NFI survey of the incidence of *Chalara fraxinea* infection of ash (*Fraxinus excelsior*) in Great Britain

Introduction

Following the discovery of the presence of *Chalara fraxinea* on growing ash trees in Great Britain, and in nursery stock, during the course of 2012, it was decided to resurvey a sub-sample of NFI survey sites that had previously been surveyed in the NFI field survey programme in order to establish an estimate of the current incidence of the disease in the ash population in Great Britain.

This document reports the results and findings of this resurvey. The information provided here is intended to compliment the results of other recent work that has investigated the pattern and current extent of *Chalara fraxinea* infections of ash trees in Great Britain.

Key findings

- The estimated incidence across Great Britain of *Chalara fraxinea* infection in one hectare squares containing woodland with ash as at the last quarter of 2012 is **0.6%** (standard error = 0.3%).
- Rounded to the nearest percentage point, such estimated incidence in individual countries is 1% in both England and Scotland and 0% in Wales.

Issued by: National Forest Inventory, Forestry Commission,
231 Corstorphine Road, Edinburgh, EH12 7AT
Enquiries: Ben Ditchburn 0131 314 6208
NFI@forestry.gsi.gov.uk
Statistician: Alan Brewer
Alan.brewer@forestry.gsi.gov.uk
Website: www.forestry.gov.uk/inventory

Summary of the National Forest Inventory

The National Forest Inventory (NFI) is a programme of assessment of the extent and content of forests and woodlands in Great Britain. Its coverage is of all woodlands of 0.5 hectares or more in extent with a minimum width of 20 metres and tree canopy coverage of 20% of the area, or the potential to achieve this.

There are two aspects to the assessment of woodland areas in the NFI programme. One of these is the production of a spatial woodland map covering Great Britain, derived mainly from interpretation of aerial photography, but with additional use of information derived from satellite imagery and administrative sources.

The other is a field survey of randomly selected one hectare squares containing woodland, according to the NFI woodland map. These sample squares are selected according to a sample survey design covering the whole of Great Britain, ensuring balanced geographic coverage, and representative coverage of different woodland types identified on the NFI woodland map. The NFI field survey is currently in its first five-year cycle, in which it is planned to survey around 15,000 sample squares across Great Britain. This operation commenced in November 2009 and the first cycle is due for completion in 2015. Consequently, at the present time, a sub-sample of the planned 15,000 survey squares have so far been visited and surveyed by field surveyors.

The survey of a sample square involves partitioning the area of the square into woodland and non-woodland, and sub-dividing areas of woodland into "sections" of relatively homogeneous structure and composition. Within each woodland section, presence of individual species are identified and recorded, samples of trees are measured or visually assessed, and a number of other observations are made and recorded, including the presence of symptoms of disease, insect attack, tree mortality and other tree damage.

At the time of conduct of the resurvey exercise of ash in the last quarter of 2012, a total of around 7,000 of the planned 15,000 sites had been visited and surveyed using the NFI field survey protocol and survey results recorded.

The NFI survey of *Chalara fraxinea* infection of ash

From the sites so far surveyed in the NFI field survey programme, an initial (first stage) resurvey exercise was undertaken on sample sites that had records of presence of ash within the woodland and also had recorded symptoms that may have been indicative of *Chalara fraxinea* infection. These observed symptoms were recorded evidence of crown dieback and higher than expected levels of mortality. The operating procedure to record specific diseases in the NFI field survey protocol does not currently include *Chalara fraxinea*

(although surveyors have now been instructed to separately report suspicious sites and it is planned to add this to the formal NFI reporting protocol later this year).

The first stage re-survey resulted in a sample of 66 survey squares that were revisited by NFI surveyors during October 2012 and the ash stock within the square was closely assessed for symptoms that may be indicative of the presence of *Chalara fraxinea* on the site. If such symptoms were observed, samples of material were taken from the suspect ash trees and submitted to Forest Research and the Food and Environment Research Agency (FERA) for laboratory analysis to determine whether there was definitive evidence of *Chalara fraxinea* infection, based on DNA amplification techniques.

A second stage of the re-survey involved re-visiting a sample of previously surveyed sites on which the presence of ash had been recorded but for which no indicators of possible disease infection had been observed during the course of the assessment. The sample for this stage of the survey was selected randomly within each NFI region from all previously surveyed squares containing ash, in proportion to the totals of all such surveyed squares within the region. A total of 403 squares were selected for re-survey across Great Britain from a total of 2,264 previously surveyed squares containing ash. The resulting sub-sample of 469 survey squares inspected in both stages of the survey for *Chalara fraxinea* infection represented a sampling fraction of 20% of all previously surveyed NFI sample squares containing ash, with this sub-sample balanced across NFI regions. (Boundaries of the NFI regions can be seen on the map in **Figure 1**.)

The same procedures of inspection, assessment, collection of suspect material, and laboratory testing of the material, was performed in the second stage as was performed in the first stage of the survey. Field visits of the second stage of the survey were conducted during November and December 2012.

Results

Results for the two stages of the survey are shown in **Table 1**. These show that, for the overall results across both stages of the survey, 12% of the one hectare squares contained ash with symptoms that might indicate the presence of *Chalara fraxinea* infection, but that after laboratory analysis of samples of the suspect material, only 0.8% of survey squares were either confirmed or still treated as under suspicion of having sustained infection by the *Chalara fraxinea* fungus. Of the four sites where this was found to be the case, two incidences of the disease were positively confirmed by laboratory analysis, and two were suspected but not positively confirmed.

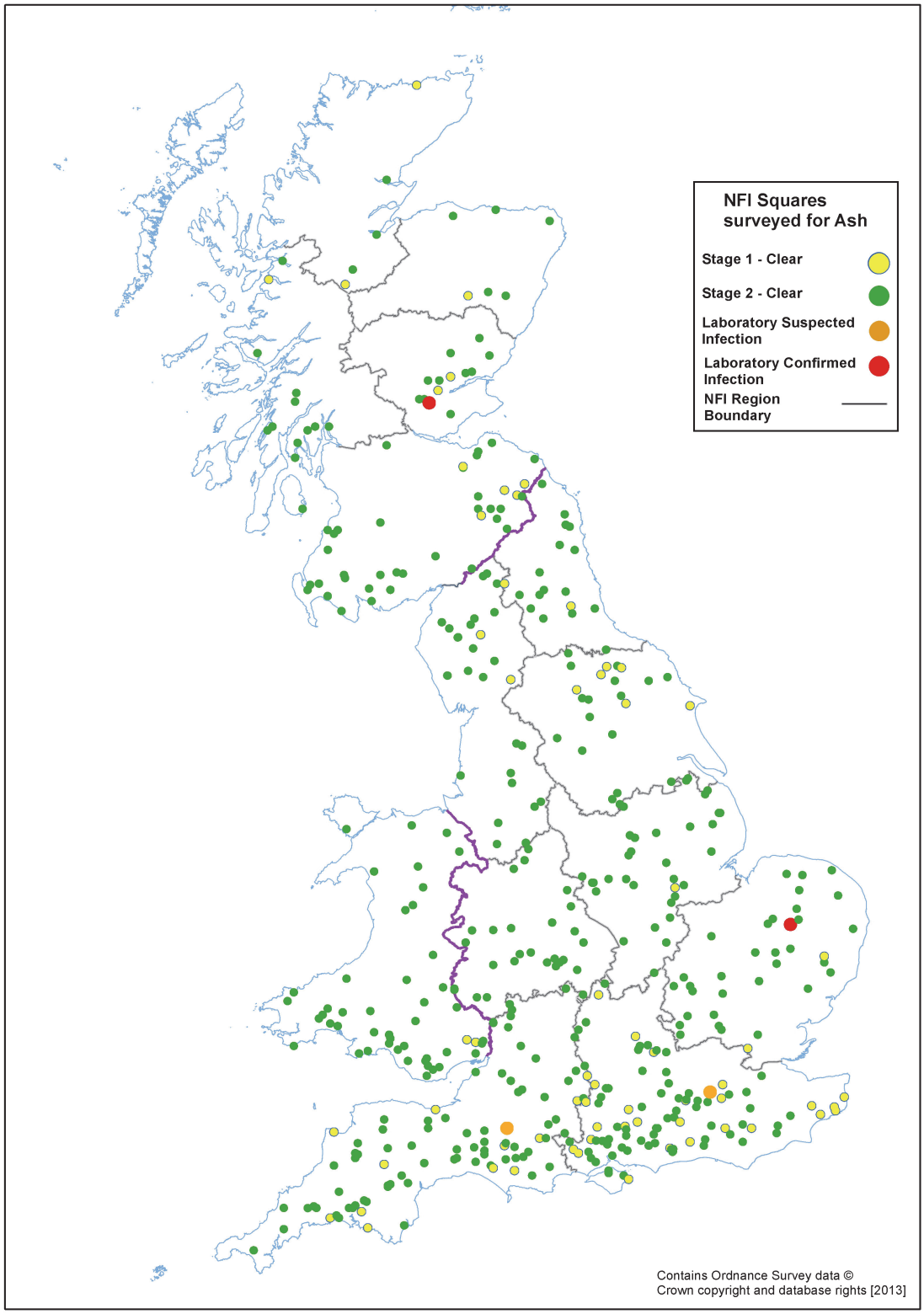
The spatial distribution of sites inspected in the two stages of the survey, and the locations of the four sites with suspected or positive laboratory results for *Chalara fraxinea* are shown on the map in **Figure 1**.

Table 1 Field and laboratory results of the NFI Chalara survey of ash

Resurvey stage:	1	2	Total	Percent of total
Ash disease indicators from original survey:	Present	Absent		
Total no. of sites surveyed	66	403	469	
Field survey results				
No potential *Chalara* symptoms	51	360	411	88%
Potential *Chalara* symptoms	15	43	58	12%
Laboratory results				
Chalara negative	13	41	54	11.5%
Chalara infection suspected	2	0	2	0.4%
Chalara infection positive	0	2	2	0.4%

Note: Indicators of ash disease from the original survey were recorded crown dieback and higher than expected levels of mortality of ash trees

Figure 1 Map of NFI ash disease inspection sites in the *Chalara fraxinea* survey



The selection of sites in stage 1 of the re-survey was made from sites that had records of ash disease indicators in the original survey. As a result of this, aggregating the positive or suspected findings from both stages of the resurvey may produce an overestimate of incidence across the population as a whole. Weighting the results from each stage of the survey to account for this effect gives an adjusted estimate of incidence of *Chalara fraxinea* of **0.6%** (standard error = 0.3%).

Table 2 provides a breakdown of the overall results of the survey into individual countries. Most ash growing in woodland is in England and in consequence the majority of the sites surveyed for *Chalara fraxinea* are located in this country. The results of the field survey and laboratory analyses identified three confirmed or suspected infections of *Chalara fraxinea* on NFI sites in England and one in Scotland. The three confirmed or suspected infections found in England were observed on older ash trees (referred to as the "wider natural environment" in other recent reports of *Chalara fraxinea* infections in Britain[1]) while the infection in Scotland was observed on young ash trees, and therefore may have been sourced from imported nursery stock. There were no confirmed or suspected NFI sites found in Wales. In terms of (unweighted) rates of incidence of infection, these equate to 1% in both England and Scotland, and 0% in Wales.

Table 2 Field and laboratory survey results by country

Country:	England	Scotland	Wales	Great Britain
Total no. of sites surveyed	346	75	48	469
Field survey results				
No symptoms present	297	68	46	411
Potential symptoms present	49	7	2	58
Laboratory results				
Chalara negative	46	6	2	54
Chalara infection suspected	2	0	0	2
Chalara infection positive	1	1	0	2

[1] See, for example, www.forestry.gov.uk/chalara

Discussion

The results of the survey provide an estimate of the level of incidence of *Chalara fraxinea* infection of ash in Great Britain that has developed to a stage whereby observable symptoms were present at the time that the field survey was performed (October to December 2012). They relate to the incidence of the disease in the population of one hectare squares in Great Britain that contain woodland (according to NFI definitions) within which ash trees are present. The unadjusted estimates moderately over-estimate average incidence across this population due to the sample being weighted in favour of NFI sample sites that showed previous indications of ash disease during their original survey. (Stage 1 of the survey was comprised entirely of such sites.) An adjusted estimate taking this effect into account is provided at the GB level.

The incidence of infection estimated in this survey will evidently be higher than that relating to the equivalent infection rate of individual ash trees, but on the other hand is likely to be lower than that relating to the presence of infection in entire woodlands that contain ash. It would not be possible to translate the results from this survey to the latter population of entire woodlands due to the likelihood of an unknown degree of positive correlation in the incidence of infection in one hectare squares within the same woodland.

The survey provides a "snapshot" of observable infection rates of *Chalara fraxinea* in British woodlands as at the last quarter of 2012 and does not provide information on possible future rates of spread of the infection, nor on the possible incidence of "hidden" infection at the time of the survey, whereby the pathogen is present but is not yet displaying observable symptoms. It should also be noted that the survey results relate to ash in woodlands of 0.5 hectares or more in extent, and therefore do not cover ash growing outside such woodland, such as in hedgerows, small copses and as individual trees.

This survey has used the statistically designed field sample of the National Forest Inventory to sample sites containing ash in order to establish a statistical estimate of the current incidence of *Chalara fraxinea* in British woodlands. It is different in nature from other recent systematic survey and reporting work on this disease which has been more extensive and has consequently found many more locations of infection, but was not based on a statistically randomised sampling design. This other work has provided information on the spatial pattern and current spread of *Chalara fraxinea* and the information in this report therefore compliments this by supplying estimates of the average incidence of the disease in British woodlands containing ash.

Further information:

For more information about the latest situation on Chalara dieback of ash, including a map of confirmed sites found in other survey and reporting activities to date, please visit: www.forestry.gov.uk/chalara.

For further information on the NFI, including contact details, please visit: www.forestry.gov.uk/inventory.

Official Statistics

This is an Official Statistics publication. For more information about Official Statistics and the UK Statistics Authority visit www.statisticsauthority.gov.uk.