

NFI 2011 woodland map Wales

National Forest Inventory Report

Summary

The National Forest Inventory provides a record of the size and distribution of forests and woodlands in Great Britain and information on key forest attributes. This report summarises the results of the mapping of woodland area for Wales that have arisen from the 2011 National Forest Inventory (NFI) woodland map update. It then looks at the changes between the initial 2010 NFI woodland map release and the 2011 woodland map. The report also analyses the differences between the National Inventory of Woodland and Trees (NIWT) woodland map published in 1997 and the NFI woodland map published in 2011.

- The total area of mapped woodland of 0.5 hectare and over in Wales is 303,572 hectares. This represents 15% of the total land area. A further 5,322 hectares of open space within woodland has been mapped as interpreted open areas. (See Appendix B for a summary of interpreted forest types (IFTs) and interpreted open areas (IOAs).) The total area of mapping including both IFTs and IOAs for Wales is 308,894 hectares. (Table 1)
- A total of 114,829 hectares or 38% of the total mapped woodland in Wales is owned by or leased to the Forestry Commission, with 188,744 hectares, or 73%, in other ownerships, based on the Forestry Commission legal boundary as at 31 March 2011. (Table 2)
- The largest interpreted forest type across GB is conifer, representing 41% of all mapped woodland. Broadleaved interpreted forest type represents 38%. (Table 3)
- NFI mapped a total of 282,078 hectares of woodland with an extent of 2 hectares and over in Wales 21,494 hectares of the woodland mapped in Wales was less than 2 hectares in extent. (Table 4)
- 64% of Forestry Commission mapped woodland in Wales is conifer interpreted forest type and 6% is broadleaved. 57% of woodland in other ownerships in Wales is broadleaved and 26% is conifer. (Table 5)
- The area in woodlands of 500 hectares or more in extent in Wales represents 30% of the total woodland area (Table 7)
- There are 35,301 woods over 0.5 hectare in Wales with a mean wood area of 9 hectares. There are 21,880 woods between 0.5 and 2 hectares in Wales with a mean wood area of 1 hectare. (Table 7)
- 68% of open areas within woodland in Wales were interpreted as grass. (Table 8)
- NFI has mapped 10,618 hectares more woodland of 2 hectares and over compared to NIWT, representing an overall increase of 4%. This represents 14% of the total land area as opposed to 13% represented by the NIWT estimate. (Table 14; based on 2 ha and over). Most of this increase is identified as being due to improved detection techniques (as explained under '2010 Woodland map revision method') rather than a genuine expansion of woodland since the NIWT mapping exercise.

The National Inventory of Woodland and Trees (NIWT) was the forerunner of the current National Forest Inventory, carried out between 1995 and 1999. The results, available as a series of inventory reports at a national and regional level, can be downloaded at www.forestry.gov.uk/inventory.

The functions and resources of Forestry Commission Wales transferred to Natural Resources Wales (NRW) from 1st April 2013

Introduction

The National Forest Inventory is composed of two elements: a woodland map and a field survey. The woodland map covers all forests and woodlands over 0.5 hectare with a minimum of 20% canopy cover (or the potential to achieve it), including new planting, clearfelled sites and restocked sites. It is based upon 25 cm resolution colour aerial photography for England and Scotland and 40 cm resolution colour aerial photography for Wales. Field survey work is used to refine the map-based estimates of woodland and clearfelled areas and to measure detailed aspects of the forest. Field surveys are being carried out between 2009 and 2014 to estimate standing volume, stocked areas, numbers of trees and other forest metrics. This involves the ground surveying of one-hectare sample squares that are partially or entirely covered by forest, including clearfelled areas and areas of assumed woodland, according to the 2010 NFI woodland map.

Further details of the mapping work and the derivation of forested areas can be found in the 2010 Woodland area reports at www.forestry.gov.uk/inventory.

2010 woodland map revision method

Since the published 2010 woodland area estimate (reference date 31 March 2010, published 26 May 2011) and 2010 woodland map launch, further work has been undertaken to improve that estimate. This has been achieved through incorporating further revisions arising from:

- a comparison exercise between the NIWT woodland map and the NFI woodland map;
- the addition of clearfell polygons identified from remote sensing analysis of 2006 and 2009 satellite imagery;
- a revision and update of the smaller assumed woodlands associated with recent woodland grant schemes.

The NIWT 1998 and NFI 2011 woodland maps were created using different methodologies and mapping standards (see appendix A for a summary of differences in mapping and methodology). The main objective of the comparison exercise is to define and explain any substantive differences in area estimates between NIWT and NFI. In order to identify those differences a symmetrical difference of the two sets of spatial data has been computed. The resultant potential woodland change areas have been categorised as 'Mapped in NIWT but not in NFI' (NFI unmapped) and 'Mapped in NFI but not included in NIWT' (NIWT unmapped). Analysis of the potential woodland change areas considers temporal, spatial, methodological and physical change, which account for many of the differences.

Temporal differences include:

- Time of year and time of day of photography. Angle of incidence of light can affect interpretation; shadows are more pronounced at different times of day and consequently may hide detail, and affect the tone of the image, which can make interpretation more difficult.
- Seasonal variation in the tree canopy can hinder interpretation.

NFI 2011 woodland map

Spatial differences include:

- Scale of photography. The woodland map features for NIWT were derived from 1:25,000 scale photography. Stereo pairs of the photos were evaluated by stereoscopic photogrammetry. This introduced a third dimension of depth conception. Because the image scale was small, the stereo element helped larger trees to stand out from surrounding vegetation and improved the visible texture of the woodland type. However, the scale resulted in indistinct woodland boundaries and, for example, led to difficulties in defining boundaries along natural gradients in vegetation where broadleaved woodland became shrub.
- Digital orthorectified imagery does not have a set scale but has a set size of pixel, which determines the quality and legibility of the image at different zoom scales. For example, 25 cm resolution imagery has a pixel size that represents 25 cm on the ground. This allows the interpreter to zoom to 1:1,000 and beyond, but the image becomes less distinguishable at higher zoom rates.
- Digital orthorectified imagery also allows for 'heads up' digitising where the operator digitises the woodland boundaries directly into the GIS system.
- Geographic registration of the digital images will in places result in improved spatial accuracy and, as a result, some of the NIWT data may seem displaced against the latest images.

Methodological differences include:

- Changes in the definition of woodland such as change in the minimum width of woodland from 50 metres to 20 metres.
- Change in the minimum size of division between interpreted forest types.
- The use of OS MasterMap® in determining both external woodland boundaries and internal divisions between interpreted forest types.

Physical differences include:

- Land-use change, where irreversible change has occurred between the two surveys resulting in deforestation
- New planting which took place during or between the two surveys. Very young trees would have been difficult to interpret from the available imagery.

Data sources used in the update process

- The potential woodland change areas resulting from the comparison exercise. All potential woodland change areas greater than 5 hectares in extent have been analysed and input to the 2011 woodland map update, either as additions or deletions as explained in Tables 11 and 12
- NFI unmapped. Where further investigation of the latest images shows evidence of woodland or transition stage, such areas are mapped as additions. Where further analysis of the latest images verifies no woodland presence then the areas are attributed as NIWT error.
- NIWT unmapped. Where further investigation of the latest images shows no evidence of valid woodland, then such areas are attributed as NFI error and omitted from the woodland area calculation.

NFI 2011 woodland map

- Assumed woodland. These are derived from areas of new planting or natural regeneration under grant schemes and areas of Forestry Commission first rotation planting. The assumed woodland areas are identified by a geoprocessing function that removes the areas of new planting already included in the NFI woodland map, resulting in an output of the balance of the unmapped features or parts of features. This process has resulted in some invalid features, which will be verified and cleaned as part of the 2012 woodland map update process.
- Assumed woodland derived from unmapped Forestry Commission new planting has been identified and added to the data. This source was not included in the 2010 woodland map.
- Some of the assumed woodland included in the 2010 woodland map has been validated, cleaned and mapped to the NFI mapping rules, around the areas where other update operations were being carried out. This has resulted in the reshape or deletion of several woodland areas.
- Remote sensing potential change areas. These are the result of a change detection analysis based on 2006 and 2009 satellite imagery. The analysis highlights areas of clearfell, extended felling, land-use change and sparse woodland which previously met the NFI woodland criteria.
 - The clearfell and extended felling areas are validated and used to update the base map features, originally mapped as mature trees.
 - The land-use change polygons are attributed as no longer woodland and are removed from the woodland area calculations.
 - The sparse areas are validated and changed from woodland to low density woodland.

In addition to the above, some corrections and improvements have been made around the areas where other update operations were being carried out, based on the latest available aerial photography. IOAs have been created or deleted based on the updates made, in accordance with the NFI mapping conventions.

There are three main woodland type attributes:

- Mapped woodland. These are the NFI base map features and have been attributed as 'woodland' or 'non woodland'. The woodland polygons represent the extent of woodlands equal to or greater than 0.5 hectare and are differentiated by interpreted forest type (IFT). The non woodland polygons represent open areas completely enclosed by woodland and are differentiated by interpreted open area (IOA).
- Assumed woodland. There are two types of assumed woodland polygons. Those with the Woodland_source attribute 'supplied grant schemes' are the balance of areas under woodland grant schemes that showed no evidence of trees or ground disturbance during the mapping aerial photography interpretation. Those with the Woodland_source attribute 'supplied FC new planting' are the balance of Forestry Commission new planting polygons extracted from the Forestry Commission's sub-compartment database that showed no evidence of trees or ground disturbance during the mapping aerial photography interpretation. Both types include areas of greater than 0.1 hectare which adjoin existing woodland. These areas have been included for future monitoring. Assumed woodland polygons have not been mapped according to the NFI mapping rules and are not differentiated by IFT.

NFI 2011 woodland map

- Low density polygons were mapped as woodland by NIWT but were not originally mapped as NFI woodland. They were included after an investigation of the archive images proved that a higher density of woodland existed at the time of NIWT mapping than at present. This was done on the assumption that such sites may have included seed tree sites, or group felling, and that they may revert to the threshold canopy occupancy for woodland within a short period of time. If future monitoring proves this not to be the case they will be removed from the map.

Statistics derived from NFI may be used in the process of policy-making, and differences in woodland area between the two surveys therefore need to be clearly explained. Understanding and interpreting the differences between the two surveys is an important issue for future use of the data and will help to ensure that the data are not misinterpreted.

Summary of differences between NIWT (1995-1998) and NFI (2011) woodland maps for GB

An important aspect of the NFI woodland map is the ability to provide the basis of reporting on changes that have occurred in both the extent and distribution of GB woodlands in the intervening period between NIWT and NFI. The combination of the woodland map resource and the field survey results towards the end of the current NFI cycle will provide a more accurate view of those changes.

The NIWT 1998 and NFI 2011 woodland maps were created using different methodologies and mapping standards (see appendix A for a summary of differences in mapping and methodology). A consequence of these changes is the inclusion of woodland that existed at the time of NIWT mapping but was not mapped and the exclusion of area that was mapped by NIWT but not included in NFI due to:

- Methodology restricting minimum width of NIWT woodlands;
- larger minimum gap between woodlands which as a consequence included more non woodland area in NIWT
- resolution of the aerial imagery which resulted in less distinct woodland edge and misinterpretation of woodland;

NIWT mapped a total of 271 thousand hectares of woodlands with an extent of 2 hectares and over in Wales. The total mapped woodland with an extent of 2 hectares and over included in the NFI 2011 woodland map for Wales is 282 thousand hectares, a net difference in woodland area of 11 thousand hectares. This difference is the result of the inclusion of 42 thousand hectares of woodland not mapped by NIWT and the exclusion of 31 thousand hectares of NIWT mapped area. (Tables 16-18). These areas have been identified by computation of a symmetrical difference of the two datasets and further analysis of these potential woodland change areas, which is currently underway, will help to explain the substantive difference in woodland area between the two maps and should result in a more accurate estimate of actual increase in woodland area. Results of the comparison analysis completed to date for Wales for

the additional area have estimated that 9% are due to methodology, 50% are due to afforestation and 41% are due to NIWT mapping errors. Similar results for the excluded areas have estimated 71% to be due to methodological differences, 4% due to land use change, 7% were mapped as young trees by NIWT but latest available imagery shows no sign of planting or other woodland transition stage and the remaining 18% were due to NIWT error or are not discernable from the current aerial photography. These estimates should be treated with caution until the conclusion of the comparison analysis exercise.

Understanding the differences between map-based and fieldwork estimates

Many of the reported areas presented in this report are based upon interpreted forest types. These are derived from desk-based interpretation of aerial photography. Mapped interpreted forest types (IFT) provide spatial information on the differentiation of total forested area into broad categories of woodland types that can be assessed from the interpretation of remote images and administrative information. As such, they provide a good indication of the spatial distribution of these different categories of mapped woodland. Summation of areas of IFT, as shown for example in Table 3, will give a broad indication of the absolute and relative extent of these categories across the country. However, they are of limited applicability with regard to the question of the breakdown of woodland areas into tree species, and in particular on the differentiation of total woodland area into that occupied by conifers or broadleaves. This is because the IFT categories used do not equate exactly with areas purely composed of either conifers or broadleaves.

Taking conifer area as an example:

- The 'conifer' IFT category represents areas of woodland assessed by photographic interpretation to be composed of at least 80% conifer species, and therefore includes woodland areas that are not pure conifer stands.
- Conifers, on the other hand, can occur in other IFT categories of high forest:
 - Between 50 and 80% within the 'mixed mainly conifer' IFT category.
 - Between 20 and 50% within the 'mixed mainly broadleaved' IFT category.
 - Between zero and 20% within the 'broadleaves' IFT category.
- A number of non-high forest IFT categories, such as the 'young trees' IFT, can also contain conifer species.

In addition to this indeterminacy of IFT categories with regard to the split into conifer or broadleaved species, the determination of IFT areas using mainly photographic interpretation will result in some degree of misclassification. Factors contributing to this relate to the quality of the images, which may be affected by the resolution of the photography, the time of year or time of day that the image was recorded, and obscuring of the image by cloud or shadow.

A more reliable estimation of the split of total forested area into that occupied by conifers or broadleaves is obtained with the use of information from the NFI field sample operation or, for Forestry Commission areas of woodland from the Forestry Commission's sub-compartment database (SCDB).

Field survey will identify areas and woodland type more accurately than interpretation of aerial photography for a specific area. However, as field survey is expensive to perform, only a small sample of woodlands have been assessed in this manner. The NFI uses statistical techniques to integrate the results arising from mapping and fieldwork to derive improved final estimates of woodland composition. It is important to note the difference between these alternative assessments. For example, the conifer and broadleaved breakout reported in the main body of this report is map-based, and as such will differ from that of the combined estimate using field survey results. The combined estimates are published in other NFI reports such as the *Standing timber volume for coniferous trees in Britain* and *Preliminary estimates of quantities of broadleaved species in British woodlands, with special focus on ash* reports both of which are available for download from <http://www.forestry.gov.uk/inventory>. Section 4 explores such differences in more detail.

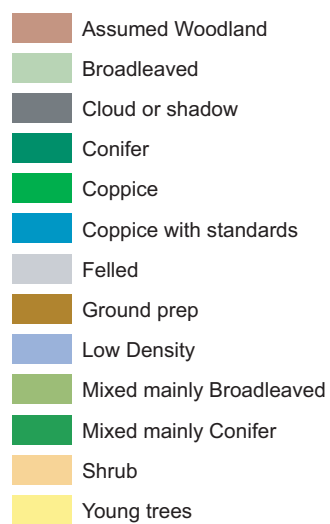
Results

Section 1 - Summary of woodland area from the NFI 2011 digital woodland map for Wales

Tables 1 to 8, Figures 1 to 7, and Maps 1 to 3 summarise the sizes of woodland areas from the NFI 2011 digital woodland map for England. Note that the figures in some tables may not add to totals due to rounding.

A total of 298,280 hectares were mapped as base data and an additional 4,723 hectares of assumed woodland and 569 hectares of low density woodland have since been included.



Map 1. Distribution of woodland by interpreted forest type




0 5 10 20 kilometres

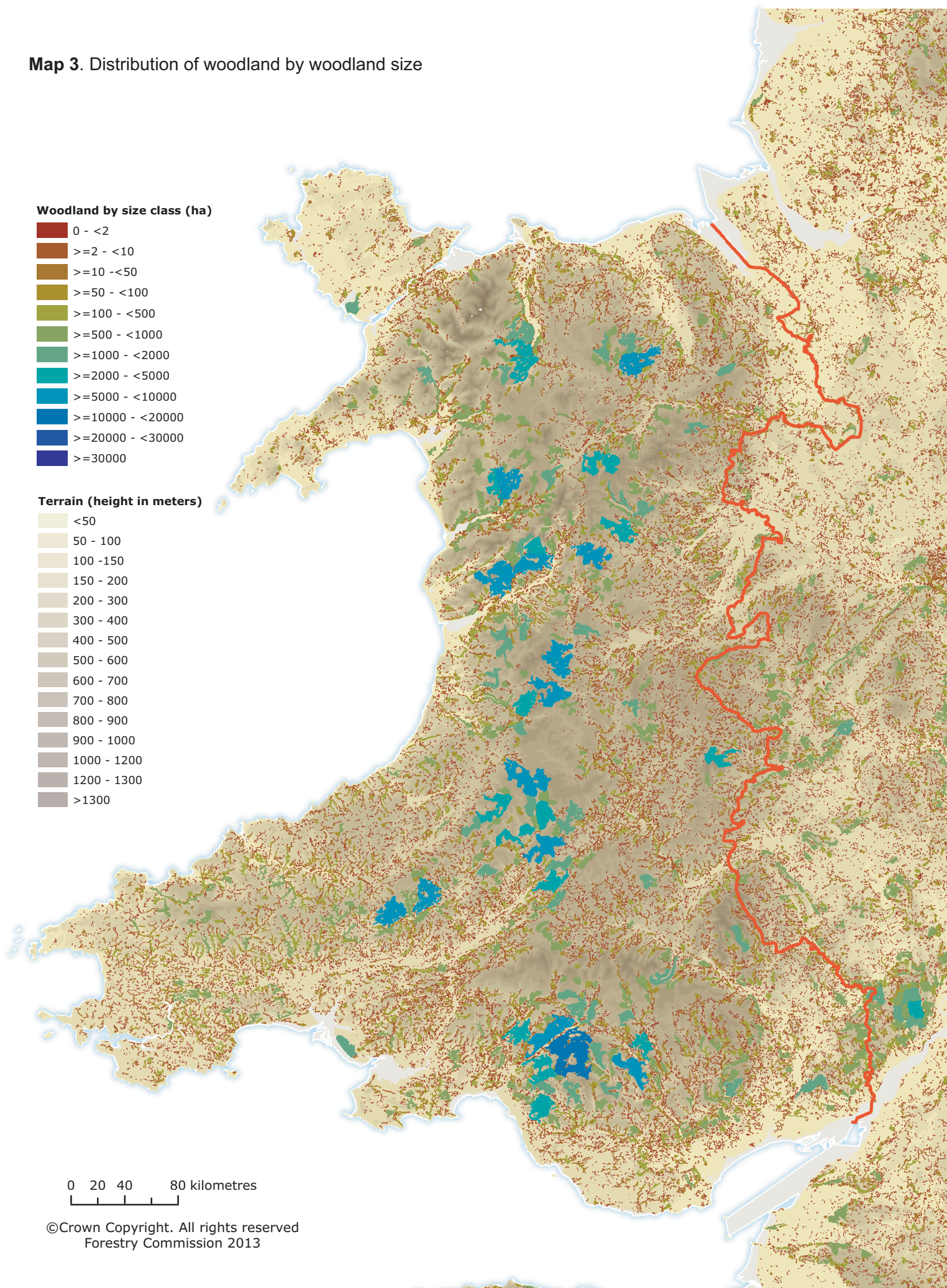
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Map 2. Distribution of woodland by ownership

 Forestry Commission
 Other

0 5 10 20 kilometres


Map 3. Distribution of woodland by woodland size



NFI 2011 woodland map

Table 1. Mapped area by woodland type

Mapped area	Area (ha)	%
Wales		
Woodland	298,280	98%
Assumed woodland	4,723	2%
Low density	569	0%
Total mapped woodland	303,572	100%
% woodland land cover		15%
Mapped non woodland	5,322	
Total mapped area	308,894	

Figure 1. Summary of woodland area as part of total land area by woodland type

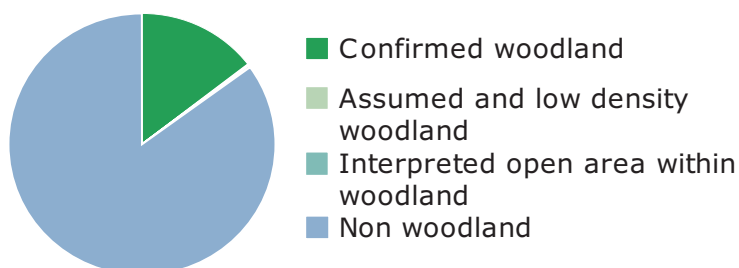


Table 2. Woodland area by ownership

Ownership	Area (ha)	% woodland
Wales		
Forestry Commission	114,829	38%
Other ownership	188,744	62%
Total area of woodland	303,572	100%

Figure 2. Summary of woodland area by ownership

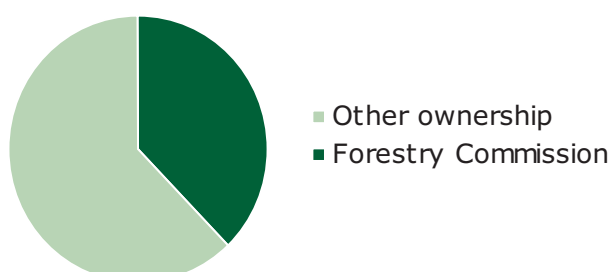
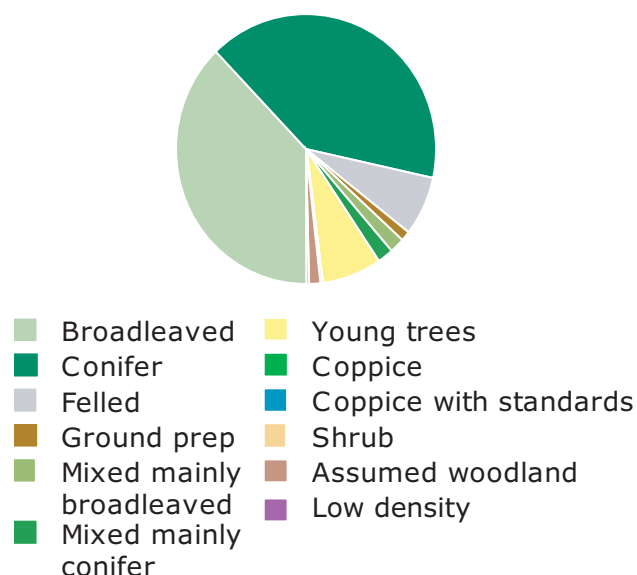


Table 3. Woodland area by interpreted forest type

Forest Type	Total area (ha)	Percentage of total area
Wales		
Broadleaved	115,075	38%
Conifer	123,143	41%
Felled	21,375	7%
Ground prep	3,195	1%
Mixed mainly broadleaved	6,108	2%
Mixed mainly conifer	6,052	2%
Young trees	22,340	7%
Coppice	12	0%
Coppice with standards	0	0%
Shrub	978	0%
Assumed Woodland	4,723	2%
Low Density	569	0%
Cloud / shadow	1	0%
TOTALS	303,572	100%

Figure 3. Summary of woodland area by interpreted forest type



Note for Table 1. The area of Wales, excluding inland water, is 2,073,359 hectares. Source: UK Standard Area Measurements, Office for National Statistics. % woodland land cover is based on mapped woodland only. Mapped open areas are not included in the calculation.

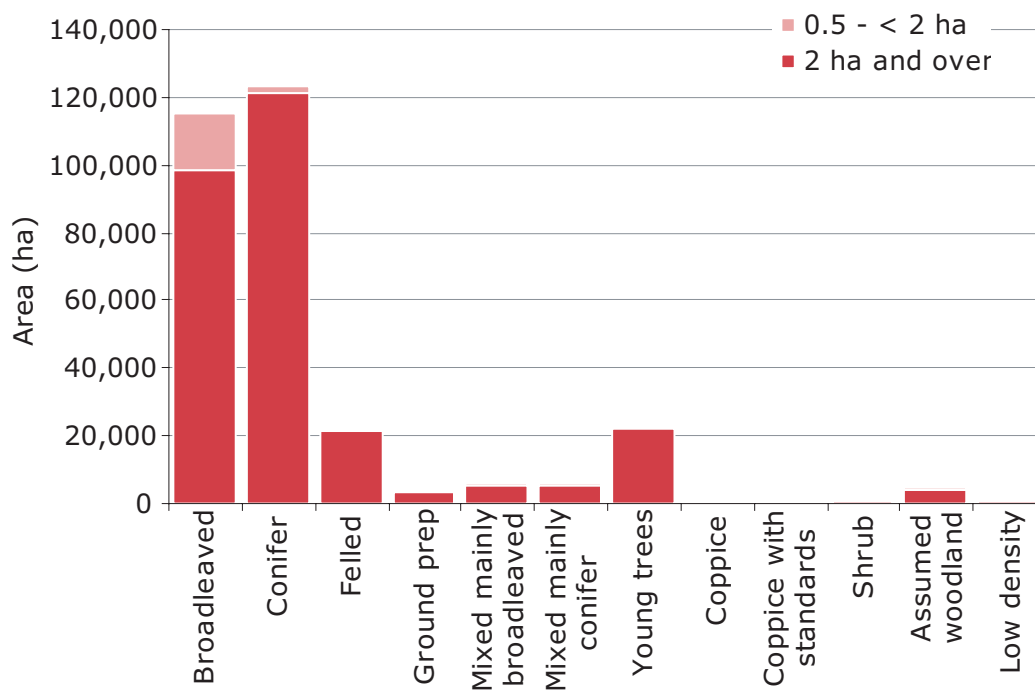
Note for Table 2. Based on Forestry Commission legal boundary dated 31 March 2011. Other ownership encompasses all woodland not owned by or leased to the Forestry Commission.

NFI 2011 woodland map

Table 4. Woodland area by interpreted forest type and woodland size

Forest type	Woodland size		Total area (ha)
	2 ha and over	0.5 - < 2 ha	
Wales			
Broadleaved	98,361	16,714	115,075
Conifer	121,404	1,740	123,143
Felled	21,315	60	21,375
Ground prep	3,172	23	3,195
Mixed mainly broadleaved	5,249	859	6,108
Mixed mainly conifer	5,410	641	6,052
Young trees	21,924	416	22,340
Coppice	12	0	12
Coppice with standards	0	0	0
Shrub	726	252	978
Assumed woodland	3,942	782	4,724
Low density	561	8	569
Cloud/shadow/uncertain	1	0	1
Total	282,078	21,494	303,572

Figure 4. Summary of woodland area by interpreted forest type and woodland size



NFI 2011 woodland map

Table 5. Woodland area by interpreted forest type and area

Forest type	Forestry Commission		Other ownership	
	Area (ha)	Percentage of total area	Area (ha)	Percentage of total area
Wales				
Broadleaved	6,623	6%	108,452	57%
Conifer	73,440	64%	49,703	26%
Felled	15,191	13%	6,184	3%
Ground prep	1,447	1%	1,748	1%
Mixed mainly broadleaved	1,472	1%	4,636	3%
Mixed mainly conifer	1,255	1%	4,796	3%
Young trees	14,237	12%	8,103	4%
Coppice	0	0%	12	0%
Coppice with standards	0	0%	0	0%
Shrub	133	0%	845	1%
Assumed woodland	712	1%	4,012	2%
Low density	319	0%	250	0%
Cloud/shadow/uncertain	0	0%	1	0%
Total	114,828	100%	188,744	100%

Figure 5. Summary of woodland area by interpreted forest type and ownership



NFI 2011 woodland map

Table 6. Woodland area by ownership, interpreted forest type and size

Forest type	2 ha and over		0.5 - < 2 ha		Total area (ha)
	Forestry Commission	Other	Forestry Commission	Other	
Wales					
Broadleaved	6,604	91,757	19	16,695	115,075
Conifer	73,399	48,005	41	1,698	123,143
Felled	15,186	6,129	5	55	21,375
Ground prep	1,447	1,725	0	23	3,195
Mixed mainly broadleaved	1,470	3,779	2	857	6,108
Mixed mainly conifer	1,250	4,160	5	636	6,052
Young trees	14,233	7,691	4	411	22,340
Coppice	0	12	0	0	12
Coppice with standards	0	0	0	0	0
Shrub	133	593	0	252	978
Assumed woodland	699	3,243	13	769	4,724
Low density	319	242	0	8	569
Cloud/shadow/uncertain	0	1	0	0	1
TOTALS	114,738	167,339	90	21,405	303,572

Note for Table 6. Some woods may consist of both Forestry Commission and other ownership. Dividing woods by ownership can generate part woods of less than 2 hectares, where the whole wood without the division may be greater than 2 hectares in extent. Such part woods are classified in Table 6 according to the size of the entire woodland.

NFI 2011 woodland map

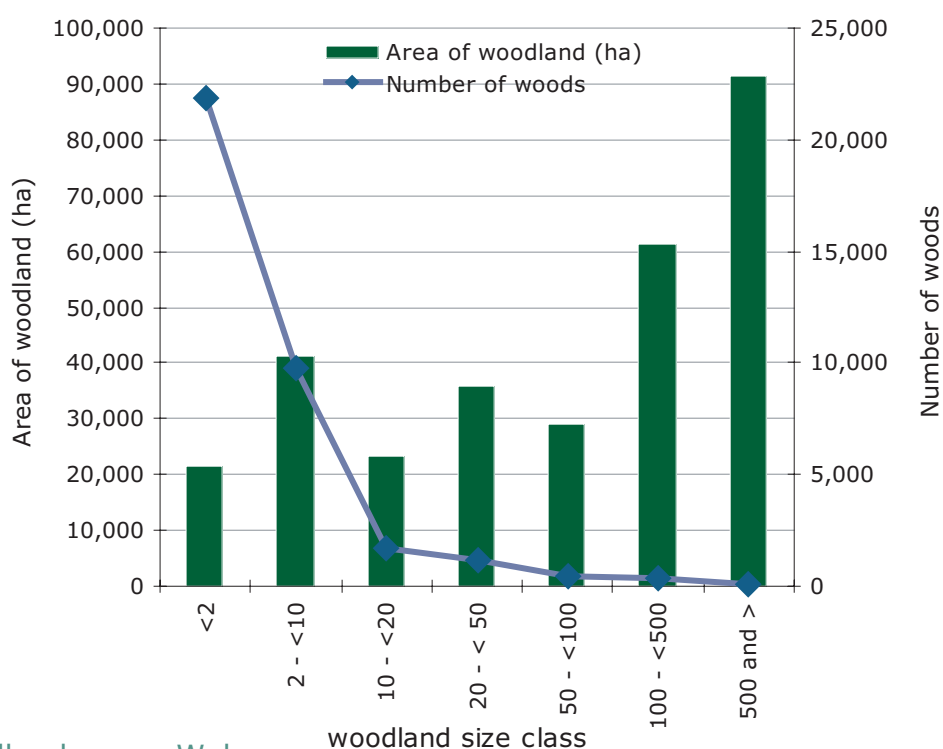
Table 7. Woodland area by size class distribution

Size Class (ha)	Total area (ha)	Number of woods	Percentage of total area	Mean wood area
Wales				
<2	21,494	21,880	7%	1
2 - <10	41,185	9,751	14%	4
10 - <20	23,379	1,688	8%	14
20 - < 50	35,859	1,168	12%	31
50 - <100	29,153	425	10%	69
100 - <500	61,245	315	20%	194
500 and >	91,257	74	30%	1,233
All woods	303,572	35,301	100%	9

Table 7a. Summary of woodland area for conifer and broadleaved woodland classes by size class distribution

Broadleaved woodland class	% Area	Number of woods	Conifer woodland class	% Area	Number of woods
Wales					
17,573	15%	18,194	2,381	2%	2,570
32,314	27%	9,457	5,715	4%	2,423
16,200	13%	2,403	4,851	4%	1,214
20,413	17%	2,524	10,845	8%	1,789
13,563	11%	1,827	11,402	9%	1,405
14,561	12%	2,556	33,708	26%	2,135
6,571	5%	1,889	60,293	47%	1,652
121,195	100%	38,850	129,195	100%	13,188

Figure 6. Summary of woodland area by size class distribution

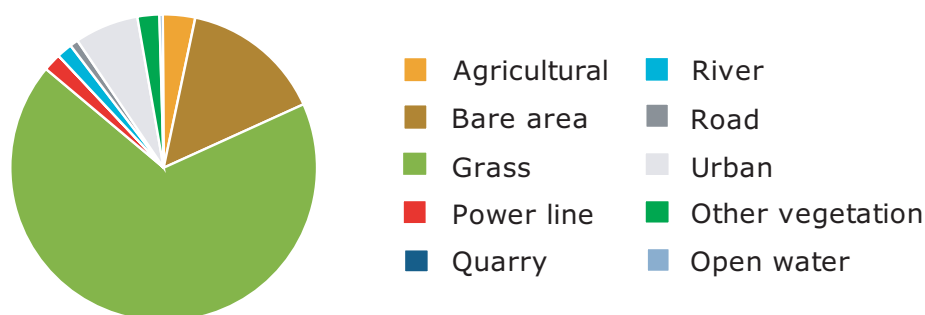


NFI 2011 woodland map

Table 8. Open areas in woodland by land-use type

Interpreted open area	Total area (ha)	Percentage of total area
Wales		
Agricultural	177	3%
Bare area	792	15%
Grass	3,619	68%
Power line	103	2%
Quarry	1	0%
River	87	2%
Road	40	1%
Urban	356	7%
Other vegetation	139	3%
Open water	8	0%
Total	5,322	100%

Figure 7. Summary of open areas in woodland by land-use type



Section 2 - Summary of differences between NFI 2010 and NFI 2011 woodland areas for Wales

The total woodland area on the 2011 NFI woodland map of GB is 303,572 hectares. The published NFI woodland area for GB for 2010 (National Forest Inventory Woodland Area Statistics: GB, NFI, 26 May 2011) was 303,500 hectares. After further correction and processing, the published 2010 woodland map contained a total woodland area of 303,123 hectares. The change in mapped woodland area from the 2010 to the 2011 woodland maps was 449 hectares. Some of this change is attributable to real change in the intervening period and other to corrections and improvements made to the map. Tables 9 and 10 provide an overall summary of these differences, and Tables 11, 12 and 13 provide more detail on the comparison of areas in the 2010 and 2011 versions of the NFI woodland maps.

NFI 2011 woodland map

Table 9. Comparison between 2010 and 2011 NFI woodland maps

Woodland type	2,010		2,011		Difference
	Area (ha)	%	Area (ha)	%	
Wales					
Woodland	298,617	97%	298,280	97%	-337
Assumed woodland	4,108	1%	4,723	2%	615
Low density	397	0%	569	0%	172
Mapped non woodland	5,296	2%	5,322	2%	26
Total mapped area	308,419	100%	308,894	100%	476
% woodland land cover		15%		15%	

Note for Table 9. The net area of the woodland category removed from the 2010 map as part of the 2011 map update is 599 hectares. Of that area 32 hectares were due to land use change, 116 hectares of assumed woodland was cleaned and the remaining 451 hectares were due to NFI error identified by the remote sensing and NIWT comparison analysis. The remaining balance of the difference in the woodland category is due to woodland being reclassified between the other categories based upon the remote sensing work, comparison analysis and the aerial photography update work. The net differences are summarised in tables 11 to 13.

Table 10. Differences in woodland area between NFI 2010 and NFI 2011 woodland map published areas

Type of change	2010 area (ha)	2011 area (ha)	Difference
Wales			
Published woodland area (26th May 2011)	303,500		
Removal of duplicate polygons	-377		
Mapped Woodland	303,123	303,572	449
Mapped non woodland (IOAs)	5,296	5,322	26
Total mapped area	308,419	308,894	476

Table 11. Summary of area removed from the 2010 woodland map for Wales

Woodland source	Source area (ha)	Woodland type	Type area (ha)
Wales			
Base map corrections	447	Non woodland	6
		Woodland	441
NIWT comparison validation	42	Low density	31
		Woodland	11
Validated grant schemes	116	Assumed woodland	116
Grand total	116		605

Table 13. Summary of changes between NFI 2010 and NFI 2011

	NFI 2010	NFI 2011
Wales		
Total mapped area 2010	308,419	
Deducted from NFI 2010	605	
Added to NFI 2010		1081
Total mapped area 2011		308,894

Table 12. Summary of area added to the 2010 woodland map for Wales

Woodland source	Source area (ha)	Woodland type	Type area (ha)
Wales			
Remote sensing	47	Woodland	47
		Low density	0
Aerial photography update	129	Woodland	112
		Low density	8
		Non woodland	9
NIWT comparison validation	151	Woodland	111
		Low density	34
		Non woodland	5
Validated grant schemes	752	Assumed Woodland	
			752
Additional mapping	2	Woodland	0
		Low density	2
		Non woodland	0
Total	1,081		1,081

Section 3 - Summary of differences between NIWT 1997 and NFI 2011 woodland maps for Wales

NIWT did not differentiate between 'mixed mainly conifer' and 'mixed mainly broadleaved' forest types and therefore in the following tables both NFI forest types have been included as 'mixed'. NFI 'assumed woodland' has been included with NFI 'young trees' and NFI 'low density' has been included with NFI 'shrub'. Tables 14 to 18 and Figures 8 and 9 summarise the differences in area based on interpreted forest type. Tables 16 to 18 and figure 10 provide an overall summary of the changes

Tables 14 and 15 compare the woodland area breakdown derived from the NIWT woodland map of 2 hectares and over, and the 2 hectares and over element of the NFI woodland map. The woodland maps, which are based upon interpreted forest type, are derived from interpretation of aerial photography. Mapped interpreted forest types provide the location, scale and distribution of woodland types; however, this process results in a different distribution of woodland types and open areas to that derived from the ground assessments. The more precise ground survey identifies areas, woodland type and species more accurately than interpretation of aerial photography for a specific area. Statistical techniques are used to integrate the results arising from mapping and fieldwork to derive improved final estimates of woodland composition. This results in a more accurate breakdown of woodland area distribution.

Note for Tables 14 to 18 and Figures 8 to 10. The reference dates for NIWT at country level are; 1995 for Scotland, 1997 for Wales and 1998 for England.

The range of dates of photography used for mapping are explained in Appendix A and illustrated in Appendix C.

Table 14. Differences in woodland area by interpreted forest type between NIWT 1997 release and NFI 2011 (based on woodlands 2 hectares and over)

Forest Type	NIWT - 1998 Inventory		NFI - 2011 Inventory		Difference NFI-NIWT
	Area (ha)	%	Area (ha)	%	
Wales					
Broadleaved	79,138	29%	98,361	35%	19,222
Conifer	138,835	51%	121,404	43%	-17,431
Felled	15,391	6%	21,315	8%	5,924
Ground prep	334	0%	3,172	1%	2,838
Mixed	16,364	6%	10,659	4%	-5,705
Young trees	17,166	6%	25,866	9%	8,700
Coppice	0	0%	12	0%	12
Coppice with standards	0	0%	0	0%	0
Shrub	4,233	2%	1,287	0%	-2,945
Cloud/shadow/uncertain	0	0%	1	0%	1
Total	271,461	100%	282,078	100%	10,616
% of land area	13%		14%		

NFI 2011 woodland map

Figure 8. Summary of differences in woodland area by interpreted forest type between NIWT 1997 release and NFI 2011 (based on woodlands 2 ha and over)

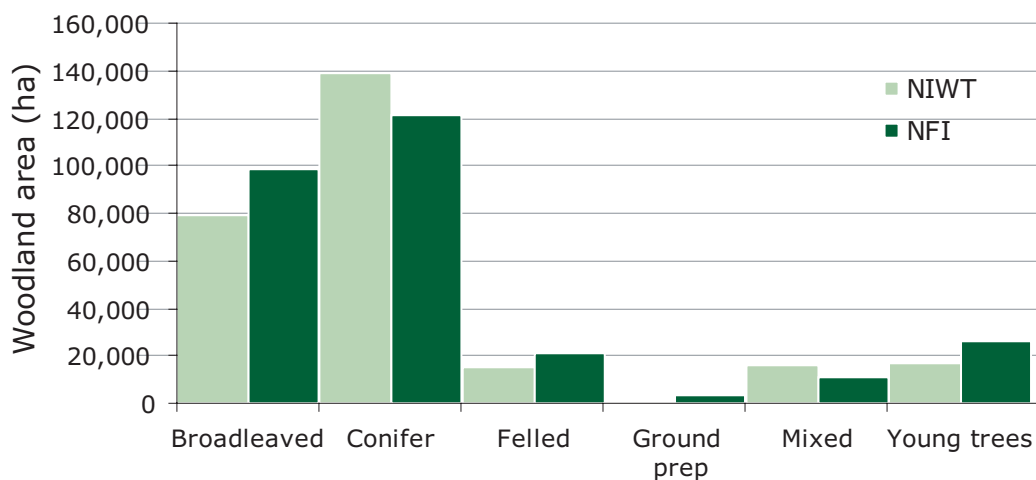
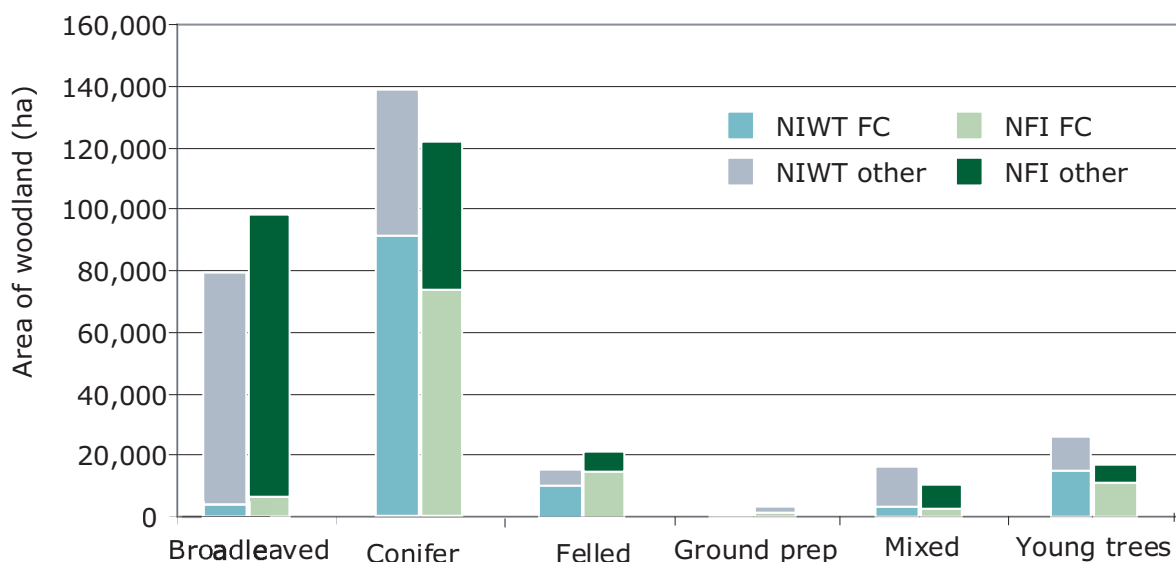


Table 15. Differences in woodland area by interpreted forest type and ownership between NIWT (1997) release and NFI 2011 (based on woodlands 2 hectares and over)

Forest type	NIWT - 1995 to 1998 Inventory		NFI - 2011 Inventory		Difference from NIWT to NFI	
	Forestry Commission	Other ownership	Forestry Commission	Other ownership	Forestry Commission	Other ownership
wales						
Broadleaved	3745	75394	6604	91757	2,859	16,364
Conifer	90985	47850	73399	48005	-17,586	155
Felled	10320	5071	15186	6129	4,866	1,058
Ground prep	237	98	1447	1725	1,210	1,628
Mixed	3528	12836	2720	7939	-808	-4,897
Young trees	10773	6394	14931	10935	4,159	4,541
Coppice	0	0	0	12	0	12
Coppice with standards	0	0	0	0	0	0
Shrub	441	3792	452	835	11	-2,957
Cloud/shadow/uncertain	0	0	0	1	0	1
Total	120026	151435	114738	167339	-5,288	15,904
% of land cover	6%	7%	6%	8%		

Figure 9. Summary of differences in woodland area by interpreted forest type and ownership between NIWT 1997 release and NFI 2011 (based on woodlands 2 ha and over)



NFI 2011 woodland map

Table 16. Additions: Post NIWT afforestation and existing woodland not identified in NIWT (based on woodlands 2 ha and over)

Woodland source	Source area (ha)	Woodland type	Type area (ha)	IFT/IOA	IFT/IOA area (ha)
Wales					
Remote sensing	263	Woodland	256	Broadleaved	10
				Conifer	2
				Felled	228
				Mixed mainly broadleaved	0
				Mixed mainly conifer	0
				Young trees	16
				Low density	8
2010 aerial photography update	110	Woodland	103	Broadleaved	49
				Conifer	3
				Felled	0
				Ground prep	0
				Mixed mainly broadleaved	6
				Mixed mainly conifer	2
				Young trees	37
				Shrub	6
				Low density	7
NIWT comparison	79	Woodland	50	Broadleaved	18
				Conifer	3
				Felled	1
				Ground prep	0
				Mixed mainly broadleaved	0
				Mixed mainly conifer	0
				Young trees	21
				Shrub	6
				Low density	29
Assumed woodland	3,171	Assumed woodland	3,171	Assumed woodland	3,171
Base map	38,370	Woodland	38,370	Broadleaved	26,620
				Conifer	5,878
				Felled	399
				Ground prep	453
				Mixed mainly broadleaved	989
				Mixed mainly conifer	870
				Young trees	2,877
				Coppice	3
				Coppice with standards	0
				Shrub	280
				Cloud / shadow / uncertain	1
Totals	41,994		41,994		41,994

NFI 2011 woodland map

Table 17. Deletions: Areas mapped as woodland in NIWT but not identified as woodland in NFI
(based on woodland 2 ha and over)

NIWT IFT	Area (ha)
Wales	
Broadleaved	18,360
Conifer	6,174
Felled	1,547
Ground prep	40
Mixed	2,035
Young trees	1,500
Coppice	0
Coppice with standards	0
Shrub	1,721
Total	31,377

Table 18. Summary of change between NIWT 1997 and NFI 2011

	NIWT 1997 Area (ha)	NFI 2011 Area (ha)
Wales		
Total woodland area	271,461	
Deducted from NIWT 1997	31,377	
Added post NIWT		41,994
Total		282,078

Figure 10. Summary of net changes from NIWT to NFI

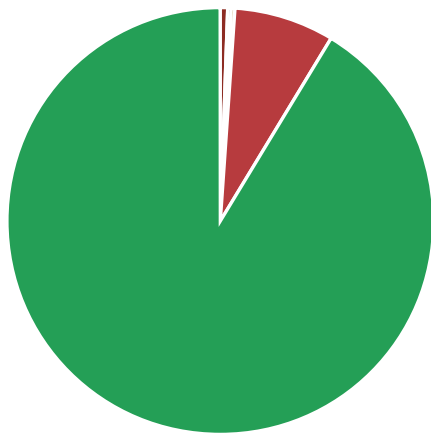


Table 16 (additions)
categorised by source of update

- Remote sensing
- Aerial photography update
- Validated potential change polygons
- Assumed woodland
- Additional woodland mapped as NFI but not identified in NIWT

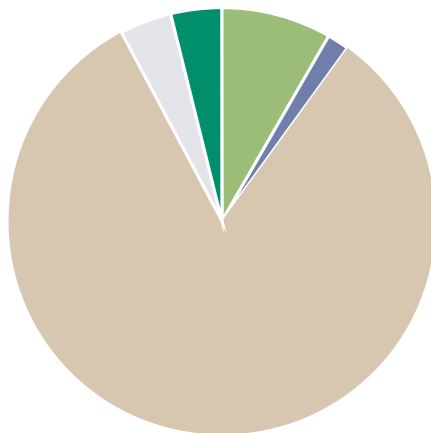


Table 17 (deletions)
categorised by type of change

- Grant schemes (no visible trees)
- Land-use change
- Methodology differences
- Not yet categorised
- NIWT error

Section 4 - Interpreted forest types and stocked areas

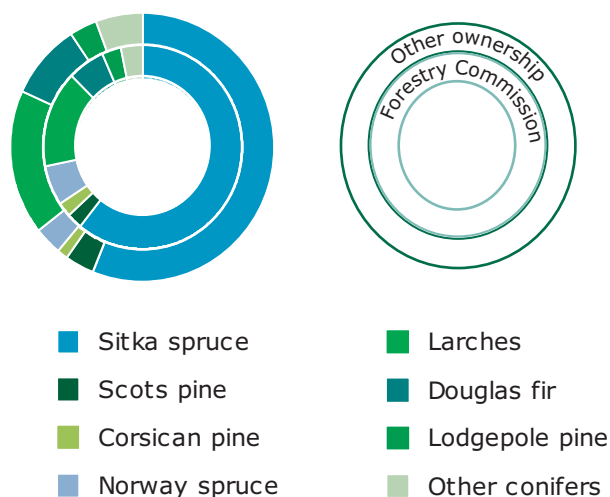
The recently published *Standing timber volume for coniferous trees in Britain* report includes estimates of stocked areas of principal conifer species and of all conifers in GB in Table 1 of the document. This is reproduced here for Wales in Table 19 and summarised in table 11. The Forestry Commission stocked areas have been derived from information in the sub compartment database, while those for other woodlands have been determined from results of the NFI field sample to date combined with information from the 2011 NFI woodland map. In the latter case, since they are based on a sample of woodland, the estimates are shown with associated sampling standard errors. The *Standing timber volume for coniferous trees in Britain* report also provides details of the methods used in the derivation of these estimates, which, in the case of 'other' woodland, has used the combined information within the NFI field sample and the NFI map, as described in that document. More information on the details of the NFI field sample operation and the use of the data from this in the derivation of country or regional estimates can be found at www.forestry.gov.uk/inventory.

Table 19. Stocked area by principal conifer species for Wales

Principal species	FC	Other		Total
	Area (000 ha)	Area (000 ha)	SE%	Area (000 ha)
Wales				
All conifers	81.4	49.7	4	131.1
Sitka spruce	49.5	28.0	8	77.5
Scots pine	2.0	1.7	48	3.7
Corsican pine	1.9	0.8	41	2.7
Norway spruce	5.2	1.6	35	6.8
Larches	12.3	8.6	16	21.0
Douglas fir	5.0	4.6	23	9.5
Lodgepole pine	2.6	1.6	30	4.2
Other conifers	2.9	2.9	26	5.7

The total stocked area of conifer in Wales, according to Table 19 is 131,100 hectares. This compares to the total area of conifer IFT on the 2011 NFI map of 123,143 hectares. The two estimates are reasonably close because the incidence of conifer species is predominantly to be found within the areas identified as conifer woodland in the aerial photography interpretation used for the construction of the NFI IFT map. However, it is not expected that these areas would be identical since there are important differences in what these estimates represent. In the case of the area of conifer IFT, the differences from the area occupied by conifer species alone are noted in the introduction section, 'Understanding the differences between map-based and fieldwork estimates'. In the case of stocked areas, the estimate represents the area occupied by conifer species, whether in pure stands of conifer or in stands mixed with broadleaves, at the time of the NFI field survey, excluding from the total forest area that occupied by broadleaved species and that which is currently felled with no evidence of a newly planted crop.

Figure 11. Summary of stocked area by principal conifer species



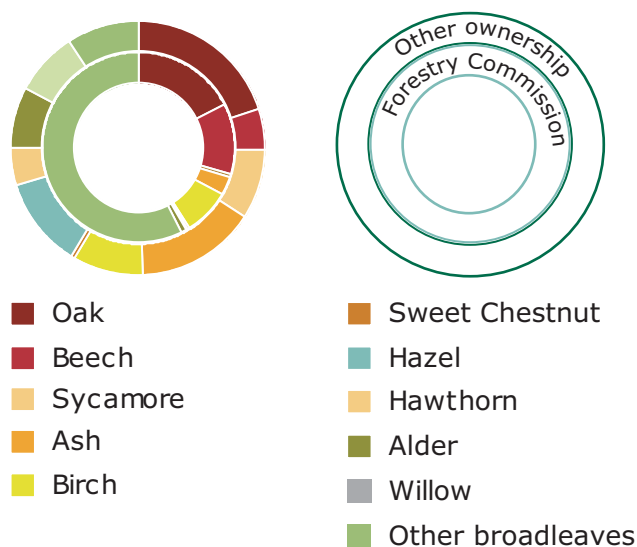
NFI 2011 woodland map

The recently published *Preliminary estimates of quantities of broadleaved species in British woodlands, with special focus on ash* report includes estimates of stocked areas of principal broadleaved species and of all broadleaves in GB in Table 4 of the document. This is reproduced here in Table 20 for Wales.

Table 20. Stocked area by principal broadleaved species for Wales

Principal species	FC	Other		Total
	Area (000 ha)	Area (000 ha)	SE%	Area (000 ha)
Wales				
All broadleaves	13.6	112.6	3	126.2
Oak	2.4	22.5	10	24.9
Beech	1.7	6.1	20	7.8
Sycamore	0.1	9.9	16	9.9
Ash	0.4	17.2	11	17.6
Birch	1.1	10.3	13	11.4
Sweet chestnut	0.0	0.4	77	0.5
Hazel	0.0	12.8	13	12.8
Hawthorn	0.0	5.4	20	5.4
Alder	0.1	9.0	15	9.1
Willow	0.0	8.9	17	8.9
Other broadleaves	7.8	10.4	13	18.2

Figure 12. Summary of stocked area by principal broadleaved species for Wales



The total stocked area of broadleaves in Wales, according to Table 20 is 126,200 hectares. This compares to the total area of broadleaved IFT on the 2011 NFI map of 115,075 hectares. The two estimates are reasonably close because the incidence of broadleaved species is predominantly to be found within the areas identified as broadleaved woodland in the aerial photography interpretation used for the construction of the NFI IFT map. However, it is not expected that these areas would be identical since there are important differences in what these estimates represent (as explained above for conifers). In the case of stocked areas, the estimate represents the area occupied by broadleaved species at the time of the NFI field survey, excluding from the total forest area that occupied by conifer species and that which is currently felled with no evidence of a newly planted crop. Figure 13 summarises the differences between the two estimates for conifer and broadleaved woodland types.

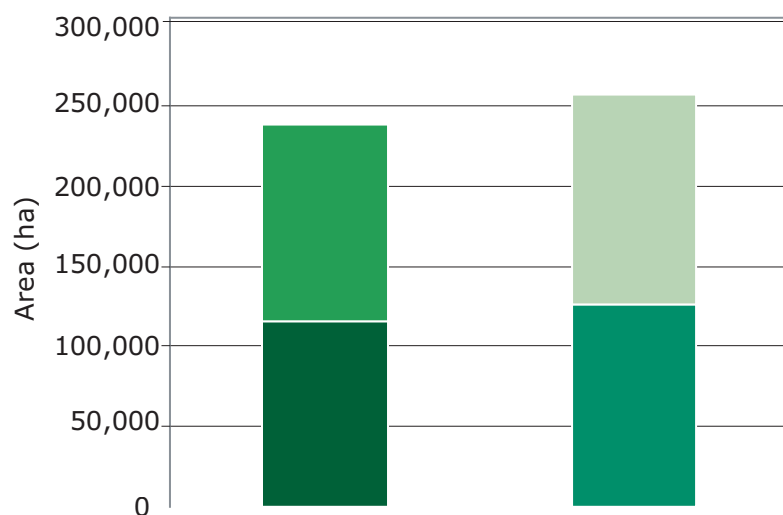
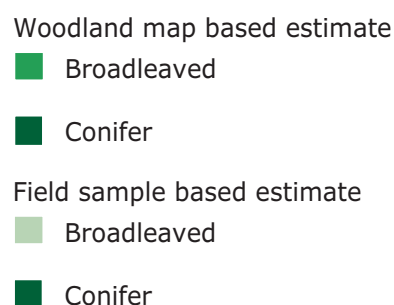


Figure 13. Comparison of mapped area estimates and stocked area estimates for Wales



Conclusion

The previous woodland map of Great Britain (National Inventory of Woodland and Trees - NIWT) was derived from 1:25,000 scale aerial photography dating between 1988 and 2000. This was updated to 2002 with new planting based on paid grant schemes and Forestry Commission first rotation planting. Like previous inventories these data were periodic and became increasingly out of date; even the new planting data that were added were accepted without visual verification of successful planting. While this approach was reasonable based on the available technology at that time, it quickly lacked current information on the nature and rate of change to the woodland resource.

The advancement of GIS technology coupled with the availability of up to date orthorectified aerial imagery meant that a new more accurate digital map could be developed to form the basis of a continuous rolling woodland inventory programme for sample plot measurement and an annual cycle for woodland map updating. This approach will enable us to create a more timely and accurate picture of the extent, nature and sustainability of GB woodland and its change over time, and provide up to date woodland analysis data as and when required, without the inhibiting cost of a complete remapping project.

The change in mapping methodology to exclude all public roads and the reduction of the minimum gap between woodlands to 20 metres has highlighted the degree and distribution of woodland fragmentation throughout GB. This is summarised in Table 7 for Wales.

Of the total number of discrete woodlands in Wales, 62% are less than 2 hectares in extent, although this represents only 7% of the total woodland area. Only 1% of the total number of discrete woodlands are greater or equal to 100 hectares in extent, although these woods represent 50% of the total woodland area.

Of the conifer woodland class 19% fall into the category of greater than or equal to 100 hectares in extent, representing 62% by area of all conifer woodland in Wales. In the case of broadleaves, just 12% of this woodland class falls into this same category representing 20% by area of the total broadleaved woodland in Wales.

In comparison, only 28% of the conifer woodland class falls within the category of less than 2 hectares, representing just 5% of the total conifer woodland area while 45% of the broadleaved woodland class falls within this category, representing 15% of the total broadleaved woodland area for Wales. The conifer and broadleaved woodland size distribution is summarised in Table 7a.

Glossary

Area (forest/woodland)	Forest and woodland area is divided into net forest area - the land area actually covered by trees (in the National Forest Inventory defined to the drip line of the canopy), and gross forest area - which includes both the area covered by trees and small open spaces of less than 0.5 hectare within the forest boundary (e.g. rides, glades, ponds).
Broadleaves	Trees and shrubs that belong to the angiosperm division of the plant kingdom (as distinct from the gymnosperm division, which includes conifers). Most broadleaves in the UK have laminar leaves and are deciduous. They are sometimes referred to as 'hardwoods' but not all produce hardwood timber.
Canopy	The mass of foliage and branches formed collectively by the crowns of trees.
Clearfelling	Cutting down of an area of woodland (if it is within a larger area of woodland it is typically a felling greater than 0.25 hectare). Sometimes a scatter or small clumps of trees may be left standing within the felled area.
Conifers	Trees and shrubs that belong to the gymnosperm division of the plant kingdom (as distinct from the angiosperm division, which includes broadleaves). Conifers mostly have needles or scale-like leaves and, with the exception of larch, all are evergreen. Sometimes referred to as 'softwoods', they produce softwood timber.
Forest (and woodland)	For the National Forest Inventory woodland is defined as land with a minimum area of 0.5 hectare under stands of trees, and tree crown cover of at least 20%, or the potential to achieve this. Areas of open space completely enclosed by woodland have been mapped as interpreted open areas. The minimum width for woodland is 20 metres, although where a woodland includes a narrow neck of woodland less than 20 metres wide, then the neck may be included if there is less than 20 metres in distance between woodlands. Tarmac roads and normal gauge railways have been excluded from the data regardless of width. Rivers, rides and power lines have been excluded when the feature (e.g. river) is visibly 20 metres wide and greater than 0.5 hectares in area. Parts of river features could be excluded, while other parts of the same feature are included.
Forestry Commission	The government department responsible for the regulation of forestry, implementing forestry policy and management of state forests in Great Britain. Forestry policy is devolved, with the exception of common issues addressed on a GB or UK basis, such as international forestry, plant health and forestry standards.

Glossary (continued)

Forestry Commission estate	Forests, woodlands, open land and other property managed by the Forestry Commission.
Great Britain (GB)	England, Scotland and Wales.
Interpreted forest type	The woodland map is differentiated into interpreted forest types (IFTs) as outlined in Appendix B1.
Interpreted open area	Open areas completely surrounded by woodland are differentiated into interpreted open areas (IOAs) as outlined in Appendix B2.
Other ownership	Land not owned or leased to the Forestry Commission. This could include private individuals, private forestry or timber businesses, other private businesses, local authorities, charitable organisations and community ownership or common land. It also includes government departments other than the Forestry Commission, such as the Ministry of Defence.

Appendix A: Summary of methodology differences between the NIWT woodland map and the NFI woodland map

	National Inventory of Woodland and Trees (NIWT)	National Forest Inventory (NFI)
Minimum extent of woodland, and also minimum extent of interpreted forest type (IFT) and interpreted open area (IOA)	2 hectares	0.5 hectare
Minimum width of gaps between woodlands and minimum width of IOA	50 metres	20 metres
Derived from	In England 1:25,000 fixed scale photography flown between 1991 and 1999. In Wales 1:25,000 fixed scale photography flown between 1991 and 1997. In Scotland, based on Land Cover of Scotland (LCS) 1988 project - which also used 1:25,000 fixed scale photography flown between 1987 and 1989	25 cm resolution orthorectified imagery for Scotland and England (Ordnance Survey). 40 cm resolution orthorectified imagery for Wales (Welsh Assembly)
Interpreted forest types (IFTs)	Broadleaved Conifer Felled Ground prepared for planting Mixed Young trees Coppice Coppice with standards Shrub	Broadleaved Conifer Felled Ground prepared for planting Mixed mainly broadleaved Mixed mainly conifer Young trees Coppice Coppice with standards Shrub Assumed woodland Low density

Appendix A: Continued

	National Inventory of Woodland and Trees (NIWT)	National Forest Inventory (NFI)
Interpreted open areas (IOAs)	N/A	Agricultural Bare area Grass Power line Quarry River Road Urban Other vegetation Open water Wind farm
Requirements	All woodland, both urban and rural, is mapped and included in the survey	All woodland, both urban and rural, is mapped and included in the survey OS MasterMap® features are used as boundaries where they fall within 10 metres of the perceived woodland edge
	Rivers visibly less than 50 metres wide are included in the woodland area	Rivers visibly less than 20 metres wide are included in the woodland area
	Roads less than 50 metres are included in the woodland area	All public roads are excluded from the woodland area regardless of width
	Power lines less than 50 metres wide are included in the woodland area	Power lines less than 20 metres wide are included in the woodland area
	Railways less than 50 metres wide are included in the woodland area	All railways are excluded from the woodland area
Updates	Updated to 31 March 2002 with new planting information from Forestry Commission sub-compartment database (SCDB) and country based grant scheme data	Annual updates based on: <ul style="list-style-type: none"> polygons identified from comparison with other sources; felling/restocking polygons from SCDB; availability of new photography; object based classification of remote sensing data

Appendix B1: Descriptions of interpreted forest types

Abbreviation code	Description text	Comments
B	Broadleaved	The canopy of broadleaved woodland is generally more uneven than that of coniferous woodland, being made up of rounded crowns but with variations according to species, age, height and season. Boundaries with adjacent internal polygons are generally less clearly defined than with conifers and naturally occurring stands. Some conifer trees may also be present but greater than 80% of the area will consist of broadleaved trees.
C	Conifer	Coniferous woodland often occurs as large plantations with trees in regular rows and the stand edges may be regular and sharply defined. Some broadleaved trees may also be present but greater than 80% of the area will consist of conifer trees.
F	Felled	Areas of woodland where the trees have been harvested or felled. Stumps or felled trees may be visible and there may be long heaps of felling debris ('windrows'). Some standing trees within this limit may also be present but should be disregarded. This category should not be confused with coppice. The areas concerned may also have been restocked but the new trees are not yet visible.
G	Ground prepared for planting	Very difficult to differentiate from agricultural, but may show plough furrows, spaced earth mounds or weed killed patches or strips as part of a new woodland regime. Likely to be part of an approved grant scheme held on Grants & Licences databases.
Mc	Mixed mainly conifer	Mixed woodland exhibits intermediate characteristics between conifer and broadleaved woodland. There can be several types of mixed woodland. A plantation of alternate rows of conifers and broadleaves may produce a 'striped' appearance. Conifers and broadleaves may be planted in blocks, or there may be general interspersed woodland. The proportion of the conifers will be more than 50% of the area and less than 80%.
Mb	Mixed mainly broadleaved	Mixed woodland exhibits intermediate characteristics between conifer and broadleaved woodland. There can be several types of mixed woodland. A plantation of alternate rows of conifers and broadleaves may produce a 'striped' appearance. Conifers and broadleaves may be planted in blocks, or there may be general interspersed woodland. The proportion of the broadleaves will be more than 50% of the area and less than 80%.

Appendix B1: Continued

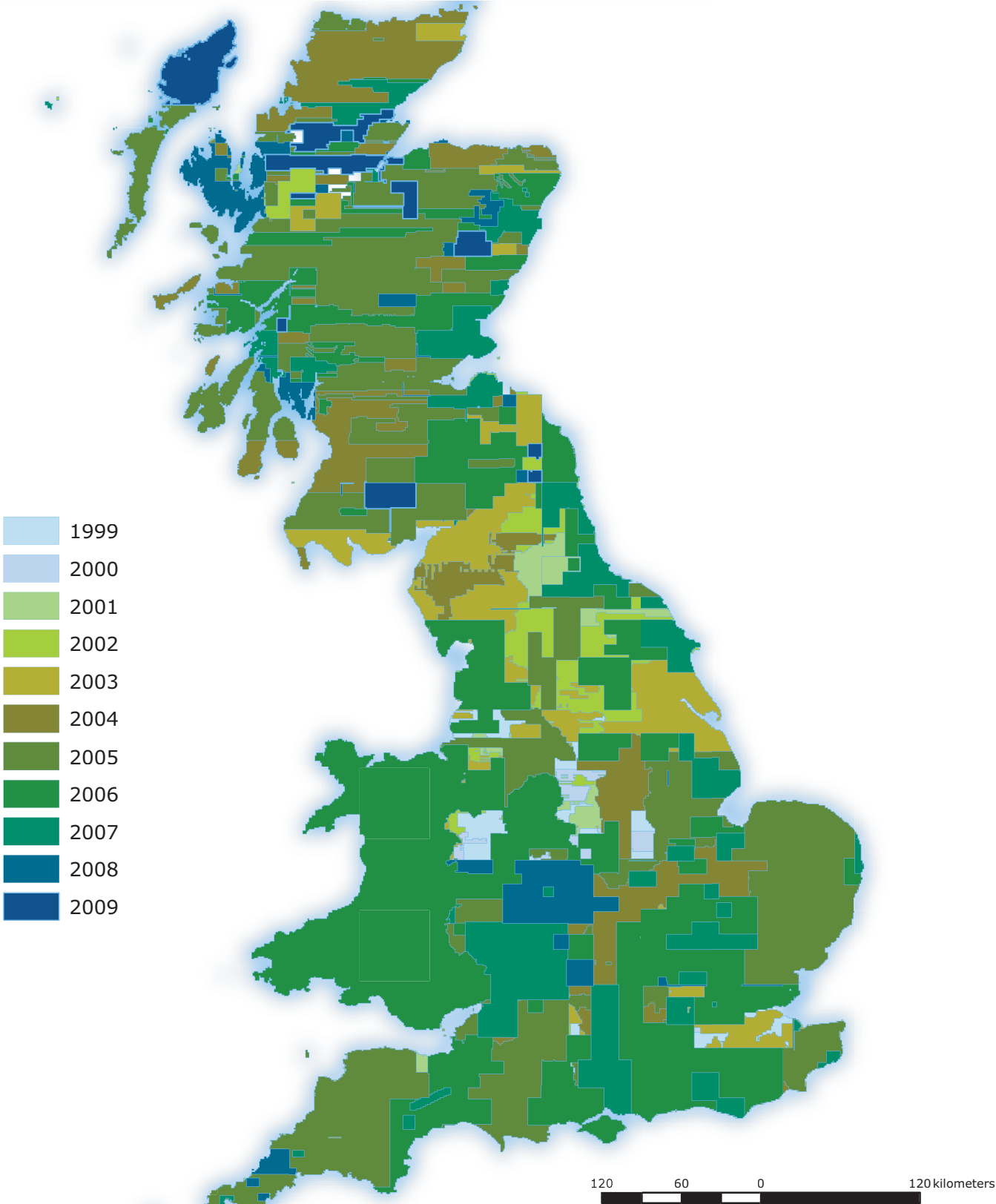
Abbreviation code	Description text	Comments
N	Young trees	Areas where planting is clearly visible but the trees cannot yet be differentiated between conifer and broadleaved due to their immaturity. Such areas can be either on land new to woodland or where a felled crop has been replaced.
O	Coppice	The most important characteristic of coppice areas on aerial photographs is their very even, smooth appearance. The coppice area may be made up of a patchwork of different ages (heights) but all exhibit this very even texture. Areas recently cut may appear to have a very clear floor with little felling debris. Coppice is always of broadleaved trees.
P	Coppice with standards	Some areas of coppice may also include larger broadleaved trees set into the coppice matrix. Such broadleaved trees, often oak, are known as standards and show very clearly over the even coppice as large, rounded crowns. The distribution of the standards may also be fairly scattered with approximately 25 stems per hectare.
S	Shrub	This category is intended to include areas that may possibly be woodland, where the growth is close to the ground and shows a rough character but no clear differentiation between conifer and broadleaved can yet be made. Areas being colonised by woody species may fall into this category. The cover will be at least 20%.
Aw	Assumed woodland	Areas of woodland identified as having been planted through woodland planting grant aid, which are not currently visible in aerial photography, but are assumed to exist.
Ld	Low density	The 'low density' polygons are areas that were mapped by NIWT but not mapped by NFI where investigation of the archive images shows a higher density than at present. These have been included for future monitoring.
CS	Cloud/ shadow	If cloud or shadow areas obscure woodland detail and it is difficult to allocate one of the above IFTs, then a feature is digitised around the uncertain area.
X	Uncertain	Where the interpreter is uncertain of the IFT/IOA to be used, X will be designated. The rate of use of this category should decline over time, as operators become more proficient and better at recognising IFTs/IOAs. As part of the quality control and update procedures Xs will be checked against the latest imagery

Appendix B2: Descriptions of interpreted open areas

Abbreviation code	Description text	Comments
A	Agricultural	May contain a cereal crop or pasture.
Ba	Bare area	Bare ground or rock.
Gs	Grass	A predominantly grassy area - may or may not be agricultural.
L	Power line	Linear feature, possibly shadow evidence of poles, pylons or even the cables/lines.
Q	Quarry	Evidence of change from vegetation to geology; sand, slate, rock etc. Active quarries could have buildings, and heavy plant tracks leading into the quarry.
Ri	River	Linear feature; depending on location can be fairly straight or meander through woodland.
Ro	Road	Linear feature; often fairly straight with gentle bends or turning circles.
U	Urban	Buildings within woodland areas; may include gardens surrounding the buildings.
V	Other vegetation	Not covered by the above (e.g. gorse, rhododendron, bracken, heather etc).
W	Open water	Normally labelled within OS MasterMap ®, areas of even colour.
Wf	Wind farm	Possible shadow evidence of turbines, normally in groups.

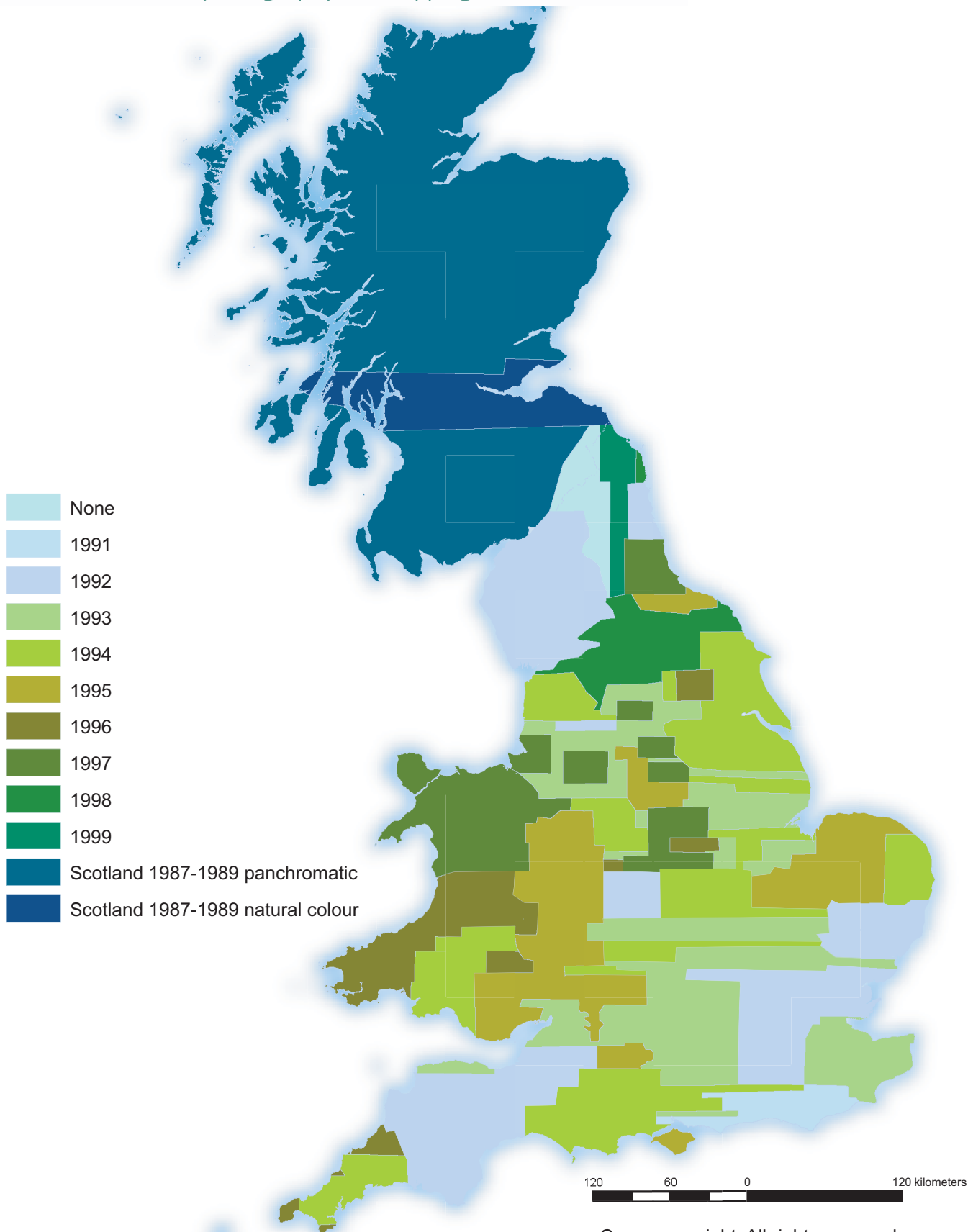
Appendix C: Aerial photography years of flying

Map C1: NFI dates of photography for mapping



Appendix C: Aerial photography years of flying

Map C2: NIWT dates of photography for mapping



Issued by: National Forest Inventory
231 Corstorphine Road, Edinburgh, EH12 7AT
Enquires: Esther Whitton
esther.whitton@forestry.gsi.gov.uk
Website: www.forestry.gov.uk/inventory

