffer zone in Glenamong is identified. Data collection is ongoing for the Srahrevagh catchment, including flow rates and water quality parameters. Currently the suspended sediments (SS) concentrations at Station 1 and Station 2 (Figure 1) are similar. At storm events, the peak SS at the two stations can range up to 15 mg/l. Also the SS concentrations are similar at Station 3 and Station 4, with concentrations of less than 10 mg/l at base flows and peak concentrations of about 60 mg/l during storm events. The total reactive phosphorus (TRP) concentrations at the upstream station (Station 1) are less than 10 µg/l. The phosphorus concentrations at the downstream station (Station 2) can vary up to 50 µg TRP/l during storm events, indicating that the effects of the clearfelling and harvesting operations in 2005 on the phosphorus release still exist. The phosphorus concentrations at Station 3 and Station 4 in the main river are similar at less than 10µg TRP/l, indicating that the dilution capacity of the main river can reduce the effect of the phosphorus release from the study catchment to acceptable levels. Biological surveys are ongoing in Srahrevagh River and Glenamong River. Blanket peat samples have been collected from the Srahrevagh River study site and were tested in the flumes and the agitator apparatus. The release of suspended sediment, phosphorus and nitrogen into solution is being studied.

ACTIVITIES PLANNED

Further project meetings will be held to steer the progress of the project.

The literature relevant to the project will continue to be reviewed during the study period.

The instrumentation of the Glenamong catchment will be completed.

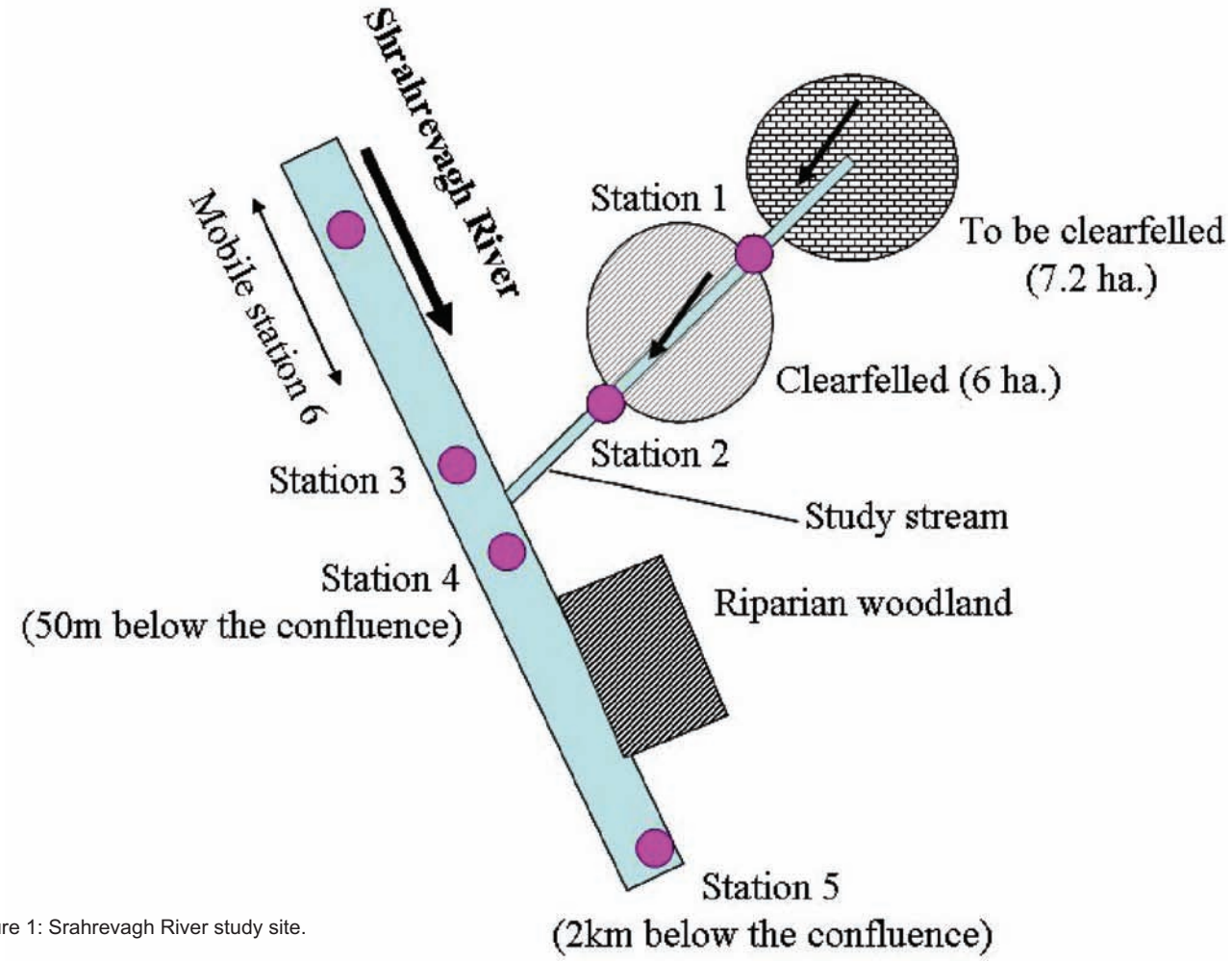


Figure 1: Srahrevagh River study site.

The buffer zones in Srahrevagh River study catchment and Glenamong will be completed.

The data collection for the Srahrevagh catchment and the Glenamong catchment will continue.

The biological surveys will be conducted four times per annum.

Four more types of soils from other catchments will be collected and tested in the flumes and the agitators.

OUTPUTS

Michael Rodgers, Liwen Xiao, Mark O'Connor. *Phosphorus and sediment release from a forest catchment in Burrishoole, Co Mayo*. EPA Annual Conference – poster session. The Royal Hospital, Dublin. (February 6 – 7, 2008).

Michael Rodgers, Liwen Xiao, Mark O'Connor. *Assessment and Mitigation of Soil and Nutrient Losses from Acid-Sensitive Forest Catchments.* A meeting with COFORD, Coillte Teo and Forest Service. The Aisling Hotel, Dublin. (April 14, 2008).

Michael Rodgers, Liwen Xiao, Mark O'Connor. *Phosphorus and sediment release from a forest catchment in Burrishoole, Co Mayo*. Engineering Research Open Day. Galway Bay Hotel, Galway. (April 22, 2008).

Michael Rodgers, Liwen Xiao, Mark O'Connor. *Assessment and Mitigation of Soil and Nutrient Losses from Acid-Sensitive Forest Catchments.* Annual Meeting Forest Service and Marine Institute Group. Marine Institute, Newport, Co Mayo (May 14, 2008).

Michael Rodgers, Liwen Xiao, Mark O'Connor. *Assessment and Mitigation of Soil and Nutrient Losses from Acid-Sensitive Forest Catchments*. In: Research day, ECI NUI Galway (June 11, 2008). The best oral presentation award.

Michael Rodgers, Liwen Xiao, Mark O'Connor. *Phosphorus and sediment release from a forest catchment in Burrishoole, Co Mayo*. In: Teagasc Farmfest, Athenry on 20 June 2008.

Michael Rodgers, Liwen Xiao, Mark O'Connor. *Phosphorus and sediment release from a forest catchment in Burrishoole, Co Mayo.* In: HYDROFOR project meeting in UCD on 12 August 2008.

Michael Rodgers, Liwen Xiao, Mark O'Connor. STRIVE-Hydrofor and STIMULUS-SANIFAC Project Meeting, 9 September 2008. Castlebar, Co. Mayo.

Michael Rodgers, Liwen Xiao, Mark O'Connor. *Forest catchment study in Burrishoole, Co Mayo.* IHYDROFOR meeting in, 3 November 2008, UCD, Dublin.

FOREST RECREATION

Forest recreation, combined with countryside recreation in general, is receiving more attention in Ireland as we realise the considerable potential benefits involved. Recreational use of forests, both state and private is set to grow significantly as a result of increased levels of urbanisation, growing wealth and increased leisure time. The change in the forestry sector with diversification into recreation is creating a need for research, training, technical updates and special new skills development.

In 2006 COFORD acknowledged the role of an important non-timber forest product - forest recreation - with the launch of the report *Review of Forest Recreation Research Needs in Ireland.*

Forest recreation has been a management objective in the Irish forest estate since the opening of Ireland's first forest park at Gougane Barra in 1966. However, developments in forest recreation have not always had the highest priority in a growing forest industry. Clinch[1] states that *while there has been a serious deficiency in data on forest recreational use* he estimated a total of 8.5 million annual visits to Irish forests at that time. More recently, the publication of Coillte's *Recreation Policy – Healthy Forest, Healthy Nation* in 2005 has given a new impetus to the development of forest recreation in Ireland and a further development in 2006 saw the publication of the Forest Service *Forest Recreation in Ireland – A Guide for Forest Owners and Managers.*

Today forest recreation users are arguably more active and environmentally aware than those of a generation ago. Consequently there are new and increasing demands being made on the forest for recreation and forest managers need to address a wide range of issues dealing with the provision of recreation. These can vary from the impact that recreation usage can have on forest activities, biodiversity or indeed other users, to the need to create woodland amenities within easy reach of a growing urban population. Recreation also has an important part to play in education on several levels. Furthermore the relationship between forest design, town planning and the use of forests are all linked to recreation in one way or another.

[1] Clinch, J.P. 1999. *Economics of Irish Forestry: Evaluating the Returns to Economy and Society.* COFORD

FINANCIAL STATEMENT

COFORD EXPENDITURE ON R&D AND RUNNING COSTS IN 2007 AND 2008[1]

	2008	2007
	€'000	€'000
1. Sectoral research and development		
Reproductive material and forest nurseries[2]	338	279
Silviculture and forest management[3]	625	892
Harvesting and transport[4]	36	143
Wood processing and product development[5]	784	491
Socio-economic aspects of forestry[6]	74	13
Environmental aspects of forestry[7]	1,163	969
	3,020	2,786
2. Linkages and technology transfer		
Linkages[8]	35	16
Technology transfer	529	886
	564	902
3. Salaries and running costs		
Salaries	246	268
Running costs	465	250
	711	518
TOTAL	**4,295**	**4,207**

1 COFORD operates a cash-based accounting system, in keeping with Department of Agriculture, Fisheries and Food procedures.

2 Forest genetics and seed, nursery practice, micropropagation of planting stock, storage, handling and transport of planting stock, and seedling physiology.

3 Forest establishment and regeneration, spacing and thinning, decision support models, pruning and shaping of forest crops, short rotation wood fibre and energy crops.

4 Harvest scheduling and planning, harvesting methods, forest roads, wood transport systems and logistics, environmental aspects of forest harvesting and wood transport.

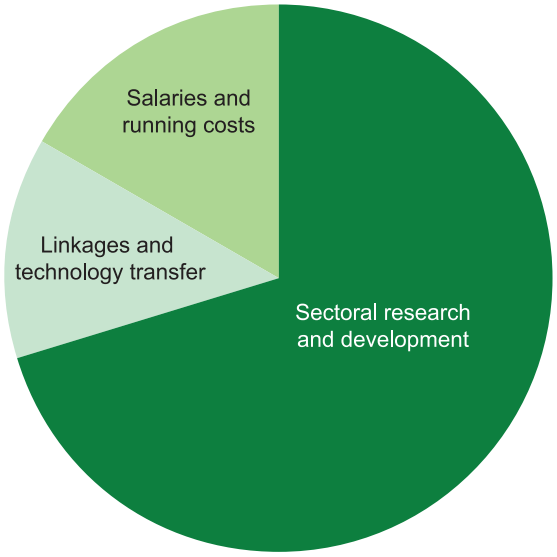
5 Wood properties, timber drying, finishing and preservation, strength properties of timber, timber grading, storage of timber, timber engineering and product development, wood fuel harvesting, processing and storage, non-timber forest products.

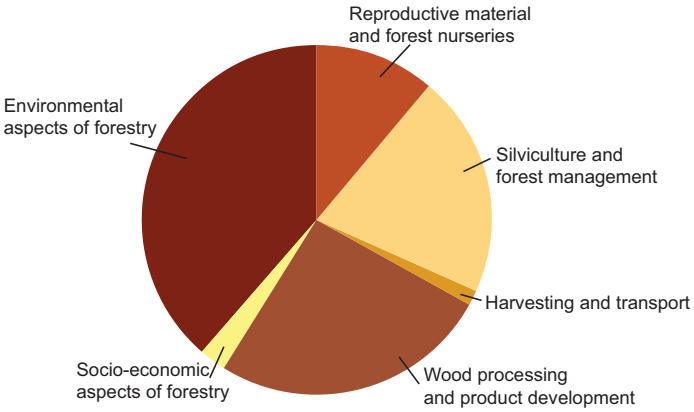
6 Macro economics of Irish forestry, sociological aspects of forestry.

7 Environmental aspects of forestry, biodiversity, water quality and carbon sequestration.

8 Attendance at conferences by COFORD, networking and knowledge transfer support initiative, COST meetings.

COFORD EXPENDITURE 2008





COFORD INCOME IN 2007 AND 2008[9]

	2008	2007
	€'000	€'000
Income	36	22

INTERNAL FINANCIAL MANAGEMENT AND CONTROL

The COFORD Council approves in advance the yearly budget of expenditure under the research and development, technology transfer, researcher training and running costs sub-measures. All new research and development projects are approved by the Council. The executive reports to the Council on expenditure against budget.

The executive has delegated authority to approve projects up to a limit of €30,000 per project (COFORD contribution) and up to €150,000 in any one financial year. Approval of expenditure is by the Director.

Financial risks related to projects are appraised by the executive during project budget negotiations. Expenditure claims are assessed by the Financial Administrator and by the Accounts Division of the Department of Agriculture, Fisheries and Food. Performance against budget is assessed by COFORD staff prior to project expenditure approval. An in-house management information system tracks project expenditure. Expenditure against financial commitment items is also tracked on the SAP system of the Department of Agriculture, Fisheries and Food.

COFORD's accounts and financial procedures are subject to periodic audit by the Internal Audit Unit of the Department of Agriculture, Fisheries and Food. COFORD reports expenditure against budget on a monthly and quarterly basis to the Forest Service. Public procurement rules are followed for all COFORD expenditure.

[9] COFORD income is from sales of publications, attendance fees for conferences and workshops, and software licensing.

COFORD

National Council for Forest Research and Development

Arena House

Arena Road

Sandyford

Dublin 18

Ireland

Tel: +353 1 2130725

Fax: +353 1 2130611

Email: info@coford.ie

http://www.coford.ie

http://www.woodenergy.ie

http://www.woodspec.ie

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