

**FORESTRY COMMISSION**

Description of the Research Project or Services

1.	<b>Research Purchasing Manager (C&amp;FS)</b>	<b>Pat Snowden &amp; Vicky West</b>
	<b>Relevant PAG</b>	<b>CFCC</b>

2.	<b>Name of FR Programme Manager (PgM) or Project Manager (PM) and staff</b>	<b>James Morison (PgM) PMs: Eric Casella (process modelling), Robert Matthews (C accounting and assessment), Mike Perks (forest operations and management), Gregory Valatin (C economics), Elena Vanguelova (soil C), Sirwan Yamulki (GHG fluxes), Matt Wilkinson (CO<sub>2</sub> flux measurements).</b>
	<b>Name of Institution/company</b>	<b>FR</b>
	<b>Official address</b>	Alice Holt Lodge, Wrecclesham, Farnham Surrey, GU10 4LH
	<b>Telephone No.</b>	
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	<b>Programme Life (years)</b>	<b>4 Years</b> ; CFS funding in 2011/12 same as 2010/11; 6% increase for 2012/13, level in 2013/14 and reduction in 2014/15, although still 2% increase above 2011/12.
	<b>Start Date</b>	<b>1<sup>st</sup> April 2011</b>
	<b>Completion Date</b>	<b>31<sup>st</sup> March 2015</b>
	<b>Revision Dates</b>	<b>31<sup>st</sup> March 2012/2013/2014</b>

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

**Managing Forest Carbon and GHG Balances**

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

Forests contain substantial carbon in the soil, trees and other vegetation. Forests are both sources and sinks for several different greenhouse gases (GHG), and forestry offers substantial emissions mitigation potential. Understanding the UK forestry GHG balance is key to inform policy and planning decisions and to meet national and international GHG emissions targets and reporting requirements. This research programme will provide the scientific evidence base to enable the FC to report UK forest carbon stocks reliably, to understand how they will change with climate change, and to recommend appropriate management and policy for the UK forestry sector. The programme quantifies the GHG balance and economic consequences of different forest management practices and operations, the role of woodland creation and the contribution of forest products and bioenergy. The programme also works on national and international calculation and reporting of carbon stocks and setting standards for forest carbon assessment methods. Underpinned by fundamental field based research,

the research is contributing to forest carbon and climate change science and is disseminating information and developing tools on forestry carbon and GHG balances to the forestry sector including policy makers, stakeholders and forest managers.

**5. Aims and objectives (word limit 500) [this version extended...]**

**5.1 Aim of the research**

**Outline & Background:**

This proposal extends and develops from the work in the ManForC programme in the last two years. Particular outputs have been substantial material for the 2009 Read Report, the UKFS Climate Change Guidelines, development of C accounting models to support FC, DA and Government policy initiatives and negotiations, support for the FC Woodland Carbon Code through calculation of forest C stocks and the Carbon Assessment Protocol, background for the FCS Forestry on Peat report, the Integrated Forest Carbon Review, and reviews on forest C additionality and valuation. The revised research questions that this 4-year programme addresses are:

1. Are present estimates of the C stock in UK trees, woods and forests robust, and can they be improved with existing and new sources of information?
2. How will forest C stocks and GHG fluxes be affected by future changes in forest areas, woodland types and management and climatic conditions?
3. What are the appropriate methods for assessing woodland C stocks and GHG fluxes at different scales?
4. What can woodland creation contribute to GHG emissions mitigation, compared to other land uses?
5. What are the benefits, costs and relative cost-effectiveness of different management decisions and options for improving GHG balances and emissions mitigation benefits of existing forests?
6. What are the key processes in forest and woodland C cycling and GHG balances that will be affected by climate change?
7. What is the scientific evidence available or obtainable on forest C and GHG balances to support sustainable forest management practices and policies?
8. What is the best use of the woodland resource to optimise GHG emissions reduction?
9. Which tools can be provided for robust stand and landscape-scale estimates and optimisation of forest GHG balances?

The focus of the programme is the C & GHG balance of forestry up to 'the forest gate' although harvested wood products and woodfuel are also considered.

**Objectives:**

- 1) Deliver a strong scientific evidence base integrating information about C and other GHG balances for woodlands, forests and forestry to guide policy and practice;
- 2) Provide estimates of forest C stocks and GHG fluxes and emissions caused by forestry operations and elsewhere in the wood chain, in order to support the current forestry sector GHG inventory, and provide forecasts of future forestry GHG balances;
- 3) Support estimates by field measurements and process modelling to target major gaps in understanding of forestry GHG balances and the effect of climate and management;
- 4) Analyse the benefits, costs and relative cost-effectiveness of different woodland and forest creation and management options for GHG balances;
- 5) Develop fundamental principles and standards to inform the management of GHG balances across the forestry and wood processing sector;

6) Inform discussions over the optimal use of the woodland resource for mitigation as part of ecosystem service provision, considering future climate conditions;

7) Produce integrated GHG balance calculation 'tools', up-to-date knowledge resources and information for stakeholders, in particular to inform reporting requirements, to assist meeting emissions reductions targets and other national, country and sector GHG management objectives and initiatives (e.g. WCC), and to support the development of UKFS.

The programme has close links with the research programmes:

a) Forest Hydrology & Soils, particularly on soil C where FHS concentrates on field measurements and survey, while ManForC focuses on assessment protocols, modelling and scaling-up soil C stock questions;

b) Climate Change Adaptation, particular points about new species, risks and adaptive management, and using climate projections;

c) Economics, particularly work on forest C valuation;

and will link into the new Land Use and Ecosystem Services programme as forest C is one of the ecosystem services, and also forest C sequestration or mitigation benefits are one of the potentially competing services that will need to be reconciled or balanced with others.

**5.2 Work Areas**

Please list your work Areas as shown in the table below and show how they further sub-divide. Work Areas should be individually costed and be time bound – see 13. below. Please state key desired outcomes from each work area. First two years should be detailed, the next two in outline. See also Note for this Section below.

*(italics are possible years 3 & 4 developments; costs are estimates for 2011/12)*

<b>Work Area 1</b> <b>£202k (27%)</b>	Measuring & understanding stand-scale GHG fluxes and processes (Casella, Craig, Crow, Eaton, Mackie, Morison, Pilgrim, Wilkinson, Yamulki, some TSU)
Work package 1.1	Woodland CO <sub>2</sub> fluxes and C balances [Straits <i>and/or others</i> ]
Work package 1.2	Non-CO <sub>2</sub> GHG fluxes
Work package 1.3	Carbon & GHG flux process modelling
<b>Work Area 2</b> <b>£255k (34%)</b>	Forest management effects on GHG balances (Benham, Chetcuti, Convery, Connolly, Eaton, Morison, Peace, Perks, Vangelova, Stokes, some TSU)
Work package 2.1	Emissions from forestry operations
Work package 2.2	Management effects on soil carbon
Work package 2.3	GHG balance of stump harvesting
Work package 2.4	GHG balance of peatbog restoration
Work package 2.5	GHG balance during woodland creation (including SRF)
<b>Work Area 3</b> <b>£146k (19%)</b>	Forestry C and GHG policy, modelling and economic assessment (Jenkins, Henshall, Mackie, Matthews, Morison, Peace, Perks, Randle, Valatin, Vangelova, White)
Work package 3.1	Forest C assessment protocols
Work package 3.2	Forest C accounting: models, values and predictions
Work package 3.3	Economic assessment
Work package 3.4	<i>UK forestry LULUCF reporting</i>

<b>Work Area 4</b> <b>£84k (11%)</b>	Communication and knowledge exchange, advice & liaison, (Casella, Duckett, Eaton, Georghiou, Morison, Matthews, Perks, Randle Vanguelova, Valatin, Wilkinson, Yamulki, RLOs)
Work package 4.1	Communication (seminars, workshops, conferences, publications)*
Work package 4.2	Advisory work (FC GB level, meetings, committees)
<b>Work Area 5</b> <b>£70k (9%)</b>	Programme management and development (Casella, Moffat, Morison, Matthews, Perks, Vanguelova, Valatin, Wilkinson Yamulki)
Work package 5.1	Programme coordination
Work package 5.2	Programme management
Work package 5.3	Programme development (£38k, 5%)

\* Note:

Note: most costs of production of specific reports and journal papers relating to WA 1-3 are included within those budgets. The communication component of 4.1 is for more general conference and seminar presentation, trade publications, FC and FR publicity and training events, workshops etc.

Main desired outcomes for each Work Area:

WA1:

- a) Building and keeping up to date national expertise in fundamental science to understand and predict forest C & GHG balances.
- b) New and continued measurement of stand-scale GHG fluxes and C balances, linked to evaluation and development of detailed process models for stand-scale GHG fluxes and stocks. (*CO<sub>2</sub> modelling underway, other GHGs from 2012 onwards*)
- c) Continued development of the Straits GHG flux tower site as a flagship site and national resource, leveraging multiple collaborations. (*Development of other contrasting sites from 2012 onwards depending on Straits management*)
- d) Using process models for projections of impacts of climate change on GHG fluxes and C stocks.
- e) Technical publications in the above areas.

WA2:

- a) Assessment of effect of forest management on site C & GHG balances to inform policy and practice. This to include different silvicultural practices (e.g. SRF) and forestry operations (e.g. thinning, harvesting, ground preparation, stump harvesting, habitat restoration).
- b) Improving quantification of national forest litter, deadwood and soil C stocks as NFI data becomes available.
- c) Technical publications on the above areas.

WA3:

- a) Further development of CSORT and Carbine forestry C models to improve stand-scale and national forestry C balance estimates, and to provide stand to national scale tools for optimising management and policy decisions.
- b) Further development of forest C assessment protocols and methods, including production of comprehensive manual.
- c) Research to underpin robust national and country forestry C stock estimates, including input into NFI soil C assessment planning, and work on new data sources and assimilation.
- d) Economic assessment and analysis of cost effectiveness of forest measures to mitigate GHG emissions. Review and develop work on forestry MACCs.
- e) Technical publications on the above areas.

WA4:

- a) To develop a communication strategy for the programme, in liaison with CFS, FR staff, and RLOs
- b) To publicise and transfer information gained in the research to stakeholders amongst forestry and land use sectors and to forest scientists, nationally and internationally, through technical and more general publications, on-line resources, workshops and conferences.
- c) To liaise with, and gather information from stakeholders, particularly of their requirements in the programme area.
- d) To support FC in a GB-level advisory role on subjects relating to the programme, including representation on appropriate FC, DA and OGD committees and participation in workshops, meetings and conferences.
- e) To build and keep up to date expertise in order to inform policy and practice across the programme work areas by participation at appropriate national and international conferences.

WA5:

- a) To manage and coordinate the programme work and budget within FR and to coordinate with C&FS managers, including reporting and liaison with the ad-hoc forest C advisory group (or other appropriate body).
- b) To coordinate work between the Work Areas, Work Programmes, and between projects, and to liaise with other relevant research in FR.
- c) To develop the programme through actively seeking and applying for external funding as suitable opportunities arise in order to support and enhance the capabilities provided by C&FS funding.

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

Protect what we already have	<input type="checkbox"/>	Reduce deforestation	<input type="checkbox"/>
Restore the world's forest cover	<input checked="" type="checkbox"/>	Use wood for energy	<input checked="" type="checkbox"/>
Replace other materials with wood	<input checked="" type="checkbox"/>	Plan to adapt to our changing climate	<input checked="" type="checkbox"/>

**7. Comment on how this research will address Country Strategy needs/targets (175 words)**

The FC GB Climate Change Action Plan aims to develop policies for forest management and wood utilisation that i) conserve and enhance forest carbon stocks, ii) contribute positively to achievement of regional and national targets for GHG emission reduction, and iii) enforce commitments to actions and monitoring of indicators. All of these policy needs which are central to the forestry strategies for FCE, FCW and FCS are directly supported by this research programme.

Scientific evidence is needed to underpin the credibility of policies and relevant management plans applied in the FC estate. FC GB and country administrations need a consistent, comprehensive and easily accessible evidence base when developing policy measures (e.g. responses to Country proposals for reducing emissions, or for development of WCC). FC reporting of forest C stocks and provision of information for Defra reporting of GHG inventories also requires scientific input to ensure robust values.

As the work of the UK Climate Change Committee continues, informed forestry carbon policies and carbon reporting requirements will only become more necessary.

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

*Risks of not undertaking*

Not engaging in this critical area would risk FR (and FC) being sidelined in science, management and policy advice, discussions and decisions about forest and woodland management, and loss of key role to competitors.

Lack of quantitative understanding of forestry C and GHG balances would have multiple risks across a range from national Governmental (e.g. inability to improve and develop UK forestry C & GHG balance values for statutory reporting under UNFCCC), to FC (e.g. unable to develop appropriate policy on forest C management), to local (e.g. forest managers and landowners unable to obtain appropriate advice and information about suitable management of woodlands).

*Risks of undertaking*

1. Breadth and size of topic, multi-faceted questions; risks managed by the multi-disciplinary and multi-scale scope of programme.
2. Not producing relevant outputs; risk managed by discussion and guidance at high level in FC through CCSG, CAG, Ad-Hoc WG on forest C data; dissemination through reports, trade/sector publicity, FC & wider sector workshops, as well as scientific literature.



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

<b>Who will benefit from this research?</b>
FC GB, FC countries, private forestry, Defra, and DECC, also forest scientific community
<b>How will they benefit from this research?</b>
Access to up-to-date information on UK forest C stocks, better understand of processes, access to on-going field sites and experiments
<b>What will be done to ensure that they have the opportunity to benefit from this research?</b>
Clear programme of dissemination and knowledge exchange in a variety of routes, including workshops and publications; inputs into relevant FC and Sector fora.
<b>Potential for innovation and new markets?</b>
Possibly the development of forest C accounting tools will have 'market'.

## 10. Communication Strategy

A communication strategy for the programme will be developed by November 2011 by the project staff, in consultation with the CFS manager, the RLOs and FR publications team. It will be reviewed annually.

<b>Publications:</b>
RN on Harvested Wood Products for 2011/12. IFC Review to be published as FC Research Report in Autumn 2011, together with: RN or other summary of IFC Review for 2011/12. FC manual on detailed forest C assessment methods for 2012/13. FC Research Report summarising 10+ years work on woodland C balance at Straits Enclosure for 2012/13. FC Research Report on Review of forestry MACCs. <i>Others tbd</i>
<b>Reports:</b> <i>numerous</i> – e.g. on Soil C assessment protocols, Review of forestry MACCs
<b>Seminars/conferences:</b>
annual (or 18 month) workshop for FC stakeholders, participate at other appropriate national and international conferences on: a) forest CO <sub>2</sub> and other GHG flux measurements and modelling b) forest C accounting modelling and forest C stock evaluation and prediction c) soil C stock and changes d) managing forest C & GHG balances <i>others tbd</i>
<b>Decision support systems:</b>
a) Forest and forestry C accounting tools b) support for WCC calculations and forest C assessment
<b>Website:</b>
FR Climate Change- Carbon & GHG pages updated with research information including a FAQ; Input into relevant FC pages.
<b>Peer review papers:</b>
Several scientific journal papers to be produced each year, e.g. on a) annual C flux and C balance measurements from oak woodland (2011/12),

- b) woodland C flux modelling and climate change projections (2011/12),
- c) GHG fluxes from afforested raised peat bog (2011/12),
- d) modelling of woodland GHG fluxes,
- e) effect of stump harvesting on C stocks and GHG fluxes ( later years)
- f) forest soil C stocks upscaled values,
- g) an evaluation of uncertainties in forest soil C stock assessments at different scales (by end 2011/12)
- h) forest C accounting model evaluation
- others tbd

**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.**

Yes  No

- If yes please give brief details

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


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

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



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**14. Deliverables and associated costs to Forestry Commission** (X or number indicates delivery date, dark grey indicates activity, light grey or italics indicates future activity, details tbd). IR indicates internal report, JP = journal paper, RR = FC Research Report, RN = FC Research Note),

Work Area number	Output	Year 1				Year 2				Year 3				Year 4				Output	Total Cost (for 2011/12)
		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		
<b>WA 1 Measuring and understanding GHG fluxes</b>																			
WA1.1	Continued measurement and development of Straits Enclosure GHG flux and C stock research flagship site and case study, including collaboration with Universities etc. <sup>1</sup>				X				X				X				X	1.1	
WA1.1	Contribution of Straits CO <sub>2</sub> flux data (or other) to international 'CO <sub>2</sub> flux network' databases and scientific communities, and resulting scientific papers																	1.2	
WA1.1	Submitted <u>JP</u> on oak woodland C balance from Straits 11 years data (1); submitted JP on effect of thinning on C balance (2)			X 1	X 2													1.3	
WA1.1	Summary and conclusions arising from long-term Straits woodland C balance research (IR, 1) and RR 2)				X 1				X 2									1.4	
WA1.2	Inter-comparison of field methods for measurement of N <sub>2</sub> O emissions; paper to NitroEurope conference, April 2011	X																1.5	
WA1.2	<i>Measurement of N<sub>2</sub>O flux in upland Sitka spruce forest under different N deposition</i>																	1.6	
WA1.3	Evaluated stand-scale woodland C balance models (SPA): oak 1, use with climate change projections 2 and extension to Sitka spruce 3. <i>further extensions – different forest types</i>		X 1	X 2			X 3											1.7	
WA1.3	Model evaluation of woodland soil GHG balances (oak woodland: IR 1, <u>JP</u> submitted 2, conifer stands: IR 3, JP 4); <i>further work tbd.</i>				X 1	X 2			X 3	X 4								1.8	

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WA1.3	Collaboration with partners of development of ROMUL soil C & N modelling. Preliminary results for Level II sites (1), IR (2)	X 1		X 2																1.9			
WA1.3	<i>Model assessment of GHG balance of UK forests on peat soils</i>																				1.10		
<b>WA2 Forest management effects on GHG balances</b>																							
WA 2.1	Submitted JP on GHG emissions from forest operations and up-scaled national/country values			X																	2.1		
WA2.2	IR on updated national forest soil C stock estimates using new Woodland Area Map			X																	2.2		
WA2.2	IR on updated C stock estimates for rendzina soils							X													2.3		
WA2.2	IR on updated litter C stock up-scaled values								X												2.4		
WA2.2	IR on effects on soil of CCF management			X																	2.5		
WA2.2	Development of improved forest deadwood C stock estimates using BioSoil and NFI procedures; methodology appraisal IR							X													2.6		
WA2.2	<i>Development of national deadwood C stock estimates from NFI, IR</i>												X								2.7		
WA2.3	IR on effects on soil of stump harvested site in Bala			X																	2.8		
WA2.3	Measurement of GHG fluxes following forest management disturbances: stump harvesting, IR leading to JP submissions -1, <i>Clear felling or ground preparation – 2.</i>							X 1				X 1								X 2		X 2	2.9
WA2.4	Submitted JP on soil GHG emissions from afforested peat bog, 1. <i>(and after felling, if carried out, 2)</i>			X 1																X 2			2.10
WA2.5	Measurement of GHG fluxes following woodland establishment for SRF (mainly ETI funded); copy of project reports (including comparison with other energy crops)				X					X										X			2.11
<b>WA3 Policy, modelling &amp; economics</b>																							
WA3.1	Review of forest soil C stock uncertainties at			X	X																		3.1









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

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

A handwritten signature in black ink, appearing to read 'Roger Cripps', written over a horizontal line.

**Proposal Approved**

CFS

Date 31<sup>st</sup> August 2011

15. Agreed Changes

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



<b>16. Detailed communications plan:</b>
<b>Year 1</b>
<b>Year 2</b>
<b>Year 3</b>
<b>Year 4</b>