

**FORESTRY COMMISSION**

**Description of the Research Programme or Services**

1.	<b>Research Purchasing Manager (C&amp;FS)</b>	Stewart Snape, Roger Coppock
	<b>Relevant PAG</b>	Monitoring and Biosecurity

2.	<b>Name of FR Programme Manager (PgM) or Project Manager (PM) and staff</b>	Joan Webber (PgM)
	<b>Name of Institution/company</b>	Forest Research
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	<b>Programme Life (years)</b>	<b>4 Years</b>
	<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 Programme or Service**

<b>Advice and Scientific Support for Tree Health</b>
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**4. Abstract of proposed research (Summary to be used on website/FRCC etc) (200 words)**

Ensuring trees remain healthy and vigorous is vital to the long-term sustainable management of Britain's woodlands and forests. However, an increasing range of biotic disorders threaten tree health, sometimes due to the introduction of novel pests and pathogens but also because climate change can increase vulnerability. To address this, tree health research is focussed into three key work streams:

(1) Pest or pathogen-specific research to provide evidence and management solutions for damaging or potentially high risk disorders. This includes single pathogen incited diseases such as Phytophthora (*P. ramorum*, *P. lateralis* and *P. kernoviae*), Dothistroma Needle Blight, and Horse Chestnut Bleeding Canker; the invertebrate pests Pine-tree Lappet Moth, Oak Processionary Moth and Pinewood Nematode; and oak decline (mainly Acute Oak Decline), apparently caused by a combination of biotic agents.

(2) The advisory and extension service which acts as a first point of contact for reports of tree ill-health, provides training and topical information on tree pests and pathogens, as well as underpinning the tree health surveillance system embedded in the Integrated Forest Monitoring Programme. A further part of this work-stream comprises formal pest risk analysis (PRA), advice provision and knowledge management in relation to national and international plant health regulations.

(3) Strategic research to predict the likely effects of new pests and pathogens including modelling the impact of climate change on existing pests and pathogens. This will feed into the formulation of management strategies to manage these risks, while taking account of forest expansion, species choice, and changing future threats to tree species likely to be used in adaptive forest management.

5. Aims and objectives (word limit 500)

**5.1 Aim of the research**

The overarching aim of this work is to support the long-term sustainable management of trees, woods and forests for future generations through:

- Evidence based research to aid understanding of the epidemiology and management of the major biotic agents currently causing forest and woodland decline;
- Genetic analysis of key introduced pests and pathogens to establish their origins and indicate the most likely pathway of entry;
- Surveillance, analysis and advice to achieve improved management of established pests and pathogens but also to anticipate and intercept any new invasive pests;
- Testing and refining management strategies to minimise the impact of damaging biotic agents in the context of climate change.

The work also cross-links with that in several other programmes, particularly elements in Forest Climate Change Adaptation Strategies (WorkArea 8), Societal Benefits (WorkAreas 2 & 7: PERMIT & Phytophthora diseases), Alternative Management Approaches (WorkAreas 1, 2, 5 & 8) and Urban Trees and Greenspace (WorkArea 6).

**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.

**This programme has eight specified work areas/projects which have been individually costed (see Table 14)**

<b>Work Area 1</b>	<p><b>Dothistroma Needle Blight</b> (Previously SSMON 3/08 RBNB)  <b>Lead (PI)</b> Anna Brown (WP1.1-1.4); other staff: Katherine Tubby, Martin Mullett, Richard Baden, Andrew Jeeves, TSU</p> <p>Dothistroma Needle Blight (DNB) is a serious disease of conifers and since the late 1990s there has been a dramatic increase in its occurrences across GB. The proposed areas of research under this programme are to monitor the extent and severity of the disease in GB and to gain an understanding of the disease epidemiology and pathogen population structure to aid disease management decisions; to assess its impact on timber yields in terms of mortality and loss in volume increment; and to evaluate the suitability of different management techniques including species susceptibility and changes in silvicultural practices. Advice and guidance will be provided to FC, the private forest industry, plant health and the scientific community through a range of media.</p> <p>Work package 1.1 <b>Disease monitoring, diagnostics and impact</b>          Work package 1.2 <b>Disease management</b>          Work package 1.3 <b>Disease epidemiology</b>          Work package 1.4 <b>Advice, technical transfer and bid preparation</b></p>
<b>Work Area 2</b>	<p><b>Phytophthora Diseases</b> (Previously SSMON 6/08)  <b>Lead (PIs)</b> Joan Webber &amp; Sarah Green (WP2.1-2.4); other staff Sandra Denman, Gavin Hunter, Suzy Sancisi-Frey, Grace MacAskill, Bridget Laue, Andrew Jeeves, TSU, statistician</p>

<p><b>Work Area 2</b></p>	<p><b>Phytophthora Diseases</b> (continued)  Over the past decade the impact of tree-infecting Phytophthoras has increased markedly, in part because of the arrival in Britain of several previously unknown species. Objectives of the project are to investigate the origins, epidemiology and impacts of Phytophthora pathogens with emphasis on two recently arrived species <i>Phytophthora ramorum</i> and <i>P. lateralis</i>, both of which are under official control as quarantine organisms. The outcomes of the research inform management strategies required to combat these pathogens. Much of the research/diagnosis for <i>P. ramorum</i> on larch is funded within Defra/Fera Phytophthora Programme <a href="http://www.fera.defra.gov.uk/plants/plantHealth/pestsDiseases/pRamorum.cfm">http://www.fera.defra.gov.uk/plants/plantHealth/pestsDiseases/pRamorum.cfm</a> These studies also underpin the evidence base required for action by FC, Defra Plant Health, Defra Plant Health &amp; Seeds Inspectorate (PHSI), and Scottish Government Environment and Rural Directorates on the risk these pathogens pose and also feeds into the EU DG SANCO Plant Health Standing Committee.</p> <p>Work package 2.1 <b>Diagnosis of symptomatic trees</b> suspected to be infected by <i>Phytophthora</i> via direct isolation or DNA-based identification, with the outcome of testing added to the FC Phytophthora Outbreaks database.</p> <p>Work package 2.2 <b>Epidemiological studies</b> including susceptibility of key hosts to <i>P. ramorum</i> and <i>P. lateralis</i> species (including Koch's Postulates) and the potential of different host tissue to support sporulation.</p> <p>Work package 2.3 <b>Genetic analysis of <i>Phytophthora</i> genotypes</b> (<i>P. lateralis</i> and <i>P. ramorum</i>) to establish the extent of variation and possible origins of individual outbreaks.</p> <p>Work package 2.4 <b>Provision of advice and analysis</b> to the FC via OMT meetings, other briefings and regularly updated PRAs. Also, bid preparation for additional funding.</p>
<p><b>Work Area 3</b></p>	<p><b>Oak Declines, Acute Oak Decline</b> (Previously SSMON 10/08)  Lead (PI) <b>Sandra Denman</b> (WP3.1-3.4); other staff Joan Webber, Susan Kirk, Gavin Hunter, Bridget Laue, Andrew Jeeves, TSU, statistician</p> <p>Increasing numbers of oaks with profuse stem bleeding have been reported in England since 2008; both <i>Quercus robur</i> and <i>Q. petraea</i> are affected. This can be associated with a severe decline in the health of individual trees over just 3-5 years and not infrequently results in mortality. The objectives of the project are to identify the cause(s) of this recently recognised disorder known as Acute Oak Decline (AOD), discover how widespread it is, and determine if the same bacteria are involved in the decline as those reported to cause similar symptoms to native oaks in Spain. Some of the field and experimental work is also aimed at understanding how other pests and pathogens that attack oak and cause a chronic oak decline (COD) may interact with AOD, and the likely future impact of climate change on the health of oak.</p> <p>Work package 3.1 <b>Identification and pathogenicity of organisms associated with declined oak trees</b> including species of bacteria, <i>Armillaria</i>, <i>Collybia</i>, <i>Agrilus</i> buprestid beetle and oak mildew.</p> <p>Work package 3.2 <b>Distribution, surveying and monitoring of oak decline.</b> This includes establishing how widespread AOD is by surveying and sampling from locations reported to have affected trees in England and Wales.</p>

Work package 3.3 **Epidemiology and interaction of oak declines (AOD and COD)**. This informs and underpins work on evidence based management so that current infections can be managed, losses minimised, and spread or introduction into currently unaffected areas avoided.

Work package 3.4 **Knowledge transfer, project management and fund raising** including involvement with project consortium and funding group.

**Work Area 4 Horse Chestnut Bleeding Canker** (Previously SSMON 01/9)  
Lead (PI) **Sarah Green** (WP4.1-4.2); other staff Grace MacAskill, Bridget Laue, Heather Steele.

Bacterial pathogens of *P. syringae* can have a highly detrimental impact in horticultural, agricultural and forestry sectors; Horse chestnut bleeding canker (HCBC) caused by *P. syringae* pv *aesculi* (*Pae*) is a recently characterised example which is now widespread in Britain on horse chestnut. This project includes DNA-based genetic analysis of specific *Pae* genome sequences to reveal the recent evolution and routes of spread of *Pae* in Europe, as well as the basis of virulence to horse chestnut. Detection of *Pae* on host tissues, in infected host debris, and in soil and water surrounding infected trees, will also be undertaken to determine the potential for spread and survival, thereby informing management actions.

Work package 4.1 **Genetic analysis and biological characterisation** of *Pae*-specific genomic regions implicated in virulence and fitness on European horse chestnut.

Work package 4.2 **Infection, survival and contamination hazard** of *Pae* on horse chestnut and environmental substrates.

**Work Area 5 Regulated Forest Pests**  
**Lead (PLs) Roger Moore** (WP5.1) & **Nigel Straw** (WP5.2); other staff Joan Cottrell, Stuart A'Hara, Christine Tilbury, David Williams, Grace MacAskill, TSU.

Two recently arrived forest pests Pine-tree lappet moth (PtLM) and oak processionary moth (OPM) are regulated organisms under official control in Britain. PtLM is a serious defoliator of pine and other conifer species in its native range in northern and eastern Europe and Russia, and in 2010 conclusive evidence emerged of a local breeding population in Scotland although its origins are unknown. Oak Processionary Moth (*Thaumetopoea processionea*) is a native of southern and central Europe but was found in recently planted imported oak trees in the west and south west of London in 2006.

Controlling both these outbreaks rests on effective surveillance to establish the limits of current outbreaks and detect any new foci; and deployment of various control methods (biological/chemical/ physical) to limit or destroy breeding populations.

Work package 5.1 **Surveys and genetic analysis of Pine-tree Lappet Moth (PtLM)** to establish the extent of the current infestation and its possible origins.

Work package 5.2 **Surveys including improvements of surveillance methods** (trapping/lures) to provide more effective methods to detect Oak Processionary Moth (OPM).

<b>Work Area 6</b>	<p><b>Advisory and Extension Service</b> (Previously MON5/08)  Multiple senior scientists and support staff (WP6.1-6.4): Anna Brown, Sarah Green, Steven Hendry, Roger Moore, David Rose, Nigel Straw, Christine Tilbury, Joan Webber, Andrew Jeeves, Grace MacAskill, Heather Steele, Joan Rose, David Williams, Brenda Mayle (.   The diagnostic and advisory project is a GB wide service which provides and compiles information on the health of trees, based on the reports and enquiries sent into the service. It provides tree health surveillance and is a 'front line' for detecting new pests/pathogens. Through laboratory and extension work the causes of damage reported by foresters and tree owners/managers are diagnosed, and advice provided on what action can be taken. All enquiries and their outcome are logged into the PATHENQ or PAS databases. These databases can be interrogated to provide information on the occurrence of pests and diseases over many decades and detect patterns in relation to sites, hosts and climate.</p> <p>Work package 6.1 <b>Disease Diagnostic and Advisory Service</b> (DDAS) embedded within at Alice Holt and NRS and resourced to deal with 600-700 enquiries annually.</p> <p>Work package 6.2 <b>Pest Identification and Advisory Service</b> (PAS) centred on Alice Holt and resourced to deal with 300-400 enquiries annually.</p> <p>Work package 6.3 <b>Small-scale projects</b> such as monitoring <i>Cameraria</i> leaf miner, <i>Heterobasidion</i> (root and butt rot), Dutch elm disease, some externally funded.</p> <p>Work package 6.4 <b>Knowledge transfer and training</b> via Forest Health days, workshops and seminars and other outlets.</p> <p>Work package 6.5 <b>Hylobius</b> including advice and alternative pesticide testing (latter funded by IFOS)</p> <p>Work package 6.6 <b>Squirrel research and advice</b> to be funded via the programme from 2013 onwards</p>
<b>Work Area 7</b>	<p><b>Scientific Support for Phytosanitary Regulation</b> (Previously MON 5/08)  <b>Lead (PIs)</b> Nigel Straw, Hugh Evans, Joan Webber; other staff Christine Tilbury, Roger Moore, Steven Hendry, David Williams, TSU.</p> <p>This project is aimed specifically at pests that pose quarantine threats to Britain's forests and trees and to evaluate scientifically the risks they pose. It includes developing proposals for risk management to reduce the likelihood of the pests being carried to Britain, as well as research to develop management strategies against regulated pests that establish in the UK or the EU. Scientists involved in this work interact with researchers and phytosanitary practitioners internationally, especially through the European and Mediterranean Plant Protection Organization (EPPO), the International Forestry Quarantine Research Group (IFQRG) and International Union of Forest Research Organisations (IUFRO) as well as with Regional Plant Protection Organisations globally.</p> <p>Work package 7.1 <b>Research and monitoring</b>, suspect organisms/samples are regularly sent in for analysis and identification. In addition, research is carried out to evidence the need for Protected Zones against named pest organisms of phytosanitary concern and required surveys co-ordinated.</p>

Work package 7.2 **Assessment of risk.** The core of the work is Pest Risk Analysis (PRA). This is a rigorous evaluation of the risk posed by a given organism and generally employs the structure developed by EPPO

Work package 7.3 **Phytosanitary advice** consisting of written and verbal advice, plus horizon scanning for new pests that pose phytosanitary risks to the UK or EU are provided as required by FC PHS. Also, input into training courses for FC and Fera PH Inspectors.

Work package 7.4 **Future threats** including input into EU projects and co-ordinated actions against high risk organisms.

**Work Area 8 Biosecurity, Climate Change and Forest Susceptibility**

Leads (PLs) Daegan Inward (WP8.1), Sarah Green (WP8.2), David Williams (WP8.3); other staff David Wainhouse, Nigel Straw, Grace Macaskill, Heather Steele, TSU.

In recent years attention on insect biosecurity issues has focused on the impact that introduced species are likely to have on our forests. Endemic pests however, can pose an equally serious biosecurity risk, and if projected changes to forests occur (longer rotations, alternative silviculture and climate warming) their impacts may be more damaging than previously anticipated. This project includes the development of models (empirical and process) to predict the impact of pests and pathogens (both endemic and 'new') under climate change. The main focus will be on bark beetles and models will take account of the implications for forest expansion, forest design, age structure and tree species to be used in adaptive forest management.

Work package 8.1 **Susceptibility of forests to invasion by exotic bark beetles** and the influence of the native bark beetle community, climate change and forest management. Determining the factors which influence the invasibility of forests, and the processes that influence the transition from endemic to outbreaking populations.

Work package 8.2 **Temperature and water stress on disease severity**, and reproduction and survival of tree pathogens. Field studies will assess climate-induced changes in pathogen behaviour, and laboratory tests will be conducted to derive empirical data showing the effects of elevated temperature on growth

Work package 8.3 **Climate change and spruce pests**, using altitudinal gradients as a proxy for climatic change. Insect populations and diversity would also be related to alternative management systems.

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

Protect what we already have	<input checked="" type="checkbox"/>	Reduce deforestation	<input checked="" type="checkbox"/>
Restore the world's forest cover	<input type="checkbox"/>	Use wood for energy	<input type="checkbox"/>
Replace other materials with wood	<input 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)**

All Country Strategies acknowledge the need to ensure the continued health of Britain's trees by protecting them from endemic and introduced invasive pests, diseases and plants. Potential for damage from new phytosanitary threats are also clearly of concern to the individual countries, although the overall drivers for work in this area are more at the GB level and hence, co-ordinated through the FC Plant Health Service. Additionally, climate change and its associated impacts are identified as a key research area by all three Countries. The research proposed here will not only facilitate the development of models and other techniques necessary to assess temporal and spatial variation in climate impacts on pests and pathogens from a UK perspective, but also guide development of future policy on adaptation and mitigation methods. Data and evidence generated from this programme are also highly relevant to the FC Biosecurity Programme Board which was initiated in 2009.

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

Not undertaking this programme of work and its associated investment in specialist expertise and infrastructure within FR would compromise the FC's ability for the protection and sustainable management of trees. Specifically:

- The context for understanding changes in tree health over time and in relation to climate change would be lost,
- The ability to provide key management advice on the array of pests and pathogens that affect trees in Britain would be undermined very significantly,
- The capacity of FR to diagnose and respond quickly to new/introduced tree pest and disease threats would be eroded.

The FC has a statutory duty to assess the risks from exotic pests and any actions taken must be supported by evidence and rigorous assessments, usually via Pest Risk Analysis. This requires expert and specialised knowledge, and if this is not available there would be an increased likelihood of challenge under WTO SPS rules and a critically reduced ability to anticipate and prepare for new pest and pathogen threats.

Direct risks associated with undertaking the work are primarily those of working with quarantine pathogens that currently have a limited presence in Britain and are subject to containment and eradication measures. These risks are managed by appropriate biosecurity measures, which include work in regulated and inspected containment facilities, full risk assessments, and biosecurity protocols. Loss of highly experienced and specialist staff could also compromise the ability to deliver the work and outputs of this programme, but this is managed as much as possible by sharing of expertise and cross linking with other similar agencies in the UK (Fera, SASA, AFBINI) and also internationally through EU COST Actions (EPPIT, PERMIT, DIAROD).

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

### Who will benefit from this research?

In addition to the FC, the FC and Fera Plant Health, and the wider UK forestry sector, information on recognising and managing tree pest and disease problems is in great demand by arboriculturists, tree wardens, conservationists and other practitioners who manage trees, as well as by the public with an interest in trees. The research will also be used by international plant health organisations such as the European Plant Protection Organisation (EPPO), and the International Forestry Quarantine Research Group (IFQRG)

### How will they benefit from this research?

FC benefits from the programme as it has a statutory duty to assess the risks from exotic pests and any actions taken must be supported by scientific evidence and rigorous assessments. Data gathered during the programme also underpins UKWAS and the UK Forestry Standard by giving an overview on the health of trees (woodland, forest and urban), how it is changing over time, and what new threats may have an impact and what steps that can be taken to counter them. Wider benefits come, both nationally and internationally from understanding fitness traits, infection processes, evolution and routes of spread/transmission and underpin the development of best-practice strategies to combat current and future emerging tree pests and pathogens.

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

To be effective, knowledge generated by the work of this project has to be transferred into timely, accessible, accurate advice to all stakeholders. Widest possible dissemination is effected via:

- FR wepages on a range of topical issues,
- Practical information and advice transmitted via pest and disease clinics and Forest Health Days, field demos, seminars and workshops as requested by countries and other stakeholders.
- Presentations at conferences and seminars.
- Information distilled into a range of newsletters (PathNews), information notes (Pest & Disease Advisory notes and FCINs) and trade journal publications available on-line or as hard copy.
- Frequent one-on-one advice/updates to FC Plant Health Service and other bodies dealing with phytosanitary. The nature of the threats and the need to react quickly, eg to a new pest intercepted by the FC PHS inspectorate, means that responses may need to be rapid and within 24 hours.

### Potential for innovation and new markets?

The statutory nature of the biosecurity work limits the potential for innovation. However, the information derived from >50 years of pest and disease diagnostic work can be marketed in the form of books and computer-based diagnostic systems to assist in identifying the commoner causes of tree ill-health and possible control options, providing there is investment to support this development. Development of molecular diagnostic tools may also have market potential.

## 10. Communication Strategy

**Publications:** Peer reviewed and trade publications, newsletters, information notes, pest alerts available electronically or as hard copy (3-10 per year). On average 5 journal papers each year, plus 2-3 IN/PN/Pest or Pathogen advice notes

**Reports:** Annual project reports to CFS. Also, formal communications in the form of PRAs, written advice to FC PHS and other stakeholders, production of Exotic Pest Alerts dealing with new threats and providing updates on previously known threats (1-5 per year).

**Seminars/conferences:** Presentations at conferences and seminars, such as the Annual AA Conference, RFS conference and update days, FC/FE Forest Health days (annually 2-3 for England, 2-3 Scotland, 0-2 Wales; total 4-6/year), Plant Health training days for FC and Defra (1-2/year).



Phytopathological findings and advice are also disseminated via workshops, field days, seminars, working groups (eg the Oak Processionary Moth Outbreak Management Team) (12/year).
<b>Decision support systems:</b> Books and computer-based diagnostic systems to assist in identifying the commoner causes of tree ill-health and possible control options. PRAs to allow decision making about the pest management.
<b>Website:</b> Dedicated 'Tree Health' webpages on a range of topics updated on a regular basis on the FR website and FC Plant Health webpages (the majority of page hits on the FR website are for pest and disease topics).
<b>Peer review papers:</b> Publications and reports go through external and internal peer review process, and the programme produces and average of three to five peer reviewed papers annually.

**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 <input type="checkbox"/> No <input checked="" type="checkbox"/>
• If yes please give brief details

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

14. Deliverables and associated costs to Forestry Commission

Work Area 1	Output	Year 1					Year 2					Year 3					Year 4					Output	Total Cost
		Q1	Q2	Q3	Q4	Cost (£k)	Q1	Q2	Q3	Q4	Cost (£k)	Q1	Q2	Q3	Q4	Cost (£k)	Q1	Q2	Q3	Q4	Cost (£k)		
<b>Dothistroma Needle Blight</b>																							
WP 1.1	Monitoring of disease extent, severity and impact on the PFE and associated diagnostics.			X	X				X	X				X	X				X				
WP 1.3	Experiments to assess different management options e.g. silvicultural, chemical				X					X					X					X			
WP 1.2	Experiments to assess disease epidemiology (including climatic impacts) and pathogen population structure.				X					X					X			X					
WP 1.4	Provide advice and guidance to the forest industry and Plant health and the scientific community e.g. attendance at Programme boards, working groups, workshops (DIAROD COST Action) and international meetings (IUFRO); delivering presentations, publication of journal papers and technical notes.				X					X					X					X		2011/CF S1/1/JP ? 2012/CF S1/1/TN ? 2013/CF S1/1/JP ? 2014/CF S1/1/TN ?	
All WPs	Provide a report on advisory work to CFS				X					X					X					X			
<b>Overall cost (£'000s)</b>																							

\* includes IFOS funding

14. Deliverables and associated costs to Forestry Commission - continued

Work Area 2	Output	Year 1					Year 2					Year 3					Year 4					Output	Total Cost (£k)
		Q1	Q2	Q3	Q4	Cost (£k)	Q1	Q2	Q3	Q4	Cost (£k)	Q1	Q2	Q3	Q4	Cost (£k)	Q1	Q2	Q3	Q4	Cost (£k)		
<b>Phytophthora Diseases</b>																							
WP 2.1	Diagnosis & database updates to generate distribution maps of Phytophthora confirmed sites				X				X				X				X						
WP 2.2	Test work & composting protocol for Pr infected residues			X			X															2012/CFS 1/2/PR	
WP 2.2	Koch's Postulates on <i>P. lateralis</i> hosts				X																		
WP 2.2	Report on larch susceptibility/ sporulation potential of <i>Pr</i>		X		X		X																
WP 2.2	Phytophthora persistence on affected sites				X				X														
WP 2.2	Evaluation of tree health on replanted <i>Pr</i> sites				X				X				X						X				
WP 2.2	Epidemiological studies on <i>P. ramorum</i> and <i>P. lateralis</i>																						
WP 2.3	Analysis and journal paper on genetic analysis of <i>P. lateralis</i> genotypes from Britain								X													2012/CFS 1/3/JP	
WP 2.3	Analysis and journal paper on genetic analysis of <i>P. ramorum</i> genotypes											X										2013/CFS 1/1/JP	
WP 2.3	Evaluation of potential for hybridisation Pr/PI								X														
WP 2.4	Advice & contribution to OMT meetings, PRA s and report on advisory work and bid preparation				X				X				X						X				
<b>Overall cost (£'000s)</b>																							

14. Deliverables and associated costs to Forestry Commission - continued

Work Area 3	Output	Year 1					Year 2					Year 3					Year 4					Output Unique Identifier	Total Cost (£k)
		Q1	Q2	Q3	Q4	Cost (£k)	Q1	Q2	Q3	Q4	Cost (£k)	Q1	Q2	Q3	Q4	Cost (£k)	Q1	Q2	Q3	Q4	Cost (£k)		
WP 3.1	Pathogenicity tests of organisms associated with AOD trees				X			X															
WP 3.1	Journal paper on bacteria (or other organisms) associated with AOD				X																	2011/CFS 1/2/JP	
WP 3.1, 3.2	Surveys of oak decline sites, with id of associated pests/ pathogens				X				X					X									
WP 3.3	Determine effect of chemical lures on trapping <i>Agrilus</i> in oak woodlands				X				X														
WP 3.3	Epidemiology studies																						
WP 3.3	Analysis of root health and dendrochronology; relationship between AOD and COD				X				X					X									
WP3.3	Disease management – updated PN																						
WP 3.4	Knowledge transfer (seminars, workshops, website, news-letters, stakeholder meetings) & CFS advisory report)																						
WP 3.4	Preparation of funding bids and project management																						
	<b>Overall cost (£'000s)</b>																						

14. Deliverables and associated costs to Forestry Commission - continued

Work Area 4	Output	Year 1					Year 2					Year 3					Year 4					Output	Total Cost (£k)
		Q1	Q2	Q3	Q4	Cost (£k)	Q1	Q2	Q3	Q4	Cost (£k)	Q1	Q2	Q3	Q4	Cost (£k)	Q1	Q2	Q3	Q4	Cost (£k)		
	<b>Horse Chestnut Bleeding Canker</b>																						
4.1	Draft and finalise Practice Note on HCBC				X		X																2012/CFS 1/4/PN
4.2	Epidemiology study with journal paper output								X														2012/CFS 1/5/JP
4.2	<i>Pae</i> multiple genome analysis & gene function study - journal paper output														X								2014/CFS 1/2/JP
4.2	Testing of <i>A. hippocastanum</i> and other <i>Aesculus</i> spp for disease resistance														X								
All WPs	Provide a report on advisory work to CFS				X					X					X								
	<b>Overall cost (£'000s)</b>																				<b>0</b>	<b>0</b>	

14. Deliverables and associated costs to Forestry Commission - continued

Work Area 5	Output	Year 1					Year 2					Year 3					Year 4					Output Unique Identifier	Total Cost (£k)
		Q1	Q2	Q3	Q4	Cost (£k)	Q1	Q2	Q3	Q4	Cost (£k)	Q1	Q2	Q3	Q4	Cost (£k)	Q1	Q2	Q3	Q4	Cost (£k)		
WP 5.1	Genetic analysis of PtLM populations			X																			
WP 5.1	Co-ordinate surveys and develop survey methodology to establish PtLM distribution																						
WP 5.1	PtLM development rates, life-cycle timing and host preferences under UK field conditions				X				X			X											
WP 5.1	Analysis of damage thresholds and impact; studies on natural controls												X						X				
WP 5.1	Advice & contribution to twice yearly PtLM OMT meetings	X		X			X	X			X		X			X		X					
WP 5.2	Draft & update OPM Action Plan and co-ordinate surveys around known outbreaks	X					X				X					X							
WP 5.2	Field experiment on efficacy of lures and trap placement				X				X														
WP 5.2	Studies on development rate, phenology, dispersal and natural controls to improve management												X						X				
WP 5.2	Advice & contribution to OPM co-ordination meetings																						
All WPs	Provide a report on advisory work to CFS				X				X				X						X				
	<b>Overall cost (£'000s)</b>																						

14. Deliverables and associated costs to Forestry Commission - continued

Work Area 6	Output	Year 1					Year 2					Year 3					Year 4					Output Unique Identifier	Total Cost (£k)
		Q1	Q2	Q3	Q4	Cost (£k)	Q1	Q2	Q3	Q4	Cost (£k)	Q1	Q2	Q3	Q4	Cost (£k)	Q1	Q2	Q3	Q4	Cost (£k)		
<b>Advisory and Extension Service</b>																							
WP 6.1+ 6.2	Upgrade advisory databases & improve horizon scanning via developing external webportal				X					X													
WP 6.1	Provide advice and/or diagnosis to 600-650 disease enquiries each year																						
WP 6.2	Provide advice for 350-400 pest enquiries each year																						
WP 6.3	Small projects (eg leaf miner, sweet chestnut)			X					X														
WP 6.4	PathNews & Pest/ Disease Advisory Notes (~ 5/yr)	X		X			X		X														
WP 6.4	Respond to PQs, press & media enquiries (up to 20 d)																						
WP 6.4	4/6 Forest Health days/other seminars training events																						
All WPs	Provide a report on advisory work to CFS				X					X					X					X			
<b>Overall cost (£'000s)</b>																							

\* For year 3 and year 4 the total for this work area will be £380k because additional resource will go to squirrel research and advice, but the details of the outputs are still under discussion.

14. Deliverables and associated costs to Forestry Commission - continued

Work Area 7	Output	Year 1					Year 2					Year 3					Year 4					Output Unique Identifier	Total Cost (£k)
		Q1	Q2	Q3	Q4	Cost (£k)	Q1	Q2	Q3	Q4	Cost (£k)	Q1	Q2	Q3	Q4	Cost (£k)	Q1	Q2	Q3	Q4	Cost (£k)		
<b>Scientific Support for Phytosanitary Regulation</b>																							
WP 7.1	Identification and input into PH surveys for pests ( <i>Ips</i> , PWN, Gypsy moth, ALH, CLH, EAB )																						
WP 7.1	Lab testing and input into PH surveys for pathogens (pitch canker, ash dieback)																						
WP 7.2	PRA and general risk assessment (proactive and on demand)																						
WP 7.2	Representation at IFQRG, IUFRO, EPPO panels, Biosecurity Programme Board																						
7.3	Specific advice on existing pests & pathogens (proactive, on demand to PH). Same advice also disseminated via FHDs																						
7.3	PH Training																						
7.4	Future threats and support to EU PWN project				X					X					X								
All WPs	Provide a report on advisory work to CFS				X					X					X						X		
<b>Overall cost (£'000s)</b>																							



14. Deliverables and associated costs to Forestry Commission - continued

Work Area 8	Output	Year 1					Year 2					Year 3					Year 4					Output Unique Identifier	Total Cost (£k)	
		Q1	Q2	Q3	Q4	Cost (£k)	Q1	Q2	Q3	Q4	Cost (£k)	Q1	Q2	Q3	Q4	Cost (£k)	Q1	Q2	Q3	Q4	Cost (£k)			
WP 8.1	Peer reviewed journal paper on phenological development of <i>Hylobius</i>		X																					
WP 8.1	Completion of modelling work on impact of temperature on <i>Hylobius</i> (geographical scale) & draft paper				X																			
WP 8.1	FC Information Note on UK forest pests & CC							X																
WP 8.1	Analysis of invasiveness of bark beetle species - development of methods to quantify risk under CC								X															
WP 8.1	PhD project - Development rate of <i>D. micans</i> life stages to determine developmental threshold and day degrees for phenology model				X				X				X											
WP 8.1	Development of field sampling & quantification methods for bark beetle communities & quantification of invasibility of conifer forests				X				X				X						X					
WP 8.2	Short communication on diagnostic pyrosequencing of <i>Armillaria</i> spp.		X																					
WP 8.2	Identification of <i>Armillaria</i> spp at selected droughty and non-droughty oak and pine sites in Scotland				X			X																
WP 8.2	Measure infection rates of different <i>Armillaria</i> spp. at droughty and non-droughty oak and pine sites								X				X											
WP 8.3	Review of climate change impacts on SS bark beetles				X				X				X							X				
WP 8.3	Development of models to predict CC impact of spruce defoliators												X							X				
All WPs	Report on advisory work, FHDs contributions, seminars & reports and bid preparation for funding				X				X				X						X					
	<b>Overall costs (£'000s)</b>																							

Signed.....Research Provider/HOD

Date.....

Signed.....C&FS Advisor

Date.....



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>		

**16. Detailed communications plan:**

**Year 1**

**Year 2**

**Year 3**

**Year 4**