The ash population in Wytham Woods

K. J. Kirby
published online September 2020

Summary

Ash (*Fraxinus excelsior)* is one of our most abundant broadleaved trees, but its future is uncertain because of Ash Dieback. The results from 164 permanent plots sited across Wytham Woods, recorded five times since 1974, provide a baseline against which to measure changes in the ash population prior to the disease reaching the Woods in 2017. Since 1974 ash had been expanding its contribution to the canopy and was the most abundant tree species amongst the seedlings of the forest floor. Its future importance is likely to be much less – many trees are starting to show canopy reductions of 10-20%, but the impacts will vary greatly across the Woods. Hazel (*Corylus avellana)* and sycamore (*Acer pseudoplatanus)* are the tree species most likely to increase after the decline of ash.

Introduction

Common ash (*Fraxinus excelsior)* is one of our most abundant broadleaved trees (Forestry Commission, 2012), but its future contribution to our woods and in the wider countryside is threatened by a dieback disease caused by the fungus *Hymenoscyphus fraxineus* (Forestry Commission, 2018). This species, initially identified as *Chalara fraxinea*, originates in East Asia; there the associated ash species are tolerant of its effects, unlike what happens when it infects European ash. There is therefore concern as to what the potential consequences – ecological, economic and social – will be if there is a major decline of ash (Hill *et al.* 2019 a, b; Mitchell *et al*. 2014). In Wytham Woods researchers will over the next four years be following the changes in the flora and fauna that take place as the ash trees become infected, from soil invertebrates to the birds of the canopy. Here, as background to this new work, I look at how the ash population has changed over the last 45 years, pre-Ash Dieback. The results provide a baseline for interpreting future changes to the structure and composition of the Woods.

Wytham Woods – Oxford's Laboratory with Leaves

Wytham Woods lie 8 km north-west of the city of Oxford in southern England (latitude 51^{o} 46' 38.4''north; longitude 1^{o} 20' 23.56'' west; elevation 60-160m above sea level). They comprise about 400 ha of mixed, mainly broadleaved woodland with a variety of histories and origins, that were acquired by the University of Oxford in 1942-43 https://www.wythamwoods.ox.ac.uk/home. Since then the Woods have been the subject of numerous research projects, in some cases extending over several decades (Savill *et al.* 2010).

One such long-term study, focussed on the vegetation was initiated as part of a NERC-funded project in the early 1970s. Dr Colyear Dawkins and colleagues from the Department of Forestry set up 164 permanent vegetation plots (each 10x10 m) at alternate intersections of a 100x100m grid across the Woods (Dawkins and Field 1978). For each plot they collected data on the ground vegetation, tree and shrub layers, and soils. Subsequent re-recordings of the plot system were made in 1991, 1999, 2012 and 2018 (Kirby *et al*. 1996; Kirby 2010b). Another full recording is planned for 2023.

The Dawkins Plot Methodology

The plots are offset from the relevant grid-points by 14.1m in a north-easterly direction. The south-west and north-east corners are marked by buried metal markers, so it is usually possible to relocate these plot corners exactly using a metal detector. Tapes are then laid out along the sides and diagonals of the plots.

Details of the ground vegetation and soil recording are given elsewhere (Dawkins and Field 1978; Kirby 2010a). For the woody layers:

- A list was made of all tree and shrub species in the plot;
- The stem diameters at breast height (dbh) of the four largest trees were measured; in 2018 this was extended to all trees in the plot;
- Canopy cover (>2.5m), split by species, and shrub cover (all species) (0.5-2.5m) was estimated across the south-west/north-east plot diagonal;
- The basal area of the trees in the plot and its surroundings estimated by relascope sweeps from plot corners (Bitterlich 1984) to provide a wider measure of the composition of the Woods;
- Regeneration (presence of seedlings or saplings up to 1m tall) was recorded in 13 $0.1m^2$ sub-plots positioned evenly along the two diagonals of the plot.
- In 2018 a canopy photograph was taken from the centre of the SW-NE diagonal using a mobile phone and Blackeye fisheye lens: these data have not yet been analysed.

The above data are supplemented in this paper by earlier accounts, notably the history of the Woods by Grayson and Jones (1955), the diaries of Elton (1942-1965) and the management plans prepared for the University shortly after they acquired the Woods (Anon 1950; Osmaston, 1959).

Results

Pre-1974

A part of the ancient woodland in the north of Wytham Woods is called Great Ash Hill, but in the nineteenth century much of the Woods was coppice with oak standards. Oak was still the most common species amongst the larger trees when the University acquired the Woods in 1942. A survey conducted in 2011 reported 218 ash >80 cm dbh, but that is compared to 1348 oaks >80 cm (Ella Cole personal communication). Some of the larger, veteran ash may have been managed as pollards on Wytham Common when that was still open and being grazed during the 18^{th} and early 19^{th} centuries.

A stand of just over a hectare of ash was planted in the Great Wood in 1933 and has grown well since. The potential for ash (some stems of 150 yrs-old but sound and 90 cm in diameter) was also noted in the early management plans. The University consequently planted ash, pure and in mixtures, between 1950 and 1962 (Figure 1). Prior to the 1954 myxomatosis outbreak, regeneration had been kept in check by rabbits, but by 1959, a cohort of young ash and sycamore natural regeneration was getting away. (Deer were not then a problem, with less than 15 individuals across the Woods).

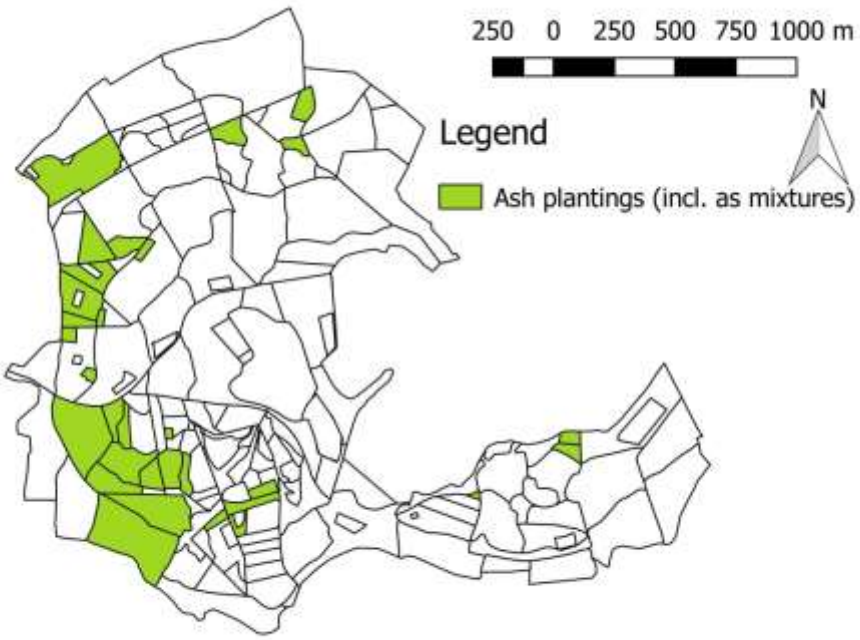

Figure 1. Ash plantations established in Wytham 1933-1961

Ash distribution 1974-2018

Ash can grow almost anywhere across the Woods and has been spreading, as judged by the records from the Dawkins Plots. It has gone from being present in 126 of the 164 plots in 1974 to 143 in 2018; mean canopy cover has increased from 18 to 25%; basal area from 2.8 m^2/ha to 11.6 m^2/ha. Of the four tree species that make up the majority of the Woods it appeared to be the most successful up to 2018 (Table 1).

Table 1. Changes in tree and shrub species abundance in Wytham Woods (1974-2018).

	No. of occurrences in plots					% Contribution to canopy					Basal area estimates (m^2/ha)				
Year	**1974**	**1991**	**1999**	**2012**	**2018**	**1974**	**1991**	**1999**	**2012**	**2018**	**1974**	**1991**	**1999**	**2012**	**2018**
Species															
Fraxinus excelsior	126	137	145	151	143	18	19	23	26	25	2.8	5.8	9.4	11.2	11.6
Acer pseudoplatanus	95	81	88	76	79	17	15	17	18	20	3	4.3	5.6	6.6	7
Quercus robur	58	47	46	45	39	12	10	9	7	8	3	4.5	5.5	5.6	5.3
Fagus sylvatica	30	32	29	37	31	10	10	12	11	10	1.6	2.5	4.1	4.1	4.4
Betula spp	32	23	16	16	11	5	3	2	2	2	1.1	0.9	1.4	1	0.9
Ulmus procera.	20	12	7	8	11	2.6	1.1	0.9	0.4	0.5	0.5	0.1	0.4	0.1	0.2
Acer campestre	33	25	22	33	30	3	2	3	2	2	0.6	0.7	0.8	0.8	0.8
Salix spp[1]	23	12	9	9	8	2	1	0.4	0.5	0.8	0.2	0.4	0.4	0.3	0.3
Ilex aquifolium	4	3	6	22	31										
Other broadleaves[2]	12	12	9	12	13	4	3	4	4	4	0.6	0.8	1.5	1.8	1.5
Conifers[3]	24	20	18	15	8	2	3	3	2	3	1.1	1.4	2.1	2.2	0.6
Shrubs															
Crataegus spp[4]	102	103	106	101	106	5	3	3	3	3	**Not recorded**				
Corylus avellana	63	52	52	61	61	7	7	8	10	8					
Prunus spinosa	30	32	32	32	28	3	1	2	1	0.5					
Sambucus nigra	54	40	20	14	13										
Euonymus europaeus	36	7	4	17	11										
Ligustrum vulgare	27	14	2	6	3	3.5	1.2	0.8	0.1						
Cornus sanguinea	26	13	7	6	4										
Other shrubs[5]	13	2	2	3	4										

1. Mainly *Salix caprea*, but some *S. cinerea*
2. *Aesculus hippocastaneum*, *Carpinus betulus*, *Castanea sativa*, *Malus sylvestris*, *Populus* spp., *Tilia europaea*
3. *Larix* spp., *Picea* spp., *Pinus* spp., *Pseudotsuga menziesii*, *Thuja plicata*, *Tsuga heterophylla*.
4. Mainly *Crataegus monogyna* but small amounts of *C. laevigata*.
5. *Rhamnus catharticus*, *Viburnum lantana*, *Viburnum opulus*

The abundance of ash varies across the Woods (Figure 2), and although from Table 1 it appears that Ash is the dominant species within the plots cited, this is not true throughout the Woods. Abundance is relatively low in the ancient semi-natural areas in the north and highest in the some of the areas allowed to grow up as woodland in the 19th century through the centre of the Woods. This means that the impact of Ash Dieback will not be uniform and may be relatively low in some of the blocks of most value in conservation terms.

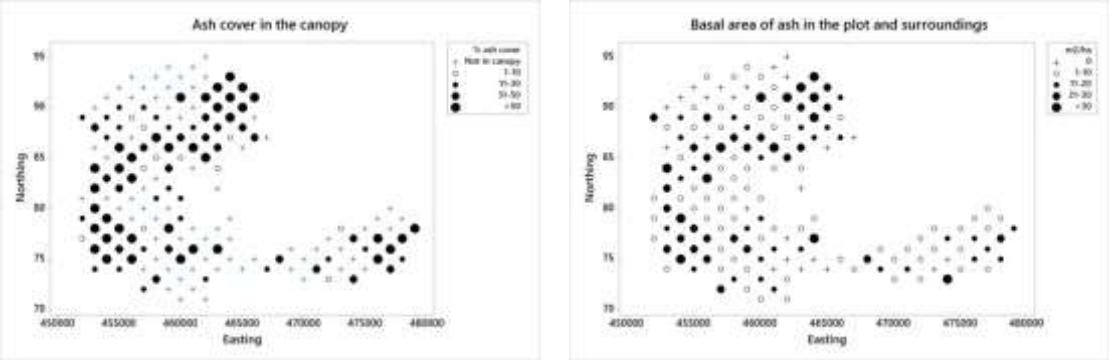

Figure 2. Abundance of ash in 2018 according to:

Figure 2a. canopy cover estimates above the plot

Figure 2b. basal area contribution in the plot and surrounding area

A preliminary age-diameter curve (Figure 3) has been constructed from ring counts of felled ash trees supplemented by the diameter of trees in plots with a known planting date. This can be used to interpret the records of diameters of the largest trees in the plot and for all trees in 2018 (Figure 4). Most of the trees appear to be less than 80 yrs-old, consistent with the comments in the late 1950s of a cohort of ash developing after the Second World War and post-war plantings.

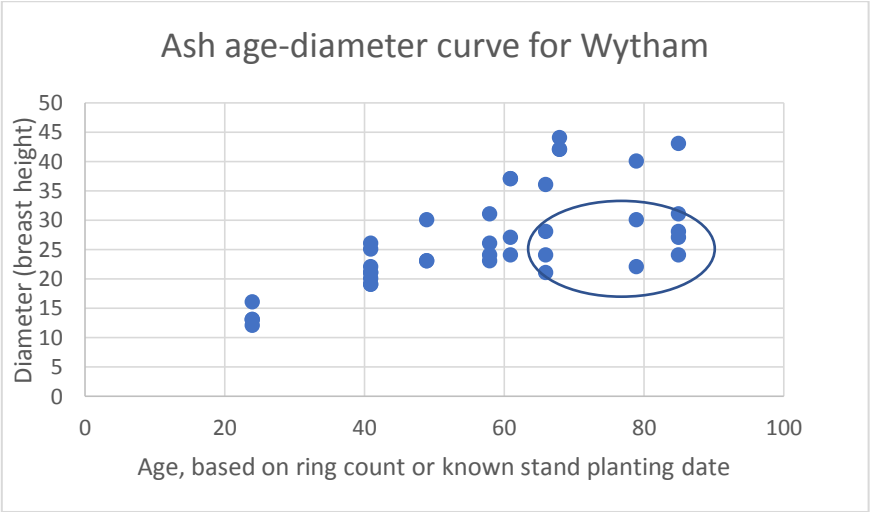

Figure 3. Age-Diameter (breast height) relationship (the circled stems are from stands of known planting date but are probably younger trees that grew up post planting).

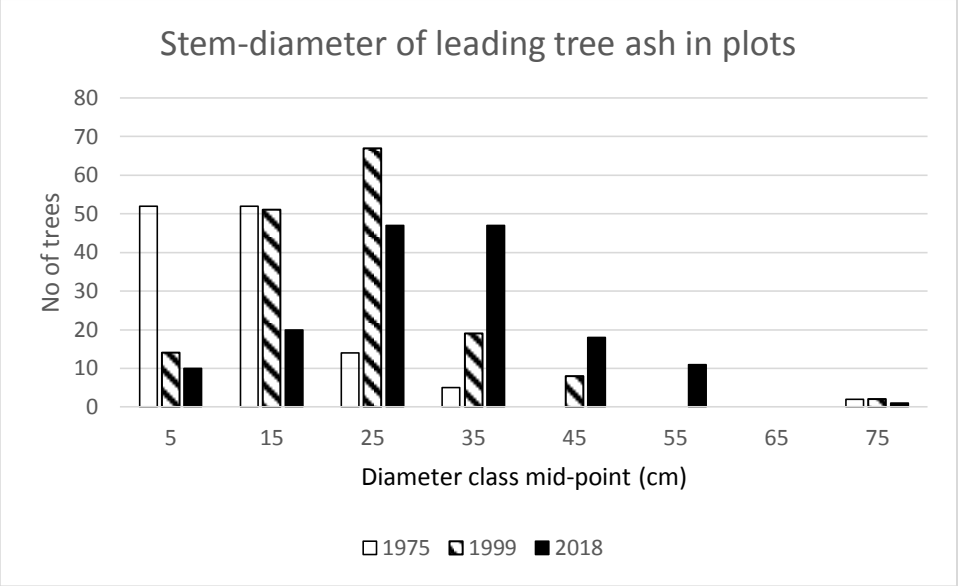

Figure 4a

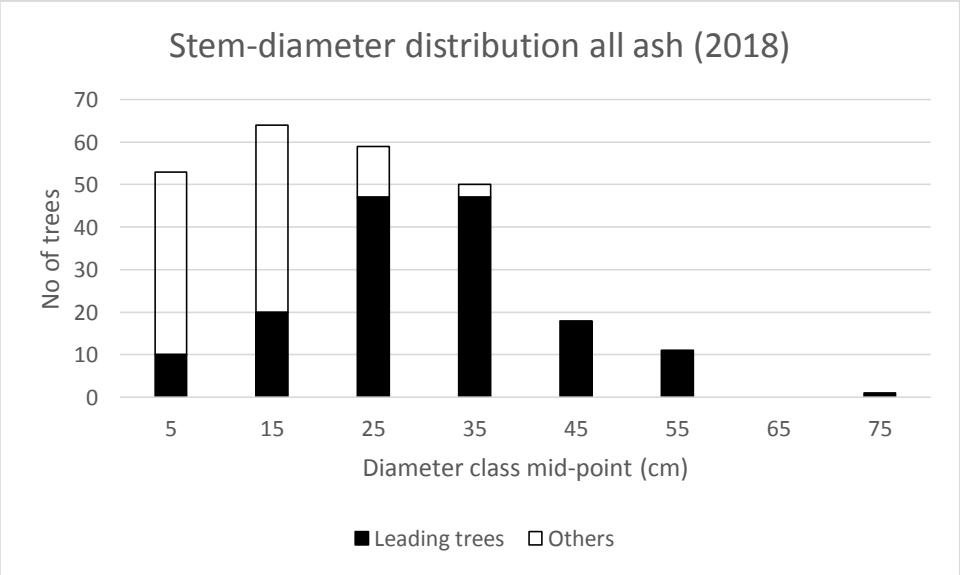

Figure 4b

Figure 4. Ash stem-diameter distribution (a) for 1974, 1999, 2018 for leading trees only (the four biggest in each plot), (b) all ash in plots in 2018

Ash was the most abundant tree or shrub species present as seedlings/saplings in the thirteen 0.1m^2 sub-plots and in 2012 and 2018 made up more than two-thirds of all such occurrences (Figure 5). In the 1990s when deer pressure was at its height few ash seedlings survived long-enough to grow to more than 20 cm tall, i.e. the population of recruits was simply turning over. From the mid-2000s more were developing into tall saplings. While walking through the Woods small clumps of young ash trees 2-4 m high could commonly be seen under canopy gaps. Unfortunately, saplings and young trees are particularly vulnerable to Ash Dieback and many of these saplings and young trees have since died.

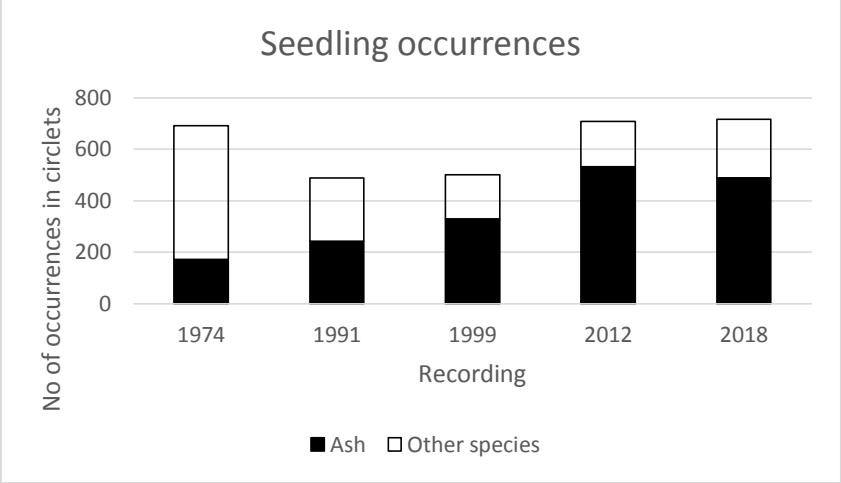

Figure 5. Contribution of ash seedlings/saplings compared to other woody species.

Discussion

The results from the Dawkins plots indicate that up until 2018 ash was the 'tree of the future' as far as Wytham was concerned. It was growing fast, increasing its canopy cover and regenerating better than the other main tree species. Similar increases in ash during the second half of the twentieth century in what had previously often been described as oak woods are not uncommon in the lowlands of Britain (Forestry Commission 2012) and have been seen in continental Europe as well (Hofmeister *et al*. 2004).

Since Ash Dieback was first identified in Wytham Woods in 2017 the trajectory for the composition and structure of the Woods has changed. Seedlings are still abundant, but casual observations suggest many larger saplings and young trees have died. Canopy trees showing 10-20% dieback are becoming common. We cannot predict yet how many affected trees will die. Up to 85% mortality has been recorded on the Continent, and surviving trees often show signs of infection and reduced canopy cover; however the impact may be less where ash is only a small part of the tree canopy (Coker *et al*. 2019; Grosdidier *et al*. 2020).

In small gaps created by Ash Dieback other tree species may be able to rapidly extend their branches into the space created. At Wytham the species most likely to benefit in this way are probably hazel (*Corylus avellana)* in the ancient semi-natural areas and sycamore (*Acer pseudoplatanus)* in areas disturbed by past planting (Kirby *et al.* 2014; Needham *et al*. 2016). Where ash makes up more than 30% of the canopy larger gaps may be created and these might be open enough for young oaks to establish. Any regeneration (whatever the species) will however be at risk from browsing by deer and subject to competition from the regrowth of bramble (*Rubus fruticosus)* that has been happening over the last two decades as deer numbers have been reduced.

A small percentage of ash trees appear to be little affected by the disease and this trait is partly heritable (Stocks *et al*. 2017, 2019). There is therefore the possibility that resistance may build up in the ash population through natural selection pressure acting on the population of ash seedlings and saplings. This though can only happen if deer pressure remains low enough to allow any resistant individuals to escape being browsed; and assumes potentially-resistant trees are not pre-emptively felled along with susceptible ones.

In some woods owners and managers may seek to reduce the uncertainty about the future state of their woods by felling affected ash and replacing it with other species (Broome *et al*. 2019; Forestry Commission 2018; Hill *et al*. 2019a; The Tree Council, 2020). At Wytham much of the woodland is under minimum intervention management, although some additional felling of ash has proved necessary for safety reasons along major roads and rides. This situation will be reviewed periodically. However, no major replanting is planned; where gaps open-up they will be left for natural regeneration, hopefully leading to the development of a more disease-resistant ash population. Meanwhile over the next four years, as the disease takes its course, the impact on the associated flora and fauna will be assessed in terms of changes in vegetation, birds and mammals, soil and litter organisms. The end result should be a better understanding of how woodland ecosystems function and their response to a major reduction in one of the keystone species, in this instance a species where the canopy is so much less dense than alternative and possible replacement species and with leaf litter particularly fast to break-down. The loss of ash trees from Wytham Woods may have more consequences than might be expected from just loss of abundance.

References

Anon 1950. *Working plan for 1949/50-1959/60 for the Woods of Hazel*, Wytham, Berkshire. Unpublished MS, Oxford.

Bitterlich, W. 1984. *The relascope idea. Relative measurements in forestry*. CABI, Wallingford.

Broome, A., Ray, D., Mitchell, R. & Harmer, R. 2019. Responding to ash dieback (*Hymenoscyphus fraxineus*) in the UK: woodland composition and replacement tree species. *Forestry*, 92**:** 108-119.

Coker, T. L., Rozsypálek, J., Edwards, A., Harwood, T. P., Butfoy, L. & Buggs, R. J. 2019. Estimating mortality rates of European ash (*Fraxinus excelsior*) under the ash dieback (*Hymenoscyphus fraxineus*) epidemic. *Plants, People, Planet*, 1: 48-58.

Dawkins, H. C. D. & Field, D. R. B. 1978. *A long-term surveillance system for British woodland vegetation. Occasional Paper 1*, Commonwealth Forestry Institute, Oxford.

Elton, C. S. 1942-1965. *Elton Archive: notes on the Wytham Area 1942-1965* [Online]. Available: http://ora.ox.ac.uk/objects/uuid:89c5e479-6003-45ba-bd78-8a8a12858bf1 .

Forestry Commission 2012. *NFI preliminary estimates of quantities of broadleaved species in British woodlands, with special focus on ash*. Forestry Commission, Edinburgh.

Forestry Commission 2018. Managing ash (*Fraxinus excelsior*) in woodlands in light of ash dieback (*Hynmenoscyphus fraxineus*). *Operations Note 046,* Forestry Commission, Edinburgh.

Grayson, A. J. & Jones, E. W. 1955. *Notes on the history of the Wytham Estate with special reference to the woodlands*. Imperial Forestry Institute, Oxford.

Grosdidier, M., Scordia, T., Loos, R. & Marcais, B. 2020. Landscape epidemiology of ash dieback. *Journal of Ecology*.

Hill, L., Hemery, G., Hector, A. & Brown, N. 2019a. Maintaining ecosystem properties after loss of ash in Great Britain. *Journal of Applied Ecology,* 56: 282-293.

Hill, L., Jones, G., Atkinson, N., Hector, A., Hemery, G. & Brown, N. 2019b. The £15 billion cost of ash dieback in Britain. *Current Biology,* 29**:** 315-316.

Hofmeister, J., Mihaljevič, M. & Hošek, J. 2004. The spread of ash (*Fraxinus excelsior*) in some European oak forests: an effect of nitrogen deposition or successional change? *Forest Ecology and Management*, 203**:** 35-47.

Kirby, K. J. 2010a. The flowers of the forest. In Savill, P. S., Perrins, C., Kirby, K. J. & Fisher, N. (eds.) *Wytham Woods, Oxford's Ecological Laboratory*. Oxford University Press, Oxford.

Kirby, K. J. 2010b. The trees in the Woods 1945-2007. *In:* Savill, P. S., Perrins, C., Kirby, K. J. & Fisher, N. (eds.) *Wytham Woods, Oxford's Ecological Laboratory.* Oxford University Press, Oxford.

Kirby, K. J., Bazely, D. R., Goldberg, E. A., Hall, J. E., Isted, R., Perry, S. C. & Thomas, R. C. 2014. Changes in the tree and shrub layer of Wytham Woods (Southern England) 1974–2012: local and national trends compared. *Forestry,* 87**:** 663-673.

Kirby, K. J., Thomas, R. C. & Dawkins, H. C. D. 1996. Monitoring of changes in tree and shrub layers in Wytham Woods (Oxfordshire), 1974-1991. *Forestry,* 69: 319-334.

Mitchell, R. J., Beaton, J. K., Bellamy, P. E., Broome, A., Chetcuti, J., Eaton, S., Ellis, C. J., Gimona, A., Harmer, R., Hester, A. J., Hewison, R. L., Hodgetts, N. G., Iason, G. R., Kerr, G., Littlewood, N. A., Newey, S., Potts, J. M., Pozsgai, G., Ray, D., Sim, D. A., Stockan, J. A., Taylor, A. F. S. & Woodward, S. 2014. Ash dieback in the UK: A review of the ecological and conservation implications and potential management options. *Biological Conservation,* 175: 95-109.

Needham, J., Merow, C., Butt, N., Malhi, Y., Marthews, T. R., Morecroft, M. & Mcmahon, S. M. 2016. Forest community response to invasive pathogens: the case of ash dieback in a British woodland. *Journal of Ecology,* 104: 315-330.

Osmaston, F. C. 1959. The revised working plan for the Wytham Woods 1959/60-1968/69. Unpublsihed MS, Oxford.

Savill, P. S., Perrins, C., Kirby, K. J. & Fisher, N. 2010. *Wytham Woods, Oxford's Ecological Laboratory*. Oxford University Press, Oxford.

Stocks, J. J., Buggs, R. J. & Lee, S. J. 2017. A first assessment of Fraxinus excelsior (common ash) susceptibility to *Hymenoscyphus fraxineus* (ash dieback) throughout the British Isles. *Scientific reports,* 7**:** 1-7.

Stocks, J. J., Metheringham, C. L., Plumb, W. J., Lee, S. J., Kelly, L. J., Nichols, R. A. & Buggs, R. J. A. 2019. Genomic basis of European ash tree resistance to ash dieback fungus. *Nature Ecology & Evolution,* 3: 1686-1696.

The Tree Council 2020. *Ash Dieback Disease - A guide for tree owners*. The Tree Council, London.

K. J. Kirby
Department of Plant Sciences, South Parks Road, Oxford, OX1 3RB, UK.
keithkirby21@virginmedia.com