Forest Research

The British Bark Industry

An assessment in the context of *Phytophthora ramorum*

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The Research Agency of the Forestry Commission

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Executive Summary

This study has been commissioned by the Forestry Commission Plant Health Service to better understand the scale and nature of the softwood bark industry in Great Britain. It considers how the rise in fellings of larch infected by *Phytophthora ramorum* (*P. ramorum*) is currently affecting the market and how these impacts may be expected to develop over the coming few years.

The UK bark industry represents a very significant market, with the total quantity of softwood bark estimated to be around 667 thousand green tonnes (kgt). Of this, about half (around 336 kgt) is produced through UK sawmills, with a further 100 kgt accounted for by panelboard mills, with the majority of this used on site either as fuel or in board manufacture. About another 100 kgt is estimated to go into the woodfuel sector, generally not separated from small roundwood, about 41 kgt goes to the pulp industry, 36 kgt to the fencing sector and the balance going to other timber markets. Of this total roughly half is purchased and processed by the bark and forest co-products companies, representing the vast majority of that produced by the sawmills.

The increased volume of infected larch is beginning to have three main impacts on the sawmilling industry and the bark and forest co-products market:

- the need to ensure segregation of infected bark and co-products that contain bark or cambium from uninfected material;
- the limitation placed on the use all such infected bark and co-products to ensure destruction of any infection, principally through combustion or incorporation into panelboard;
- infected larch from enforced fellings substituting for other conifer timber, leading to an increasing shortage of timber and co-products from preferred conifer species.

At present there is very little bark imported into GB, except for low volumes of very specialist, high value products. If there is a shortage of home grown material, or if it is perceived to represent a plant health risk, then a consequence could be that material is imported from overseas, which could open pathways for new pests that are not yet established in GB. The potential for the introduction of new pests or diseases, or P. ramorum to evolve to infect new timber species are both legitimate concerns for the processing industry. A continuation of the spread of P. ramorum within larch is already accepted within the industry as inevitable.

The sawmill and forest co-products industries are keen to work with the Forestry Commission Plant Health Service to find solutions and procedures that are workable, acceptable to all parties, and allow the optimum balance between biosecurity and realizing the maximum value of infected timber crops. In order to achieve this it is important that industry is regularly involved and informed of the progress of research

and other activities, including the development of regulations and recommendations for best practice. A working group chaired by Forestry Commission Scotland and with participants from FC Plant Health and the sawmilling and bark processing sectors has been set up to look specifically at the issues associated with the increased volume of infected bark that will come to market over the next few years. This bark working group is also in communication with Forest Research.

It is also important that the Forestry Commission and industry provide a clear and consistent message to the general public and mass media to minimize the potential for loss of confidence in UK products.

1. Introduction

Phytophthora ramorum (*P. ramorum*) is now widely established in larch in parts of the west of the British Isles, especially in the Galloway region of south west Scotland, south west England and south Wales. As a consequence, significant quantities of infected larch are being felled and the timber is supplied to the forest products industry. Sawlogs are being sent to sawmills, and small roundwood (SRW) is being used for panelboard manufacture and biomass fuel. It is anticipated that fellings of larch infected by the *P. ramorum* pathogen will increase significantly over the coming years from its current level of less than 7% of the total intake, however locally it can be much higher, especially within infected regions. Bark from infected trees can carry the pathogen and can also pick up infected needles, so cannot be used in many of the current markets for uninfected bark such as mulching, plant growing media and path surfacing. It must therefore only be used as fuel or in applications subject to temperatures and pressures sufficient to kill the pathogen. Material from infected fellings, including bark, must be kept separate from other, uninfected material and while sawn wood with no inclusions of bark or cambium can be regarded as free of infection, other co-products containing bark, such as woodchips, must be treated as infected material.

This situation is already having an impact on a number of businesses within the forest products sector, particularly sawmills and those processing conifer bark. As the volume of larch wood from felling infected forest stands increases this impact can be expected to rise. It is therefore important to undertake an assessment of the UK bark industry to gain a greater understanding of its scale, how it works, and the current and expected future impacts of increasing volumes of larch from felling of infected stands coming to market.

2. Background

P. ramorum was first encountered in Japanese larch in the south west of England, in 2009. Since then it has also been found to be established in Japanese larch in south Wales, Northern Ireland and the Republic of Ireland in 2010, and western Scotland in 2011. The rate of spread of infection and the total area of woodland now found to be infected means that there are already increased volumes of larch being felled as a result, and the volumes are expected to increase significantly over the next few years. The primary methods of spread of infection are release of zoospores released from sporangia which form on needles, especially in moist air or rain, and movement of infected plants. However hyphae of *P. ramorum* have been detected in bark and the phloem layer, and also both needles and spores can be caught in the bark. Consequently bark from infected trees is regarded as presenting a potential infection source and may only be

used in applications in which the pathogen will be destroyed by heat and/or pressure, such as combustion as biomass fuel, or incorporation into panelboard.

Larch is not currently a majority timber species in the UK. It is classed as a redwood and has a high resin content, and is not favoured by the UK construction industry so it has relatively limited applications at present. A significant increase of larch being brought onto the market will inevitably have an impact. Bark-free or heat treated or kiln dried sawn larch wood from infected trees, however, is regarded as presenting no biosecurity risks, and may be used in any suitable application.

Consequently there are expected to be three principal, primary impacts of increasing levels of fellings of infected larch in the UK:

- the necessity to keep any potentially infectious material separate from other trees;
- the limited applications to which it may be put owing to phytosanitary requirements;
- the finite capacity of the harvesting contractors and timber processing industry leading to larch being harvested and brought to market displacing other species and resulting in a shortage of non larch conifer timber.

These primary impacts can lead to secondary impacts:

- additional cost of producing certain sawn timber and loss of revenue from co-products;
- inconvenience and additional expense from handling and scheduling constraints and any pre or post processing requirements;
- the requirement to meet any potential shortfall from other GB softwood displaced by larch processing, such as potentially having to import alternative feedstock or substitute other materials, or promote new markets for larch.

The market for wood co-products, in particular bark, in the GB is not well understood outside the industry. The purpose of this study is to attempt to improve our understanding of the bark market in the UK: the size of the market; the flows of bark; the end markets it goes into; the impacts of current and increasing levels of infected larch fellings; and the concerns, reactions and requests of the industry as it attempts to work with the Forestry Commission Plant Health Service to minimize the spread of *P. ramorum* whilst simultaneously limiting any negative economic impact on the forestry and forest products sectors.

3. Methodology

The purpose of this project was to attempt to characterize all stages of the bark industry. The first stage was to undertake some initial, desk based and Internet research to gain greater background understanding of some key aspects of the industry, make an initial list of relevant companies and organizations and identify the most suitable contact(s) in each. Both this initial stage and subsequent stages involved liaison with various staff within the Forestry Commission Plant Health Service who already had involvement with the British bark and co-products industry, and also the UK Forest Products Association (UKFPA). The initial list of relevant contacts included large, medium and small sawmills, panelboard companies and pulp mills, a very large forestry co-products company, the key bark products companies, a woodfuel company licensed to handle *P. ramorum* infected materials, and relevant staff within the Forestry Commission and Forest Research.

The next stage was a series of telephone interviews with the contacts identified and a smaller number of site visits to give a better understanding of the processes and constraints involved, and time for more detailed discussions. Finally, a meeting with many of the key industry representatives was organized. This was a meeting in which representatives of the various sectors were encouraged to discuss the issues that they encountered and their main concerns, both current and looking forward.

4. Current regulations

Infected larch wood and co-product movement restrictions within GB

Confirmed infection of larch by *P. ramorum* requires felling or killing of all larch within a 100 m buffer zone around the infection, usually enforced by a statutory Plant Health Notice (SPHN). Recent changes to the treatment of other non larch conifer species felled within a SPHN or in proximity to a SPHN mean that the felled material no longer has to be treated, provided on site biosecurity procedures are followed – see http://www.forestry.gov.uk/pramorum.

Once felled, any movement or processing must be authorised by an inspector and undertaken by licensed operators. A Movement Licence is required to transport either *P. ramorum* infected roundwood or material regarded as potentially infected, and it must be transferred to a facility that holds a Processing Licence. After transport of any infected material, either roundwood or co-products, the vehicle must be swept down to remove any bark or residues.

Once delivered to a licensed processing facility infected roundwood must be kept on hard standing, segregated from non-infected timber, and after processing the hard standing

and processing equipment must be swept down and any bark or other debris must be stored separately from non-infected co-products.

Square cut **sawn** larch timber (i.e. sawn on all four surfaces) is deemed to be free of infection and may be used and handled free of any restrictions. Bark from *P. ramorum* infected timber must either be burned, preferably as fuel, or used for an application where the temperature and pressure conditions are sufficient to render it inactive, such as for panelboard manufacture. The situation for waney edge boards, however, even cut from bark free roundwood, was not clear at the time of writing.

Sawdust from processing bark free *P. ramorum* infected larch can be regarded as disease free as a result of the temperatures and pressures generated at the saw blade tips. As these temperatures and pressures are also present when processing timber with bark on, it has been suggested that this be extended to all sawdust, however a decision has yet to be made.

Wood chips from processing bark free roundwood are currently a matter of some uncertainty, as is an acceptable level of bark freedom for this co-product. The International Standard on Phytosanitary Measures No. 5 (ISPM 5), Glossary of Phytosanitary Terms describes bark free wood as "wood from which all bark, except ingrown bark around knots and bark pockets between rings of annual growth has been removed". This is distinctly different from, and more stringent than the term "debarked" which ISPM 5 describes as "removal of bark from round wood", and simply means that the wood has been through a mechanical process to strip off the layer of bark, though with no criteria of quality. Debarking therefore does not necessarily make that wood bark-free.

Although it is possible using knife debarkers to reduce the level of bark contamination of roundwood to extremely low levels (for example a figure of less than 0.15% is required routinely by one spruce pulp mill), the potential infection of the surface ring of sapwood by *P. ramorum* means that even when bark-free there can still be some residual contamination and a small (though probably minimal) potential for infection. Wood chips from infected timber that might include bark must be treated as infected bark and either burned or used in an application in which temperature and/or pressure afford sterilization, such as panelboard manufacture.

Any co-products of non-infected timber processing that are mixed with infected co-products, or are processed following infected timber but before the equipment has been swept down, must also be treated as infected.

Import requirements of isolated conifer bark into UK from other Member States

As the UK has EU Protected Zone status against certain species of bark beetles that are found in continental Europe but not the UK, within the EU plant health legislation there are special landing requirements stipulated for conifer bark entering the UK from other EU member states (Council Directive 2000/29/EC Annex IV Part B points 14.1 – 14.6 refer). These requirements state that consignments of isolated bark of conifers must be accompanied by a plant passport stating that the material:

1. Has been subjected to fumigation or other appropriate treatments against bark beetles (including composting and/or pulverisation to a particle size not exceeding 6mm). N.B. the option for fumigation is no longer appropriate as in March 2010 the EU banned the use and storage of methyl bromide which was the fumigant that had an approved treatment specification for isolated bark of conifers;
2. Originates in an area known to be free of *Ips amitinus*, *Ips duplicatus* and *Ips typographus*.

In relation to these requirements in 2010 the Portuguese Plant Health Authority, on behalf of the Portuguese bark producers, presented a heat treatment specification based on natural composting methods to the European Food Safety Authority (EFSA) for a scientific opinion on its effectiveness against pine wood nematode (PWN) in consignments of isolated conifer bark originating in Portugal. The Panel concluded that:

- The process was not adequately described and information was not provided on a number of key aspects relating to the size and specification of the lot (e.g. particle size, moisture content) and monitoring of the treatment;
- Information was not provided to enable an accurate characterisation of the temperature profile within each treated lot;
- The treatment process as described did not provide evidence that a minimum temperature of 56°C for 30 minutes had been achieved throughout the bark;
- The dossier provided insufficient evidence on the sampling methodology and there was a high level of uncertainty on the reliability of the testing method in determining freedom from PWN.

Both the Portuguese bark producers and the Portuguese Plant Health Authority worked on refining the heat treatment protocol using the natural composting methodology for a further two years however after a number of unsuccessful trials they concluded that:

1. Natural heat treatment can provide temperatures that go beyond the internationally accepted phytosanitary treatment standard (56°C for 30 minutes);
2. Temperatures rise very fast to >60°C only in the top and centre. Some zones remain with low temperatures - conditions for nematode survival and reproduction;

3. After screening and incubation, nematodes, including *Bursaphelenchus* species, were still detected in different bark sizes.

The Portuguese therefore decided that heat treatment using a natural composting methodology was not an appropriate treatment against PWN and with the impending publication the new EU legislation i.e. Commission Implementing Decision 2012/535/EU dated 26 September 2012, the Portuguese bark producers concentrated their resources into getting steam treatment approved as a form of heat treatment against PWN. Annex III Section 1 of Commission Implementing Decision 2012/535/EU has a provision for bark in a PWN infected area to be subject to certain treatments to permit it to be moved from that area.

Export requirements of conifer bark from the mainland UK to other EU Protected Zones

When UK exporters move conifer bark to other EU Protected Zones including Greece, France (Corsica), Ireland, Cyprus or other parts of the UK i.e. Northern Ireland, Isle of Man and Jersey, it must be accompanied by a plant passport stating that the material:

1. has been subjected to fumigation or other appropriate treatments against bark beetles (including composting and/or pulverisation to a particle size not exceeding 6mm);

2. originates in an area known to be free of species of bark beetles (*Dendroctonus micans*, *Ips cembrae*, *Ips sexdentatus*, *Ips amitinus*, *Ips duplicatus*, *Ips typographus*) that are of concern to the Protected Zone or part of the Protected Zone.

Additionally, at present there is a policy agreement between government and industry members of the UK Phytophthora ramorum Outbreak Management Team members that infected round wood and co-product must not be exported outside GB but may be transported around the GB coast by ship.

5. The scale of the industry

The purpose of this section is to attempt an estimate of the approximate total quantity of conifer bark generated within the UK forestry sector, based on statistics for total conifer timber deliveries, and other statistics on bark and roundwood. These figures can then be compared with figures supplied by the co-products industry to allow us to assess whether there are large quantities that are not currently accounted for, or whether we have a reasonable understanding of flows of bark. Unfortunately a few companies were not prepared to give their own figures as they were considered commercially sensitive and consequently it has not been possible to have a complete picture.

Forestry Commission (FC) statistics on forestry in the UK in 2012 report 9,831 thousand green tonnes (kgt) of conifer roundwood delivered from UK harvesting to processors or for other uses, of which 535 kgt were exported and a further 236 kgt imported, giving total net softwood roundwood used by UK industry of 9,532 kgt.

The proportion of bark by weight varies between species, and also depending on the diameter of log. Based on long term experience the sawmills estimate that approximately 6% of the weight of the sawlogs they take in is bark, while the small roundwood (SRW) used by panelboard mills they estimate to be around 8.5% bark. For the smaller diameter material used for fencing and woodfuel an average figure of 10% has been estimated. An average figure for UK softwood of 7% therefore suggests that the total quantity of softwood bark in the UK is around **667 kgt**.

This total may then be broken down by sector. The following sections discuss each sector in turn, while the information is summarized in Table 1 at the end of the section.

Sawmills

Of the 9,532 kgt of softwood, 6,198 kgt (consisting of 6,073 kgt from the UK, plus 124 kgt imported) was used by UK sawmills. Based on an assumed 6% proportion, this leads to an initial estimate of **372 kgt** of softwood bark from this sector. They produced 3,361 k m^3 of sawn timber. "Large sawmills" in the UK, defined as those processing more than 10,000 m^3 p.a., produced 3,145 k m^3 of sawn timber from 5,805 kgt of roundwood, representing 93.6% and 93.7% of the UK totals respectively. They also marketed 3,039 thousand tonnes (kt) of co-products, including wood chips (65%), sawdust (24%) and bark (10%). This then accounts for around 304 kt of bark from the large sawmills, or a calculated **336 kt** from all sawmills, including 43 kgt of biomass used internally as fuel by sawmills. This will be a mixture of low value material such as slabwood, butt chips, sweepings and offcuts, of which bark may be expected to be a relatively large proportion.

Using FC statistics, 10% of the bark sold (30 kt from the larger mills, or **32 kgt** in total) was sold for bio-energy, while the rest (274 kgt from the larger mills, or **293 kgt** in total) was sold for other purposes. These other purposes include mulch and landscape products (about 50%), play bark (about 20%) and growing media such as peat free compost (about 20%).

Sawmills represent the biggest single users of harvested conifer roundwood, and hence the biggest source of conifer bark. This bark may be then either used on the premises as a part of the biomass fuel used, or (predominantly) sold to one of the companies that process and market bark and other forestry co-products. There is a relatively small number of companies who collect from sawmills both large and small throughout Britain. The main primary processors are: AW Jenkinsons, TMA, William Sinclair, Scotbark and Melcourt. They undertake screening of the bark into particle size classes and the various product types, processing and packaging, as well as selling on to secondary processors.

Based on figures from a number of sources, an estimate of the bark sourced directly from sawmills or roundwood (such as at panelboard mills) handled by these five primary processors gives a total figure of about **336 kgt**, representing 5.4% of the 6,198 kgt of feedstock; relatively close to the initial estimate of 6%, and agreeing well with the figure from FC statistics.

Panelboard mills

UK **panelboard** mills used 1,269 kgt of UK softwood, plus sawmill residues (1,851 kgt), recycled wood fibre (909 kgt), hardwood roundwood (2 kgt), but no imported roundwood. Assuming bark represents 8.5% of the total weight, this then represents **108 kgt**.

Discussion with the three principal panelboard companies identified that each was producing 30 – 40 kgt of bark, with a total between them of about **100 kgt**. Most of this is used on site, either in panelboard or burned as fuel, though a small proportion of perhaps around **35 kgt**, is sold to Jenkinson's.

Pulp mills

UK pulp mills used 461 kgt of UK softwood, plus sawmill products (79 kgt) and recovered paper (3,867 kt). The bark component of the roundwood, again assuming 8.5% by weight, corresponds to 39 kgt.

The two pulp mills between them accounted for **41 kgt** of bark from pulpwood feedstock. However they also use a further 300,000 tonnes of roundwood between them (corresponding to a further **30 kgt** of bark) and 320,000 tonnes of chips, for fuel. It is uncertain the source of the chips and hence the proportions of sawmill chips from debarked wood and roundwood chips. None of this material leaves the sites.

Woodfuel

Around 1,000 kgt of UK softwood was used for **woodfuel**, which would correspond to **100 kgt** of bark, assuming a 10% proportion of bark. Most of this will not be separated from the roundwood and will be burned.

Other uses

Fencing used 338 kgt of UK softwood, plus 22 kgt of imported softwood, giving a total of **360 kgt**, corresponding to **36 kgt** of bark, and **other applications** used 154 kgt, corresponding to **15 kgt** of bark, again assuming 10% for both. It is assumed that this bark remains with the product or is disposed of by burning on site.

Total

The individual figures for bark accounted for give a total of approximately **628 kgt**. For the panelboard and pulp mills, all the bark taken in is accounted for, either used internally or sold into the co-products market. In the case of sawmills, where there is a

much greater number, it is not possible to speak to each one and ask what happens to the bark generated. For a large proportion it is collected on a regular basis by the co-product processors, of whom AW Jenkinson's are significantly the largest. For some of the smaller sawmills, especially in geographically more remote locations such as Devon and Cornwall, this is not economically viable and consequently any infected bark is burned on site. However, despite the difficulties in obtaining a comprehensive set of figures, it is clear that a very large proportion of the predicted quantity of conifer bark available is accounted for. Adding together all figures for bark directly obtained from sawmills or roundwood obtained from companies, and making an estimate of those figures from companies unable to supply them for confidentiality reasons, gives a total of about **480 kgt** of the calculated total of **483 kgt**. To both of these figures a further **151 kgt** must be added for the component that goes into woodfuel, fencing and other markets, making totals of **631 kgt** and **634 kgt** respectively.

Table 1. Summary of annual UK roundwood consumption and bark production by sector

Quantity of material by sector (kgt)	Sawmill	Panelboard	Pulp	Fuel	Fencing	Other	Total
Roundwood delivered	6,198	1,269	461	1,000	360	154	9,532
Bark – derived from an estimate for the proportion of bark in roundwood (%)	372 (6%)	108 (8.5%)	39 (8.5%)	100 (10%)	36 (10%)	15 (10%)	670[1]
Bark – actual or as derived above	336	100	41	100	36	15	628

[1]Equivalent to 7% of overall roundwood consumption

6. Issues for sawmills

Not all sawmills face the same issues. For a start not all are licensed to handle *P. ramorum* infected larch. For those not licensed the most likely impact could be a reduction in the roundwood of other conifer species coming to market for processing as harvesting contractors are involved in felling *P. ramorum* infected trees.

For the sawmills licensed to process *P. ramorum* infected larch however there are a number of potential impacts, though their relative severity will vary from one sawmill to another depending on the specific characteristics and resources of each.

Large and small sawmills are likely to handle *P. ramorum* infected larch differently. For smaller sawmills, the larch will be processed as required to meet orders rather than for stock. For those more distant from the main bark processors, such as in south west England, co-products are likely to be used for fuel on site, sold to a local woodfuel company, or simply burned for disposal, so rigorous clean down after processing infected larch is not necessary. For larger sawmills however there are a number of competing requirements:

- keeping the sawmill operating to maximize throughput;
- often only shutting down processing at the weekend to allow cleaning down;
- maintaining processing of whitewood timber to keep up with orders;
- minimizing the amount of non-infected timber processed between a batch of infected larch and the next clean down to minimize loss of income from non-larch co-products that have to be treated as infected.

Therefore it is necessary to process infected larch as a batch, fed through the system on a periodic basis. The processing chain then needs to be swept free of bark, which requires it to be shut down. For many larger sawmills as this can only be done at the weekend so infected larch is processed late in the week to minimize either downtime or bark and other co-products from uninfected timber having to be treated as infected.

If hard standing space is limited this can be a difficulty. For larger sawmills it is necessary to schedule in a full batch of redwood for processing together before the mill is swept down. If there is insufficient hard standing to allow a full processing batch of infected roundwood to be built up over a period of time then some or all must be delivered on the day of processing. To allow full sweep down after processing, which for larger mills often can only take place at the weekend, processing must be scheduled late in the week, but in order to allow for potential delays in delivery this cannot be left until the very last minute. Consequently it will be necessary to process some non-infected roundwood after the infected larch, but before the sweep down, requiring all the bark produced to be treated as infected too. In order to maintain deliveries of whitewood products such as spruce carcassing and chips for pulp mills, it is unlikely to be possible to set aside a prolonged period for processing redwood species for which there is not an immediate market.

Even if the sawmill has sufficient hard standing to allow infected roundwood to be stored until there is sufficient for a batch run (the size of which will depend on the capacity of the sawmill), hoppers to catch bark from the de-barker will still need to be emptied and swept down before the next batch of uninfected timber can be processed. This requires

that there is either alternative storage space, or that lorries are scheduled to collect and remove the bark to the next (licensed) destination as material is produced.

At present it can take time to accumulate sufficient infected larch to warrant processing a batch. This can lead to all redwood, including uninfected larch and other redwood species such as Douglas fir, being processed together, in turn leading to all co-products having to be treated as infected. As fellings of infected larch increase it may be that this becomes less of an issue with full batches arriving within a shorter period, however the necessity to maintain processing of spruce for construction products and pulp mills will remain. In smaller sawmills, especially those handling a large proportion of larch, it can be necessary simply to treat all co-products as potentially infected and have them all sent to licensed processors, thus avoiding the need for segregation at all.

In some sawmills in the south west, where *P. ramorum* has been present in larch since 2009, the majority of larger timber processors are processing larch timber unbarked, principally for the fuel market, either chips or for pellets. This is not popular with the woodfuel sellers, especially pellet manufacturers as it increases the ash content.

At present larch represents just a few percent of the total harvest, though in certain regions of the UK the processed proportion is considerably higher, with a figure of 35% over the last few years being quoted for sawmills in the south west. The figures for areas that need to be felled in the near future suggest that volumes in the region of several million cubic metres of infected larch may be expected soon, and this then will form a very significant proportion of the total softwood harvest.

The issues for smaller sawmills appear frequently to be significantly less. Because a batch of larch will take longer to processes there is less of an issue about having to schedule in a day's processing and then allow a weekend to sweep down afterwards. The smaller sawmills spoken to would just receive a batch, process it over a period and then sweep down afterwards before moving on to, uninfected timber. Bark and relevant co-products were usually burned on site, either in a biomass boiler or simply in a bonfire. In South West England, Forest Fuels are licensed to handle infected material and can take slabwood from sawmills who process bark-on roundwood, for biomass fuel use. Products such as waney edge slats for panel fencing have too great a bark content and cannot therefore be produced and marketed form infected roundwood.

Because of the issues of scheduling in the processing of redwood, good communication between harvesting operations and the sawmill are very important if downtime and loss of revenue from potentially uninfected timber are to be minimized. Long term contracts for the processing of infected larch are also valuable in order to assist more efficient scheduling.

If infected larch forms a greater and greater proportion of the entire GB softwood harvest, as seems likely, at least for the next few years, the displacement of spruce and other timber species will become more acute, potentially leading to shortages of British

grown timber. Some sawmills are attempting to address this by developing new markets for larch, arguing that it can be structurally superior to spruce. However potential stability issues in drying and storage means that some companies are more cautious about attempting to convert the market for carcassing products. In addition, those using the X-ray based timber grading technology such as the Microtec Goldeneye system, do not yet have accepted calibration factors for larch.

The loss of revenue from being unable to sell redwood bark, including infected larch bark, and other co-products into higher value product markets also has an impact in the overall economic profitability of the operation. While those sawmills who have biomass fuelled kilns can use bark in the fuel mix, most kilns can only accept a limited proportion in the fuel unless specifically designed to use bark. Similarly, when selling bark as fuel to power stations or other industrial users, there will be a maximum proportion set out in the fuel specification. While this may already limit usage at an individual sawmill, it is not yet a major constraint overall, however as the felling of *P. ramorum* infected larch increases this could place a limit on how much can be burned as biomass fuel until the number of biomass power generators increases. Although there is a significant number of new biomass power stations currently in planning, it is likely that a proportion will not make it to construction. Of those that are completed most of the larger ones are planning to use imported wood pellet fuel, and will be unlikely to be able to burn bark. Of the others, many are designed to burn straw, or other specific, locally available fuels. Consequently, even when more biomass power stations are built, and there will be very few completed in the next two or three years, there will be limited additional capacity to burn bark.

Another issue, not related to infection by *P. ramorum*, is that larch is slower to process than spruce, and is harder on bandsaws. High resin content, combined with greater hardness, gradually leads to coating of bandsaw blades, guides and rollers which, in time, can lead to the band coming off, or cracking. Reported figures for reduction in throughput of larch compared to spruce vary, depending on factors such as equipment (e.g. bandsaw vs. circular saw), but range from 15% up to 50%. With fewer product options available, especially from the potentially more valuable heartwood, shorter log lengths, lower throughput and increased stoppages, a higher proportion of larch through the mill leads to reduced profits.

7. Issues for bark processors

Bark from larch infected by *P. ramorum* cannot currently be used in any of the main commercial markets for bark, and consequently burning it as biomass fuel is the only available market. Most of the commercial bark processors produce horticultural, landscape and play products from bark, but not fuel to any extent, and are therefore not currently licensed for processing or moving infected bark. A.W Jenkinson handle all

forestry co-products and markets, performing a collection service for co-products from many large and small sawmills around the UK, and also produce a range of biomass fuel products. They have the relevant processing and movement licences for these products but their markets for infected larch bark and co-products are still restricted to biofuel and panelboard manufacture usage.

At present, for the majority of bark processors the principle concern is the potential for a shortage of bark suitable for horticultural and landscape applications as a result of displacement of uninfected timber, and its bark , by *P. ramorum* infected larch.

It has been estimated by the industry that around 50% of the market for all high value bark products is for mulch and landscaping, 20% for play bark, 20% for growing media, and 10% for other specialised applications including reptile bark and bio-filtration products. However as there is significant crossover between mulch, landscaping and play bark markets, it has been suggested by industry representatives that the most sensible division is between the landscaping products (in the broader sense – 80%) and the growing media (20%). Within the growing media there is a roughly 50:50 split between products marketed to the retail sector and those used by professional growers and nurseries.

At present none of these markets are open to bark from infected larch, or bark from other species contaminated by this. This means that there is an economic impact from the loss of this material from the market.

Bark has been imported in the past from overseas, especially Spain, but at present this only happens in small quantities for a very few niche markets. If substitution of infected larch for other conifers reaches a point where there becomes a shortage of British grown product then the industry would be prepared to import again. However the possibility of importing yet another tree pest or disease, such as pine wood nematode, is of considerable concern to the industry. It was expressed more than once that while it is known that there is a small risk of spreading *P. ramorum* infection associated with bark products, lower still if heat treated, there is potentially an uncertain risk of bringing a new disease or pest into the country by importing bark.

The other concern is for the potential for new strains of *P. ramorum* to evolve, opening up the potential for infection of other commercial conifer tree species.

There has been some research into whether it might be possible to sterilize bark reliably using heat generated by a natural, aerobic composting process. This is still in relatively early stages and issues such as developing a protocol and evidence base to ensure that all material reaches a sufficiently high temperature for sufficient time have yet to be resolved. Two of the bark processing companies have been participating in trials to establish the temperatures achievable by an open windrow composting process, and whether all material can be exposed to high temperatures. These experiments are not yet complete, however initial results show that high temperatures can be achieved and

maintained for extended periods (see Section 9 below). Lessons have been learned about some of the factors that can prevent good results being achieved. Trials have been undertaken to establish the efficacy of turning the windrow using mechanical turners and whether all material could reach the same temperatures. Subsequent research aims to determine methods to detect the presence of the pathogen in bark.

8. Issues for woodfuel companies

Some woodfuel supply companies have been licensed for the handling and supply of woodchips from infected larch including bark. In order to comply with regulations the establishments they supply with fuel must also be licensed, which also requires certain conditions to be met. In the case of some of the larger woodfuel supply companies the initial checking and licensing of customers is performed by themselves and the Forestry Commission Plant Health Service are kept informed.

Provided the necessary conditions can be met, such as containing the fuel sufficiently from delivery to combustion, then there is no restriction on burning woodchips that contain bark from infected larch, and this is an appropriate use for such material. There are however practical limits to the proportion of bark that can be included in woodchips as this increases the ash content of the fuel. This will be limited by the design of the combustion unit, and also by the specification of the fuel to be used, provided by the equipment manufacturer. Using fuel that does not comply with the specification stated is not only likely to cause difficulties with the boiler, but also invalidate the equipment warranty.

Fuel customers who cannot meet the requirements to be licensed as users of fuel from infected trees need a supply which has been kept segregated from infected fuel. This can be done using separate bins at a single depot, but a more robust, and easily maintained, approach for larger companies operating from multiple supply depots, is to have some depots only handling infected woodchip, and others only handling uninfected fuel.

9. Heat treatment of isolated larch bark

Although steam sterilizing has been demonstrated to be effective against pine wood nematode in Portugal, this is currently too expensive a procedure to be employed for the vast majority of British bark products. The alternative is to use the heat generated by the natural composting process to achieve phytosanitary treatment. The internationally accepted figure is 56 degrees Celsius throughout the profile of the material being treated for at least 30 minutes. Unfortunately there is currently a lack of uniformity within the

scientific literature as to whether this temperature and time combination is sufficient for effective sanitization of *P. ramorum* infected bark. A literature review carried out by Forest Research (FR) looked at a number of studies on composting of *P. ramorum* infected residues, which suggested that the requirement for lethal conditions for the pathogen could range from 5 consecutive days at 45°C to 14 days at 55°C. The lower temperature conditions were applied to composted rhododendron/*Vaccinium* leaves and shoots, whereas the more demanding conditions were applied to woody material from oak and leaves of California bay laurel. However, with the latter the efficacy of shorter and cooler composting conditions was not evaluated. The science to establish which of these temperature regimes would be effective in destroying *P. ramorum* infected larch bark has yet to be completed.

It is likely that more than one single threshold temperature and time combination will be effective at eradicating *P. ramorum* in larch bark, and slightly lower temperatures might be effective if maintained for a longer time. Conditions that are lethal to *P. ramorum* mycelium have been reported to be less effective against chlamydospores which are able to survive more challenging conditions. Owing to the range of temperatures experienced at different positions within the windrow, it is necessary to understand the survival of different parts of the pathogen under different combinations of temperature and time. At present such data, of sufficient quality and relevance to UK conditions, are simply not available and more research is needed.

Experiments have been undertaken by two companies to establish what temperatures can be routinely achieved, and for how long, within an open windrow composting based process, combined with periodic mechanical turning. These experiments are still ongoing, and a number of lessons have been learned concerning how best to generate and maintain elevated temperatures; results have so far been encouraging. The best trial has demonstrated that all 18 dataloggers in the experiment achieved temperatures exceeding 56°C for 97 hours or more, with 36 hours the shortest consecutive period above 56°C, and peak temperatures ranging from 64.5° to 70° attained. Another experiment involved dataloggers distributed throughout the cross section of the windrow in seven different positions, in both the centre axis and periphery. These were then left in the windrow during three passes of the turning equipment. All exceeded 56°C for a minimum of 18 hours.

These results have yet to be reproduced by a second company at another site; however specific factors have been identified which hamper the ability of the windrows to achieve and maintain high temperatures.

What remains to be seen is whether the temperatures and times are reliably achievable though the entire volume of the windrow, through several turnings, and are sufficient to afford efficient destruction of *P. ramorum*. It must then be decided to what end use such treated bark can be confidently put without unacceptable risk of further spread of infection.

There is a draft proposal for further research which the FC Plant Health Service is in the process of commissioning from Forest Research. The proposal has now been forwarded to the bark group, see Appendix 4 for details.

The EPPO (Organisation Européenne et Méditerranéenne pour la Protection des Plantes) describes in PM 3/53(1) a standard phytosanitary procedure using composting (fermenting) bark of conifers in order to prevent the spread of EPPO quarantine pests found in the bark of conifers. EPPO Phytosanitary Procedure PM 3/53(1) includes requirements for the bark particle size range to be 5-50mm; that bark stacks should comprise no less than 4 tonnes and be treated with 1-2% nitrogen; and the composting period is 4-6 weeks during which the stack is turned 3-4 times. Controlling bark particle size would be an aid to ensure that the core of particles reaches agreed temperatures.

Within the UK, Publicly Available Specification PAS 100 (www.wrap.org.uk/content/bsi-pas-100-compost-specification) sets out the requirements for composting of source segregated biowastes and biodegradable non-wastes, including bark. Its principal role is to define a set of treatment criteria that allows a waste derived product to be no longer regarded as a waste by regulatory authorities.

However PAS100 is specifically intended to allow the conversion of a relatively wide range of organic materials to a new product with different physical characteristics and establish criteria to demonstrate that it is no longer a waste product. This is not directly applicable to the bark heat treatment process which is intended simply to afford protection against *P. Ramorum*, but still retain the physical properties of the bark.

The heat treatment performed by some of the bark processors is not a full composting process, but has been simply to assess the ability of the sanitization step to subject all the material to prolonged high temperature. Some processors, however, produce peat-free growing media from the fine particles, subjected to a full composting process. The majority of bark products, used for mulch, play bark and landscaping purposes, are screened into different size classes, with the smallest (<8 mm) predominantly going into the growing media.

The EPPO guidance recommends that where biowaste/material of plant origin is known or suspected to contain any "notifiable" (also referred to as "quarantine") plant pests or pathogens the sanitization step and whole composting process should be authorized and supervised by the National Plant Protection Organization, i.e. either Fera or the Forestry Commission depending on the material being treated.

10. Conclusions

Forest owners, sawmills and forest co-products industries are all being impacted as a result of widespread infection of larch by *P. ramorum*. At present larch represents only a small percentage of the timber processed by most sawmills, except for those situated in

certain regions, but this figure is likely to rise significantly as the felling of infected trees increases. This will mean that available volumes of British whitewood sawn timber products and chip wood and non-infected bark will be impacted. The industry is aware of this and is very willing to work with the Forestry Commission Plant Health Service to try to develop regulations and protocols to minimize the further spread of infection while attempting to recover the maximum value from already infected timber without excessive restrictions, inconvenience or cost.

There is however an appreciation of the seriousness of the outbreak, and particularly concern from the industry that *P. ramorum* might infect other commercial species which might in turn become sporulating host species. There is also concern from the industry that if regulations on the use of infected bark and co-products are too restricting, bark will be imported from overseas and that phytosanitary measures and regulations may not be sufficient to prevent other pests and diseases arriving in Britain.
Key operational issues:

- separation of infected material, both before and after debarking, and associated issues of batch processing and sweep down of hard standing, equipment and bunkers afterwards;
- a limited market for infected bark;
- substitution of infected larch for other timber more desirable to the market in the harvesting and processing sectors.

The possibility of allowing bark from infected trees to be used in a wider range of applications is very desirable and the industry is very keen to establish whether this will be a realistic option, and what restrictions will be imposed.

There is a feeling that some of the regulatory controls could be eased, such as documentation for some movements within core infected zones, and a clear explanation of the relative and absolute level of infection risks from different co-products and activities would be helpful. The perception is that in attempting to further reduce a very low risk of further spread of infection, measures are being taken, or activities prevented, that are in danger of having a disproportionate impact on the industry, and that are not justified in comparison with other, uncontrolled risks, such as from the general public, the weather, mountain bikers and animals, and may even have unintended consequences as a result of stimulating import of alternative products and materials.

The representatives of the bark and co-products industry felt the role of the Forestry Commission in presenting a clear, positive message to the general public and mass media to be central in ensuring there is no loss of confidence in UK products.

11. Recommendations

A number of issues have been raised by representatives of the industry. Even if some of the complaints are unfair or based on misunderstanding, this should be regarded as an indication that better communication is required. The following is a list of issues that should be considered by the FC Plant Health Service.

1. Review Movement Licences and controls. Can they be simplified or automated? Are they always necessary?
2. Keep industry regularly updated. Even if there is no further information available this should be conveyed to the industry. Ensure there is a forum where industry concerns and questions can be raised and that even smaller companies are aware of this.
3. Review regulations for material that stays within statutory control infected zones.
4. Undertake research to establish acceptable minimum temperature/time combination(s) necessary for effective destruction of *P. ramorum*.
5. Complete research into temperatures achievable for all material within open windrow composting. Develop practical operational protocol if temperatures appear to be acceptable.
6. Ensure FC Communications are kept fully briefed and ready to respond to enquiries from the media or public, and issue carefully worded press releases as required.

Appendix 1. Comments from the British bark industry arising from the industry meeting

It was made clear that all parts of the industry express a clear willingness to work closely with the Forestry Commission Plant Health Service to develop regulations and protocols for operation. However it was stressed that is important to achieve a balance between the necessity for effective biosecurity, and achieving maximum value from infected timber, whilst ensuring that any measures are realistic, workable and proportionate. In addition, they must be viewed in the context of the magnitude of the potential risks from other activities.

A working group chaired by Forestry Commission Scotland and with participants from the FC Plant Health Service, Forest Research and the sawmilling and bark processing sectors has been set up to look specifically at the issues associated with the increased volume of infected bark that will come to market over the next few years, and the possible impacts. This group is seen as the main vehicle for ensuring good communication and collaborative working between the industry, the Forestry Commission Plant Health Service and Forest Research.

A number of suggestions were made to reduce the impact on the industry.

The requirement for full documentation in the form of Movement Licence and Movement Schedule to accompany any movements of infected material was raised by sawmill representatives. It was felt that all the relevant information contained in these would normally be contained in the dispatch documentation. The requirement to enter this again, into separate forms, that also need to be retained for three years, could perhaps be reviewed, especially when the movement is entirely within one of the proposed core infection zones.

It was suggested that if infected material remains within a core infected or management zone, then use for landscaping and playbark purposes should not represent significant additional risk if the area is deemed to be one in which infection is already present. There was, however, concern that the widespread use of potentially infected material beyond the boundaries of the forests could increase the potential for further spread outside the zone. Another question was whether hard standing and segregation were needed in sawmills within the core zone if all co-products were to remain within the zone. However again it requires a mechanism to ensure that co-products do not either move outside the zone, or become mixed with material that does.

There was a lack of clarity among the bark processors involved in the heat treatment trials as to what temperature and time duration they needed to achieve to eradicate *P.*

ramorum. The international figure of 56°C for 30 minutes is known as an accepted phytosanitary treatment against a wide range of quarantine organisms in wood and wood products and therefore the FC considered that bark treatment trials should prove that this 56°/30 specification could be achieved throughout a pile of bark using a windrow turning machine, which was a unique trial. The UK bark producers were not fully aware that the 56°/30 temperature and time combination to achieve destruction of *P. ramorum* in bark had not yet been established in the scientific literature[1]. This led to some disappointment when impressive results with temperatures in excess of 56°C in second generation trials could not be confirmed as definitive against *P. ramorum*. This was felt to be a breakdown in communication in terms of what the bark treatment trials were trying to achieve exactly, although it was always recognised that they were only trials and improvements and refinements were inevitable.

In discussions with the industry, they said they also felt that they were not always made aware of what research was being undertaken or commissioned, leading to concern about lack of progress. In particular they said they would be prepared to commission, fund or undertake further research themselves, or in conjunction with FR, if this would help to answer some of the outstanding uncertainties quicker. Since then however the research mentioned in Section 9 above has been commissioned from Forest Research. The Bark Group has been made aware of this, individual companies will be involved in the research and the industry will be kept up to date with progress. Because of the economic implications of the exclusion of this infected bark from the market it is felt to be important that any necessary research be undertaken as soon as possible.

There also seemed some lack of clarity in understanding the infection risks presented by bark and other co-products from infected trees. There appeared to be the perception that it is only from needles and spores that have been caught in crevices in the bark, rather than also the possibility of hyphae within the bark and outer sapwood, which can also present a risk. There is also a difficulty in comparing the relative magnitudes of risks of infection spread from different mechanisms, such as standing trees, isolated co-products such as bark or bark-free timber, or other vectors such as the general public, mountain bikers, animals and transport of roundwood. This can lead to the perception that the industry is being asked to make significant efforts to reduce the spread of infection of P. ramorum while it is still being spread by other vectors beyond their control.

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[1] This is true for bark and for dry heat processes. However the 56°/30 temperature and time combination through scientific research has been found to be adequate in wet heat conditions for material other than timber and bark.
Noble R, Blackburn J, Thorp G, Dobrovin-Pennington A, Pietravalle S, Kerins G, Allnutt TR and Henry CM (2011b). Potential for eradication of exotic plant pathogens *Phytophthora kernoviae* and *Phytophthora ramorum*. Compost and Science & Utilisation 19 (4), 219-225.
Swain S, Arnnik T, Mejia-Chang M, Hayden K, Bakx W, Creque J, Garbelotto M. (2006). Composting is and effective treatment option for sanitization of *Phytophthora ramorum* infected plant material. Journal of Applied Microbiology ISSN 1364-5072.
Turner J, Jennings P, Budge G. (2008). Investigation of alternative eradication control methods for *P. ramorum* and *P. kernoviae* on/in plants. Defra project PHE/2122A. Final Report, CSL York.

The bark processors spoken to have said that they would be prepared to undertake the type of heat treatment of bark proposed if it opened up the markets to bark from infected trees. The perception is that the biggest risk is from its use in growing media, principally that sold into the professional market, and that this would therefore require additional biosecurity measures. There was, however, resistance to additional regulation to control this. There is a proportion of bark in the form of fines that is unsuitable for any other end use than growing media, though. If it is not possible to use the bark fines for this purpose then disposal will be more of a problem as they are not suitable even as biomass fuel.

Woodfuel supply companies operating in south west England have been handling infected larch for the longest time, and report that handling it does not in itself present any major difficulties. However there is significant time and inconvenience associated with completing all the Movement Licences, which involves effectively inputting the same information as required for the delivery documentation. For a company making perhaps 20 – 30 deliveries in a day, the majority of which are to licensed customers, this means a significant amount of additional work and therefore cost. It has been suggested by a major woodfuel supply company that a more automated licensing system that allows data to transferred directly from the company database, such as by CSV file, in the way used for their delivery documents, would be both quicker and more reliable than typing the information into a PDF form each time.

The representatives of the industry stressed the importance of ensuring that they are kept informed of developments in the science and of any changes in regulations. If there is research being undertaken at other research establishments they would like to know what is being done, what information is expected to be obtained, and the likely timescales. If there is to be a delay as a result of funding, scheduling, personnel or facility availability, it would be very helpful if this were explained to the industry. Any delays in allowing wider use of co-products from infected trees are likely to have cost implications to the industry. Being kept fully informed as much as possible will help to ensure continued goodwill and buy-in to any solutions or initiatives proposed.

It was also stressed that the role of the Forestry Commission in providing a clear, consistent, positive message to the general public and mass media is vital to ensure that the problem and potential risks are kept in proportion. The potential for ill-informed sensationalizing of the issues, leading to loss of public confidence in UK products, was felt to be a risk that could potentially do more long term damage to the industry than the outbreak itself. Consistent, clear, factually based information from a respected body such as the Forestry Commission was seen as vital in counteracting this. Private forest owners are already felling healthy larch in an attempt to forestall infection and possibly further loss in value.

The view was expressed that, despite the much greater economic impacts of *P. ramorum*, it is seen as receiving less attention than *Chalara fraxinea* owing to the latter's landscape impact, especially in southern England.

It was also commented that there are controls and associated restrictions administered by the country environment agencies on the burning of bark or brash in the forest, and consequently this cannot be readily used as a mechanism for disposal of large quantities of such material.

Appendix 2. Contacts

Sawmills

BSW	Gavin Adkins Richard Scott
Charles Ransford	Craig Leitch
James Jones	David Leslie Iain Gale
Rattery Sawmill	Oliver Fogden
Ridley Sawmill	Julie Ridley
Vastern Timber Co.	Tom Barnes

Bark and co-products processors

A.W. Jenkinsons	Richard Palmer Simon Bullock
Melcourt Industries	Andy Chalmers Catherine Dawson
Scotbark	Mick Boyle
TMA Bark Supplies	Graham Andrews
William Sinclair	Richard Iveson Paul Smith

Panelboard mills

Egger	John Paterson
Kronospan	Chris Emery
Norbord	George Webb

Pulp & paper

Iggesund	Gavin Davidson
UPM Caledonian	Steve Bradley

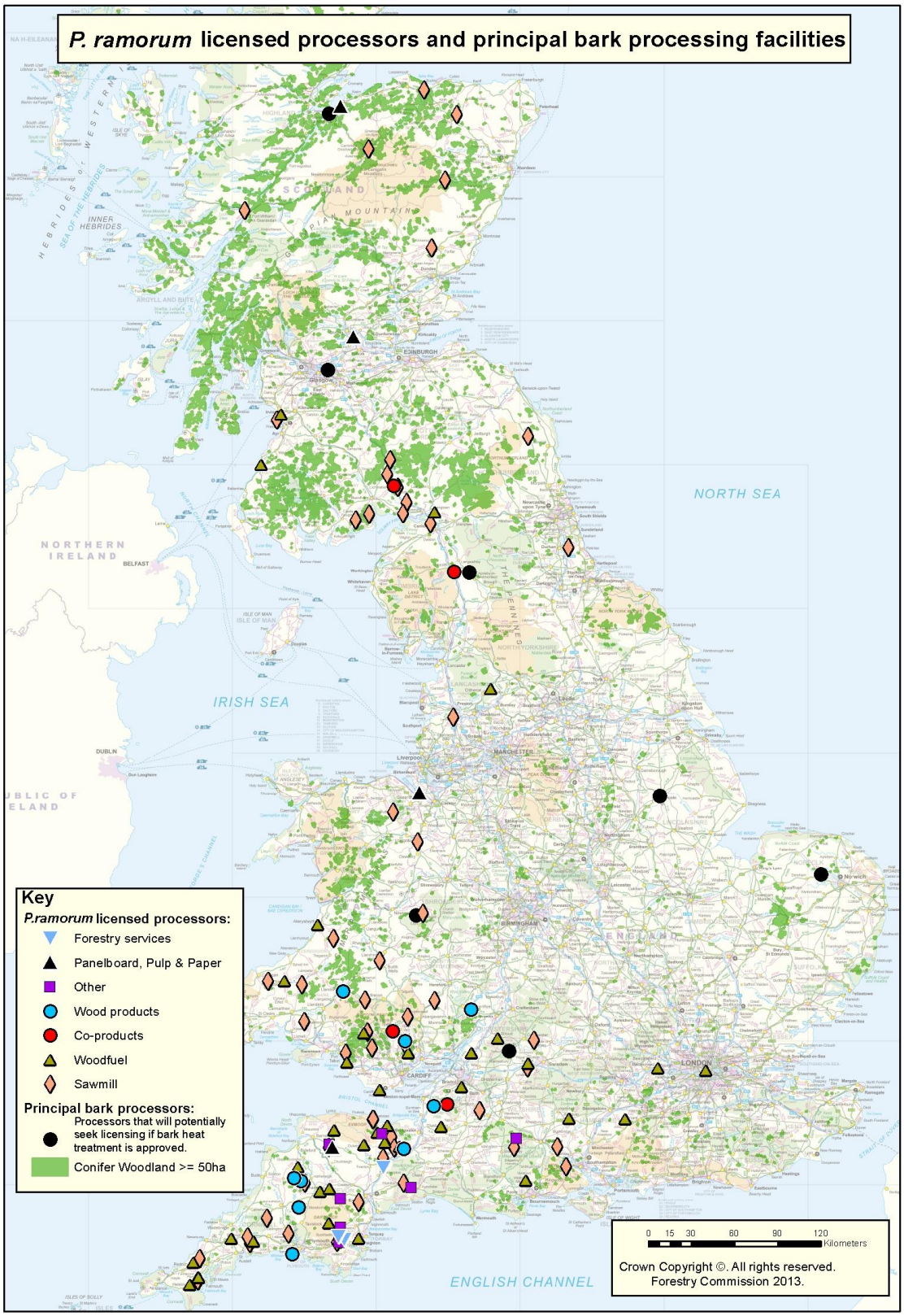
Woodfuel supply

Forest Fuels	Will Frost

Others

Forest Enterprise	Alan Corson
Forest Research	Joan Webber
UKFPA	David Sulman

Appendix 3. Map of processors



Appendix 4. Research proposal to be undertaken by Forest Research

Development of a reliable assay to test for live *Phytophthora ramorum* in larch bark

Aim

This project aims to develop a reliable assay for detecting living *P. ramorum* in larch bark, suitable for use with composted material.

Plan of work

Research will assess both baiting and incubation + real-time PCR as methods for detecting live *P. ramorum* in larch bark. If possible, both EU1 and EU2 lineages of *P. ramorum* will be included in this study. The work will consist of the following three phases;

1. Obtain larch bark known to be infected with *P. ramorum* (EU1 and EU2 lineages if possible) and determine viability of the pathogen.

This will be done using two methods i) collecting bark from infected cankers on recently felled larch trees and ii) obtaining chipped bark material from a sawmill and inoculating this material with mycelium of *P. ramorum*. The bark samples will be tested for the presence of *P. ramorum* by a combination of culturing and baiting (to ascertain viability) and quantitative real-time PCR to determine amount of pathogen DNA present.

Time scale: month 1

2. Develop a reliable assay for detecting live *P. ramorum* in bark samples down to very small quantities of the pathogen.

This will involve two methods; i) incubation of bark samples in culture medium followed by real-time PCR, and ii) baiting.

For this study samples of larch bark known to be infected with living *P. ramorum* will be split into two batches. One of these batches will be autoclaved to kill the pathogen. Both batches (autoclaved and non-autoclaved) will be incubated for a period of time in a culture medium that will encourage growth of *P. ramorum* if present and viable. Various incubation time periods and culture solutions will be tested (i.e. carrot broth, Petri solution, river/pond water). An appropriate method of harvesting the samples will be developed (i.e. drying and grinding the incubated bark samples, or simply sampling the suspension, followed by DNA extraction and real-time PCR).

The principle behind this approach is that samples containing living *P. ramorum* will grow and thus DNA will be detected at higher levels by qPCR than dead DNA. By comparing several batches of autoclaved and non-autoclaved samples, threshold levels of dead DNA per g of composted larch bark will be determined and used as a basis for comparison when testing 'unknown' samples exposed to the composting process. While the cultures are incubating, Rhododendron leaves will be floated on the surface of the solution as bait tests. Any lesions that develop will be tested with real-time PCR to determine whether *P. ramorum* is present in the lesion.

Time scale: months 2-4

3. Validate the assay using composted *P. ramorum*-infected larch bark.

Once the assay has been developed we will work with industry to validate it in situ in composting windrows.

Bark samples known to be infected with living *P. ramorum* (i.e. as determined in Phase 1 above) will be sealed within nylon mesh bags and placed in composting windrows of larch bark. Each sample will have a temperature datalogger attached. Samples will have to be removed and replaced each time the windrow is turned. After a period of time such that the samples will have been exposed to temperatures of 55°C, the bark samples will be tested for the presence of live *P. ramorum* using the method developed in Phase 2 above.

Time scale: months 5-6