AN ASSESSMENT OF THE POTENTIAL IMPACTS OF ASH DIEBACK IN SCOTLAND

Dr. Richard Worrell, Forestry Consultant

Commissioned by Forestry Commission Scotland

January 2013

DISCLAIMER: The opinions expressed in this report are those of the author and are not necessarily held by Forestry Commission Scotland.

ACKNOWLEDGEMENTS

Many very busy people had to be contacted at short notice in the course of drawing up this report and the response was universally constructive. The effort put in by the Native Woodland Survey of Scotland staff was exceptional. Particular thanks go to:

Forestry Commission Scotland: Hugh Clayden, David Howat, Derek Nelson, Paddy Robertson, Colin Edwards, Douglas Wright, Cameron Maxwell, Gordon Patterson, Ben Ditchburn, Andy Leitch, Geoff Hogan (FC Biomass energy Centre)

Forest Research: Alice Broome (impacts on lower plants), Anna Lawrence (social impacts)

Confor: Stuart Goodall, Fiona Angier, Angela Douglas (consultant)

Nurseries: Grant Murray, Rodney Shearer, Jamie Dewhurst

Timber Trade: Gavin Munro, Jake Willis, Jim Burley, Malcolm Mack, Graeme Murray, Archie MacConnel, Keith Threadgall, Patrick Baxter

Environmental impacts: Jeanette Hall (SNH), Graeme Walker (SNH), Deborah Long (Plantlife Scotland), Brian and Sandy Coppins (lichens), Graham Rothero (bryophytes), Liz Holden (fungi), Craig Macadam (Buglife Scotland), Mike Wood, Paul Bellamy (RSPB), Tim Hall, Andrew Fairbairn (Woodland Trust Scotland)

Landscape impacts: Alison Grant

Urban Trees: Paul Hanson (Arboretum Internationale), Angus Corby (Transport Scotland)

Author contact: Rick Worrell, Forestry Consultant, Upper Park ABERFELDY, Perthshire PH15 2EH
01887 840331 rick@thinkingtrees.co.uk

CONTENTS

EXECUTIVE SUMMARY

This report sets out the main potential impacts of ash dieback caused by *Chalara fraxinea* covering the likely environmental, economic, landscape and social consequences. The report gives an account of the *values* of ash, followed by the *impacts* caused by the likely damage and death of ash trees over an extended period.

1. The Disease – Likely Spread and Damage

The disease could spread to most or all of Scotland within 5 years (Confidence Rating - moderate). Young trees and regeneration will die quickly once infection is present. Polestage trees will die, beginning 3-5 years after infection. Mature trees will show progressive crown dieback over a period of many years and will then start to die due to the combined effects of *Chalara* and other pathogens/pests. A proportion of both polestage and mature trees will remain alive for many years (Confidence Rating – high); however loss of foliage and other systemic damage will render them increasingly vulnerable to other pathogens, pests and climatic damage. It is possible that a high proportion of trees will be badly damaged or dead throughout Scotland within 10-15 years (Confidence Rating – moderate). The current population of ash will be killed in the long term (Confidence Rating – moderate). A very small proportion of trees will survive with few or no symptoms and some of these may be genetically resistant.

2. Status of Ash in Woodland Management/Silviculture

The potential loss of ash in woodland managed for **quality timber** is serious because there are no alternative species which can wholly replace it; i.e. that are easy to establish, grow fast and straight, are resistant to grey squirrel damage; and are native. It is an important component in **native woodland**, and its potential loss compounds the earlier disappearance of elm from similar woodlands. Several native tree and shrub species could replace ash in native woodland, each with various impacts on the conservation of associated species. Ash is a specialist species in **gap-replacement**, and there are no large stature native tree species that can obviously take its place in this respect; and there will be a need for management to ensure satisfactory outcomes for canopy gaps. The loss of ash in **riparian woodland**, occurring simultaneously with disease on alder, is serious. One outcome of the loss of ash might be to stimulate the creation of woods that mix native and non-native trees in ways that combine ecological resilience, timber production and conservation.

3. The Ash Resource

Estimates for the ash resource are available from the National Forest Inventory (NFI), Native Woodland Survey of Scotland (NWSS) and the National Inventory of Woodlands and Trees 1995 (NIWT). The **total** area of ash woodland is 13,500 ha. According to NWSS, the gross **area of native woodland** with ash trees present is approximately 150,000 ha; this spanning the range from pure ash stands, to woods with just a few ash trees in them. The area of native woodland that comprises ash trees is 12,090 ha. The area of ash-dominated woodland (where ash is >50% of the canopy) is 6,229 ha. About 25% of the total area of ash (3,000 ha) in native woodland occurs in woods where the canopy cover of ash is greater than 50%, and it is these woods where the potential impacts of ash dieback will be severe. NWSS is in a position to map these woods.

Ash comprises 5% of the broadleaved woodland area and about 1% of the total forest area. There are 10.7 million ash trees in Scotland, which is equivalent to 4% of Scotland's total number of broadleaved trees. Ash is **Scotland's 6th most abundant broadleaved tree** species (after birch, oak, sycamore, alder and beech); and **Scotland's 5th most abundant native tree species** (after Scots pine, birch, alder and oak).

About 39% of the area of ash is 20 years or younger; 22% is 21- 40 years (i.e. pole stage) and 39% is 40 years or older (i.e. mature). About 40-50% the area of ash in *native woodland* is **mature/veteran** (5,648 ha or 47%); **polestage** trees account for 4,270 ha (35%), and **young trees / regeneration** (<7cm DBH) is 2,174 ha (18%); this being important because the disease manifests itself differently in these different

growth stages. Ash is one of the largest contributors to regeneration in broadleaved forest areas - NFI estimates that there are 53 million seedlings in Scotland (18% of all broadleaved seedlings), and 11 million saplings (5% of all broadleaved saplings).

The **standing volume** of ash in Scotland according to NFI is 2.7 million m^3, which is equivalent to 8% of the standing volume of all broadleaves. The timber volume increment per year is estimated to be *very approximately* 54,000m^3/year (Confidence Rating – moderate). NWSS will be able to identify **ancient woodland** with ash and this could be done in mid-2013 if required.

Regional scale woodland area information is available from NFI for 5 regions of Scotland and from NWSS for the 5 **conservancies**, plus those **local council areas** for which reports have been published. NFI's "Southern Scotland region", which includes South Scotland and Central Scotland Conservancies, has by for the largest area of ash (about 67 % of the total) and largest standing volume (about 39% of total). **Perth and Argyll, South Scotland and Central Scotland Conservancies** all have the greatest areas of ash trees and ash dominated native woodland; and **Central Scotland and South Scotland Conservancies** have the greatest area of young ash woodland. Figures for the percentage of ash in the canopy of native woodland are available for local authority areas, which will be useful for council environment departments.

About 97% of the ash woodlands area owned by private/charitable owners and 3% managed by Forestry Commission; showing that this is primarily a problem for private/charitable owners.

There were ca 970,000 individual **ash trees outside woodland** in 1995 i.e. in hedges, small groups of trees, windbreaks, wood pasture, etc. Ash trees make up 17% of the **veteran tree** resource in UK and Woodland Trust and the Ancient Tree Forum have recorded 300 veteran ash trees in Scotland; though this represents only a small proportion of the total population.

Ash is distributed throughout Scotland but is most common in:

- southern Scotland, especially Dumfries and Galloway
- south-western Scotland, especially western Central Belt and Lanarkshire and Argyll,
- the Tay and Earn valleys in Perthshire
- parts of Lochaber, western Sunart and Fiunary,
- the valleys and cleughs of Lothian and central and eastern Borders.

Its gross distribution reflects underlying geology.

4. Potential Impacts on Biodiversity

The loss of ash, coming on top of the loss of elm, would significantly impact woodland diversity and would leave seriously impoverished native woodlands. The onset of damage will be gradual and impacts will only potentially become serious in the medium-longer term. Whilst there are several potential "replacement" tree species, the loss of ash is still very serious, and the impacts would depend on which tree and shrub species replaced it. **Flowering plant** communities are quite robust, and gradual increases in canopy gaps and changes in tree composition would only have limited impacts. Replacement species with greatest impact would be species casting heavy shade or deep leaf litter such as beech, Norway maple, and sycamore.

Ash is a critically important for **lichens, mosses and liverworts**, which grow as "epiphytes" on the bark, deadwood, and rocks, and as a component of the ground flora. Loss of ash woodlands, wood pasture and individual trees would all be very serious; especially coming on top of the loss of elm which provided similar niches. The atlantic woods of western Scotland are particularly important.

Of the 536 **lichens** that grow on ash in the UK, 220 are nationally rare or scarce; and 84 have a conservation status. The impacts will depend on which other trees replace ash and whether key lichen species also occur on alternative habitat niches such as rocks. Where other alkaline bark tree/shrub

species take over (hazel, willow, elder – to an extent rowan and old oak), impacts will be less; where birch, alder and oak colonise, impacts will be greater. There are several species of **bryophyte** potentially under threat, and loss of individual trees across Scotland will have serious impacts.

Loss of ash, or the disappearance of an entire age class of ash, would severely impact all types of **fungi** and **invertebrates** associated with ash; especially those which rely solely on ash trees. Decomposing fungi and saproxylic insects might experience a sudden temporary increase in habitat conditions as branches and trees die, but this would be followed by a sustained period with sharply contracting habitat that would threaten species dependent on ash. There is less information on fungi than for other species groups. Ash is one of the most important trees for invertebrates, supporting a wide spectrum of over 100 insects (in the UK), mainly beetles, flies and moths including uncommon or declining ones. At least 40 species are wholly or largely dependent on ash (in the UK). Replacement by heavy shade tree such as sycamore, or species with slowly decaying leaf-litter (such as oak), will have implications for insects that inhabit the ground flora and soil**.** It will be important that significant amounts of ash timber remain in woodlands to act as habitat for lower plants, fungi and invertebrates, rather than being harvested.

Ash forms a significant proportion of old, large trees that are important for **hole nesting birds** (woodpecker, tits, nuthatches, house and tree sparrow, flycatcher, robin, kestrel and owls). Similarly they are important for roosts and hibernating places for **bats**. Ash keys are food for finches and wood mice.

There are 94 **Sites of Special Scientific Interest (SSSI)** and 18 **SACs** in Scotland in which ash is a qualifying or significant feature, and impacts on these of the loss of ash will potentially be very acute. The loss of ash in **wood pasture and veteran trees** would entail a small number of highly valuable, totally irreplaceable trees, some dating back to the 1600-1700's. **Forest Habitat Networks** will continue to function, albeit without species associated with ash.

The impacts listed above translate into a range of influences on ecosystem services. The high biodiversity value of ash trees and ash woodland, in both rural and urban situations, translate to considerable monetary values via their contributions to visitor experience and hence tourism revenues, and quality of life for residents.

5. Potential economic impacts

Woodland owners will incur costs in the following main ways:

- Destruction and removal of ash, and restrictions on activity where statutory Plant Health Notices are issued. Costs of this can be very high. Currently policy is to serve infected sites in Scotland only with containment notices until such times as the costs and potential benefits of further removal of infected young trees has been assessed.
- Surveying woods to monitoring the arrival and progress of the disease and reporting this to the authorities.
- The cutting of diseased trees and their replacement. Costs of this are variable but can be very high.
- Felling and extraction of ash timber before the optimum felling age, and at a time of lower log prices.
- Revised management planning to cope with the disease.
- Felling and tree surgery work to comply with health and safety obligations.
- Substitution of ash by less satisfactory species in future timber production

DEFRA research suggests that staining and **degrade of sawlog material is only likely to occur four or more years after infection** (and may be longer); but that it can happen in as little as two years in younger trees and smaller diameter material; or where epicormics shoots on the main stem act as a direct pathway for infection. Thus, in general there is no need for woodland managers to fell and market

valuable sawlogs immediately after infection is detected, but they should remain alert for the development of epicormics on the main stem and then take earlier action accordingly.

Ash is thought to comprise roughly 10% of the **hardwood sawlog market** in Scotland, with an annual production of very roughly 2,000 m^3/yr; of which 15-20% is processed in Scotland (Confidence Rating – low). A sudden increase in harvesting sustained over period of several years, followed by ash effectively disappearing from the market, would clearly be unwelcome. Log prices for ash are currently at a historic low (due to fashion and imports). The bulk of ash felled would end up as domestic firewood. **Small sawmills (ASHS members)** report ash representing 2-10% of their turnover. Some mills report being able to potentially process more (up to 2 or 3 times more) than present, though this would still only entail small quantities. The loss of ash in the medium-long term would take away a small but significant resource for this sector, but would probably not result in unemployment.

The bulk of ash felled would end up as **domestic firewood**. Because of the healthy state of demand and steady prices, this timber is likely to find a ready market.

Returns to growers for ash **sawlogs** at roadside is estimated to be worth about £100,000 per year; and for **firewood** about £300,000-£350,000 per year (Confidence Rating- low). The value of firewood as delivered split logs is thought to be about £1.5-2 million (Confidence Rating- low). The value of sawn and kiln dried timber to the Scottish sawmill industry is estimated to be about £150,000-200,000 (Confidence Rating – low). If 90% of the ash resource in Scotland died in the next 20-30 year and 60% was recovered for second grade logs/firewood, this would be worth about £50 million at roadside (Confidence Rating – low).

Forest Enterprise Scotland have planted an average of 177,000 **ash plants** per year in restock and 178,000 in woodland creation since 2009 (representing about 8-11% of broadleaved planting respectively). Calculations based on recent planting areas suggest (speculatively) a likely average annual planting in Scotland during the period 2009-12 of between roughly 746,000 trees (354,000 by FES, 392,000 private/charitable); and 914,000 (354,000 by FES and 560,000 by private/charitable); with the upper figure being more likely (Confidence rating – moderate). If these figures are broadly correct, this would suggest that **trade in ash trees** in forestry in Scotland during recent years was worth between about £298,000 and £366,000 (Confidence rating – moderate); with this being split between nurseries in Scotland, the rest of the UK and importing wholesalers.

There are thought to be about 28 **nurseries** producing ash trees in Scotland, with some 460,000 plants currently 'in the ground' (November 2012). The Horticultural Trades Association estimates that there is £2.5 million worth of ash trees held currently in UK nurseries. Nurseries are currently having ash orders rejected or returned, and sales in spring 2013 are halted. This means lost revenue in the order of £40 per 1,000 trees sold. As an example, Alba Trees plc is facing lost revenue for this planting season of the order of £40,000. It is likely that all the 460,000 stock will be unmarketable, in which case the sector may loose about £184,000 in sales. Nurseries will be able to adjust by selling stock of substitute species; however this is limited for the next 1-2 years due to low stocks of some replacement species and a poor seed collecting season in 2012. In the longer term, this situation should improve as buyers adjust their requirements and nurseries alter their stock.

There could be significant potential economic impacts in **urban areas** in the form of activity to minimise the risk of spreading the disease via infected leaves and, in the longer term, costs to owners of felling trees due to health and safety concerns. Public agencies and councils with land holdings along roads and other infrastructure would face the highest costs. In the eventuality of all the urban ash trees in Scotland needing to be removed over a period of several decades, the total cost of removal might be in the order of £180 million. Urban trees have very high indirect monetary values associated with their landscape

value, ecosystem services and biodiversity. Monetised values for these are typically much larger than the costs of their maintenance or removal, typically exceeding £1000 per tree.

The monetised values of **non-market benefits** of ash woodland in Scotland are estimated to be about £3 million.

The UK forestry sector is coping with the **aggregate effects** of a number of serious new tree diseases with significant commercial and environmental impacts. The combined effects of cost burdens on woodland owners and uncertainties about the future health of forests could undermine confidence in the sector as a whole, jeopardising woodland creation, jobs and investment. The arrival of these multiple diseases, largely facilitated by global trade, now constitutes one of the most significant ecological issues in Scotland.

6. Potential Impacts on Landscape

Ash is important in the **landscape** as hedgerow and roadside trees, in riparian woodlands, as veteran trees and in ash-dominated woodlands in the uplands where sloping ground makes it visible. Impacts will be greatest in respect of individual trees in hedgerows, on roadsides and along rivers. Woodlands in urban areas and peri-urban situations with large numbers of walkers will also attract attention; as will individual veteran trees. The impacts on landscape will develop fairly slowly, starting with damage to and death of small trees and then manifesting as incremental damage on older trees. As such, the immediate visual impact will probably be relatively undramatic. Concern will heighten at the point when mature trees are felled at any scale, especially in districts where ash is common

7. Potential Social Impacts

Ash is a "second tier" tree species re public recognisability behind oak, birch, pine, rowan and cherry. Ash doesn't have noticeable flowers, noteworthy autumn colours nor recognisable seeds. It is not particularly valued for collectable mushrooms, nor is it associated with particular birds or mammals. The main context in which ash/ash woodlands are apparent to the public is as **landscape trees** in the general environment and as hedgerows, roadside trees and trees in urban areas. In addition, the value of ash woodland ground flora (wild hyacinth/bluebell, primrose, wood anemone etc.) is apparent for countryside residents and walkers in the countryside, though they might not link this directly to ash. An overview is given of the ecological, economic and landscape impacts outlined earlier in this report, and how they will be experienced by a range of people/stakeholders. The impacts will be significant for the informed public i.e. ramblers and naturalists. The disease will add to the concerns of sections of society that feel weighed down by climate change, deforestation, species loss etc.; but others may be galvanized to 'do something' e.g. get involved with citizen science, community woodlands or conservation.

8. Summary of impacts

A categorisation of the ecological, economic and landscape and social impacts identified in this report is given in table 15, according to severity (low to very high) and duration (short-long term). The highest impacts are anticipated to be:

1. Potential loss of ash in general woodland management and silviculture, especially as a **timber tree**, **component of native woodlands**, a **specialist species in gap replacement** and in **riparian woodlands.**
2. Biodiversity: in relation to **lichens, mosses/liverworts, fungi** and **invertebrates**; damage to **designated sites, veteran trees** and **wood pasture**.
3. Economic activity: **costs to woodland owners of cutting diseased trees and replanting including compliance with Statutory Plant Health Notices**; **felling individual trees for health and safety reasons**, and short term losses in the **nursery industry**.
4. Landscape and Social: **loss of individual trees along roadsides and field margins**, in woods heavily used by the public and in urban situations.

Impacts will generally develop fairly slowly as the disease progresses from killing twigs and branches, to more extensive dieback, followed in the longer term with tree death. The most immediate impacts will be the damage to young planted woodlands.

1. THE DISEASE – LIKELY SPREAD AND DAMAGE

1.1 Current knowledge of infected sites in Scotland.

1.1.1 The disease is currently known to be present in Scotland (as at 11December 2012) at 23 locations in recently planted woods, one nursery, and in 5 established woodlands. Known infected young planted woodlands are concentrated in the central belt, Angus and Fife, but extend north as far as Strathspey [1] and south into Dumfries and Galloway. Infected mature woodland is currently all in east coast areas (Berwickshire, Fife, Banffshire/Moray).

1.1.2 The rapid survey of woods undertaken in November 2012 was a sample survey involving 2,730 sites, of which 4-5% were recorded as having symptoms of potential die-back; suggesting that the disease is already established in parts of Scotland. However, the full extent of infection will not be apparent until at least autumn 2013, once the wider survey programme has been completed.

Rate of spread

1.1.3 The advancing front of infected sites was observed to spread at 20-30 km a year in Norway[2]. However, in Sweden it took only 4 years to spread 900 km across the distribution of the species. In Estonia, it probably spread ca. 200 km in the course of 3 years[3]. It was first detected in Belgium in 2010, but was widespread in the country by 2012. In Slovenia, the disease was detected in autumn 2006 near Hungarian border, but by 2007 the symptoms were observed all over the state (including near the Italian border – about 150 km eastwards).

1.1.4 In order to have spread the 1500 km from eastern Poland in 15-20 years the pathogen must have advanced at an average rate of 75-100 km per year (natural + man-assisted spread). If woodlands in coastal eastern England were infected directly from trees in Belgium or the Netherlands as seems likely, this suggests a capacity to spread over 100 km in a single event.

1.1.5 This suggests the rate of spread could be rapid in Scotland (Confidence Rating – moderate). If surveying in 2013 shows *Chalara* to be more widely distributed the wider environment than currently apparent, spread to the rest of Scotland could be very rapid.

Progress of disease and tree mortality

1.1.6 DEFRA guidance[4] states:

- trees cannot recover from infection, but larger trees can survive infection for a considerable time and some might not die.
- trees under 10 years of age are likely to die from *C. fraxinea* in 2-10 years.
- trees under 40 years old will die in 3-5 years if also infected with honey fungus, and likely more rapidly if the tree is already debilitated.
- for mature trees more than 40 years old, there is no direct evidence of tree deaths just from *C. fraxinea* to date, but there is little comprehensive survey data from Europe on which to base firm conclusions.

1.1.7 In Denmark, 6 years after the disease arrived, it was estimated that 50% of the trees were infected leading to loss of about 40% of the leaves[5].

---

[1] Just 25 newly planted trees, all of which have now been destroyed

[2] Souce: *Department of Environment, Food and Rural Affairs - Key Scientific Facts - Chalara fraxinea*

[3] Source: Forestry Commission: Current state of knowledge on *Chalara fraxinea* (ash dieback disease) in Europe – November 2012 Peter Freer Smith.

[4] Source: www.forestry.gov.uk/website/forestry.nsf/byunique/infd-8zss7u

[5] Source: Dr. Anja Byg, Denmark email to Anna Lawrence, FR

Individual resistant trees

1.1.8 Only a small proportion of trees appear to be surviving the epidemic in Europe without showing symptoms, and about 1% of trees may be genetically resistant[6].

1.2 Possible progress of disease in Scotland

1.2.1 The potential progress of the disease cannot yet be forecast, as it is dependent on: a) the extent and distribution of infected sites that don't involve nursery stock (="wider environment"); b) how rapidly the disease spreads in Scotland's particularly oceanic climate; and c) how resistant the Scottish population of ash turns out to be. It is, however, possible to say that:

1. Based on the European experience, without control measures, the disease could spread to most or all of Scotland within 5 years. However, individual, isolated woods are likely to be infected last.
2. Experience from Europe shows that it is highly unlikely that the disease can be prevented from spreading. The only hope is to slow down the rate of spread, and further research is required to determine how much time can be 'bought' and the cost of achieving that.
3. Young trees and regeneration will die quickly once infection is present.
4. Twigs and small branches of older trees will die first, followed by progressive crown dieback. Progress of the disease will vary from tree to tree in a way not clearly linked to site conditions or other external factors.
    1. Polestage trees will die, beginning 3-5 years after infection.
    2. Mature trees will show progressive crown dieback over a period of many years and will then start to die due to the combined effects of *Chalara* and other pathogens and pests; particularly, in woodland settings, honey fungus.
5. A proportion of polestage and mature trees will remain alive for many years; however the loss of foliage and other systemic damage will render them increasingly vulnerable to other pathogens, pests and climatic damage.
6. Significantly damaged trees will be felled by owners because they are unsightly, contribute to local inoculum loading, and pose health and safety risks; or simply to recover timber value.
7. It is possible that, without control, a high proportion of trees will be badly damaged or dead throughout Scotland within 10-15 years (Confidence Rating – moderate).
8. It is possible that the current population of ash will be killed in the long term (Confidence Rating – moderate).
9. A very small proportion of trees will survive with few or no symptoms and some of these may be genetically resistant. Experience in Europe suggests 1% of trees show less than 10% infection.
10. The best hope of re-instating ash in the long term is via resistant strains produced by intensive tree breeding.

[6] Source: www.fraxback.eu/index.php?option=com_content&view=article&id=79&Itemid=290

2. STATUS OF ASH IN WOODLAND MANAGEMENT AND SILVICULTURE

2.1 Timber Management

2.1.1 Ash is a **valuable broadleaved timber tree** alongside ash, oak, cherry, sycamore, beech and potentially, silver birch. It is a key species in efforts to increase planting of quality broadleaved timber because it is easy to establish, generally grows fairly fast and straight, and is resistant to damage by grey squirrel. It is unique in terms of combining **high conservation value, fast growth rates and high timber value.** It is also a useful firewood species.

Impacts – Timber Management

*2.1.2 The potential loss of ash for **quality timber** is serious because there are no alternative species which can wholly replace it; i.e. that are easy to establish, grow fast and straight, are resistant to grey squirrel damage; and are native. The most obvious replacements are sycamore, gean/cherry, oak, possibly lime, and silver birch.*

Impacts: High, Short-Long term

2.2 Native Woodland Management

2.2.1 Native ash woodland is very valuable: it is quite a **rare** native woodland type**;** very **diverse** and often **highly natural.**

2.2.2 Ash is an important component in native woodland creation on lowland / semi-uplands sites. However , ash woodland HAP types have often been under-represented in woodland creation in recent years compared to pine, birch and oak woodland[7].

2.2.3 Ash is a very important species in regeneration and succession (dynamics) in native woodlan**d**. It is one of Scotland's few native species that:

- is "later successional" (as opposed to pioneer);
- *is relatively* shade tolerant (though only when young)
- successfully seeds and regenerates in a wide variety of circumstances.

2.2.4 This makes it a **critical species in "gap replacement"** (i.e. infilling gaps in woodland left when other trees die) which drive natural succession in woodland. For example:

- Ash has often taken the place of elm following Dutch elm disease;
- Ash can replace sycamore in gaps in sycamore woodland (and vice versa) in a cyclical process.
- Oak woodlands were frequently established historically on ash woodland sites – but in the last 20 years ash has started to re-assert its presence by gap replacement when oak trees die;
- Ash can replace alder by succession in riparian /wet / floodplain woodlands. With alder also subject to *Phytophthora alni* , that process is (was) potentially ecologically important.

[7] Worrell, R. Are Rural Priorities Native Woodland Creation Schemes delivering improvements to Forest Habitat Networks ? FCS unpublished report.

2.2.5 Ash has been gradually been increasing its presence naturally by gap replacement as woodland restoration efforts have been taking effect in recent years – and this has increased the diversity and value of woodlands. These processes will now presumably stop in infected woodlands.

Impacts – Native Woodland Management

*2.2.6 There are a range of native species that can replace ash in **planted native woodland** (see Patterson 2012[8]), each with various impacts on the conservation of associated species (see section 4) and on timber production.*

*2.2.7 Where ash disappears as a native species in **gap replacement**, there is no large stature native tree species that can obviously take its place, because most native trees cannot regenerate in low light on fertile sites. The place of ash will be taken by other species, either by expansion of adjacent trees, or colonisation via seed/suckers. Dependent on site these might include:*

- *commonly - hazel, goat and grey willow, sycamore, downy birch, oak;*
- *occasionally - silver birch, bird cherry, alder or beech;*
- *more rarely – aspen, gean (wild cherry) or Norway maple.*

2.2.8 Hazel and bird cherry will probably expand (by seed) where these are present and this is a desirable ecological outcome. Sycamore will potentially benefit; and the positive and negative effects of this on conservation are outlined in section 4; for timber production, sycamore is a good replacement (provide grey squirrel can be controlled). There will be a need for managers to consider management to ensure satisfactory outcomes for canopy gaps currently occupied by ash, and new ones emerging now that ash regeneration is likely to cease.

Impacts: Medium-High, Medium-Long term

2.3 Riparian Woodland

2.3.1 Ash is an important component of **riparian woodland** i.e. river banks, river islands and floodplains. As such it contributes to bank stability, moderating water temperature, and leaf litter input to aquatic ecosystems.

Impacts – Riparian Woodland Management

*2.3.2 The loss of ash in **riparian woodland**, occurring simultaneously with damage to and death of alder, is serious and will have local impacts on bank stability and wider impacts via decreased leaf litter input to aquatic ecosystems and ultimately fisheries.*

Impact: High, medium-long term

2.4 Other Management Issues

2.4.1 Management of ash takes the following forms:

1. **Intensive management of ash for quality timber** involving thinning and pruning: small areas typically 0.5-2 ha; probably not amounting to more than 50-100 ha in established woods (Confidence Rating – low). In the last 5 years about 1,000 ha[9] of broadleaved woodland have been planted in Scotland in which timber production is a major objective and probably

[8] Paper by Gordon Patterson: www.forestry.gov.uk/pdf/FCSBriefingNote7.1UPDATE-Chalaradiebackofash.pdf/$FILE/FCSBriefingNote7.1UPDATE-Chalaradiebackofash.pdf

[9] Source: Scottish Forestry Strategy indicators

about 10% of this comprises ash, suggesting an area of about 100 ha (Confidence Rating – medium).

2. **Mixed broadleaved woodlands** including ash where timber production is one objective of several; woodlands on farms and traditional estates are mainly in this category.
3. **Native woodland** in which conservation and landscape are the main objectives but where local cutting for firewood is conceivable.
4. Native woodland and small mixed woodlands with **minimal or no management** due to their high conservation value, location or lack of owner engagement.

2.4.2 Ash typically occurs as **mixtures** with a wide variety of other trees in both semi-natural and planted woodland. Pure stands are rare. The wide variety of situations in which ash features in stands / woodlands means that it will be more difficult carry out surveying of disease impacts, or develop cost effective management to mitigate the effects of the disease.

2.4.3 One outcome of the loss of ash might be to stimulate the creation of woods that mix native and non-native trees in ways that seek to combine ecological resilience, timber production and conservation.

3. THE ASH RESOURCE

3.1 Data sources

3.1.1 Estimates for the ash resource are available from the following:

1. The National Forest Inventory (NFI) published *preliminary estimates* for broadleaves in the UK in December 2012[10];
2. Native Woodland Survey of Scotland (NWSS) has interim data for *native woodlands*;
3. National Inventory of Woodlands and Trees (NIWT) published data from an inventory in 1995.

Published data - Caveats

3.1.2 Information comes with the following caveats:

- the Native Woodland Survey of Scotland (NWSS) does not include woods comprising less than 40% native species, and so this misses some ash; and data analysis is not yet complete[11,]
- NWSS and NFI surveyed woods over 0.5 ha and wider than 20m and so does not include small groups of trees, hedgerows etc.
- NFI values for small categories of broadleaved woodland have quite high levels of sampling error.

3.2 Scotland-scale information for woodland[12]

Total area of ash in Scotland

3.2.1 The ***total area of ash*** in woodland in Scotland according to NFI is 13,500 ha. Southern and central Scotland together contain 9,100 ha of ash; which is 67% of the area of ash in Scotland (see table 1).

Table 1 Area of ash and percentage of forest area by regions of Scotland; 000 ha (source NFI)

	Area (000 ha)					% ash in broadleaved area	% ash in total forest area
Region	**FC**	**Private**	**Total**	**All broadleaves**	**Broadleaves & conifers**		
N. Scotland	0.0	1.1	1.1	33.9	178.0	3	1
NE. Scotland	0.1	0.2	0.3	41.8	216.6	1	0
E. Scotland	0.1	1.7	1.8	38.1	119.7	5	1
S. Scotland (incl. Central Scotland)	0.1	9.0	9.1	81.4	363.5	11	2
W. Scotland	0.2	1.1	1.3	69.8	293.3	2	0
SCOTLAND	**0.4**	**13.1**	**13.5**	**264.9**	**1,171.1**	**5**	**1**

[10] www.forestry.gov.uk/pdf/NFI_Prelim_BL_Ash_Estimates.pdf/$FILE/NFI_Prelim_BL_Ash_Estimates.pdf

[11] Data are available for approximately 95% of Scotland including all regions where ash is frequent.

[12] Not including urban trees; or recent amenity planting along road and around buildings; except data derived from NWSS, which includes urban woodlands > 0.5 ha.

3.2.2 The area of ash in ***native woodland in Scotland*** according to NWSS, is set out below and in table 3:

1. ***the gross area of woodland with ash trees present*** is approximately **150,000 ha**. This spans the range from pure ash stands, to woods with just a few ash trees in them. The actual area of trees in these (all species) is 114,000 ha (removing small canopy gaps).
2. The area **that comprises ash trees is 12,090 ha.** This value is generated by multiplying the area of woods with ash trees present (i.e. 1 above) by the average canopy cover.

The area of **ash-dominated woodland** (where ash is >50% of the canopy) is **6,229 ha.** This shows that the ash resource is split roughly 50/50 between ash-dominated woods and woods where ash is a more minor component.

Area of ash in Scotland as proportion of UK total

3.2.3 The area of ash in Scotland is equivalent to 5% of total area of broadleaves and 1% of the total forest area (see table 1). It should be noted that some individual counties in England have similar or greater areas of ash than in all of Scotland.

3.2.4 Values for the proportion of the total *native woodland* resource occupied by ash cannot yet be generated because no comparable estimate of the total native woodland area is available yet.

Numbers of trees

3.2.5 There are 10.7 million ash trees in Scotland according to NFI, which is equivalent to 4% of Scotland's total number of broadleaved trees (see table2).

Table 2 Numbers of ash trees (millions) and percentage of total trees by regions of Scotland; (source NFI)

	Numbers of trees (million)					**% ash in broadleaved trees**	**% ash in all tree species**
Region	**FC**	**Private**	**Total**	**All broadleaves**	**Broadleaves & conifers**		
N. Scotland	0.0	0.6	0.6	39.1	252.5	2	0
NE. Scotland	0.0	0.2	0.2	39.2	179.0	1	0
E. Scotland	0.0	1.3	1.3	33.8	123.3	4	1
S. Scotland inc. Central Scotland	0.1	7.0	7.1	92.0	485.9	8	1
W. Scotland	0.2	1.3	1.5	71.2	438.8	2	0
SCOTLAND	**0.4**	**10.4**	**10.7**	**275.2**	**1,479.6**	**4**	**1**

Table 3. Area of ash in native woodland in Scotland (Source: Native Woodland Survey Scotland interim data, Nov. 2012). Slight inconsistencies in totals are caused by woods that span conservancy boundaries. "Ash dominated woodland" has ash as 50% or greater canopy cover.

	Area of native woodland with ash trees present (ha)	% of national total	Total area of trees (all species) in woodlands containing ash (ha)	% of national total	Total area of ash trees (ha)	% of national total	Area of ash dominated woodland (ha)	% of national total
MATURE / VETERAN TREES > 20cm DBH								
Highland	22,859	20.5%			**664**	11.8%		
Grampian	8,244	7.4%			**245**	4.3%		
Perth and Argyll	41,644	37.3%			**1,638**	29.0%		
Central Scotland	16,201	14.5%			**1,262**	22.3%		
South Scotland	22,859	20.5%			**1,866**	33.0%		
SCOTLAND	**111,660**	**100%**			**5,648**	**100%**		
POLESTAGE TREES 7- 20cm DBH								
Highland	24,806	20.8%			**350**	8.2%		
Grampian	9,903	8.3%			**313**	7.3%		
Perth and Argyll	42,710	35.8%			**1,139**	26.7%		
Central Scotland	18,771	15.7%			**1,185**	27.8%		
South Scotland	23,738	19.9%			**1,293**	30.3%		
SCOTLAND	**119,320**	**100%**			**4,270**	**100%**		
SAPLINGS <7CM DBH								
Highland	21,228	19.1%			**174**	8.0%		
Grampian	9,828	8.8%			**230**	10.6%		
Perth and Argyll	41,157	37.0%			**419**	19.3%		
Central Scotland	19,265	17.3%			**827**	38.0%		
South Scotland	20,390	18.3%			**530**	24.4%		
SCOTLAND	**111,337**	**100%**			**2,174**	**100%**		
ALL SIZE CLASSES								
Highland	31,003	20.6%	22,986	20.1%	**1,188**	9.8%	565	9.1%
Grampian	13,943	9.3%	10,336	9.1%	**788**	6.5%	232	3.7%
Perth and Argyll	53,575	35.6%	40,857	35.8%	**3,194**	26.4%	1,658	26.6%
Central Scotland	22,598	15.0%	17,417	15.3%	**3,273**	27.1%	1,738	27.9%
South Scotland	29,829	19.8%	23,054	20.2%	**3,689**	30.5%	2,043	32.8%
SCOTLAND	**150,302**	**100%**	**114,162**	**100%**	**12,090**	**100%**	**6229**	**100%**

Table 4. Breakdown of area of ash in Scotland by canopy cover classes for all size classes of tree (Source NWSS). Slight inconsistencies in totals are caused by woods that span conservancy boundaries. Notice column 1 gives area of *ash trees,* whereas column 8 in table 3 (above) gives the *total area of woodland in which ash is >50% (=ash-dominated woodland).*

	Area of ash trees in woodland with greater than 50% ash by canopy share (ha)	***% of total***	Area of ash trees in woodland with 20% to 45% canopy cover of ash trees (ha)	***% of total***	Area of ash trees in woodland with >3% but < 20% canopy cover of ash trees (ha)	***% of total***	**TOTAL**
ALL ASH							
Highland	267	22	435	37	486	41	1,188
Grampian	108	14	397	50	283	36	788
Perth and Argyll	847	27	1,387	43	960	30	3,194
Central Scotland	825	25	1,834	56	615	19	3,274
South Scotland	979	27	1,967	53	744	20	3,690
SCOTLAND	3,020	25	5,995	50	3,075	25	12,090

Notes:

- All figures are from DRAFT NWSS data. Final datasets will be available summer 2013 at which point any figures provided here will be invalid.
- For the purpose of this exercise, woodlands overlapping conservancy boundaries were added to the total of each conservancy.
- Native woodland figures include 'nearly native' woodlands and are defined as all woods >0.5 ha that are composed of 40% or greater native trees by canopy share.

Ranking by species

3.2.6 NIWT suggests that ash (in 1995) was **Scotland's 6th most abundant broadleaved tree species** (after birch, oak, sycamore beech and alder); **Scotland's 5th most abundant native tree species** (after Scots pine, birch, oak and alder); and Scotland's 12th most abundant tree species (adding in conifers).

3.2.7 Ash was less well represented in small woods in 1995, where it was the **8th most abundant broadleaved tree.**

Proportion of ash in native woodland canopy (source NWSS)

3.2.8 Table 4 gives data from NWSS on canopy cover of ash in native woodlands showing:

- **About 25%** of the total area of ash (3,000 ha) occurs in woods where the canopy cover of ash is **greater than 50%.** It is these woods where the potential impacts of ash dieback will be **severe**.
- A further **50%** (6000 ha) occurs in woods where the canopy cover of ash is **20-45% ash;** and in these woodland impacts will be **high**.
- The remaining **25% of the ash area** (3000 ha) occurs in woods where the canopy cover is between **3 and 20 %;** and here potential impacts will be **slight-moderate**.
- Highland Conservancy has the highest proportion of woods in the lowest (3-20%) canopy cover class - 41%
- Grampian Conservancy has the lowest proportion of woods in the highest (>50%) canopy cover class - 14%
- Perth and Argyll, Central Scotland and South Scotland all have the highest proportions of woods in the highest (>50%) canopy cover class – each 25-27%.

3.2.9 NWSS is in a position to map the ash resource according to canopy cover, which could be used to assess the severity of impacts according to the classes set out above.

Age and growth stage

3.2.10 Knowledge about the age class distinction is important because the disease affects young trees more quickly and severely than older trees; and Forest Research is formulating management prescriptions according these categories. The important fact is that **40-50% of the area of resource is mature.**

3.2.11 About 39% of the area of ash is 20 years or younger; 22% is 21- 40 years (i.e. pole stage) and 39% is 40 years or older (i.e. mature) (see table 5, source: NFI).

3.2.12 The age class distribution of tree *numbers* (see table 6) shows only small numbers in the 1-10 year age class, because trees under 7 cm DBH were not recorded. There are relatively large numbers of pole stage trees (4.8 million in age class 21-40 yrs) as would be expected; and 3.8 million matures trees (> 40 years old). These include an estimated 100,000 that are over 100 years of age.

Table 5. Age class distribution of ash woodlands by area (Source: NFI)

Age Class	Area (ha)	% of total	Cumulative % of area
0-10	3.2	24	23
11-20	2.0	15	39
21-40	3.1	23	61
41-60	3.4	25	87
61-80	1.1	8	95
81-100	0.4	3	100
100+	0.0	0	
Total	**13.5**	**100**	

Table 6. Number of trees (>7 cm DBH) by age class (Source: NFI)

Age Class	Number of trees (million)	% of total
0-10	0.8	7
11-20	1.8	17
21-40	4.8	45
41-60	2.7	25
61-80	0.7	7
81-100	0.3	3
100+	0.1	1
	10.7	100

3.2.13 According to NWSS (see table 3, column 6 rows 9, 17 and 25), the area of ash in native woodland in Scotland can be categorised into:

- **Mature or veteran** (>20cm DBH) **is 5,648 ha (47%)**
- **Polestage** (7-19 cm DBH) **is 4,270 ha (35%)**
- **Young trees / regeneration** (<7cm DBH) **is 2,174 ha (18%)**

Seedlings and saplings

3.2.14 Ash is one of the largest contributors to regeneration in broadleaved forest areas. NFI estimates that there are 53 million seedlings in Scotland (18% of all broadleaved seedlings), and 11 million saplings (5% of all broadleaved saplings).

Timber standing volume and volume increment

3.2.15 The **standing volume** of ash in Scotland according to NFI is 2.7 million m^3, which is equivalent to 8% of the standing volume of all broadleaves (see table 7). The fact that the proportion by volume (8%) is larger than the proportion by area (5%), shows that ash trees tend to be large volume trees compared with other hardwoods.

Table 7 Standing volume of ash and percentage in forest area by regions of Scotland; 000 m3 over bark (source NFI)

	Standing volume 000 m^3					**% ash in broadleaves**	**% ash in total forest area**
Region	**FC**	**Private**	**Total**	**All broadleaves**	**Broadleaves & conifers**		
N. Scotland	1	62	63	3,788	30,537	2	0
NE. Scotland	2	10	12	4,152	40,739	0	0
E. Scotland	2	392	394	5,460	26,718	7	0
S. Scotland inc. Central Scotland	7	1,954	1,961	13,348	82,418	15	2
W. Scotland	26	244	271	7,298	66,019	4	0
SCOTLAND	**38**	**2662**	**2700**	**34,046**	**246,431**	**8**	**1**

3.2.16 Most of the timber volume (73%) is in the diameter classes 20-60 cm DBH (see table 8).

Table 8 Diameter class (DBH) distribution of standing volume of ash according to NFI

Age Class	Area (ha)	% of total
0-7	2	0
7-10	68	3
11-15	148	5
16-20	230	9
20-30	560	21
30-40	680	25
40-60	720	27
60-80	292	11
80+	0	0
TOTAL	**2700**	**100**

3.2.17 Based on an area of ash trees of 13,500 ha, and assuming an average annual timber volume increment per hectare over the rotation of 4 (=General Yield Class); the total timber volume increment per year is estimated to be very approximately **54,000 m^3/year** (Confidence Rating – moderate).

Ancient semi-natural woodland

3.2.18 In NWSS it will be possible to split the ash woodland area into **ancient woodland, semi-natural woodland, planted woodland**; but this requires considerable analysis. This could be carried out in mid-2013 if required.

Ownership

3.2.19 About 97% of woodlands in which ash is the principle species is owned by private/charitable owners and 3% managed by Forestry Commission (on behalf of Scottish Ministers); showing that this is primarily a problem for private/charitable owners.

3.3 Regional scale information

3.3.1 Published information is available at regional level as follows:

1. National Forest Inventory give details of the resource by the 5 regions (see maps in appendix1 and the regional values included in tables 1,2,5,6,7&8).
2. Native Woodland Survey of Scotland gives details for the 5 Conservancies (as per tables 3 and 4 above) and those local council areas for which reports have been published (21 out of 32 as of November 2012)

3.3.2 NFI shows that "Southern Scotland region" which includes South Scotland and Central Scotland Conservancies, has by for the largest area of ash (about 67 % of the total) and largest standing volume (about 39% of total). NFI give further detail of the breakdown by region in its appendices.

3.3.3 NWSS shows that (see table 3):

1. **Perth and Argyll, South Scotland and Central Scotland Conservancies** all have the greatest areas of ash dominated native woodland and ash trees (each with 26-32% of national area; see far right hand column table 3).
2. **Perth and Argyll Conservancy** has the greatest area of native woodland containing ash (36% of national total; see column 3 table 3);
3. **Perth and Argyll, South Scotland and Central Scotland Conservancies** all have the greatest areas of **polestage and mature** ash (each with 26-33% of national total; see column 7 table 3).
4. **Central Scotland and South Scotland Conservancies** have the greatest area of young ash woodland (each with 24-38% of national total; see column 7 table 3), mainly reflecting recent planting of mixed woodland containing ash.
5. Grampian Conservancy has the lowest area of ash.

Council Areas

3.3.4 The Native Woodland Survey of Scotland gives data by council area for the areas of UK Habitat Action Plan woodland types (see table 9). "Mixed Upland Ash" and "Lowland Mixed Deciduous" are those known to contain most ash (though "Wet Woodland" can also contain a small proportion). Table 9 illustrates how ash is concentrated in Ayrshire, around Glasgow, the Lothians and the Central

Belt. (Note: table 9 ranks council areas by total woodland area of these two woodland types combined).

3.3.5 The percentage of ash in the canopy of native woodland in these council areas is generally between 10 and 25%. These figures will be important for local council environment departments, especially in relation to the health and safety implications of damaged trees.

Table 9. Areas of Mixed Upland Ash and Lowland Mixed Broadleaved native woodland types; and average canopy cover of ash in native woodland by Council area. Ordered by total area of the two woodland types combined (source: NWSS)

Council area	Area of Mixed Upland Ashwood (ha)	% of native woodland area	Area of Lowland Mixed Deciduous (ha)	% of native woodland area	TOTAL AREA UPLAND ASH AND MIXED DECIDUOUS	% ash in native woodland canopy
Stewartry*	529	9	922	15	**1451**	15
South Ayrshire	606	19	565	18	**1171**	22
East Lothian	80	6	861	61	**941**	17
West Lothian	33	2	822	58	**855**	11
East Ayshire	335	13	467	18	**802**	22
North Ayrshire	362	12	463	15	**825**	21
Midlothian	69	6	671	60	**751**	17
Annandale and Eskdale*	259	8	481	16	**740**	14
Falkirk	67	5	634	43	**701**	6
Renfrew	33	2	535	40	**568**	13
Glasgow	8	1	548	63	**556**	26
West Dumbarton	87	7	382	31	**469**	13
Edinburgh	3	<1	385	75	**388**	11
East Dumbarton	49	6	285	34	**334**	9
Inverclyde	20	4	108	20	**128**	14
East Renfrew	2	1	119	47	**121**	14
Aberdeen	32	5	50	10	**82**	-
Dundee	2	4	25	58	**27**	
Caithness*	4	1	15	3	**19**	-
Orkney & Shetland	0	0	6	0	**6**	-
Western Isles	1	<1	0	0	**1**	-

*These are parts of council areas published as interim separate reports; in the final published reports they will be consolidated into single council areas.

3.4 Individual trees outside woodland

3.4.1 There were **ca 970,000 individual ash trees outside woodland[13] in 1995** i.e. in hedges, wood pasture, small groups of trees, windbreaks etc according to NIWT; (Note: the Centre for Ecology and Hydrology Countryside Survey figures (below) suggest smaller numbers, but this may reflect a

[13] There is no regional breakdown of this figure.

different definition of woodland[14]) . This does not include trees in towns and cities. Individual trees make a strong contribution to cultural landscapes and ecology, especially in lowland areas and will be the trees most noticed by the public once the disease takes hold. Ash is the 5th most abundant broadleaved tree "outside woodland" and accounts for 6% of these trees.

3.4.2 Most individual trees (49%) are in the 5-15 m height band and 17% are over 15 m tall. NIWT provides breakdowns of this value by the type of feature they occur in (i.e. boundary trees, groups, linear features).

3.4.3 Centre for Ecology and Hydrology provides maps of the frequency of ash across the UK (see appendix 2).

Veteran trees

3.4.4 Veteran ash trees are very important ecologically and as landscape features, with cultural links to traditional land use practices. The Centre for Ecology and Hydrology estimated that ash is the second most common species of veteran tree in the UK (after oak), comprising 17% of the total. Woodland Trust Scotland and the Ancient Tree Forum have recorded 300 veteran ash trees in Scotland; and this will represent only a small proportion of the total population.

3.4.5 Presence of veteran trees was recorded NWSS, and it might be possible to generate a picture of how these are distributed around Scotland; but it isn't possible to provide a meaningful area estimate for veteran trees.

3.5 The general distribution of ash

3.5.1 Ash is distributed throughout Scotland but is most common in:

- southern Scotland, especially Dumfries and Galloway
- south-western Scotland, especially western Central Belt and Lanarkshire and Argyll,
- the Tay and Earn valleys in Perthshire
- parts of Lochaber, western Sunart and Fiunary,
- the valleys and cleughs of Lothian and central and eastern Borders.

3.5.2 It is also an important part of native woodland on several of the inner isles such as Isla, Mull, and parts of Skye; it occurs locally around Inverness including the Great Glen; and in sandstone gorges in Angus.

3.5.3 It is *infrequent* in Sutherland and Caithness and other parts of Highlands north of a line from Pitlochry to Spean Bridge; and in Strathspey and Deeside.

3.5.4 Its gross distribution reflects underlying geology, being strongly represented in the more base-rich Dalradian, Carboniferous, Silurian and Tertiary rocks; and on basalts and limestones ; and becoming much rarer on acid rocks such as Moine, granites and Torridonian (e.g. Northern half of the Highlands and especially the Cairngorms area).

3.5.5 In places geological boundaries can effectively be located by the abundance of ash - such as the switch between:

[14] Distribution of Ash trees (*Fraxinus excelsior*) in Great Britain from Countryside Survey data. www.ceh.ac.uk/news/documents/Ash-tree-distribution-Countryside-Survey-Nov-2012-FINAL.pdf

- Moine schists / granites in Sunart, to basalts on Ardamurchan, Fiunary and Mull;
- base-rich (Dalradian) mica schists, to acidic Moine schists in Perthshire.

It occurs most commonly on the lower slopes of valleys; in river gorges and upland gullies; on cliffs, screes and rocky slopes; and is often found associated with raised beaches on the west coast and islands. It is an important species in riparian woodlands, on river islands and floodplains. Single trees are a feature of farmland throughout Scotland up to elevations of about 250m. Ash occurs locally up to 450 m in elevation.

4. POTENTIAL IMPACTS ON BIODIVERSITY

4.1 Woodland and Associated Trees and Shrubs

4.1.1 Native ash woodland is **very diverse** (i.e. it has a high number of associated tree, shrub and plant species); is a quite **scarce native woodland type;** and is often **highly natural** (has not been strongly modified by people).

4.1.2 Semi-natural ash woodland has the ***largest number of associated tree and shrub species*** of any native woodland type. The National Vegetation Classification lists 16 native trees and shrubs associated with ash woodland, as opposed to 9 for oak-birch woodland and 4 for pine woodland[15]. Ash woodland is habitat for Guelder rose (*Viburum opulus*), which is quite rare in Scotland.

4.1.3 Semi-natural ash woodland is a relatively ***scarce native woodland type*** compared to oak, birch or pine woodland. In 1998 it was estimated that the HAP woodland types that contain ash (Upland Ash and Lowland Mixed Broadleaved woodland) comprised 10% or the area of semi-natural woodland in Scotland[16]. This is partly because ash woodland grows on rich soils which were preferentially cleared for agriculture.

Impacts: Tree and Shrubs

4.1.4 The ecological impact on ash woodlands is likely to be high***,*** *despite their relatively limited extent in Scotland. However* ***onset of damage will be gradual*** *and impacts will only potentially become serious in the medium-longer term.*

4.1.5 The loss of ash, coming on top of the loss of elm, would significantly impact woodland diversity and would leave a seriously impoverished woodland type on damp, fertile woodland sites. This used to be called "ash/elm woodland" and now we have the prospect of <u>both</u> principle tree species diminishing or disappearing. Their place would be taken by other species, either by expansion of adjacent trees, or colonisation via seed/suckers. Dependent on site these might include:

- *commonly -hazel, goat and grey willow, sycamore, downy birch, oak;*
- *occasionally - silver birch, bird cherry, alder or beech;*
- *more rarely - aspen , or gean or Norway maple.*

4.1.6 Whilst there are several potential "replacement" species, the loss of ash is still very serious, and impacts on biodiversity would depend on which tree and shrub species replaced ash (see below).

Impact: High, Medium-Long term

4.2 Flowering Plants

4.2.1 Ash woodland has a ***very diverse ground flora*** of vascular plants (herbs, grasses and ferns). The National Vegetation Classification lists about **80 associated vascular ground flora species**, as opposed to about 60 for oak-birch woodlands and 20 for pine woodlands[11].

4.2.2 Ground flora include several woodland **plants that the public will recognise and value** including: bluebell (wild hyacinth), primrose, wood anemone, wood cranesbill, red campion, wild garlic, early purple and spotted orchids, globe flower, giant bell flower, bugle and wood sorrel.

[15] Based on a comparison of W9 ash woodland with W11 oak-birch woodland and W18 pine woodland

[16] MacKenzie 1999 The Native woodland Resource of Scotland: a review 1993-1998. FC Technical paper 30.

4.2.3 It has several ***rare vascular plants*** associated with it including: yellow star of bethlehem, herb paris, birdsnest orchid, baneberry, whorled solomon's seal and northern hawksbeard.

4.2.4 Ash woodland typically lets a lot of light to the forest floor and has light leaf fall comprising leaves that rot down quickly; making for good growing conditions for woodland plants.

Impacts: Flowering (Vascular) Plants

4.2.5 These are quite robust communities and the gradual appearance of canopy gaps as a result of Chalara would, in itself, not generally significantly damage woodland ground flora in the long term, but would change species composition. Only where more weedy light-demanding species were present might this cause a problem (e.g. nettles, burdock, comfrey, sweet sicily). Some ground flora species dependent on higher light levels in order to flower may benefit temporarily .

4.2.6 Longer term impacts would largely be mediated by which tree and shrub species replaces ash in the woodland canopy. Where ash is replaced by tree species that cast heavier shade (e.g. sycamore, maples, bird cherry or beech) and/or cast heavier or more durable leaf litter (e.g. oak, sycamore, beech), this would negatively affect plant communities. The species with least impact are probably: willows, hazel, silver and downy birch, oak. The species with greatest impact would be beech, Norway maple, and sycamore.

4.2.7 A pure sycamore canopy, especially in polestage, reduces the diversity of ground flora species, with only the most shade/litter tolerant ground flora species able to thrive (e.g. dogs mercury). However in most mixed ash woodlands, assuming a variety of tree species gradually replaced ash, there would be limited impacts on the ground flora.

Impact: Low-Medium, Medium-Long term

4.3 Lower Plants

4.3.1 Ash is critically important for **lichens, mosses and liverworts** (=lower plants**)**, which grow as "epiphytes"[17] on the bark, deadwood, rocks and as a component of the ground flora. Ash (together with elm , hazel, willow and elder) has a "base-rich/alkaline" bark that supports quite different communities of these plants than acid barked species such as oak, birch and alder. West coast ash/hazel woods have particularly rich lichen and moss/liverwort floras, which are recognised as internationally important; and contain some nationally and globally rare species. There are 44 species of lower plant associated with ash that are rare/endangered enough to be UKBAP species[18]. In the drier east of the country, old ash trees often harbour notable lichens, mosses and liverworts. The loss of ash, coming on top of the loss of elm which provided similar niches, is particularly serious. Large, old (=veteran) trees are particularly valuable, including those grown in wood pasture (see section 4.8).

Lichens

4.3.2 There are at least 1850 lichen species in Britain,[19] compared with 1400 species of native flowering plants; so the potential loss of an important host tree for lichens is clearly very serious. Ash has a large lichen flora because of the light, dappled shade beneath its canopy and the "base-

[17] An epiphytye is a plant that grow on other plants, typically on trees and shrubs
[18] Source: Alice Broome, Forest Research. This figure may have been updated.
[19] Source: Plantlife Scotland: Lichens of Atlantic Woodlands Guide 1.

rich" bark. Several of the more 'demanding' lichen species that were severely affected by loss of habitat following Dutch elm disease, found refuge on ash.

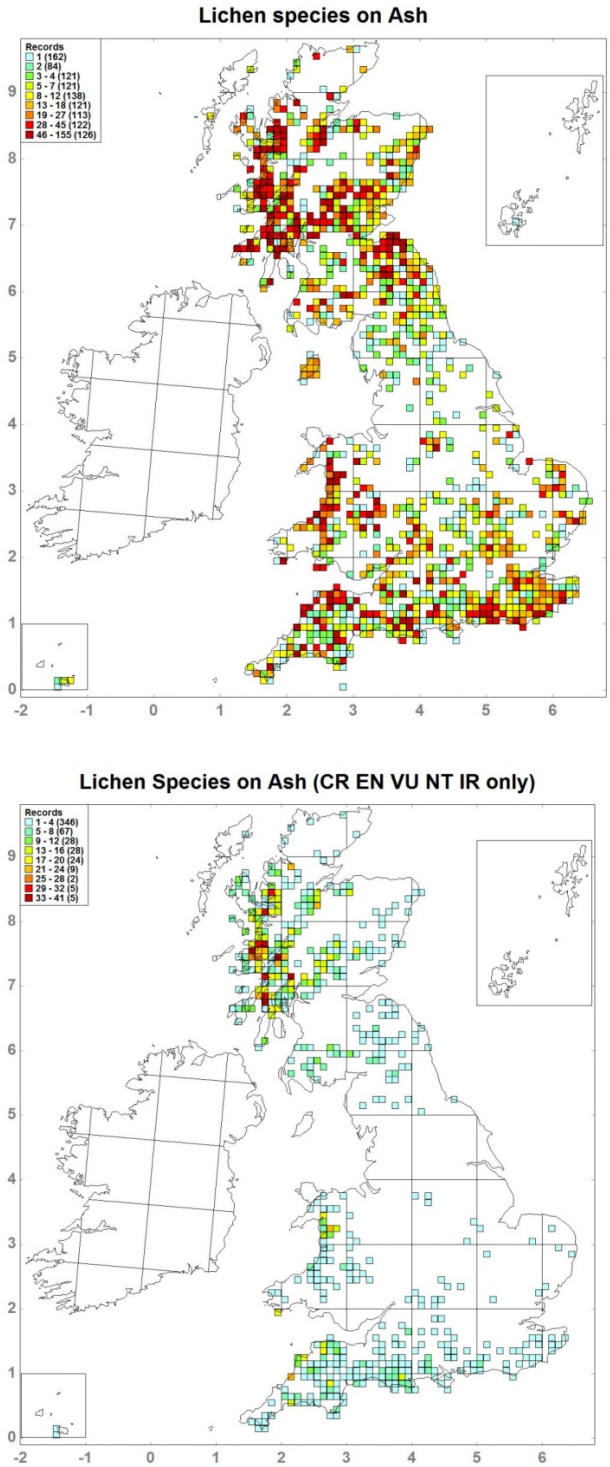


Figure 1. Records of lichen species on ash (upper); endangered species of lichen on ash (lower).

4.3.3 At least **536 species of lichen** grow on ash trees in the UK, which is, remarkably**, 27% of the British lichen flora.** In addition, it hosts 31 lichenicolous fungi and 15 of the non-lichenized fungi that are recorded by lichenologists. Of these species, 220 are nationally rare or scarce; and 84 have a

conservation status of critically endangered, endangered, vulnerable or near-threatened[20]. A list of lichen species considered rare and therefore potentially under risk[21] and maps of lichen records on ash[22] (see figure 1 above) are provided by the British Lichen Society.

4.3.4 A very high number of lichens/lichen-like fungi, 101, also have a status of **"International Responsibility"**, meaning that the British population is considered to be of international significance in a European or global context. Fifty are priority species listed within the UK Biodiversity Action Plan, and 6 are given special protection under Schedule 8 of the Wildlife and Countryside Act.

4.3.5 The mixed ash woods of northern and western Britain are particularly rich lichen habitats (see figure 1 lower); hosting strong populations of species rare in the rest of the UK and in Europe, and often including many ancient woodland lichen indicator species. Wayside and hedgerow trees right across Scotland, particularly veteran trees are also important. The key elements of lichen communities include *Lobaria, Sticta* and *Psuedoctphellaria* species which are large conspicuous leafy species; felt lichens, shingle lichens and jelly lichens

Mosses and Liverworts (Bryophytes)

4.3.6 Mosses and liverworts grow both in woodland and on individual trees across Scotland. The more diverse and valuable communities tend to occur on trees with a base-rich bark chemistry, and elm and ash trees provide habitat for the most rare and interesting species**.**

4.3.7 Ash is one of the main trees, or even the primary host, for many relatively common epiphytic species, such as *Frullania dilatata*, *Radula complanata, Zygodon* spp., *Orthotrichum* spp., *Ulota* spp., *Syntrichia laevipila* etc, and also rarer plants such as *Leucodon sciuroides*[23]. The numbers and cover (="biomass") of such bryophyte communities is greatest in the oceanic west, but the diversity of species is often greater in more open habitats in the east.

4.3.8 The following species can be considered to be **under direct threat**[24]:

- the BAP species *Habrodon perpusillus* has a number of its Scottish localities on ash trees.
- *Orthotrichum pallens* and *Orthotrichum pumilum*, both "Endangered" on the current Red Data Book List, will have their preferred habitat much reduced.
- the "Endangered" oceanic liverwort *Lejeunea mandonii*. This tiny plant is currently known from just three sites in Scotland, all on ash trees.

4.3.9 The loss of elm was a serious blow (for example, almost all of the then known sites for the Red List species, *Orthotrichum obtusifolium*, were lost with the elms) and losing a large proportion of our ash trees would be very serious. Mature wayside, parkland and hedgerow trees have been undervalued as habitat for bryophytes and have been subject to ongoing losses through unsympathetic management; and *Chalara* will add significantly to this problem.

[20] Source: British Lichen Society: www.britishlichensociety.org.uk/the-society/latest-news
[21] www.britishlichensociety.org.uk/resources/lichens-ash
[22] www.britishlichensociety.org.uk/about-lichens/habitats-conservation/distribution-maps-lichens-ash
[23] Source:Nick Hodgetts via Keith Kirby
[24] Source: Gordon Rothero

Impacts: Lower Plants

4.3.10 Loss of ash woodlands, wood pasture and individual trees would all be very serious; especially coming on top of the loss of elm, which provided similar niches. It will be important that a significant proportion of dead and dying trees are left in woodlands, rather than being harvested.

4.3.11 If mature trees persist for years or decades with only slowly increasing loss of canopy and bark area, the loss of habitat will be relatively gradual (though rapid in ecological timescale). Lichen/moss/liverwort species composition will presumably start to change towards species which thrive in higher light levels and drier conditions. Eventually the ash resource will come to miss an age class of trees (in the period following death of trees and before recruitment potentially starts again in the future). The impacts of this will depend on which other trees occupy ground lost to ash, and whether the species also occur on alternative habitat niches such as rocks. Where other alkaline bark species take over (hazel, willow, elder – to an extent rowan and old oak), impacts will be less; where birch, alder and oak colonise, impacts will be greater.

4.3.11 Management for the future should focus on providing alternative habitat for the more demanding lower plant species. The spread of sycamore, although not always welcome, provides another base-rich substrate for some lower plants and there are several records of rare species from this tree; and it can also support the Lobarion lichen community. However the heavy shade cast by sycamore can be damaging for lichens in nearby niches. Aspen, some clones of which appear to have a similar bark chemistry to ash; has provided a number of records for rare species in recent years.

Impact: Very high, Medium-Long term

4.4 Fungi

4.4.1 Fungi on trees are categorised into: 1) parasitic/pathogenic species which cause damage or death; 2) saprotrophs or 'recyclers' that decompose leaves and wood; and 3) mycorrhizal species which are symbiotic with trees , providing trees with vital nutrients in exchange for carbohydrates and water.

4.4.2 Ash has all 3 types associated with it, but is unusual in that it does not have the usual (ectomorphic) form of micorrhizal fungi. This means that it **lacks the showy autumn fungal mushrooms and toadstools a**ssociated with most trees. Ash directly supports a good number of wood rotting species and a several parasitic fungi (see appendix 3 for a partial list), including several rare or rarely recorded species in Scotland – though none of them with a national conservation designation. The sandy stilt ball (*Battarrea phalloides*) and Coral Tooth (*Hericium coralloides*) are also specifically associated with ash trees[25]. The **micro-habitats associated with ash woodlands** on base rich soils, such as drifts of dogs mercury (*Mercurialis perenis*), provide a home for several species of unusual fungi such as Lepiota's, Cystolepiota's, Clavarioid fungi and delicate cup fungi. The systemic mycology and microbiology website can potentially be used to provide a more comprehensive list of fungi associated with ash - http://nt.ars-grin.gov/fungaldatabases/fungushost/FungusHost.cfm

4.4.3 There is less high-quality, easily accessible information about fungi on ash than for other species groups.

[25] Source: Alice Broome, FR

Impact - Fungi

4.4.3 Loss of ash, or the disappearance of an entire age class of ash, would severely impact all types of fungi associated with ash; especially those which rely solely on ash trees. Decomposing fungi might experience a sudden temporary increase in habitat conditions as branches and trees die, but this would be followed by a sustained period with sharply contracting habitat that would threaten species that were dependent on ash. There appears to be no easily accessible information on the suitability of other tree species as alternate hosts for ash fungi. Our understanding of the impacts on fungi may improve if better information becomes available. It will be important that a significant proportion of dead and dying trees are left in woodlands, rather than harvested.

Impact: High, Medium-Long term

4.5 Invertebrates

4.5.1 Ash is **one of the most important trees for invertebrates**, supporting a rich diversity of beetles, hoverflies and moths, plus a wide spectrum of other types of insect, including uncommon or declining species. At least **100 insects have an association with ash** (in the UK). These include at least rare 60 species (in the UK) - mostly rare beetles and flies. Ash is the **sole foodplant for at least 29 species of invertebrates** and the principal tree for others that can exist on alterative trees to varying extent[26].

- 28 species of invertebrate only eat ash (=are monophagous on live ash); 10 leaf-eaters, 10 galls causing mites and flies, 7 sap suckers and 1 other.
- 9 species of insect eat ash, privet and/or lilac (=oligophagous leaf-eaters); in most districts it is unlikely that these alternative food plants are available in sufficient quantity or in satisfactory ecological context to support viable populations of these insects; so they are potentially reliant on ash.
- More than 30 species of moth are dependent on Ash (in the UK), including two UK Biodiversity Action Plan (BAP) species, one provisional Red Data Book list species and two nationally scarce species[27]. Some eight species of moth are solely dependent on the tree as a food plant including the provisional Red Data book listed *Pammene suspectana.* Ash is classed as an important food plant for a further eight species including the Barred Tooth-striped - a BAP species, the Lilac Beauty, Ash Pug, Brick and Coronet. A further 19 species rely on the Ash as a minor food plant, including the Goat Moth – a BAP species, and the nationally scarce micro moths *Caloptilia cuculipennella* and *Oecophora bractella.*The tree is also important for the rare Brown Hairstreak butterfly which often uses ash as "master trees" around which they to congregate and find mates.

4.5.2 There is a need to check the presence in Scotland of the UK species listed above.

4.5.3 A list of species associated with ash is given at:
http://www.buglife.org.uk/Resources/Buglife/Invertebrates%20associated%20with%20Ash%20.pdf

[26] Source: Buglife Scotland and Alan Stubbs
[27] Source: Butterfly Conservation:
www.butterfly-conservation.org/article/9/309/moths_could_be_at_risk_from_ash_dieback.html

4.5.4 Where ash is a major feature of woods and hedgerows, a large number of invertebrates may use ash as its predominant foodplant (whilst also using other plant species). Information is largely lacking on the age classes used by the various invertebrate species.

4.5.5 Ash is one of the most important trees for invertebrates that eat dying/dead and decaying wood (saproxylic). In the UK, 7 species of saproxylic insect appear to be totally ash dependent, plus the 6 species of beetles which feed on the ash fungus *Daldinia concentrica*. This fungus is common on ash, but scarce or absent on other trees in a wood/district; and these insects include 4 species only associated with dead and dying branches of ash.

4.5.6 Thus, at least **40 species of invertebrates are totally or very largely ash dependent**. Trees able to support both living and saproxylic fauna include old coppice and old pollards.

4.5.7 Many other insects inhabit ground flora and soil under ash and currently 5 insects found in litter and soil are considered rare, 4 of them confined to ash.

Impacts- Invertebrates

4.5.9 Loss of ash, or the disappearance of an entire age class of ash, would severely impact all types of invertebrates associated with ash; especially those which rely solely on ash trees. Wood-eating invertebrates might experience a sudden temporary increase in habitat conditions as trees die, but this would be followed by a sustained period with sharply contracting habitat they would threaten species dependent on ash. There appears to be no easily accessible information on the suitability of other tree species as alternate hosts for ash invertebrates. It will be important that a significant proportion of dead and dying trees are left in woodlands, rather than harvested.

4.5.10 The invertebrate fauna of ash (relatively soft wood) has important differences from that of oak (relatively hard wood); elm used to be very important for the 'soft' wood decay fauna; the loss of ash will compound the difficulties for those species.

4.5.11 Ash allows light through to the forest floor and its fallen leaves readily decay. Replacement (natural or artificial) by heavy shade tree such as sycamore (which will readily seed into canopy gaps) or species with low decay leaf-litter (such as oak) will have implications for the many insects that inhabit the ground flora and the soil, including the many insects whose larval stages are found in litter and soil.

Impact: Very high, Short-long term

4.6 Birds and Mammals

4.6.1 Birds and mammals are less strongly associated with particular species of tree than lower plants, fungi and invertebrates. Redstart, wood warbler and, in north-west Scotland, redwing are recorded as breeding in upland ashwoods[28]. Ash forms a significant proportion of old, large trees that are important for **hole nesting birds** (woodpecker, tits, nuthatches, house and tree sparrow, flycatcher, robin, kestrel and owls). Marsh tit and nuthatch used holes in ash frequently; however woodpeckers appear to use ash trees relatively infrequently. Redstart and pied flycatcher are also recorded nesting in ash. Ash seed are an important winter food source for bullfinches[29].

[28] Source: SNH
[29] Source: Paul Bellamy, RSPB.

4.6.2 Ash woodland and ash trees form general habitat for birds in lowland agricultural landscapes where native woodland is typically scarce.

4.6.3 Ash keys are eaten by wood mice and form a minor of component of the diet of squirrel.

4.6.4 Old ash trees are important for roosts and hibernating places for bats, especially natterers, noctule and brown, long-eared bats.

Impacts - Birds and Mammals

4.6.5 Impacts on birds are hard to characterise, but are expected to be fairly low; with many birds finding alternative habitat or food sources to compensate for the potential loss of ash trees. Loss of large old trees with nesting cavities and hibernating places for bats could be locally significant in the long term.

Impacts – Low, Medium – Long term. Locally medium impact for bats in the long term.

4.7 Designated sites

4.7 1 There are **94 Sites of Special Scientific Interest (SSSI) in Scotland** that cite ash as a qualifying feature, or in which ash is noted in the citation as a significant component (see table 10)[30]. These are mainly Mixed Upland Ashwoods and Lowland Mixed Broadleaved Woodlands; but also include wood pasture, and SSSIs where bryophytes and lichens are features in addition to the ash woodland itself.

4.7.2 There are 18 Special Areas of Conservation (SACs), which although described as lime-maple woods in the European designation, manifest themselves as ashwoods in Scotland

Table 10. The number of designated sites in which ash is a qualifying feature or in which ash is noted in the citation as a significant component. Source Jeanette Hall, SNH.

	SPECIAL AREA OF CONSERVATION (SAC)	**SITE OF SPECIAL SCIENTIFIC INTEREST (SSSI)**				
FEATURE		**Upland mixed ash**	**Lowland mixed broadleaves**	**Wood-pasture**	**Bryophytes**	**Lichens**
Argyll and outer Hebrides	2	5	1	0	0	0
Forth	1	22	0	2	1	2
Northern Isles and North Highland	0	0	1	0	0	0
South Highland	9	18	0	1	4	3
Southern Scotland	2	14	1	1	0	4
Strathclyde and Ayrshire	1	20	2	1	0	0
Tayside and Grampian	3	15	3	0	2	4
Total	**18**	**94**	**8**	**5**	**7**	**13**

4.7.3 Ash is probably also a significant component of some other designated woodland sites, such as Wet woodland and Upland oakwood SSSIs; and alder woodland and western oakwood SACs.

[30] Source: Jeanette Hall, SNH

4.7.4 Note that this list is based on citations and there will be other woods where ash is important, but is not mentioned on the citation, particularly pockets of ash in oak woodland sites.

4.7.5 The **most important sites** are probably those designated as SACS, namely: Glen Creran Woods Loch Etive Woods, Kippenrait Glen, Kinloch and Kyleakin Hills, Loch Moidart and Loch Shiel Woods, Morvern Woods, Ness Woods, Onich to North Ballachulish Woods, Rassal, Rigg – Bile, Strath Sunart, Borders Woods, Upper Nithsdale Woods, Clyde Valley Woods, Craighall Gorge, Keltneyburn, Lower Findhorn Woods

Impacts - Designated sites

4.7.6 The impacts on designated sites of the loss of ash will be very acute, especially coming on top of the loss of elm.

Impact: Very High, short-long term

4.8 Veteran Trees and Wood Pasture

4.8.1. Centre for Ecological and Hydrology estimated that ash is the second most common species of veteran tree in the UK (after oak), comprising 17% of the total. In Scotland, the Woodland Trust Scotland and Ancient Tree Forum have (so far) recorded 300 veteran ash trees. These are highly important ecologically because of the continuity of micro-habitat they provide. Three ash trees are listed in the 2006 FC/Tree Council publication: "Heritage Trees of Scotland" – the Tinnis ash, the Glen Lyon ash and the Gordon Castle ash.

4.8.2 Ash is an **infrequent species in wood pasture** (compared to birch, alder and oak), but where it does occur it is valuable and can be very old some **dating from the 1600-1700's**. Some of these were managed as pollards in the 1700's and are important as archaeological features providing information historic land use. They also host lichen floras with a high incidence of ancient woodland indicators. Sites with ash wood pasture include: Fleet Valley, Bealach nam Bo (Wester Ross), Glen Finglass and Loch Katrine.

Impact – Veteran Trees and Wood Pasture
4.8.3 The loss of ash veteran trees and wood pasture would entail a small number of highly valuable, totally irreplaceable trees. Experience from the continent suggests that these trees are susceptible to ash dieback, but can withstand attack for longer periods that younger trees.

Impact: Locally and as a small national resource: Very High, medium-long term.

4.9 Habitat networks

4.9.1 Ash woodland is an important component of habitat networks in the lowlands and semi-uplands. These provide connected high quality habitat in landscapes that otherwise have limited biodiversity. The loss of hedgerows and hedgerow trees will impact connectivity at small scales.

Impacts – Habitat networks
4.9.2 In the medium to long term, gaps left by ash will be recolonised by other tree and shrub species and at a gross level the networks will continue to function, albeit without species associated with ash.

Impact: Low-Medium, Short to Medium term

4.10 Deadwood

4.10.1 Ash dieback will lead to a rapid increase in the amount of deadwood, bringing forward in time deadwood production which otherwise would have occurred over a longer period in the more distant future.

Impacts - Deadwood

4.10.2 This will temporarily increase deadwood quantities and will manifest itself as "boom and bust" for organisms dependent on deadwood as habitat. A similar event occurred with Dutch elm disease. Impacts will be greatest for lower plants, fungi and invertebrates dependent on ash deadwood. In the long run, the pale of ash deadwood will be taken over by other species which replace ash in the canopy.

Impact: Medium, Medium to Long term

4.11 Wider ecosystem services

4.11.1 The Millennium Ecosystem Assessment developed 4 categories for ecosystem services: Supporting, Regulating, Cultural, and Provisioning. Ash in common with other trees, contributes to all these ecosystem services, especially:

Supporting services: Soil formation, soil protection and nutrient cycling on lowlands sites with rapid nutrient turnover. Protection of watercourses especially via bank stability, moderation of water temperatures, and flood control. Biodiversity.

Regulating services: Carbon capture as a fast growing broadleaved tree (see section 5.8).

Cultural services: Ash has particular landscape and cultural connections (see section 6 and 7)

Provisioning services: via wood production including firewood, nursery production and woodland management (see section 5).

4.12 Monetary value of biodiversity

4.12.1 The high biodiversity value of ash trees and ash woodland, in both rural and urban situations, translate to considerable monetary values via their contributions to visitor experience and hence tourism revenues, and quality of life for residents. An overview of non-market benefits is given in section 5.8 which suggests that the monetary value attributable to the biodiversity of ash woods in Scotland might be of the order of £1 million annually (as a share by area of the 480 million attributable to biodiversity of forests for the UK).

5. POTENTIAL ECONOMIC IMPACTS

5.1 Woodland Owners

5.1.1 Woodland owners could incur costs in the following main ways:

- Destruction and removal of ash and restrictions on activity where statutory Plant Health Notices are issued.
- Surveying woods to monitoring the arrival and progress of the disease and reporting this to the authorities.
- The cutting/felling of diseased trees and their replacement.
- Felling and extraction of ash timber before the optimum felling age, and at a time of lower log prices.
- Revised management planning to cope with the disease.
- Felling and tree surgery work to comply with health and safety obligations.
- Substitution of ash by less satisfactory species in future timber production.

General management activity aimed at mitigating the impacts of *Chalara* will also divert effort and resources away from other essential woodland management work.

Costs associated with Statutory Plant Health Notices

5.1.2 Some 58,000 young trees (including uninfected trees and their roots) were destroyed before leaf fall at the first known infected new planting site in Scotland, on the national forest estate near Kilmacolm. Twenty-five young trees at a second site near Boat of Garten have also been destroyed. All other infected sites in Scotland will be served only with **containment notices** until such times as the costs and potential benefits of further removal of infected young trees has been assessed and a detailed Scottish control plan developed with the help of the proposed Tree Health Advisory Group (Scotland).

Impacts - Statutory Plant Health Notices

5.1.3 Individual owners could incur very high costs associated with the cutting, extraction and disposal of ash and replanting of replacement crops. Removal and destruction of newly planted trees and their roots, can cost per tree as much as £2; and replanting costs, including tree shelters, can be as high as £3 per tree. FCS also incurs costs in the administration of these notices.

Impacts: High-Very High for individual owners, Short term

Costs Associate with Surveying/Monitoring

5.1.4 Surveying activity will occur initially during routine visits to woods, but as the disease takes hold, there will be a period when more intensive monitoring is needed. Site visits will be required where large quantities more or less pure ash will have been planted. In the longer term this type of work will eventually become integrated into general woodland management activity.

Impacts: Low-Medium Short-Medium term

Costs Associated with Replacement of Ash

5.1.5 Cutting of dead or damaged ash, and adjacent trees where damage is anticipated, will leave gaps in woodlands. Where these gaps are on a scale that affects the integrity and value of woodlands, replanting will be required.

5.1.6 For infected mature trees, in most cases there will be **no statutory action** requiring their felling. However, there may be some cases where there is strong rationale for removing mature trees to slow the spread of Chalara (e.g. isolated trees a long way from other areas of infection, or to protect valuable sites). Outwith statutory action, trees are also likely to be felled when damage becomes unsightly, when they pose health and safety risks, or to recover timber value.

5.1.7 Voluntary felling of mature ash trees, subject to felling licences and other regulatory controls, can be expected to begin once Chalara 'takes hold'. This could be in as little as 2-3 years where the disease is already present, but the full extent and timing of such work will depend on the rate of spread of the disease. It is likely to remain a fact of life in Scotland for at least the next 20 years.

5.1.8 The most likely circumstances where replacement planting with other species will be necessary are:

- on sites planted for quality broadleaved timber and/or biomass, including recent planting by Forestry Commission Scotland, which involves areas of ash at close spacing;
- farm woodlands on lowland sites where ash comprised as significant proportion of the trees planted
- native woodland on "ash" sites where ash comprised as significant proportion of the trees planted.

5.1.9 Data from Native Woodland Survey of Scotland suggest that the young ash is most common in Central and Southern Scotland Conservancies, followed by Perth and Argyll.

Impacts: Costs Associated with Replacement of Ash

Young woodlands

5.1.10 It will be possible to estimate cutting costs using standard respacing costs (which might be in the range £200-£600/ha dependent on size of trees); and replanting costs could be estimated from restocking costs of small groups (as in CCF management). Costs will be higher if the felled trees also need to be disposed of.

5.1.11 The most significant losses *will be faced by owners of young woods where ash trees are just short of the dimensions that makes extraction for firewood feasible. It will be hard to estimate costs because of the way that ash is typically planted in mixtures.*

5.1.12 Gross costs for the sector could be estimated very roughly by taking information on the numbers of ash trees planted in recent years (see sections 3.1 and 5.2); and applying a range of per hectare (or per tree) costs for cutting, disposal and replanting.

Older woodlands

5.1.13 Felling will be carried out as thinnings, group and small coupe fellings, with timber extracted and sold where possible. Where timber cannot be extracted, felling to waste will need to be done at cost. Costs could be estimated from the thinning/felling costs in CCF management of broadleaved woodland, but it will be hard to estimate costs because of the way that ash typically occurs in mixtures.

5.1.14 All operations are likely to be more expensive than typical per hectare standard costs because of operating over small disjunct areas.

Impacts: High, Short-Long term

Premature felling of timber

5.1.15 The optimal age for felling hardwoods is generally determined by the need to maximise the volume of logs large enough to make butts and decent second length logs. Although mean growth rates for ash reach a maximum at 45-55 years; the age of maximum economic return in ash is probably more like 60-100 years. There is no apparent published analysis that gives details of this.

5.1.16 Premature felling may also take place in order to prevent timber degrade due to staining resulting from *Chalara*, and this is likely to be a concern of owners. The speed at which ash wood develops staining following *Chalara* infection will depend on the size of the stem or branch wood, and can occur in as little as two years in younger trees and smaller diameter material. DEFRA research suggests that **degrade of sawlog material is only likely to occur four or more years after infection** (and may be longer) [31]. However, the presence of epicormics on the main stem (either as a reaction to *Chalara* infection or in response to heavy thinning) can act as a direct pathway for infection, and hence staining, in the main stem. Thus, in general there is no need for woodland managers to fell and market valuable sawlogs immediately after infection is detected but they should remain alert for the development of epicormics on the main stem and then take earlier action accordingly.

Impacts - Premature felling of ash timber

5.1.17 The most significant losses would be faced by owners of woods that have been thinned, but not yet reached dimensions for sawlogs, and have to be sold into the firewood market (but at least that is a steady market at present).

5.1.18 Losses are likely be exacerbated because ash log prices are already low (in historical terms) and timber is likely to have to be sold into an oversupplied market (see below).

Impacts: Medium, Medium-Long term

Revised management planning

5.1.19 Managers will need to divert time and funding into planning for the management necessary to cope with the disease in both the short and longer term. This may include amended forest plans and grant applications.

Impacts: Low- Medium, Short-Medium term

Felling and tree surgery work to comply with health and safety obligations

5.1.20 Felling and tree surgery work on ash will become necessary in the medium term for the large number of trees beside roads and paths, in landscaping around buildings and in parks and gardens.

Impacts - Felling and tree surgery

5.1.21 These costs, which will be high and extend over a pronged time period, will be born by land owners and local councils.

Impacts: High, Medium-long term

[31] DERFA Interim Chalara Control Plan 6 December 2012.

Substitution of ash by less satisfactory species in future timber production.

5.1.22 Owners will forego income when other tree species replace ash in woodlands that are less valuable for timber than ash. Of the likely replacement species, only sycamore and cherry will probably give equivalent timber income in the future; with species like oak, beech, birch and lime providing lower revenues due to either longer rotations and/or lower timber value.

Impacts: Low, Long term

Overall impact on owners: Medium-High, High for owners having recently planted significant areas of ash; Short-Long term

5.2 Timber Market

Quality timber

Prices

5.2.1 Ash is a valuable timber with quality logs being sold mainly as:

- first length or butts for veneer or high quality planking
- second logs/poorer grades for 2nd quality planking.

5.2.2 Currently butt logs of ash typically sell for **£100-120/m^3** and second lengths for **£35-40/m^3** (roadside prices). Prices for ash are now at their lowest for many years; and are only slightly better than for beech, and second logs are selling for prices similar to firewood. Even 5 years ago, butt logs were selling at more like £160-£170/m^3. The current low prices are seen as mainly a response to fashion but competition from imported, kiln-dried North American white ash[32] also plays a role.

End uses

5.2.3 Its main end uses are in furniture making (especially chairs), interior joinery and sports goods. The traditional use in tool handles has diminished due to replacement by plastics and imported timbers. There is a small but growing market in selling ash from polestage trees into the sports stick industry in Ireland. Whilst limited, this can be a significant source of early revenue from thinnings, which has a disproportionate effect on the profitability of growing ash, and can give it an edge over similar species.

Volumes

5.2.4 The Scottish Hardwood Timber Market Development Group (SHTMDG)[33] estimated hardwood log production (*all species*) in Scotland in 2002 to be about 25,000 cubic metres. Some 5,500 m^3 (22 %) of this timber was processed in Scotland; with the remaining 78% being "exported" to England or the Continent for processing. This consisted mostly of the higher quality veneer, planking and beam logs. A trade representative estimates the current market volume to be rather lower than this, probably more like 20,000m^3 [34], and with a smaller proportion being processed in Scotland. This reflects the fact that current processing capacity by small sawmills (see below) has not grown sufficiently to replace the loss of the last few major sawmills such as Petersmuir.

5.2.5 Total hardwood deliveries in Scotland[35] including fuelwood is currently estimated by the Forestry Commission to be about 40,000 m^3, based on "recorded deliveries and administrative records". It is not clear how this figure is split between sawlogs and fuelwood.

---

[32] Source: Gavin Munro, hardwood timber buyer.

[33] The work of the Scottish Hardwood Timber Market Development Group (September 1996 – March 2003). www.forestry.gov.uk/pdf/SHTMDG2003.pdf/$FILE/SHTMDG2003.pdf

[34] Gavin Munro: hardwood timber merchant.

[35] www.forestry.gov.uk/pdf/Woodproduction1976-2011final.pdf/$FILE/Woodproduction1976-2011final.pdf

5.2.6 The proportion of ash in the hardwood sawlog market in Scotland is estimated to be about 10% of total volume[36], which equates roughly to its area in the woodland resource of those species which are used for quality timber (oak, beech , sycamore, elm, ash) in the 1995 NIWT inventory. This suggests a **total sawlog production of ash** of about 2000 m^3 per year (i.e. 10% of 20,000 m^3). If 15-20% of this is processed in Scotland, this equates to 300-400 m^3 (Confidence Rating – moderate).

5.2.7 Total hardwood production in the UK (all species) is estimated to be 530-540,000 m^3 with the vast majority originating in England; and ash timber represents 8% of hardwood deliveries to mills[37].

Impacts – Quality Timber

5.2.8 Ash is a small but significant part of the hardwood sawmilling market in Scotland; one of a small suite of species that supports hardwood marketing activity. A sudden increase in harvesting sustained over period of several years, followed by the species effectively disappearing from the market in the longer term, would be clearly be unwelcome. The net effect of the felling of ash timber would be a temporary increase in haulage and processing activity, but with the bulk ending up as domestic firewood. The market would be impacted by the liquidation of the resource in England over a similar timeframe. This may spill over to Scotland in the form of lower demand and lower prices; though with prices currently at a historic low, and now underpinned by a buoyant firewood market, prices for the lower end of the market might remain relatively stable.

5.2.9 If ash disappeared from the timber market for a period in the future, this would lead to reduced activity in the longer term but probably would not be significant enough to result in loss of employment in this sector (i.e. operators would adapt[38]). In the long term, the trade would come to terms with the loss of ash; and eventually (hopefully) genetically resistant ash would re-emerge onto the market.

5.2.10 The sector could experience problems in the short term if significant restrictions on the movement of logs /firewood from infected sites are imposed – but this is not thought to be a strong possibility given current research advice on the biosecurity risk from such material.

Impacts: Medium, Short–long term

5.3 Small Hardwood Sawmilling Sector

5.3.1 ASHS has around 30 member sawmills and joinery workshops, with turnover typically lying in the range £50,000 - £300,000 per year and with an aggregate turnover of about £2.5 million. Individual members report ash **usage of 30-60 m3 annually representing 2-10% of their turnover**.

5.3.2 Ash is a "second tier" species behind oak, elm, cherry and yew; of similar importance to sycamore beech and lime. The timber dries rapidly and can be can be kilned almost from green i.e. requires less air drying prior to kilning. It is easy to work (plane, sand etc); typically easier than both sycamore and beech. Big logs with brown / olive timber are quite common in Scotland and can be used for similar markets as elm.

[36] Source: Gavin Munro, Timber Merchant.
[37] DERFA Interim Chalara Control Plan 6 December 2012.
[38] Source: Gavin Munro, hardwood merchant

5.3.3 Some mills report being able to potentially process more (up to 2 or 3 times more) than is typically available in local markets. The combined demand for ash from ASHS members is still small compared with the amount potentially in the market (as with other hardwoods).

5.3.4 Ash is sold into the furniture making/carpentry markets for indoor products. There would be potential to expand into flooring and construction. However prices are held down by imports and have been quite low in recent years – though lower prices in the general hardwood trade don't always limit activity by ASHS members.

5.3.5 Ash is difficult to store in the round, and typically splits and stain from the ends, leading to wastage. This means that if supply and usage was to suddenly increase, the only option for storage at mills would be as planks.

Impacts – Small Sawmilling

5.3.6 The loss of ash in the medium- long term would take away a small but significant resource for this sector, which relies on a suite of timbers to supply a range of niche markets.

5.3.7 A marked increase in felling over a period, followed by a reduction and possible disappearance of ash from the market would be unwelcome. This might lead to reduced prices for both logs and planks, possibly followed in the longer term with price increases as ash became scarce again (as with elm).

5.3.8 The small sawmilling sector could process more ash; however even increasing throughput of ash 2 or 3 times would only absorb small relatively quantities. However, this would be a better use than firewood because of the extra downstream added value.

5.3.9 If ash disappeared entirely from the timber market Scotland for a period it would probably not result in loss of employment in this sector.

5.3 10 The sector would experience problems in the short term should restrictions to the movement of logs from infected sites were introduced on a scale that affects ASHS members. However, given current research advice on the biosecurity risk of such material, this is not thought to be a strong possibility.

Impacts: Low- Medium, Short–long term

5.4 Wood fuel

5.4.1 Hardwood wood fuel (for domestic heating and biomass) typically sells for about £30-35/m^3 roadside. It retails as delivered firewood split logs at £150-200/m^3 (as solid timber volume).

5.4.2 The market for firewood (all species) was estimated in 2005 to be 52,000 dry tonnes per year[39]. This includes both hardwoods and softwoods, but the bulk would be hardwood. In addition, small quantities of hardwood also end up as industrial fuelwood (biomass).

5.4.3 The (mainly hardwood) domestic firewood sector has invested in improved machinery in recent years, which has increased throughput and enabled it to process far bigger logs. There are signs of a considerable increase in activity in the last 3-5 years, but there appears to be no more up-

[39] Woodfuel consumption in Scotland 2005. H.M Mackay, J. Pendlebury, B. Hudson, C. Beck, S. Ward, H. Snowling. 2006.

to-date data to support this. Significant volumes of hardwood firewood are harvested on farms and estates and consumed locally without entering the formal firewood or biomass markets.

5.4.4 The emerging biomass market, whilst geared almost exclusively towards softwoods, will also take hardwood chips. The Wood Fuel Task Force suggests that there is *potential* for hardwood deliveries to increase to about 20,000 oven dry tonnes per year in Scotland (out of a total of about 600,000 oven dry tonnes from all sources of fibre)[40]. This would equate to very roughly 40,000 m^3 of green timber.

5.4.5 ***If*** the proportion of ash in hardwood fuelwood production equates to its standing volume volume in the broadleaved resource in the 1995 inventory, this would suggest that **ash comprises 8% of the hardwood fuel wood market in Scotland**. However there is reason to believe it might be higher than this, because ash tends to grow in rather more accessible lowland locations, and closer to market than for example birch (which is the largest hardwood by area). There is no evidence that ash is preferentially felled for firewood because of its reputation as a good fuel.

Impacts – Wood fuel

5.4.6 Most of the trees harvested as a result of Chalara are likely to end up as firewood or biomass. Because of the healthy state of demand and steady prices, ***this timber is likely to find a ready market****. The scale of potential fellings, spread over say the coming 2-3 decades, is not likely to be large enough to significantly disrupt these markets, but will simply add volume.*

5.4.7 In the long term there may be a slight reduction in supply as a result of the disease; but that depends on how successful owners are at restocking ash lost to the disease.

Impacts – Low, Medium to Long term

5.5 Gross Values in Timber Trade

5.5.1 If the values outlined in the preceding sections are more or less correct, very rough estimates of the value of ash in the timber market can be made. However, it should be noted that the estimates of volume production of sawlogs (source: SHMDG), roundwood deliveries (source: FC) and fuelwood (source: McKay et al, see above) do not appear to give a clear or mutually consistent picture of the hardwood market.

Recent timber market:

5.5.2 **Sawlogs**: 2000 m3 of sawlogs harvested per year- split 25% butt log selling at £110/m^3 and 75% second grade selling at £35/m^3. This is equivalent to an annual value at roadside for Scottish growers of **£50,000 butt logs**, and **£50,000 second grade** i.e. **totalling £100,000/yr** (Confidence Rating – low). If 15-20% of this is processed in Scotland (300-400 tonnes), and assuming 50% sawnwood recovery and an aggregate price of £1000/m3 for sawn and kiln dried timber, the value of this timber would be about £150,000-200,000 to the Scottish sawmill industry (Confidence Rating – low).

5.5.3 **Firewood**: 52,000 dry tonnes per year marketed (all hardwoods/softwood, 2005 figures), equivalent to 100,000 m^3 green logs, of which 8% is ash; equivalent to 8,000m^3/yr. These values

[40] www.forestry.gov.uk/pdf/WoodFuelDemandandUsageinScotland-UpdateReport2011-Opencirculation.pdf/$FILE/WoodFuelDemandandUsageinScotland-UpdateReport2011-Opencirculation.pdf

might reasonably be expected to be 20% higher in 2012 due to increased firewood sales since 2005 i.e. 10,000 tonnes. In addition there would significant volumes harvested on estates and farms that never come to market. Selling at roadside for £30-35/m^3, this is equivalent to **£300,000 - £350,000/yr** for Scottish growers (less harvesting and extraction costs)**.** Selling to customers as loose, dry, split logs at £80 per cubic metre delivered (which is about 40-50% wood) this equates to roughly: £1,500,000 - £2,000,000/yr as value to hardwood firewood merchants (Confidence Rating – low).

Possible future scenario

5.5.4 If 90% of mature ash was to die over the next 20-30 years and 60% was recovered for its firewood value; total volumes of *roundwood* eventually harvested might be circa 1.5 million m3 (to 7 cm top diameter). Assuming 2012 second grade log/firewood roadside price of £35 a tonne, this is equivalent to £50 million (Confidence Rating – low).

5.6 Plant Supply and Nursery Sector

5.6.1 Ash planting stock is produced for the following markets:

- transplants for the forestry market;
- transplants for the landscaping / amenity trade;
- larger stature, high value plants including semi-mature, in the landscaping/amenity trade.

5.6.2 In terms of numbers of trees, the forestry market is the largest, followed by transplants for the landscaping/amenity trade; with larger stature trees only sold in low numbers. However the larger trees, especially semi-mature, can be very valuable and contact with nurseries in England suggests that it is this sector that might be facing the largest financial impacts UK-wide.

Planting of broadleaved trees in forestry sector

5.6.3 The average annual area planted with broadleaves in Scotland for the period 2009-12 was 4,800 ha but reached 6,800 ha in 2012 (see table 11). This represents 65% percent of the average UK total 2008-12, and 57% for 2012.

5.6.4 Broadleaved trees have typically been established at 1600 per hectare since 2009, but at 3300 per hectare (and sometimes above) where quality timber is being sought[41]. The proportion of ash in broadleaved planting is not known, but reports from 2 of the major nurseries, figures from FES planting and information from FC conservancies[42] suggest that it probably lies in the range of **7-10%** of trees planted (and most likely in the mid-upper part of that range).

[41] 1023 ha of broadleaved woodland where wood production is a major objective have been established in the 5 year period to 2012.

[42] Source: Conservancy data provided by Douglas Wright, FCS

Table 11. Area of broadleaved trees planted in forestry in Scotland and UK Source: FC Statistics[43]

	Area of broadleaved planting (000 ha)						
	Scotland					UK total	Scotland as % of UK total
	Woodland creation		Restocking		Total		
Year	FC	Non-FC	FC	Non-FC			
2009	0.6	1.6	0.6	0.8	3.7	9.0	51%
2010	0.6	1.6	0.4	1.1	3.7	8.5	58%
2011	0.7	2.9	0.7	0.6	4.9	10.4	65%
2012	0.5	5.2	0.8	0.5	6.8	12.5	65%
Mean	***0.6***	***2.8***	***0.6***	***0.7***	***4.8***	***10.8***	***57%***

Table 12. Areas planted (all broadleaves) and numbers of ash trees used in forestry in Scotland since 2009 (thousands).

		FES		Private/Charitable sector		
		Total broadleaved area planted (ha)	Actual numbers of ash trees planted annually (000s)	*Total broadleaved area planted (ha)*	Estimated numbers of ash trees planted annually (000s)	
					If 1600 trees/ha and 7% ash in BL planting	If 1600 trees/ha and 10% ash in BL planting
Scotland: average planting 2009-12	**Woodland Creation**	*600*	178	*2800*	314	448
	Restock	*600*	177	*700*	78	112
	Total	***1200***	**354**	***3500***	**392**	**560**
Scotland: 2012 planting season	**Woodland creation**	*500*	169	*5200*	582	832
	Restock	*800*	274	*500*	56	80
	Total	***1300***	443	***5700***	**638**	**912**

[43] www.forestry.gov.uk/pdf/planting1976-2012rev.pdf/$FILE/planting1976-2012rev.pdf

5.6.5 Forest Enterprise Scotland have planted an average of **177,000 ash plants per year in restock** (representing abut 11% of broadleaved planting) and **178,000 in woodland creation** (representing about 8% of broadleaved planting) since 2009; making a total of 325,000 plants per year (Confidence rating – high). Stocking in FES woodland creation schemes have typically been 3,000 -5000 trees/ha.

5.6.6 Table 12 shows how rough estimates of the numbers of trees planted in the private/charitable sectors can be generated from information the areas of woodland planted, showing scenarios for ash comprising 7 and 10% of plants used. This, combined with the FES plant numbers, can give an indication of total numbers of ash trees planted.

5.6.7 Though speculative, this suggests a likely average annual planting in Scotland during the period 2009-12 of between **roughly 746,000 trees (354,000 by FES, 392,000 private/charitable); and 914,000 (354,000 by FES and 560,000 by private/charitable**); with the upper figure being more likely (Confidence rating – moderate). During the 2012 planting season, when the area of woodland creation by the private sector was higher, these totals will have increased.

5.6.8 Estimates of the total number of ash trees planted in the UK generated by trade groups and government appear to vary widely between about 1 million to over 3 million trees. Some of this discrepancy will relate to if it is only the forestry market that is being considered, or if it extends to the amenity market; and if it relates to just the main nurseries, or also includes the large number of small producers. Problems estimating numbers are compounded by the fact that not all nurseries or importing wholesalers are members of the trade groups attempting to collate figures.

5.6.9 If the figures in table 12 (above) are broadly correct this would suggest that **trade in ash trees in forestry in Scotland** during recent years was worth about between about £298,000 and £366,000 per year (Confidence rating – moderate); with this being split between nurseries in Scotland , the rest of the UK and importing wholesalers.

Nurseries

5.6.10 Ash transplants generally retail for 35-40p for large orders (1000+plants), about 50p to £1.00 for small orders (under 1,000 plants).

5.6.11 There are thought to be about 28 nurseries producing ash trees in Scotland, with some **460,000 plants currently 'in the ground'[44].** Confor Nursery Group members, representing the 5 largest nurseries in Scotland, estimate a current stock of 290,000 ash trees; with a further 30,000 destroyed at one nursery due to infection. Alba Trees plc is the largest producer of broadleaved trees, with a typical stock of about 7 million plants (broadleaf and conifer), of which 190,000 are ash, representing 2.7 % of sales.

5.6.12 Horticultural Trades Association (HTA) estimate that there is £2.5million worth of ash trees held currently in UK nurseries[45], with the majority being 1-2 year old plants, although the total market value is spread quite evenly across all tree sizes.

5.6.13 Loss of ash trees in small local nurseries are likely to be of a similar order of importance – i.e. a small but significant part of total turnover.

5.6.13 Approximately half of ash trees planted in the UK are imported: this is estimated by the Horticultural Trades Association to equate to nearly 1.5 million ash trees having been imported by

[44] Source: FCS
[45] Source: HTA www.the-hta.org.uk/page.php?pageid=1025

the nursery trade over the last 12 months and nearly 4 million since January 2009[46]. This doesn't take into account imports by the landscape and construction market which could well increase import numbers to nearer 3.5 million trees per year; making imports as high as 60% of the market.

5.6.14 There is a desire on the part of many in the nursery trade to move to greatly reduce or eliminate imports of trees in the future by increasing domestic production. This would be within the capacity of the nursery trade to achieve, but would lead to less flexibility in responding to the changes in demand which typically occur in forestry

Impacts - Nurseries

5.6.15 Nurseries are currently having ash orders "dumped" i.e. rejected or returned, and sales in the spring are halted. This means lost revenue in the order of £40 per 1,000 trees sold. As an example, Alba Trees are facing lost revenue for this planting season of the order of £40,000. Some of the larger English nurseries are facing losses of up to £65,000.

5.6.16 Assuming that about half of the 460,000 trees in the ground in Scotland were due to be sold this planting season, this equates with a ***financial loss of £92,000*** *for Scottish nurseries supplying transplants. In reality it is likely that all the 380,000 stock will be unmarketable, in which case the sector may loose about* ***£184,000 in sales****.*

5.6.17 Currently nurseries are, where possible, selling stock of substitute species. However this is difficult for the current season due to low stocks of some replacement species. 2012 was also a poor seed collecting season, especially for oak, which will limit sales of some alternative species for the next year or two. In the medium term, this situation should improve as buyers adjust their requirements and nurseries alter their stock.

5.6.18 If growers choose to replace ash in young damaged woodlands with other species, this might increase demand for plants. However this would probably only happen if there is extra funding to support this activity, and if woodland creation and restocking continue at current levels.

Impacts: High, Short term

5.7 Urban and landscaping trees

5.7.1 Ash is widely used as a tree in landscaping along roads, around buildings and in parks. It occurs in gardens and as self seeded trees along railways. There is an estimated 89 million urban trees in the UK[47]; suggesting there may be about 9 million in Scotland (if the extent urban areas is in proportion to population). In England 4% of urban trees are ash, and if this was the proportion in Scotland, the **total number of urban ash trees in Scotland would be 360,000** (Confidence rating – low).

5.7.2 HTA suggests that possibly as many as 2 million ash trees are imported into the UK landscape and construction trade per year[48] but probably no more than 30% of this planting activity takes place in Scotland. There are no statistics on the occurrence of ash along transport networks, but surveys are currently being undertaken to clarify the species composition of roadside/trackside trees (source: Angus Corby, Transport Scotland).

[46] Source: HTA www.the-hta.org.uk/page.php?pageid=1025
[47] Trees in Towns II Government recognition of urban forest needs. Dr Mark Johnston
[48] www.the-hta.org.uk/page.php?pageid=1025

5.7.3 Urban trees have very high indirect monetary values associated with their landscape value, ecosystem services and biodiversity. Monetised values for these are typically much larger than the costs of their maintenance or removal, typically exceeding £1000 per tree.

Impacts - Urban and landscaping trees

5.7.4 There could be significant potential economic impacts in urban areas in the form of:

1. *Costs to owners of felling and other tree surgery work due to health and safety concerns. Public agencies/ councils with land holdings along roads and other infrastructure could face considerable cost is in the longer term.* The typical cost of felling and removing a mature urban tree is £500 per tree. In the eventuality of all the urban ash trees in Scotland needing to be removed over a period of several decades, the total costs of removal might be in the order of £180 million.
2. *There may be potential for unscrupulous contractors to exploit public concern by advising householders to fell trees unnecessarily ('white van activities')*.
3. *Activity to minimise the risk of spreading the disease via infected leaves arising as leaf fall from individual known infected trees, or more generally as street sweepings carried out by local councils. Advice on disposal of infected leaves is given at: www.forestry.gov.uk/forestry/infd-92gjvb*

Impacts: Medium-High, Short – Long term

5.8 Monetised non-market benefits

5.8.1 The draft DEFRA Socio-economic Impact Assessment of Chalara provides estimates of the monetised non-market benefits for landscape, biodiversity, carbon sequestration and air pollution absorption for GB forests; and first approximations for the proportions attributable to ash. The share of these attributable to ash in Scotland is estimate to be about £3million (see table 13), based on the area of ash in Scotland being equivalent to 4% of the GB total in 1995.

Table 13 Estimates of the monetised values of non-market benefits of ash in GB and Scotland (source DEFRA)

	UK Forests **Estimated Annual Value UK (£m)**	**Ash in UK forests** **First approximation of component (£m)**	**Scottish share assuming 4% of GB total (m)***
Landscape	185	9	**0.4**
Recreation	484	25	**1**
Biodiversity	480	25	**1**
Carbon sequestration	115	17	**0.7**
Air Pollution absorption	0.4	0.1	**0.004**
Total	**£1.2 bn**	**£76 m**	**£3.1m**

5.9 Aggregate Impacts of Tree Diseases

5.9.1 The UK forestry sector is currently confronted by a number of significant new tree diseases with serious commercial and environmental impacts. In Scotland, these are damaging key commercial softwood trees (pine, larch), quality hardwoods (ash), important native trees and shrubs (Scots pine, ash, alder, juniper) and minor conifers (cypresses).

5.9.2 This restricts the range of species available for planting in all types of forest/woodland, which impacts on the design of forests and their capacity to deliver the full range of benefits. In addition, woodland owners bear significant costs of damage to their woodlands.

5.9.3 There are fears that combined effects of cost burdens on woodland owners and uncertainties about the future health of forests might undermine confidence in the forestry sector , jeopardising woodland creation, jobs and investment. However this will not happen if control measures are effective and new planning and management responses are developed. Ash dieback might impact particularly on future broadleaved planting, especially by farmers.

5.9.4 The arrival of these multiple diseases, largely facilitated by global trade (and starting with the virulent form of Dutch elm disease in the 1970s), has to be regarded as unprecedented. On an ecological timescale, these events are very rapid, and now constitute one of the most significant ecological issues in Scotland.

6. POTENTIAL LANDSCAPE IMPACTS

6.1 Ash is typically a large, elegant tree with characteristic upswept branches. It is important in the landscape in the following situations:

1. As **hedgerow , roadside and urban trees** – it here that the disease is likely to impinge hardest on landscapes. This is particularly true of very large, old, characterful trees, which are widely distributed in lowland areas.
2. In **riparian woodlands**, where ash is often the largest stature tree emerging above, alders, willows and birches, especially in more upland situations.
3. In ash-dominated **woodlands in the uplands where sloping ground** makes it visible (esp. Tayside, Argyll, Borders, Galloway).
4. As veteran trees, particularly "named trees" such as the Glen Lyon Ash, with their links to past land use.

6.2 Ash is Scotland's 5th most common native tree outside woodlands; and comprises about 6% of all trees in mall groups, roadsides, hedgerows and fields. In some parts of lowland Scotland, ash has become more prominent in the landscape after the elm was devastated by Dutch elm disease in the 1970's.

6.3 It is less important, but still significant in designed landscapes; though it doesn't usually feature in large settings such as avenues or roundels. It is often present in town parks, though as a minor component; and in urban gardens, more especially in areas of Victorian age housing[49]. Weeping ash is popular in urban situations. Several ash species have also been used in recent amenity plantings along roadsides and around buildings, all of which are susceptible to *Chalara*.

Within woodlands, it is valued by landscape architects because of its light canopy which lets sunlight through, forming characteristic patterning of light and shade.

Impacts – Landscape

6.4 The impacts on landscape will develop fairly slowly, starting with damage to and death of small trees and then manifesting as incremental damage on older trees. As such, the immediate visual impact will probably be ***relatively undramatic****. It is possible that the general public will experience the disease in a sequence:*

- *initial concern due to press coverage ;*
- *heightened concern as symptoms begin to appear- level dictated by speed of spread, rate of progress of dieback on individual trees and level of press coverage;*
- *accustomisation to the gradual progression of damage. This was the case in southern Norway in September 2012 and in Denmark[50], despite the high level of mortality; and*
- *heightened concern at the point when mature trees are felled at any scale, especially in districts where ash is common.*

6.5 Impacts will be greatest in respect of individual trees in hedgerows, on roadsides and along rivers. Woodlands in peri-urban situations with large numbers of walkers and urban trees in general will also attract attention; as will individual veteran trees.

Impacts: Low, locally medium, short-long term

[49] Source: Alison Grant,consultant
[50] Source: Dr. Anja Byg, Denmark email to Dr. Anna Lawrence, FR

7. POTENTIAL SOCIAL IMPACTS

Value to General Public (rural and urban communities, visitors, tourists)

7.1 Ash is a "second tier" tree species in terms of public recognisability behind oak, birch, pine, rowan and cherry. Ash doesn't have noticeable flowers, noteworthy autumn colours or recognisable seeds. It is not particularly valued for collectable mushrooms, nor is it associated with particular birds or mammals. Its black buds will be recognisable in winter by some people. The value of ash for firewood, due to its inherently low moisture content is well known. The "oak before ash…" weather saying is also popular.

7.2 Ash is an important tree in Celtic mythology and has a range of lore and sayings attached to it[51]. In British fairy lore, the ash is one of three magical woods, along with oak and thorn. In Gaelic it denotes the 5th letter of the alphabet, and the modern form is *uinnseann*. Children were given the astringent sap of the tree as a medicine and as a protection against witch-craft. The value of ash for weapons, tools and latterly, sports sticks, is quite widely known.

7.3 **The current profile** of ash is rising sharply due to press coverage, and this disease will make ash far more familiar to the general public.

7.4 The main contexts in which the values of ash/ash woodland are apparent to the public are the **landscape value of ash as single trees** in the general environment; hedgerows, roadsides and urban trees (ash is Scotland's 5th most common broadleaved tree as individual trees). Three ash trees are listed in the 2006 FC/Tree Council publication: "Heritage Trees of Scotland" – the Tinnis ash, the Glen Lyon ash and the Gordon Castle ash. In addition, the value of ash woodland ground flora (bluebells, primroses, wood anemone etc.) is apparent for countryside residents and walkers in the countryside, though they might not link this directly to ash. The high value of old ash for lower plant, fungi and invertebrates will become better understood through publicity.

7.5 The low frequency of ash in woodland will limit impacts; the main exception being peri-urban with as significant proportion of ash, with high numbers of recreational users.

Impacts - Landscape

7.6 Social impacts arise as a result of different people interacting with ash trees in a wide range of circumstances. The ecological, economic and landscape impacts outlined earlier in this report, will be experienced differently by a range of people and an overview of this is proposed in table 14.

7.7 The way that the public will experience dieback is outlined in section 6 above (landscape impacts). The main public interface will be the impacts of the loss of trees in local hedgerows, field edge and urban areas, rather than woodland. The impact will be more significant for the informed public (i.e. ramblers and naturalists) –as with most issue to do with trees- they are already engaged and concerned.

7.8 The problem may well get perceived by sections of the public as further evidence that 'everything environmental is getting worse' and as exemplified by the widely held belief that forest area

[51] See: http://mandyhaggith.worldforests.org/index.asp?pageid=358555

continues to decrease in Scotland[52]. Whilst this perception does not always correlate with the facts, in this case it would be correct to frame Chalara as part of a serious threat to forests worldwide. This will be exacerbated by the reality that little can be done by anyone to mitigate the effects of this disease.

7.9 This will add to the concerns of sections of society that feel weighed down by climate change, deforestation, species loss etc.; but others may be galvanized to 'do something' e.g. get involved with citizen science, community woodlands or conservation.

Impacts: Low-medium, Short to long-term

Table 14. Likely interaction of different social groups with impacts of ash dieback. The number of stars represents how different groups will experience the impacts (*** very significant; ** significant * slight).

GROUP	Economic Impacts	Environmental Impacts	Landscape Impacts
PUBLIC			
Rural communities, farmers		*	**
Urban communities			**
Visitors /tourists engaged in rural recreation			*
Visitors /tourists in urban areas			
"Informed public" and environmental interest groups		***	**(*) locally
FOREST OWNERS			
Forest owners – commercial/ investors	*	**	*
Forest owners – mixed and native woodland, including charitable owners	**	***	**
Forest owners & lessees - community	*	**	**
Forestry agents/advisers	*(*)	**	*
TIMBER AND NURSERY TRADE			
Small sawmills	*		
Timber trade	*		
Tree nurseries and seed suppliers	**		

[52] Source: Dr Anna Lawrence FR, based on the Public Opinion of Forestry survey. www.forestry.gov.uk/forestry/INFD-5ZYL9W

8. SUMMARY OF IMPACTS

8.1 An overview of the impacts is shown in table 15 below. The impacts are conceived of as **aggregate impacts at national scale**, rather than the impacts on individual woodlands, owners or businesses (which will be very variable). However, where there is particular scope for high individual/local impacts, this is highlighted.

8.2 The highest impacts are anticipated to be:

1. Potential loss of ash in general woodland management and silviculture, especially as a **timber tree**, **component of native woodlands**, a **specialist species in gap replacement** and in **riparian woodlands**
2. Biodiversity: in relation to **lichens, mosses/liverworts, fungi** and **invertebrates**; damage to **designated sites, veteran trees** and **wood pasture**.
3. Economic activity: **costs to woodland owners in cutting diseased trees and replanting including compliance with Statutory Plant health Notices**; **felling individual trees for health and safety reasons**, and short term losses in the **nursery industry**.
4. Landscape and Social: **loss of individual trees along roadsides, field margins and urban settings** and in woods heavily used by the public.

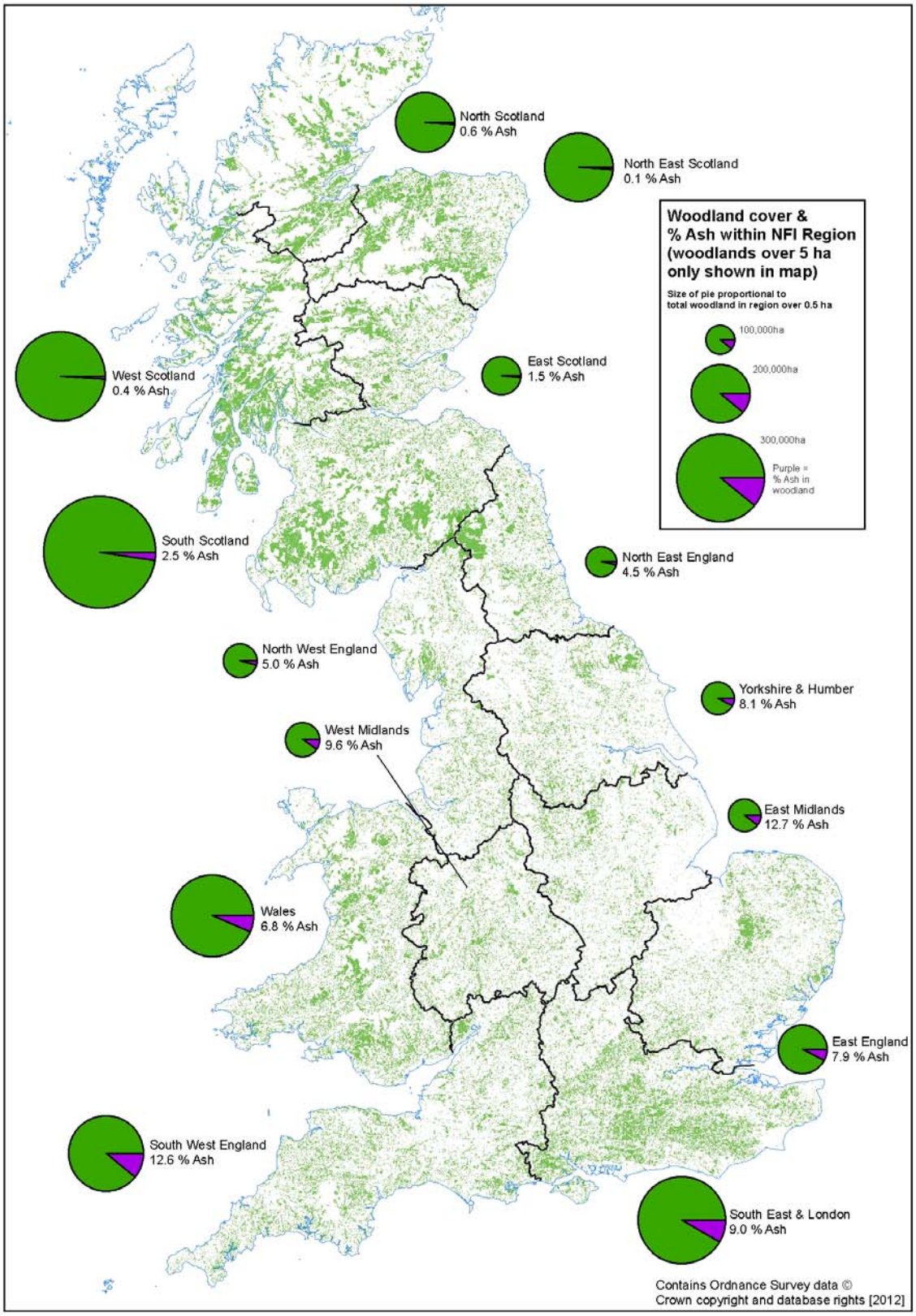
8.3 Impacts will generally develop fairly slowly as the disease progresses from killing twigs and branches, to more extensive dieback, followed in the longer term with tree death. The most immediate impacts will be the potential damage to young planted woodlands.

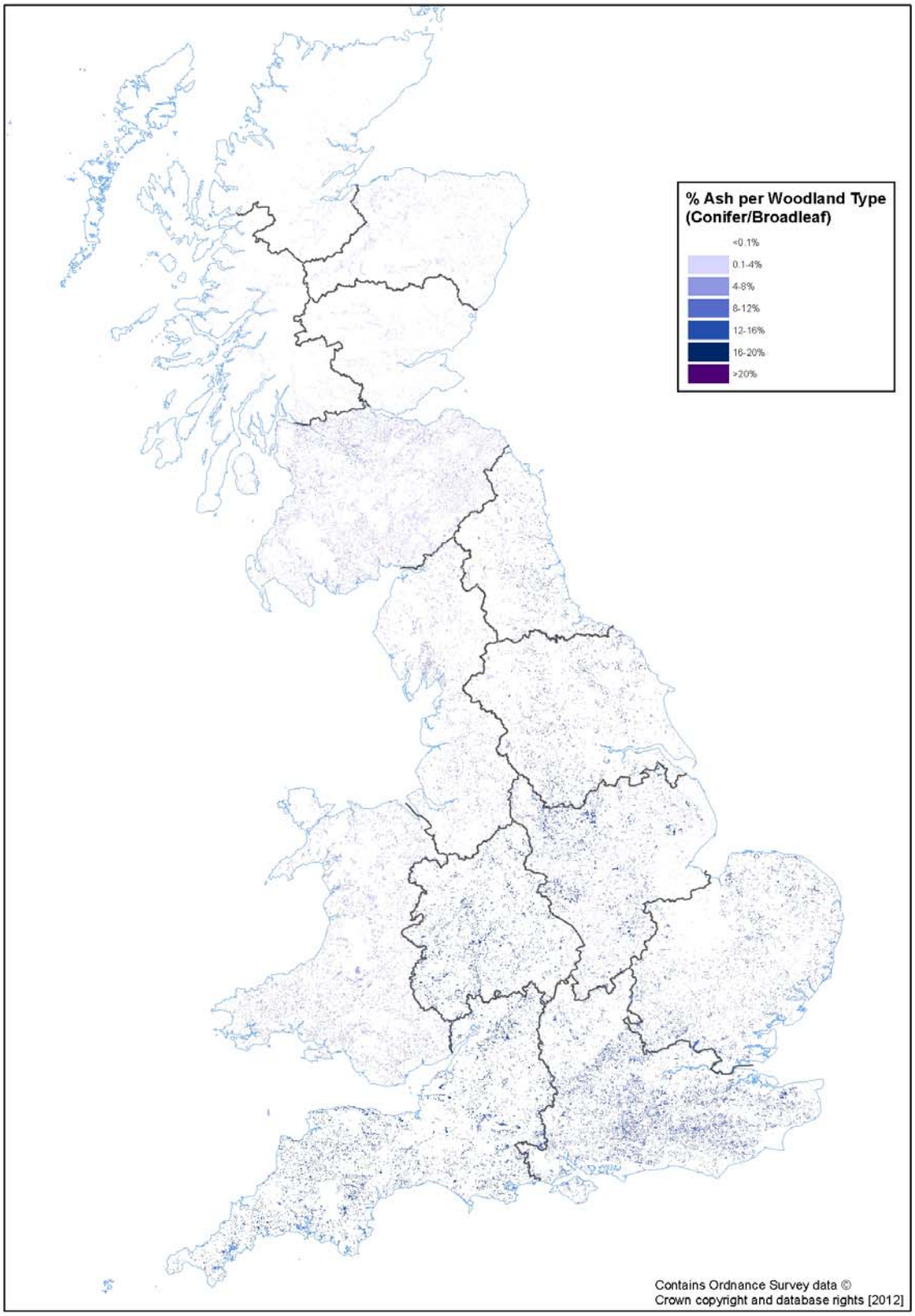
IMPACT TYPE	DESCRIPTION	SCALE				TIME PERIOD			Significant Local Impacts	Quantitative data (see main text for confidence ratings)
		V High	High	Med	Low	Short	Med	Long		
MANAGEMENT AND SILVICULTURE										
Loss of timber tree	No alternative species can wholly replace ash		✓			✓	✓	✓	✓for some owners	
Loss in planted native woodland	There are conservation losses with alternative species		✓	✓		✓	✓	✓	✓in certain localities	
Loss in gap-replacement dynamics	No alternative large stature native tree species		✓				✓	✓		
Riparian woodland	Loss of ash compounds problems with alder		✓				✓	✓	✓in certain localities	
BIODIVERSITY										
Trees/shrubs	Impacts woodland diversity coming on top of loss of elm		✓				✓	✓	✓in certain localities	
Flowering (vascular)plants	Quite robust communities; impacts depend on which tree/shrub species replace ash			✓	✓		✓	✓		
Lichens, Mosses, Liverworts	Loss of very important habitat coming on top of loss of elm; impacts depend on which alternative tree and shrub species replace ash	✓	✓				✓	✓	✓Especially western Scotland	220 rare/scarce lichens 84 with conservation status
Fungi	Loss of important habitat for fungi which rely solely on ash trees		✓				✓	✓		
Invertebrates	Loss of important habitat for invertebrates; especially those which rely solely on ash trees	✓	✓			✓	✓	✓		40 species totally or very largely ash dependent

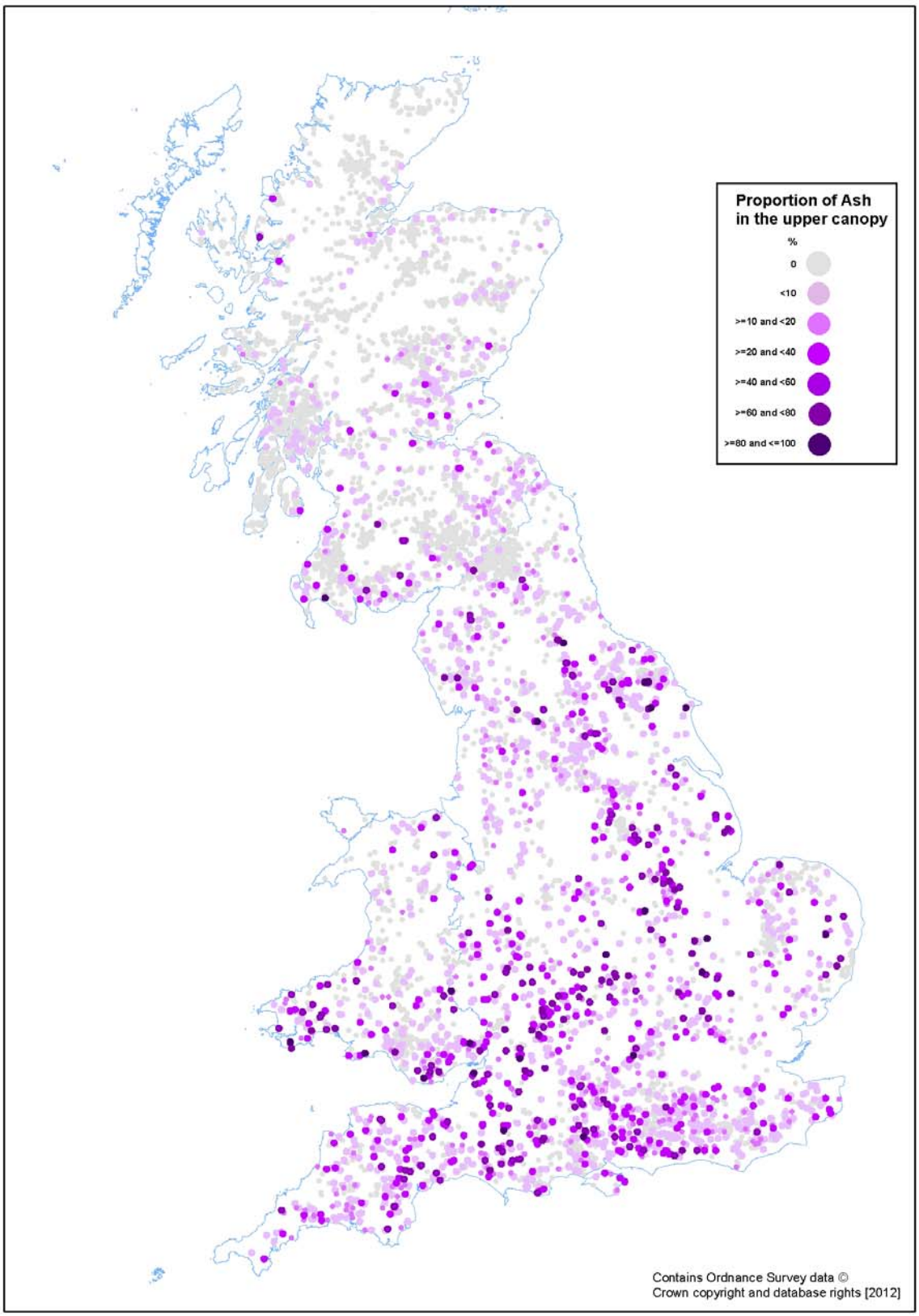
IMPACT TYPE	DESCRIPTION	SCALE				TIME PERIOD			Significant Local Impacts	Quantitative data (see main text for confidence ratings)
		V High	High	Med	Low	Short	Med	Long		
Birds and Mammals	Ash provides nesting sites for birds and hibernating places for bats			✓	✓		✓	✓		
Designated sites	Severe degradation of habitat and potential loss of species	✓	✓			✓	✓	✓	✓damage to key sites	94 SSSIs 18 SACs
Veteran Trees and Wood Pasture	High local impacts on the few sites small scale sites that exist	✓					✓	✓	✓damage to key sites	17% of veteran trees (in UK) are ash
Habitat Networks	Networks will continue to function, albeit without species associated with ash.			✓		✓	✓			
Deadwood	Temporarily increased deadwood quantities and will manifest itself as "boom and bust" for deadwood species			✓	✓		✓	✓		
ECONOMIC										
Owners' costs re Statutory Plant Health notices	Individual owners could incur high costs – cutting and disposal of ash and replanting	✓	✓			✓			✓high cost burdens on owners	
Owners' costs re surveying/monitoring	Owners will need to monitor the progress of the disease			✓	✓	✓	✓			
Owners' Costs re replacement of ash	Owners will eventually need to remove / fell infected tree and replace with other species		✓			✓			✓high cost burdens on owners	
Owners' Costs re felling before optimal age	Owners may need to fell ash plantations before optimum age			✓	✓		✓	✓		
Owners' costs re revised management planning	Amended forest plans to cope with the disease; plus grant applications.			✓		✓	✓			

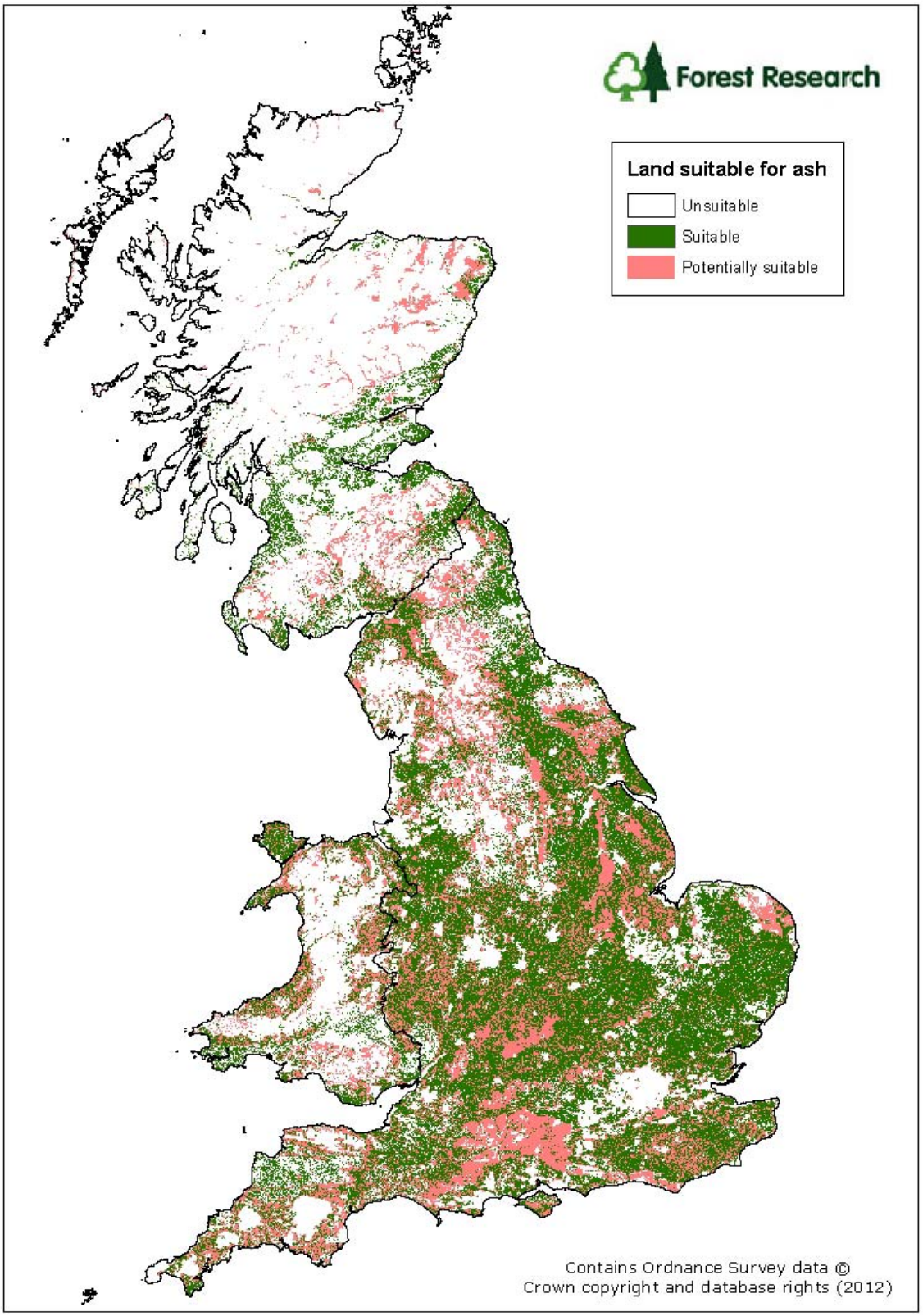
IMPACT TYPE	DESCRIPTION	SCALE				TIME PERIOD			Significant Local Impacts	Quantitative data (see main text for confidence ratings)
		V High	High	Med	Low	Short	Med	Long		
Owners' Costs re health and safety	Felling and tree surgery work on trees beside roads and paths etc.		✓				✓	✓	✓high cost burdens on some owners	
Owners' Costs re substitution of ash by less satisfactory timber species	Foregone income when other tree species replace ash				✓			✓		
Quality timber	Ash is one of a small suite of species that supports hardwood markets. Timber glut will reduce prices.			✓		✓	✓	✓		Sawlog production in ash roughly about 2000 m^3 per year
Small Hardwood Sawmilling	Loss of ash would take away a small but significant resource				✓	✓	✓	✓		
Wood fuel	Most trees harvested will end up as firewood or biomass. Increased supply not enough to impact markets				✓		✓	✓		
Plant supply and Nurseries	Lost sales in 2012/13. Nurseries and customers will adjust in the future by using alternative species		✓			✓			✓high short term cost burdens	In 2009-12 325,000 ash trees planted per yr by FES and roughly 392-560,000 per yr by private/charitable owners. Scottish nursery losses roughly £155,000.
Urban trees	Costs of dealing with tree surgery work and infected leaves		✓	✓		✓	✓	✓	✓	Felling removal of all urban trees = £180 m
LANDSCAPE	Damage, death & felling of trees visible to public. in hedgerows, on roadsides and along rivers			✓	✓	✓	✓	✓	✓high impacts in some localities	
SOCIAL	Loss of trees in hedges, roadsides and along woodland walks, esp. for the informed public			✓	✓	✓	✓	✓		

Appendix 1 Maps of ash resource (source: National Forest Inventory).

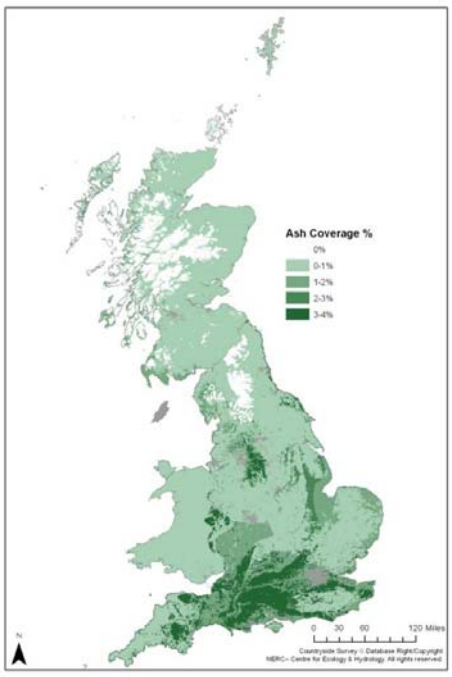



% Ash per Woodland Type (Conifer/Broadleaf)
<0.1%
0.1-4%
4-8%
8-12%
12-16%
16-20%
>20%
Contains Ordnance Survey data ©
Crown copyright and database rights [2012]

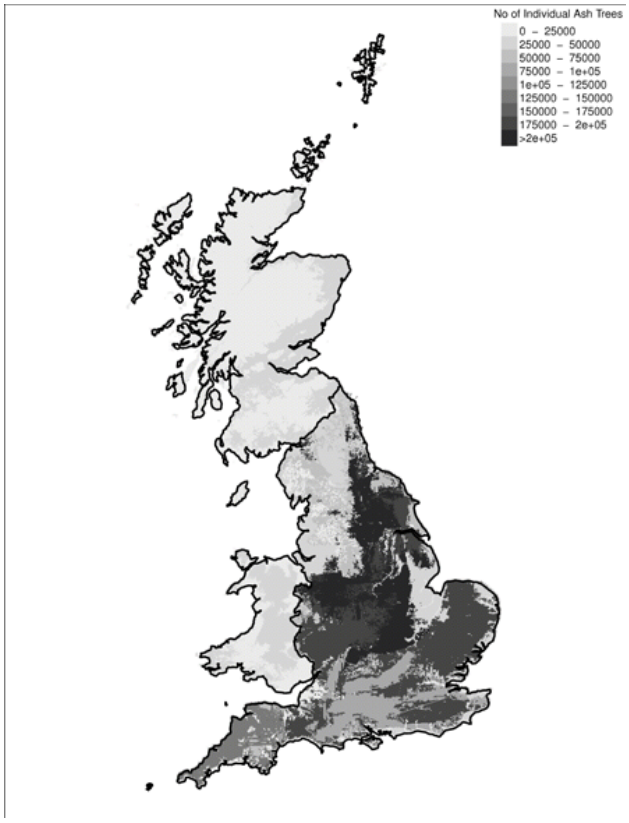

Proportion of Ash in the upper canopy
%
0
<10
>=10 and <20
>=20 and <40
>=40 and <60
>=60 and <80
>=80 and <=100
Contains Ordnance Survey data ©
Crown copyright and database rights [2012]


Forest Research
Land suitable for ash
Unsuitable
Suitable
Potentially suitable
Contains Ordnance Survey data ©
Crown copyright and database rights (2012)

Appendix 2 Maps of the frequency of ash according to the Countryside Survey (CEH)



Areal extent of ash based on % cover in Broadleaved woodland habitat parcels, mapped using land class means, shading relates to % of land class containing ash woodland



Distribution of individual ash trees based on number of individual ash trees per land class and scaled up using land class extent.

Appendix 3. Some fungal species typically associated with ash (source Liz Holden).

Inonotus hispidus (parasitic - large bracket fungus often high up on the trunk of mature trees)

Nectria galligena (small ascomycete causing a conspicuous and common canker on ash)

Phyllactinia fraxini (a leaf parasite)

Hymenoscyphus albidus (saprotrophic on leaves and petioles)

Cryptosphaeria eunomia (small fungus common on dead branches)

Daldinia concentrica (distinctive fruit bodies on dead trunks and fallen wood)

Hypoxylon rubiginosum (saprotrophic on dead wood)

Phomopsis pterophila (saprotrophic on fallen samaras)