



Biomass in live woodland trees in Britain

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 Inventory Report provides an estimate of the amount of biomass in living trees within British woodlands – including estimates for England, Scotland and Wales – broken down by principal species and by Forestry Commission and Private sector management.

- Total biomass in all forests and woodlands in Great Britain is estimated to be 426 million oven-dry tonnes. For England this is 211 million oven-dry tonnes, for Scotland 171 million oven-dry tonnes and for Wales 44 million oven-dry tonnes.
- Total biomass for the Forestry Commission estate is estimated to be 96 million oven-dry tonnes.
- Total biomass for the Private sector estate is estimated to be 330 million oven-dry tonnes.
- Total biomass for coniferous trees is estimated to be 218 million oven-dry tonnes.
- Total biomass for broadleaved trees is estimated to be 208 million oven-dry tonnes.

Introduction

National forest inventories are carried out by the Forestry Commission to provide accurate, up-to-date information about the size, distribution, composition and condition of the forests and woodlands in Great Britain (GB). This information is essential for developing and monitoring policies and guidance to support sustainable forest management.

The current National Forest Inventory, which began in 2009 (the first cycle due for completion in 2014), is a multi-purpose operation that has involved the production of a forest and woodland map for GB and a continuing programme of field surveys of the mapped forest and woodland areas. Information and data collected by the National Forest Inventory will be used for a number of purposes, including estimates and 25-year forecasts of forest metrics such as:

- Standing volume
- Timber availability
- Tree growth and increment
- Carbon storage
- Biomass

Estimates of aspects of the biodiversity and social value of forests and woodlands will also be provided by the Inventory.

This Inventory Report sets out the results (as at 31 March 2011) for the amount of biomass contained in living trees within all forests and woodlands in GB. Further information on this and other National Forest Inventory outputs is available from www.forestry.gov.uk/inventory.

Biomass

The last estimate of biomass within forests and woodlands in GB was published by the United Nations Food and Agriculture Organization (FAO) in the 2010 Forest Resources Assessment. This new report, in addition to providing the latest overall estimates of total biomass stocks, gives a breakdown of biomass by species group, ownership type and by country and National Forest Inventory region (see map on page 11).

This assessment of woodland biomass stocks will form a new baseline for biomass accounting within British forests and woodlands and it will be used in the development of the forthcoming (2015) reporting to the FAO for the Forest Resources Assessment. These estimates of biomass also form the basis for Forestry Commission estimates of woodland carbon stocks, which can be found in the National Forest Inventory Report *Carbon in live woodland trees in Britain*.

Biomass is defined as all living plant material in both the above and below ground parts of trees (including major roots, stumps, stems, branches, twigs and foliage) in stands with a mean diameter (at breast height) of 7 cm or more. The estimates do not include biomass in young stands that have not grown to this minimum mean diameter, nor, for example, biomass in the stems of coppice that are harvested before reaching this minimum mean diameter. See the Glossary for further explanation of the terms used in this report.

How biomass is estimated

Estimates of total biomass are determined by:

- Woodland area.
- Woodland characteristics (e.g. tree height) within this area.
- Number and size of trees.

The estimates of biomass in this report have been derived separately for the Forestry Commission estate and for the Private sector estate. They are based on the same principles but use different data sources. For the Forestry Commission estate, information on woodland area and woodland characteristics has been extracted from the Forestry Commission's long-established Sub-compartment database. For the Private sector estate, the estimates were derived from results obtained to date from the National Forest Inventory.

Sub-compartment database

The Sub-compartment database (SCDB) is a record of all land managed by the Forestry Commission. Each stand of trees is represented spatially, together with information on individual stand characteristics (for example species, planting year, spacing and yield class) which is periodically updated. As new surveys of stands are conducted (e.g. for operational purposes), survey results are also recorded against the stands. In addition, the SCDB contains details of how the stands are being managed – in particular, the planned frequency and type of thinning operations and a 'due date' for felling.

National Forest Inventory

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 hectares 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 aerial photography for Wales. The map was validated and updated using satellite imagery, which gave an independent crosscheck of woodland present. Satellite imagery was also used to identify areas of recently felled forests and woodland. Particular attention was paid to identifying areas of woodland loss verified as being due to the establishment of windfarms or the restoration of habitats.

Field survey work is used to refine the map-based estimates of woodland and clearfelled areas and to measure detailed aspects of the forest. The results in this report were derived from field surveys carried out between 2009 and 2012. This involved the ground surveying of one-hectare sample squares that were

partially or entirely covered by forest, including clearfelled areas, according to the 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.

Biomass estimates

The stand attributes derived from data from the SCDB and the National Forest Inventory are used to estimate the amount of biomass contained in the living trees of the stand. Estimates exclude biomass contained in other vegetation associated with the stand (e.g. shrubs and herbs). The derivation involves the application of allometric relationships of the volume of tree components to the size and shape of trees, and species-specific estimates of wood density that convert volume to weight of biomass.* By this means, separate biomass estimates are obtained for the various components of the trees of the stand in roots, stems, branches and leaves. For the purposes of estimation, it is assumed broadleaves are in full leaf. These biomass estimates are expressed in terms of oven-dry tonnes (i.e. representing the mass of the wood and leaves not including any moisture content).

Estimates for the Forestry Commission estate

Information from the SCDB was used to estimate biomass in living trees at the reference date of 31 March 2011 on a stand-by-stand basis. This was then aggregated to produce the estimated total across a defined geographic area for particular types of stand (classified, for example, by species, tree age or tree size class). For each stand, if an operational survey had been carried out close to the reference date, information from that survey was used to estimate total biomass. Otherwise, an estimate was made of the state of the stand, normally involving the application of standard Forestry Commission growth and yield models that take into account the past management of the stand. Estimated biomass is then modelled from the output of this stand modelling process.

Because the resulting estimates are based on a full record of data from the SCDB, there is no sampling error involved in the estimation process, therefore no sampling standard error is calculated. However, the nature of the estimation process within each individual stand does introduce estimation error, with variable contributions from stand to stand, due to the type, age and accuracy of the information held in the SCDB. In addition to these estimation errors, the reported biomass estimates have been derived from predictive models that estimate the amount of biomass present in stands of a given state. Application of these models introduces modelling errors in addition to estimation errors.* These estimation and modelling errors have not been quantified in this report.

*Details of the BSORT model are available from www.forestry.gov.uk/forecast.

Estimates for the Private sector estate

Forests on the National Forest Inventory woodland map were first separated into Forestry Commission estate and Private sector estate holdings using Forestry Commission spatial records of management boundaries. Estimates of biomass on the Private sector estate used a woodland area obtained from the map updated to 31 March 2011 (published in May 2012). This map contained a larger area (around 2.2 million hectares) of Private sector woodland than has been estimated by previous forest inventories.

For the field survey work, initial effort was directed towards Private sector sites that, according to the map, contained areas of coniferous woodland. 4036 sample squares were surveyed and the resulting data used to produce the results in this report. These sample squares represent a sub-sample of a planned 15 000 statistically representative squares covering all GB woodland that will be surveyed during this first cycle of the National Forest Inventory survey (due for completion in 2015).

At each sample square, the forest was stratified into different woodland types or stands, where information on species, age, management and a range of other parameters was collected. An average of around two stands per square was found, resulting in 8052 stands being assessed. Within each stand, field-based computer systems were used to locate two or three 100 m² (0.01 hectare) circular plots, within which all trees of greater than or equal to 4 cm diameter at breast height (DBH) were mapped, species identified and diameters measured. A total of 228 311 trees were measured in the sample used for this report. For 59 334 of these trees, additional measurements of tree height and crown dimensions were taken. The resulting data were used to estimate total biomass in the living trees. All squares were marked on the ground with metal pegs and GPS data of their location were recorded for checking and future measurement. At least 3% were re-measured by an independent quality assurance team to ensure standards. Further details of the methodology are available from www.forestry.gov.uk/forecast.

The results for individual surveyed squares were aggregated and scaled up to the areas identified by the woodland map, using standard statistical survey methodology, to produce the estimates in this report. Along with these estimates, associated sampling standard errors have also been calculated and reported in relative terms as percentages of the estimate. The sampling standard error will account for random variation arising from the selection of the sample, and random measurement errors.

It should be emphasised that, for the Private sector estimates, while large sampling standard errors indicate less reliability in

the quoted estimates due principally to relatively small numbers of samples available for estimation purposes, the converse of a small sampling standard error does not in itself imply that the quoted estimate is subject to a small amount of error. This is because, as described above, the derivation of biomass estimates at the stand and component level is based on the application of a series of modelled relationships and calculation parameters that convert the field measurements and observations in the sample squares to total tree biomass estimates. The errors and biases that may be present in these series of models and calculation parameters are not accounted for in the quoted sampling standard errors and are therefore additional, unquantified errors that may have a significant impact on the overall accuracy of the biomass estimates. More precise estimates for this sector, derived from a larger sample, will become available when the first cycle of the National Forest Inventory field survey is completed in 2015.

Results for biomass

This section provides the estimates of total biomass in living trees in forests and woodlands in GB. Estimates are also provided at individual country level and at National Forest Inventory region level (see map on page 11), with breakdowns for the Forestry Commission and Private sector estates; coniferous trees and broadleaved trees; and principal tree species.

All estimates are of total biomass in living trees in forests and woodlands as at 31 March 2011. The figures in the tables may not add to the totals shown as they have been individually rounded or, in some cases for Private sector estimates, because the estimates have been independently calculated per species from slightly different samples within the survey. Sampling standard errors (SE) attached to Private sector estimates are expressed in relative terms (%) to the right of the relevant estimate.

The estimate of total biomass in living trees in woodlands in Great Britain is 426 million oven-dry tonnes (Table 1). Of this, 96 million oven-dry tonnes (23%) is estimated to be on the Forestry Commission estate and 330 million oven-dry tonnes (77%) on the Private sector estate. The estimate of total biomass is composed of an estimate of 218 million oven-dry tonnes (51%) in coniferous trees and 208 million oven-dry tonnes (49%) in broadleaved trees. These results are illustrated in Figures 1a and 1b.

Tables 2, 3 and 4 provide the equivalent estimates for England, Scotland and Wales respectively, and these are illustrated in Figures 2a, 2b, 3a, 3b, 4a and 4b.

Table 1 Total biomass in principal woodland tree species in Great Britain.

Principal species	FC	Private sector		Total
	000 odt	000 odt	SE%	
Great Britain				
All conifers	84 023	134 308	2	218 331
Sitka spruce	47 741	62 258	3	109 999
Scots pine	9 431	26 169	4	35 600
Corsican pine	3 870	3 382	11	7 253
Norway spruce	3 678	7 159	8	10 837
Larches	6 128	16 329	5	22 458
Douglas fir	3 622	6 628	10	10 250
Lodgepole pine	7 534	6 256	9	13 790
Other conifers	2 019	6 014	12	8 032
All broadleaves	11 993	195 922	2	207 915
Oak	3 845	57 890	4	61 735
Beech	3 092	25 785	7	28 877
Sycamore	178	21 426	6	21 604
Ash	437	27 646	5	28 083
Birch	1 689	19 300	4	20 990
Sweet chestnut	121	6 020	10	6 141
Hazel	69	6 058	6	6 127
Hawthorn	0	3 420	7	3 420
Alder	128	7 695	8	7 824
Willow	0	4 787	10	4 788
Other broadleaves	2 434	16 832	6	19 265
All species	96 016	329 927	1	425 943

Figure 1a Total biomass in conifer and broadleaved woodland trees in Great Britain.



Figure 1b Share of total biomass in principal woodland tree species in Great Britain.

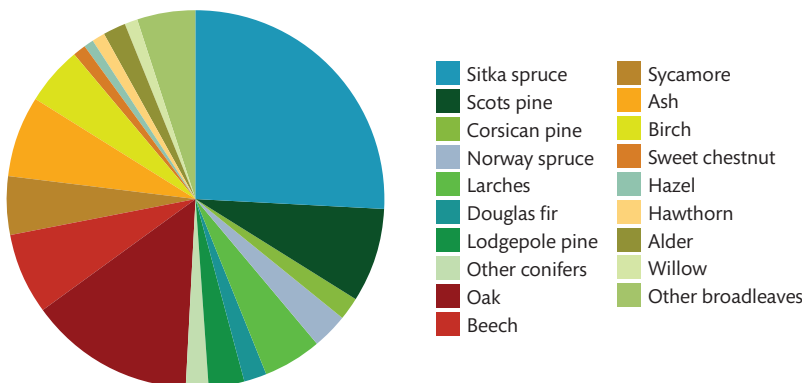


Table 2 Total biomass in principal woodland tree species in England.

Principal species	FC	Private sector		Total
	000 odt	000 odt	SE%	
England				
All conifers	17 186	38 209	3	55 395
Sitka spruce	5 804	5 954	9	11 759
Scots pine	2 762	10 382	7	13 144
Corsican pine	3 289	3 004	11	6 293
Norway spruce	977	3 910	10	4 888
Larches	1 126	6 734	7	7 860
Douglas fir	1 762	3 880	13	5 642
Lodgepole pine	605	822	25	1 427
Other conifers	859	3 585	10	4 444
All broadleaves	7 608	147 801	2	155 409
Oak	2 996	45 988	5	48 984
Beech	2 616	19 358	7	21 974
Sycamore	130	15 883	8	16 013
Ash	342	21 228	5	21 571
Birch	374	10 478	6	10 852
Sweet chestnut	114	5 803	10	5 917
Hazel	32	4 881	7	4 913
Hawthorn	0	2 833	8	2 833
Alder	52	4 885	10	4 937
Willow	0	3 594	12	3 595
Other broadleaves	952	13 543	6	14 495
All species	24 794	185 982	2	210 776

Figure 2a Total biomass in conifer and broadleaved woodland trees in England.

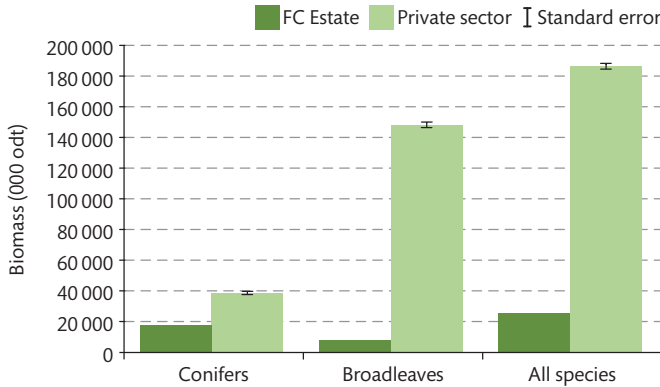


Figure 2b Share of total biomass in principal woodland tree species in England.

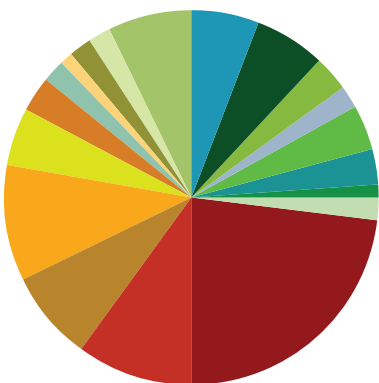


Table 3 Total biomass in principal woodland tree species in Scotland.

Principal species	FC	Private sector		Total
	000 odt	000 odt	SE%	
Scotland				
All conifers	54 633	85 277	2	139 909
Sitka spruce	34 961	50 494	3	85 454
Scots pine	6 306	15 562	6	21 867
Corsican pine	213	217	49	430
Norway spruce	1 908	2 799	14	4 708
Larches	3 217	7 690	8	10 907
Douglas fir	975	1 524	23	2 499
Lodgepole pine	6 484	5 134	10	11 618
Other conifers	569	1 705	34	2 274
All broadleaves	3 035	28 225	5	31 259
Oak	515	5 568	14	6 083
Beech	134	4 488	17	4 622
Sycamore	37	3 259	14	3 296
Ash	37	2 295	23	2 332
Birch	1 263	7 765	5	9 028
Sweet chestnut	0	0	-	0
Hazel	34	340	22	374
Hawthorn	0	253	21	253
Alder	62	1 448	23	1 510
Willow	0	457	15	457
Other broadleaves	952	2 394	18	3 346
All species	57 667	113 214	2	170 881

Figure 3a Total biomass in conifer and broadleaved woodland trees in Scotland.

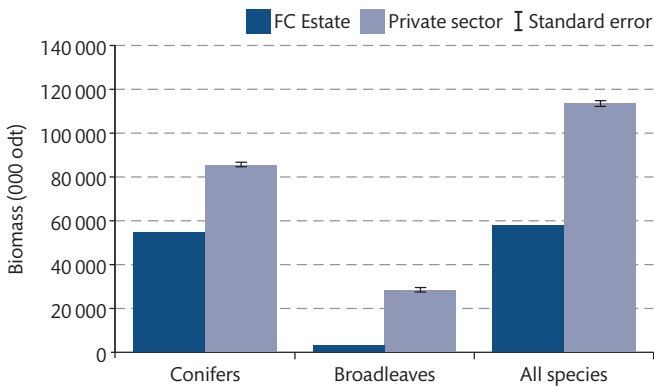


Figure 3b Share of total biomass in principal woodland tree species in Scotland.

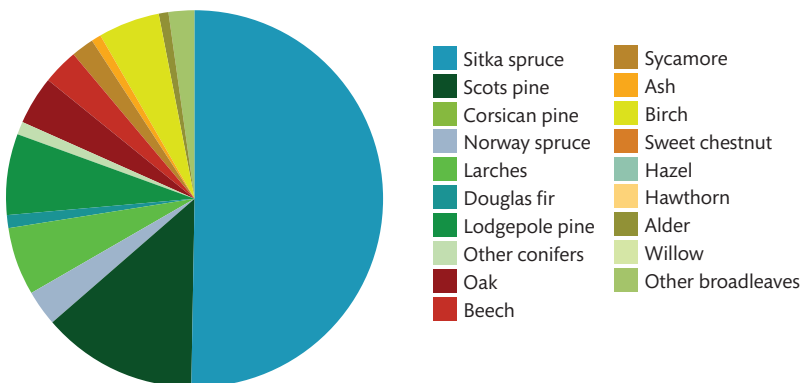


Table 4 Total biomass in principal woodland tree species in Wales.

Principal species	FC	Private sector		Total
	000 odt	000 odt	SE%	
Wales				
All conifers	12 205	10 822	6	23 027
Sitka spruce	6 975	5 810	11	12 786
Scots pine	363	225	46	588
Corsican pine	368	162	43	530
Norway spruce	792	450	42	1 242
Larches	1 785	1 906	20	3 691
Douglas fir	885	1 224	25	2 109
Lodgepole pine	445	300	35	745
Other conifers	590	724	38	1 314
All broadleaves	1 350	19 896	6	21 247
Oak	333	6 334	14	6 668
Beech	343	1 939	26	2 281
Sycamore	11	2 284	22	2 295
Ash	58	4 123	16	4 180
Birch	52	1 057	17	1 109
Sweet chestnut	7	217	85	224
Hazel	2	837	19	840
Hawthorn	0	335	24	335
Alder	15	1 362	17	1 377
Willow	0	736	27	736
Other broadleaves	530	895	20	1 424
All species	13 555	30 730	5	44 285

Figure 4a Total biomass in conifer and broadleaved woodland trees in Wales.

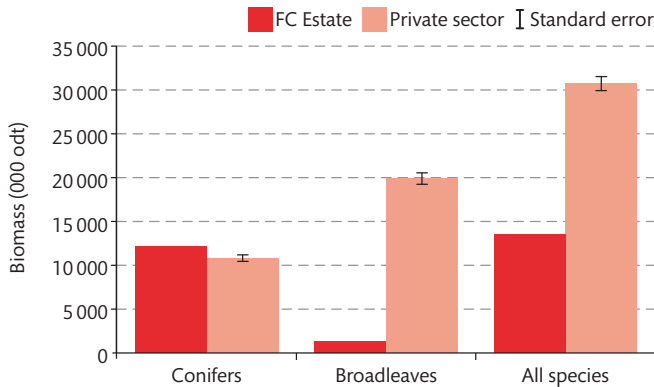


Figure 4b Share of total biomass in principal woodland tree species in Wales.

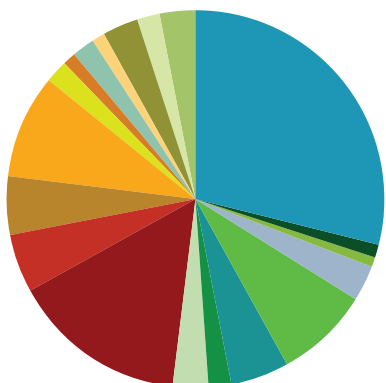
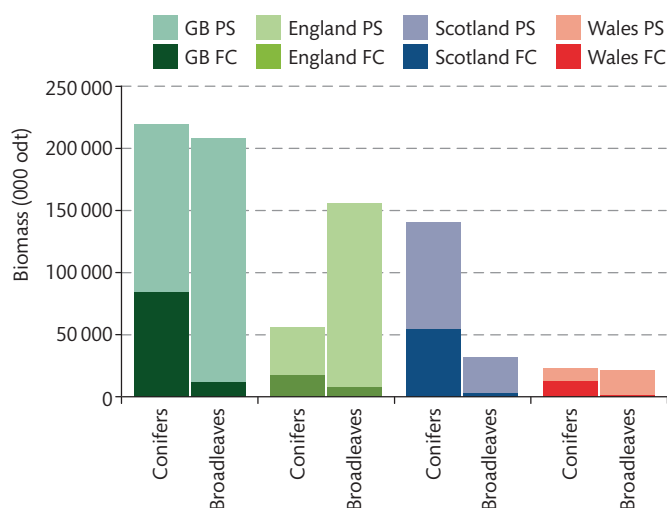


Table 5 and Figure 5 provide a comparative representation of the estimated amount of biomass in living trees in forests and woodlands in Great Britain and in each of the three individual countries. They show that England is estimated to have a total of 211 million oven-dry tonnes (50% of the total for Great Britain); Scotland is estimated to have 171 million oven-dry tonnes (40% of GB); and Wales is estimated to have 44 million oven dry-tonnes (10% of GB).

Table 5 Total biomass in conifer and broadleaved woodland trees in GB and countries.

Country	FC	Private sector		Total
	000 odt	000 odt	SE%	
England				
All conifers	17 186	38 209	3	55 395
All broadleaves	7 608	147 801	2	155 409
All species	24 794	185 982	2	210 776
Scotland				
All conifers	54 633	85 277	2	139 909
All broadleaves	3 035	28 225	5	31 259
All species	57 667	113 214	2	170 881
Wales				
All conifers	12 205	10 822	6	23 027
All broadleaves	1 350	19 896	6	21 247
All species	13 555	30 730	5	44 285
Great Britain				
All conifers	84 023	134 308	2	218 331
All broadleaves	11 993	195 922	2	207 915
All species	96 016	329 927	1	425 943

Figure 5 Total biomass in conifer and broadleaved woodland trees in GB and countries.



Tables 6 and 7 provide the estimates of total biomass in living trees in forests and woodlands for each of the National Forest Inventory regions in England and Scotland respectively (Wales is not split into separate regions in the Inventory). These results are illustrated in Figures 6 and 7.

Table 6 Total biomass in principal woodland tree species in National Forest Inventory regions. England.

Principal species	FC	Private sector		Total
	000 odt	000 odt	SE%	
North West England				
All conifers	1 886	3 955	8	5 842
Sitka spruce	1 311	1 722	17	3 033
Scots pine	107	514	20	621
Corsican pine	47	47	99	94
Norway spruce	46	370	27	415
Larches	188	971	16	1 158
Douglas fir	64	16	64	79
Lodgepole pine	92	195	60	286
Other conifers	33	127	53	159
All broadleaves	324	10 477	8	10 801
Oak	104	3 050	13	3 154
Beech	38	1 347	39	1 385
Sycamore	11	2 330	22	2 341
Ash	24	836	20	860
Birch	46	1 236	19	1 282
Sweet chestnut	4	63	82	67
Hazel	20	128	25	148
Hawthorn	0	143	25	143
Alder	5	839	19	843
Willow	0	159	28	159
Other broadleaves	73	289	25	361
All species	2 211	14 474	6	16 685

Table 6 (continued) England.

Principal species	FC	Private sector		Total
	000 odt	000 odt	SE%	
North East England				
All conifers	4 536	4 728	8	9 264
Sitka spruce	3 354	1 353	20	4 707
Scots pine	265	1 534	18	1 799
Corsican pine	33	32	85	66
Norway spruce	354	445	36	799
Larches	140	857	28	998
Douglas fir	47	142	54	189
Lodgepole pine	298	264	48	562
Other conifers	43	101	50	144
All broadleaves	111	4 756	9	4 867
Oak	9	861	28	870
Beech	20	408	25	428
Sycamore	6	750	27	755
Ash	0	480	23	480
Birch	16	971	22	987
Sweet chestnut	0	0	-	0
Hazel	0	225	26	226
Hawthorn	0	29	32	29
Alder	6	534	32	540
Willow	0	260	59	260
Other broadleaves	54	218	17	272
All species	4 647	9 523	6	14 170
Yorkshire and the Humber				
All conifers	1 537	3 870	6	5 408
Sitka spruce	422	1 125	17	1 547
Scots pine	468	828	14	1 295
Corsican pine	70	176	37	246
Norway spruce	51	284	21	336
Larches	292	935	12	1 227
Douglas fir	62	151	39	213
Lodgepole pine	120	244	32	364
Other conifers	53	127	27	179
All broadleaves	274	10 683	5	10 957
Oak	49	2 541	15	2 590
Beech	47	1 411	17	1 458
Sycamore	36	2 709	14	2 746
Ash	23	1 362	13	1 385
Birch	44	872	12	916
Sweet chestnut	1	77	58	78
Hazel	0	79	24	79
Hawthorn	0	214	15	214
Alder	3	463	21	466
Willow	0	217	21	217
Other broadleaves	71	752	12	823
All species	1 811	14 539	4	16 350

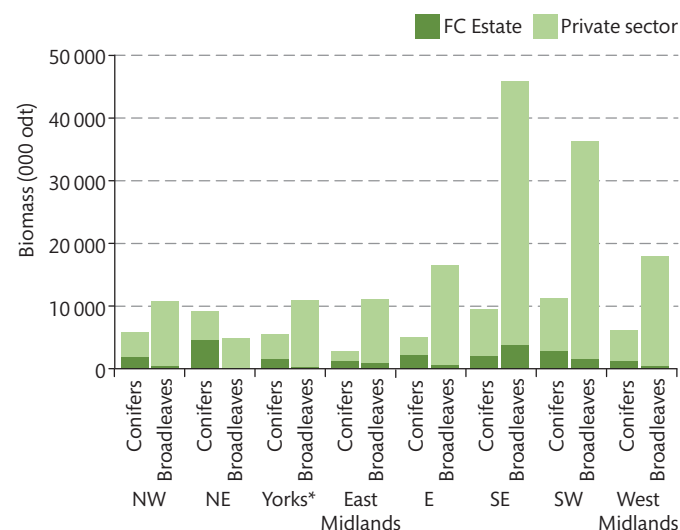
Principal species	FC	Private sector		Total
	000 odt	000 odt	SE%	
East Midlands				
All conifers	1 126	1 716	16	2 842
Sitka spruce	38	3	110	42
Scots pine	334	1 038	26	1 373
Corsican pine	561	245	33	806
Norway spruce	44	144	36	188
Larches	32	209	26	242
Douglas fir	14	46	81	60
Lodgepole pine	48	0	-	48
Other conifers	54	30	59	84
All broadleaves	861	10 402	7	11 262
Oak	448	2 798	15	3 246
Beech	75	135	32	210
Sycamore	22	1 532	21	1 554
Ash	122	2 709	20	2 830
Birch	58	490	21	547
Sweet chestnut	8	333	50	341
Hazel	1	195	22	195
Hawthorn	0	449	20	449
Alder	1	102	63	104
Willow	0	263	41	263
Other broadleaves	126	1 396	18	1 522
All species	1 987	12 115	6	14 102
East England				
All conifers	2 106	2 994	9	5 100
Sitka spruce	0	24	70	24
Scots pine	522	1 339	16	1 861
Corsican pine	1 421	742	23	2 163
Norway spruce	9	202	33	210
Larches	22	357	25	379
Douglas fir	77	157	37	234
Lodgepole pine	3	0	-	3
Other conifers	52	174	33	226
All broadleaves	490	16 103	6	16 593
Oak	138	4 648	15	4 786
Beech	147	1 436	22	1 583
Sycamore	13	2 099	21	2 112
Ash	32	2 029	18	2 061
Birch	47	909	21	956
Sweet chestnut	11	823	30	834
Hazel	3	245	26	248
Hawthorn	0	119	19	119
Alder	7	457	53	465
Willow	0	526	48	526
Other broadleaves	92	2 811	18	2 903
All species	2 596	19 098	5	21 693

Table 6 (continued) England.

Principal species	FC	Private sector		Total
	000 odt	000 odt	SE%	
South East England and London				
All conifers	1 986	7 533	6	9 519
Sitka spruce	8	128	43	136
Scots pine	610	2 859	13	3 470
Corsican pine	517	789	21	1 307
Norway spruce	152	771	16	923
Larches	87	1 076	15	1 163
Douglas fir	334	625	23	959
Lodgepole pine	4	12	107	16
Other conifers	274	1 303	17	1 577
All broadleaves	3 711	42 518	3	46 229
Oak	1 609	12 781	7	14 390
Beech	1 643	8 341	10	9 983
Sycamore	18	1 483	20	1 501
Ash	53	5 253	9	5 306
Birch	93	3 741	8	3 835
Sweet chestnut	35	2 580	13	2 615
Hazel	2	1 836	11	1 838
Hawthorn	0	881	14	881
Alder	18	852	26	870
Willow	0	589	17	589
Other broadleaves	239	4 321	10	4 560
All species	5 697	49 943	3	55 640
South West England				
All conifers	2 780	8 526	6	11 306
Sitka spruce	610	1 370	20	1 980
Scots pine	240	1 002	18	1 242
Corsican pine	399	397	29	796
Norway spruce	249	971	18	1 219
Larches	226	1 495	14	1 722
Douglas fir	768	2 197	19	2 964
Lodgepole pine	22	6	105	28
Other conifers	265	1 115	17	1 380
All broadleaves	1 482	35 127	5	36 609
Oak	506	12 262	10	12 767
Beech	561	5 047	15	5 608
Sycamore	17	3 042	13	3 059
Ash	69	6 087	8	6 156
Birch	39	1 310	13	1 349
Sweet chestnut	48	1 328	24	1 377
Hazel	4	1 524	13	1 528
Hawthorn	0	660	20	660
Alder	8	1 093	20	1 101
Willow	0	1 287	19	1 287
Other broadleaves	229	2 071	13	2 300
All species	4 261	43 631	4	47 892

Principal species	FC	Private sector		Total
	000 odt	000 odt	SE%	
West Midlands				
All conifers	1 229	4 886	12	6 115
Sitka spruce	60	230	64	290
Scots pine	215	1 268	27	1 483
Corsican pine	241	575	33	817
Norway spruce	73	724	30	797
Larches	138	833	24	971
Douglas fir	397	546	37	943
Lodgepole pine	19	101	73	119
Other conifers	86	609	32	695
All broadleaves	356	17 734	8	18 090
Oak	133	7 047	16	7 180
Beech	84	1 234	35	1 318
Sycamore	7	1 939	36	1 946
Ash	20	2 472	21	2 492
Birch	31	949	25	979
Sweet chestnut	6	599	35	605
Hazel	2	650	25	652
Hawthorn	0	338	20	338
Alder	4	545	34	548
Willow	0	293	28	293
Other broadleaves	69	1 685	25	1 753
All species	1 585	22 660	6	24 245

Figure 6 Total biomass in conifer and broadleaved woodland trees for National Forest Inventory regions. England.



*Yorks = Yorkshire and the Humber

Table 7 Total biomass in principal woodland tree species in National Forest Inventory regions. Scotland.

Principal species	FC	Private sector		Total
	000 odt	000 odt	SE%	
North Scotland				
All conifers	8 682	10 186	5	18 868
Sitka spruce	2 057	3 815	11	5 872
Scots pine	2 582	2 160	19	4 742
Corsican pine	6	74	108	80
Norway spruce	220	177	53	397
Larches	480	614	28	1 094
Douglas fir	397	558	43	954
Lodgepole pine	2 845	2 751	12	5 596
Other conifers	96	0	-	96
All broadleaves	547	3 071	14	3 619
Oak	28	54	59	82
Beech	8	555	67	564
Sycamore	1	65	91	66
Ash	1	71	65	71
Birch	429	1 783	12	2 212
Sweet chestnut	0	0	-	0
Hazel	6	62	61	67
Hawthorn	0	0	-	0
Alder	8	220	42	228
Willow	0	45	56	45
Other broadleaves	67	213	24	280
All species	9 230	13 178	5	22 408
North East Scotland				
All conifers	6 605	17 388	4	23 993
Sitka spruce	2 335	3 515	15	5 849
Scots pine	2 221	9 378	7	11 598
Corsican pine	128	0	-	128
Norway spruce	312	661	31	973
Larches	515	1 991	17	2 506
Douglas fir	194	632	38	826
Lodgepole pine	821	845	27	1 666
Other conifers	80	316	62	396
All broadleaves	216	3 902	10	4 118
Oak	7	486	59	493
Beech	30	425	41	455
Sycamore	3	173	51	176
Ash	2	11	88	13
Birch	77	2 381	10	2 458
Sweet chestnut	0	0	-	0
Hazel	0	26	88	26
Hawthorn	0	1	58	1
Alder	9	31	45	39
Willow	0	60	53	61
Other broadleaves	88	283	26	371
All species	6 821	21 227	4	28 048

Principal species	FC	Private sector		Total
	000 odt	000 odt	SE%	
East Scotland				
All conifers	3 971	9 381	5	13 352
Sitka spruce	1 824	4 499	10	6 323
Scots pine	907	1 969	14	2 877
Corsican pine	48	0	-	48
Norway spruce	234	532	22	766
Larches	254	1 785	16	2 039
Douglas fir	117	144	33	261
Lodgepole pine	522	130	40	652
Other conifers	65	291	42	356
All broadleaves	172	4 696	9	4 868
Oak	15	529	34	544
Beech	25	1 244	28	1 270
Sycamore	10	567	23	578
Ash	2	316	43	318
Birch	66	1 171	11	1 238
Sweet chestnut	0	0	-	0
Hazel	0	29	32	29
Hawthorn	0	49	66	49
Alder	3	345	52	348
Willow	0	198	25	198
Other broadleaves	51	374	34	425
All species	4 144	14 043	4	18 186
South Scotland				
All conifers	16 179	28 987	4	45 166
Sitka spruce	13 476	23 273	5	36 749
Scots pine	201	1 499	21	1 700
Corsican pine	21	26	69	47
Norway spruce	460	1 244	23	1 704
Larches	920	2 043	15	2 963
Douglas fir	142	183	37	325
Lodgepole pine	860	439	32	1 299
Other conifers	100	273	33	373
All broadleaves	391	11 388	10	11 779
Oak	91	2 618	22	2 708
Beech	28	1 752	26	1 780
Sycamore	15	2 077	17	2 092
Ash	7	1 680	29	1 688
Birch	54	1 223	13	1 277
Sweet chestnut	0	0	-	0
Hazel	0	43	44	44
Hawthorn	0	190	22	190
Alder	6	369	24	374
Willow	0	121	22	121
Other broadleaves	190	1 316	29	1 506
All species	16 570	40 350	4	56 919

Table 7 (continued) Scotland.

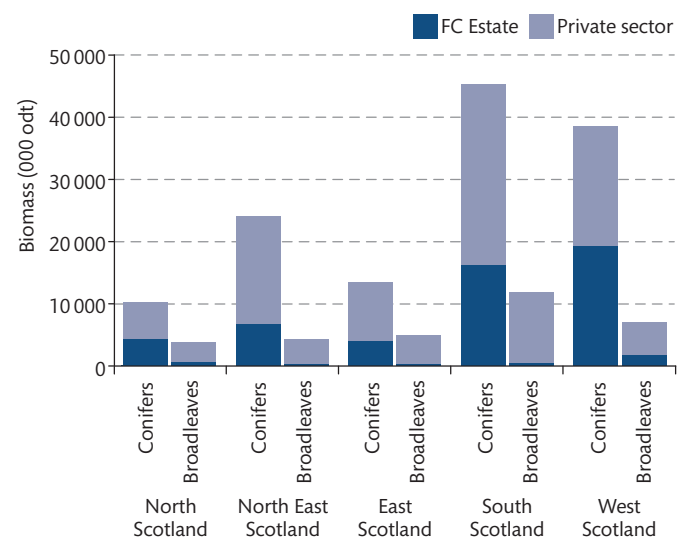
Principal species	FC	Private sector		Total
	000 odt	000 odt	SE%	
West Scotland				
All conifers	19 195	19 334	5	38 529
Sitka spruce	15 269	15 391	5	30 660
Scots pine	395	556	32	951
Corsican pine	11	117	58	128
Norway spruce	682	186	64	868
Larches	1 047	1 256	20	2 304
Douglas fir	126	7	84	133
Lodgepole pine	1 437	969	24	2 405
Other conifers	228	825	63	1 053
All broadleaves	1 709	5 167	13	6 876
Oak	374	1 882	22	2 257
Beech	43	511	65	554
Sycamore	8	377	70	385
Ash	25	217	45	242
Birch	637	1 206	13	1 844
Sweet chestnut	0	0	-	0
Hazel	28	180	31	208
Hawthorn	0	14	77	14
Alder	37	484	50	520
Willow	0	32	37	32
Other broadleaves	556	208	43	764
All species	20 903	24 417	5	45 320

The National Forest Inventory regions.

The Wales area is treated as both a country and a region in the Inventory.



Figure 7 Total biomass in conifer and broadleaved woodland trees in National Forest Inventory regions. Scotland.



What the results tell us

This is the first National Forest Inventory estimate of the amount of biomass in living woodland trees in Great Britain. The combination of National Forest Inventory data and Forest Research models has provided the most accurate estimate of biomass produced to date in Great Britain. The results provide a snapshot, as at March 2011, of both the total amount of biomass and its geographic distribution.

The results show that nearly a quarter of all biomass in living woodland trees is contained within forests and woodlands in the south of England (South East England and London, and South West England National Forest Inventory regions*) and this is primarily made up of broadleaved species. There are an estimated 56 million oven-dry tonnes in South East England and London, and an estimated 48 million oven-dry tonnes in South West England.

Forty per cent of all biomass in living woodland trees is contained in forests and woodlands in Scotland (all National Forest Inventory regions) and this is primarily made up of coniferous species. There are an estimated 57 million oven-dry tonnes in South Scotland and an estimated 45 million oven-dry tonnes in West Scotland.

The results of the estimates of the distribution of biomass between conifers and broadleaves show that most biomass in England is contained in broadleaved trees, while most of that in Scotland is contained in coniferous trees.

The results also show that there is a significantly higher amount of biomass in forests and woodlands in Great Britain than that previously reported in the 2010 Forest Resources Assessment (FAO). The principal source of the difference between estimates is an improvement in the inventory data upon which the estimates were based (for example due to the application of more advanced technology such as satellite imagery, geographic information systems and computer models, all of which have improved the accuracy of estimates). It is now evident that previous inventories, such as the National Inventory of Woodlands and trees (NIWT), under-estimated both forest area and numbers of trees, which therefore led to an under-estimate of associated biomass stocks. There are also differences in scope between the National Forest Inventory and the previous NIWT surveys; the former, for example, includes woods found in urban areas that the latter excluded.

However, while improved methodology and more accurate tools account for the majority of the difference between the National Forest Inventory and the previous NIWT surveys, the

results are, to some extent, a reflection of the real growth and increment of forest and woodland trees in Britain and the fact that Britain currently harvests less than that annual tree growth (see the National Forest Inventory Reports *GB 25-year forecast of standing coniferous volume and increment*, *50-year forecast of hardwood timber availability* and *Forestry Facts and Figures 2013*). The average age and average size of trees will have increased between the inventories and as a consequence biomass stocks will also have risen. The evidence of this can be seen from the age class and mean stand diameter data reported in the Inventory Reports *Standing timber volume for coniferous trees in Britain* and *Preliminary estimates of quantities of broadleaved species in British woodlands, with a special focus on ash*. The age class data in the reports show that most trees in Britain are currently relatively immature and, by comparing their current age to the average duration of tree crop rotations, it can be deduced that the majority of trees were younger and smaller at the time of the NIWT survey.

The estimation of biomass contained in living trees is an essential step in the calculation of carbon stocks for Britain's forests and woodlands. The results are also an essential primary source of information for studies of the potential availability of a range of wood-based products (with particular relevance for the supply of wood fuel). However, it is important to recognise that the estimates of total biomass in living trees in forests and woodlands are not the same as estimates of available biomass. A significant proportion of biomass is contained in trees that will not be harvested (for example, for conservation or amenity reasons). Great Britain also has an existing timber products industry, which already uses a high proportion of available increment.

A direct measure of changes in biomass stocks will be available when the second cycle of the National Forest Inventory Reports in 2020.

*It should be noted that National Forest Inventory regions are not equal in area and these rankings are not established on a per unit area basis.

Glossary

Age class: a grouping of trees into specific age ranges for classification purposes.

Allometric relationship: a mathematical relationship explaining the change in size (growth) of one or more parts of an organism. Allometric relationships are often used in forestry to estimate a difficult-to-measure variable, such as volume, from an easily measured attribute, such as diameter at breast height (DBH).

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 the small open spaces (of less than 0.5 hectares) within the forest boundary (e.g. rides, glades, ponds).

Biomass: all of the material making up a tree, or one of its components, such as the stem or branches.

Broadleaves: trees and shrubs that belong to the angiosperm division of the plant kingdom (as distinct from the gymnosperm division that includes conifers). Most in the UK have laminar leaves and are deciduous. 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 hectares). 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 that includes broadleaves). Conifers mostly have needles or scalelike leaves and, with the exception of larch, all are evergreen. Sometimes referred to as ‘softwoods’, they produce softwood timber.

DBH (diameter at breast height): the diameter of a tree (overbark) at breast height, which is usually defined as 1.3 m along the axis of the stem from the ground.

Forest (and woodland): land predominately covered in trees (defined as land under stands of trees with a canopy cover of at least 20%, or the ability to achieve this, and with a minimum area of 0.5 hectares and minimum width of 20 m), whether in large tracts (generally called forests) or smaller areas known by a variety of terms (including woods, copses, spinneys or shelterbelts).

Forestry Commission: the government department responsible for the regulation of forestry, implementing forestry policy and management of state forests in Great Britain as at 31 March 2011. 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.

Forestry Commission estate: forests, woodlands, open land and other property managed by the Forestry Commission as at 31 March 2011.

Great Britain (GB): England, Scotland and Wales.

Oven-dry tonnes (odt): A unit of weight, conventionally used for reporting quantities of biomass. The weight in metric tonnes (1 tonne = 1000 kg) after all moisture has been driven off. The oven-dry weight of a sample is the minimum weight achieved when left in an oven at 105°C.

Overbark: a term used in measurements of wood volume that include the bark.

Private sector estate: forests and woodlands in GB not managed by

the Forestry Commission. In the context of the National Forest Inventory, ‘Private sector’ is used for convenience although it includes land owned or managed by bodies such as local authorities and charities.

Production forecast: a forecast of softwood availability from the Forestry Commission (GB), the Forest Service, an agency within the Department of Agriculture and Rural Development in Northern Ireland) and potential softwood availability from the Private sector (UK).

Softwood: wood of coniferous trees or the conifers themselves.

Stand: a relatively uniform collection of trees (from either planting or natural regeneration) composed, for example, of a single species or a single age class.

Standard error (SE): the measure of the margin of error associated with an estimate as a result of sampling from a population with statistical variability. Larger standard errors indicate less precision in the estimate. Standard errors in this report are quoted in relative terms (i.e. as percentages of the value of the estimate).

Standing volume: a measurement of timber volume within standing trees. Usually expressed as cubic metres overbark standing (m³ obs). In the Production forecast, standing coniferous volume is defined as live coniferous stemwood and useable branchwood (to 7 cm top diameter and at least 3 m in length). It excludes roots, below-ground stump material, small branches, foliage and deadwood. For Private sector woodland only, it also excludes standing volume in trees in woodlands less than 0.5 hectares.

Stemwood: the volume of wood in stems, with stems being defined internationally as the above-ground part of the main shoot (or offshoots) with apical dominance. In GB stemwood includes wood from the stump up to 7 cm top diameter of the main stem and sometimes branchwood at least 3 m in length with a minimum top diameter of 7 cm.

Stocked area: the area stocked with living trees. The stocked areas in this report are quoted in gross terms for the Forestry Commission estate and in net terms for the Private sector estate (see **definitions of Area above**).

Sustainable forest management: the stewardship and use of forests and forest lands in a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity and vitality and their potential to fulfil, now and in the future, relevant ecological, economic and social functions at local, national and global levels, and that does not cause damage to other ecosystems.

Thinning: the removal of a proportion of trees in a forest after canopy closure, usually to promote growth and greater value in the remaining trees.

Top diameter: diameter of the smaller (top) end of a log, often used to define different categories of wood products (e.g. sawlogs, roundwood, pulp) and merchantable timber.

Top height: the mean total height of the 100 largest DBH trees per hectare.

Yield class (YC): a classification based on tree species, height growth (top height) and tree age, used to assess the volume production of a stand of trees. It reflects the potential productivity of the site for the tree species growing on it.



This report is one of a series of Inventory Reports that will report on the outputs from the Forestry Commission National Forest Inventory. See www.forestry.gov.uk/inventory for more information. The woodland map and areas calculated from it can be found in the 'National Forest Inventory Woodland Area Statistics' for Great Britain, England, Scotland and Wales, which can also be downloaded here.

The National Forest Inventory supports sustainable forest management in Great Britain. For more information see The UK Forestry Standard and its supporting Guidelines on:

- Forests and Biodiversity
- Forests and Climate Change
- Forests and Historic Environment
- Forests and Landscape
- Forests and People
- Forests and Soil
- Forests and Water

www.forestry.gov.uk/ukfs

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