Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

Countryside Survey

Distribution of Ash trees (*Fraxinus excelsior*) in Countryside Survey data

Lindsay Maskell, Peter Henrys, Lisa Norton, Simon Smart and Claire Wood

January 2013

(revised January 8th 2013)

Summary

Countryside Survey is a unique study or 'audit' of the natural resources of the UK's countryside. The Survey has been carried out at regular intervals since 1978. The countryside is sampled and studied using rigorous scientific methods, allowing us to compare new results with those from previous surveys. In this way we can detect the gradual and subtle changes that occur in the UK's countryside over time.

This report provides estimates of the area of ash trees (*Fraxinus excelsior*) in Great Britain in woods <0.5ha in size, the number of individual ash trees, the extent of ash in linear features and the trends in ash distribution in fixed vegetation plots. The areal extent of other common Broadleaf tree species are also provided.

Key Findings

- The estimated area of ash in Broadleaved woodlands <0.5ha in size is 38.51 000ha.
- Ash is found in different landscape components, in fields and field boundaries, alongside rivers and streams and particularly in hedgerows.
- Ash is the second most abundant tree species in small woodland patches (<0.5ha) in GB after Oak**.** It is more abundant in England (32.1 000ha) than Scotland (4.4 000ha) or Wales (1.99 000 ha).
- There are estimated to be 2.2 million individual ash trees (outside of woodland) in the countryside and ash is the 2nd most common species of individual tree.
- Most ash trees tended to be in low to mid-range DbH categories i.e. >40% between 21 and 50cm DbH. There were very few veteran ash trees.
- Ash is the most common hedgerow tree species (i.e. species growing as a full standard as part of a hedgerow)
- The estimated length of woody linear features (hedgerows and lines of trees) composed of ash is 98.9 000km across GB with most of this (86.1 000 km) found in England.
- In analyses based on repeated vegetation plots ash trees increased in number of plots occupied on linear features, which include hedgerows, between 1978 and 2007 and in the number of area (field) plots occupied between 1990 and 2007.

Further Research

- Development of monitoring protocols to capture impact of tree diseases
- Further development of a linear product to be able to scale from linears within a 1km CS square to all of GB.
- Further analyses of vegetation plot data (CS plot data and data from the GB woodland survey) to determine the potential impacts of ash on other plant species.
- Attribution of ash distribution and change in extent to multiple explanatory driving variables.

1. Introduction

This report has been produced in response to concern about ash dieback (*Chalara fraxinea*). In order to determine the potential impact of the disease it is necessary to understand the extent and distribution of ash trees in the countryside, not only the total extent but the spatial distribution, in which landscape components ash is most frequent e.g. in large woodlands, in small habitat patches, as individual trees or as part of a hedgerow.

2. Methodology

The Countryside Survey samples 1km squares across GB using a stratified random sampling system (based on landclasses which are comprised of the major national ecological gradients e.g. soils, geology and climate) (Bunce *et al*. 1996, Carey *et al*. 2008). This enables scaling up from samples to produce national estimates using the landclasses.

2.1 Areas

In each CS 1km square habitats are mapped and are assigned to a Broad or Priority Habitat, the dominant species are recorded according to Percentage cover categories (e.g. <10%, 10-25%, 25-50%, 50-75%, 75-95%, 95-100%). This data has been used to extract areas where ash is present. The Forestry Commission collect data on forests and woodlands across GB as part of the National Forestry Inventory and they have extensive information on the size, distribution, condition and composition of woodlands, the smallest sample size they report on is 0.5ha. Another difference between NFI/FC and CS is that they report on stocked areas (i.e. areas that are clear-felled but still part of a woodland management cycle are recorded as woodland) whereas CS is solely based on current land cover (i.e. felled woodland is recorded as the habitats currently dominating rather than woodland). The Forestry Commission are reporting on the extent of ash in large woodlands in a separate report 'Preliminary estimates of broadleaved species in British Woodlands' (http://www.forestry.gov.uk/forestry/INFD-935MSY).

Although Countryside Survey also surveys larger woodlands, to avoid conflicting figures this report will focus on woodlands less than 0.5 ha not sampled by the NFI. To avoid duplication we have overlain the NFI forestry map on CS squares and excluded any woodland parcels that are reported on by NFI. Using the percentage cover data (mid-point of the range) the average area of ash woodland within a 1km square by landclass has been calculated. This is multiplied by the area of each landclass and summed over all landclasses to create a national estimate in hectares for the areal extent of ash for GB which can be seen in Table 1. Upper and lower confidence intervals around the estimates are also given. More information about methods can be found on www.countrysidesurvey.uk.

2.2 Individual trees

Within each 1km square each individual tree outside of woodland is recorded along with an estimate of modal DbH. In the analyses presented here trees that were in small clumps were also included (less than a minimum mappable unit (mmu) of 20m x 20m; if they were above the mmu they would have been included in area analyses). These clumps were not included in previous analyses released in November so figures have increased slightly since then. Surveyors were also asked to record up to

10 veteran trees within each 1km square (maximum 2 per species), for these, additional information was collected such as presence of epiphytic species, presence of dead wood or hollow trunk. National estimates were created in a similar way to the areas from the number of individual trees within each 1km square which were recorded as point features (either in a field or as a hedgerow tree) using landclasses. Spatial analysis of CS data overlaying individual tree point data with linear data (hedgerows) was used to identify hedgerow trees and these are also reported on.

2.3 Woody Linear features (hedgerows and lines of trees)

Linear features are landscape elements less than 5m wide that form lines in the landscape. CS reports on the length and condition (and changes in these over time) of a range of linear features including woody linear features (hedgerows), walls and fences. Linear features have a minimum length of 20m and may include gaps of up to 20m. Two types of Woody Linear feature were recorded; those with Natural Shape (e.g. lines of trees, belts of trees) and those of Unnatural shape (hedgerows). In those with a Natural Shape, a proportion is recorded against each species present (recorded as: <10%, 10-25%, 25-50%, 50-75%. 75-95%, 95-100%, 'Individual Tree'). In order to calculate national estimates of ash within lines of trees, the length of ash recorded in each proportion band was calculated per 1km square (using the midpoint of the band i.e. 5%, 17.5%, 37.5%, 62.5%, 85%, 97.5%, 100%) similarly to areas. A 1km mean length of ash in lines of trees was obtained per sampling strata (Bunce et al. 1996). To obtain the final length estimate per country, the mean was multiplied by the area of each Land Class and totalled per country. To calculate the amount of ash contained in belts of trees (recorded as linear features in Countryside Survey) the same methodology was followed as per the lines of trees, the difference being that features recorded as 'Belts of trees' or 'Belts of scrub' were included in the analysis.

In WLF's with an unnatural shape, species composition is surveyed in a slightly different way to lines of trees in that individual species are not recorded against the length of the linear feature, instead they are recorded as 'mixed species', '>50% hawthorn' and '>50% other'. This meant that slightly different methods were used to estimate the proportion of hedgerow length depending upon the Woody feature type. In order to estimate the proportion of ash in hedges, it was necessary to analyse data from 'D plots' (vegetation diversity plots recorded in hedgerows, up to 10 per 1km square). A total percentage cover of each species present in the plot is recorded. To obtain a mean length of ash, the mean percentage cover from 'D' plots next to hedges was calculated per sampling strata (Land class, as above) and multiplied by the total amount of hedge measured in all sampled 1km squares in each strata (Land Class). The 1km means of these totals were multiplied by the area of the Land Class strata and then totalled per country.

2.4 Vegetation plots

A series of vegetation plots were located within each 1 km square using a restricted randomisation procedure designed to reduce aggregation (Figure 1). Linear features (road verges, watercourse banks, hedges, arable margins and field boundaries) and areal features (fields, unenclosed land and small semi-natural biotope patches) were sampled. Linear plots were 1 x 10 m laid out along a feature whilst unenclosed land and small biotopes were sampled using 2 m x 2 m plots. Larger randomly-placed plots were nested 14 m^2 plots with an inner nest of 2 m x 2 m. The significance of the change in occupancy of Ash across these vegetation plots and between pairs of surveys was

based on the value of a change index calculated using the same methods as Atlas 2000 but additionally accounting for the nested design of the survey.

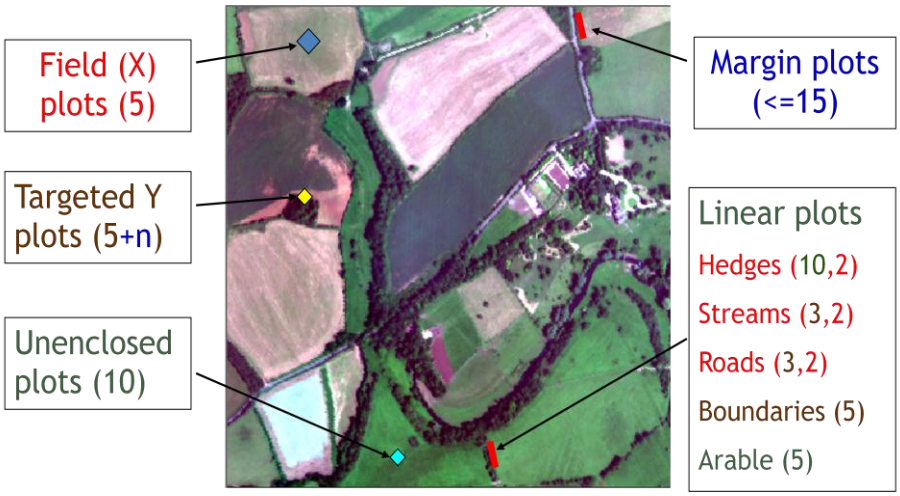

Figure 1: Distribution of vegetation plots within a 1km square. Colour coding of the text is as follows; red=plot types first established in 1978; brown=first established in 1990; green=1998; blue=2007.

3. Results

3.1 Areas

Table 1 presents the national estimates for the extent of ash and the other most abundant Broadleaved species in woodlands less than 0.5 ha in size.

Ash is the second most abundant tree species in small woodland patches (<0.5ha) in GB (38.5 000ha) (Table 1) after Oak**.** Out of the three countries, ash is most abundant in England (32.1 000ha) with some in Scotland (4.4 000ha) and less in Wales (2 000ha). In England, Ash is still second in abundance to Oak. In Scotland Birch is the most abundant tree followed by Oak, Sycamore and Ash. In Wales Oak is the most abundant, then Birch and then Ash.

Figure 2 shows the estimated distribution of ash in small woodland patches (<0.5 ha). The map has been produced by using estimates of ash area cover within a 1km square and weighting by the proportion of broadleaved woodland taken from the Land Cover Map. This is not an accurate spatially explicit map but it does give an indication of where ash is most abundant (South-east England) in small habitat patches and where it is least likely to be found (i.e. North-West Scotland).

Similar maps for all of the other broadleaved species can be found in Appendix 1.

Figure 2: Areal extent of ash based on % cover in Broadleaved woodland habitat parcels < 0.5 ha in size recorded in CS2007, distribution has been mapped using mean % of ash per landclass (based on 32 landclasses for GB used for the 1990 CS survey) then scaled to % of 1km by weighting by the proportion of Broadleaved woodland in each 1km square in the corresponding landclass according to Land Cover Map 2007.

High, medium and low densities are shaded.

Table 1: National estimates of the area extent of principal broadleaved trees in woodlands <0.5 ha

Principal species	000 ha	Lower confidence limit	Upper confidence limit
Great Britain			
Ash	38.51	28.85	48.17
Birch	35.23	19.61	50.85
Oak	48.41	37.79	59.04
Beech	8.89	6.33	11.45
Sycamore	21.70	16.76	26.64
Hazel	8.79	6.34	11.25
Hawthorn	26.89	19.58	34.20
Willow	9.24	6.18	12.30
Alder	4.84	3.34	6.33
Sweet Chestnut	1.36	-0.25	2.98
England			
Ash	32.07	22.79	41.35
Birch	14.58	5.62	23.53
Oak	35.71	27.45	43.98
Beech	5.92	3.72	8.12
Sycamore	14.76	10.90	18.62
Hazel	6.73	4.48	8.99
Hawthorn	22.47	15.60	29.33
Willow	5.84	3.17	8.51
Alder	2.31	1.42	3.21
Sweet Chestnut	1.33	-0.29	2.94
Scotland			
Ash	4.44	2.16	6.72
Birch	18.22	5.52	30.93
Oak	7.20	0.96	13.45
Beech	1.97	0.91	3.03
Sycamore	5.63	2.63	8.64
Hazel	0.50	-0.10	1.09
Hawthorn	2.74	0.37	5.10
Willow	2.35	0.99	3.71
Alder	1.41	0.40	2.42
Sweet Chestnut	0.02	-0.02	0.05
Wales			
Ash	1.99	0.56	3.42
Birch	2.43	0.92	3.93
Oak	5.50	3.13	7.86
Beech	1.00	0.23	1.76
Sycamore	1.31	0.62	1.99
Hazel	1.56	0.80	2.32
Hawthorn	1.69	0.82	2.55
Willow	1.05	0.40	1.69
Alder	1.12	0.47	1.76
Sweet Chestnut	0.02	-0.01	0.06

3.2.1 Individual Trees

There are estimated to be 2.2 million individual ash trees outside of woodlands in GB (Table 2). This also includes those in small clumps less than the Minimum Mappable unit for CS (20m x 20m). Most of these are found in England (1.8 million) with Scotland and Wales having smaller numbers (147 000 and 240 000 respectively).

Figure 3 shows the distribution of individual trees displayed as a mean per landclass. Unlike the area map we were unable to scale by the Land cover Map and the presence of areas of Broadleaved woodland so the landclasses themselves have been mapped and shaded.

Table 2: National estimates of the number of individual ash trees

	Number of Trees	Lower confidence limit	Upper confidence limit
Great Britain			
Individual Ash trees	2208213	2049303	2367123
England			
Individual Ash trees	1821284	1669874	1972695
Scotland			
Individual Ash trees	146795	104617	188974
Wales			
Individual Ash trees	240133	216719	263547

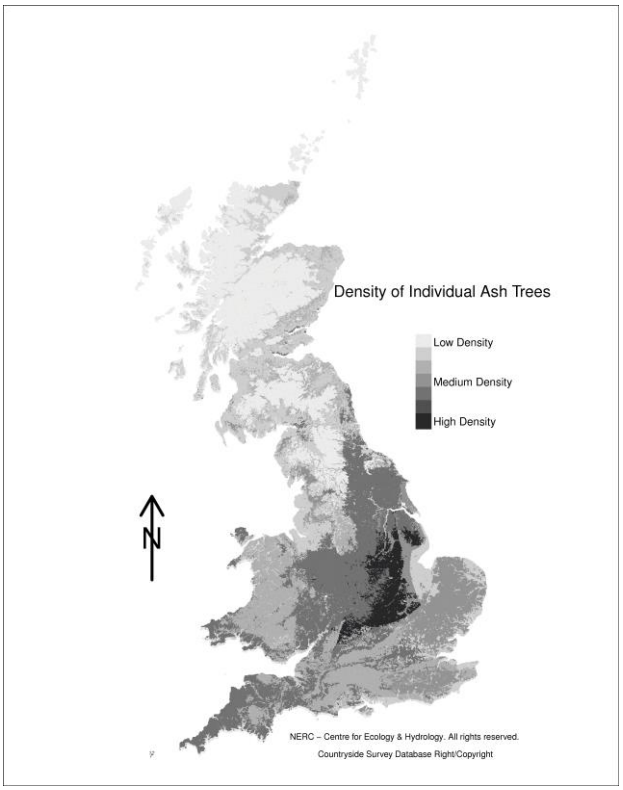

Figure 3: Distribution of individual ash trees using CS 2007 point data. The mean number of individual ash trees per landclass has been scaled up using landclass extent. Unlike Figure 1 this map is not based on the Land Cover Map so the land classes are mapped directly and colored appropriately (see Barr 2000)

Ash is the second most common species of individual tree (Figure 4).

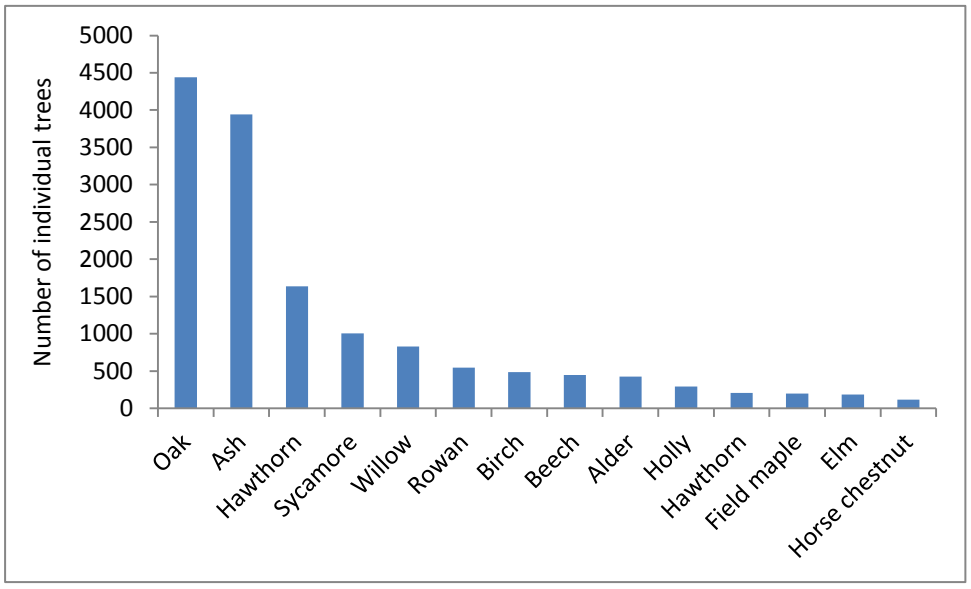

Figure 4: Number of individual trees recorded in CS 1km squares by species in total across GB

Surveyors were asked to identify veteran ash trees in the field using a DbH of >2m as a guide to potential veteran/interesting trees. Surveyors recorded ash as veterans across a range of different diameters, with most falling into the 1-2m category. This may reflect surveyor error or tree variability under different environmental or management conditions including ash in extreme upland environments or coppiced ash, with an ancient stool but narrow individual trunks.

Figure 5 shows the age distribution (by DbH) of individual ash trees recorded in CS 1km squares. Most of the trees are in the mid-range with only a few very old veteran trees.

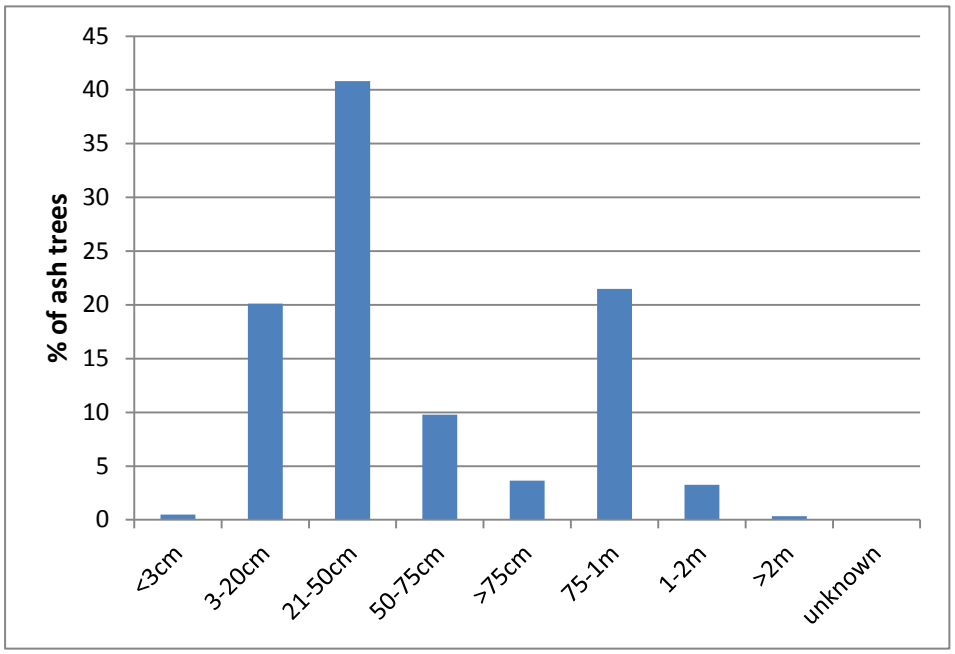

Figure 5: Distribution of age classes (DbH) of *Fraxinus excelsior* mapped as individual trees

3.2.2 Individual trees: Hedgerow trees

Ash is the most frequent hedgerow tree species (Figure 6) (this doesn't include the hedgerow itself only the individual trees associated with a hedgerow). Oak is the next most frequent but none of the other species are close to the frequency of ash and oak.

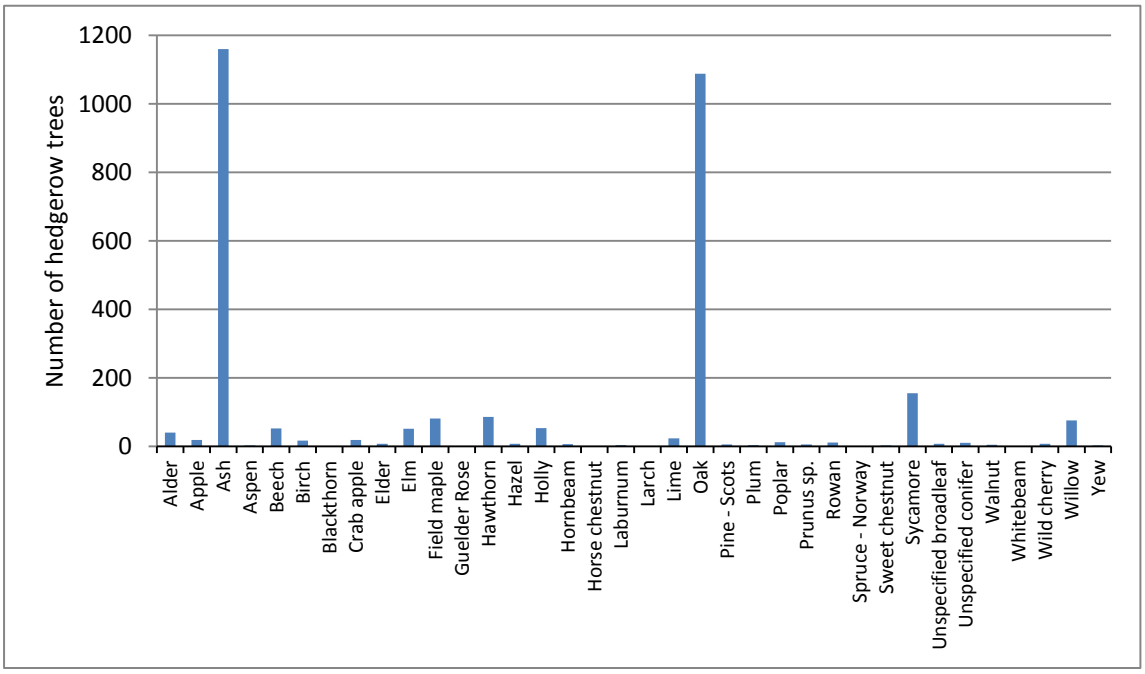

Figure 6: Numbers and species of hedgerow trees recorded in the CS 1km square mapping.

3.3 Woody Linear Features (Hedgerows and Lines of Trees)

The estimated length of linear features composed of ash is 98.9 000km across GB (Table 3). Ash is most abundant as a component of woody linear features in England (86.1 000km), of these it appears to be an important hedgerow component (66.3 000ha) (in addition to its occurrence as standard hedgerow tree as discussed above) but is also found as a component of lines of trees (19.7 000ha). Ash is much less frequent in linear features in Scotland and Wales (slightly more frequent in hedgerows in Wales than Scotland).

Table 3: Total length of Woody Linear Features (WLF) ('000s km) containing ash

	Lines of Trees	Hedgerows	Belts	Total WLF
Great Britain				
Length of woody linear feature ('000s km)	23.6	75.1	0.1	98.9
England				
Length of woody linear feature ('000s km)	19.7	66.3	0.1	86.1
Scotland				
Length of woody linear feature ('000s km)	1.6	2.1	0	3.7
Wales				
Length of woody linear feature ('000s km)	2.3	6.7	0	9.1

Figure 7 shows the estimated mean density of ash in woody linear features (lines of trees, belts of trees and hedgerows) across GB as a mean length per km square per landclass.

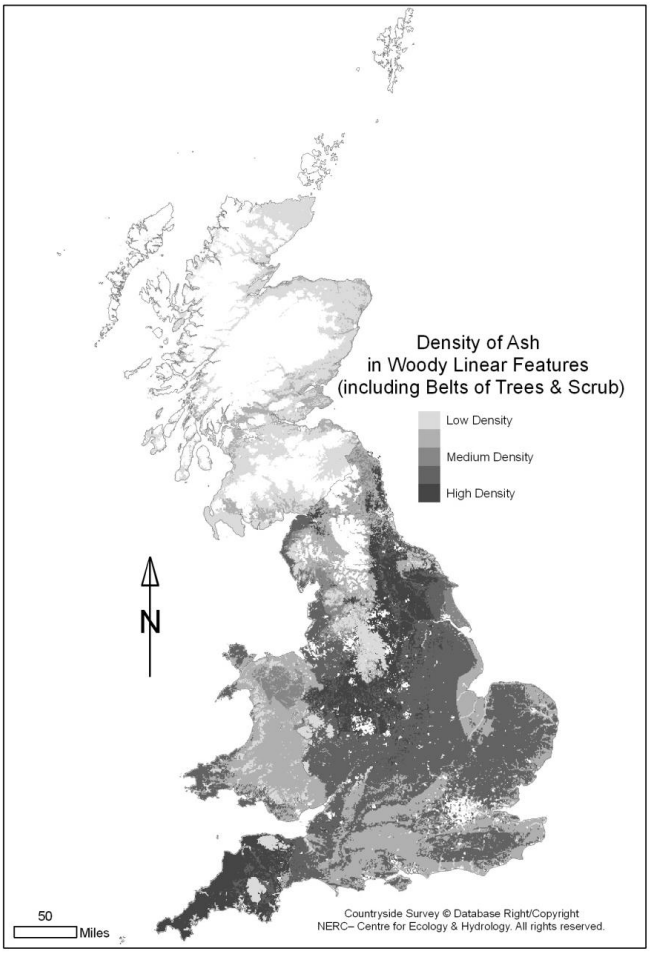

Figure 7: Distribution of ash trees in woody linear features using CS 2007 linear data. Data from lines of trees, belts of trees and hedgerows has been determined using slightly different methods to obtain a mean length per km square and per landclass then scaled up to GB using landclass extent.

4.4 Vegetation plots

Ash is found in different landscape components, in fields and field boundaries, alongside rivers and streams and particularly in hedgerows. It was found in 30% of hedgerow plots (Table 4).

Table 4: Data from CS 2007 Vegetation plots, number of plots containing ash (*Fraxinus excelsior*), percentage of total plots containing ash and mean cover of ash in different plot types.

Plot types	Number of plots	Percentage of total plots	Mean cover
Boundary	216	11	23.8
D (Hedge diversity plots)	720	30	17.7
H (Hedge plots)	121	20	20.8
M (Arable margins)	6	5.4	18.8
RV (Roadside)	211	9.8	19.7
SW (Streamside)	313	13.3	24.8
X (Field plots)	139	5.1	15.5
Y (Small habitat patches)	257	9.7	30.9

Changes in distribution of Ash

Ash (*Fraxinus excelsior*) has increased across the countryside (as recorded in CS vegetation plots) on linear features between 1978 and 2007 (Figure 8). Increases were significant in linear plot types but not area plots; however ash has increased in area plots between 1990 and 2007 (Figure 9). Statistically significant change reflects the size of the change index value relative to the distribution of change indices for all species tested.

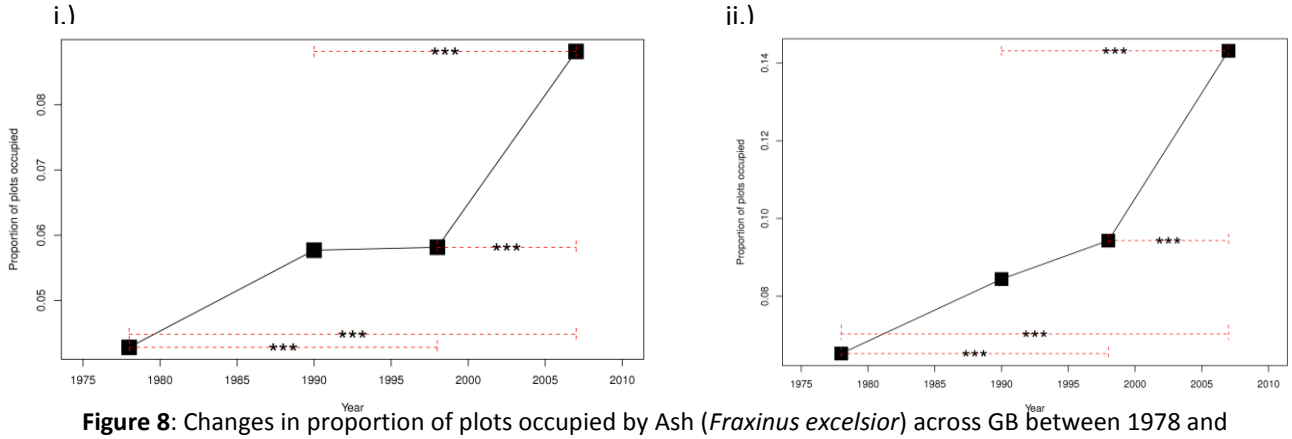

Figure 8: Changes in proportion of plots occupied by Ash (*Fraxinus excelsior*) across GB between 1978 and 2007 in i.) all plot types, ii). Linear plots only. Red-dashed lines show statistically significant results, ***=p<0.001

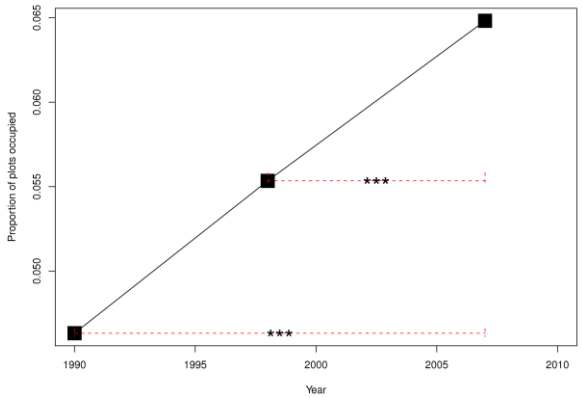

Figure 9: Changes in proportion of area plots in GB occupied by Ash between 1990 and 2007

Discussion

This report uses countryside survey data to estimate the extent of ash in small woodland patches, as individual trees and on linear features. We have also attempted to create spatially explicit products i.e. maps either based on land class distribution or where possible using the Land Cover Map 2007. This is novel work and we hope to build on it in future.

These results show that ash is a significant component of the British countryside. Although within small woodland patches other tree species are also quite abundant (e.g. oak, birch, hawthorn) ash is very importan. Ash is the second most frequent individual tree species (after oak) and much more common than most other tree species. Individual ash trees tend to be small to medium in size (<1m DbH) and veteran trees are rare, however, they are still an important component of the countryside and likely to provide habitat for birds and invertebrates.
Ash is the most common hedgerow tree (as a hedgerow standard), oak comes a close second but all of the other tree species are much less frequent, so if ash is lost there will be a significant gap. Ash is also an important hedgerow component and is estimated to form 98.9 000kms in length of woody linear features (hedgerows and lines of tree) across GB (mostly in England). We have not provided data on other tree species as components of linear features as a comparison.

The vegetation plot data has been used to determine the location of ash trees within the landscape and change over time. Ash is found along linear features particularly streamsides and hedgerows, it does appear to be more prevalent in small habitat patches than in larger areas of woodland. Between 1978 and 2007 ash increased along linear features, analyses to determine causes of change have not yet been carried out, one possibility is that this was a response to the loss of elm trees, however, the first CS was in 1978 after the elm had been lost so it is not possible to test this. Ash was also found to have increased in area plots between 1990 and 2007 and certainly appears to have been a species that has become more abundant in all parts of the landscape over recent years.

Future work

The area and individual tree data from CS2007 have been used to estimate extent and distribution of ash. In future surveys it would be possible to add to existing methods to survey tree diseases, extent of damage or mortality of trees. There could also be additional survey of trees within woodland e.g. recording DbH and veteran trees, currently this is not done in CS to avoid duplication by the FC, however, CS does survey quite different types of woodland to the FC and there could be additional complementarity by extending the methods.

The linear data has been used to create a map based on landclass means of length of hedgerow. With the area data it was possible to scale up and produce a more accurate map based on the distribution of broadleaved woodland in the Land Cover Map 2007. CEH are currently working on a linear product that combines CS field survey data, LIDAR, OS map data and the Land Cover Map. This would be similar to the Land Cover Map but solely for linear features. Using a product such as this it would be possible to scale up by mean per km square to the whole of GB.

As mentioned above it was not possible to use CS data to assess what impact the loss of elm species (through Dutch Elm disease) had on the British countryside. A virulent strain of Dutch Elm disease entered Britain in 1967 but dispersed slowly reaching Edinburgh in the late 1970's, there is a dataset

from 1971, the GB woodland survey which was re-surveyed in 2003 that might have some baseline data that could be used to detect the effects of the loss of elm. Further analysis of the woodland survey dataset would be a useful task. It would also be useful to carry out further analysis of the CS vegetation plot data to determine which species are associated with ash. Comparisons of plots with similar abiotic conditions with and without ash might help to determine which plant species would benefit from the loss of ash and which would suffer.

This report focuses on the extent and distribution of ash trees but does not attempt to explain this distribution by attributing extent, condition and changes to explanatory variables such as climate, soil type and dispersal patterns. One of the key strengths of the Countryside Survey dataset is that it collects data on soils, water, landuse, vegetation within the same 1km squares, we have also assembled many other datasets with potential explanatory data e.g. deposition, climate and developed analytical techniques to carry out analyses. Understanding past and present ash distribution in relation to multiple driving factors will help to develop models of future distribution including the impacts of ash dieback as an additional variable.

References

Barr, C.J. 2000. The sampling strategy of CS2000. Contract report for Defra.

Bunce R.G.H., Barr C.J., Clarke R.T., Howard D.C., Lane A.M.J. (1996) ITE Merlewood Land Classification of Great Britain. Journal of Biogeography 23:625-634

Carey, P.D.; Wallis, S.; Chamberlain, P.M.; Cooper, A.; Emmett, B.A.; Maskell, L.C.; McCann, T.; Murphy, J.; Norton, L.R.; Reynolds, B.; Scott, W.A.; Simpson, I.C.; Smart, S.M.; Ullyett, J.M.. 2008 Countryside Survey: UK Results from 2007. NERC/Centre for Ecology & Hydrology, 105pp. (CEH Project Number: C03259).

Appendix 1: Distribution maps of other Broadleaved species

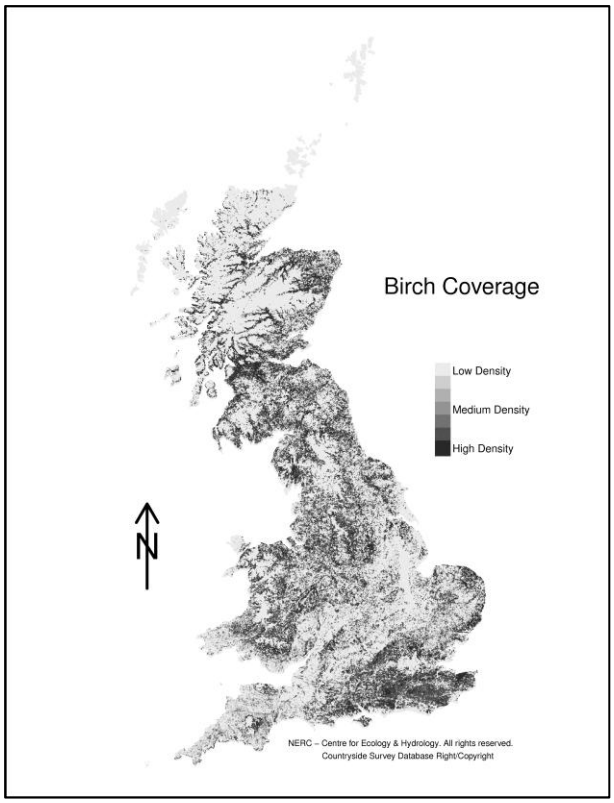

Figure i: Areal extent of birch (*Betula* sp.) in small habitat parcels < 0.5 ha using same methods as Figure 2 above

Figure ii: Areal extent of Oak in small habitat parcels < 0.5 ha using same methods as Figure 2 above

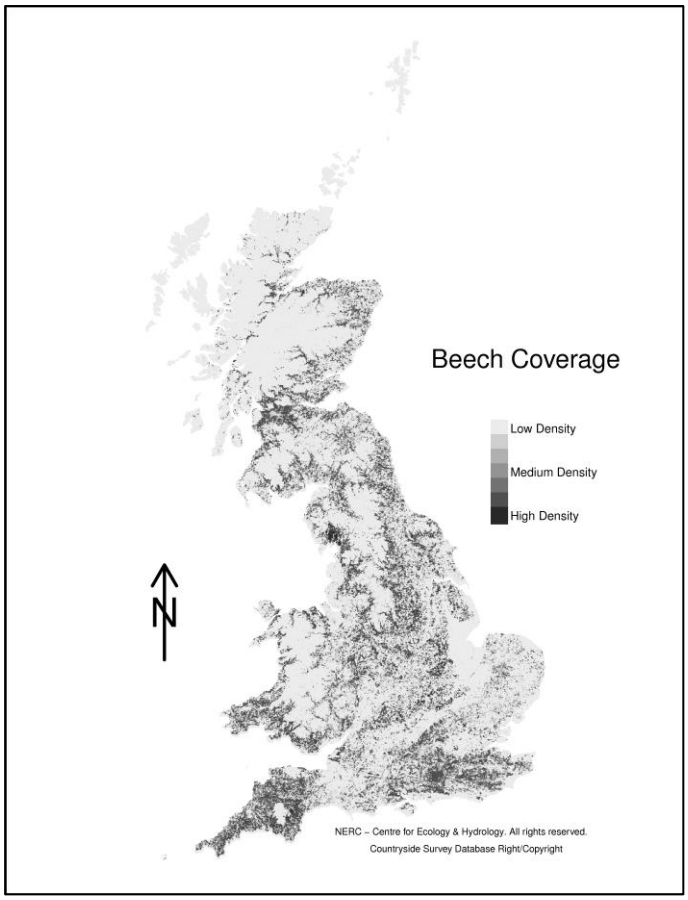

Figure iii: Areal extent of Beech (*Fagus sylvatica*) in small habitat parcels < 0.5 ha using same methods as Figure 2 above

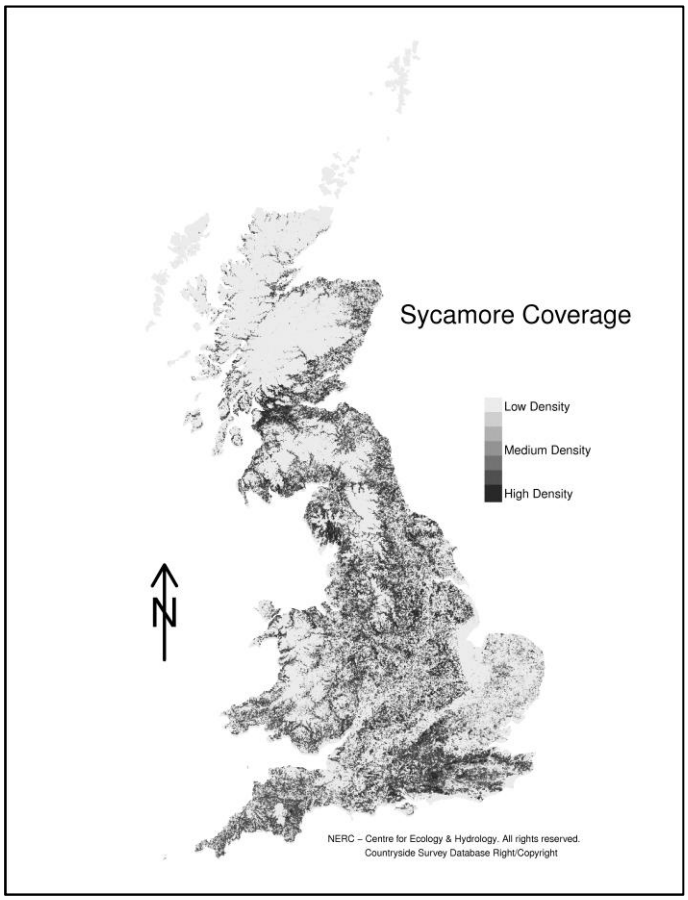

Figure iv: Areal extent of Sycamore (*Acer pseudoplatanus*) in small habitat parcels < 0.5 ha using same methods as Figure 2 above

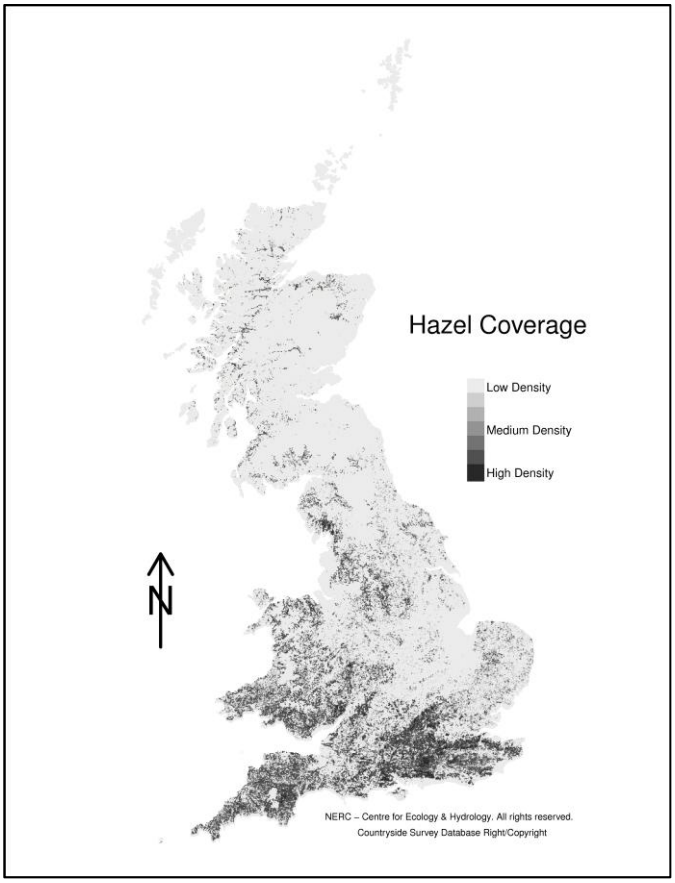

Figure v: Areal extent of Hazel (*Corylus avellana*) in small habitat parcels < 0.5 ha using same methods as Figure 2 above

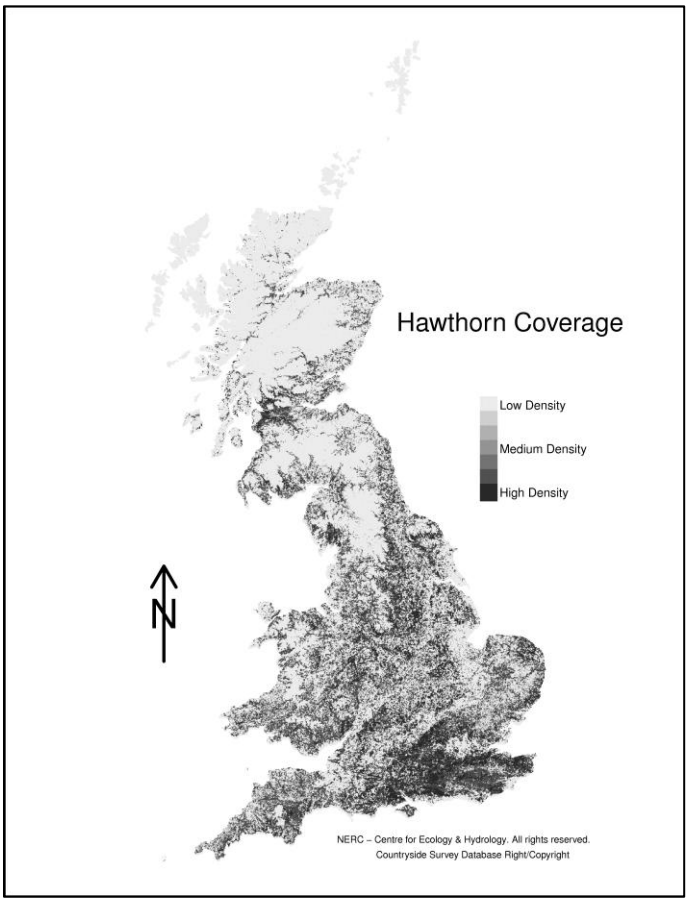

Figure vi: Areal extent of Hawthorn (*Crataegus monogyna.*) in small habitat parcels < 0.5 ha using same methods as Figure 2 above

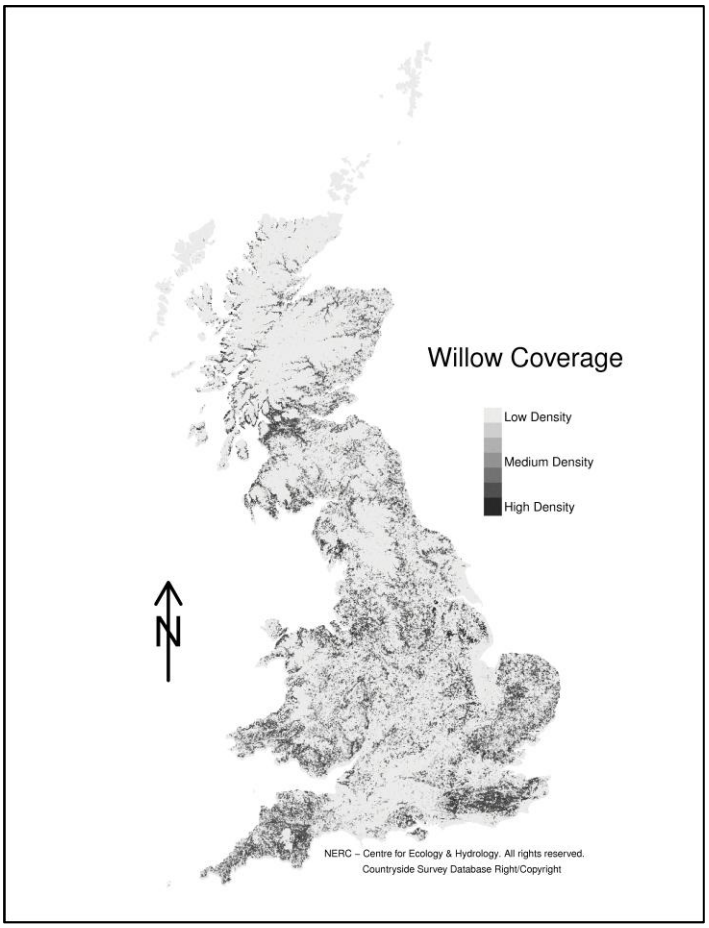

Figure vii: Areal extent of Willow (*Salix sp.*) in small habitat parcels < 0.5 ha using same methods as Figure 2 above

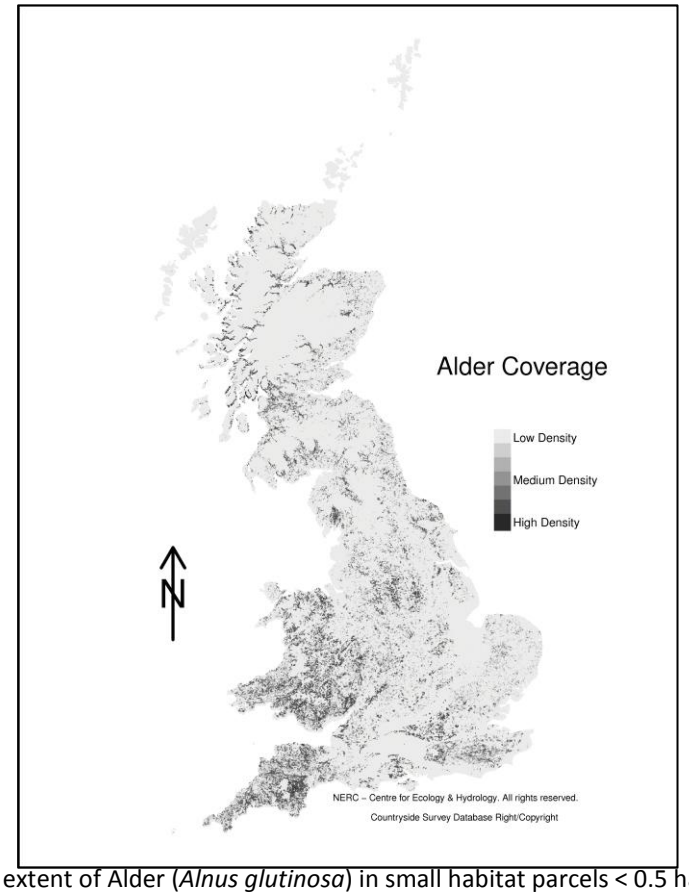

Figure viii: Areal extent of Alder (*Alnus glutinosa*) in small habitat parcels < 0.5 ha using same methods as Figure 2 above

Figure ix: Areal extent of Chestnut (*Castanea sativa*) in small habitat parcels < 0.5 ha using same methods as Figure 2 above