What can we do about "Chalara" ash dieback (*Hymenoscyphus fraxineus*) on woodland SSSIs? Joint advice from Natural England and the Forestry Commission

Over half of the woodland and wood-pasture SSSIs in England contain significant amounts of ash. As nationally important areas for the conservation of biological diversity, it is vital that the impact of ash dieback disease on the SSSI 'features of interest' is managed to reduce negative effects where this is possible. The woodland SSSIs are only *representative* of the total amount of woodland biodiversity, and as such, it is likely that this advice will be applicable to protecting biodiversity at a range of other sites with ash. Various suggestions are made in this document, and there is only limited experience of implementing many of these in the UK ash dieback scenario. Therefore it will be important to trial different management strategies, monitor their effectiveness, and continue to share practical experience.

The most common questions we are asked by owners, agents and SSSI advisers are:

Will all my ash trees die? Should diseased trees be felled? Should I fell healthy trees now? How can I manage the structure of my wood? Should ash coppice or pollards be cut? How will the designated features be affected? How should replacement trees be established? What replacement species can be used? What should I do about sycamore? Will my wood be classed as "unfavourable"?

This note sets out some possible responses to these questions to help when providing advice to SSSI owners, based on our own research and others' work (including from continental Europe) over the last 2 years. However, it is very important that Natural England and Forestry Commission's advice is tailored to the specific conditions on each site, including: the current proportion of ash and other trees and shrubs present; the woodland structure; existing issues and challenges acting on the wood; its context in the surrounding landscape; the SSSI features of interest; the owner's objectives; and public access and safety.

Existing challenges and wider resilience

Often the ash dieback disease, which is wind dispersed over large distances, is arriving in woods which have existing issues and challenges, such as:

- A reduced range of tree and shrub species;
- Tree regeneration being unsuccessful – usually through either lack of light or grazing/browsing by deer and other animals;
- A lack of structural diversity across the wood in terms of tree size classes, shrub layer, open space and dead wood;
- Damage to trees and regeneration from grey squirrels or other tree pests and diseases, or other negative influences like invasive non-native species and climate change impacts

Addressing these now is important, so we have more options for addressing ash dieback as the disease progresses. Action to address these issues will also help to ensure the wood is resilient to other pests and diseases and future climate change.

Will all my ash trees die?

The level and rate of tree mortality will vary from site-to-site and can be influenced by a wide range of factors but, primarily, a tree's level of susceptibility to ash dieback (*Hymenoscyphus fraxineus*), is determined by its genetic makeup (genotype). Trees with a very low level of disease tolerance can die very quickly and even large trees can succumb in a few years. Other trees can tolerate the disease for longer periods of time and some trees, with high levels of tolerance may appear largely unaffected. Trees are likely to be more susceptible if they are poor specimens and/ or suffering additional stresses, for example from water logging or over-crowding. Secondary infections, such as those caused by honey fungus (*Armillaria* sp), can significantly increase mortality rates.

Trees showing 0-25% of their crowns affected, can be considered as having a good level of disease tolerance where they are within a known area of infection and surrounding trees are more severely affected. Sometimes it can take several years following the arrival of ash dieback at a site to identify the more tolerant trees. Tolerant trees can still produce good annual growth increment. Trees with more than 50% of the crown affected will show little or no annual growth increment and are likely to die.

Within Europe to date no trees within infection zones have been found to be completely free of the disease, yet very recent research has shown that some degree of local resistance[1] may be possible. Of a sample of 140 trees tested from the UK, 1 in 6 showed resistance as a heritable trait genetically, although the geographical distribution of this is still being researched, and this may not play out under infection conditions. Other studies have shown that ash trees which come into leaf early, and shed leaves early are more likely to be tolerant to the disease. However, there is some suggestion that the genes conferring resistance may be linked to those giving lower tolerance to herbivory by mammals.

At best, the conclusion from studies in continental Europe estimate 2-5% of the ash population will remain unaffected by the disease, whilst Kjær et al (2011) believe that under current infection pressure, only 1% have the potential of producing tolerant offspring and even then they will be expected to have up to 10% of their crowns damaged by ash dieback.

Should diseased trees be felled?

It is worth keeping as much of the current population of ash trees as possible to maintain a diverse genetic resource, and identify and retain those trees (and any of their progeny) showing the highest levels of disease tolerance. **Regular monitoring** to assess the health of ash trees as the disease

[1] There is a difference between tolerance and resistance. An organism that is **tolerant** of the pathogen will be affected but survive, and will allow the pathogen to carry on its life cycle; while an organism that is **resistant** will not be affected, and in doing so will prevent the pathogen from continuing its life cycle. It's worth noting the difference, but don't get hung up on it. In breeding terms, we'd be ideally looking for resistance. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3434923/

progresses is important (we'd suggest at least annually between late July and early August), along with identifying phenotypic traits like early leaf budding and senescence. Premature conclusions regarding levels of disease tolerance should be avoided, as the health of individual trees can vary from year to year. Mature ash with epicormic growth from the main stem, or broomstick growth in a secondary inner crown, indicates a highly-stressed tree which is likely to die faster.

Diseased trees that are dying could shed limbs, or lean and collapse. Where this is likely to pose a safety hazard (adjacent to roads, footpath or in heavily used areas etc.) such trees should be felled.

Felling diseased trees will not limit the spread of this wind-dispersed disease to other parts of the wood. It is likely that the remaining ash trees have already been exposed to the disease anyway as the spores are wind-borne. Studies have shown that ash trees present at a low proportion of mixed stands are no less affected by the disease than whole stands of ash, although clearly the overall impact on the stand will be less in mixed stands.

Thinning dense stands of diseased ash will enable the more tolerant ash trees to seed and provide space for the seedlings to grow. Each time the tree produces seeds they will be of a different genetic make-up to their parent trees. This gives opportunity, potentially each year, for more tolerant ash to grow.

Felling lots of mature diseased ash in the same stand whilst retaining a few tolerant trees can have the effect of suddenly raising the water table, thus stressing the remaining trees and making them more vulnerable to infection by honey fungus. It is preferable to retain more mature trees as a structural component of the woodland.

Can I fell *healthy* ash trees now? Can manipulating stand structure affect disease impacts?

As previously stated, retaining as much ash as possible is important to ensure protection of any tolerant/ resistant ash in the stand.

However, thinning or harvesting mature ash as part of a normal programme of silvicultural management of the wood could continue in line with the advice in Table 1 below. In uninfected sites where thinning operations are required – we suggest you retain ash trees with the biggest crowns and / or those which are prime (biggest and healthiest) amongst their cohorts. Once stands become infected, such trees in addition to all specimens showing the highest levels of disease tolerance, should be retained and promoted as these will have the best chance of survival and reproduction. Thought should be given to what will regenerate beneath dying or felled trees, and whether planting is necessary and appropriate (see below).

Sites with high air and/or soil humidity will lead to increased spore production from the *Hymenoscyphus fraxinea* fungus.

The fungus re-infects the trees each year. In some situations a dense understorey may act as a physical barrier to the fungal spores reaching the canopy after they are released from the fruiting bodies on the fallen leaf stems. Spore density is highest near the ground (0-5m). However, as a note of caution, the fungus can also infect through the roots.

Prime specimens, such as those above average size with larger crowns tend to survive best, therefore thinning tightly packed younger stands could help. It should be noted that within stands comprised of trees with low levels of disease tolerance, thinning operations will likely have a

negligible effect. Very heavy thinning and salvage operations to remove dying trees, has been shown to accelerate the disease (Alsop, 2015).

If there is potential for high mortality i.e. lots of vulnerable ash, retaining even moderately healthy trees – especially if they are seed bearing - will help maintain forest conditions (preventing coarse ground vegetation smothering any regeneration) and avoid stand collapse. Tree species other than ash should be promoted by thinning around them. This will aid future stand management and provide shelter for any under-planting or natural regeneration.

Should I continue coppicing and pollarding, and work on veteran trees?

Unless coppice stools harbour good levels of disease tolerance, they can be particularly susceptible - especially recently cut ash coppice re-growth. Continuing with a regular cutting cycle however will allow any resistant ash stools to be identified more quickly, and will maintain the coppice conditions which are potentially supporting other woodland wildlife (such as ground flora and butterflies etc).

Old/ veteran ash pollards in a regular pollarding cycle should continue to be cut provided they are healthy. These trees have a better chance of survival possibly because of the compartmentalisation within the stems. If the cutting of pollarded trees is not required imminently, then in order to avoid unnecessary works, monitoring the health of such trees as the disease progresses may be the most prudent measure.

Re-pollarding previously neglected pollards (or veteran coppice stools) should not be undertaken, as this will place too much stress on the tree where it is also under infection pressure.

Veteran ash trees (other than in-cycle pollards) should never be cut without an overwhelmingly good reason. Carrying out tree surgery puts the tree under stress. If the tree is susceptible to ash dieback the 'pathway' for the disease to the main stem is shortened when the tree has been cut, the new shoots are worst affected, making it difficult for the tree to recover from the intervention.

By not undertaking surgery, some veteran ash might undergo very severe mechanical failure. However, ash sometimes survives quite well after such a failure, although this will be tempered if new growth is affected by the disease.

What replacement species can be used? How should replacement trees be established?

To identify which alternative tree species could be encouraged to support the wildlife supported by ash, we'd recommend studying the ash species database and report here. Making this specific to individual sites will involve checking the NBN and/ or using other survey data to find out what wildlife species are present, then checking their level of association with ash using the database. Natural England is planning to create a "quick look-up" database which will enable a user to take a table from NBN, drop it into the ash database, and get out a list of species that are dependent (but not wholly obligate) on ash, and identify what other tree and shrub species they can utilise. In addition, the selection of alternative species should also consider their suitability for the site conditions. The Ecological Site Classification tool can assist with this, however please note it does not include some common native species like field maple and hazel.

We'd recommend encouraging these tree and shrub species which support ash wildlife, and also promoting other native trees associated with ash habitat at your site using the appropriate National Vegetation Classification community as a guide, and being informed by the composition in nearby

semi-natural woodlands on similar soil types. Where appropriate, these may include other main canopy trees like oak and beech; make use of currently less frequent species like birch, rowan, whitebeam, aspen, willow, alder, lime, yew, holly, field maple, hazel, wych elm, cherry; and also key nectar bearing species such as hawthorn, blackthorn, crab apple, dogwood, rose. There may be a case for introducing tree species which are at the limits of their current natural range at the site in question where it would be expected that these species might arrive naturally over the next few decades (eg beech).

Tree and shrub species should be established by natural regeneration where possible – e.g. by creating space for new regeneration around existing specimens of the desired trees and shrub species.

If stands/ woods are dominated by ash, or have very little or no seed source of the desired species, then planting could be considered. Planting stock should ideally be grown on from trees already in the SSSI or from sites nearby. This will help retain genetic adaptation to the site present in these species. Outside SSSIs, especially on new planting sites, the inclusion of up to 20% exotic species and 20% 'naturalised' species may be acceptable for 'new native woodland'. We do not recommend using this material on SSSIs. Likewise, while the use of provenances of native species from 2-5 degrees south of the planting site south as a component of the planting mix outside of SSSIs is recommended as a possible strategy for aiding adaptation to future climate change, this does not apply to SSSIs for the reasons given above. The key function of SSSIs is to protect the native biodiversity (including genetic diversity) across the country and to use these sites as a natural touchstone for future environmental change. The use of planting stock acquired from continental Europe carries a significant biosecurity risk so we recommend only using plants grown here in the UK.

Introducing non-native (to the UK) tree and shrub species to an SSSI is not usually acceptable or necessary for the management of the site and its features (but see below).

What should I do about sycamore?

Many SSSIs with ash also have a proportion of sycamore. As a non-native tree, sycamore (especially the seed bearing trees) has been cut out of many SSSI and other nature conservation sites in the past, in an attempt to control its spread – often because of its shady canopy which can limit the rich ground flora associated with ash. Recent research has however shown that sycamore has similarities to ash in some respects, in terms of the species it supports (nearly half of those associated with ash can also use sycamore) and some of its other ecological functions (nutrient cycling) and qualities (such as its similar bark pH – important for some lichens). In European ash forests sycamore is a native component, and it has now naturalised itself into many UK woodlands. As a veteran tree, sycamore can provide an excellent habitat for bats in its flaky bark, and heart rot qualities similar to ash (white rot).

It is likely that where sycamore is present with ash, and the ash dies, that sycamore will fill the gaps if left undeterred. We need to consider on a site basis how appropriate this is, and whether it is better to have natural regeneration of sycamore or introduced planted stock of other species like oak, lime or beech, which may, in any case, have similar shady canopies to sycamore. Sycamore is more vulnerable to squirrel damage than many native species and this should also be considered if timber production in an objective.

Where sycamore is *not* already present on an SSSI it should *not* be introduced. Where it is present and the impact of sycamore on ground flora is a concern we'd recommend manipulating stand structure to allow more light to reach to forest floor, and maintaining the total amount of sycamore in the canopy at a low proportion, ideally below 15%.

How should I manage the additional deadwood?

Potentially ash dieback, especially if accompanied by honey fungus, could lead to a sudden influx of dead wood. This is likely to be a relatively short-lived resource in woodland terms, as it is likely to rot quickly. There is no reason why a proportion of this cannot be marketed as firewood. However, dead wood is an important resource in woodland ecology, and a proportion of deadwood should be retained (standing and fallen). The minimum proposed by UKFS is 20m^3/ha and UKWAS is at least 3 standing/fallen decaying trees per ha. More is desirable on most SSSIs. If it is likely to impede woodland management, it can be moved, but still retained.

How will the designated features be affected?

Many SSSI woodlands containing ash are designated for their W8 or W9 ash woodland vegetation community (NVC), often on ancient woodland sites, or found in mixtures with oak in W10. They often have outstanding ground flora, rarer plants species like the helleborines, rich lichen assemblages, and can have a high diversity of native tree and shrub species associated with these communities. They may also be designated for invertebrate assemblages including moths, butterflies and saproxylic (deadwood) invertebrates, woodland birds, molluscs and bats.

Recent research has shown that ash has unique ecological properties and functions in these woodlands and is at one end of a spectrum for many qualities such high nutrients in senescent leaves and low lignin, meaning it has the ability to rapidly cycle soil nutrients, and the dappled light beneath its canopy in high summer. Other tree species do not do this, and the ground flora could change as a result of this. Across the UK, 955 species make use of ash trees as a habitat although on any one site only a proportion of these will be present. Some of these are obligate or highly dependent on ash. These species are vulnerable and likely to decline if suitable alternative habitat is not provided, when ash dies.

Will my ash dieback infected SSSI be classed as "unfavourable"?

Many woods will maintain their woodland interest if we can succeed in diversifying the native tree and shrub species present (see above), and/ or if we find disease-tolerant ash.

If a site has ash dieback, it will not automatically go into unfavourable condition, but will go onto our threats register. Natural England standard target for tree disease is: "*No rapid loss of native species due to unnatural factors (greater than 10% in a five year period)*". This will trigger a site to be switched into unfavourable condition, but if the land owner were already in discussion with Natural England about diversifying the tree and shrub species, and taking steps as set out in this guidance, the site condition may be classed as *unfavourable recovering*.

This means decisions on condition should follow this approach:

- If a woodland does <u>not</u> have ash dieback, then there is no impact on condition. However where its features are AT RISK then a Condition Threat and appropriate Action should be

recorded. The Action may include establishment of a management strategy to diversify and reduce other stress factors, prior to the arrival of the disease.

If ash dieback is present, and:

- If the loss of native species is less than 10% over a 5 year period, then there is NO impact on condition, but we try to manage it (and this must be recorded via an appropriate Condition Threat Action); OR
- If the loss of native species is greater than 10% over a 5 year period, then condition is UNFAVOURABLE and either:
    - If appropriate management is in place to manage a shift in component species to re-establish the woodland structure, then if this is the only factor affecting condition then it is unfavourable recovering. A Condition Threat Action must be recorded to reflect the continuing need to manage the site; OR
    - If appropriate management is not in place, then an unfavourable declining category is likely to be most appropriate if the impact of the disease is continuing to increase.

In the future, if there is a permanent adverse effect that fundamentally alters the notified features of specific sites, then advice will need to be sought as to the way forward. However, staff should not focus on this activity now as we are a long way off this scenario.

In summary:

1. The *risk* of ash dieback does not have any impact on current condition
2. If ash dieback is *present*, then there must have been a loss of more than 10% of native species over a five year period before condition is affected.
3. Where more than 10% of the trees are badly affected and it can be demonstrated that this is having a detrimental impact on the designated features, then the wood should be classed as unfavourable. Where a plan is in place to address the issues and protect the designated features then the wood should be classed as recovering.

Table 1: Varying the response in relation to the proportion of ash

Amount of ash: Low (<30%); medium (30-70%); high (>70%);

There will be different responses for different amount of ash on site. Assuming soil conditions are suitable throughout for ash: if only part of the site is suitable for ash, this applies to the part where ash is growing (or has potential to grow). For any specific site, more than one of these scenarios might apply.

Amount of ash → / **Structure** ↓	**Low amount ash** **<30%;**	**Medium amount ash** **30-70%;**	**High ash** **>70%**	**Mostly ash** **>90%**
High Forest	Leave the ash: survival important.	Diversity age structure, and open	Avoid drastic changes in forest conditions.	Avoid drastic changes in forest

	Promote regen. Thin if needed to promote crown development and space for regeneration.	up stands around minor species to promote their regeneration and regeneration of 'prime' & any tolerant ash.	Diversify age structure and promote minor component tree species. Retain at least 50% of ash. Encourage natural regen/ underplanting of appropriate alternative species.	conditions. Re-structure stand if needed to promote crown development in 'prime' ash; and encourage space for ash regeneration. Under-plant ash with appropriate species as the ash canopy thins.
Coppice	If in mixed coppice stand – cut all stools on normal rotation and promote regeneration/ layering of other coppice species around ash stools. Leave ash standards.	Where ground-flora/ inverts of coppice are important and/ or comprise the designated feature, then re-coppice and gap up with other suitable coppice species; allow and promote ash regen as well. Leave ash standards. Promote other species of coppice.	Where ground-flora/ inverts of coppice are important and/ or comprise the designated feature, then re-coppice and gap up with other suitable coppice species; allow and promote ash regen as well. Leave ash standards. Promote including planting - where necessary - other species of coppice.	Coppice in rotation and consider replanting with other coppice species.
Neglected (overstood) coppice: ***Old stools can be important source of veteran interest and feature. Retain where possible for as long as possible.***	Leave overstood ash stools - they are more likely to survive and seed uncut. Get more light into stand by thinning/ re-coppicing other tree species to promote regeneration.	Is coppicing a practical option? Could manage to begin change to an 'irregular' forestry system that will increase light to benefit woodland and promote other regeneration. Most ash likely to die eventually; but retain ash maidens to keep forest conditions whilst establishing other components; retain some ash stools if no maidens and thin around other tree species to	Same as previous column. Retain at least 50% ash. Consider best future structure for SSSI features. Overstood ash may have benefits (ash stools, veteran features) but may be single-aged, dark woodland.	

		encourage regeneration.		

References and further reading:

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For further information on the disease and its management see the Forestry Commission website http://www.forestry.gov.uk/chalara

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