

FORESTRY COMMISSION

Description of the Research Project or Services

1.	Research Purchasing Manager (C&FS)	Helen Sellars
	Relevant PAG	Sustainable Management

2.	Name of FR Programme Manager (PgM) or Project Manager (PM) and staff	Gary Kerr (PGM); Nigel Straw (PM); Tom Jenkins (PM); Victoria Stokes; David Williams; Duncan Ireland; Sophie Hale; Catia Arcangeli; Andrew Peace; Ralph Harmer; Colin Edwards; Bill Mason
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	e-mail address	gary.kerr@forestry.gsi.gov.uk
	Programme Life (years)	4 Years
	Start Date	1st April 2011
	Completion Date	31st March 2015
	Revision Dates	31st March 2012/2013/2014

3. **Title of Research Project or Service**

Alternative Management Approaches

4. **Abstract of proposed research (Summary to be used on website/FRCC etc) (200 words)**

The main aim of this research is to answer the question: how can we adapt forests to increase resilience to climate change and biotic threats, whilst maintaining productivity? Forests in Britain are composed of a relatively small range of species and one method of management, clearfelling, has been the main *modus operandi*. The best way to adapt forests to the risks of climate change and increase resilience is to increase the diversity of species, vertical structure and spatial location. This research helps to achieve this by widening our knowledge of different approaches to management. Throughout the history of forestry in Britain a small number of managers have attempted to use alternative silvicultural systems to clearfelling with varying degrees of success (Hart, 1995). The key challenge of this research is to provide the scientific basis and the associated technology transfer to ensure that alternative approaches to clearfelling become part of mainstream forestry practice in Britain.

5. Aims and objectives (word limit 500)

5.1 Aim of the research

The main aim of the work in this project will be to answer the question:

How can we adapt forests to increase resilience to climate change and biotic threats, whilst maintaining productivity?

Work will be divided into five work areas each of which has a key objective that relates directly to the above aim.

1. Vertical and spatial structure of forests

- Understanding how to manipulate forests to diversify vertical structure, spatial arrangement and species composition to increase resilience to climate change and biotic threats.

2. Modelling Mixed-Age and Mixed-Species Stands

- To calibrate and validate more flexible models of individual tree and stand growth (MOSES-GB) to evaluate the impacts on stand growth and development of alternative approaches to management.

3. Regeneration of forests

- Examine the key factors determining the success of underplanting and understand how climate change will affect them.
- Define a strategy for the modelling of natural regeneration in MOSES-GB.

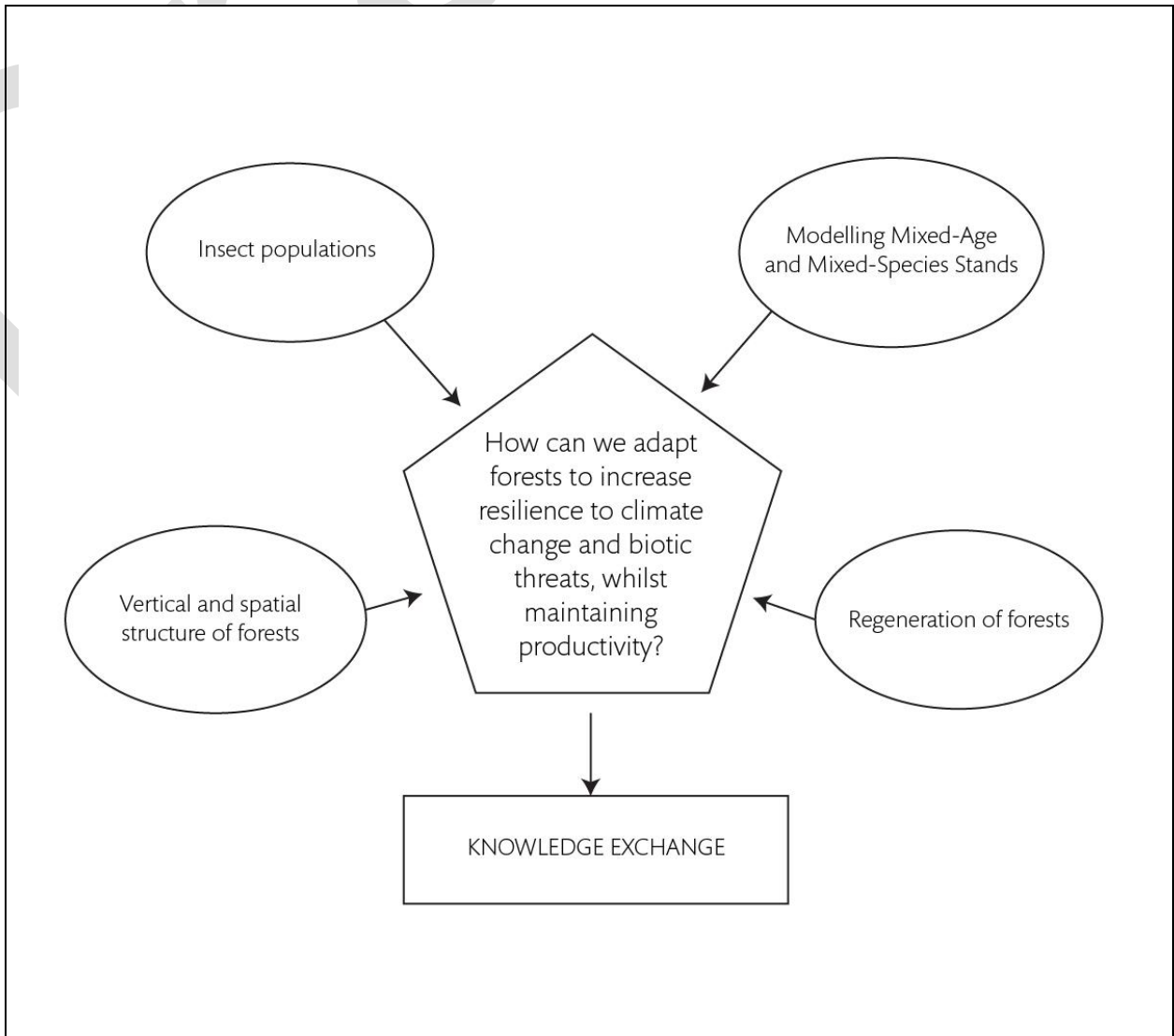
4. Insect populations

- To determine the extent to which greater structural and habitat complexity within forest stands influences insect populations and diversity and hence stand resilience to biotic threats.

5. Knowledge Exchange

- Ensure that all research is communicated effectively to the forestry industry and scientific community via the FR website, peer-reviewed scientific papers, other publications and verbal presentations.

Figure 1 below shows how each of the Work Areas interacts; more detail on each is given in section 5.2 below.



Links with other programmes

Work in this programme is diverse and links with a wide range of other work in Forest Research funded by the Forestry Commission and external customers. In Work Area 1 there are strong links with Forest Climate Change Adaptation Strategies, Operational Efficiency in a Sustainable Forest-Industry Woodchain, Habitat Management, Economic Research and Managing Forest Carbon and GHG Balances. Work Area 2 is complementary to the majority of the IFOS work under the direction of Robert Matthews. We also work closely with the Regeneration and sustainable silviculture programme, notably in Work Area 3. The research in Work Area 4 is closely allied to the work in Advice and Scientific Support for Tree Health.

5.2 Work Areas

Work Area 1: Vertical and spatial structure of forests (GK, VS, DI, CE, BM, AP)

The main challenge of this Work Area is to provide the scientific basis to support the diversification of British forests. Diversifying forests is critical to any adaptation strategy to reduce the future risks of climate change and biotic threats. Past research has developed robust and effective methods of clearfelling and replanting forests, which were straightforward to manage and followed well defined patterns of development. Any attempt to increase the diversity of forests will

require the creation of more varied forest structures, use of a wider range of tree species, implementation of different methods of regeneration, and felling areas at a wider range of spatial scales compared with present practice. Each of these factors presents a need for greater understanding of how to manipulate forests to achieve the desired structures and species composition.

The main research questions will be:

1. To define the best methods of transforming even-aged stands to more diverse structures and how these should vary for different species and site types.
2. To understand the best methods for developing mixed species stands and how these should vary for different regions and site types.
3. To understand the operational requirements of diversifying British forests

Work Area 2: Modelling Mixed-Age and Mixed-Species Stands (TJ, CA, SH, AP)

This Work Area will adapt and further develop an existing tree growth model from Austria (MOSES-GB) for use within Forest Research and the Forestry Commission in order to enable better understanding of the impact of alternative approaches to management on stand development over time (e.g. greater use of CCF, more emphasis on creating mixed species stands, etc.).

The growth and yield models currently used in British forestry have been designed for use in single species even-aged plantations and can only predict average tree development. As such, they are ill-suited to handling the more complex structures that are one of the goals of contemporary forest management. The Modelling Mixed-Age and Mixed-Species Stands Work Area consequently adopts a completely different modelling approach which describes the development of each individual tree in a stand based on its specific growth potential and competition situation.

The flexibility of such a single tree growth model will be invaluable for modelling silvicultural alternatives to clear-cutting, and particularly for the analysis of different and potentially unorthodox scenarios for transformation of even-aged stands. Existing work will be completed to calibrate a 'research version' of MOSES-GB that can be used to model the transformation of pure Sitka spruce stands.

The main research questions for the Work Area will be:

1. How accurate are the projections from MOSES-GB for Sitka spruce managed using alternatives to clear-cutting?
2. How can we overcome the lack of data and sampling methodologies which hamper the calibration and application of MOSES-GB to mixed-species stands?

Work Area 3: Regeneration of forests (GK, VS, RH, AP)

Previous work in this area has focussed on natural regeneration and developed a method of scoring forest stands that helps forest managers predict the likelihood of natural regeneration of SS, DF, LA and SP. Ensuring this information is effectively communicated will be a priority for Knowledge Exchange. Future research will focus on underplanting of the main conifer species, with species selected that represent the full range of shade tolerance. In addition, a range of possible new species could be included to examine how best to deploy them in future adaptation

strategies. An important aspect of this work will be to look at the way in which future climate change may affect regeneration as this is one of the most vulnerable stages in stand development to projected changes in seasonal temperature and rainfall. Looking further ahead the Work Area will also seek to define how the natural regeneration module within MOSES-GB model could be developed in order to make best use of the information gathered in this Work Area.

The main research questions will be:

1. What are the key factors determining the success of underplanting and how will they be affected by climate change?
2. How can the modelling of natural regeneration be better approached in MOSES-GB?

Work Area 4: Insect populations (NS, DW)

Alternative approaches to the management of forests will develop more complex stand structures and a greater variety of micro-habitats compared with traditional even-aged forestry, and these features are expected to increase overall biodiversity. If this increase in biodiversity is reflected in greater numbers of invertebrate predators and parasitoids, and these are more effective in suppressing populations of herbivorous species, then there is the potential for alternative approaches to management to suffer less damage from key insect pests, to be more resistant to invasion by new pests and to be more resilient to climate change.

However, these ideas remain largely untested and this project was established with the aim of comparing insect numbers between three types of forest structure (even-aged, group selection & shelterwood) and identifying relationships between insect diversity, abundance and stand structural complexity. The project focuses on Sitka spruce, the insects that feed on the foliage of Sitka spruce and bark-beetles.

The main research questions will be:

1. How do insect numbers and species richness differ between the three stand types and are differences related to stand structural complexity?
2. Are pest populations higher or lower in more diverse stands compared with even-aged stands?

Work Area 5: Knowledge Exchange

The aim of this Work Area is to ensure that all research is communicated effectively to the forestry industry and scientific community via the FR website, peer-reviewed scientific papers, other publications and verbal presentations.

6. Please indicate which of the FC's 6 Climate change priority actions this work fits into

Protect what we already have	Yes	Reduce deforestation	No
Restore the world's forest cover	No	Use wood for energy	Yes
Replace other materials with wood	Yes	Plan to adapt to our changing climate	Yes

7. Comment on how this research will address Country Strategy needs/targets

In Wales, diversifying approaches to management is a key strategic objective in *Woodlands for Wales* (Forestry Commission Wales, 2009) that seeks to 'avoid clearfelling on our own woodland estate whenever alternative management methods would deliver a wider range of ecosystem services' (p19).

In Scotland, climate change is a key theme in the *Scottish Forestry Strategy* (Scottish Executive, 2006) and places heavy emphasis on work that will increase knowledge of alternative approaches to management. 'Climate change is one of the most serious threats facing the world today. It also creates great uncertainty and future generations will need flexibility in terms of the type, extent and management of woodlands. We need to facilitate ecological and management adaptation to provide those future options' (Scottish Executive, 2006; p23).

In England, the *de facto* forestry policy *Strategy for England's Trees, Woods and Forests* (DEFRA, 2007) places heavy emphasis on 'taking action now while ensuring that implementation is adaptable to new circumstances, such as the changing climate'. Outputs from the programme will also be important for the *Keepers in time policy for England's Ancient and Native Woodland* (Forestry Commission, 2005). Gary Kerr was an author of the FC Handbook 'Managing Native Broadleaved Woodland' and will maintain a 'watching brief' on this subject during the course of the project.

In all three countries the Forestry Standard (Forestry Commission, 2004) requires forest managers to consider alternative management approaches:

- For planted woodlands Standard Note 4 (SN4) requires forest managers to 'decide whether continuous cover or other irregular silvicultural systems are preferable to clearfelling in some parts of the area' (p37).
- For broadleaved woodlands SN4 advises forest managers that 'shelterwood systems, group felling and sequential coppicing are alternatives to clearfelling and can produce environmental benefits (p38).
- For conifer and mixed woodland SN4 advises that 'it may be possible to introduce group felling or a continuous cover system of silviculture (with or without the use of natural regeneration) on lowland and less exposed upland sites with well drained soils (p39).
- For small woodlands Standard Note 6 (SN6) advises that 'adopting a coppice or continuous cover system may avoid the need for clearfelling, particularly in broadleaved woodland (p47).

The United Kingdom Woodland Assurance Scheme (UKWAS) requires that where there is a range of options in windfirm conifer plantations, lower impact silvicultural systems shall be increasingly favoured where they are suited to the site and species (UKWAS, 2006; p23).

The Forestry Commission Working Group on continuous cover forestry has established National Network sites in each of the three countries and the project is closely involved in supporting the management of these sites and advising the working group.

8. Identify and comment on any associated business risk of undertaking/not undertaking the research and how that will be managed

1. Climate change is one of the major risks facing forestry in Britain and the main strategy to reduce this risk is to diversify forests. Attempts to diversify forests usually focus on increasing species richness and introducing greater structural and spatial heterogeneity: the main way to achieve this is by the application of alternative management approaches to clearfelling.
2. Expertise in alternative approaches to management is generally low in the forestry industry and there is a business risk caused by the misapplication of alternative approaches to management – e.g. poor silviculture that exposes stands to windthrow, incorrect site selection leading to a reversion to clearfelling, regeneration failure, poor operational practice – with the result that the desired benefits are not achieved.
3. The work area on modelling mixed-age and mixed-species stands is a key strategic tool because the growth and yield models currently used in British forestry have been designed for use in single species even-aged stands. However, future development of this modelling approach is hampered by a critical lack of data for model calibration and validation.
4. There is a danger that work on climate change adaptation in Forest Research is not joined up, particularly between work examining the science behind adaptation strategies (as currently in ‘Forest Climate Change: adaptation strategies’) and work examining how they can be applied in practice, as in this project. The budget of the former has not been reduced as a result of government spending cuts, but the latter has a 48% cut over four years, despite strong support from the countries at the PAG meeting in February 2011.
5. A reduction of funding of 48% from April 2011 to March 2015 will mean that a significant number of existing research experiments will have to be closed or mothballed and staff with key skills may be lost.

9. Research impact (economic, social, or biodiversity)

Who will benefit from this research?

People involved with the management of forests and woodlands at the practical, strategic and policy level

How will they benefit from this research?

The work will lead to a better understanding and improved knowledge of alternative approaches to the management of British forests

What will be done to ensure that they have the opportunity to benefit from this research?

The four science Work Areas in the project will produce information that will be communicated by the knowledge exchange Work Area, as shown in Figure 1. In addition, the expertise residing in the group will be available to the forestry industry for advisory services through (centrally agreed) Service Level Agreements (FC) or as consultancies (non-FC). An important part of the communication strategy of the project (see below) is to maintain a close working relationship with the FC Working Group on continuous cover forestry.

Potential for innovation and new markets?

Innovation is a key part of the research process and we will actively pursue new ways of carrying out our work and trying to integrate with other disciplines

10. Communication Strategy

The programme will aim to produce a healthy balance of:

- peer-reviewed journal papers; for scientific credibility and to enable communication with specialists in other countries that will lead to bids for external research projects.
- written guidance for forest managers in publications such as the *Quarterly Journal of Forestry* and Forestry Commission Research Notes and Practice Guides.
- maintaining a dynamic and informative website.
- verbal presentations at conferences, seminars and field meetings; support for L&D training courses.
- maintaining a close relationship with the FC Working Group on continuous cover forestry.

11. Under government survey control procedures, Ministerial approval must be sought before statistical surveys of businesses or local authorities can proceed. Please indicate any intention to carry out a survey.

No intention

12. Details of support agreed or to be sought from funding bodies for project (including in-kind support) (£K)

13. Resources (times and fees) requested from the Forestry Commission



Forestry Commission

Proposal for funding Agreement Number CFS 2-2011-15

Please enclose a copy of page 1 of the FR Budget Spreadsheet compiled for each year of the proposed research

14. Deliverables and associated costs to Forestry Commission

Work Area number	Output	2011/12				2012/13				2013/14				2014/15				Output	Total Cost
		Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4		
1. Vertical and spatial structure of forests																			
1.1	Publication of FR Report 'The Costs and Revenues of Transformation to Continuous Cover Forestry' (see also 5.1)		X																
1.2	Supervision of Hamish Mackintosh on FC/SFT funded PhD on the Glentress Trial Area; production of Thesis by September 2012 (see also 5.2)							X											
1.3	Glentress Trial Area – an internationally important trial of the adaptation of plantations to climate change Annual assessments and working with FC Scotland to achieve the agreed management plan (see also 5.3)			X			X			X				X					
1.4	Clocaenog National Network Site for CCF Management of CCF Trial Area in consultation with SENR, Bangor and FC Wales, including an annual meeting		X			X				X				X					
1.5	Lead FR input to possible FP7 bid on the mitigation potential of different silvicultural systems (to include detailed work on this for Britain if bid is successful)					X													
1.6	Project to examine six experiments planted in 1966 of different provenances of European silver fir – fieldwork in 2011. Analysis of data and report in 2012			X			X												
1.7	TD Project Report on provision of access roads and tracks during transformation to CCF			X															

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Work Area number	Output	2011/12				2012/13				2013/14				2014/15				Output Unique Identifier	Total Cost
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4		
2. Modelling Mixed-Age and Mixed-Species Stands																			
2.1	Production of an 'evaluation questionnaire' for testers of the release of the demonstration version of MOSES-GB	X																	
2.2	Completion of the initial user manual with updated text including detailed installation instructions, screen-grabs etc.		X																
2.3	Release a demonstration version of MOSES-GB for testing by selected end-users		X																
2.4	Workshop(s) to support release to selected end-users.		X																
2.5	Steering Group Meetings – 2 per year																		
2.6	Analysis of 'evaluation questionnaire' and informal feedback			X															
2.7	Model validation					X													
2.8	Pre-release revision of demonstration version of MOSES-GB					X													
2.9	Alpha release, and model support, within FR and to selected FC users in each country					X													
2.10	Investigate links to timber properties modelling.													X					
2.11	Assess the need to calibrate the mortality function													X					
2.12	Investigate links with volume assortment programmes																X		
2.13	Examine recruitment models for use with natural regeneration (see 3.4)																		
2.14	Produce scientific paper(s) (see 5.14)							X					X				X		
2.15	Define future options for development of project																X		

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Work Area number	Output	2011/12				2012/13				2013/14				2014/15				Output	Total Cost
		Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4		
3. Regeneration of forests																			
3.1	Establish three underplanting experiments (one in England, Scotland and Wales) to examine the impact of microclimate on growth and survival of planted SS/DF seedlings on restocking and underplanting sites. This will involve detailed assessment of the micro-environment conditions of open restock and understorey sites over at least three years.				X				X				X				X		
3.2	Carry out a survey of underplanting practice in FC forests and combine this information with existing knowledge and experience to produce a Practice Guide (see 5.6).								X										
3.3	Analysis of data on long-term sapling survival at the Glentress Trial Area (see also 5.2)		X																
3.4	Define a strategy for the modelling of natural regeneration in MOSES-GB (see also 2.13) – internal FR/FC report.															X			
3.5	Complete project work on the prediction of natural regeneration of SS,SP, DF and LA (see also 5.4 and 5.5)		X																
3.6	Complete project work on the Respacing of Sitka spruce and design one new experiment (see also 5.9)		X						X										
	Maintain and assess the following experiments:																		
	Clocaenog 16 (CCF Research Area, respacing expt.)																		
	Clocaenog 26 (CCF Research Area, underplanting expt.)																		

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Work Area number	Output	2011/12				2012/13				2013/14				2014/15				Output	Total Cost
		Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4		
4. Insect populations																			
4.1	Presentation and paper to IUFRO bark-beetle conference in Hungary, Sept 2011. (DW)			X															
4.2	Journal article on bark beetles & dead wood insects in relation to CCF.				X														
4.3	Journal article on insect diversity in relation to canopy structure & forest type.							X											
4.4	Update web-pages on Insects & CCF project				X				X							X			
4.5	Annual Report to C&FS				X				X							X			
4.6	Journal article on the impact of spruce aphid (<i>Elatobium</i>) in even-aged and CCF stands, and the influence of host quality, natural enemies and micro-climate.											X							
4.7	Insect biodiversity and abundance of forest pests in relation to stand structure & CCF - Information Note & journal article.															X			
Work Area will end in March 2014																			

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Work Area number	Output	2011/12				2012/13				2013/14				2014/15				Output	Total Cost
		Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4	Q 1	Q 2	Q 3	Q 4		
5. Knowledge Exchange																			
5.1	Conversion of 'The Costs and Revenues of Transformation to Continuous Cover Forestry' into a peer-reviewed paper. Production of draft to enter FR approval process				X														
5.2	Scientific papers arising from the Glentress PhD: (1) Structure in 2008 and management scenarios; (2) Long-term sapling survival								X				X						
5.3	Host visits to Glentress Trial Area including CCFG Scotland in September 2011			X															
5.4	Publication of paper on prediction of natural regeneration in journal				X														
5.5	Draft <i>QJF</i> paper on a managers guide to using the scoring system to predict natural regeneration			X															
5.6	Write Practice guide on underplanting in forests to support adaptation to climate change and deployment of wider range of species in British forests												X						
5.7	Progress to publication TD report on CCF and steep ground working			X															
5.8	Maintain an informative and useful website describing the work of the projects in the programme group				X				X				X				X		
5.9	Progress to publication in a peer-reviewed journal the paper describing FR Respacing experiments				X														
5.10	Act as Chairman (GK) of the Wessex Silvicultural Group 2010-2012 – this provides								X										



Proposal for funding Agreement Number CFS 2-2011-15

Signed.....Research Provider/HOD Date.....

Signed.....C&FS Advisor Date.....

A handwritten signature in black ink, appearing to read 'Kerry Cappock'.

Proposal Approved...

CFS

Date 31st August 2011

15. Agreed Changes

Description of change:		
<p>Signed.....Research Provider Date.....</p> <p>Signed.....C&FS Date.....</p>		
<p>Signed.....Research Provider Date.....</p> <p>Signed.....C&FS Date.....</p>		
<p>Signed.....Research Provider Date.....</p> <p>Signed.....C&FS Date.....</p>		

16. Detailed communications plan:
Year 1
Year 2
Year 3
Year 4