The Extent of Ash Dieback in the Upper Eden Valley of Cumbria

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SUMMARY

Surveys of ash trees (*Fraxinus excelsior*) were conducted in the Upper Eden Valley, an area of north-western England where the species is omnipresent. Visual inspections of ash were undertaken in early September 2020, with survey areas chosen to encompass a variety of settings such as woodlands, roadsides, field margins, riverbanks and green lanes. Across all survey areas around 77% were observed to be symptomatic. The proportion of trees showing signs of the disease varied within and between the survey zones such that, for example, trees within a stand of several hundred 45 year-old poles adjacent to a main road showed 97% dieback whereas for 214 mixed-age ash within a nearby block of farmland the value was 69%. The size of approximately 75% of the trees examined was recorded. Saplings and smaller trees (less than 30 years old) most commonly displayed signs of dieback and were the most likely to show severe symptom or be already dead whilst middle-aged and mature ash were largely similar with respect to the proportion affected and the severity of symptoms exhibited.

INTRODUCTION

Ash dieback (AD) disease (*Hymenocyphus fraxineus*) was first officially noted to have occurred in the UK in 2012 although the pathogen is suspected of having been present as early as the mid-1990s (Enderle et al., 2019, Clark and Webber, 2017). The spread of ash dieback has been rapid and the disease poses a threat to virtually all *Fraxinus excelsior* L. in Britain. Ash is a particularly important tree in the UK, principally in England and Wales, where it can comprise up to 12.7% of trees in certain areas, this value undoubtedly rising significantly at the local scale (Clark and Webber, 2017). As such, the progressive loss of this tree species from the UK landscape will have serious ecological and aesthetic implications for much of the British countryside.

In parts of the UK where there is a mix of hardwood tree species the impact on the landscape, although significant, is not likely to be as intense as in areas where ash is the predominant tree. In the North West region of England, whilst ash is thought to comprise just 5% of trees overall, in certain areas it is the dominant species. One such area where ash is particularly numerous is the Upper Eden Valley of Cumbria, the southern part of a valley that lies between the Lake District and the Pennine mountain range. Land-use within this part of the valley is almost exclusively devoted to livestock rearing and the area is not particularly well-wooded with most trees confined to relatively small woods, narrow stands along riverbanks or, most notably, occurring singly at the margins of fields and roads. Outside of more recent plantations (often ash but also birch or conifers) and areas of natural re-growth, ash is the most commonly encountered tree in this part of the country, to the degree that loss of the species will undoubtedly have a significant impact on the environment. Ash, whilst no longer particularly valued economically (Pratt, 2017), is known to be a significant provider of ecological services and a large number of species have been documented as being partially or wholly dependent on the tree (Mitchell et al., 2014). Therefore, loss of the majority of ash will have important ramifications for biodiversity in the Eden Valley, particularly as alternate tree species are relatively sparse by comparison with other regions within the UK. The disease was first noted in this region in 2015 and limited surveys conducted in 2019 (H. A. Bell, unpublished) indicated that the disease was beginning to cause dieback in a significant number of the trees examined with *ca.* 25% of trees exhibiting very clear signs of the disease. Accordingly, a more detailed examination was strongly indicated and ultimately conducted in the summer of 2020 to quantify the numbers of trees affected. It is hoped that, through carrying out such a survey, data will be provided that will help

inform with regards to the actions that are clearly required to ameliorate the impacts of the loss of ash from this region of England, particularly in non-woodland and agricultural situations.

MATERIALS AND METHODS

Survey areas

Surveys were conducted around the market town of Kirkby Stephen (54.47°N, 2.35°W) and the village of Brough (54.53°N, 2.32°W) in early September of 2020 The majority of trees surveyed were at an elevation of between 150 and 200 m whilst a small area of woodland lying at between 265 and 370 m was also included. Survey routes were chosen to take in a mixture of tree sizes/ages, from mature freestanding trees to stands of younger trees. Routes included roadsides, public footpaths, woodland, green lanes, stretches of riverside and blocks of farmland No attempt was made to examine all trees within view and only those directly adjacent to the survey route were included in the survey. Dense stands of young trees were generally avoided due to difficulties in adequately assessing their health through an inability to observe the trees in their entirety and/or differentiate the crown of one individual from another. Where such stands were surveyed, only the outermost trees, for which a clear view could be had, were examined and categorized.

Tree classification

Trees were assessed primarily for the progressive loss of leaves associated with the disease on both surveying occasions. Although such symptoms can be induced by a range of factors other than *H. fraxineus* (Kopinga and De Vries, 2017) it was assumed that most of the symptoms observed were likely to be due to the disease and not other causes (see **Figure 1**). Each tree was scored according to the observable degree of dieback using a system much simplified from that used by Keßler et al. (2012) (**Box 1**).

Figure 1. Young ash trees near Swindale beck (Brough) showing advanced symptoms of AD (class 3).

Box 1. Symptoms classification

Class 0. Ostensibly healthy - trees with intact canopy.

Class 1. Mild symptoms - <10% crown volume loss.

Class 2. Pronounced symptoms - >10% to ca. 70% crown loss.

Class 3. Severely affected trees - <30% crown remaining, remnant epicormic growth only or dead.

Trees that were not overtly affected (no obvious leaf loss) were more extensively examined for areas of dead/dying leaves associated with dieback. Such trees fell into classification 1. A subset of the trees were revisited in order to classify them according to their age/size. This classification was somewhat subjective and trees were categorized as described below (**Box 2**).

Box 2. Tree size classification

Young – saplings and young trees up to ca. 3.0 m in height (<20 years old).

Medium – smooth-barked poles >3 m in height.

Mature trees – trees with grooved bark, typically >100 years old.

Mapping

Whenever possible, the position of each surveyed tree was recorded using the mobile Geographic Information Systems (GIS) application SW Maps running under Android on a tablet computer. The precise location of a small number of trees could not be determined due to the absence of a reliable Global Positioning Signal (GPS) signal. The data collected in SW Maps were exported as comma delineated (*.csv) files to the desktop GIS package QGIS 3.14 and subsequently mapped to allow examination of the spatial distribution of affected trees.

Tree cover in the area immediately surrounding the survey areas was calculated from the European CORINE land-use dataset (https://land.copernicus.eu/pan-european/corine-land-cover) using the procedures described by Bell (2020) and compared to values generated using UK Ordnance Survey (OS) digital maps (https://www.ordnancesurvey.co.uk/business-government/products/open-zoomstack) of the same area.

In addition to this, woodland coverage was also calculated *de novo* from aerial photography (primarily Google satellite imagery). The area for which woodland cover was calculated encompassed 251 km^2 of the valley floor to the east of the town of Appleby (54.58°N, 2.49°W) and bounded by the edge of the open moorland to the north, east and south of the survey areas.

RESULTS

Levels of infection

The symptoms of AD were present in 76% of trees examined in and around Kirkby Stephen, whilst around Brough the incidence of dieback was slightly less at 73% (**Figure 2**). Highest disease levels (86%) were recorded in surveys of trees growing alongside minor roads between Kirkby Stephen, Brough and Appleby. Wherever possible, the location of surveyed trees was recorded and mapped to allow examination of the distribution of affected and unaffected trees. **Figure 3** provides an example of the maps generated, in this case for ash included the Kirkby Stephen survey area. It was possible to see only weak clustering of highly affected trees and groupings of unaffected individuals. The measurement of the distances between healthy trees and the nearest diseased individual indicated that only *ca.* 21% of the 261 unaffected ash trees identified across the entire survey were >30 metres from the nearest affected individual.

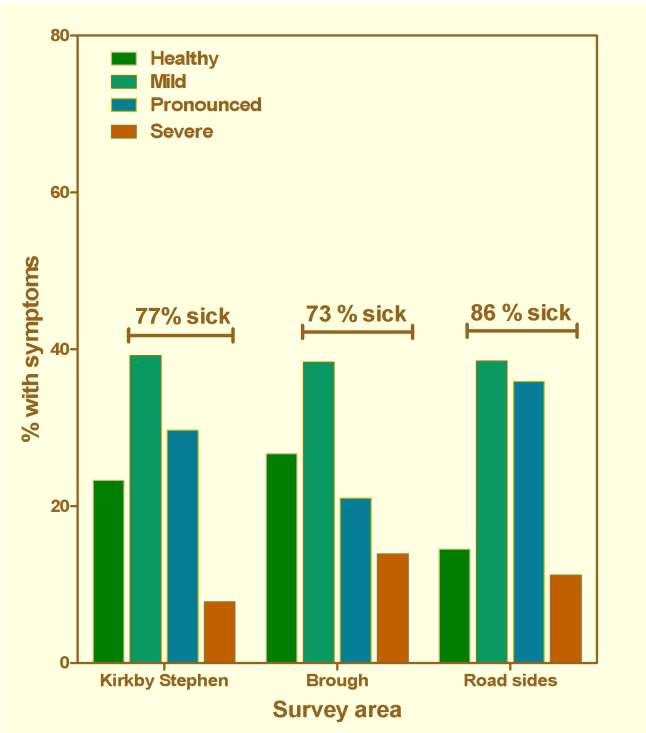

Figure 2. The percentage of trees showing the symptoms / absence of symptoms of ash dieback.

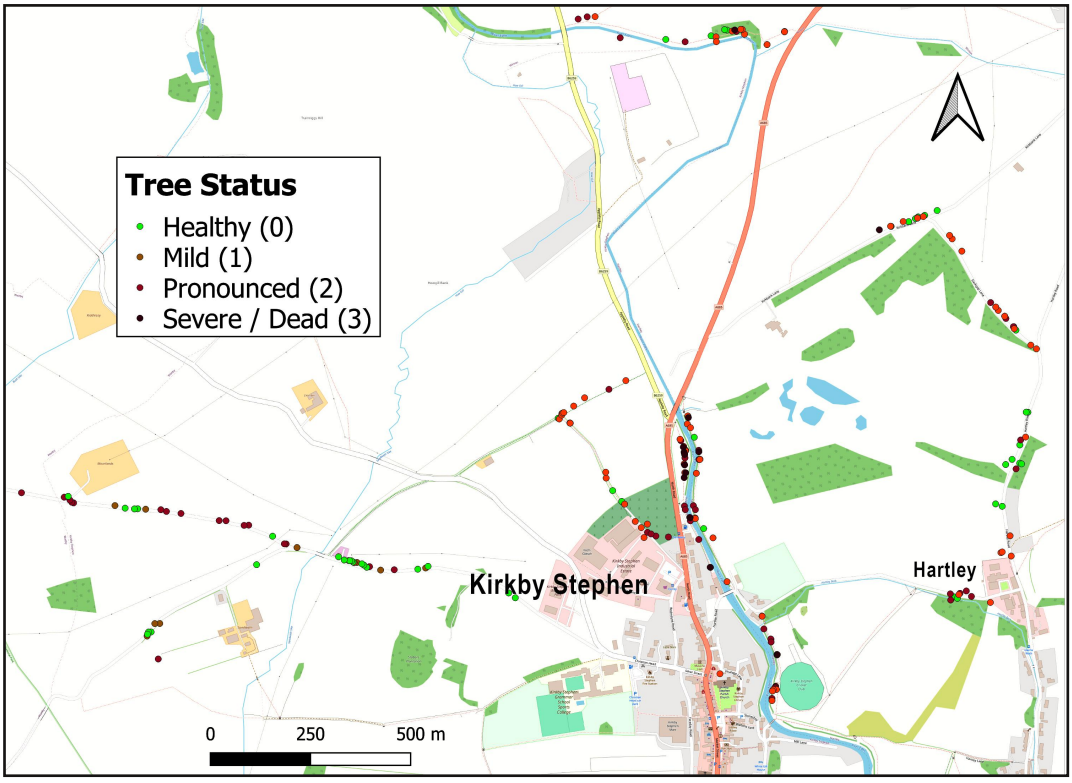

Figure 3. Distribution of affected ash trees in and around Kirkby Stephen. The survey focussed on free-standing trees and, for the most part, dense stands were avoided.

Dieback extent by land use type

Figure 4 plots data extracted from the datasets (summarized in **Figure 2**) in order to place diseased trees within certain types of land. Here, it can be seen that Highfield Farm (Brough) had the lowest incidence of the disease, at *ca.* 69%. On the other hand, trees found within Swindale Wood (Brough), an area comprising a mixture of mature and recently planted ash, were symptomatic in over 88% of cases. A stand comprised exclusively of ash poles (no other species present) planted 45 years ago and lying adjacent to the A66 trunk road (Brough) was symptomatic to the extent that only 2.9% of the trees were categorized as healthy. However, a second group of similarly-aged poles growing within a mixed-species stand, situated on Highfield Farm (and included in the data for that area, **Figure 2**), showed much less signs of disease with only 48% of the trees showing disease.

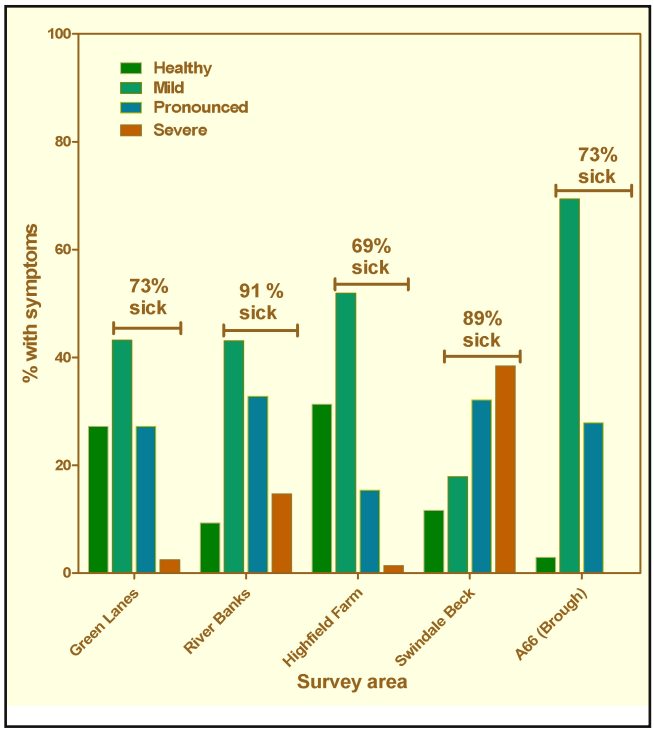

Figure 4. The occurrence of AD within different land use type areas. This is a subset of the full data set.

Impact of tree size on disease extent

A selection of trees were classified by approximate size in order to examine whether age of the trees affects the likelihood that they were infected with the disease. The data, plotted in **Figure 5**, indicates that, overall, small trees and saplings were the most likely to be diseased whilst medium and larger/older trees showed the least signs of disease. Most noteworthy was the fact that the majority of trees showing pronounced or severe symptoms were in young/small category.

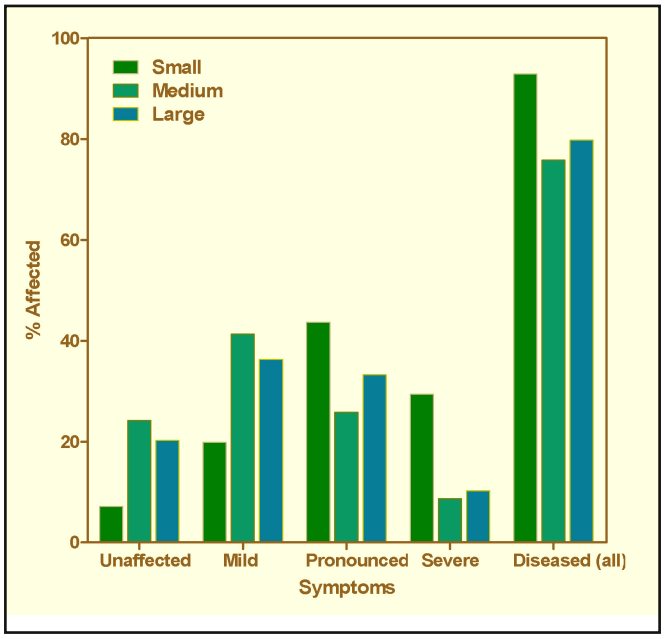

Figure 5. The extent of AD in trees of different sizes. Data is a subset of the whole data set (around 75% of trees examined had their sizes determined).

DISCUSSION

It is now becoming very clear that a significant proportion of the ash trees in the UK are likely to die within the next decade or so. The data presented here for a small area in northern England suggests that around three quarters of trees in that region are now exhibiting signs of dieback and it is possible that many of the remaining, unaffected, trees will develop the disease in the coming years. As a result, surveys of this nature are now probably of limited value and simply serve to highlight the fact that action needs to be taken to make good the inevitable loss of most of these trees

Whilst the data presented here could have been examined at a more granular level with respect to different areas (parks, open farmland, riverside areas, woods etc.) it is unlikely that any additional value would be extracted from the data. The information presented here does, however, indicate that some of the areas surveyed have significantly lower incidences of the disease than others but, due to the arbitrary nature of the areas chosen, it is unlikely that this provides firm evidence to suggest that certain land-use types will ultimately be less affected than others. It has been noted previously, however, that the rapidity of the onset of ash dieback can be influenced by a number of environmental factors, such as soil quality and draining characteristics, the proximity of other trees and the sex of the individual, amongst others (Enderle et al., 2019). The current study may, therefore, suggest that the progress of the disease is least rapid in the areas most suitable to ash growth (e.g. well-drained open farmland) and is more pronounced in damper/poorer soils and/or at higher elevations such as the those found in the wooded areas and riverside zones examined here.

Approximately 25% of the trees examined appeared unaffected. In many cases these trees were found in close proximity to diseased individuals (see **Figure 6**), which may suggest that some ash express a degree of resistance to the disease. Continued surveying of these (healthy) trees over coming years will enable this premise to be substatiated.

In more diverse and extensively wooded areas of England, such as the South East and, for example, Herefordshire, loss of *F. excelsior* is not likely to be as impactful to the landscape as larger numbers of hardwood trees will remain, despite these regions having significant numbers of ash. In other areas, such as eastern Cumbria, however, where this species often predominates, the effects of loss of ash will be more keenly felt. This fact alone can be illustrated by the fact that within the 16 hectares of Highfield Farm

Figure 6. A severely affected medium sized ash tree (middle) with two unaffected trees (right) and a slightly affected tree (left).

(Brough survey zone) 214 ash were surveyed that, when added to the *ca.* 40-50 that could not be evaluated, comprised more than half of all the trees present within that area. It is likely that this farm is broadly representative of the farmland in and around the areas surveyed and would suggest around 350-400,000 ash trees are at risk in the Upper Eden Valley. Estimates of how many trees will ultimately be killed by ash dieback in the UK and elsewhere vary, with values up to 80% indicated (Coker et al., 2019). If the higher mortality estimates are realised within the Eden Valley, given the fact that almost 80% appear affected currently, a very denuded environment will ensue. It is particularly concerning to note that a proportion of the ash included in the present survey had been planted relatively recently (last 20-45 years), or comprised re-growth, and, as a consequence, the disease will not only remove many long-established trees but also impact upon newer plantations that were destined to increase tree cover within the study area over the coming years. The corollary of this is that despite governmental initiatives to increase woodland cover over coming decades, in some areas of the UK tree cover is likely to be in decline at the present time.

When total tree cover was examined, estimates varied wildy for the Upper Eden Valley. The European CORINE dataset gave just 4% cover whereas the Ordnace Survey data gave around 13%. Calculations made *de novo*, however, produced what is likely a far more realistic value of around 7%. This value serves to indicate the poor tree coverage present in the valley and reinforces the need to take action to make good losses due to AD.

The management of ash dieback has received significant attention, particularly with respect to reducing species loss, identifying alternative tree species and maintaining woodland cover. Much of this work appears to consider ash primarily in the context of discreet stands of trees, such as Mitchell et al. (2014), or from the point of view of local authority management of trees on public land (Ambrose-Oji et al., 2019), and provides options appropriate to those situations. However, areas such as those examined here, where ash is most apparent as a freestanding tree within a pasture-dominated landscape, require more attention. Given the extent that the disease is now present, it is very clear that management strategies need to be implemented that seek to replace ash

with suitable, and ecologically valuable, alternatives such as oak (*Quercus* spp.) and beech (*Fagus sylvatica*). In open/field margin situations the replacement of diseased trees may only be possible following the removal of the dead/dying individual and a programme of selective felling of a proportion of affected trees would appear to be strongly indicated in order that restoration of the aesthetic and ecological characteristics of the landscape is achieved as soon as is possible.

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