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Evaluation of BioSoil Demonstration Project: FOREST BIODIVERSITY

Analysis of Biodiversity module

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1 Introduction

The BioSoil demonstration project is one of the studies initiated in response to the stipulations of Article 6 of *Regulation (EC) No. 2152/2003* (Forest Focus) [1] to develop the EU forest monitoring scheme by means of studies, experiments, demonstration projects, testing on a pilot basis and establishment of new monitoring activities. The aim of the BioSoil project was to demonstrate how a large-scale European study can provide harmonised soil and biodiversity data and contribute to research and forest related policies. It directly supported achieving the objectives of the monitoring scheme of assessing “the requirements for, and develop the monitoring of soils, carbon sequestration, climate change effects and biodiversity, as well as protective functions of forests” (Forest Focus, Article 1(1)b).
The first ideas concerning the project were discussed by the Commission with experts from EU Member States. The results of the expert meetings were then discussed at the level of the Standing Forestry Committee on 22 December, 2004. The project started in November 2006 for the duration of 2 monitoring years to conduct the surveys. It was coordinated by the European Commission Joint Research Centre (JRC) under an Administrative Arrangement with the Directorate General Environment (DG ENV).and implemented by the participating EU Member States.

The BioSoil demonstration project comprised two main modules:

a) Soil Module;
b) Biodiversity Module.

Both modules use a common site for sampling data, which was also the location in many countries of the existing network of sites for monitoring the forest environment under Forest Focus / International Cooperative Programme on assessment and monitoring air pollution effects on Forests[2]. In this way existing information about the sites could be used to add value to the results of the BioSoil study.

This report focuses on the analysis and results from the Biodiversity module.

2 Background

The BioSoil demonstration project was taken as an opportunity to assess and demonstrate the efficacy of the Level 1 network, as a representative tool of European forests, in order to address other issues of relevance to European forestry, such as forest biodiversity, with the addition of a few assessment variables. The approach to the forest biodiversity component of BioSoil was devised following a meeting of biodiversity experts from 16 Member States in co-operation with the JRC. The goal of BioSoil/Biodiversity is to provide data to support policy, international and national, on forest biodiversity, by:

1. Conducting a demonstration study to collect harmonised information relevant to forest biodiversity at the European level and demonstrate the use of the Level 1 network in this context;

2. Presenting a European forest type classification of the Level 1 plots and give a first attempt of habitat classification of the forests of Europe

3. Testing selected, internationally recognised, robust and practical indicators of forest biodiversity on a large scale survey thereby to develop a practical methodology as a manual.

[1] OJ L 324, 11.12.2003, p. 1-8
[2] Operating under the UNECE Convention on Long Range Transboundary Air Pollution

4. Establishing an improved common baseline framework to integrate other information and ongoing projects (including the soil initiative of BioSoil) on forest biodiversity to achieve maximum added value;
5. Designing a multi-scale hierarchical approach to quantify European forest biodiversity and monitor changes over time and space.

The final version of the manual was released at the end of 2006 (Appendix 1). It should be noted that some countries had already started to collect data by this stage, and in a few cases older versions of the protocols (in which slightly different coding for some variables was defined) was used. This came to light during the validation process and the data required further harmonisation in these cases.

3 Data collection and submission

Although it was foreseen that data were to be collected in the network of Level I points for the countries that joined the project proposal, some countries used a subset of their network and at least one country (UK) set up an entirely new network specifically for the project. Information on tree species, diameters, forest canopy, deadwood and vascular species of ground vegetation was collected. The bulk of the work was done during 2006 and 2007, although a few plots were measured in 2008.

The data were requested to be submitted by e-mail to the JRC in 6 ASCII comma separated files. In practice some countries found it difficult to work in ASCII, so Excel files were also accepted provided that they followed a given template and that the columns and worksheets were clearly labelled.

The six requested files contained information on different aspects of forest biodiversity.

- **GPL:** This file contains general information about the plot.
- **DBH:** This contains information about the trees within the plot. Collected data includes tree species, status (live,dead) and DBH. Optionally countries were also able to provide information about the relative positions of all the trees in the plot.
- **THT:** Contains tree height and canopy height for a subset of the trees in the plot.
- **CAN:** Gives canopy closure score and number of tree layers in the plot. The total number of trees in the plot and the percentage of trees measured are also reported.
- **DWD:** This file contains information about all the coarse woody debris found in the plot, including length, diameter and state of decay.
- **GVG:** This contains a list of all the ground vegetation species found in the plot. The procedure for reporting ground vegetation is very similar to that used in the Forest Focus Level II Ground vegetation survey (ICP Forests, 2007) and the sampling area is the same, although a different shape.

The variables requested for each of these files are listed in Appendix 2.
The deadline for data submission was June 2008. Most, but not all, countries sent their data by the deadline. Initial validation took place during the summer and reports were sent on 24/10/2008 to those countries who had submitted data. They were given until 21/11/2008 to respond. For those countries who had submitted data late, reports were compiled and deadlines for response were given on an individual basis.

As a result of the validation checks every country resubmitted data at least once. Resubmissions went through the same validation process, and sometimes resulted in further submissions or email confirmations of minor problems.

When a country resubmitted only a subset of the 6 data files, the most recent previous versions of the omitted files were added to the submission to allow complete validation to be carried out. The general principal was not to modify anything the country sent, and to request all modifications to made by them. A few exceptions were made for very minor issues (e.g. change of date in one or two records) if the country explained the necessary updates clearly by email. In these cases an export was made of the modified data and sent back to the originator of the data, who was requested to check that the modifications had been made correctly. These data then became the definitive version.

3.1 Work flow

Data submission/resubmission dates are given in **Table 1**. Only full submissions are shown; email confirmations are not included. Every country had to resubmit at least once; some required up to 6 attempts. On average, 2-3 attempts were made before the submitted data had no compliance/conformity errors and the remaining warnings were clarified.

Table 1: Data submission process.

Country Name	GPL	DBH	THT	DWD	CAN	GVG
France	12/06/2008 04/11/2008	12/06/2008 04/11/2008	12/06/2008 04/11/2008	12/06/2008 04/11/2008	12/06/2008 04/11/2008	12/06/2008 04/11/2008
Belgium (Flanders)	27/11/2007	27/11/2007	27/11/2007	27/11/2007 19/11/2008 25/08/2009	27/11/2007	27/11/2007
Italy	06/08/2008 10/12/2008 14/08/2009 03/09/2009 19/10/2009	06/08/2008 28/11/2008 03/12/2008 10/12/2008 14/08/2009 03/09/2009	06/08/2008 28/11/2008 03/12/2008 10/12/2008 14/08/2009 03/09/2009	06/08/2008 03/12/2008 10/12/2008 14/08/2009 03/09/2009	06/08/2008 03/12/2008 10/12/2008 14/08/2009 03/09/2009	06/08/2008 10/12/2008 14/08/2009 03/09/2009
United Kingdom	29/04/2008 21/11/2008	29/04/2008 21/11/2008 27/05/2009	29/04/2008 21/11/2008 27/05/2009	29/04/2008 21/11/2008 27/05/2009 19/08/2009 20/08/2009	29/04/2008 21/11/2008	29/04/2008 21/11/2008
Ireland	12/06/2008 03/12/2008	12/06/2008 03/12/2008	12/06/2008 03/12/2008	12/06/2008 03/12/2008 18/05/2009	12/06/2008 03/12/2008	12/06/2008 03/12/2008
Denmark	05/05/2008 21/11/2008 26/06/2009	05/05/2008 21/11/2008 26/06/2009	05/05/2008 21/11/2008 26/06/2009	05/05/2008 21/11/2008 26/06/2009	05/05/2008 21/11/2008 26/06/2009	05/05/2008 21/11/2008 26/06/2009
Spain	24/06/2008 01/07/2008 21/11/2008 25/05/2009 05/10/2009	24/06/2008 01/07/2008 21/11/2008 25/05/2009	24/06/2008 01/07/2008 21/11/2008 25/05/2009	24/06/2008 01/07/2008 21/11/2008 25/05/2009	24/06/2008 01/07/2008 21/11/2008 25/05/2009	24/06/2008 01/07/2008 25/05/2009 17/06/2009
Sweden	28/12/2007 21/11/2008 28/11/2008	28/12/2007 21/11/2008	No THT submitted	28/12/2007 21/11/2008	28/12/2007	No GVG submitted
Austria	24/06/2008 20/11/2008	24/06/2008 20/11/2008	24/06/2008 20/11/2008	24/06/2008 20/11/2008	24/06/2008 20/11/2008	24/06/2008 20/11/2008
Finland	13/06/2008 31/10/2008 04/12/2008	13/06/2008 31/10/2008	13/06/2008 31/10/2008	13/06/2008 31/10/2008	13/06/2008 31/10/2008	13/06/2008 31/10/2008
Hungary	16/09/2008 12/11/2008 22/07/2009 27/07/2009	16/09/2008 12/11/2008 22/07/2009 23/07/2009 27/07/2009	16/09/2008 12/11/2008 22/07/2009 27/07/2009	16/09/2008 12/11/2008 22/07/2009 27/07/2009	16/09/2008 12/11/2008 22/07/2009 27/07/2009	16/09/2008 12/11/2008 22/07/2009 27/07/2009
Poland	13/06/2008 20/11/2008	13/06/2008 20/11/2008	13/06/2008 20/11/2008	13/06/2008 20/11/2008	13/06/2008 20/11/2008	13/06/2008 20/11/2008

		20/05/2009			20/05/2009	
Slovak Republic	25/06/2008 11/11/2008 05/12/2008 27/07/2009	25/06/2008 11/11/2008 05/12/2008 27/07/2009	25/06/2008 11/11/2008 05/12/2008 27/07/2009	25/06/2008 11/11/2008 05/12/2008 27/07/2009	25/06/2008 11/11/2008 05/12/2008	25/06/2008 11/11/2008 27/07/2009
Lithuania	11/06/2008 19/08/2008 22/11/2008	11/06/2008 19/08/2008 22/11/2008	11/06/2008 19/08/2008 22/11/2008	11/06/2008 19/08/2008 22/11/2008	19/08/2008 22/11/2008	11/06/2008 19/08/2008 22/11/2008
Czech Republic	19/12/2008 26/05/2009 07/10/2009	19/12/2008 26/05/2009 07/10/2009	19/12/2008 26/05/2009 07/10/2009	19/12/2008 26/05/2009 07/10/2009 27/10/2009	19/12/2008 26/05/2009 07/10/2009	19/12/2008 26/05/2009 07/10/2009 27/10/2009
Slovenia	25/11/2008 09/12/2008 28/05/2009	25/11/2008 09/12/2008 28/05/2009	25/11/2008 09/12/2008 28/05/2009	25/11/2008 09/12/2008 28/05/2009	25/11/2008 09/12/2008 28/05/2009	25/11/2008 09/12/2008 28/05/2009
Latvia	16/06/2008 21/11/2008 24/11/2008 01/12/2008	16/06/2008	16/06/2008 21/11/2008	16/06/2008	16/06/2008 21/11/2008	16/06/2008
Cyprus	13/05/2008 30/10/2008	13/05/2008 30/10/2008	13/05/2008 30/10/2008	13/05/2008 30/10/2008 05/11/2008	13/05/2008 30/10/2008	13/05/2008 30/10/2008
Canaries (Spain)	24/06/2008 01/07/2008 21/11/2008 05/10/2009	24/06/2008 01/07/2008 21/11/2008	24/06/2008 01/07/2008 21/11/2008	24/06/2008 01/07/2008 21/11/2008	24/06/2008 01/07/2008 21/11/2008	24/06/2008 01/07/2008 25/05/2009
Germany (Baden-Württemberg)	07/08/2008 13/08/2008 11/11/2008	07/08/2008 13/08/2008 11/11/2008	07/08/2008 13/08/2008 11/11/2008	07/08/2008 13/08/2008 11/11/2008	07/08/2008 13/08/2008 11/11/2008	07/08/2008 13/08/2008 11/11/2008
Germany (Bavaria)	13/06/2008 02/11/2008	No DBH submitted	No THT submitted	No DWD submitted	No CAN submitted	13/06/2008 02/11/2008
Germany (Brandenburg-Berlin)	29/04/2008 15/11/2008	29/04/2008 15/11/2008	29/04/2008 15/11/2008	29/04/2008 15/11/2008	29/04/2008 15/11/2008	29/04/2008 15/11/2008
Germany (Hessen)	24/06/2009 06/07/2009	24/06/2009 06/07/2009	24/06/2009 06/07/2009	24/06/2009 06/07/2009	24/06/2009 06/07/2009	24/06/2009 06/07/2009
Germany (Mecklenburg-Vorpommern)	23/04/2008 10/11/2008	23/04/2008 10/11/2008	23/04/2008 10/11/2008	23/04/2008 10/11/2008	23/04/2008 10/11/2008	23/04/2008 10/11/2008
Germany (Niedersachsen)	24/06/2009 06/07/2009	24/06/2009 06/07/2009	24/06/2009 06/07/2009	06/07/2009	06/07/2009 15/07/2009	24/06/2009 06/07/2009
Germany (NRW)	13/06/2008 19/11/2008	13/06/2008 19/11/2008	13/06/2008 19/11/2008	13/06/2008 19/11/2008	13/06/2008 19/11/2008	13/06/2008 19/11/2008 09/01/2009
Germany (Rheinland-Pfalz)	03/06/2008 07/11/2008 18/11/2008	03/06/2008 07/11/2008	03/06/2008 07/11/2008	03/06/2008 07/11/2008	03/06/2008 07/11/2008	03/06/2008 07/11/2008
Germany (Saarland)	11/06/2008 19/08/2008 25/11/2008	11/06/2008 19/08/2008 25/11/2008	11/06/2008 19/08/2008 25/11/2008	11/06/2008 19/08/2008 25/11/2008	11/06/2008 19/08/2008 25/11/2008	No GVG submitted

4 Data validation

A test database was built in MS-Access, incorporating approximately 85 separate validation checks. The submitted files went through a process of validation following a similar procedure to that set up for the Forest Focus Level II data.

The initial (Compliance) stage checked whether the correct files had been submitted in the requested formats and data types. Because of the difficulty some NFCs had in manipulating ASCII files, some of these checks were relaxed slightly, and if the data were clearly identified and could be easily interpreted, other formats were allowed and the conversion to correct format was made at the JRC. The data were then transferred to the test database for further checks.

The other validation checks raised either error or warning messages, depending on the type and severity of the problem. Error messages were given when there was a clear mistake (invalid code, impossible date) and warnings if the data might be correct but extreme (unusual dbh, height values) or if it was not possible to state the source of the error (inconsistent information between 2 files). A graphical representation of the work flow and process control is given in Figure 1 below.

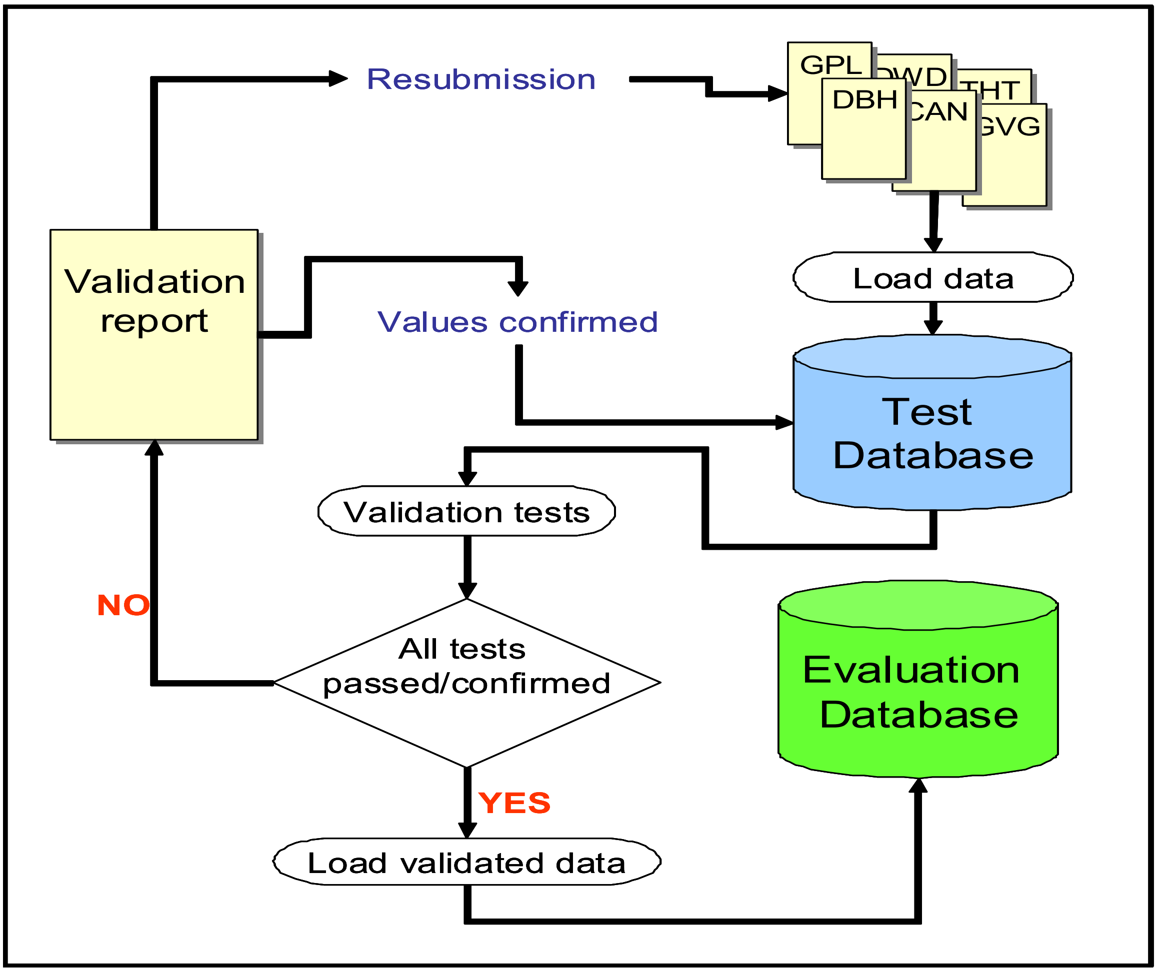


Figure 1: Process control

Validation tests included:

- Checking for referential integrity (all plots reported in the data files must have a corresponding entry in the Plot information)
- Duplicate values
- No null values allowed in key fields (e.g. plot id, location)
- Checking that all codes were valid.
- Checking for correct date format
- Plausible location of plot (not in sea or outside country boundary)
- Plausibility of date values
- Plausibility of dimensions (size of trees, deadwood)
- Crosschecks between number of trees measured and number reported in plot.
- Check that all occurrences of zero mean 0 rather than null (eg. zero trees in plot, not "no information available")

A complete list of the validation checks is included in Appendix 3.

After the validation checks were completed each country was given a report detailing every problem and the line on which it occurred. Data that raised error messages had to be corrected; warnings could either be corrected or confirmed as correct but extreme values. Corrected data were resubmitted and went though the full process again until all error messages were eliminated and all remaining warnings confirmed.

The validated data were then transferred to a separate database for evaluation and statistical analysis. All previous versions of the data remain on the test database for audit trail purposes.

Figure 2 shows a summary of the complete data collection and validation phases.

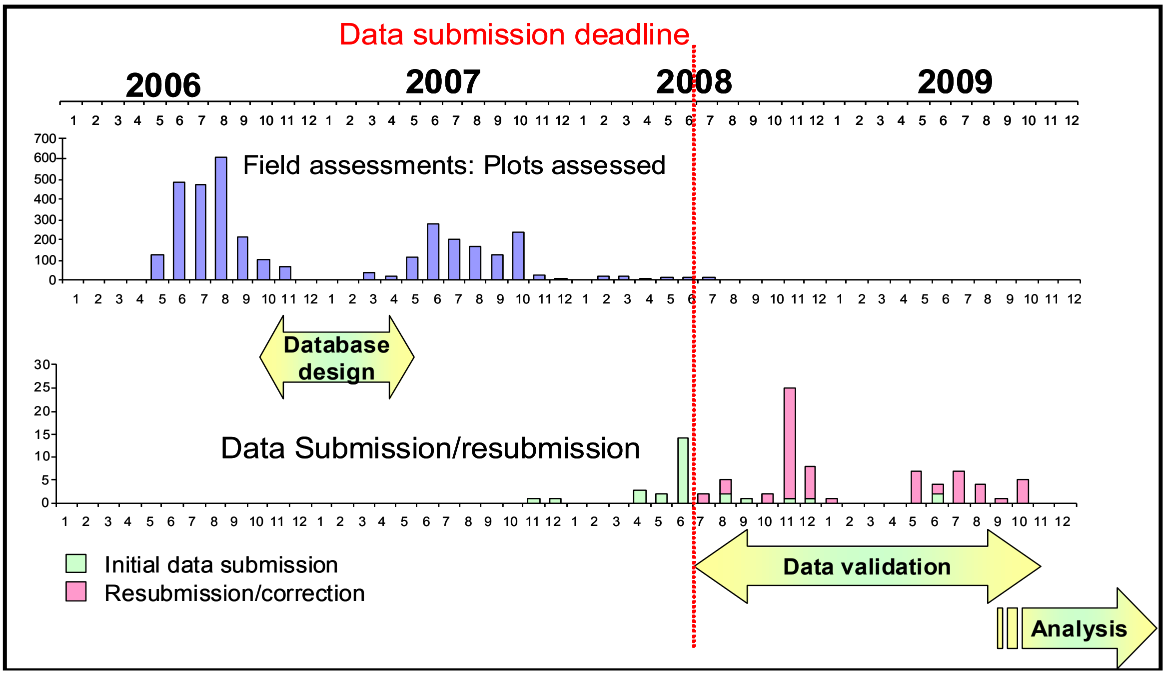


Figure 2: Summary of work flow

Table 2 shows the records stored in the evaluation database after the validation process was completed. The numbers of records available for analysis are slightly lower as there are some null records and some extra assessments made outside the normal protocols.

Table 2: Data records stored in the database

COUNTRY	GPL	DBH	THT	DWD	CAN	GVG
France	548	18111	2562	6648	1206	14761
Belgium (Flanders)	10	514	46	173	20	154
Italy	224	7780	825	3572	1319	17542
United Kingdom	167	5092	756	1455	484	2285
Ireland	35	1836	173	633	105	292
Denmark	22	701	80	9	66	285
Spain	151	2940	739	828	300	3870
Sweden	100	2836	-	840	100	-
Austria	136	3775	555	2176	272	3295
Finland	630	20098	1858	6870	1260	19429
Hungary	78	2495	284	1312	159	432
Poland	438	12964	1432	4668	955	13608
Slovak Republic	108	2899	441	1537	216	2965
Lithuania	62	2370	291	646	186	2019
Czech Republic	146	4881	436	3772	417	5714
Slovenia	44	1378	243	460	132	2391
Latvia	95	3483	450	1189	190	2749
Cyprus	19	238	115	165	57	592
Canaries (Spain)	4	105	20	15	8	58
Germany (Baden-Württemberg)	50	1425	149	1253	92	1740
Germany (Bavaria)	97	-	-	-	-	3053
Germany (Brandenburg-Berlin)	53	1927	160	446	82	429
Germany (Hessen)	29	667	246	794	58	790
Germany (Mecklenburg-Vorpommern)	17	532	103	289	34	824
Germany (Niedersachsen)	42	1050	358	1048	84	1261
Germany (NRW)	39	970	144	789	78	737
Germany (Rheinland-Pfalz)	26	780	189	666	52	637
Germany (Saarland)	9	292	292	186	27	-
Total	**3379**	**102139**	**12947**	**42439**	**7959**	**101912**

4.1 Data Preparation

Plot location

Plot locations were reported in a wide variety of projections and units. These were converted to a single projection to allow easy display of the data. The INSPIRE compliant European Terrestrial Reference System 1989 and Lambert Azimuthal Equal Area (ETRS89/ETRS-LAEA) projection was chosen for this purpose (Annoni *et al.*, 2003).

For the purposes of analysis, the separate submissions from the German Länder were grouped and results presented for Germany as a whole, except where differences between the Länder warrant separate treatment. (NB. Some Länder did not participate in the Biosoil Biodiversity study and therefore the data do not represent coverage of the entire area). Island territories (eg Corsica, Sardinia, Canaries etc) were also included with the parent country, unless otherwise stated.
Only Belgium (Flanders) participated in the project so there is no coverage of Wallonia. Figure 3 shows the location of the plots.

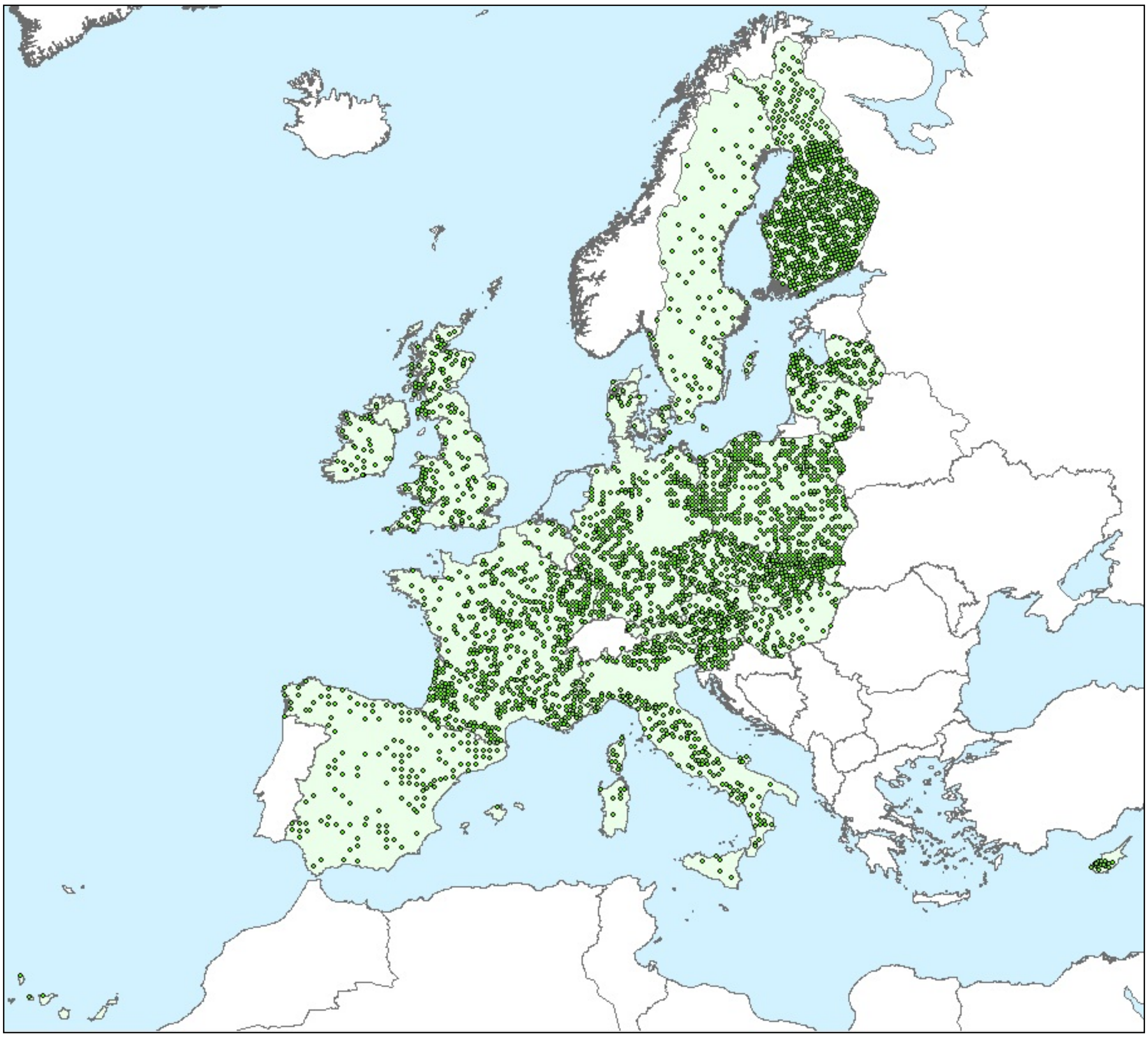


Figure 3: Biosoil Biodiversity plot locations

The following country abbreviations are used in the next sections:

Abbreviation	Country Name
AT	Austria
BE	Belgium (Flanders)
CA	Canaries (Spain)
CY	Cyprus
CZ	Czech Republic
DE	Germany (all plots)
DE01	Germany (Baden-Württemberg)
DE02	Germany (Bavaria)
DE04	Germany (Brandenburg-Berlin)
DE07	Germany (Hessen)
DE08	Germany (Mecklenburg-Vorpommern)
DE09	Germany (Niedersachsen)
DE10	Germany (NRW)
DE11	Germany (Rheinland-Pfalz)
DE14	Germany (Saarland)
DK	Denmark
ES	Spain
FI	Finland
FR	France
HU	Hungary
IE	Ireland
IT	Italy
LT	Lithuania
LV	Latvia
PL	Poland
SE	Sweden
SI	Slovenia
SK	Slovak Republic
UK	United Kingdom

5 General Plot Information

In addition to location and date of assessment, plots were assessed for a variety of characteristics (Table 3).

Table 3: Assessed plot characteristics

NAME	Description	Values
GPSELEV	Elevation reading from the GPS of the plot centre in m	Values range from 0 to 2223m
ORIENT	Prevalent orientation of the BioSoil plot	N,NE,E,SE,S,SW,W,NW,Flat
AVSLOPE	Prevalent slope of the BIOSOIL plot in percent	
PREVUSE	Previous land-use	1: Forested more than 300 years; 2: Forested more than 100 years 3: Forested for 25-100 years ago; 4: Forested in the past 25 years 5: No information
ORIGIN	Origin of the actual stand	1: Planted; 2: Seeded; 3: Natural regeneration; 4: Mixed; 5: Unknown
MANAGE	Forest management such as thinning and selective felling	1: Unmanaged (no evidence) 2: Management (evidence but >10 years ago) 3: Managed (within the last 10 years) 4: Unknown
FORTYPE	Forest Type	1: High forest (even-aged) – Femelschlag 2: High forest (even aged) – Small groups 3: High forest (uneven aged)– Plenterwald 4: High forest (other) 5: Young/Medium forest (under development to high forest) 6: Coppice without standards 7: Coppice with standards 8: Other
DWREMOV	Removal of coarse woody debris	1: Yes, all stems and main branches have been removed 2: Yes, stems and main branches have been removed 3: No, stems and main branches are lying in the forest 4: Partly, some stems and main branches removed, others still present 5: Unknown 6: Introduced 7: Presence of accumulation (branches stacked in piles or in rows)
TREEMIX	Pattern of tree mixture See also glossary for explanations	1: Intimate (different tree species are mixed throughout the stand) 2: Non-intimate (different trees occur in clusters) 3: No mixture
AGE	Mean age of the dominant storey (in 20 year classes + unknown)	1: 0-20 years 2: 21-40 years 3: 41-60 years 4: 61-80 years 5: 81-100 years 6: 101- 120 years 7: >120 years 8: Irregular stands 9: Unknown
FENCE	Fencing	1: Fenced; 2: Not Fenced; 3: Fenced in parts
EFTC	European Forest Type Classification	1: Boreal forest 2: Hemiboreal and nemoral Scots pine forest 3: Alpine coniferous forest 4: Atlantic and nemoral oakwoods, Atlantic ashwoods and dune forest 5: Oak-hornbeam forest 6: Beech forest 7: Mountainous beech forest 8: Thermophilous deciduous forest 9: Broadleaved evergreen forest 10: Coniferous forests of the Mediterranean, Anatolian & Macaronesian regions 11: Swamp forest 12: Floodplain forest 13: Native plantations 14: Exotic plantations and woodlands

The following pages give an overview of the plots with respect to each of the measured characteristics.

5.1.1 Elevation

Plot elevation ranged from sea level (Finland) to over 2000m above sea level (France, Italy, Austria; see Figure 4). Minimum and maximum values are given by country in Table 4. Almost half of all measured plots were at an elevation of between 1 and 250m above sea level.

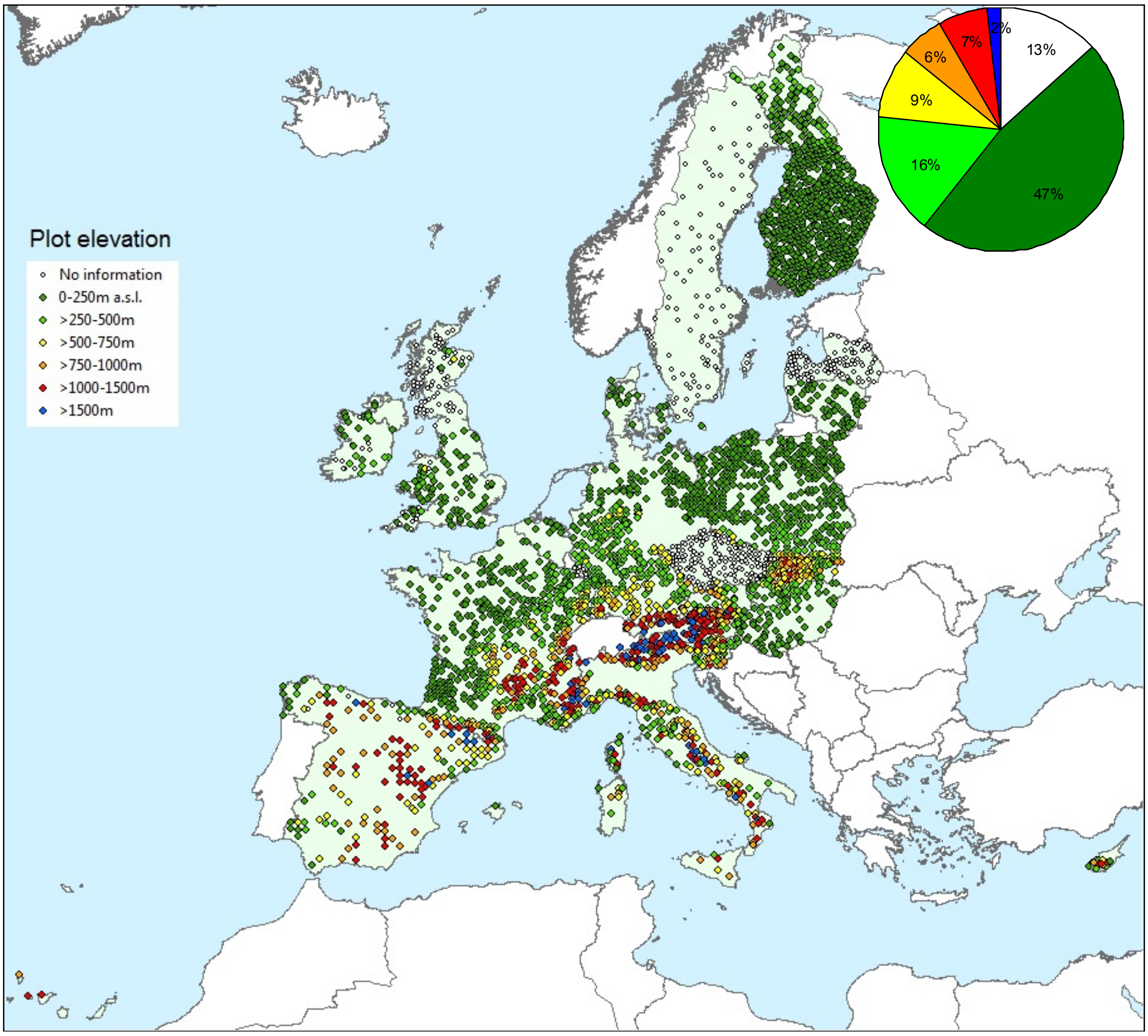


Figure 4: Plot elevation

Table 4: Minimum and maximum plot elevation in m above sea level

COUNTRY	Minimum elevation	Maximum elevation	COUNTRY	Minimum elevation	Maximum elevation
AT	272	2040	IE	48	382
BE	3.6	85.5	IT	14	2212
CY	209	1390	LT	41	207
DK	5.3	148	PL	12	1173
FI	0	470	SK	101	1301
FR	7	2223	SI	98	1460
DE	2	1280	ES	18	1750
HU	80	490	UK	7	553

CZ, LV, SE: No information supplied

5.1.2 Previous use of land

The majority of plots (65%) have been forested for more than 100 years, with over a third forested for more than 300 years (see Figure 5). A relatively small number of plots were reported as new forests (forested in the last 25 years).

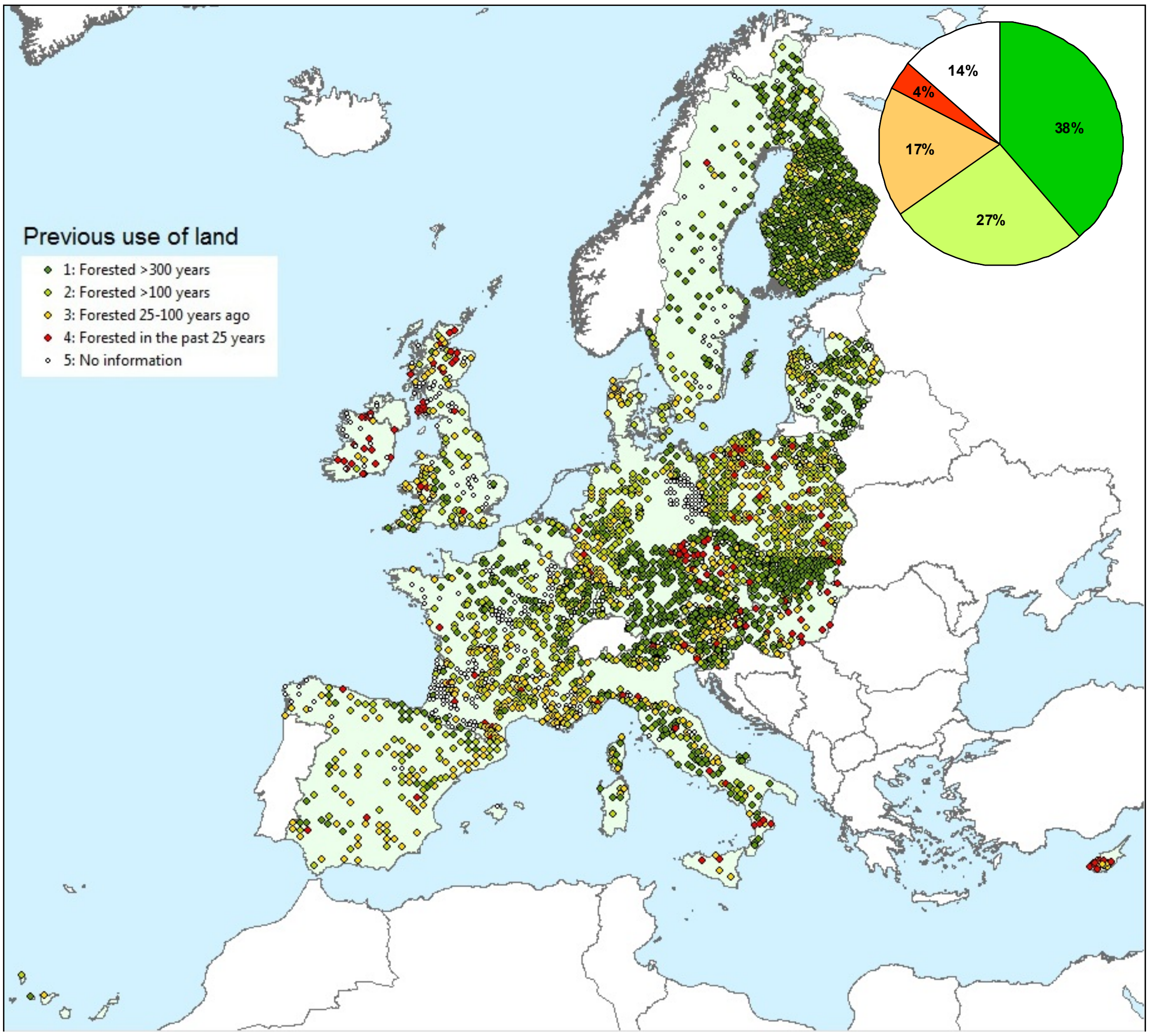


Figure 5: Previous use of land

Table 5: Previous use of land by country

PREVUSE	AT	BE	CY	CZ	DE	DK	ES	FI	FR	HU	IE	IT	LT	LV	PL	SE	SI	SK	UK
Forested in the past 25 years	5		8	19	3		4		8	15	17	14			20	1	2		21
Forested 25-100 years ago	32	2	9	17	37	10	56	46	117	15	3	50	1	20	103	8	4	3	43
Forested more than 100 years	12	4	2	27	122	12	54	130	154	8	1	41		39	228	15	11	6	41
Forested more than 300 years	74	4		72	129		29	447	95	32		98	40	27	70	51	22	97	15
Unknown/No information	13			11	71		12	7	174	8	14	21	21	9	17	25	5	2	47

5.1.3 Origin of Stand

Half of all stands are reported to originate from natural regeneration (Figure 6) although there are clear country differences (e.g. the majority of plots in UK, CZ and PL are planted; Table 6).

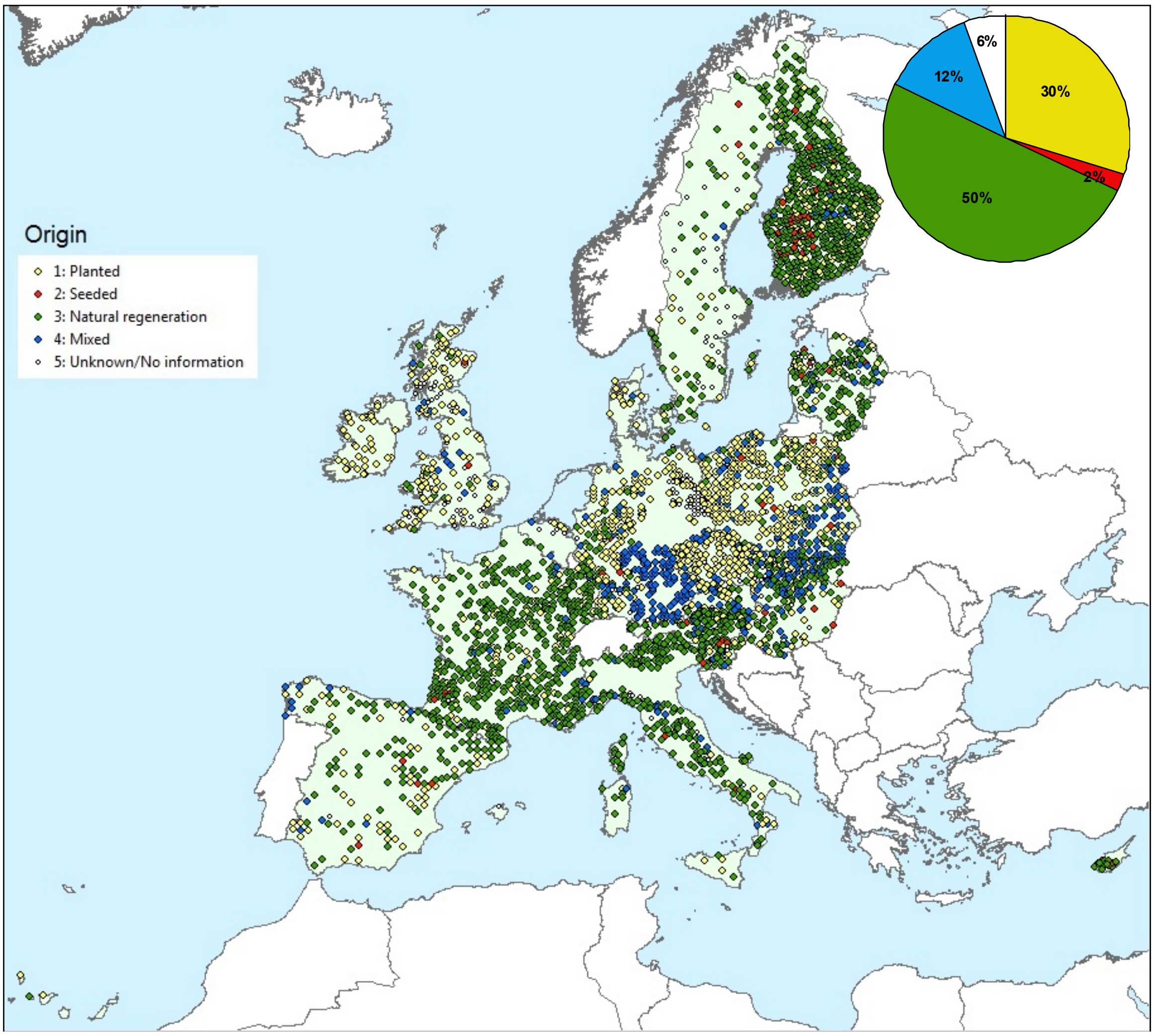


Figure 6: Origin of stand

Table 6: Origin of stand by country

ORIGIN	AT	BE	CY	CZ	DE	DK	ES	FI	FR	HU	IE	IT	LT	LV	PL	SE	SI	SK	UK
Mixed	18	1	1	22	124	1	11	13	14	16		20	5	8	92	3	5	43	12
Natural regeneration	87		16	9	44	7	85	497	470	32		180	46	49	58	49	23	43	11
Planted	24	4		101	145	14	52	87	58	23	35	13	11	17	277	19	8	21	97
Seeded	2		2		3		4	30	4	4		2		5	6	2	4		2
Unknown/not reported	5	5		14	46		3	3	2	3		9		16	5	27	4	1	45

5.1.4 Forest Management

Two thirds of plots have been managed within the last ten years (Figure 7). The ten percent of plots that show no evidence of management are mostly concentrated in mountainous regions (Alps, Pyrenees, and Apennines).

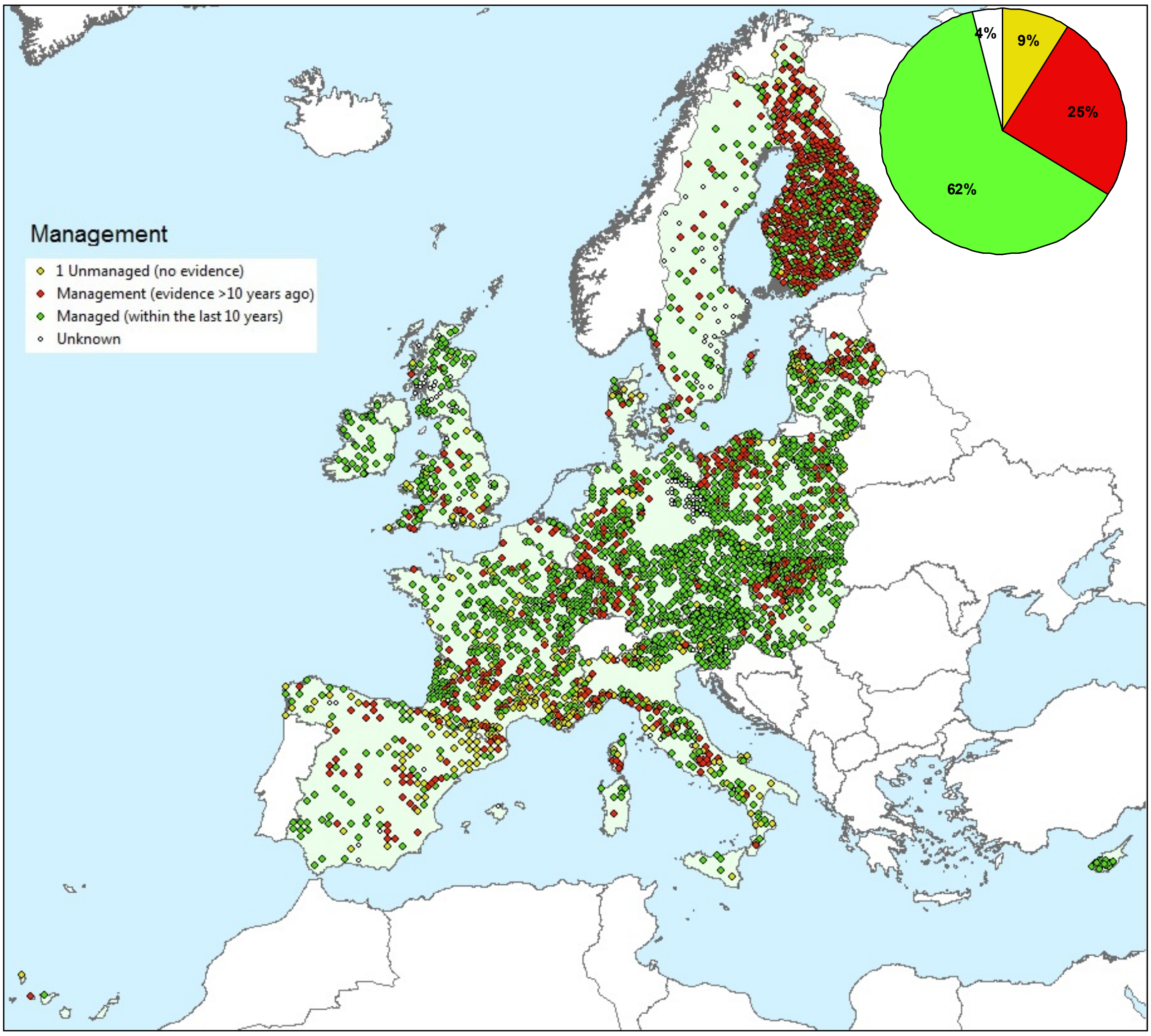


Figure 7: Forest Management

Table 7: Forest management by country

MANAGEMENT	AT	BE	CY	CZ	DE	DK	ES	FI	FR	HU	IE	IT	LT	LV	PL	SE	SI	SK	UK
Managed (within the last 10 years)	125	6	19	134	249	11	58	238	350	69	35	116	61	40	344	53	37	56	103
Management (evidence but for more than 10 years ago)		4		5	66	7	40	386	81	6		48		35	76	20		48	19
Unmanaged (no evidence)	8			3	8	4	50	6	113	2		52	1	20	12	1	2	1	15
Unknown/not reported	3			4	39		7		4	1		8			6	26	5	3	30

5.1.5 Removal of Coarse Woody Debris

The original 7 point code for deadwood removal was simplified after inspection of the data. The first two codes were amalgamated to one ("stems and main branches removed from the plot"), and the last two were amalgamated to ("presence of accumulation: branches stacked") resulting in 4 categories plus "unknown". (Table 8, Figure 8).

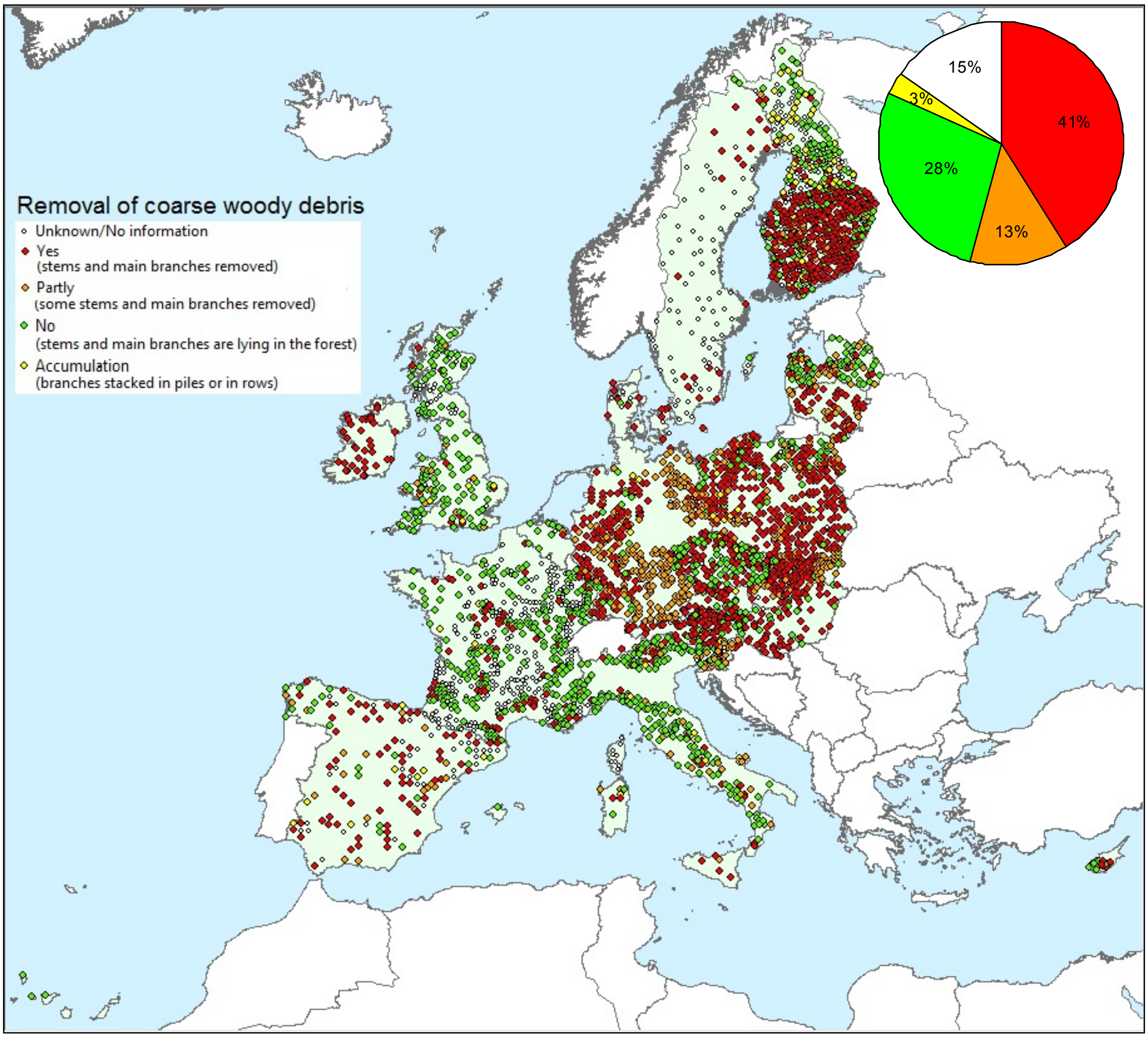


Figure 8: Removal of Coarse Woody Debris

Table 8: Removal of coarse woody debris after re-classification

DWREMOVE	AT	BE	CY	CZ	DE	DK	ES	FI	FR	HU	IE	IT	LT	LV	PL	SE	SI	SK	UK
Yes, stems and main branches removed	107	1	8	68	139	13	66	402	67	59	35	31	46	15	301	22	5	71	9
Partly, some stems and main branches removed	2	1	1		186		19	30		1		23	15	23	68		19	29	12
No, stems and main branches are lying in the forest	25	7	10	71	17	2	25	123	240	18		158	1	56	53	1	13	3	116
Accumulation (branches stacked in piles or rows)	1			2	9		8	53	4			11			9		1		4
Unknown/No information	1	1		5	11	7	37	98	237			1		1	7	77	6	5	26

5.1.6 Pattern of Tree Mixture

Nearly half of all plots were reported as being in an intimate tree mixture (Figure 9). 37% were reported as not mixed. However, on analysis of the data submitted in the DBH survey, only 23% of plots were actually found only to contain a single species (see section 6.8). The other 14% of "not mixed" plots contained occasional other species.

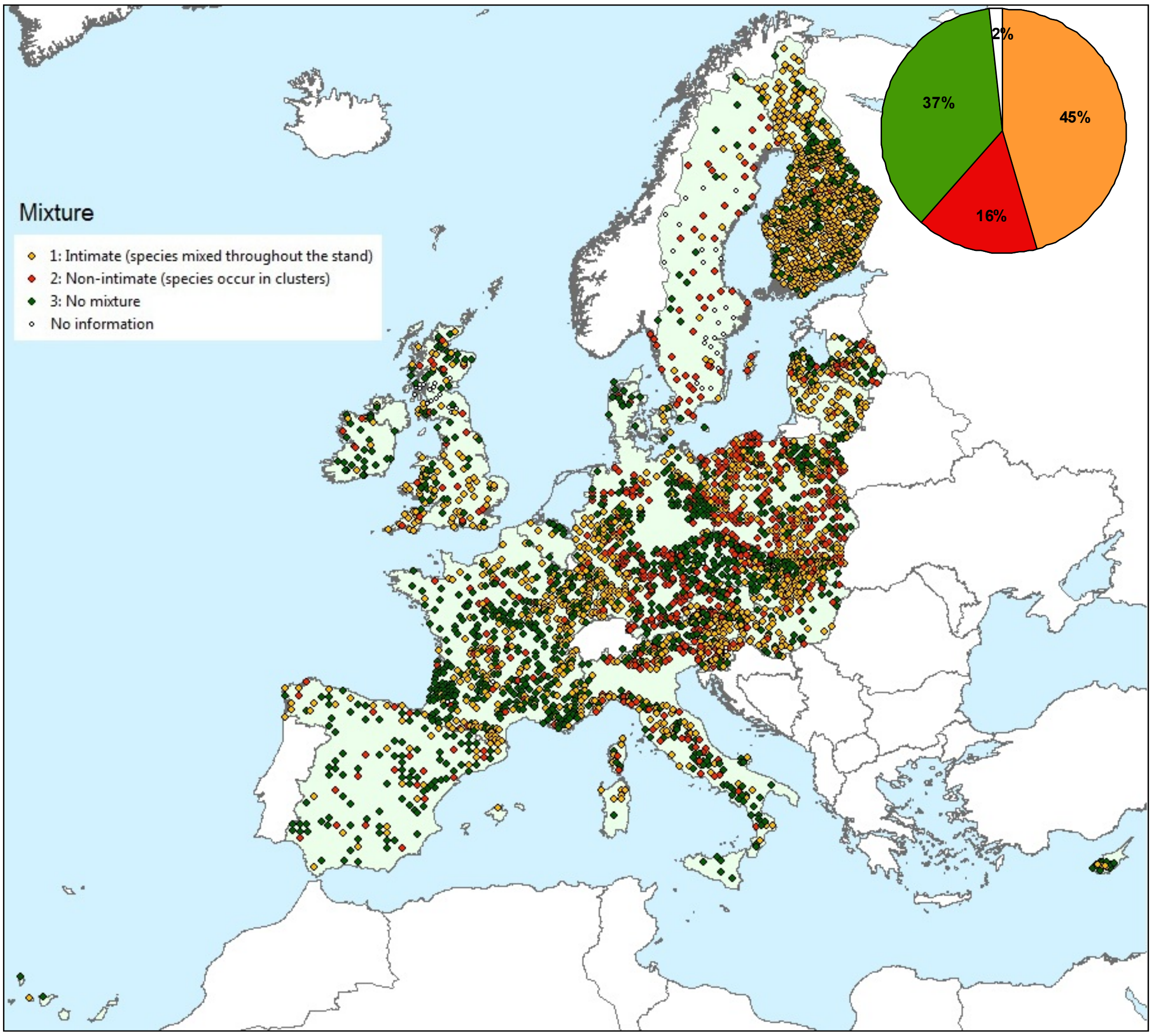


Figure 9: Pattern of Tree Mixture

Table 9: Pattern of tree mixture by country

TREEMIX	AT	BE	CY	CZ	DE	DK	ES	FI	FR	HU	IE	IT	LT	LV	PL	SE	SI	SK	UK
Intimate (different tree species are mixed throughout the stand)	60	3	8	19	120	5	38	505	203	42	7	88	50	44	170	12	22	64	77
No mixture	44	7	11	97	139	15	96	122	311	23	23	91	11	35	114	14	5	35	56
Non-intimate (different trees occur in clusters)	32			26	103	2	21	3	32	13	5	45	1	16	154	49	13	8	18
No information				4					2							25	4	1	16

5.1.7 Mean Age of Dominant Storey

The age classes of the plots form a more or less regular distribution with the modal age category reported as 3 (between 41-60 years). France has the highest number of plots in the oldest age category (>120 years). Ireland has the youngest forests, with no plot having a reported age class over 4 (61-80 years).

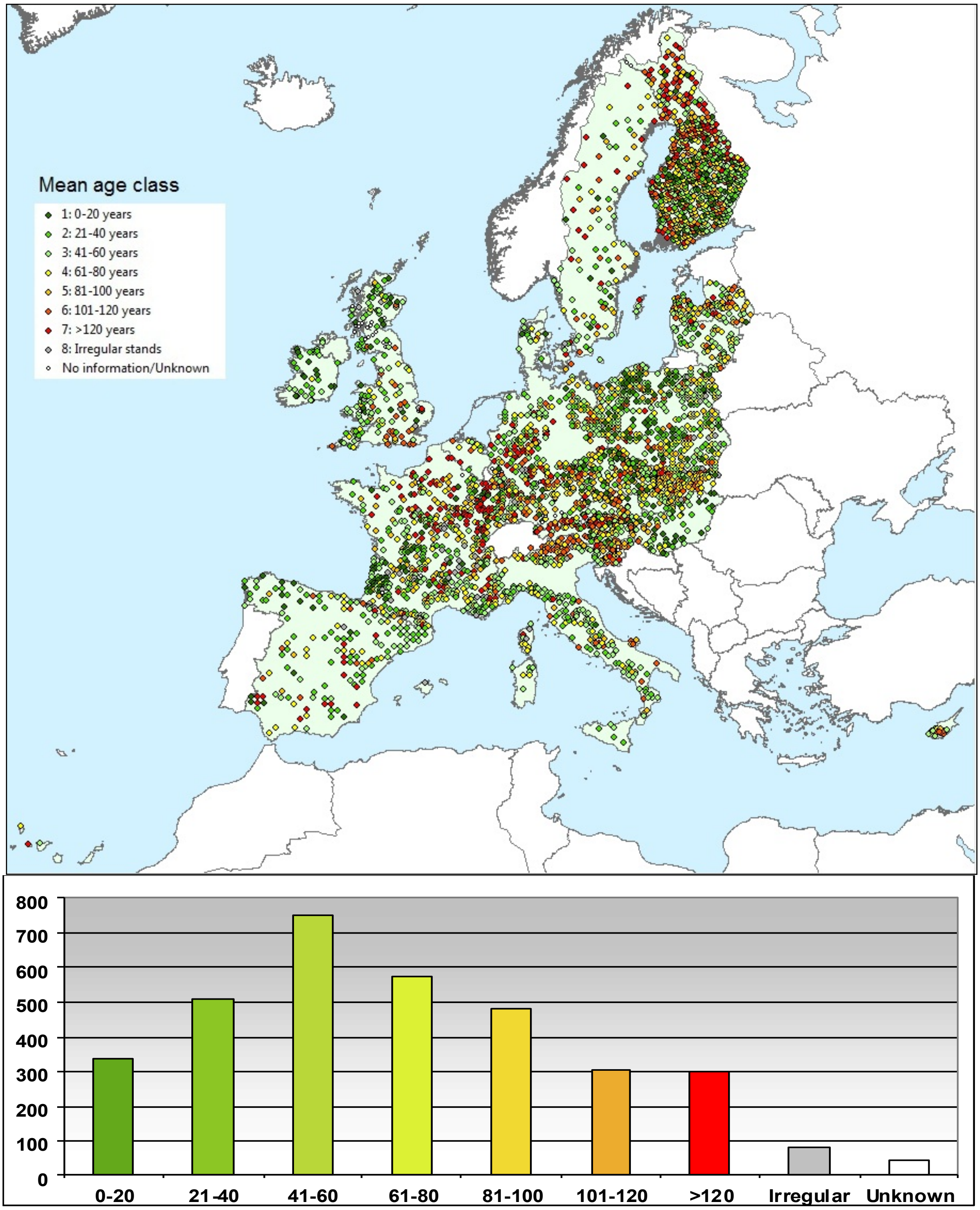


Figure 10: Mean age of Dominant Storey

5.1.8 Fencing

The vast majority of plots (over 90%) were reported not to be fenced (Figure 11). The UK had the largest proportion of fenced plots with approximately one third fenced. Spain, Italy and France reported more than 10 fenced plots. Several countries (Denmark, Latvia, Lithuania, Slovakia, Slovenia and Sweden) reported no fenced plots in their survey.

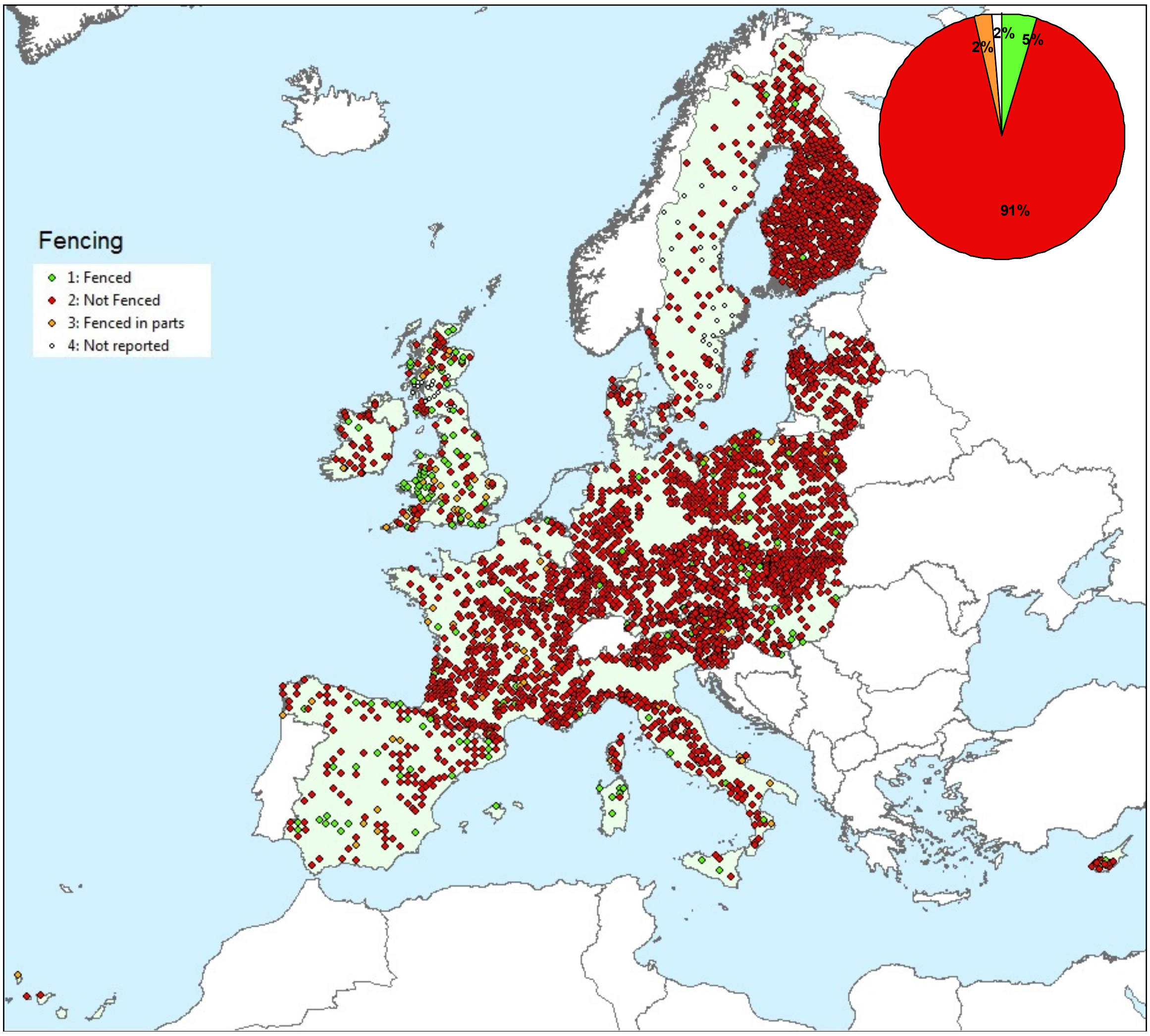


Figure 11: Fencing

Table 10: Fencing by country

FENCE	AT	BE	CY	CZ	DE	DK	ES	FI	FR	HU	IE	IT	LT	LV	PL	SE	SI	SK	UK
Fenced	7	1	2	5	2		29	4	15	8	2	15			16				56
Fenced in parts	1						9	2	20		1	6			9				23
Not Fenced	128	9	17	137	360	22	117	624	511	70	32	203	62	95	413	75	40	108	72
No information				4					2							25	4		16

5.1.9 Type of Forest

More than half of the plots were described as "high forest" of different types. The 20% of plots in the "Other" category were mostly in Finland, which described a large proportion of its plots in this way. The "High Forest: Other" category was used by Germany for nearly 80% of their plots. This implies that, for these two countries, a category that well fits their forests is missing from this code.

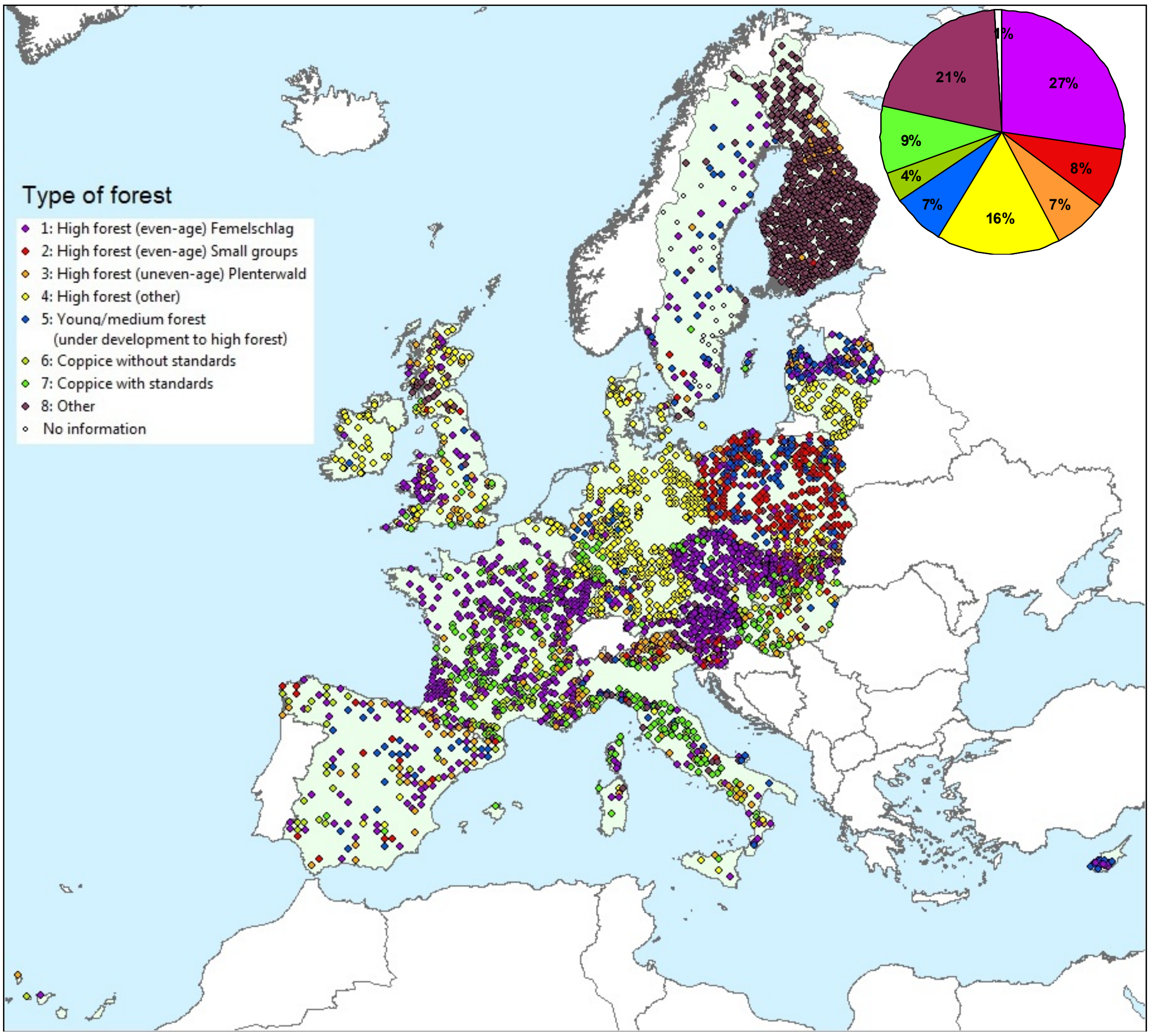


Figure 12: Type of forest

5.1.10 European Forest Classification Type

The European Forest Type classification[3] was used to classify the plots. The most prevalent forest type according to the EFTC scores given is class 1: Boreal Forest (18% of plots), followed by Hemiboreal and nemoral Scots Pine forest (12% of plots). Around 12% of plots were not given an EFTC score: 2 countries (UK and CZ) did not report any information and France did not identify around 10% of its plots (Table 11).

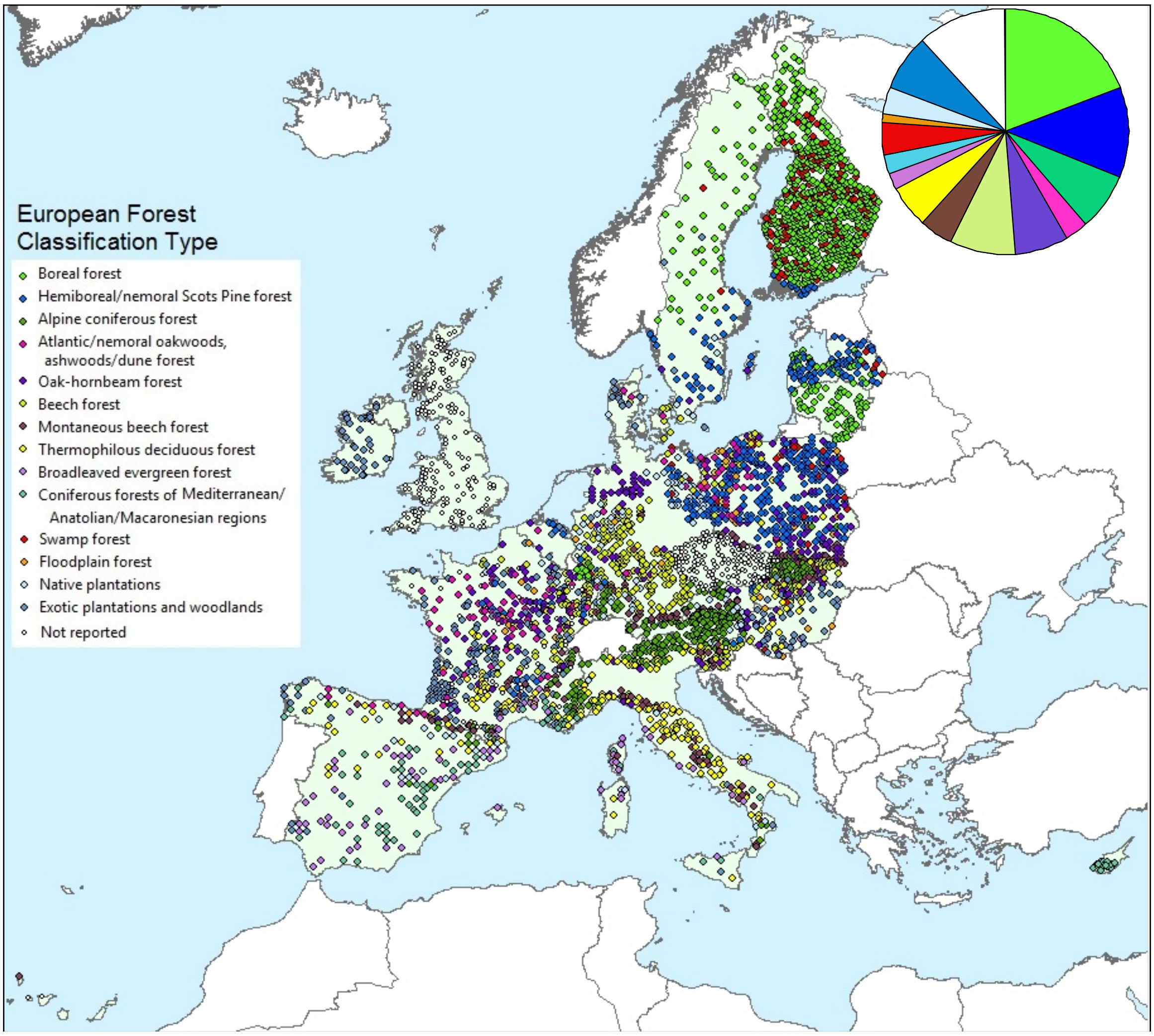


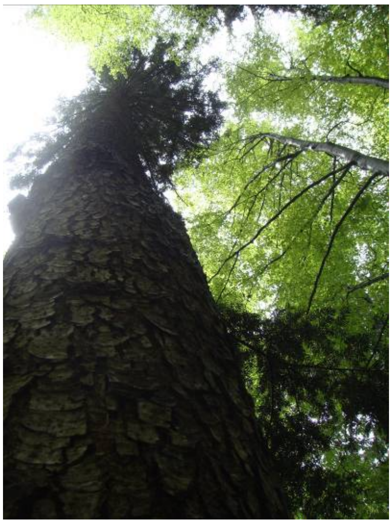
Figure 13: European Forest Classification Type

[3] EEA Technical Report 9/2007: "*European forest types - Categories and types for sustainable forest management reporting and policy*"

Table 11: Distribution of EFTC by country: number of plots by forest type

COUNTRY	<No EFTC score>	Alpine coniferous forest	Atlantic and nemoral oakwoods, Atlantic ashwoods and dune forest	Beech forest	Boreal forest	Broadleaved evergreen forest	Coniferous forests of Mediterranean, Anatolian & Macaronesian regions	Exotic plantations and woodlands	Floodplain forest	Hemiboreal and nemoral Scots pine forest	Mountainous beech forest	Native plantations	Oak-hornbeam forest	Swamp forest	Thermophilous deciduous forest
AT		99									15	20	2		
BE			1					3		5			1		
CY							19								
CZ	146														
DE	1	21	5	146	9			3	5	30	23	64	42	5	8
DK			3	7				11				1			
ES	3	7	6			40	45	12	1		7	15			19
FI					504					12				114	
FR	67	29	60	49		18	17	139	9	20	25	6	65		44
HU		1		6		1		43	3				11	2	11
IE	4							31							
IT		55		4		11	4	3	1		31	6	5		104
LT					62										
LV					21					68				6	
PL		8	26	19					17	228	29		91	18	2
SE				1	52			4		33		5	3	2	
SI	3	2		26						3	7		3		
SK		35		31				8	2	3	15		10		4
UK	167														

6 Structural Biodiversity



The DBH, THT and CAN surveys contain information about the stand structure. In the DBH survey all trees are measured (at different size thresholds according to subplot; see below). In the THT survey a subset of the largest trees were also assessed for height, and general information regarding the canopy closure and sampling fraction is given in the CAN file.

6.1 Plot design and sampling

Different intensities of measurement were made in each of the circular subplots. The structure of a typical Biosoil biodiversity plot is shown in Figure 14.

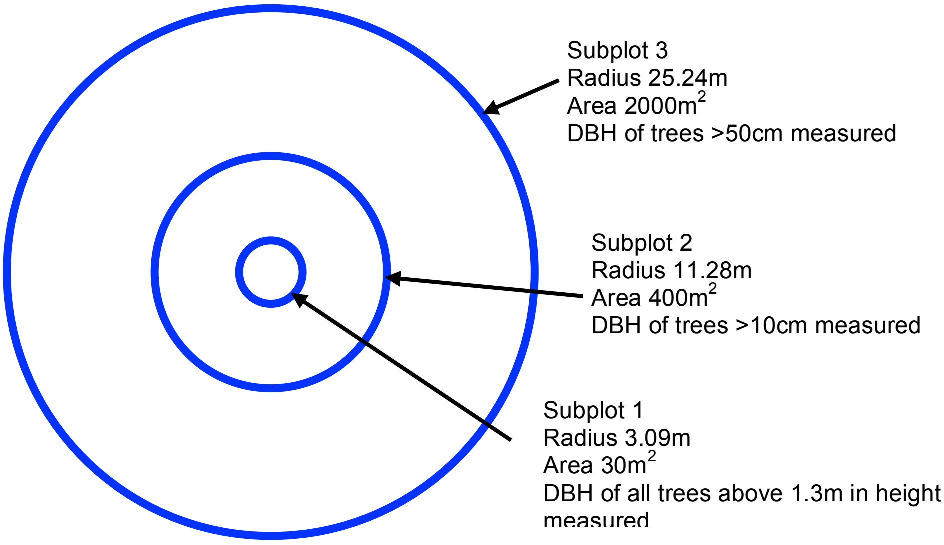


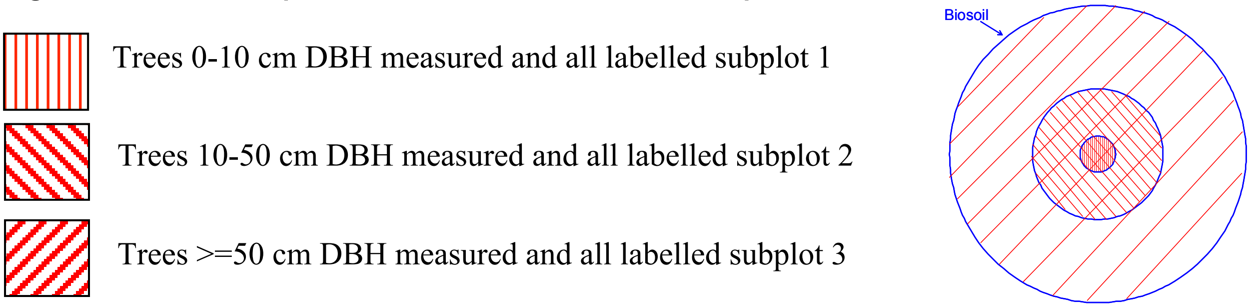
Figure 14: Biosoil subplots and measurement protocol for DBH measurements

The status of the tree (living, dead, standing, lying) and its species were also recorded. Tree top height and height of base of the canopy layer were measured on a minimum of 3 trees with the largest DBH across the entire sampling subplots 1, 2, and 3, regardless of the tree species.

6.2 Data quality and limitations

Not all countries applied the measurements to subplots in the same way.
AT, SK, LV, CA, DE01, DE04, DE08, DE11, DE12 followed the protocol stated in the manual.
IT, IE, DK, ES, FI, HU, PL, LT, CZ, SI, CY, DE10 followed the protocol and additionally measured a few smaller trees in subplot 3.
FR followed the protocol for assessment, but labelled their subplots differently (Figure 15)

Figure 15: French subplot labels: differences from Biosoil protocol



BE measured extra trees in subplot 3 (all trees over 10 cm instead of all over 50). This leads to a higher count of trees in the plot compared with other countries. Unless otherwise stated, the extra trees are excluded from calculations that involve a direct plotwise comparison with other countries.

UK measured extra trees in some plots. The extra trees were flagged and excluded from analysis as for BE.

SE followed the protocol (according to supporting documentation) but did not report the subplot numbers. No analysis directly using subplot numbers can be made although it can be assumed that trees of <10cm DBH are from subplot 1, trees of 10-50cm DBH are either from subplot 1 or 2 and trees of ≥50cm DBH may come from anywhere in the plot area.

DE07 and DE09 used different thresholds and subplot sizes. Original subplot numbering and concept was also similar to that used by France. For summarising information by subplot number (Figure 17-Figure 19), the information was harmonised as much as possible using the trees' actual distances from the centre of the plot to allocate new subplots based on the original Biosoil areas. However the different size thresholds cannot be reconciled and lead to an underestimate of counts of trees in the plot for subplots 1 and 2 (threshold 7 for subplot 1 instead of 0; threshold 20 instead of 10 for most of subplot 2). In subplot 3 extra trees are measured (threshold 30 instead of 50) but the entire plot is smaller than the Biosoil plot. See Figure 16.

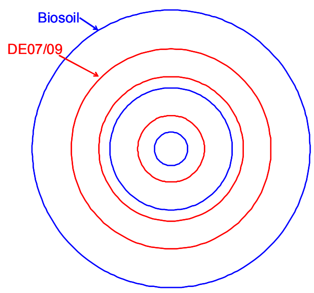
For plot level statistics such as estimates of basal area and numbers of trees per hectare, the different subplot sizes and diameter thresholds were taken into account, and figures were calculated separately for these two Länder.

Figure 16: DE07/DE09 subplot structure: differences from Biosoil protocol

<ins>Subplot 1</ins>
No trees below 7 cm were measured

<ins>Subplot 2</ins>
All trees >=20 cm were measured

<ins>Subplot 3</ins>
Plot is smaller than Biosoil plot (1000m^2 total area instead of 2000m^2)
All trees >=30 cm were measured.



The situation is summarised in Table 12.

Table 12: Summary of measurements taken compared with specification in manual.

Country	Subplot 1	Subplot 2	Subplot 3	Follows procedure set out in manual?
FR	**All trees with DBH 0-10 assigned to subplot 1**	**All trees >=10-50 assigned to subplot 2**	**All trees >=50 assigned to subplot3**	Yes, but subplot numbers do not correspond to plot areas – analysis by subplot number not possible; see Figure 15
BE	All trees	All trees >=10	All trees >=**25?** (289 <50)	Yes, plus extra trees in subplot 3
IT	All trees	All trees >=10 (+8 smaller)	All trees >=50	Yes
UK	All trees	All trees >=10 **(except for one plot: all trees** + 52 other smaller)	All trees >=50	Yes, plus some extra in subplot 2
IE	All trees	All trees >=10 (+1 smaller)	All trees >=50	Yes
DK	All trees	All trees >=10 (+1 smaller)	All trees >=50 (+1 smaller)	Yes
ES	All trees	All trees >=10 (+13 smaller)	All trees >=50 (+52 smaller)	Yes plus some extra
SE	All trees	All trees >=10	All trees >=50	Yes, but subplots not identified in data – analysis by subplot number not possible
AT	All trees	All trees >=10	All trees >=50	Yes
FI	All trees	All trees >=10 (+1 smaller)	All trees >=50	Yes
HU	All trees	All trees >=10 (+5 smaller)	All trees >=50	Yes
PL	All trees	All trees >=10 (+20 smaller)	All trees >=50 (+9 smaller)	Yes
SK	All trees	All trees >=10	All trees >=50	Yes
LT	All trees	All trees >=10 (+1 smaller)	All trees >=50	Yes
CZ	All trees	All trees >=10 (+6 smaller)	All trees >=50 (+1 smaller)	Yes
SI	All trees	All trees >=10 (+18 smaller)	All trees >=50	Yes
LV	All trees	All trees >=10	All trees >=50	Yes
CY	All trees	All trees >=10	All trees >=50 (+2 smaller)	Yes
CA	All trees	All trees >=10	All trees >=50	Yes
DE01	All trees	All trees >=10	All trees >=50	Yes
DE04	All trees	All trees >=10	All trees >=50	Yes
DE07	**All trees>=7 Subplot 1 larger**	**All trees >=20 Subplot 2 larger**	**All trees >=30 Subplot 3 smaller**	NO; see Figure 16
DE08	All trees	All trees >=10	All trees >=50	Yes
DE09	**All trees>=7 Subplot 1 larger**	**All trees >=20 Subplot 2 larger**	**All trees >=30 Subplot 3 smaller**	NO; see Figure 16
DE10	All trees	All trees >=10 (+1 smaller)	All trees >=50	Yes
DE11	All trees	All trees >=10	All trees >=50	Yes
DE12	All trees	All trees >=10	All trees >=50	Yes

6.3 Diameter distribution of measured trees

The tree diameters of the measured live and dead trees broadly follow the same distribution, taking into account the much smaller numbers of dead trees (Figure 17, Figure 18). There is a slightly higher proportion of dead trees in the smaller size classes compared with the larger ones (Figure 19).

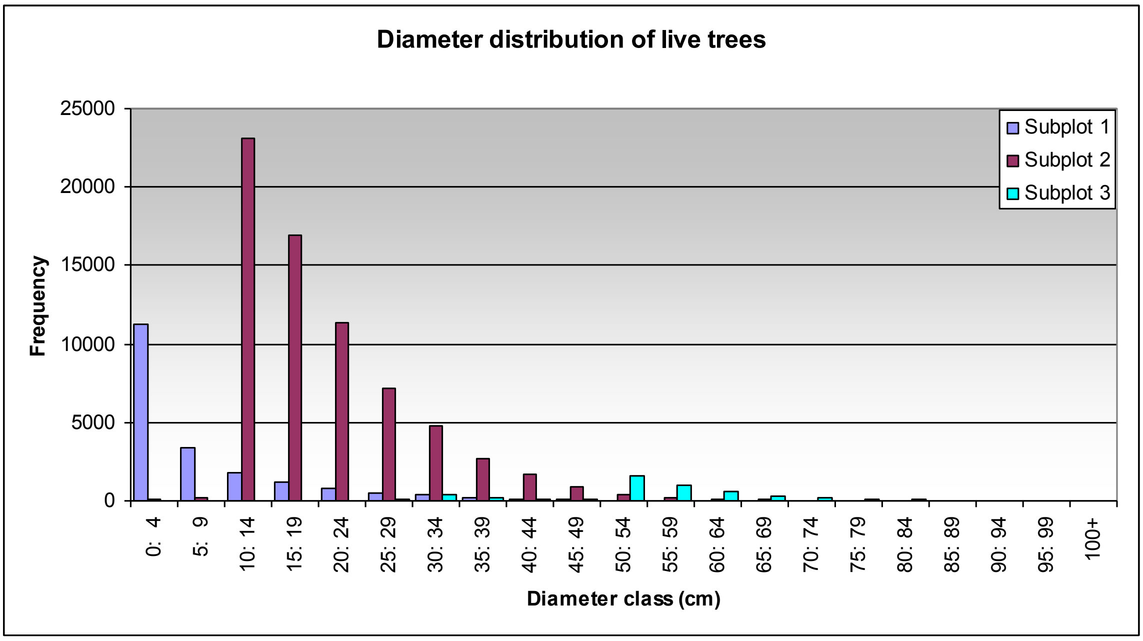


Figure 17: Distribution of live trees. Subplots are shown separately. SE excluded from figure (no subplot information).

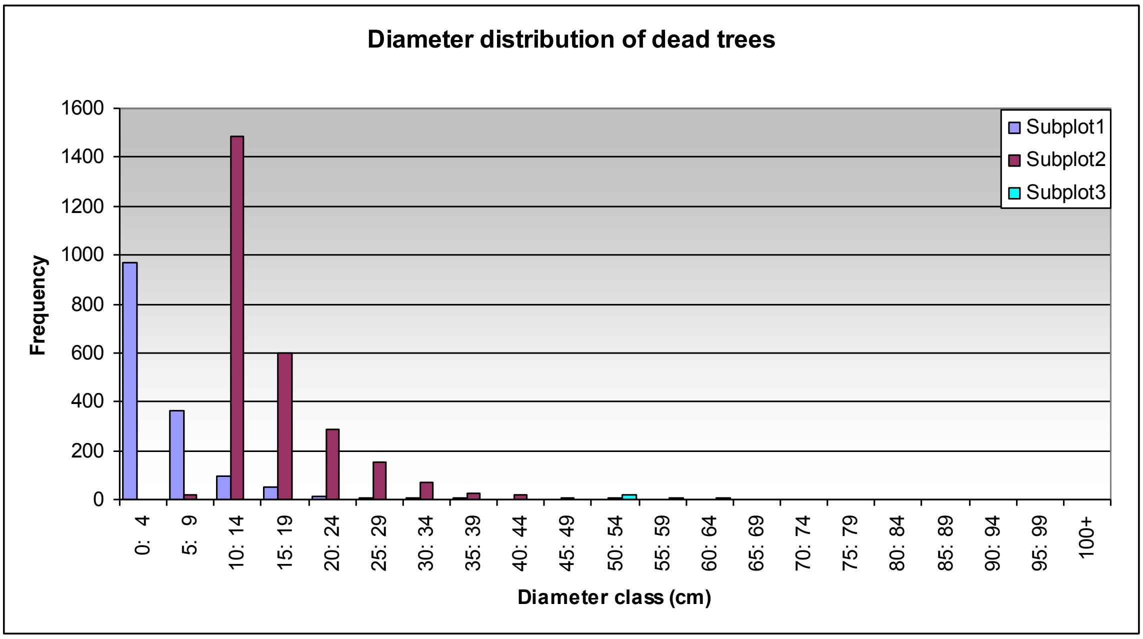


Figure 18: Distribution of dead trees. Subplots are shown separately. SE excluded from figure (no subplot information).

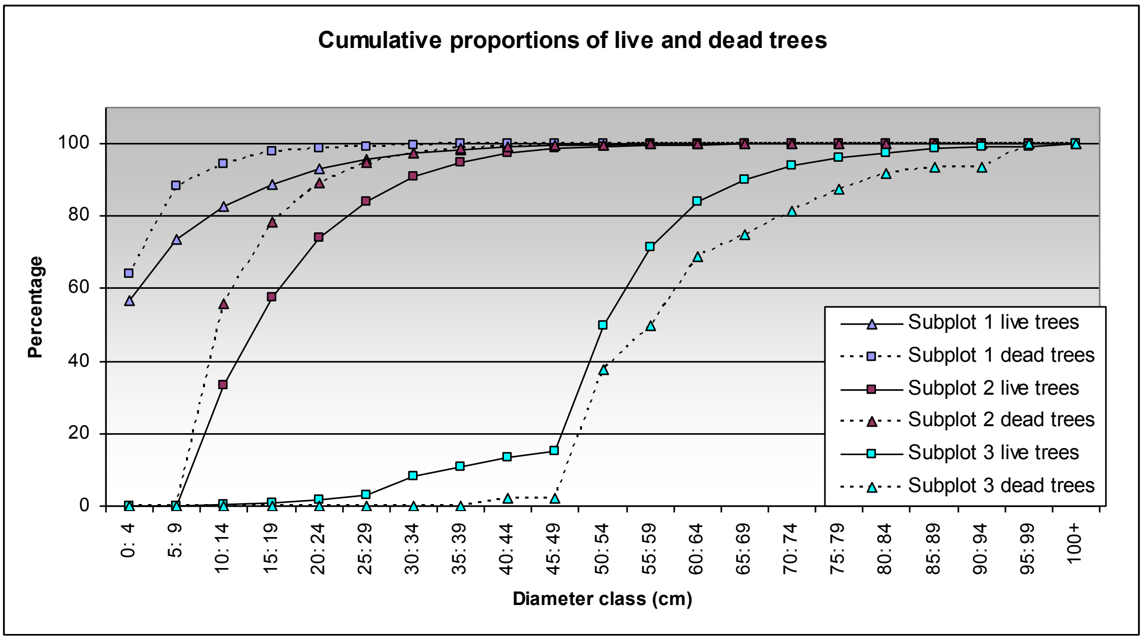


Figure 19: Cumulative proportions of trees in each diameter class. SE excluded from figure (no subplot information).

NB. the small number of trees <50cm in subplot 3 are from DE07 and DE09 who used different thresholds for measuring trees.

In addition there are 68 standing dead trees (all in PL) and one lying dead tree in CZ whose diameter was not measured and which had to be excluded from the analysis. These are likely to be very small trees according to the supporting documentation sent with the data.

To harmonise the data for analysis at European level, the 289 trees in BE subplot 3 with DBH<50 cm and the 120 trees < 10cm in one UK subplot 2 were excluded from the calculations. The data from DE07 and DE09 were treated separately using the different plot and diameter thresholds.

No dead tree was recorded having a DBH of more than 100cm (max=98).

The relationship of dead trees to live was similar for most species (Figure 20) with a general mortality rate of just over 4%. One or two species stood out as outliers with unusually high mortality: eg 16.4% for *Castanea sativa* (point A on Figure 20) and 48.3% for *Salix cinerea* (point B). In the case of *S cinera*, all recorded cases of the species occurred in a single country (PL) so it is not possible to separate out a species and a location effect. However, the general tree mortality rate recorded in PL was otherwise average (point C on Figure 21).

The two German Länder who used a slightly different protocol to assess DBH did not record any dead trees in the DBH survey (point D on Figure 21).

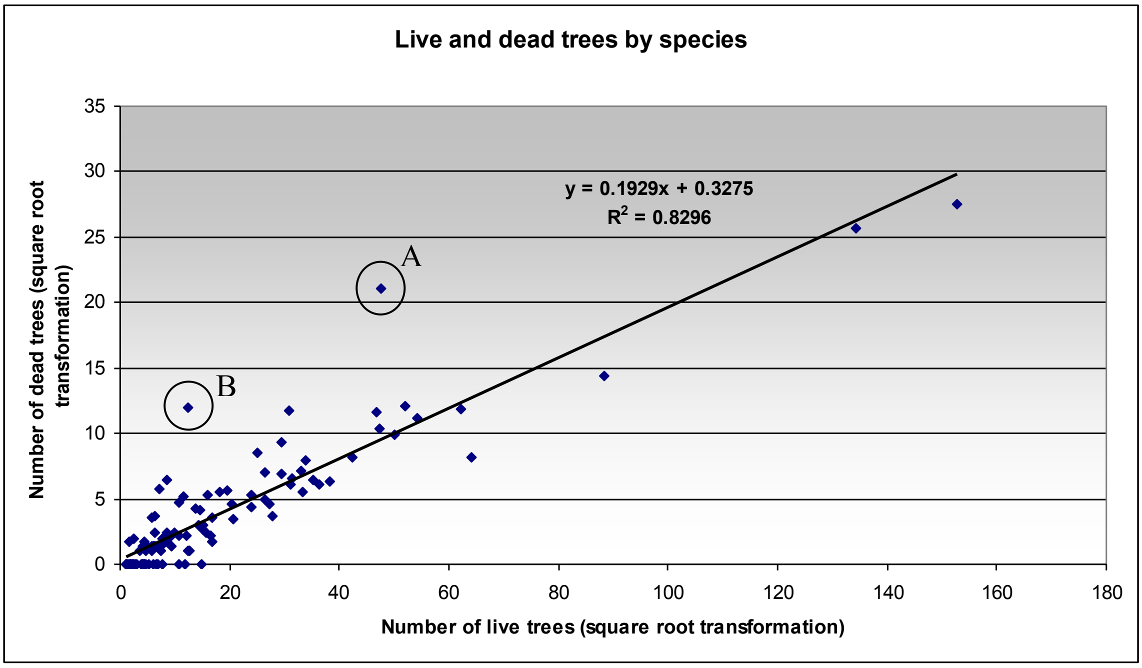


Figure 20: relationship between dead and live trees according to species

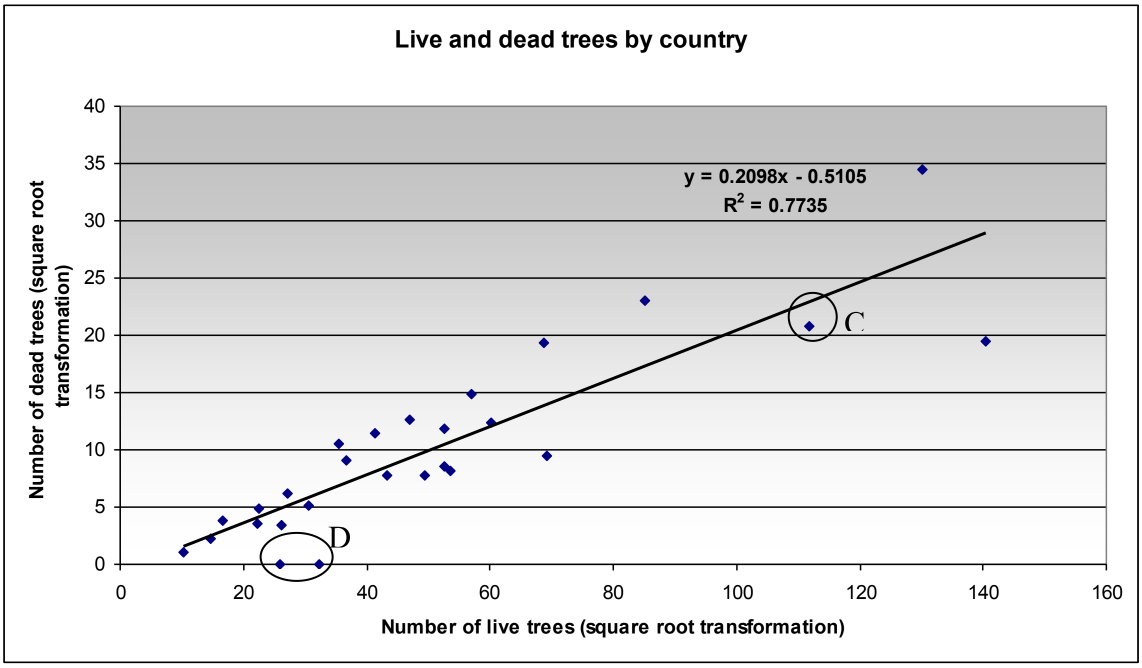


Figure 21: relationship between dead and live trees according to country

6.4 Tree density

The number of trees in the plot had to be estimated because of the different size thresholds used for measuring trees in the three subplots. In order to produce a figure comparable across Europe, only live trees with a DBH of at least 7cm were considered. (DE07 and DE09 used 7cm as the minimum threshold for measuring trees). The extra trees in subplot 3 measured by some countries were also excluded from the count.

Trees with DBH measurements of less than 10cm were assumed to have been taken from a sampling are of 30m^2(i.e. subplot 1); those with a DBH of ≥10cm but <50cm were assumed to have been taken from a sampling area of 400m^2 (i.e. subplots 1+2) and those of ≥50cm were assumed to have come from an area of 2000m^2 (subplots 1+2+3).
The number of live trees per hectare N was then estimated as

$$N = 333.3 * n_1 + 25 * n_2 + 5 * n_3$$

where n_1 is the number of trees of size 10>DBH≥7;
n_2 is the number of trees of size 50>DBH≥10;
n_3 is the number of trees of size DBH≥50.

For DE07/DE09 the calculation was accordingly weighted to take into account the different diameter thresholds and subplot sizes used.

Average tree density for each country is shown in Figure 22. The highest tree density is found in Ireland, the country that also reports the youngest forests. There is also a high average tree density in plots in DE04 (Brandenburg-Berlin); in this case because of a high number of small trees in subplot 1 recorded in some of the plots. Tree density for all the plots is shown in Figure 23.

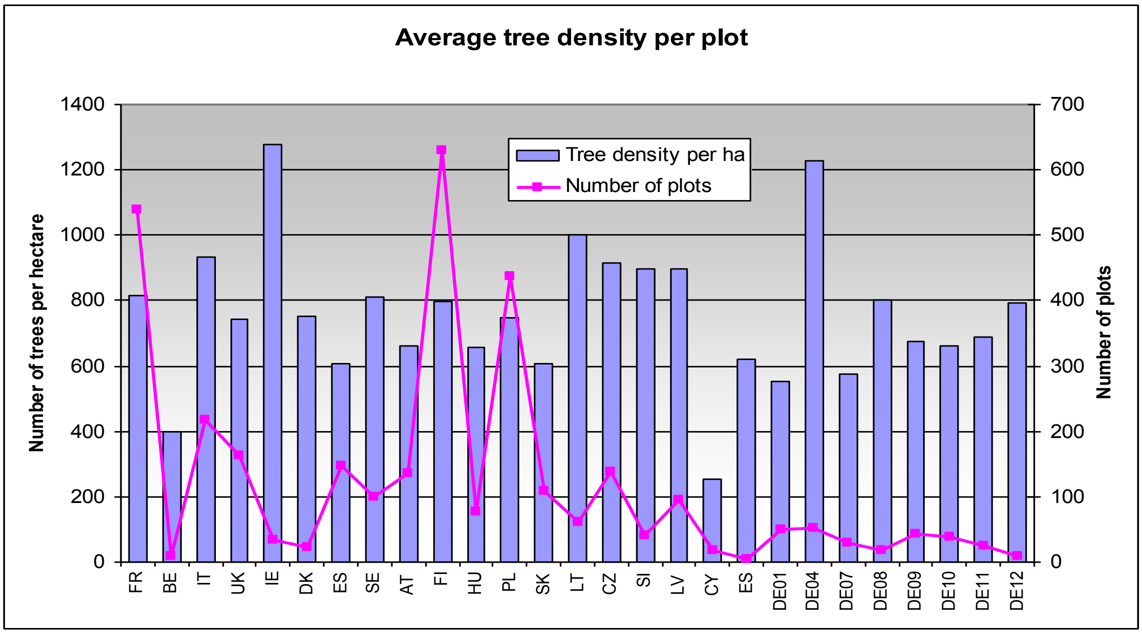


Figure 22: Average tree density for each country

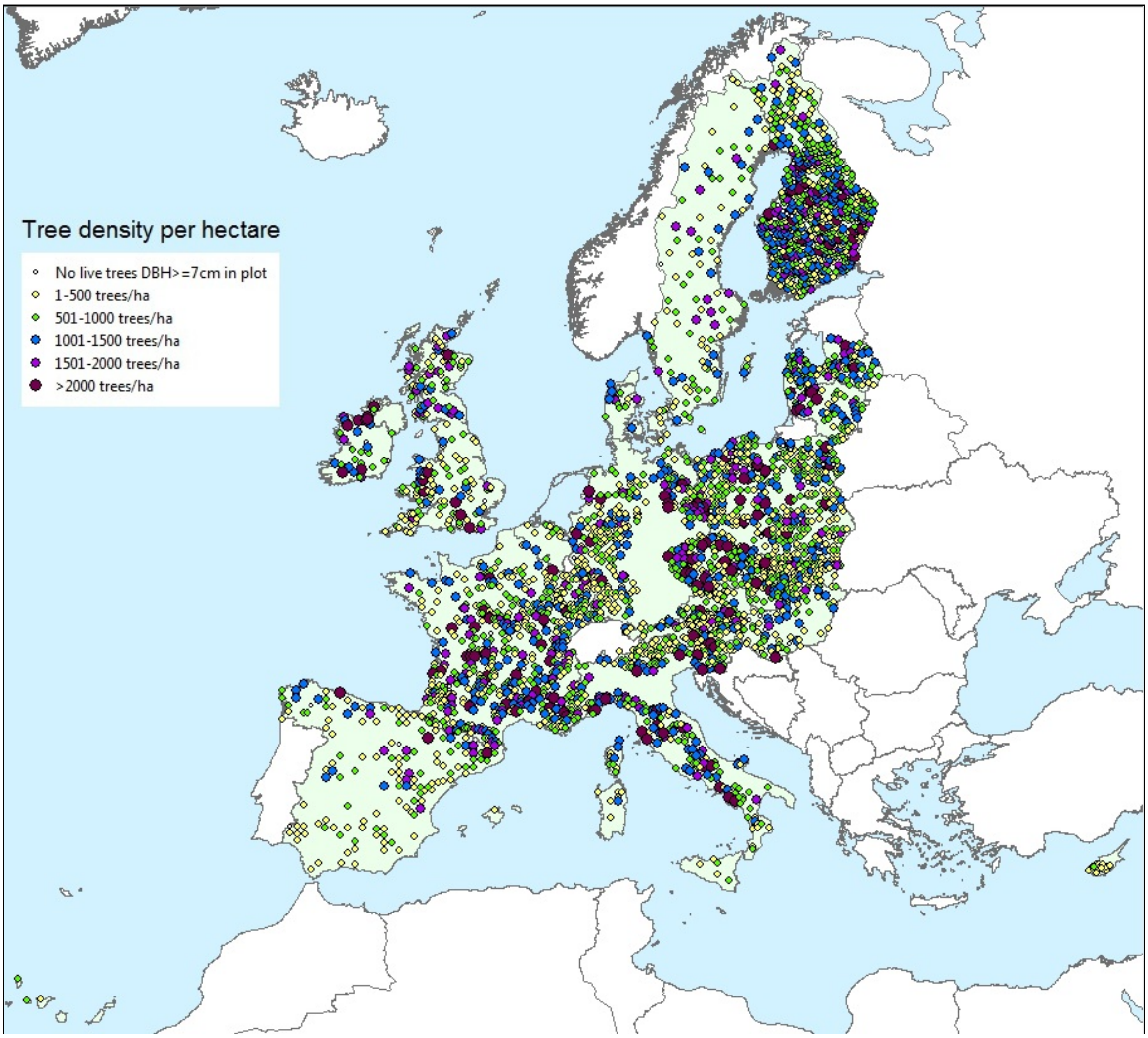


Figure 23: Average tree density

6.5 Basal area

Basal area (BA) can be defined as the sum of the cross-sectional areas of the stems of all live trees measured at 1.3m above ground, and given in square metres per hectare. The differential sampling of trees within the three subplots meant that BA had to be calculated for each of the three areas separately and then scaled to gain an overall figure. In order to produce a figure comparable over Europe, only trees with a DBH of at least 7cm were included in the calculations (DE07 and DE09 used 7cm as a minimum threshold for including trees in their DBH survey).
Trees with a measured DBH of less than 10cm were all assumed to have come from a plot area of 30m^2 (i.e. subplot 1); those that had DBH measurements of ≥10cm but <50cm were assumed to have been taken from a sampling area of 400m^2 (i.e. subplots 1+2) and those of ≥50cm were assumed to have come from an area of 2000m^2 (subplots 1+2+3). Basal area values per hectare were calculated for each of the three size classes and then summed to get a total value for each plot as follows:

$$BA/ha = \frac{\left(\sum \pi d_1^2\right)}{120} + \frac{\left(\sum \pi d_2^2\right)}{1600} + \frac{\left(\sum \pi d_3^2\right)}{8000}$$

where d_1 is the DBH of a tree belonging to the first group (10>DBH≥7)
d_2 is the DBH of a tree belonging to the second group (50>DBH≥10)
d_3 is the DBH of a tree belonging to the third group (DBH≥50)

The divisors include a conversion of units (cm to m and diameter to radius) and a weighting for the different subplot sizes.

For DE07 and DE09, where different plot sizes and diameter thresholds were used, the same principle was applied but with thresholds of 100m^2, 500m^2 and 1000m^2 for plot areas and <20cm, 20-30cm and ≥30cm for diameter classes. Plot basal area per hectare was calculated using the following formula:

$$BA/ha = \frac{\left(\sum \pi d_1^2\right)}{400} + \frac{\left(\sum \pi d_2^2\right)}{2000} + \frac{\left(\sum \pi d_3^2\right)}{4000}$$

In this case d_1 is the DBH of a tree belonging to the first group (20>DBH≥7)
d_2 is the DBH of a tree belonging to the second group (30>DBH≥20)
d_3 is the DBH of a tree belonging to the third group (DBH≥30)

This gives BA figures broadly comparable with the other countries, although with a slightly different precision because of the smaller size of the plots. It must also be borne in mind that all the plot estimates consist of parts that are estimated with different precision levels.

Average basal area per plot is presented in Figure 24 and Figure 25 below.

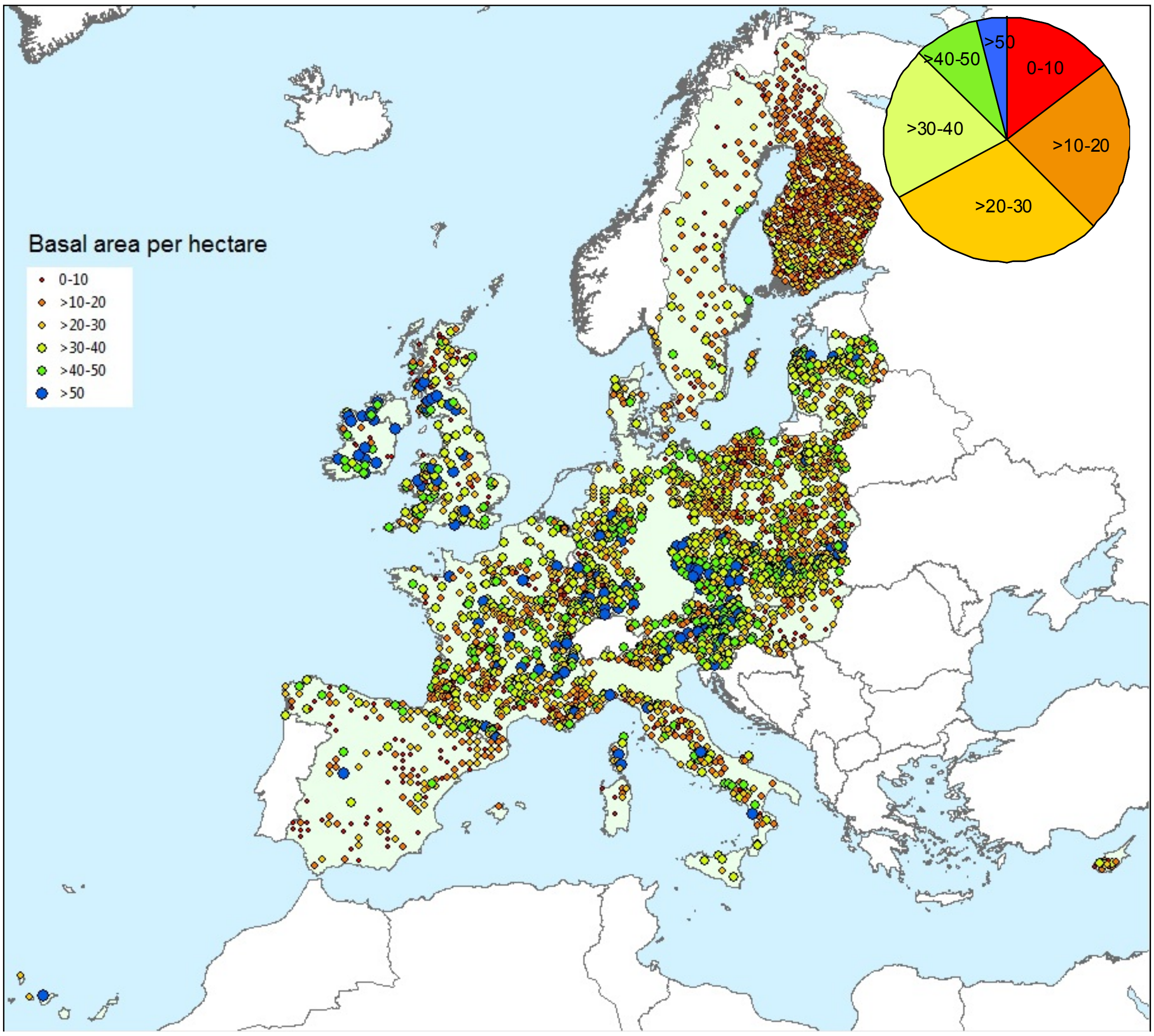


Figure 24: Average basal area m^2 per hectare

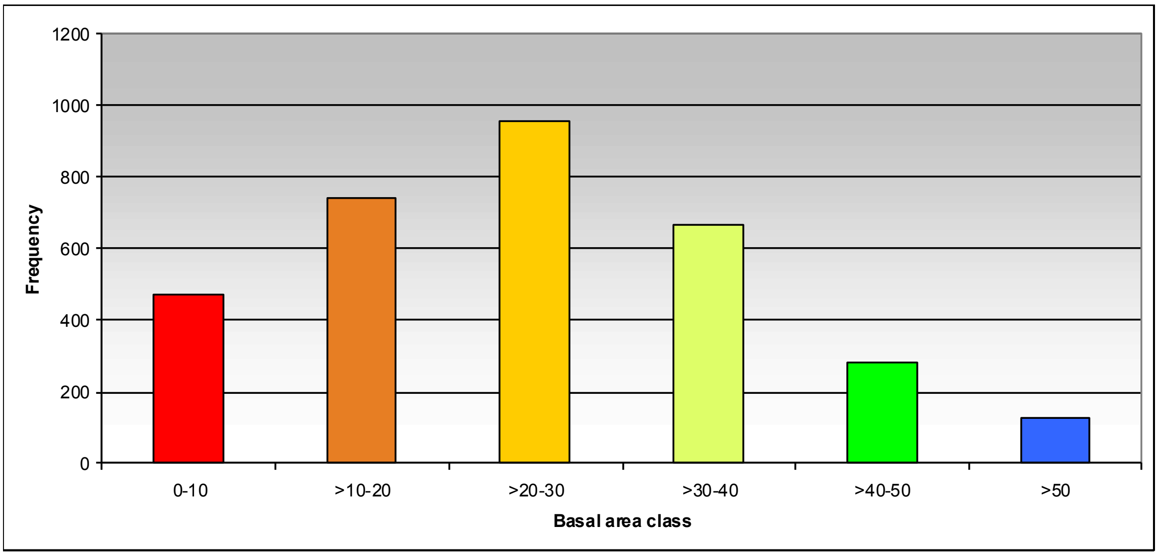


Figure 25: Basal area distribution

6.6 Canopy closure

The canopy closure assessment was a 5 point code and plots were given a visual assessment of canopy closure for each subplot (1: Open sky; 2: 1-25% canopy closure; 3: 25-50% closure; 4: 50-75% closure and 5: >75% closure). The majority of countries assessed only subplots 1 and 2 as required in the manual, but a few also gave scores for all 3 subplots, and IT assessed the 4 subplots that were used for the GVG assessment (see section 8.1 for description).. In 73% of all cases the same score was given to all of the assessed subplots. To assign a single plot canopy closure value for the remaining plots, the value given for subplot 2 was used (since this covers the majority of the area and all countries had assessed it). For IT the most frequently occurring score over the 4 subplots was given. In those situations remaining where there was no majority score and the difference between maximum and minimum was 2 points, the middle one was assigned (score 4 in all cases), and for the remaining 20 plots that had been given two scores of 4 and two of 5, 4 was chosen as the plot score. The distribution of plot canopy closure scores is shown in Figure 26.

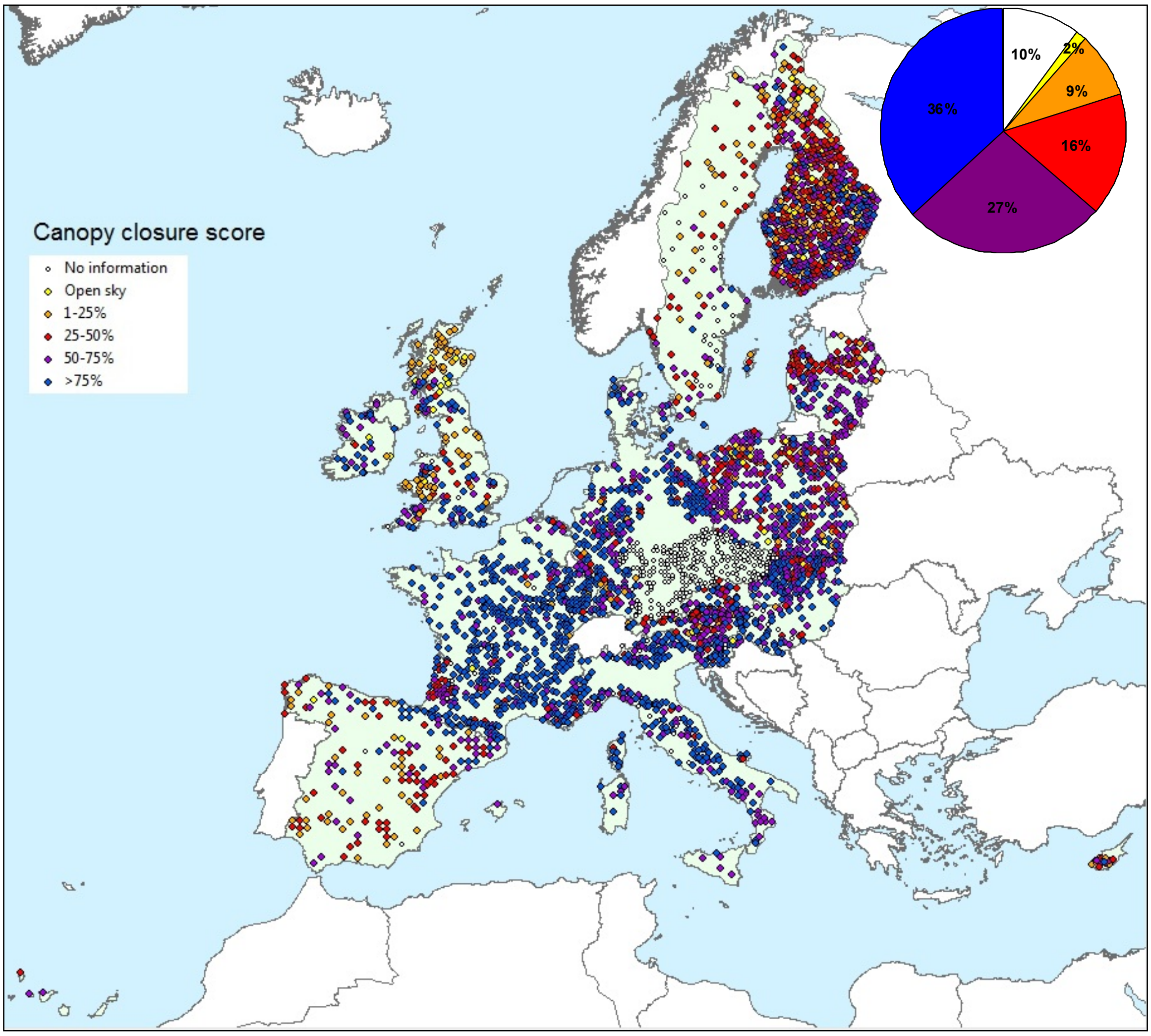


Figure 26: Plot canopy closure scores

6.7 Tree layers

A visual overall estimate of the number of distinct tree layers on the plot was assessed at the same location as for the ground vegetation within the two BioSoil subplots 1 and 2. Some countries also made an assessment of subplot 3. In over 90% of cases the same score was given to all the subplots assessed. To assign a single tree layer score value for the remaining plots, the value given for subplot 2 was used (since this covers the majority of the area and all countries had assessed it). For IT, where the alternate subplot arrangement of 4 equal sized subplots had been used, the most frequently occurring score was given. In those few cases remaining where there was no majority score the higher value was given if it occurred at least twice, ignoring those subplots that had scored 5 (no tree layer). Nearly two-thirds of all plots were reported to have a single dominant tree layer.

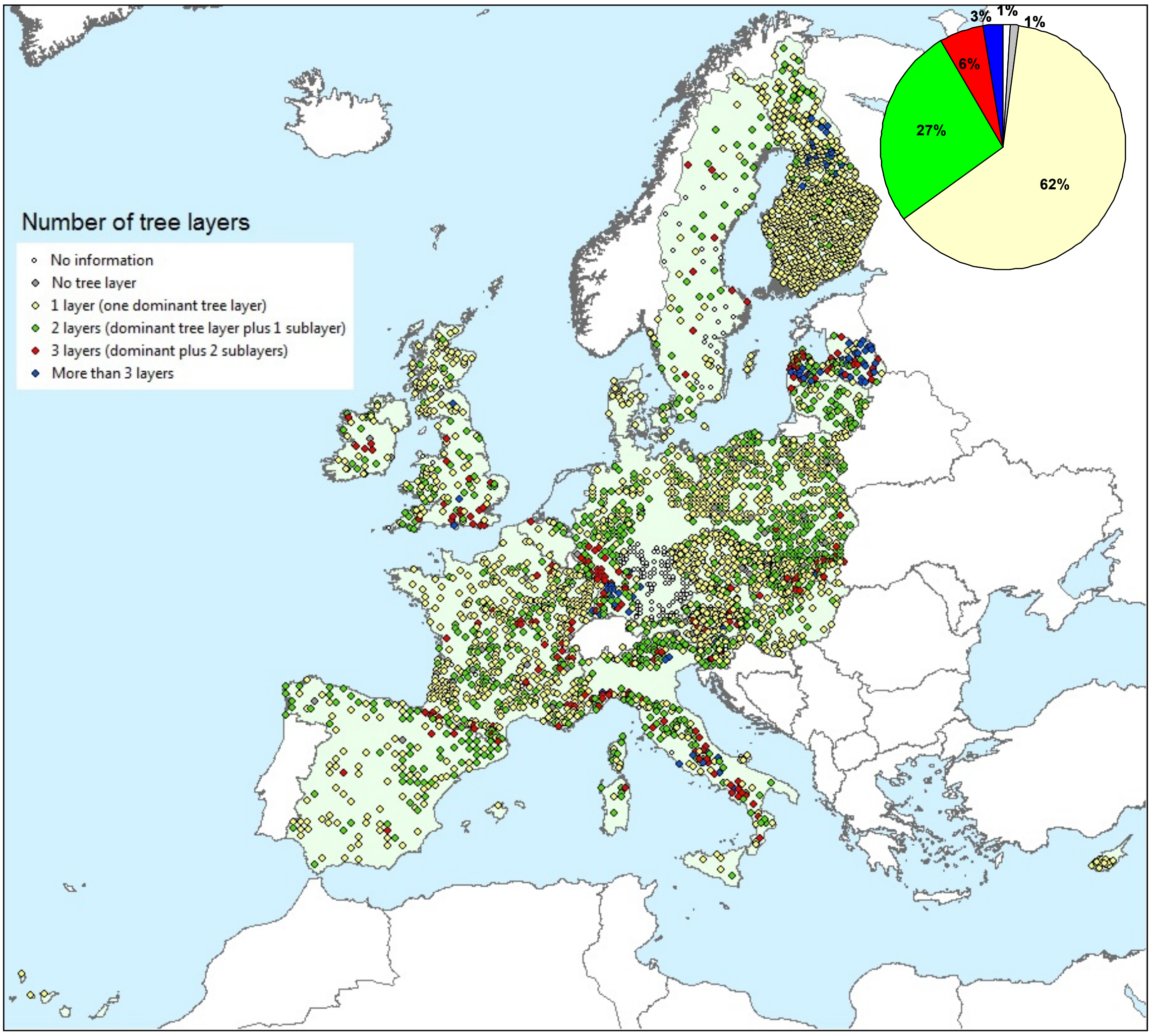


Figure 27: Number of distinct tree layers

6.8 Species Composition

118 species were reported in the DBH survey. Some of these are not separate species but general types (e.g. "Betula sp", "Other broadleaves"). Table 13 shows the number of plots in which a particular species was observed. This does not take into account the relative proportions of the species within the plot. In Appendix 6 some of the most commonly recorded species are mapped, with an indication of their proportion within each plot.

Table 13: Tree species reported in DBH survey

code	SPECIES name	Plot frequency
134	Pinus sylvestris	1340
118	Picea abies (P. excelsa)	1235
10	Betula pendula	677
20	Fagus sylvatica	605
51	Quercus robur (Q. pedunculata)	464
11	Betula pubescens	439
48	Quercus petraea	289
64	Sorbus aucuparia	266
13	Carpinus betulus	257
22	Fraxinus excelsior	214
35	Populus tremula	194
116	Larix decidua	188
100	Abies alba	173
16	Corylus avellana	169
5	Acer pseudoplatanus	159
49	Quercus pubescens	147
99	Other broadleaves	142
15	Castanea sativa (C. vesca)	141
7	Alnus glutinosa	126
8	Alnus incana	102
36	Prunus avium	101
46	Quercus ilex	99
58	Salix caprea	96
1	Acer campestre	93
111	Juniperus communis	89
120	Picea sichensis	85
130	Pinus pinaster	82
41	Quercus cerris	82
90	Crataegus monogyna	79
129	Pinus nigra	69
56	Robinia pseudoacacia	69
23	Fraxinus ornus	67
63	Sorbus aria	58
29	Ostrya carpinifolia	58
136	Pseudotsuga menziesii	55
68	Tilia cordata	52
66	Sorbus torminalis	51
4	Acer platanoides	47
125	Pinus halepensis	46
12	Buxus sempervirens	43
24	Ilex aquifolium	33
38	Prunus padus	30

Plot frequency less than 30:

Pinus contorta; Ulmus minor - **29**

Populus hybrids – **27**

Quercus rubra – **25**

Prunus serotina; Quercus pyrenaica; Tilia platyphyllos – **24**

Pyrus communis – **22**

Ulmus glabra; Other conifers; Acer opalus – **21**

Pinus brutia; Salix sp.; Erica arborea – **18**

Larix kaempferi; Acer monspessulanum – **17**

Malus domestica; Arbutus unedo; Juniperus oxycedrus – **16**

Eucalyptus sp.; Fraxinus angustifolia spp. oxycarpa; Phillyrea latifolia – **14**

Quercus suber – **11**

Erica scoparia – **10**

Sorbus domestica; Salix cinerea – **9**

Pinus pinea – **8**

Pinus strobus; Ulmus laevis; Populus nigra; Juglans regia – **7**

Tsuga sp; Salix fragilis; Rhamnus alaternus; Quercus faginea – **6**

Pinus cembra; Tilia sp; Populus alba; Betula sp; Populus canescens; Juniperus thurifera; Pinus uncinata – **5**

Olea europaea; Alnus viridis; Alnus cordata; Pinus radiata; Cupressus sempervirens; Cedrus atlantica; Phillyrea angustifolia; Pistacia lentiscus – **4**

Chamaecyparis lawsonia; Quercus coccifera; Taxus baccata; Abies grandis; Juniperus phoenicea; Prunus sp. – **3**

Ulmus sp; Unknown/no information; Quercus alnifolia; Pistacia terebinthus; Pinus canariensis – **2**

Ulmus canescens; Quercus sp; Arbutus andrachne; Carpinus orientalis; Quercus frainetto; Ceratonia siliqua; Prunus dulcis; Fagus moesiaca; Cedrus brevifolia; Salix eleagnos; Salix alba; Quercus trojana; Pinus mugo; Platanus orientalis; Laurus nobilis – **1**

The plots are more or less evenly divided between conifer and broadleaf species (Figure 28). Of the 3224 plots in which DBH was measured, around a quarter are composed purely of conifers and 14% have a majority of conifer species (over 75% of the trees in the plot). A similar pattern is observed for broadleaves. The remaining fifth are mixed (no more than 75% of either broadleaf or conifer present). Around two-thirds of the pure conifer plots and one quarter of the pure broadleaf plots are single species (Table 14).

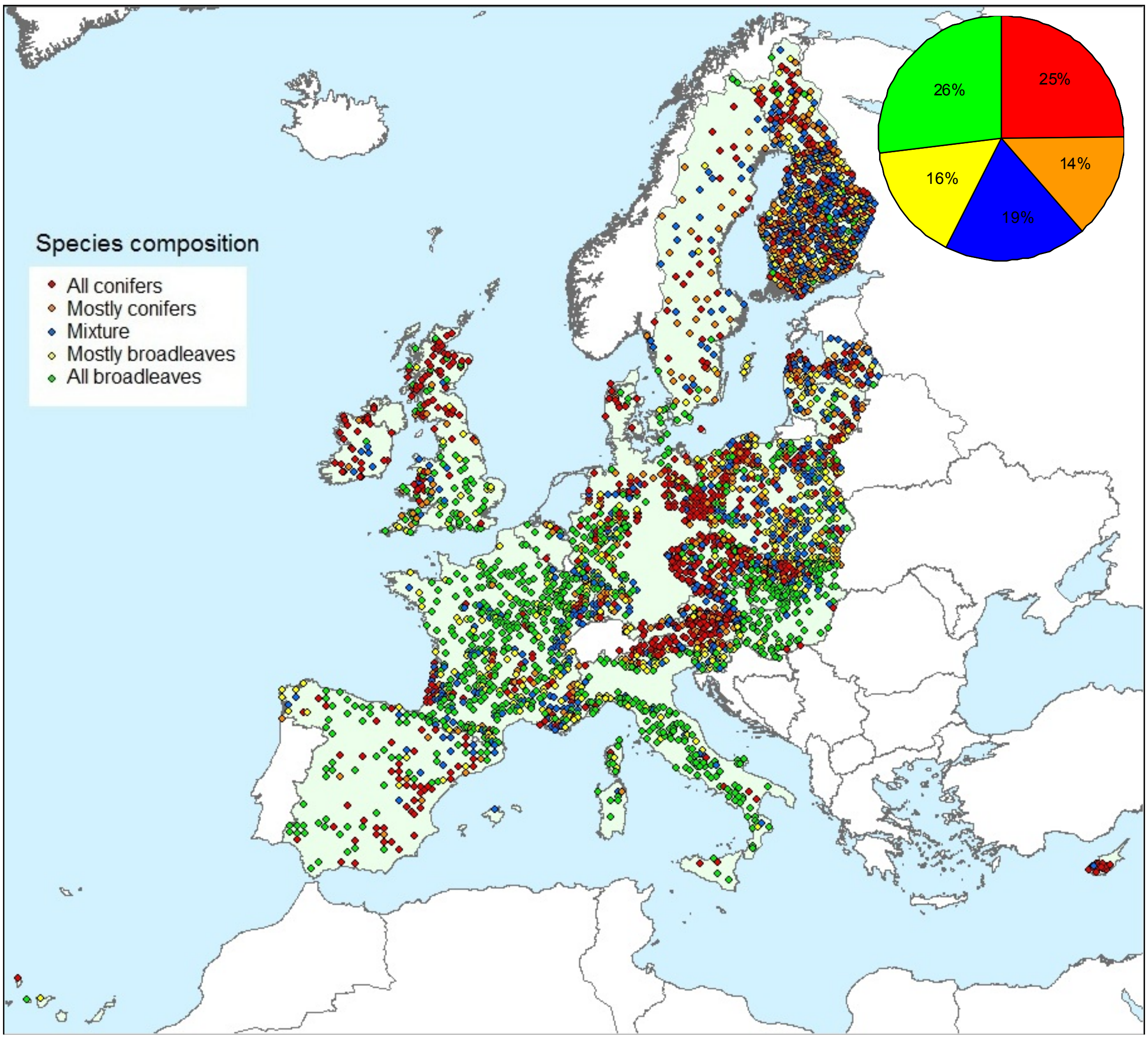


Figure 28: Tree species composition. Proportions are weighted to take into account the different sampling intensity in each subplot.

Table 14: Tree species composition

Species composition	Number of plots
All conifers	796 *(530 of which are single species)*
Mostly conifers	447
Mixture	612
Mostly broadleaves	504
All broadleaves	865 *(215 of which are single species)*

6.9 Tree Species Biodiversity

6.9.1 Species richness

This is simply a count of the total number of species in the plot. Since it does not rely in frequencies of each species, the statistic was derived directly from the data with no account taken of the different sampling thresholds in each of the three subplots. The number of species found in the plots varied from 1 to 13 with nearly half of all plots recording only one or two tree species (Figure 29, Figure 30). The highest average number of species reported per plot was in Slovenia with an average of more than 4.

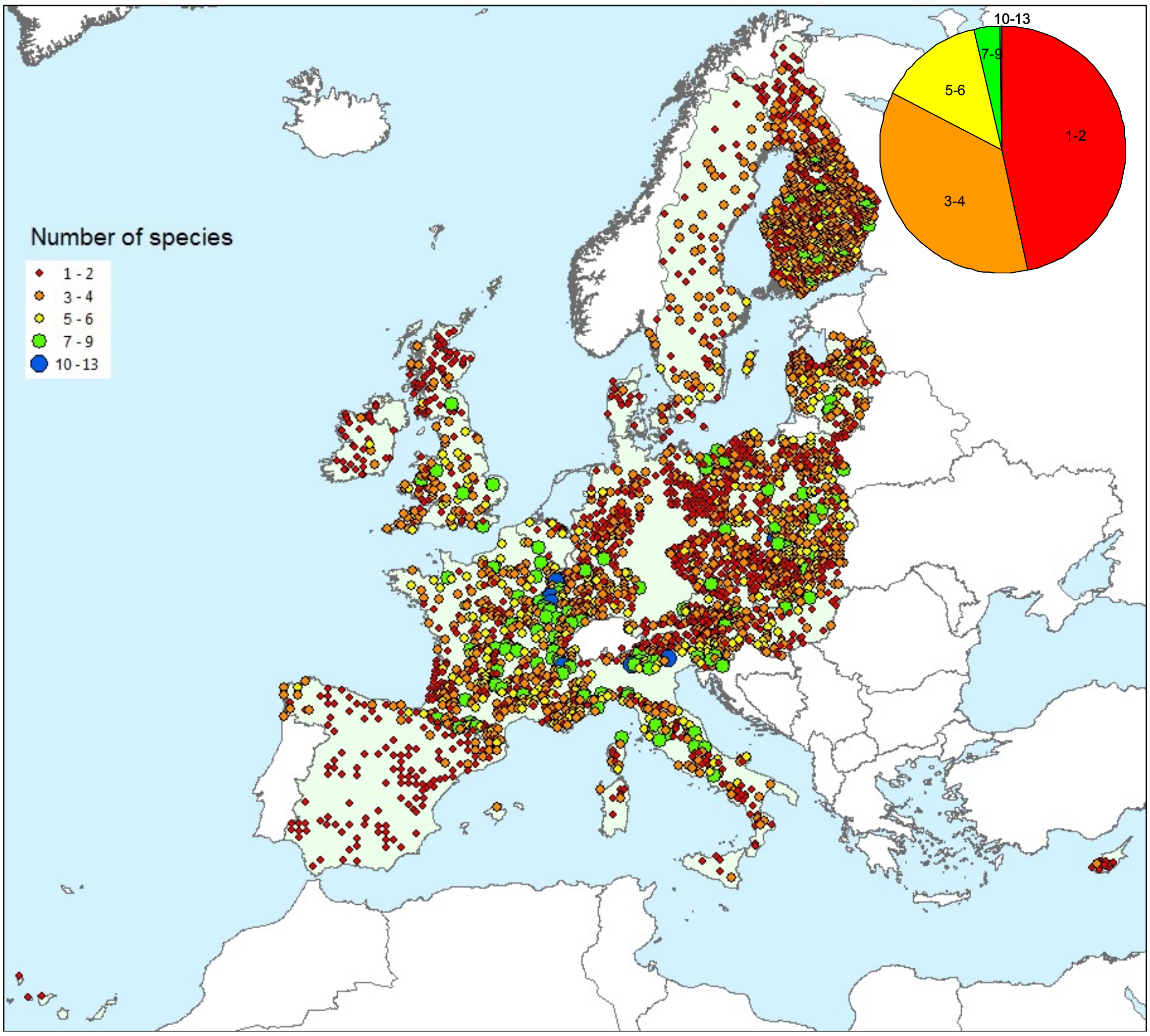


Figure 29: Species richness of measured trees

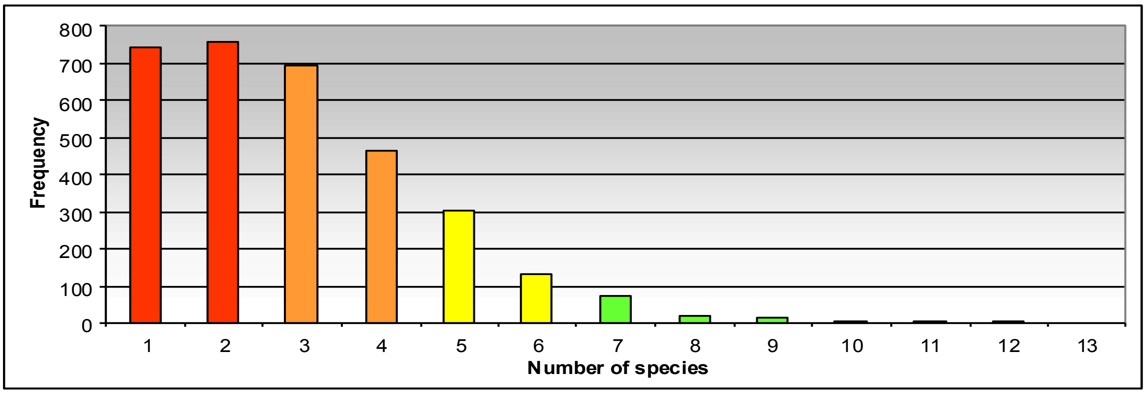


Figure 30: Frequency distribution of species richness

6.9.2 Species diversity indices

There are a number of different indices for measuring species diversity. All give slightly different results as some focus on dominance, some on richness and others on evenness. Two of the most extensively used are the Shannon (Shannon, 1948) and Simpson (Simpson, 1949), which are presented below.

The different sampling size thresholds in the 3 subplots were dealt with in a similar manner to that used for the calculation of basal area. To estimate biodiversity of species in the plots, an estimate first had to be made of the frequencies of each species over the entire plot area, taking into account the different subplot sizes and tree size thresholds. DE07/DE09 were calculated separately, as before.

The indices were then calculated using the estimated frequencies of each species over the plot area.

The Shannon index (Shannon, 1948) is based on the concept of **evenness** or equitability (i.e., the extent to which each species is represented among a sample). The index accounts for both abundance and evenness of the species present and is calculated as follows:

$$H = -\sum_{i=1}^{s} p_i \ln p_i$$

where S is the number of species in the plot (richness)
p_i is the proportion of S making up the ith species.

The index is zero when only one species is present. Its maximum value is ln S. Figure 31 shows the plot scores for the Biosoil plots.

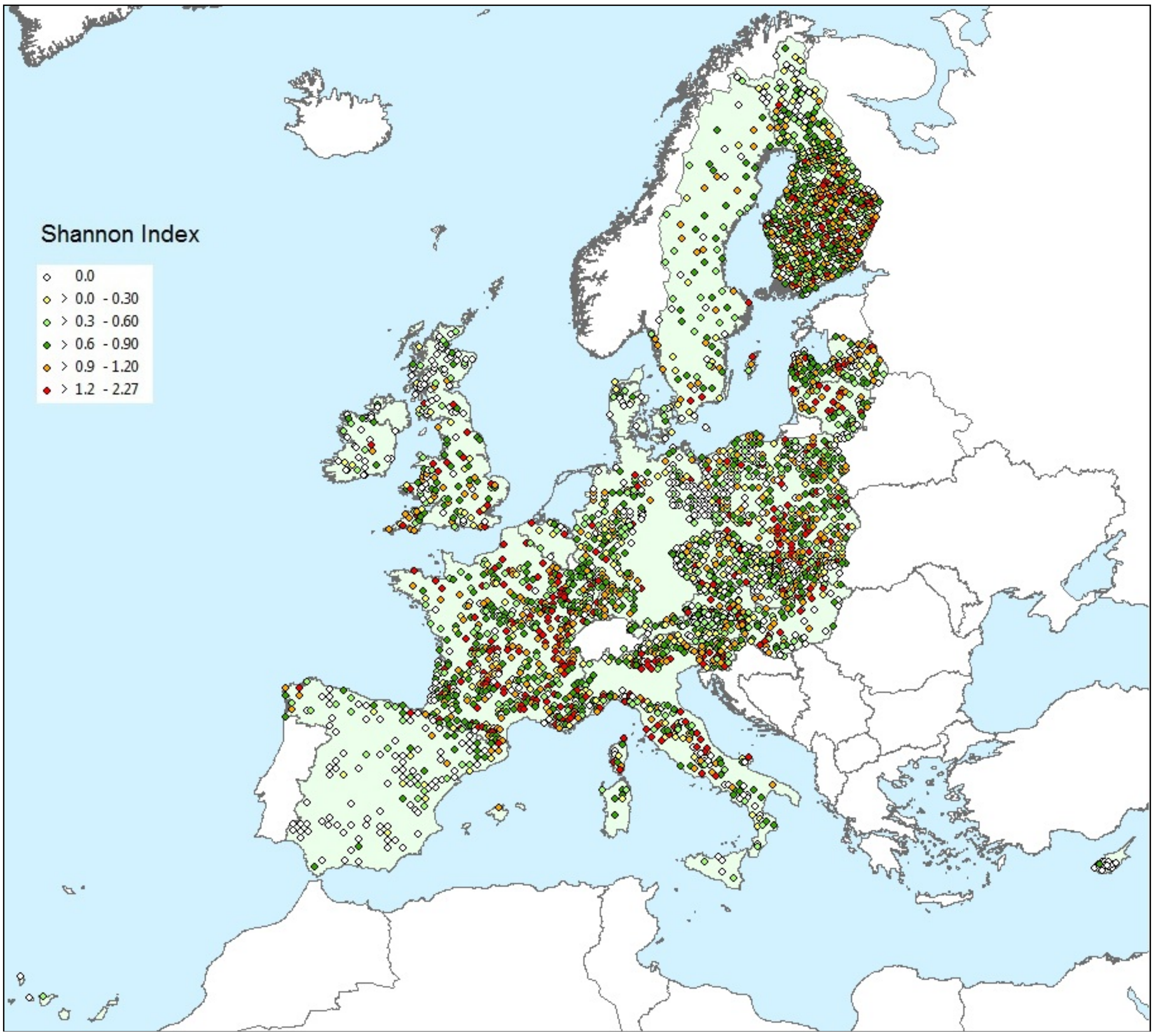


Figure 31: Shannon index of diversity for tree species

The Simpson index (Simpson, 1949) gives a slightly different measure: it is the probability that two individuals drawn at random from a given plot will belong to the same species. As such it is actually a measure of **dominance**, and for a highly dominated population (i.e. almost all individuals belong to one species) the probability of drawing two individuals from the same species approaches 1. For a population in which all individuals belong to different species, the probability of drawing two individuals from the same species will be 0. The index is frequently subtracted from 1 to make it more intuitive (i.e. high diversity → high score) and referred to as the Gini-Simpson index:

$$D = 1 - \sum_{i=1}^{s} p_i^2$$

The distribution of scores is shown in Figure 32.

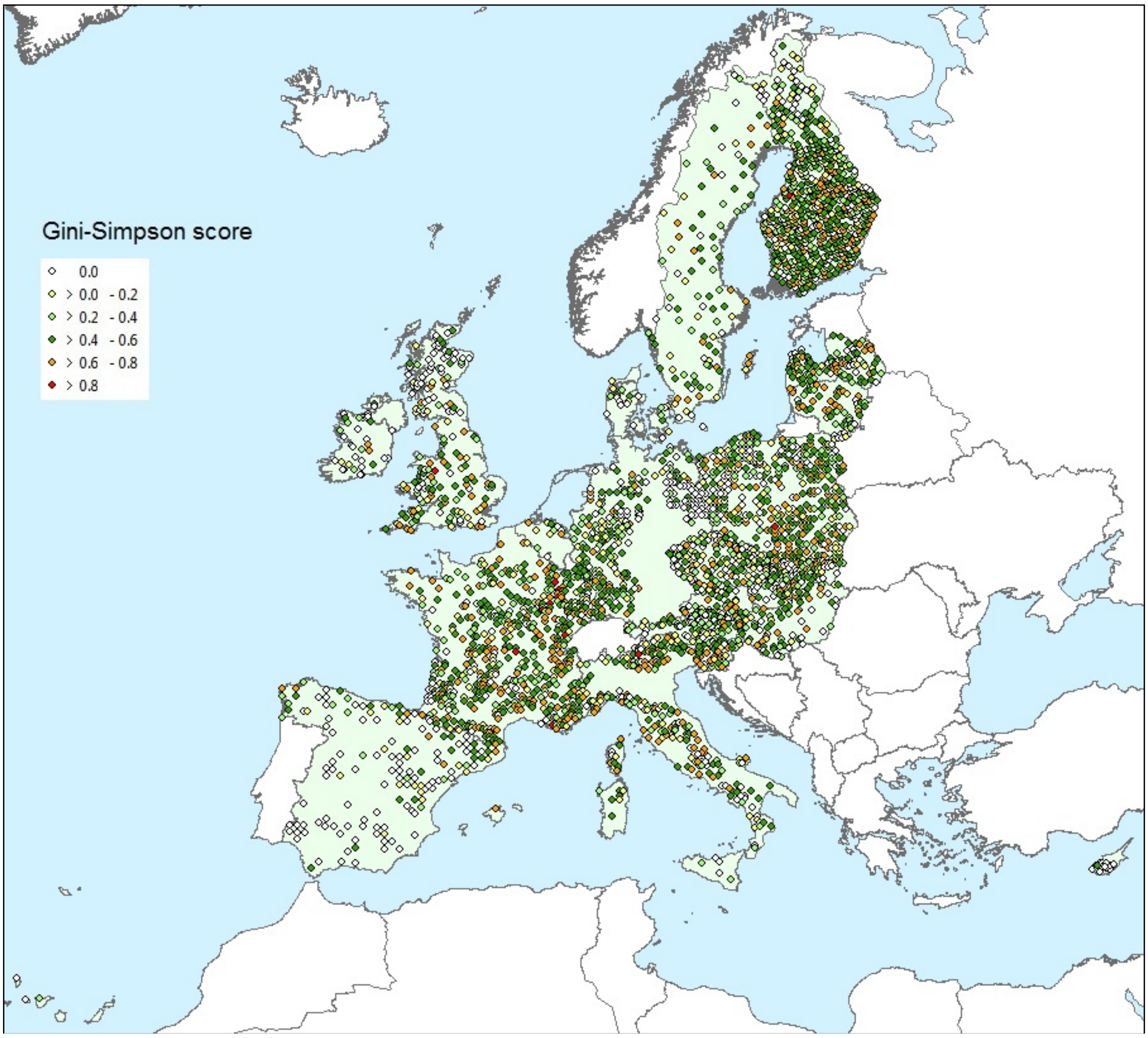


Figure 32: Gini-Simpson index of diversity for tree species

6.10 Dead trees

In order to make an estimate of deadwood volume it is necessary to have a measurement of both length and width of the measured piece. Dead trees were measured for DBH but not for height; therefore estimates of heights had to be made using relationships found between height and DBH. This introduces another level of error into the volume estimate and has to be taken into consideration when interpreting the results.

78 species from 37 genera were recorded for dead trees, in addition to 72 “other broadleaf”, 33 “other conifer” and 2 unrecorded species. Tree heights were estimated according to the procedure detailed in the next section.

6.11 Tree heights and height/diameter relationship

Most countries measured either 3 or 5 trees for heights in each plot (Figure 33).

UK reported 19 heights for trees in 9 plots without any accompanying DBH measurements. UK explained that in these cases it was because the largest tree in the plot fell below the size threshold for DBH measurement and so this was not recorded. These trees are included in height summaries but are excluded from any analysis that also uses DBH.

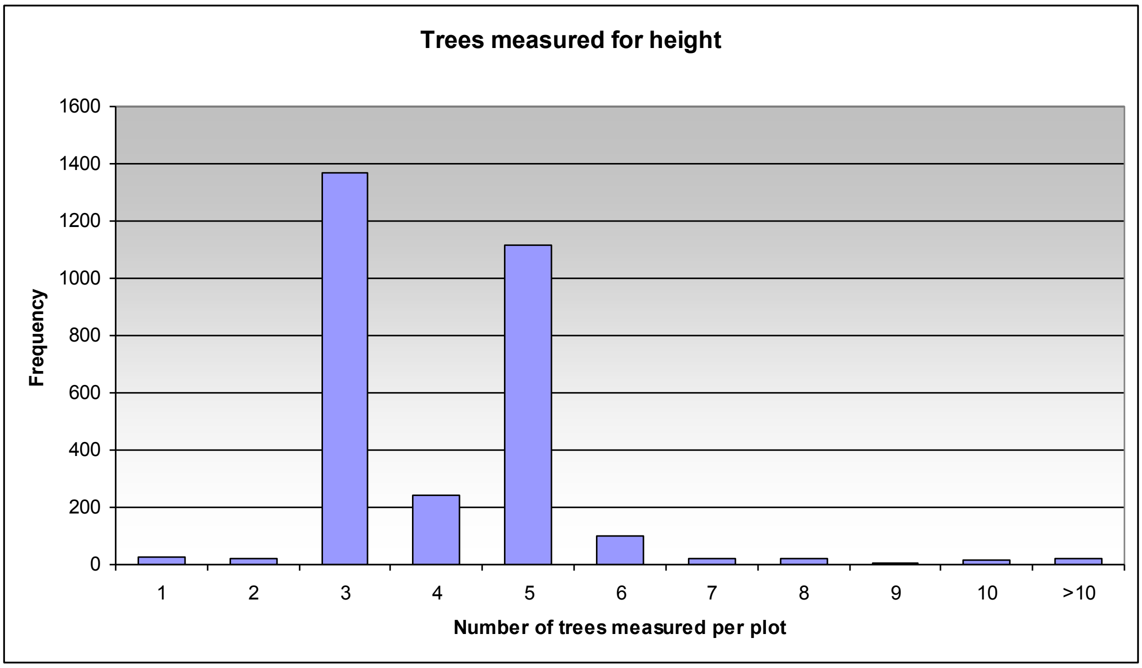


Figure 33: Number of trees per plot measured for height.

In total there were 12123 records for which both height and DBH were measured. 24 records were flagged as outliers because although the values for height and DBH had individually passed the validation checks, the relationship between them was significantly outside the expected range, given the species, location and forest type. This may be for good reason; eg a tree that has been snapped and which therefore has a large DBH compared with its height. These 24 figures are excluded for calculations of modelled height/diameter relationships, but are included in summaries that do not link the 2 variables.

With a total of 93 species from 39 separate genera, growing in 14 possible forest types and under different forms of management, it was not possible to model all conditions separately. The following pragmatic approach was taken:

First, the most frequently assessed species were investigated individually. Preliminary investigation had already revealed that differences between countries were normally at least as great as those between species, forest type or any other factor. This is not entirely surprising since forest type is also associated with country, and different soil types / climatic conditions / management regimes / genetic stock may be expected to affect growth and form. In addition there may be differences in protocols for taking the measurements between the countries. When there were enough data points and observable differences between countries, individual countries or groups of countries were modelled separately for the most frequently occurring species.

Where there was insufficient data to model a species separately, observations were grouped according to genus after first checking that none of the species observed within that genus had clearly different forms. This gave an acceptable fit in most cases. This left a few unspecified conifers which were modelled using data from the same country/forest type.

Table 15 gives summary statistics for the modelled species. The calculated growth curves are shown in Appendix 4 and plots of the data are in Appendix 5.

Various models were initially investigated. The one that consistently performed best for these data was a modified Weibull function (Yang *et al.*, 1978). A similar conclusion was made by (Temesgen and Gadow, 2004) when testing height-diameter models for stands in British Columbia.

The model takes the form $H = 1.3 + a\left(1 - \exp\left(b[DBH]^c\right)\right)$ (1)

where H is the estimated height;
[DBH] is the diameter measured at breast height
and a, b and c are parameters specific to the data being modelled.

On the very few occasions where no fit could be made using this model, an alternative function was used after (Wykoff *et al.*, 1982).

This can be expressed by $H = 1.3 + \exp\left(a + \frac{b}{([DBH] + 1)}\right)$ (2)

Table 15: List of modelled species and genera

Fit 1/2 denotes which of model 1 or 2 was used for the growth curve. X denotes that a different approach was used (generally because of insufficient data for non-linear fit) and the solution is described in the comments.

SPECIES	Count	DBH		HT		Fit	Comment
		Min	Max	Min	Max		
Abies alba	272	11.3	98	8.2	47.6	1	16 observations from AT excluded (clearly different growth trajectory but not enough data to model separately)
Abies grandis	5	36.7	48.2	24.7	34.8		
Acer campestre	15	1	31	3	21.1	1	
Acer monspessulanum	7	20	50	8.5	11.7		
Acer opalus	7	20	32	13	20.5		
Acer platanoides	12	16.7	76	5.8	25.8		
Acer pseudoplatanus	73	6	95	6.1	35.2		
Alnus cordata	5	25	45	18.1	33	1	
Alnus glutinosa	159	2	63.1	2.4	33.6		
Alnus incana	41	0.8	47	2	23.3		
Arbutus unedo	6	10	15	3.8	6.1	X	Dead trees 1-12 cm DBH. Linear interpolation between 1.3 and 4.9 (average height of trees over 10cm DBH)
Betula pendula	467	0	73	1.35	36	1	2 curves: LT/LV and rest
Betula pubescens	154	0.6	43	1.68	28.2		
Carpinus betulus	101	0	70	1.58	34.8	1	
Carpinus orientalis	1	29	29	12.8	12.8		
Castanea sativa	206	10	141	6.9	31.6	1,2	2 curves: UK (Eq. 2) and rest (Eq. 1)
Chamaecyparis lawsonia	6	9.3	34	15.3	25.1	X	All dead trees from one plot (DBH 7.3-22.5cm). Use mean height of live trees (18.9m) for all
Corylus avellana	9	1.7	48	1.3	20.7	1	
Crataegus monogyna	4	10	76	5.6	11.4	X	Dead trees 0-18 DBH. Height estimated with a linear fit between 1.3 and 6m
Erica arborea	5	10	26	12.4	17.8	X	16 dead trees DBH 1-3cm. Height estimated with linear fit 1.3 to 15m at 25cm DBH
Eucalyptus sp.	45	2	54	3	25	1	
Fagus sylvatica	1167	3	130	2.6	43	1	3 curves: HU/AT, FR/IT/UK and rest
Fraxinus angustifolia spp. oxycarpa	9	7	42	5.9	30.1	1	
Fraxinus excelsior	150	7	101	8.5	38.6		
Fraxinus ornus	15	1	46	2	22.2		
Ilex aquifolium	3	1.5	10	1.5	6.3	X	3 dead trees DBH 2-12.8. 2 small trees set to 1.5, 1 large one set to 5.8 (mean of comparable live trees)
Juniperus communis	4	10	15	5.5	6.4	X	29 dead trees DBH 0.7-11. Heights estimated with linear fit between 1.3 and 5.5m
Juniperus oxycedrus	2	2	12	3.5	7.5		
Juniperus thurifera	16	9	30	3.5	10.5		
Larix decidua	257	1.5	102	3.2	45.3	1	2 curves: AT and all other countries
Larix kaempferi	30	10.8	60.5	9.5	31.1		
Malus domestica	2	1.8	1.9	2.4	2.9	X	1 small dead tree; height set to 1.5m
Olea europaea	11	19	39	5.5	7	X	2 dead trees DBH 1 and 10. Small tree set to 1.5; larger given interpolated value
Ostrya carpinifolia	21	12	32	5.8	18	1	
Other broadleaves	29	1.2	44	3.2	23	1	
Other conifers	2	35.6	35.7	16	22.7	X	Use country-specific conifer data for the 33 dead trees
Picea abies (P. excelsa)	1773	0.8	94	1.4	47.4	1	4 curves: AT, FI/LT, SI/DE and rest
Picea sichensis	294	1	77.9	1.9	34	1	
Pinus brutia	78	15.3	87.5	7	29	1	All in CY
Pinus contorta	95	13	45.5	5.1	27.5	1	
Pinus halepensis	180	5	66	3	27.7	1	
Pinus nigra	201	10	120	5.1	31	1	

Pinus pinaster	302	9	77	4.6	33.5	1	2 curves: ES and FR
Pinus pinea	24	11	65.3	3	14.1	1	No dead ones
Pinus strobus	5	28	59	20	38.1	X	Same equation as P. sylvestris
Pinus sylvestris	3126	0.7	88	1.2	40.3	1	7 curves: ES, FR, AT, FI/BE, UK/IT/DK, PL/HU, others
Pinus uncinata	11	13	62	6	15	X	2 dead trees DBH 20 and 31. Height set to 9.9 (mean of comparable live trees)
Platanus orientalis	6	29	46	19	25	1	
Populus alba	6	26	58	8.5	28.1	1	
Populus canescens	7	8	52	7	25.5		
Populus hybrides	75	7	68	6.9	43.6		
Populus nigra	13	17	66	10	34.6		
Populus tremula	111	3.4	70	6.5	36.5		
Prunus avium	13	12	57	12.8	29.4	1	
Prunus padus	3	5	17	3.3	19		
Prunus serotina	1	28	28	15	15		
Pseudotsuga menziesii	128	2.2	103	3.1	42.6	1	
Quercus cerris	170	1	79	2	35	1	
Quercus faginea	11	11	59	4.5	20	X	1 dead tree - use average of trees of the same age/size class (5m)
Quercus ilex	272	2	82	2.5	22.6	1,2	2 curves: ES (Eq 2) and rest (Eq. 1)
Quercus petraea	513	1	94	2	39.5	1	
Quercus pubescens	329	1	80	2	29.3	1	
Quercus pyrenaica	56	7	103	5	15	1	
Quercus robur	656	0	104	1.4	39.8	1	2 curves: UK/ES and rest
Quercus suber	33	19	60	5	20	1,2	2 curves: ES (Eq 1) and FR/IT (Eq. 2)
Robinia pseudoacacia	85	1	54	2	31	1	
Salix alba	1	28	28	18.7	18.7	1	
Salix caprea	16	6.6	59	9.2	18.4		
Salix cinerea	7	5	37.6	4.9	13.9		
Salix fragilis	3	5.2	23.2	8.8	21.7		
Salix sp.	4	7.7	50	9.8	21		
Sorbus aria	8	12	52	9.4	16.4	1	
Sorbus aucuparia	13	0	39.9	1.5	16.1		
Sorbus domestica	1	21	21	15.4	15.4		
Sorbus torminalis	7	5	12	5.7	10.5		
Tilia cordata	19	9	60	8.6	26.2	1	
Tilia platyphyllos	17	10	70	8.1	28		
Tsuga sp.	20	31	71.8	13.8	33.5	1	
Ulmus glabra	6	0	39	1.65	21.8	1	
Ulmus laevis	2	30	79	17.5	22.6		
Ulmus minor	3	15	86	10.3	30.1		

Data from some species were not used (Table 16). No dead trees of these species were found in the data and the number of height measurements was too low to form estimates of relationships between height and diameter.

Table 16: Tree species found only as live examples in the THT survey.

SPECIES	No of obs	DBH		HT	
		Min	Max	Min	Max
Cedrus atlantica	7	10	64	4	31.3
Cedrus brevifolia	3	36.1	42	11	12
Cupressus sempervirens	1	50	50	34.9	34.9
Fagus moesiaca	1	18	18	10.9	10.9
Juglans regia	3	16	56	10.5	17
Pinus canariensis	10	22	81	20.5	36.8
Pinus cembra	8	51	66	11.4	27.4
Pinus radiata (P.insignis)	11	14	62	16	22
Pinus uncinata	11	13	62	6	15
Quercus rubra	21	21.9	97	16.8	39.5
Quercus trojana	2	48	65	10.3	14.4

Using this approach meant that 97% of the dead trees could be given an estimated height based on the relationships calculated from the data leaving 127 remaining trees which had to be dealt with on an individual basis (described in Table 15). In addition there were two dead Buxus sempervirens, 1 Phillyrea latifolia, 1 Phillyrea angustifolia, 1 Rhamnus alaternus and 2 Pyrus communis which were not represented anywhere by live trees in the THT data set. These were given estimated heights based on average values found in the literature for a tree of that diameter and age class.

The estimated heights of dead trees were then used to form a crude estimate of the volume of dead wood found in the plots (see section 7: Deadwood).

It should be noted that some of these relationships, and therefore the height estimates, are not very precise. For modelling heights for some species, more data and site information would be required. However, in the absence of other information, it at least allows us to gain some idea of the component of deadwood contained in the dead trees that were not included in the DWD survey.

7 Deadwood

7.1 Plot design and sampling

Deadwood was assessed over an area of 400 m^2 (subplots 1 and 2). The total volume of deadwood in each plot is estimated by the sum of the volumes of all pieces of lying and standing deadwood.

7.2 Data quality and limitations

Measurement of fine woody debris (defined as woody debris with a diameter of <10cm) was optional. 10 countries chose to assess and report this. Since not every country submitted data for fine deadwood, it is excluded from the total plot volume figures given below.

NOTE

There are some problems regarding deadwood. According to the manual, coarse deadwood, fine deadwood, stumps and snags were to be recorded in the DWD file. Each piece has a length (m) and mid-diameter (cm) assessment. However, standing and lying dead trees (distinguished from coarse deadwood and snags by the presence of branches) could be recorded in the DBH file where only diameter at breast height is recorded (no height). In some cases the distinction can be quite subtle and there is thus the possibility to classify dead trees either as “coarse deadwood” or “snag” to be recorded in the DWD file with a mid-diameter and length measurement, or a “dead tree” (lying or standing) and recorded in the DBH file with only a DBH measurement. For example, France recorded lying dead trees in the DWD survey, and hence the DBH survey for France contains only living and standing dead trees. The two German Länder Hesse and Niedersachsen recorded no dead trees (either standing or fallen) in the DBH survey and it must be assumed that all dead trees were assessed in the DWD survey.

This situation can also lead to the risk of certain elements being recorded twice (in both DWD and DBH surveys) or missed altogether. In the UK it was discovered that in some plots, standing and lying dead trees were recorded in both surveys. The duplicates were eliminated from the calculations wherever they were found. However, since it is very difficult to test for, there is a possibility that some duplicates may still remain.

Table 17 compares the number of pieces of deadwood recorded in the plots with the number of lying and standing dead trees with a DBH of ≥10cm recorded in the DBH survey in subplots 1 and 2 (comparable area and size thresholds to the DWD survey).

Table 17: Total number of pieces of deadwood and standing/lying dead trees recorded

		From DWD survey					From DBH survey (DBH≥10, no subplot3)	
COUNTRY	No of plots*	Unknown/ Other	Coarse debris	Fine debris	Snag	Stump	Standing dead tree	Lying dead tree
France	548	0	4330	-	175	2143	787†	0
Belgium	10	0	18	91	4	60	5	4
Italy	224	13	655	2006	112	786	237	38
United Kingdom	167	5	685	23	177	565	215‡	24‡
Ireland	35	15	106	-	2	510	85	22
Denmark	22	0	9	-	0	0	6	0
Spain	151	61	127	200	36	404	48	2
Sweden	100	0	260	35	67	478	33	29
Austria	136	0	553	-	0	1623	117	0
Finland	630	53	989	-	93	5735	176	61
Hungary	78	0	318	-	31	963	39	3
Poland	438	28	675	-	53	3912	115	13
Slovak Republic	108	7	558	11	2	959	123	0
Lithuania	62	0	166	-	41	439	78	42
Czech Republic	142	28	835	91	0	2818	72	2
Slovenia	40	0	178	44	15	223	54	39
Latvia	95	7	536	-	116	530	135	56
Cyprus	19	35	6	107	0	17	1	3
Canaries (Spain)	4	0	3	8	3	1	0	0
DE (Baden-Württemberg)	50	0	462	-	30	761	55	12
DE (Brandenburg-Berlin)	53	0	154	-	69	223	8	49
DE (Hessen)	29	0	369	-	37	388	0	0
DE (Mecklenburg-Vorpommern)	17	0	101	-	3	185	23	1
DE (Niedersachsen)	42	0	427	-	45	576	0	0
DE (NRW)	39	1	218	-	5	565	14	5
DE (Rheinland-Pfalz)	26	0	284	-	25	357	27	10
DE (Saarland)	9	0	115	-	7	64	13	1

**includes plots that were assessed but found to be without any deadwood*
† excludes 19 trees over 50cm DBH which could have come from anywhere in subplots 1-3
‡ excludes 8 standing and 2 lying trees that were also counted in the DWD survey

Incomplete data

Some deadwood measurements were incomplete; either a length or a diameter measurement, but not both, was supplied. In total, out of 42271 pieces of deadwood reported, 2539 (6%) were incompletely recorded. Practically all these records came from 3 countries: 1623 in Austria (did not record lengths of stumps), 776 in Hungary (did not record lengths of stumps) and 134 in UK (sometimes did not record snag lengths). After consultation with the countries involved, the stumps were given notional lengths of 0.2m in Hungary and 0.3m in Austria (average cutting height for these locations), and the snags in the UK were set to a notional height of 1.3m (the minimum theoretical height for a piece of deadwood to be classified as a snag). These notional values were used in the estimations of deadwood volume. The small number (<10) of other records with incomplete measurements were excluded from the calculations.

7.3 Stumps

The number of stumps recorded in the plots gives an indication of the amount of silvicultural intervention, and, indirectly, of "naturalness". Figure 34 gives the number of stumps recorded expressed as a per hectare equivalent.

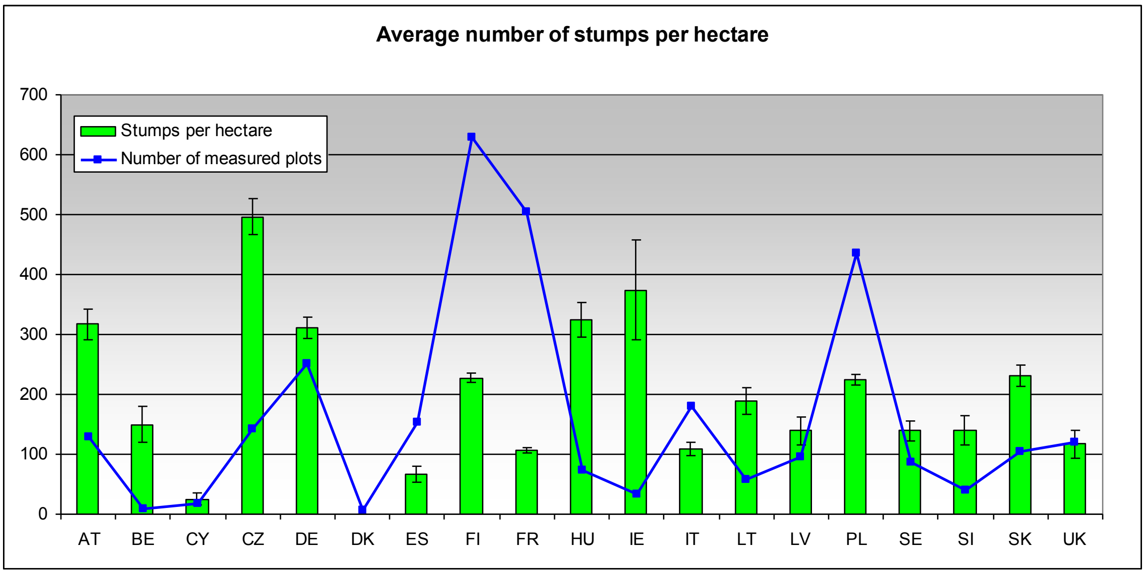


Figure 34: Average number of stumps per hectare

Unsurprisingly this statistic is closely related to the plot code MANAGE (Table 18), and its distribution is very similar to Figure 7 shown in section 5.1.4.

Table 18: Average number of stumps per plot

CODE	DESCRIPTION	Average stumps per plot	Number of plots assessed
1	Unmanaged (no evidence)	2.4	259
2	Management (evidence but for more than 10 years ago)	5.6	813
3	Managed (within the last 10 years)	10.4	1893
4	Unknown	4.6	82

7.4 Deadwood volume per plot

Volume was calculated in several stages.

1. Deadwood volume from DWD survey

Fine deadwood volume was calculated separately and is not included in the plot totals because not every country included this optional part of the survey in their assessments (see Table 17). Volume was calculated using Huber's formula for all pieces of deadwood recorded in the DWD file that had both a length and a mid-diameter measurement:

$$V = \frac{\pi (d)^2}{4} * (l)$$

where d is the mid-diameter measurement of the piece of deadwood and l is its length.

2. The estimated volumes from the incomplete measurements were added to the totals for the three countries affected.

3. Deadwood volume of dead trees from DBH survey

If only information from the DWD survey is used, the total deadwood volume in the plots is significantly underestimated because standing and lying dead trees that were assessed in the DBH survey are not included.

It was not possible to make an accurate calculation of the volume of dead trees because volume estimates require at least both a height and diameter measurement, but only DBH was assessed in the DBH survey.

In order to make a crude estimate of the volume of the deadwood recorded in the DBH survey, first the height/length of the dead trees was estimated using height/diameter relationships derived from the THT survey, which includes heights of the largest DBH trees in the plot (see section 6.11 for full summary). This approach was used in preference to standard tables because of the complications arising from trying to source tables for all species calibrated to local conditions. Tree volume was then estimated with a cylindrical component for the first 1.3m of length and then the volume of the remaining part (if any) was estimated using the standard equation for volume of a cone, excluding the top portion where the diameter was estimated to be less than 10cm (Figure 35):

$$V \approx \frac{\pi}{4} dbh^2 * 1.3 \quad + \quad \frac{\pi}{12}\left(dbh^2 * (h - 1.3) - {d_{10}}^2 l_{10}\right)$$

where dbh = recorded diameter at breast height;
h = estimated height;
d_{10} = 0.1m;
l_{10} = the length from the 10cm diameter point to the estimated tree height.

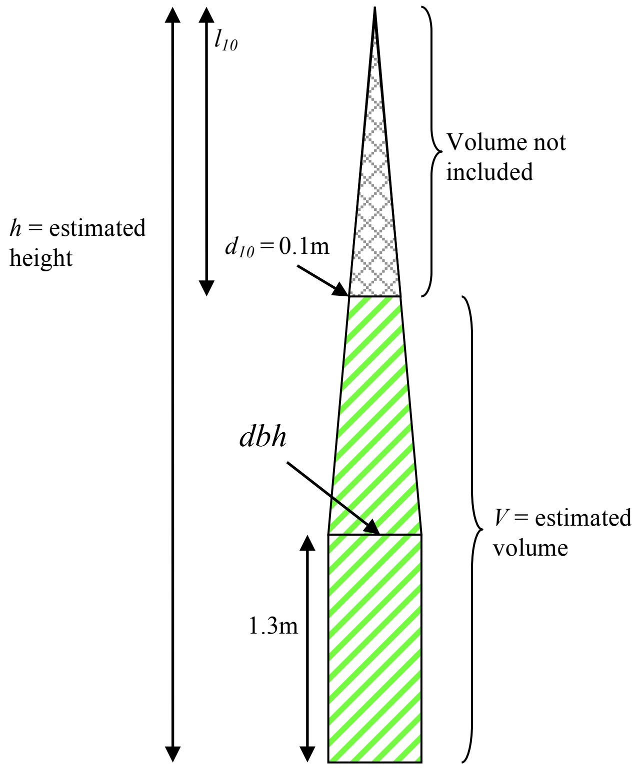


Figure 35: Schematic representation of volume estimation of dead tree

All dead trees were treated as snags. No allowance was made for branches because there was no information that could be used to form an estimate. Only trees of ≥10cm DBH found in subplots 1 and 2 were included. Trees in subplot 1 with diameters of <10cm and all dead trees in subplot 3 (which was outside the sampled area of $400m^2$ for deadwood) were also excluded. For Sweden, which did not label subplots, all trees of ≥10cm DBH were included (i.e. includes subplot 3 as there is no way to separate the subplots). However, since only one dead tree of over 50cm DBH was recorded in the entire Swedish survey this is unlikely to bias the results significantly.

In France there were 19 dead trees of over 50cm DBH. FR labelled all trees of this size as belonging to subplot 3 regardless of their actual location in the plot, so the total volume of deadwood from the 19 trees was calculated separately, scaled to estimate the portion coming from the $400m^2$ area of subplots 1 and 2 and then added to the total. This affected 10 of the 504 French plots.

10 trees were removed from the UK calculation as it was clear that the same objects were also measured in the DWD survey. As it is difficult to check, however, (since a plot may legitimately contain both a dead tree and a piece of deadwood of the same dimensions) other duplicate values may still remain, which would inflate the UK deadwood volume totals.

However, the 10 confirmed duplicate values did allow some check to be made of the validity of the height estimates for dead trees. Figure 36 shows the relationship between the actual lengths as reported in the DWD survey and the estimated length/height formed from the height/diameter models. While the number of data points is very small, it seems that at least for the UK, and for the 3 species represented in the data, the estimated values appear to be realistic.

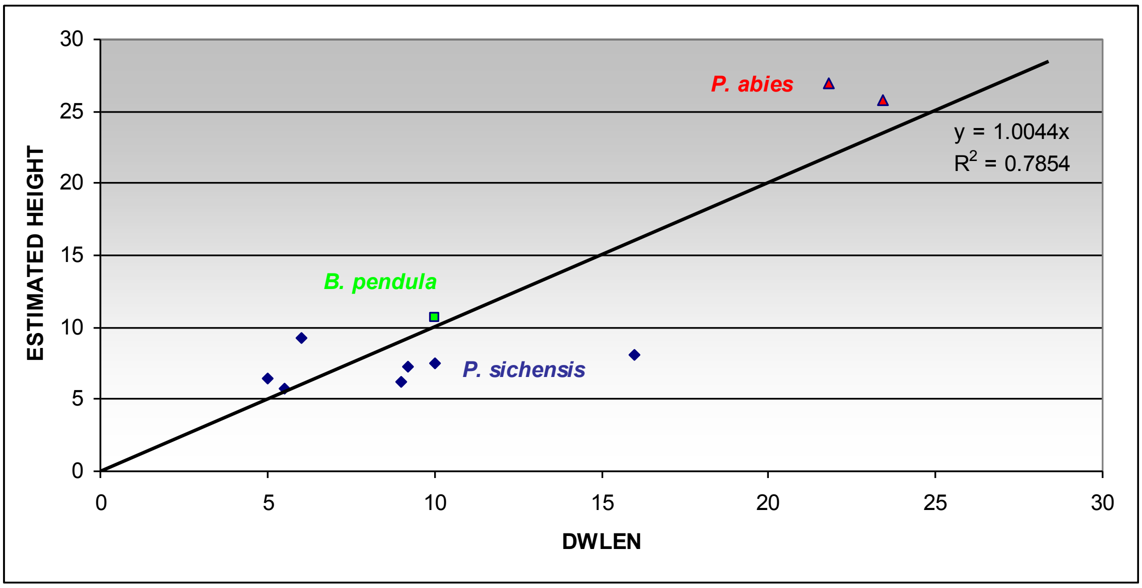


Figure 36: Comparison of estimated versus measured lengths for 10 UK standing/fallen dead trees

Plots for which no deadwood information and/or no dead tree information was submitted were checked to establish whether the plot had been assessed and no dead wood found (given a zero value in the data and included in averages) or whether the plot had not been assessed for these parameters (set to null and excluded from averages). In some cases it was quite difficult to distinguish between the two conditions and the countries were contacted for confirmation. In future surveys a clear way of differentiating between the different "null" conditions (i.e. "assessed but nothing found" vs. "not assessed") should be established at the outset, since the inclusion/exclusion of zero values can have a significant effect on the average values obtained.

Table 19 shows the mean volume of deadwood expressed in m^3/ha for the different deadwood types and the estimated volume that might be added from the standing and lying dead trees assessed in subplots 1 and 2. This additional volume can be quite considerable in some cases (see Figure 39), although it should be borne in mind that the estimates of dead tree volume are not precise.

Table 19: Mean volume of deadwood and dead trees recorded per plot (m^3/ha)

	From DWD survey					From DBH survey (DBH≥10, no subplot3)		
COUNTRY	Unknown/ Other	Coarse debris	*Fine debris*	Snag	Stump	Standing dead tree	Lying dead tree	**Total** (excluding fine debris)
France	0	10.18	*0*	2.01	2.15	3.20*	0	17.54
Belgium	0	3.66	*1.06*	1.47	1.51	3.28	3.99	13.90
Italy	0.10	2.56	*1.33*	2.74	1.95	2.75	0.95	11.06
United Kingdom	0.01	9.39	*0.05*	6.65	1.29	3.15‡	1.11‡	21.60
Ireland	0	1.51		0.04	4.52	4.19	1.52	11.78
Denmark	0	4.81		0	0	0.87	0	5.68
Spain	0	2.27	*0.17*	0.36	0.97	0.91	0.03	4.55
Sweden	0	15.32	*0.08*	3.25	1.13	1.57	1.58	22.85
Austria	0	14.58			7.92	5.85	0	28.36
Finland	0	2.17		0.34	2.41	0.84	0.38	6.13
Hungary	0	4.10		1.11	3.26	2.79	0.07	11.33
Poland	0	3.98		0.77	2.66	0.93	0.08	8.41
Slovak Republic	0.05	12.62	*0.04*	0.02	4.80	6.91	0	24.40
Lithuania	0	3.02		1.47	2.00	4.16	2.18	12.83
Czech Republic	0.50	3.43	*0.17*		5.84	2.23	0.06	12.05
Slovenia	0	6.29	*0.28*	0.98	3.50	6.29	4.25	21.31
Latvia	0	11.08		3.09	1.30	5.14	2.69	23.29
Cyprus	0.27	0.21	*0.23*	0	0.76	0.09	0.45	1.77
Canaries (Spain)	0	0.19	*0.20*	6.26	0.07	0	0	6.51
DE (Baden-Württemberg)	0	14.24		2.59	9.98	4.58	0.72	32.10
DE (Brandenburg-Berlin)	0	4.89		21.20	0.63	0.51	2.04	29.27
DE (Hessen)	0	21.81		7.09	9.15	*None recorded*		38.05
DE (Mecklenburg-Vorpommern)	0	7.18		0.38	2.87	3.06	0.14	13.63
DE (Niedersachsen)	0	16.63		3.05	6.61	*None recorded*		26.28
DE (NRW)	0	6.30		0.84	7.31	3.06	2.99	20.50
DE (Rheinland-Pfalz)	0	12.05		1.24	5.10	5.46	1.95	25.80
DE (Saarland)	0	17.95		0.97	7.80	11.13	2.06	39.91

**includes scaled figures from 19 trees >50cm DBH in 10 plots which could have come from anywhere in subplots 1-3. Total excluding these trees is 2.68*

‡ Excludes volume from duplicated information

The great majority of plots (around two thirds) contained less than 10 m^3/ha of deadwood, of which 10% contained no deadwood at all. (Figure 37, Figure 38). However, extremely large volumes of deadwood were recorded at some plots (maximum > 600 m^3/ha on a clear-fell site in the UK).

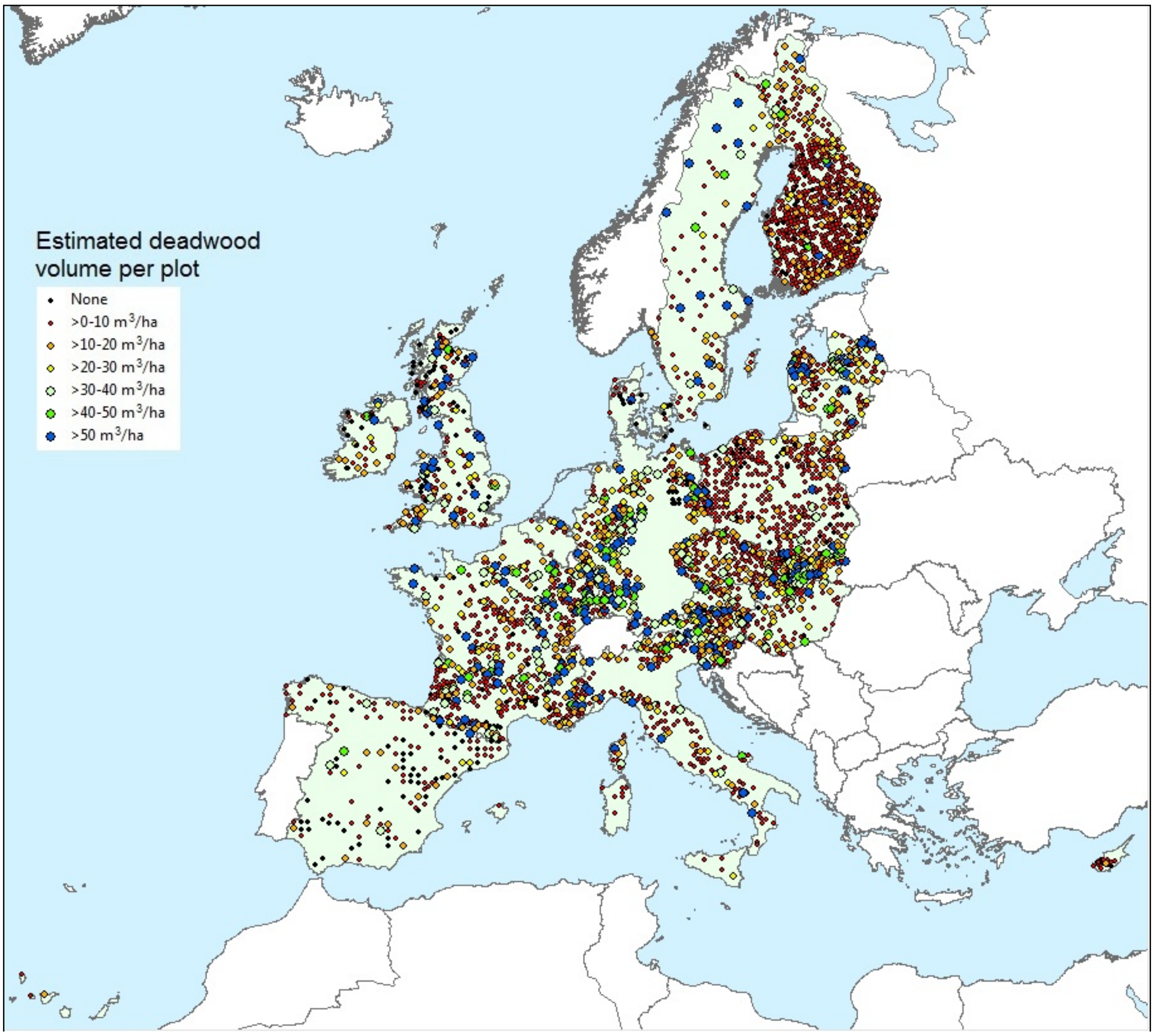


Figure 37: Total estimated deadwood volume per plot expressed in m^3/ha

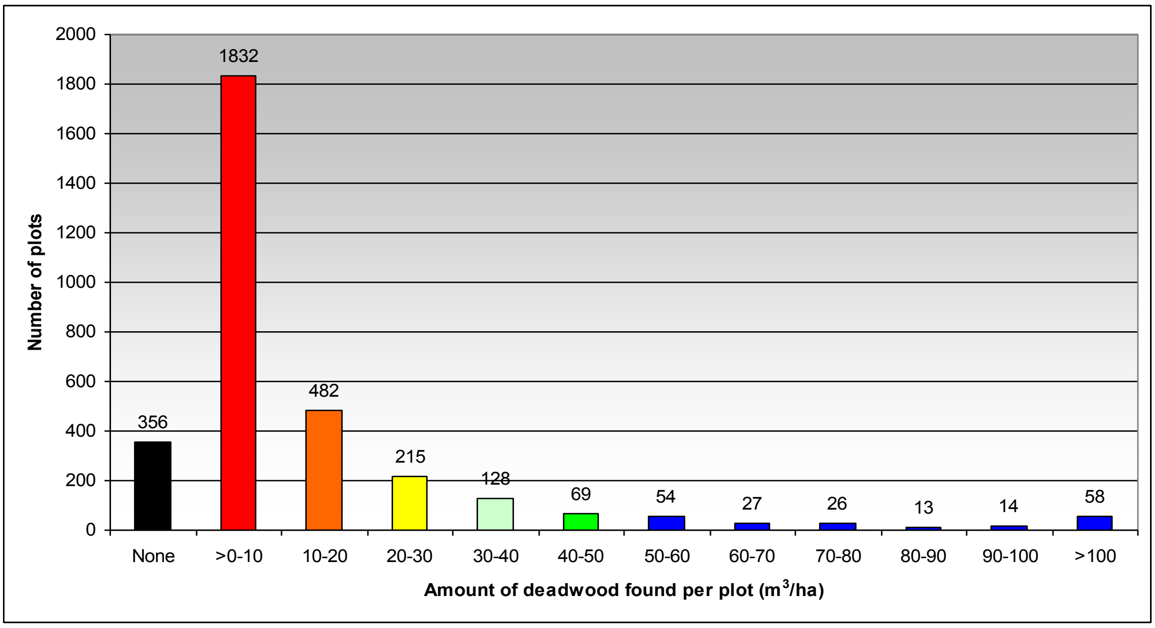


Figure 38: Frequency of occurrence of deadwood volume per plot

Average deadwood volume by country is given in Figure 39. The highest mean values were found in several of the German Länder and Austria. The UK's values are skewed by one extremely high point and would be otherwise similar to France. Around one quarter of the total volume comes from dead standing and lying trees. This is probably an underestimate given the necessarily approximate calculation of dead tree volume.

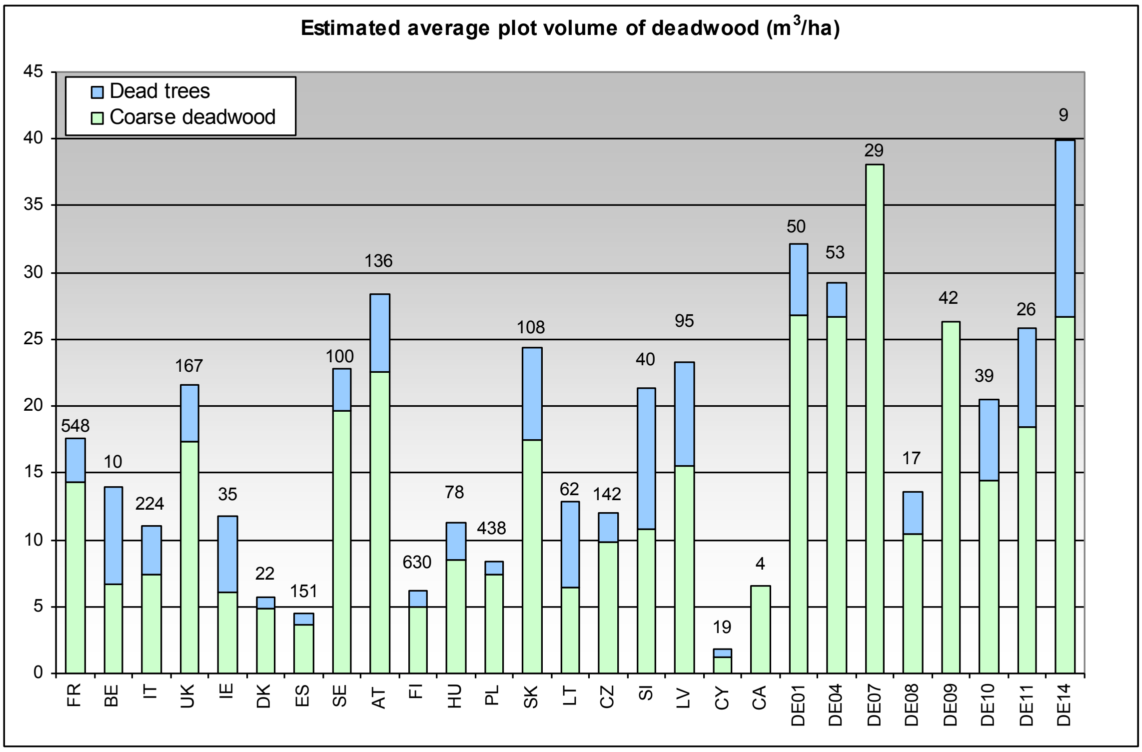


Figure 39: Average volume of deadwood found per plot. Numbers above the bars give total number of plots assessed.

7.5 Decay class

Deadwood and dead trees were given a 5 point decay classification (Table 20):

Table 20: Decay classes

DECAY	DESC_DECAY
1	No evidence of decay
2	Solid wood. Less than 10 % changed structure due to decomposition; the wood is solid at its surface. The wood is attacked only to a very small degree by wood decomposing organisms
3	Slightly decayed. 10-25% of the wood has a changed structure due to decomposition. This can be assessed by sticking the wood with a sharp object
4	Decomposed wood 26-75% of the wood is soft to very soft
5	Very decomposed wood. 76% - 100 % of the wood is soft

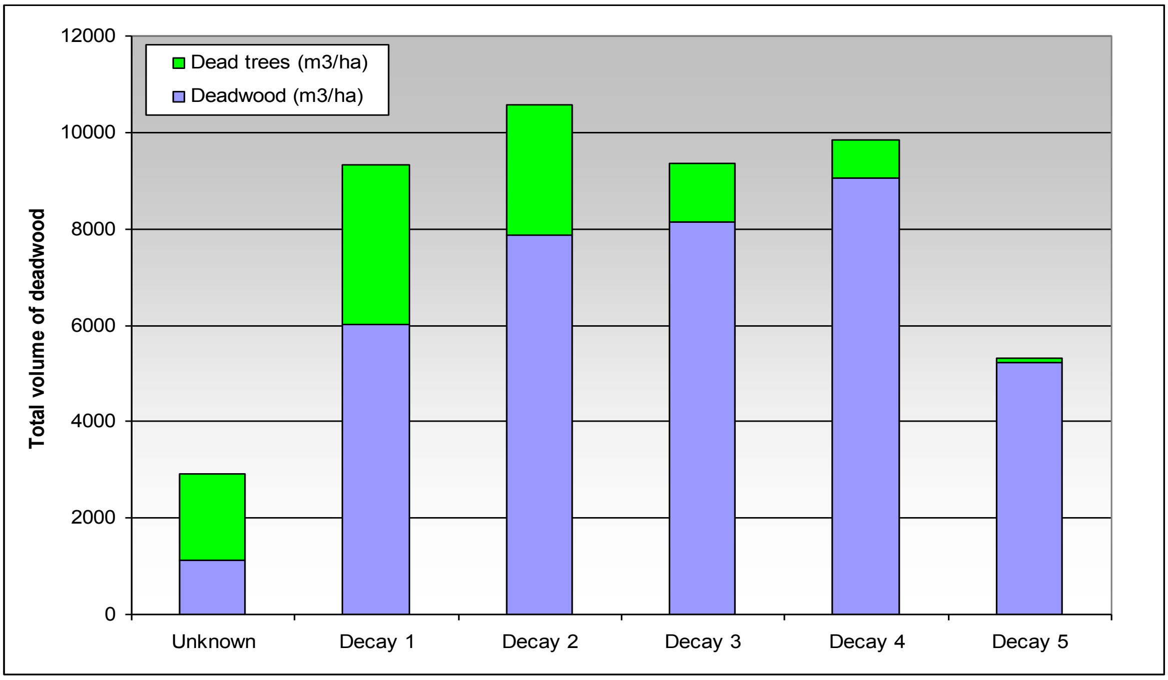


Figure 40: Distribution of deadwood volume by decay class

The proportion of deadwood in each decay class for dead trees (a) and coarse deadwood (b) is shown in Figure 41 below. As expected, the higher deadwood classes (more decayed) are more prevalent in the coarse woody debris while the dead trees are mostly classified in groups 1 and 2 (less decayed).

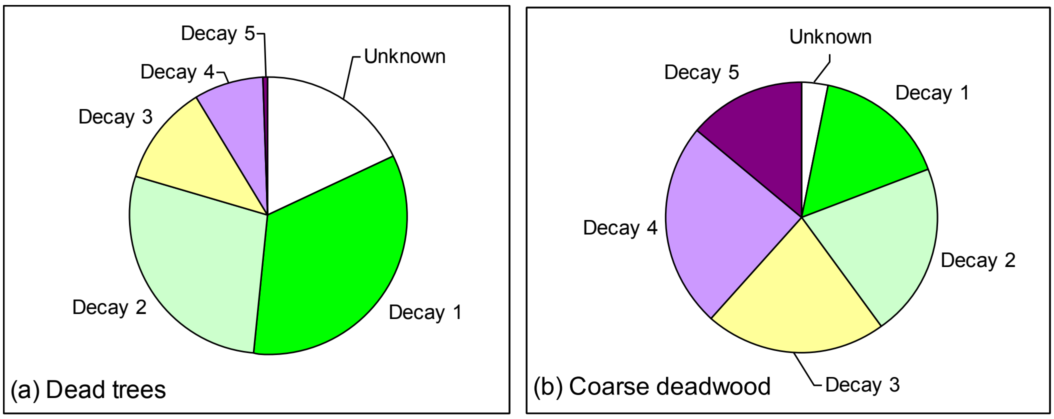


Figure 41: Proportion of deadwood in each decay class

7.6 EFTC

There is a significant relationship between the European Forest Type Classification and the amount of deadwood found in the plots (Figure 42). Plots in forest types 3 (Alpine coniferous forest) and 7 (Mountainous beech forest) contained the most deadwood on average (26 and 25 m^3/ha respectively). Broadleaved Evergreen forest (EFTC 9) contained the lowest amounts (2 m^3/ha). It must be borne in mind that this may also be related to the countries in which the different forest types are found: EFTC 9, for example, was only reported in 4 countries (Table 11).

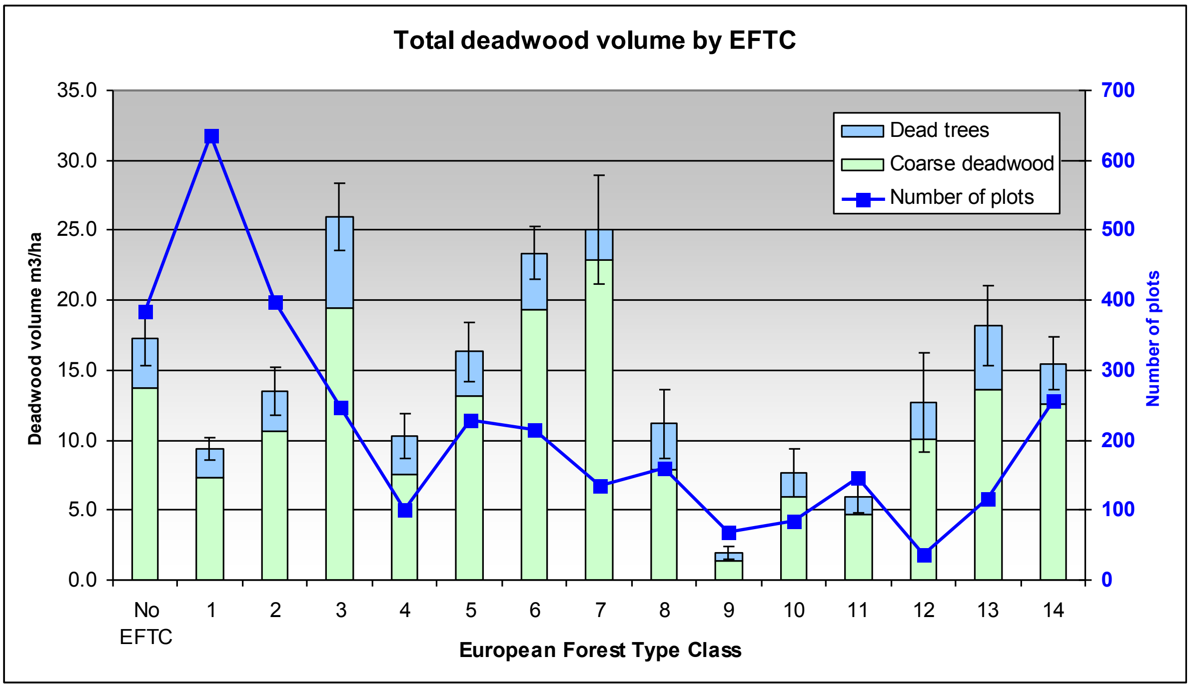
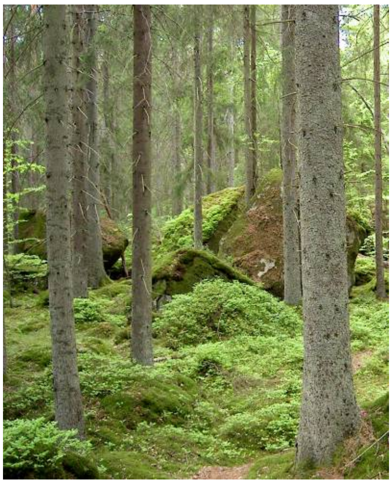


Figure 42: Average amount of deadwood found in each of the European Forest Type classes. Error bars signify ±1 standard error of the mean total deadwood volume.

8 Ground vegetation



8.1 Plot design and sampling

The specification for sampling Ground Vegetation was given in the manual as follows:

A

> Following the recommendations of the EU/ICP Forest Expert Panel on Ground Vegetation, vascular plant species are assessed across the minimum sampling area of 400 m2.
>
> Vascular plant species are assessed by a full sampling within the inner subplots 1 and 2. Species are described according to the Flora Europaeae and the species codes found in the Manual are used.

An alternative method of selecting the 400 m^2 was given in the Annex:

B

> Optionally, for the specific surveys of ground vegetation and coarse woody debris within the BioSoil biodiversity plot, 4 **randomly selected** squares of 10 m x 10 m (so called random sampling units a, b, c and d) may be established within the 2000 m^2 plot.

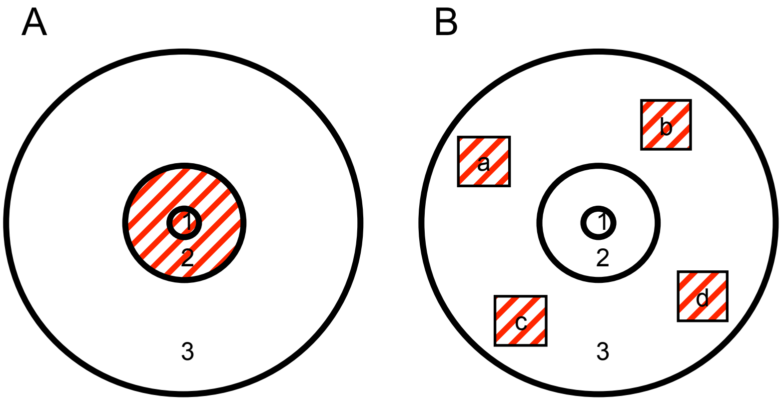


Figure 43: Sampling areas for Ground Vegetation survey.

The sample layouts used by each country are summarised in Table 21. All adhered to a total sampling area of 400 m^2, with most using layout **A**. Italy was the only country to use layout **B**. Three German Länder used slight variations of plot shape which came to the same overall total area. Spain and the UK also reported species from subplot 3. For the purpose of consistency, species recorded in subplot 3 but not in the other subplots are not included in the country comparisons. A separate investigation of the species in subplot 3 is given in Box 1 below.

Table 21: Sampling layouts used by each country for Ground Vegetation assessment

Country	Method used
AT, BE, DE02, DE04, DE10, DK, FI, FR, HU, LT, LV, PL, SI, SK	**A** (subplots 1 and 2 reported together as a single entity)
CY, CZ, DE01, DE08, IE	**A** (subplots 1 and 2 reported separately)
ES (including Canary Islands), UK	**A** (subplots 1 and 2 reported separately) plus data from subplot 3
IT	**B** (subplots a,b,c,d reported separately)
DE07, DE09	20x20m permanent marked subplot in the northeast corner of the plot centre
DE11	400sq.m as described in Level II manual of ICP-Forests
DE12, SE	No GVG assessment

BOX 1: Vegetation assessments in subplot 3

Two countries measured ground vegetation in subplot 3. In neither case was it stated whether the entire $2000m^2$ was covered or whether only a part was assessed. Of the 21 UK plots that gave information about species composition in subplot 3, extra species (i.e. not found in subplots 1 or 2) were recorded in 16. Spain had also made assessments in subplot 3. In this case extra species were found in 62 of the 151 plots assessed. There was no significant relationship found between the number of species in the original sampling area and the number of extra species recorded. Between 0 and 10 more species were found in the third subplot, totalling 121 species. Of these, 11 (all in Spain) occurred only in these subplots and were not found anywhere else in the survey (Table 22).

Table 22: Species found only in subplot 3

CODE	FAMILY	GENUS	SPECIES
193.087.016	Gramineae	Agrostis	delicatula
080.035.020	Rosaceae	Prunus	lusitanica
154.022.001	Scrophulariaceae	Hebe	salicifolia
193.004.042	Gramineae	Festuca	Ampla
183.048.999	Liliaceae	Asparagus	sp.
081.038.061	Leguminosae	Astragalus	granatensis
169.056.001	Compositae	Santolina	oblongifolia
193.004.154	Gramineae	Festuca	Indigesta
151.032.005	Labiatae	Origanum	majorana
185.006.017	Amaryllidaceae	Narcissus	triandrus
088.001.999	Rutaceae	Ruta	sp.

8.2 Data quality and limitations

Cover scores

The COVER score was not consistently applied between countries. The manual requested only percentage cover with no specific recommendation as to which method should be used (e.g. Braun-Blanquet). Consequently a variety of different scales were applied and several countries gave no indication of cover at all (Table 23). Therefore, only species richness is presented for the ground vegetation species, and other scores of diversity (e.g. Simpsons, Shannon, etc) could not be calculated for these data.

Table 23: Percentage cover scores reported by country

Country Name	Score Type	Cover scores used in GVG data
France	Class	0,25,50,75,100
Belgium (Flanders)	Class	0,1,2,4,5,8,13,20,30,50,60,90,98
Italy	Percentage	0.01-100 (but some plots conversion from BB score)
United Kingdom	Class	5,10,15,20,50,75
Ireland	-	-none-
Denmark	-	-none-
Spain	Class	5% classes
Sweden	-	-no GVG data-
Austria	-	-none-
Finland	-	-none-
Hungary	-	-none-
Poland	Score conversion	0.1, 1, 2.5, 15, 37.5, 62.5, 87.5
Slovak Republic	Percentage	0.01-100
Lithuania	-	-none-
Czech Republic	Score conversion	0.01, 0.5, 2.5, 10, 20, 37.5, 62.5, 87.5
Slovenia	Score conversion	0.01, 0.5, 2, 4, 8.8, 18.8, 37.5, 62.5, 87.5
Latvia	-	-none-
Cyprus	-	-none-
Canaries (Spain)	Class	2,3,5,then 5% classes
Germany (Baden-Württemberg)	Score conversion?	3,10,20,38,63,88
Germany (Bavaria)	Score conversion?	0.1, 0.5, 2,3,4,10,20,31.75, 43.75, 62.5, 82.5
Germany (Brandenburg-Berlin)	Percentage	0-100
Germany (Hessen)	Class	0.5, 1,2,3,4,5,6,8,10, then 5% classes
Germany (Mecklenburg-Vorpommern)	Percentage	1-100
Germany (Niedersachsen)	Class	1,2,3,4,5,8,10,12,15, then 5% classes
Germany (NRW)	Class	0.0.5, 1,2,3,4,5,6,7,10, then 5% classes (except 1x83, 1x87)
Germany (Rheinland-Pfalz)	Class	1,2,3,4,5,8,10,12,15, then 5% classes (except 1x77)
Germany (Saarland)	-	-no GVG data-

Species assessed

The requirement was to assess all vascular species in the plots. However, FR, UK, PL, LT, CZ and DE (all Länder) additionally assessed bryophytes, and FR, PL, CZ and DE02 also assessed some lichens. 187 species of bryophytes and lichens were assessed in a total of 1289 plots. These came from 45 familes of which the most prevalent found in the countries making the assessments were Hypnaceae, Polytrichaceae and Dicranaceae (Table 24).

For the analyses of ground vegetation species at European level, lichens and bryophytes are excluded for consistency over the entire survey.

Table 24: assessment of bryophytes and lichens in 6 countries

Family	Number of species within family	Observation frequency
Hypnaceae	17	1295
Polytrichaceae	9	1000
Dicranaceae	14	959
Brachytheciaceae	22	789
Mniaceae	11	431
Thuidiaceae	3	240
Plagiotheciaceae	9	237
Lichenes	26	157
Bryaceae	5	124
Sphagnaceae	11	91
Fissidentaceae	6	63
Geocalycaceae	2	31
Lepidoziaceae	2	27
Ditrichaceae	1	24
Plagiochilaceae	2	19
Amblystegiaceae	7	18
Ptilidiaceae	1	13
Aulacomiaceae	3	9
Climaciaceae	1	9
Tetraphidaceae	1	9
Calypogeiaceae	3	8
Pottiaceae	2	7
Thamnobryaceae	1	7
Marchantiaceae	1	6
Pelliaceae	1	4
Pterigynandraceae	1	4
Encalyptaceae	1	3
Lophoziaceae	3	3
Neckeraceae	2	3
Anomodontaceae	2	2
Jungermanniaceae	2	2
Radulaceae	2	2
Aneuraceae	1	1
Cephaloziaceae	1	1
Cinclidotaceae	1	1
Conocephalaceae	1	1
Cratoneuraceae	1	1
Funariaceae	1	1
Grimmiaceae	1	1
Leucodontaceae	1	1
Orthotrichaceae	1	1
Pseudolepicoleaceae	1	1
Scapaniaceae	1	1
Schistostegaceae	1	1
Trichocoleaceae	1	1
Total	187	5609

Species codes

Species codes used were from the Flora Europea (ref) with additional species as listed in the ICP-Forests web site and used for the Level II Ground Vegetation survey (ref). It was found that some species could not be fully identified. In these cases, it was possible to report genus level by using the code 999 to replace the final 3 digits of the 9-digit code (e.g. 026.007.999 for an unspecified *Pinus*). Species that could only be identified at family level could be coded using e.g. 026.999.999 and totally unknown species were labelled 999.999.999. This has implications for analysis because incomplete identification will tend to under-estimate the total number of species reported, since two different species of the same genus would be classes together using the same code.

In addition it was found that some countries discovered species in their plots that are not listed in the Flora Europea list. There could be several reasons for this. First, the species name used by the country may be a synonym of a listed species. Second, it may not be a native European species or a hybrid, or for some other reason not included. For the purposes of analysis, all species that were named in the data submission but not found in the code list were checked. If they were found to be synonyms of listed species the appropriate code was added. For "new" species a new code was created (flagged in the database to distinguish it from original codes).

Some plots contained no vascular ground vegetation species. In this case it is difficult to distinguish between situations where results are missing because no assessment was made, and those where the assessment was made but there was nothing to report. Some countries made a note of plots that contained no ground vegetation species. In cases where the situation was ambiguous, countries were contacted and asked to clarify the situation. Plots with no vegetation are included in the maps and figures with zero values; plots that were not assessed or whose status could not be confirmed are left out.

Layer information

The manual supplied 6 possible classes for layer information, although only 2 countries used two of the classes (Table 25). France made an extra distinction between "shrubs" and "upper shrubs", which they defined as "includes tree species that are <9.5cm in diameter but that could normally be higher than 5m at maturity". Slovenia divided all their shrubs into "upper" and "lower" shrubs.
For the purposes of analysis these were all included in the Shrubs category and the classification was reduced to 4 categories. After exclusion of the non-vascular species that some countries assessed very few species remained in the Moss layer. On inspection of the data, the 15 different species reported as belonging to the moss layer could all be included in the Herb layer instead.

Not every country supplied layer information. Austria, Cyprus, Denmark, Hungary, Ireland, Italy and the UK gave no information about layers. Therefore all the following analyses have been made at general plot level.

Table 25: Number of species assessed in each layer by country

COUNTRY	No information	Tree layer	Shrub layer	Herb layer	Moss layer	Lower Shrubs	Upper Shrubs
AT	3295						
BE		19	34	101			
CY	592						
CZ			670	3960	7		
DE	1	750	1313	5932	12		
DK	285						
ES		654	519	1195	1		
FI		2546	3120	13762			
FR		1578	3725	7521			812
HU	432						
IE	278						
IT	17542						
LT		214	220	1292			
LV		261	414	2074			
PL		1066	1801	9102			
SI		209		1727		307	148
SK		275	509	2181			
UK	1982						

<u>Month of assessment</u>

Work was carried out during 2006 and 2007 with a few late plots assessed during 2008. The majority of plots were assessed in the summer, with over 50% of assessments falling in July or August (Figure 44). Some countries visited their plots more than once, and then combined the assessments to a single survey. In these cases only one of the dates was reported.

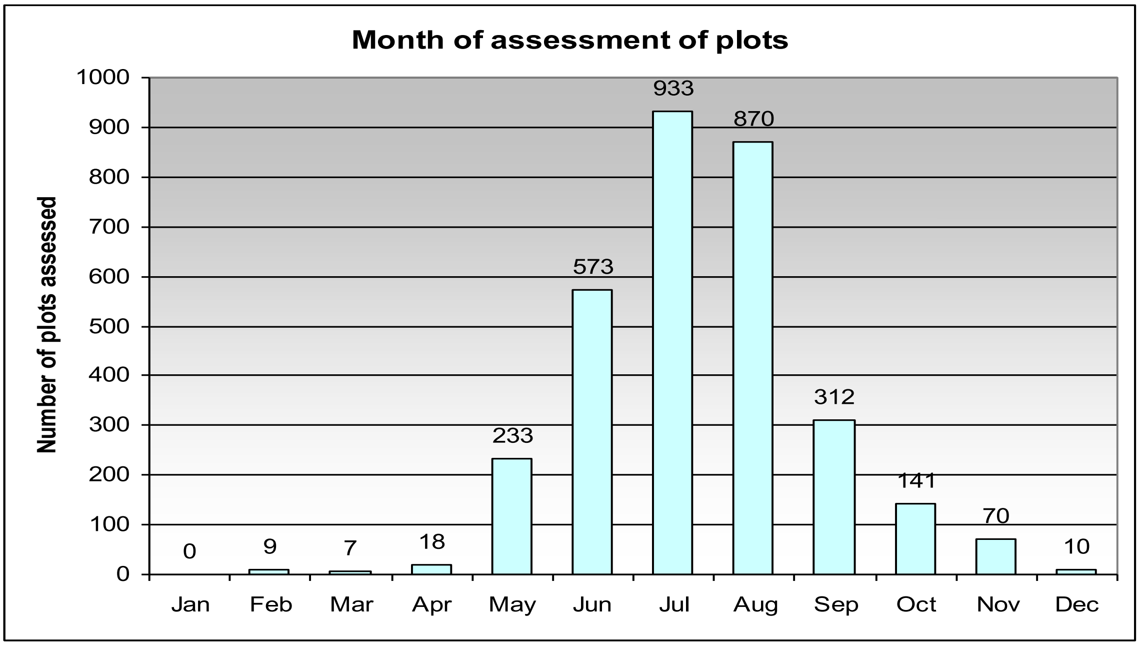


Figure 44: Number of plots assessed by month

8.3 Species richness

Excluding the 187 non-vascular species, a total of 2302 species were recorded across Europe, of which 1072 were endemic to a single country (Figure 45). The pattern of species richness accords with the findings of (Granke, 2006) in the ForestBIOTA study (*Project proposal under Regulation (EC) No 2152/2003 (Forest Focus) for the development of forest biodiversity monitoring (Art 6(2) monitoring test phase)*), with the greatest numbers of species being recorded in Alpine areas. The average number of species per plot was around 24, although the distribution is skewed (Figure 46).

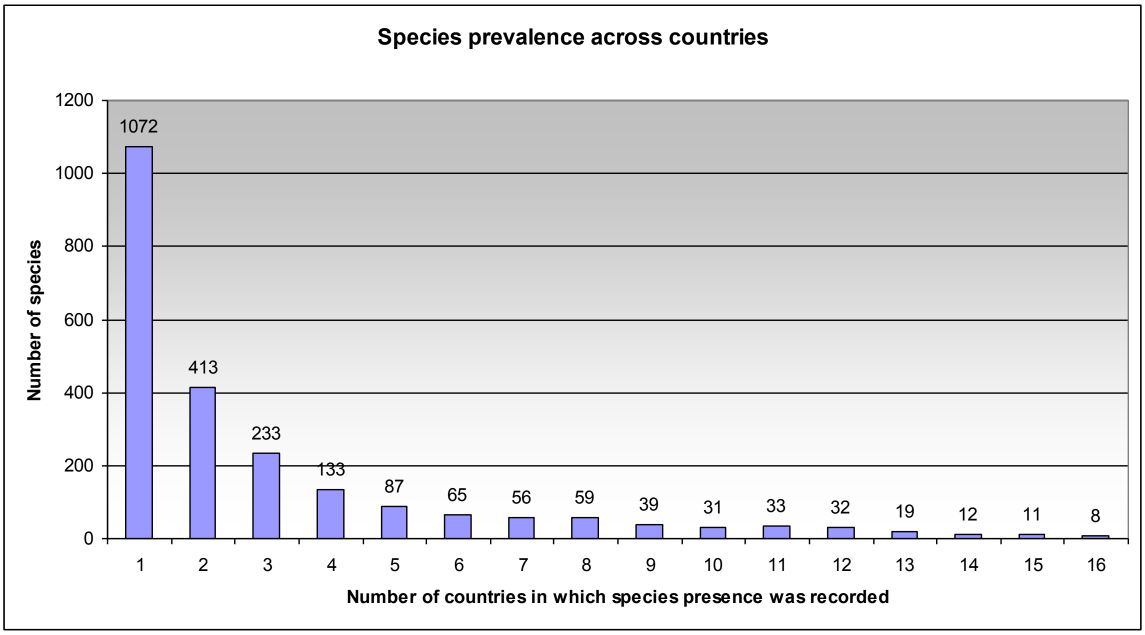


Figure 45: Number of different countries in which a species was reported.

The highest number of species found in a single plot was 111, in Italy. The highest average number of species per plot (49) was recorded in Slovenia. 20 plots had only one vascular species recorded (10 in UK, 4 in DE, 3 in IE and one each in DK, PL and CZ) and 17 plots (mostly in UK and IE) had no ground vegetation cover at all. Figure 47 shows the distribution of vascular species richness.

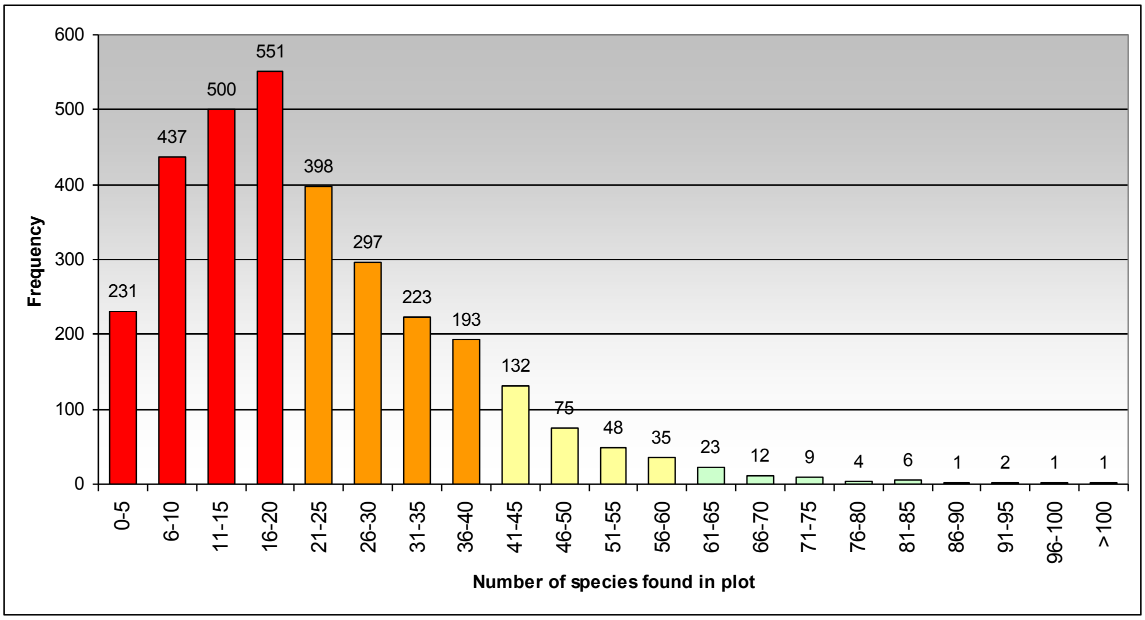


Figure 46: Number of vascular species per plot.

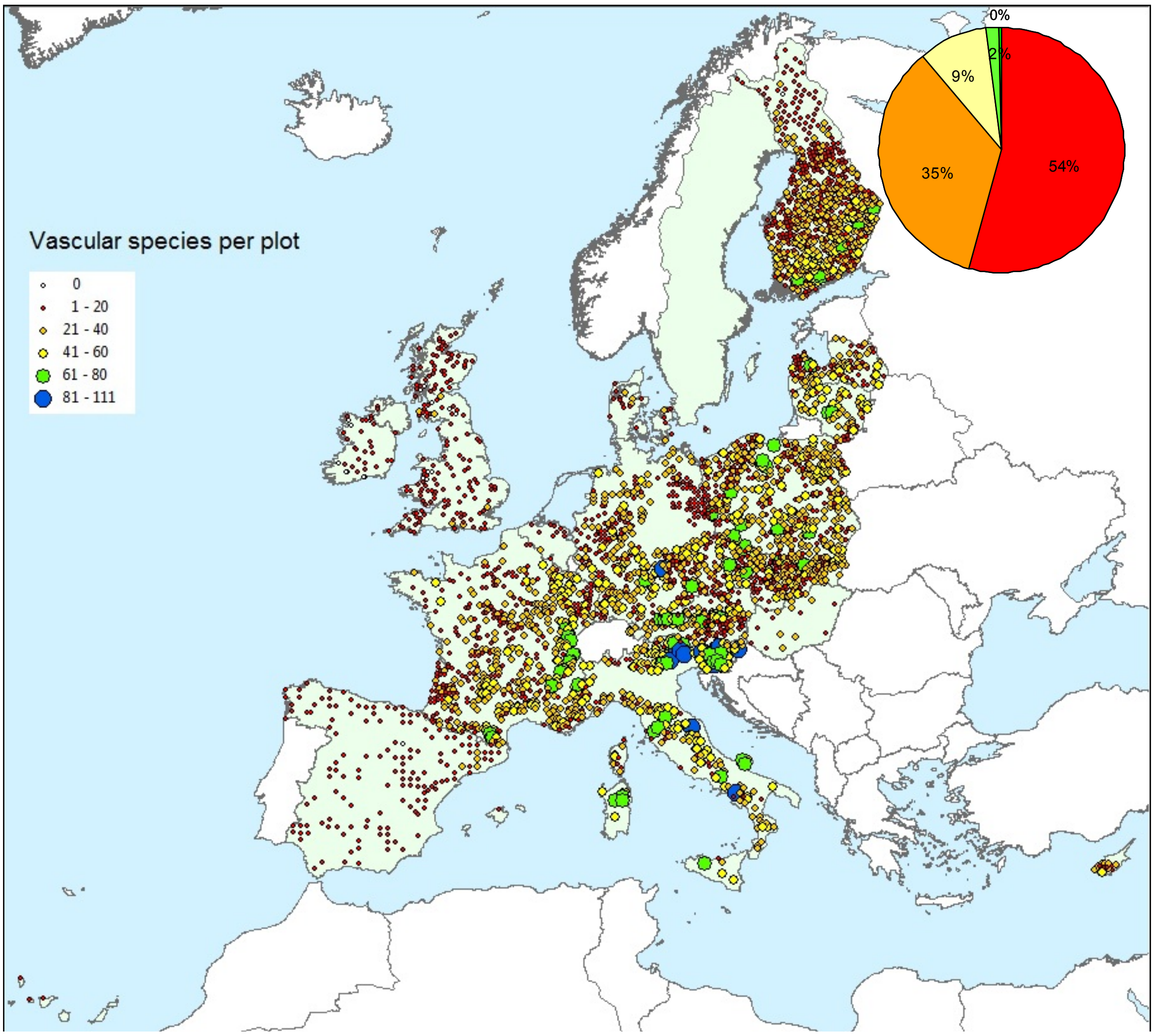


Figure 47: Ground vegetation – vascular species richness

640 species were recorded only once in the database (i.e. found only in one single plot). Both the highest total number of species and the highest number of single occurrences of a species were found in Italy, although relative to the number of assessed plots the highest proportion of single recorded/endemic species were found in Cyprus. At plot level the picture is somewhat different, with Slovenia registering the highest average number of species recorded per plot by a significant margin (Figure 48).

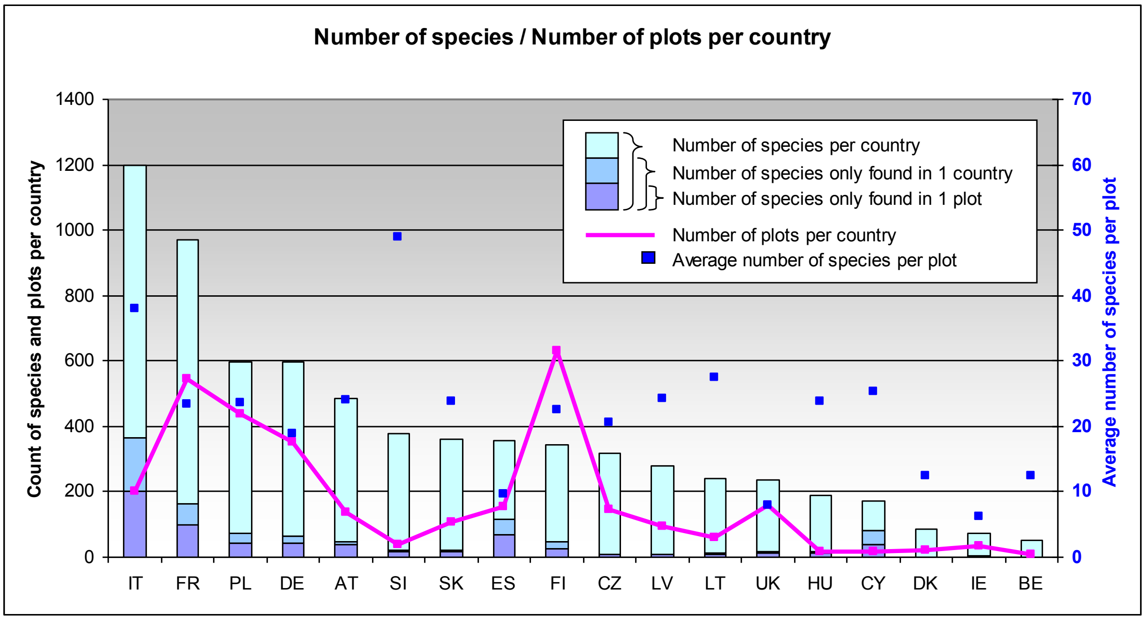


Figure 48: Total number of vascular species found per country compared with total number of plots. Second axis gives the average number of species found in each plot.

With respect to EFTC category, the class associated with the greatest total number of species was Alpine coniferous forest, in which a total of 1020 different species were recorded. The smallest number of species recorded (266) was in floodplain forest, although this is a function of the small number of plots within that forest type. Relative to the number of plots, the lowest total number of species was recorded in boreal forests. At plot level, the greatest average number of species found per plot was in Thermophilous deciduous forest, closely followed by Alpine coniferous forest and Mountainous beech forest. (Figure 49).

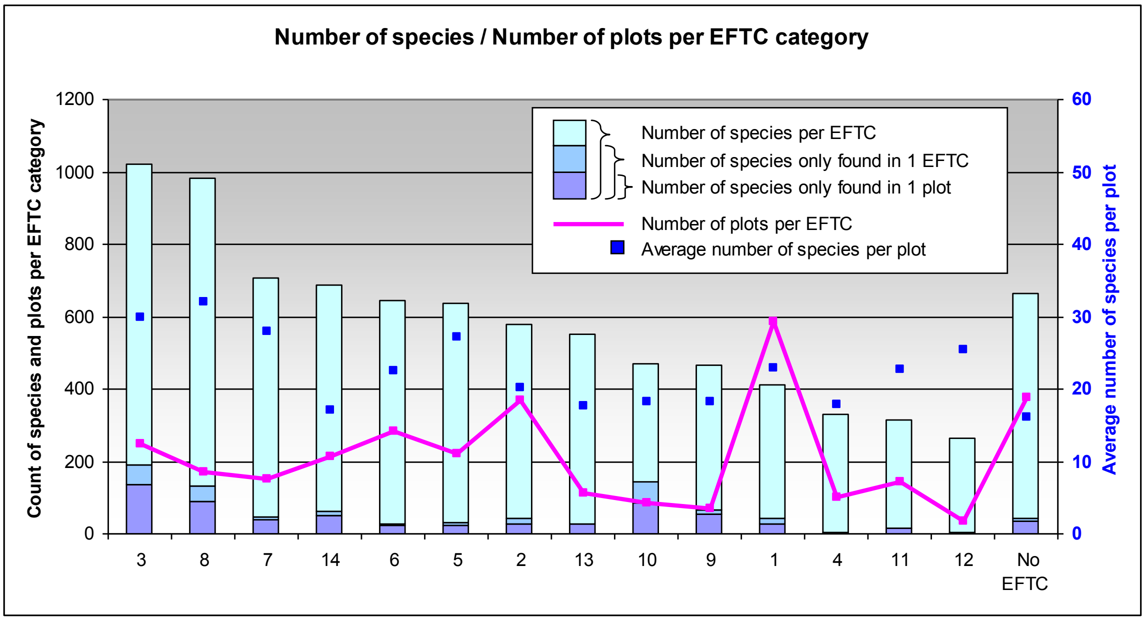


Figure 49: Total number of vascular species found per EFTC category compared with total number of plots. Second axis gives the average number of species found in each plot.

EFTC score	Description	Total number of species	Number of plots
3	Alpine coniferous forest	1020	250
8	Thermophilous deciduous forest	981	169
7	Mountainous beech forest	708	150
14	Exotic plantations and woodlands	686	213
6	Beech forest	646	283
5	Oak-hornbeam forest	636	220
2	Hemiboreal and nemoral Scots pine forest	577	369
13	Native plantations	551	112
10	Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions	469	85
9	Broadleaved evergreen forest	465	69
1	Boreal forest	411	586
4	Atlantic and nemoral oakwoods, Atlantic ashwoods and dune forest	330	101
11	Swamp forest	314	143
12	Floodplain forest	266	34
No EFTC	Missing information (mostly from UK and CZ)	663	378

838 species (37%) could only be found within a single EFTC category, with nearly two thirds covering no more than 3 categories (Figure 50). 8 species were found in every EFTC class.

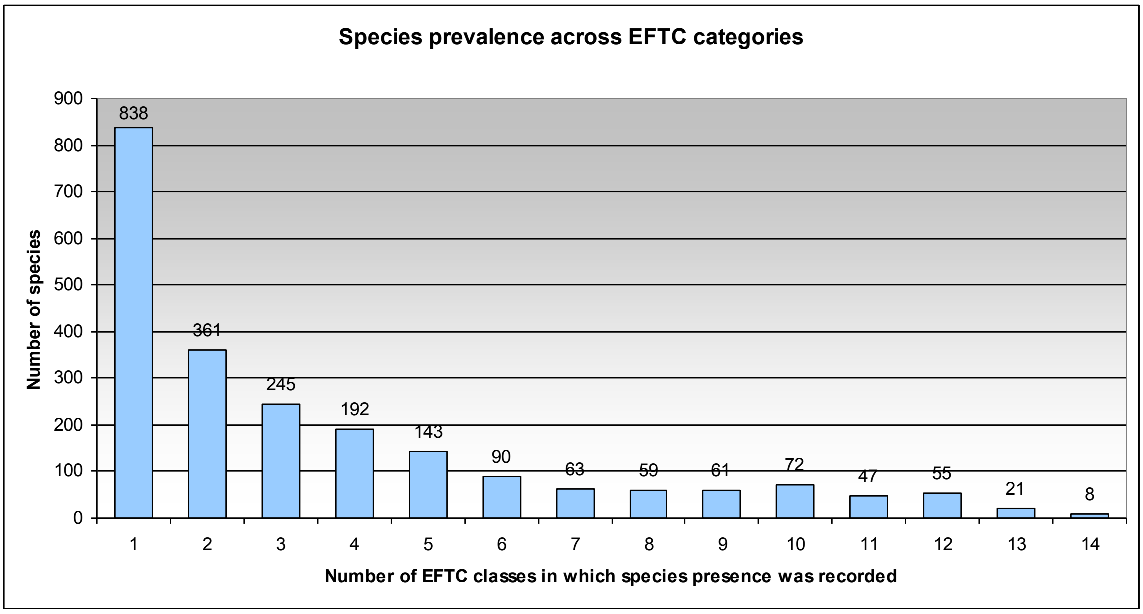


Figure 50: Number of different EFTC classes in which a species was recorded. Plots without any EFTC class assigned are excluded from this figure.

<u>Widespread species</u>

The most frequently reported ground vegetation species was *Vaccinium myrtillus*, which was recorded in 16 of the 19 participating countries and all EFTC classes except type 9: Broadleaved evergreen forest.

If only the total number of plots in which a species is recorded is taken into account, there is a bias towards countries with a lot of plots (e.g. FI). Table 26 shows the total number of plots, the number of countries and the number of different EFTC classes in which the species was observed for those species that occurred in at least 12 countries and in at least 10 forest types. Maps of the distribution of the 40 most frequently occurring species are shown in Appendix 7.

Table 26: Most widespread vascular ground vegetation species (reverse order of plot frequency)

Code	FAMILY	GENUS	SPECIES	Plot frequency	Country frequency	EFTC frequency*
132.018.006	Ericaceae	Vaccinium	myrtillus	1420	16	14
026.004.001	Pinaceae	Picea	abies	1411	13	13
080.028.002	Rosaceae	Sorbus	aucuparia	1312	16	15
026.007.007	Pinaceae	Pinus	sylvestris	1251	16	15
193.074.005	Gramineae	Deschampsia	flexuosa	1216	15	13
019.003.017	Dryopteridaceae	Dryopteris	carthusiana	923	14	13
132.018.004	Ericaceae	Vaccinium	vitis-idaea	885	12	12
034.001.001	Betulaceae	Betula	pendula	876	14	14
080.009.007	Rosaceae	Rubus	idaeus	869	15	13
036.001.001	Fagaceae	Fagus	sylvatica	817	14	12
082.001.006	Oxalidaceae	Oxalis	acetosella	767	15	13
189.002.029	Juncaceae	Luzula	pilosa	750	13	13
036.004.014	Fagaceae	Quercus	robur	701	15	14
183.043.001	Liliaceae	Maianthemum	bifolium	690	12	13
103.004.001	Rhamnaceae	Frangula	alnus	580	14	14
132.003.001	Ericaceae	Calluna	vulgaris	579	16	13
080.021.001	Rosaceae	Fragaria	vesca	579	14	14
128.001.001	Araliaceae	Hedera	helix	551	14	13
169.003.001	Compositae	Solidago	virgaurea	531	12	14
018.001.001	Woodsiaceae	Athyrium	filix-femina	497	15	13
035.003.001	Corylaceae	Corylus	avellana	493	16	13
123.005.001	Onagraceae	Epilobium	angustifolium	491	15	13
015.001.001	Dennstaedtiaceae	Pteridium	aquilinum	483	14	15
031.002.004	Salicaceae	Populus	tremula	480	12	13
193.091.011	Gramineae	Calamagrostis	arundinacea	473	13	12
019.003.001	Dryopteridaceae	Dryopteris	filix-mas	469	13	13
040.001.006	Urticaceae	Urtica	dioica	434	15	13
095.001.005	Aceraceae	Acer	pseudoplatanus	423	12	11
193.087.019	Gramineae	Agrostis	capillaris	411	12	13
193.074.001	Gramineae	Deschampsia	cespitosa	404	13	14
139.004.003	Oleaceae	Fraxinus	excelsior	385	16	13
080.034.014	Rosaceae	Crataegus	monogyna	378	12	14
169.172.001	Compositae	Mycelis	muralis	376	13	14
035.001.001	Corylaceae	Carpinus	betulus	349	12	11
193.045.001	Gramineae	Brachypodium	sylvaticum	345	15	15
019.003.009	Dryopteridaceae	Dryopteris	dilatata	329	12	12
031.001.041	Salicaceae	Salix	caprea	322	12	13
193.026.001	Gramineae	Dactylis	glomerata	318	16	15
164.001.002	Caprifoliaceae	Sambucus	nigra	308	12	12
183.042.001	Liliaceae	Convallaria	majalis	299	13	13
083.001.037	Geraniaceae	Geranium	robertianum	296	14	15
193.016.027	Gramineae	Poa	nemoralis	287	14	13
199.012.064	Cyperaceae	Carex	sylvatica	277	14	12
151.012.001	Labiatae	Lamiastrum	galeobdolon	270	13	13
061.014.001	Ranunculaceae	Anemone	nemorosa	249	13	13
057.002.002	Caryophyllaceae	Moehringia	trinervia	243	12	14
144.005.010	Rubiaceae	Galium	odoratum	242	13	11
080.017.009	Rosaceae	Geum	urbanum	235	13	14
193.113.001	Gramineae	Molinia	caerulea	233	15	14
193.102.001	Gramineae	Milium	effusum	221	14	13
164.006.008	Caprifoliaceae	Lonicera	xylosteum	216	12	13

Code	FAMILY	GENUS	SPECIES	Plot frequency	Country frequency	EFTC frequency*
080.019.052	Rosaceae	Potentilla	erecta	215	15	13
080.035.014	Rosaceae	Prunus	avium	210	12	11
080.035.008	Rosaceae	Prunus	spinosa	210	12	13
144.005.132	Rubiaceae	Galium	aparine	195	13	14
189.001.012	Juncaceae	Juncus	effusus	194	13	13
110.001.018	Violaceae	Viola	riviniana	186	13	12
154.021.030	Scrophulariaceae	Veronica	chamaedrys	184	12	12
109.001.054	Guttiferae	Hypericum	perforatum	183	13	13
087.004.006	Euphorbiaceae	Mercurialis	perennis	182	12	13
061.019.006	Ranunculaceae	Ranunculus	repens	159	16	11
183.046.004	Liliaceae	Polygonatum	multiflorum	158	13	13
080.010.018	Rosaceae	Rosa	canina	158	12	13
169.173.030	Compositae	Taraxacum	Officinale	157	12	12
095.001.001	Aceraceae	Acer	platanoides	153	14	11
123.005.008	Onagraceae	Epilobium	montanum	152	15	12
061.015.001	Ranunculaceae	Hepatica	nobilis	152	13	11
057.006.006	Caryophyllaceae	Stellaria	holostea	144	12	13
080.035.017	Rosaceae	Prunus	padus	137	12	11
151.016.024	Labiatae	Stachys	sylvatica	130	13	13
123.002.001	Onagraceae	Circaea	lutetiana	129	12	12
034.002.002	Betulaceae	Alnus	glutinosa	129	12	13
129.026.001	Umbelliferae	Aegopodium	podagraria	124	12	12
154.008.018	Scrophulariaceae	Scrophularia	nodosa	118	13	12
193.004.008	Gramineae	Festuca	gigantea	113	12	12
164.002.001	Caprifoliaceae	Viburnum	opulus	104	12	12
057.006.001	Caryophyllaceae	Stellaria	nemorum	86	12	11
081.051.001	Leguminosae	Lathyrus	vernus	79	12	10
151.021.003	Labiatae	Prunella	vulgaris	76	12	12
169.118.060	Compositae	Cirsium	arvense	69	12	12
193.087.022	Gramineae	Agrostis	stolonifera	64	12	13

* *EFTC frequency also includes "unknown" as a 15th category*

8.4 Relationships with other variables

A CART analysis (Classification And Regression Tree) was performed to investigate the relationship of the vascular species richness with other variables. CART is a nonparametric technique that can select from among a large number of variables those that are most important in determining the outcome variable to be explained (Breiman *et al.*, 1984). It is a useful tool in exploratory analysis since it makes no distributional assumptions of any kind, either on dependent or independent variables. The explanatory variables in CART can be a mixture of categorical, interval, and continuous and the analysis is not affected by outliers, collinearities, heteroscedasticity, or distributional error structures that affect parametric procedures. CART also has the ability to detect and reveal interactions in the data set.

The variables used in the analysis were: COUNTRY, C.EFTC, C.FENCE, C.AGE, C.TREEMIX, C.DWREMOV, C.FORTYPE, C.MANAGE, C.ORIGIN, C.PREVUSE, C.ORIENT, plot canopy closure score, plot tree layer score, number of tree species, tree density, basal area/ha and total deadwood volume. The tree was pruned to 9 nodes to show only the most important grouping variables.

Elevation and slope were not included because there were too many missing values. For EFTC, which was not recorded in 2 countries, a dummy value was assigned for the missing values. This allowed all countries to be included, although it also meant that for EFTC classes, UK and CZ were grouped together.

Results are shown in Figure 51. The most important explanatory factor was COUNTRY which formed the primary node. This is interesting as it implies that certain national factors override all others including forest type, management regime, age of forest, etc. This could indicate a difference in assessment protocol between countries or even a difference in the expertise of the people identifying ground vegetation species.

There were three main groups: [BE, DE, DK, ES, IE and UK] with a relatively low number of species, and the other countries which were further split into 2 groups: IT and SI with an average high count of vascular ground vegetation species and all others with intermediate values.

After country, the most important grouping factors were tree density (higher density being associated with lower vascular ground species diversity) and number of tree species present (higher numbers associated with higher vascular species diversity). EFTC was identified as a grouping variable for some plots, with types 3, 5, 12 and 13 (Alpine coniferous forest, Oak-hornbeam forest, Floodplain forest and Native plantations) tending to be associated with relatively higher ground vegetation species diversity for plots in the “low” and “medium” country groups. The other EFTC types showed different relationships depending on tree density and number of tree species.

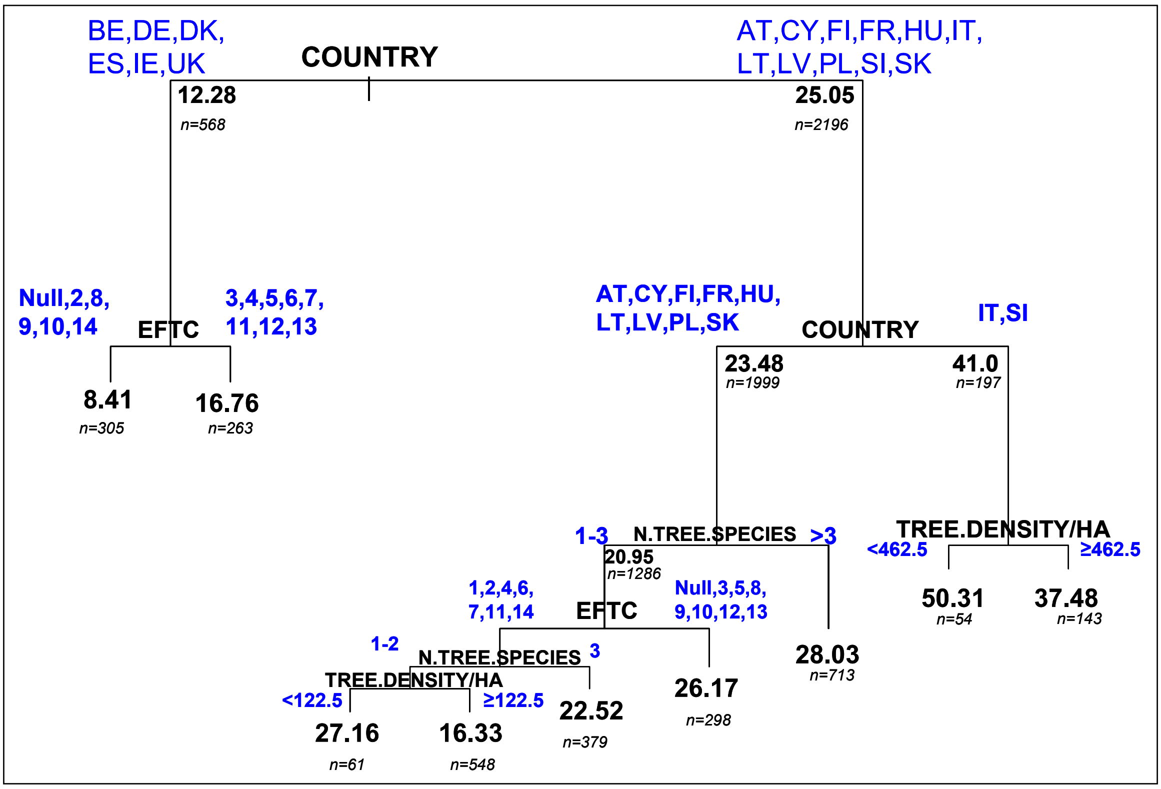


Figure 51: Results of CART analysis. Branch lengths are proportional to node deviance.

9 Sites with high Biodiversity scores

The following maps (Figure 52 -Figure 55) depict those plots that have relatively high scores in terms of a) number of tree species; b) number of ground vegetation species; c) amounts of coarse woody debris and d) number of distinct tree layers.

Figure 52: Plots containing at least 8 tree species

Figure 53: plots containing at least 60 vascular ground vegetation species

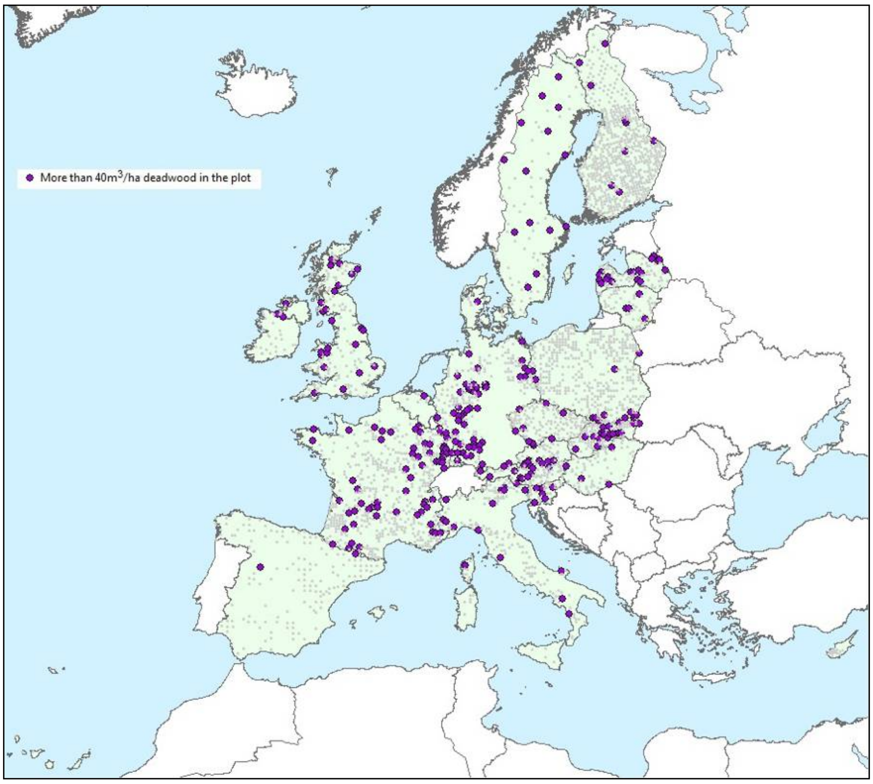


Figure 54: Plots containing more than 40 m3/ha coarse deadwood

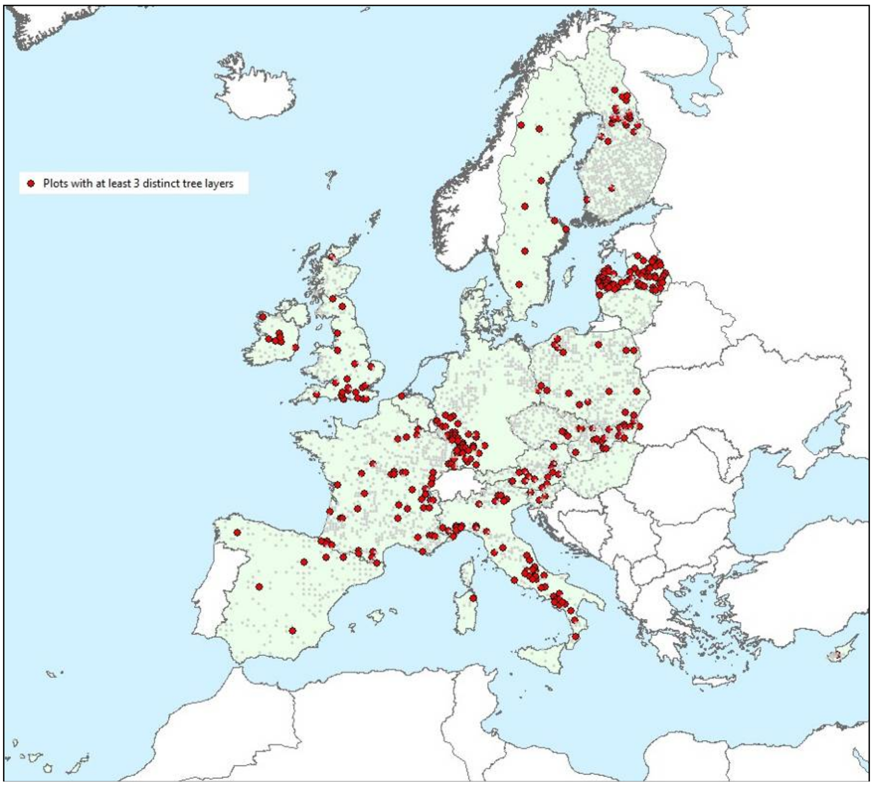


Figure 55: Plots containing at least 3 distinct tree layers

10 Conclusions and recommendations

As a test of practical indicators of forest biodiversity the project was largely successful, although some differences in methodology between countries became apparent during the evaluation, and should be addressed for future similar surveys.
Several of these issues could be addressed by clarifications to the BioSoil Biodiversity Manual, which was produced especially for the study as one of the stated objectives of the project. For future similar campaigns the following recommendations should be considered:

General

- Geo-referencing of the plots was an issue. Most countries used different projections, which required harmonisation. Some gave measurements that were rounded because of Data Protection issues. This must be born in mind for any analysis that attempts to link other spatial information with these data.
- The size, shape and use of subplots should be clarified. Not every country used the same design for subplots. Some countries designated trees into subplots according to their size rather than their spatial position in the plot. Others used different shaped subplots that added up to the same area as the BioSoil subplot. The impact of different sampling designs at sample plots (e.g. use of subplots: size, shape and location) should be investigated to ascertain whether they constrain proper comparisons of results.
- There is currently no agreed written protocol in place for dealing with plots that fall on non-homogeneous land. Some countries recorded in their data when the situation occurred, but with no consistency between countries it is not possible from these data to evaluate the best way of dealing with the situation.
- Measurements that were not made or where the answer is not known should be indicated with a blank (null value). Plots that were assessed but where the relevant parameter was not present should be indicated in the data in such a way as to distinguish them from cases in which the plot was not assessed.

Structural biodiversity

- The specification of integer centimetre values for the diameters of trees proved too crude and consequently the DBH measurements for a number of small trees rounded down to zero. The agreed precision to which variables are reported should be checked to ensure that it is sufficient. Rounding down to zero should be avoided wherever possible. The use of 0 should be reserved only for cases where the variable is a measured zero (e.g. number of trees, sample percent).
- Trees that are measured for height should always also be measured for DBH, regardless of whether they exceed the normal threshold for DBH sampling in that subplot.

Deadwood

- Significant difficulties were caused by the possibility to assess dead trees either in the DWD survey or the DBH survey. This led to different assessment protocols being followed depending on which survey was used to record the information. Since a large proportion (up to 50%) of the total deadwood in a plot could be in the form of dead standing or lying trees, they should be considered together with the rest of the deadwood survey and sufficient measurements made (at least a height or length measurement) to allow a good estimate of volume to be calculated. In this survey the deadwood volumes from dead trees had to be estimated using a value for height that was itself an estimate. This reduces the precision of the result.
- The C_DWTYPE score caused some confusion. Strictly the only necessary piece of information is whether the deadwood is standing or lying, as all the other information

(coarse/fine, stump/snag) can be deduced from the measured dimensions. (However, it had some uses as a crosschecking device during data validation). The deadwood type code could therefore be simplified from the present 5 categories (coarse, fine, stump, snag, other) to 2 (lying, standing) if deadwood dimensions are recorded. The more detailed deadwood type score is only necessary in cases where the actual size of the deadwood is not reported.

Ground vegetation

- The percentage cover assessment for ground vegetation differed in application between countries, making statistical comparisons at EU level difficult. A true percentage score is difficult to achieve, but a common approach (e.g., Braun-Blanquet conversion, 10% classes…) should be agreed for future campaigns.
- Incomplete identification of ground vegetation species (to only genus or family level), and in particular, lack of identification (unknown species) will tend to lead to an underestimate of the total number of species reported, since several unidentified species within a plot may be given the same code. Indeed, some of the differences between plots or countries in terms of species richness may actually be partially explained by differences in expertise in species identification.
- Several species were found that are not listed in the current code list. A common approach to coding these species should be adopted, to avoid the same species being given different codes in different countries.

The main recommendation for future biodiversity monitoring projects resulting from the evaluation is to clarify and simplify procedures wherever possible. Even apparently simple parameters, such as the number of trees in the plot, and percentage cover of vegetation, were sometimes given a local interpretation (which trees to count, what classes to use for cover), that may affect the comparability of the data at European level.

Despite being a demonstration project, the Biosoil Biodiversity project has produced considerable amount of data on vegetation structure and composition across Europe, which can provide a valuable common baseline on forest biodiversity information where changes over time and space can be monitored in the future. This is of particular relevance to the EU biodiversity policy and for the assessment of the new 2020 biodiversity goals.

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12 Appendices

Appendix 1: BioSoil Biodiversity Manual

Appendix 2: Data files and formats

Appendix 3: Biodiversity Data Validation tests

Appendix 4 Height-diameter relationships: parameters

Appendix 5 Height-diameter relationships: curves

Appendix 6 Distribution of the most commonly recorded tree species

Appendix 7 Distribution of the most commonly found ground vegetation species

12.1 Appendix 1: BioSoil Biodiversity Manual

FOREST FOCUS DEMONSTRATION PROJECT
BIOSOIL 2004-2005

THE BIOSOIL FOREST BIODIVERSITY FIELD MANUAL

VERSION 1.0/1.1/1.1A

FOR THE FIELD ASSESSMENT 2006-07

Elaborated by:
Working Group on Forest Biodiversity
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TABLE OF CONTENTS

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INTRODUCTION

The intention of the Forest Focus Regulation (EC) N° 2152/2003 is to broaden the scope of the monitoring scheme from the protection of forests against atmospheric pollution and forest fires towards other environmental issues such as soils and forest biodiversity. Article 6 of the basic act allows the Commission as well as the Member States to carry out studies and demonstration projects for this purpose. The BioSoil project is such a study, which aims to carry out an inventory of soil chemical characteristics and forest biodiversity at the Level 1 plots. This paper concentrates on the forest biodiversity component of BioSoil. The approach outlined was devised following meetings of biodiversity experts from the Member States combined with field testing of the approach and in co-operation with the Joint Research Centre of the European Commission.

Many initiatives are currently taken to estimate the loss of biodiversity in Europe. Efforts to develop guidelines for assessing forest biodiversity have been under way for many years. Several processes like the MCPFE process (Vienna, 2003) and the Convention on Biological Diversity are presenting lists of indicators relevant to forest biodiversity. However, there is still a need to select and test simple and suitable indicators to measure and describe forest biodiversity at stand as well as at European level and there is still no large scale monitoring system of forest biodiversity in Europe.

The existing Level 1 survey of the monitoring programme represents an option for such a large scale monitoring system. The Level 1 survey is a systematic network based on a 16km x 16km trans-national grid of sample plots and as such represents a statistically unbiased sampling tool for European forests. It should also be stressed that the Level 1 survey does not aim and has not been designed to be a comprehensive forest biodiversity survey, but represents a unique opportunity to examine selected parameters of biological interest in forests at the European level.

The BioSoil initiative represents this opportunity to assess and demonstrate the efficacy of the Level 1 network, as a representative tool of European forests and to address other issues of relevance to European forestry such as forest biodiversity with the addition of a few assessment variables. The approach adopted is known as the stand structure approach, which assumes an increased potential for biological diversity with increasing complexity of the forest stand. This approach is complemented with the addition of biological data such as information on the ground vegetation community.

Objectives of BioSoil Biodiversity

The overall objectives of the biodiversity component of BioSoil are to make an inventory of components of forest biodiversity such as forest structure and species diversity using the Level I systematic network.

The BioSoil project will provide data to support both international and national policy on forest biodiversity, by:

- Conducting a **demonstration study** to collect harmonised information relevant to forest biodiversity at the European level and demonstrate the use of the Level 1 network in this context;
- Presenting a European forest type classification of the Level 1 plots and **provide a first attempt at habitat classification** of the forests of Europe
- Testing selected, internationally recognised, robust and practical indicators of forest biodiversity on a large scale survey thereby to develop a practical methodology as a manual.
- Establishing an improved common baseline framework to integrate other information and ongoing projects (including the soil initiative of BioSoil) on forest biodiversity to achieve maximum added value;
- Designing a multi-scale hierarchical approach to quantify European forest biodiversity and monitor changes over time and space;

BioSoil sampling approach

The sampling approach of the biodiversity component of BioSoil includes the following surveys;

- Plot design:
    - BioSoil sampling plot design
    - Geo-referencing of the plot using a common projection
- Forest type classification
    - Verification of actual forest type
- Structural forest diversity
    - Diameter at breast height and species composition of all woody plants (including standing and lying trees, living and dead))
    - Coarse woody debris, snags, and stumps)
    - Canopy closure and tree layering
- Compositional forest diversity
    - Ground vegetation (vascular plant species list)

Time schedule

The project is foreseen to follow the time schedule outlined below in Table 1.

Table 1: Work plan of the BioSoil biodiversity study

Project period: From: 01.01.2006 To: 31.12.2007	2006				2007			
Main activities over the project period	1	2	3	4	1	2	3	4
Preparation, training	x	x						
A workshop including a pre-field sampling to ensure a harmonised approach for the project		x						
Field assessment of the selected parameters		x	x	x	x	x	x	
Data management and reporting								x

THE BIOSOIL BIODIVERSITY FIELD MANUAL

Introduction

The manual of crown condition assessment gives detailed instructions of crown condition plot establishment and operation. Despite this, although annual surveys of crown condition are conducted at the Level 1 sampling points across Europe, different countries may operate different sampling configurations of the crown condition sample trees. This leaves many countries operating at a point sample level rather than at a plot sample level of known and fixed area.

For the purposes of this demonstration project on BioSoil biodiversity, components of forest biodiversity will be sampled across a known plot of fixed area with the plot location being related to the location of the crown condition survey and to the soil pit of the soil survey of BioSoil.

BioSoil plot installation

The basic BioSoil plot is devised as a circular plot with a radius of 25.24 m (2000 m^2) divided into three circular subplots: an outer subplot (subplot 3) with a radius of 25.24 m (2000 m^2) and including 2 inner circular subplots with fixed radii of 3.09 m (30 m^2, subplot 1) and 11.28 m (400 m^2, subplot 2); see Figure 1.

It is recommended that the BioSoil sampling plot is located in relation to the location of the crown condition assessment and the soil pit of the soil component of the BioSoil project in such way that the soil pit should be within the 2000 m^2, but where possible outside the boundaries of the subplots 1 and 2.

The ground vegetation, forest deadwood surveys, and canopy characteristics, are conducted in the BioSoil subplots 1 and 2 only.

Optionally random sampling units can be established: see Annex 1.

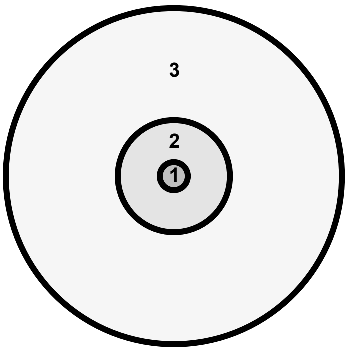


Figure 1: ***The basic BioSoil plot.*** *Coarse woody debris, snags, stumps, ground vegetation and canopy characteristics are measured in the BioSoil subplots 1 and 2 (a total sampling area of 400 m2). Tree species and DBH (diameter at breast height 130 cm) are recorded across the entire BioSoil plot.*

Slope correction

Where the BioSoil plot occurs on steep slopes, slope correction factors must be used.

Clarification:

For plots on flat ground, the radius proposed above can be used. Where the BioSoil plots occur on steep slopes, the plot's radius varies, depending on the steepness of the hill, and the plot becomes oval in shape, not circular. The radius of a plot that occurs on sloping ground must be adjusted using trigonometry (secants) or as done by most foresters by using a slope correction table. The slope of the plot can also be measured using a clinometer.

Method of establishment of the plot
It is important to record the exact centre of the plot. This can be done by registration with GPS coordinates, complemented by simple maps and azimuth along with distance assessments to allow for a precise location of the plot. The plot centre is marked using e.g. a metallic bar (inert material is recommended) driven into the ground, (down to the surface of the forest floor in order not to disturb works or traffic in the forest). The geo-referencing is mandatory to the project, using GPS registration whenever possible.

It is also recommended to draw simple diagrams, and to take photos of the plot to assist possible future plot relocation. The diagrams should include several identifiable elements (road, large tree, rivulet, etc) to help to find the plot again if the GPS registration has not been satisfactory or if the metal pin has disappeared.

Also if there are clear features and characteristics of the plot which may help in the evaluation of the data such as big rocks, rivulets, trails, forest edges, changes in plant communities, it is recommended to make a sketch of these features.

Table 2: *The basic BioSoil circular plot of 25.24 m radius consists of 3 subplots of different radii.*

Unit	Shape	Radius*/(area)
Subplot (1)	Circle	3.09 m (30 m^2)
Subplot (2)	Circle	11.28 m (400 m^2)
Subplot (3)	Circle	25.24 m (2000 m^2)

*distance from the centre of the plot.

Geo-referencing of the plot centre and of the soil pit(s)
The geographic location of the BioSoil plot centre is determined using a GPS receiver. All GPS readings must be differentially corrected to yield an accurate position and elevation. The location of the soil pit must also be geo-referenced.

The BioSoil plot location must be geo-referenced using a common European projection. The ETRS89 Lambert Azimuthal Equal Area Coordinate Reference System (ETRS-LAEA) is recommended being the geodetic datum for pan-European spatial data collection, storage and analysis (Annoni *et al*., 2003). If another system is used, it is mandatory to submit datum and projection in order to make a conversion to ETRS-LAEA possible by the European Commission.

Method
The GPS coordinates are read using the GPS equipment and are noted on the forms **without** decimals. For an exact assessment of the coordinates in the centre of the plot at least 10 (preferably 30) data values from contact with at least 3 satellites (ideally 5-7 satellites) must be read (time 1-3 minutes). If the satellites are too close to each other, the measurement is imprecise. The mean of the coordinate measurement is written in the form and eventually also on the simple drawing.

In the event that the plot centre cannot be located, (*i.e.* poor quality or no signal), the GPS can be registered at another point where signals may be received. The distance and azimuth from this point to the plot centre can be measured and thus the plot centre can be located.

Table 3: ***Mandatory minimum measurement in the BioSoil Plot.*** *Tree species and DBH of standing and lying, living and dead trees (H >130 cm) are recorded across the entire BioSoil plot according to the diameter thresholds shown above. Forest deadwood (incl. coarse woody debris (D>10 cm), snags, stumps), ground vegetation (vascular plant species list only), and canopy characteristics are assessed performed in the BioSoil subplots 1 and 2 corresponding to a total sampling area of 400* m^2.

BIOSOIL PLOT ASSESSMENTS AND MEASUREMENTS	Subplot 1 30 m^2	Subplot 2 400 m^2	Subplot 3 2000 m^2
General plot description	Yes		
Check of the European forest type classification	Yes		
DBH and species of all woody plants taller than 130 cm (standing and lying, living and dead)	All trees DBH > **0** cm (taller than **130** cm)	All trees DBH ≥ **10** cm	Only trees DBH ≥ **50** cm
Top height and bottom of canopy layer	Selection of minimum 3 trees		
Coarse woody debris, snags, and stumps	D > **10 cm**	D > **10 cm**	No
Canopy closure (visual)	Yes	Yes	No
Tree layering (visual)	Yes	Yes	No
Ground vegetation – vascular species list only	Yes	Yes	No

General Plot Description

A general description of the Level I plot has been performed according to the description of the EU/ICP-Forests Level 1 plots (UN-ECE, 2004). Under the BioSoil demonstration project, this description is validated in the field.

The following complementary parameters are included:

- the previous land use,
- the origin of actual stand
- the forest management such as thinning and selective felling
- the type of forest
- the removal of coarse woody debris
- the pattern of tree mixture
- the age of the dominant tree layer
- the prevalent slope of plot (prevalent slope of the BIOSOIL plot in percent (%)
- the plot orientation (prevalent orientation of the BioSoil plot in 8 main geographic directions).
- the fencing of the plot

The complementary parameters definitions and codes are found in the reference tables on pages 26-32.

The European Forest Type Classification

An ecologically oriented categorisation of the plots is useful for stratification and interpretation of forest plot information throughout Europe. At present a number of different forest type classifications have been proposed to classify the forests of Europe into broad classes based on EUNIS (European Union Nature Information Scheme) and the BEAR project (Larsson et al., 2001). The forest type classification adopted in the BioSoil biodiversity project follows the TBFRA and EUNIS definitions and uses the same methodology as the expanded BEAR forest type classification (Barbati *et al*., 2004).

A parallel study to BioSoil has classified the Level 1 points into broad forest types based on the main tree species and some few other selection criteria using the existing data of the Monitoring Programme (Chirici et al., 2005). A system using the nomenclature developed by the EEA is used, which classifies Europe into 28 general forest types. This process will allow verification of other systems of forest classification and should also be a very useful tool to permit pre-stratification of the plots at national level for sampling purposes.

The European Forest Type Classification performed in the BioSoil will comprise the verification at the plot level of the pre-assessed forest type classification of the Level 1 (EEA system).

A list of the forest type for each Level I plot of the countries will be delivered by the JRC. Countries will confirm this or supply corrected information at the data entry.

Structural Biodiversity

Forest structure is of interest in biodiversity monitoring due to its use by forest organisms, i.e. habitat range. The measurement of forest structure provides an important, robust and repeatable indicator of forest biodiversity. Structural diversity including tree diameter, tree species composition of all trees on the BioSoil sampling plot, deadwood and canopy characteristics, are assessed on the 16 km x 16 km grid as a minimum requirement of the BioSoil project.

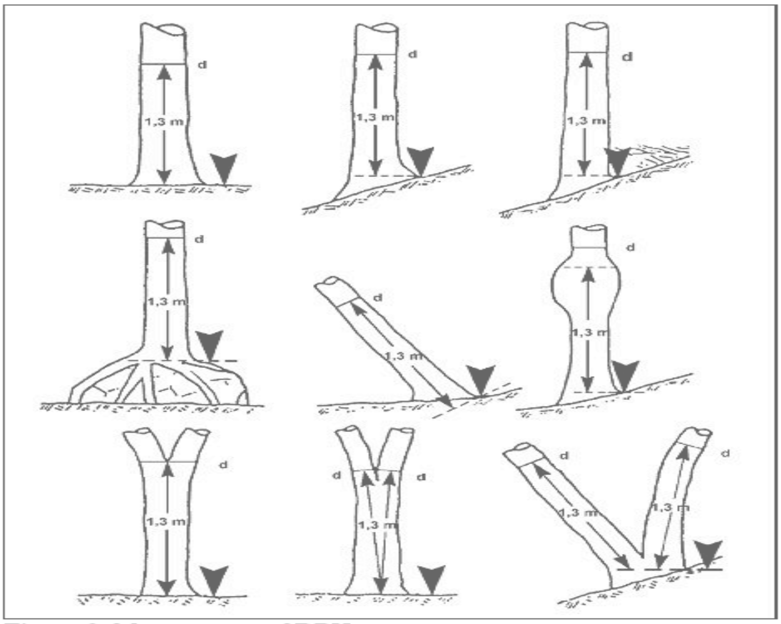
Tree diameter distribution, species composition, tree height, and canopy base

The tree diameter distribution is used to describe the structure of the forest stand. The diameter at breast height (DBH at 130 cm) and the species of all woody plants are recorded on standing and lying, living and dead, trees taller than 130 cm. DBH measurements are recorded across the entire BioSoil sampling subplots 1, 2, and 3 using different diameter thresholds in each of the three sub-plots (see below). Trees are considered to be part of the BioSoil plot if the centre of the stem is inside the sampling plot.

Method

The DBH is recorded in cm only and as follows:

- Subplot 1: DBH > 0 cm and taller than 130 cm
- Subplot 2: DBH ≥ 10 cm
- Subplot 3: DBH ≥ 50 cm



1.

Figure 2: *Guidelines for the measurements of DBH (diameter at 130 cm) in special cases.*

1. Mandatory

- All trees (standing and lying, living and dead) are callipered (or measured by tape) at DBH (130 cm) if the height is greater than 130 cm. Note that snags are only registered in subplots 1 and 2.
- Tree species is recorded for all measured living and dead trees according to the species list.
- Tree status is also recorded: (1: standing living, 2: standing dead, 3: lying dead). For standing and lying dead trees, decay state is also recorded (see p. 14)
- Tree top height and height of base of the canopy layer are measured on a minimum of 3 trees with the largest DBH across the entire BioSoil sampling subplots 1, 2, and 3 and regardless the tree species.

2. Optional

- distance from plot centre to each tree (in meters with 1 decimal)
- azimuth from plot centre to each tree (in degrees 360°)

When measuring 130 cm above the ground, it is not necessary to remove litter; however, measure below any large woody debris (e.g., down logs or branches) that may be at the base of the tree, see **F**.

To ensure that the breast height is precisely assessed, use a pin of precisely 130 cm when callipering the trees with a height of more than 130 cm. DBH is always measured uphill, from the left side of the tree (with respect to the plot centre), perpendicular to the axis of the tree and always with the ruler of the calliper pointing towards the centre of the plot. If there is abnormal growth on the stem at breast height then the calliper is turned or moved to the closest normal place on the stem. The trees may be marked with chalk after being callipered to avoid repetition of the measurement.

Special considerations for the DBH measurements in the inner BioSoil subplot 1, where all trees higher than 130 cm are measured, may arise. Under situations with high stem numbers, because of e.g. coppices or natural regeneration, where DBH measurements become impractical in the field, a proportion of the total may be measured instead of all trees. The total number of trees in the subplot and the sampling fraction used is to be reported, to allow estimates to be made of the structure of the subplot.

Standing and lying dead trees are callipered, whether there is bark present or not. In cases where the breast height occurs on the broken part of a tree, then calliper the tree at this breast height.

Tree height and canopy base measurements
Minimum 3 dominant trees according to the largest measured DBH are selected for tree height measurements using e.g. a clinometer or a Vertex. The base of the canopy layer is also recorded on the same trees.

Forest deadwood

Forest deadwood is an important component of forest ecosystems in providing habitat, nutrients and shelter to a range of forest organisms. Forest deadwood is a recognised indicator of forest biodiversity as it helps to describe the quality and status of habitats, and the structural diversity within a forest. The forest deadwood assessment involves mandatory measuring of standing and **lying dead trees**[4], coarse woody debris (CWD), **snags**, and **stumps**.

Lying deadwood components, with diameter greater than 10 cm, are considered as coarse woody debris (CWD) and are assessed by a full sampling within the subplots 1 and 2. Coarse woody debris (CWD) includes stems, limbs, branches lying on the ground occurring in the inner subplots 1 and 2.

The mandatory inventory of CWD does NOT include woody pieces less than 10 cm in diameter, dead shrubs, self-supported by their roots, trees showing any sign of life, dead foliage, bark or other non-woody pieces that are not an integral part of a stem or limb, roots or main stem below the root collar. When a piece of CWD has irregular diameter along its length, the section under 10 cm in diameter is not considered.

Fine woody debris is measured as an option only using the same approach as CWD but using a 5 cm threshold in this case.

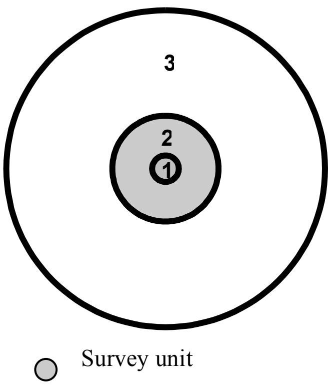


Figure 3: ***Survey units for coarse woody debris, snags, and stumps.***

[4] As standing and lying dead trees are concerned, refer to the chapter "Tree diameter distribution, species composition, tree height"

Method
A **stump** is measured if the centre of the stump is inside the subplots 1 or 2, if stump height (or length if lying) is less than 130 cm from the base and if the diameter at cut is greater than 10 cm. The height (or length if lying) of the stump is measured from stump base until the point where the tree was cut (or where the stem has broken off). The stump diameter is measured at cut height.

A **snag** is defined as a standing deadwood without branches, with a height greater than 130 cm and with a DBH greater than 10 cm (DBH > 10 cm). **If branches are present,** the snag is considered as **standing dead tree** and should be measured with respect to diameter threshold in subplots 1, 2, and 3 (DBH at 130 cm, see Table 3 and refer to the chapter "Tree diameter distribution, species composition, tree height"). **If branches are absent** and if the centre of the snag is inside the subplots 1 or 2 then **snag height and diameter** at half snag height are recorded. Diameter mensuration can be done callipering the snag at 130 cm and visually adjusting the recording to the midpoint of the snag with respect to the 10 cm diameter threshold (**F**). **If the snag is less than 130 cm** in height it is considered and measured as a **stump.**

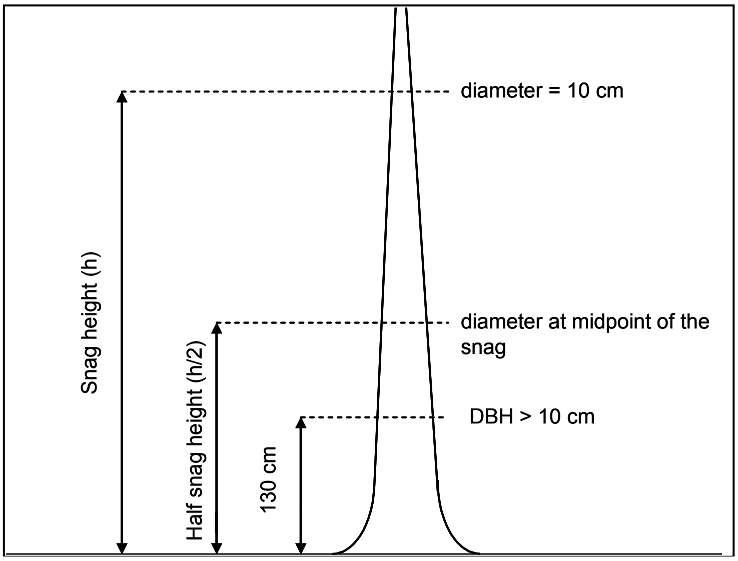


Figure 4: ***Procedure for snag diameter and snag height measurement.***

A piece of **coarse lying woody debris** is surveyed if its diameter at thicker end is greater than 10 cm and if more than 50% of its thicker end lies within the subplots 1 or 2. Diameter measurements are recorded at the mid-point of the CWD piece with diameter greater than 10 cm. The length of the lying woody debris in metres and with 1 decimal is measured from its thicker end until the point after which the size of the diameter is always under 10 cm. The diameter at half length of the piece is also recorded (**F**).

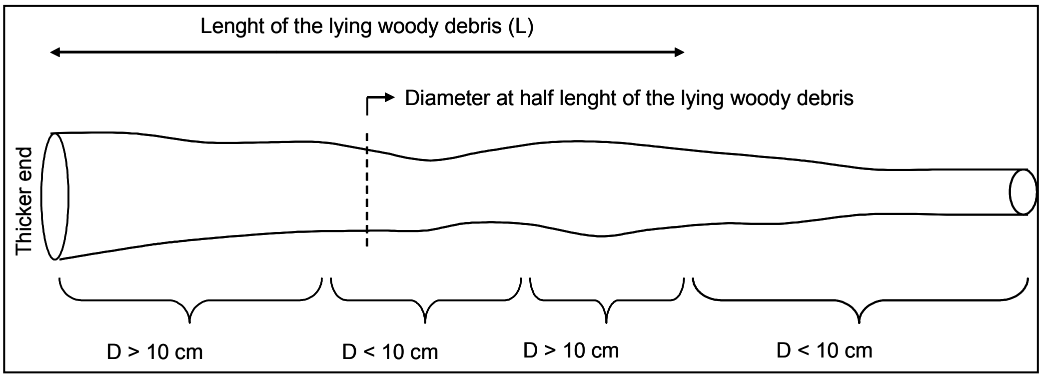


Figure 5: ***Procedure for measure length and diameter at half length of a coarse lying woody debris.***

The forest deadwood measurements include:
1. Mandatory
• Diameter (in cm) and length (in m) of coarse lying woody debris
• Species of the coarse woody debris if possible (see species list)
• Height (in m) and diameter (in cm) of stump less than 130 cm in height with a diameter at normal cut height greater than 10 cm
• Species of stump if possible (see species list)
• Estimated diameter of snag (cm) and snag height (in m)
• Species of snag if possible (see species list)
• Decay state (5 classes) of all deadwood components (see **F** on page 15).

2. Optional
• Diameter (in cm) and length (in m) of fine woody debris
• Species of fine woody debris species if possible (see species list)

The diameter and length of fine woody debris is measured when the diameter of the woody material is equal to or smaller than 10 cm but greater than 5 cm.

Canopy characteristics

The canopy structure has widespread ramifications on the function of the forested ecosystem and its suitability to support other species. It plays an important role for the regeneration of trees as well as for understorey species. They can also serve as early warnings for changes in the abundance of difficult to measure species including endangered species and soil species.

The BioSoil project includes **estimates of canopy closure** and **number of tree layers**.

Canopy closure is estimated as the amount of shade that the canopies of trees create on the ground. Canopy closure is agreed to be estimated visually, but it can be estimated more precisely using a spherical densiometer to measure this amount of shade. The instrument has a round concave mirror with a grid marked on it. The grid divides the mirror into small squares.

Method
The visual estimates of **average canopy closure** are made for each of the BioSoil subplots 1 and 2. Estimates of canopy closure are expressed in 5 % classes; see reference table for codes.

The visual overall estimate of the number of **distinct tree layers** on BioSoil plot is assessed at the same location as for the ground vegetation within the two BioSoil subplots 1 and 2**;** see reference table for codes.

Compositional Biodiversity

Ground vegetation

The species diversity of the understorey vegetation represents an important component of overall forest biodiversity. The diversity and abundance of vegetation has also been linked to the diversity of specific faunal groups by many research projects. In the scope of the BioSoil project, only the vascular plant species have been chosen as a compositional indicator of biodiversity. Other components like bryophytes, lichens, and etc. while recognised as important components of forest biodiversity are not mandatory to record on this occasion. The number of tree layers occurring above the ground vegetation sample areas should also be recorded.
2.

Following the recommendations of the EU/ICP Forest Expert Panel on Ground Vegetation, vascular plant species are assessed across the minimum sampling area of 400m^2.

Vascular plant species are assessed by a full sampling within the inner subplots 1 and 2. Species are described according to the Flora Europaeae and the species codes found in the Manual are used.

As an option, the entire ground vegetation component can be assessed using the approach outlined in the Ground Vegetation Manual (**www.icp-forests.org/pdf/manual8.pdf**).

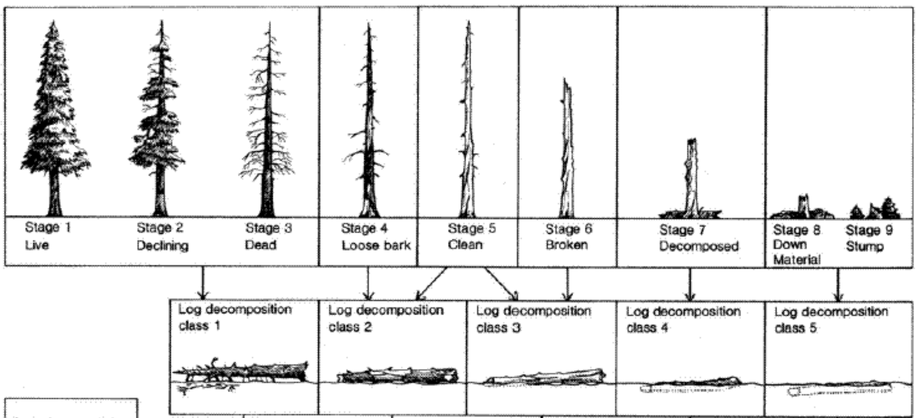
GLOSSARY AND DEFINITIONS

Canopy base
The canopy base is the height from the ground to the bottom of the live crown of an individual tree (starting at the lowest main branches of the tree).

Coppicing
A tree cutting method based on renewal of newly cut trees by vegetative reproduction like sprouting, growth of several stems from one root system.
'Coppice with standards' includes scattered trees that are left to grow as normal ('standards')
Coppice without standards is considered to be simple coppice

Deadwood

- ***Coarse woody debris (CWD):*** Pieces of lying wood with a minimum small-end diameter D >10 cm. CWD pieces must be detached from a bole and not self supported by a root system with a lean angle of more than 45 degrees from vertical
- ***Decay class (1 – 5)***. The deadwood decomposition is assigned in 5 decay classes according to Hunter 1990 (**F**).



Log characteristics	Class 1	Class 2	Class 3	Class 4	Class 5
Bark	intact	intact	trace	absent	absent
Twigs < 3 cm	present	absent	absent	absent	absent
Texture	intact	intact to partly soft	hard, large pieces	small, soft, blocky pieces	soft and powdery
Shape	round	round	round	round to oval	oval
Color of wood	original color	original color	original color to faded	light to faded brown or yellow	faded to light yellow or gray
Portion of log on ground	log elevated on support points	log elevated but sagging slightly	log is sagging near ground	all of log on ground	all of log on ground

Figure 6: Decay classes

- ♦ ***Fine woody debris (FWD):*** Lying woody debris with a diameter between 5 cm < D < 10 cm
- ♦ ***Lying dead tree:*** Whole tree lying on the forest floor – the tree must be recognisable and the rooted part must be within the plot to be considered. The diameters of lying dead tree are recorded according to the diameter threshold of:
    - o DBH > 0 cm and taller than 130 cm in the BioSoil Subplot 1,
    - o DBH ≥ 10 cm in the BioSoil Subplot 2,
    - o DBH ≥ 50 cm in the BioSoil Subplot 3.
- ♦ ***Snag:*** A snag is defined as standing dead wood **without branches with height greater than 130 cm**, otherwise it may be considered as a standing dead tree if it has branches and is taller than 130 cm or as a stump if the height is less than 130 cm. If branches are present treat as standing dead tree and record the DBH at 130cm height.
- ♦ ***Standing dead tree:*** All standing dead trees with a height taller than 130 cm.
- ♦ ***Stump:*** Standing dead tree with a height less than 130 cm also including stumps.

Intervention
The term describes the silvicultural activities in the stand, mainly the management operations, clear cutting and regeneration.

Intimacy
The mixture of different tree species in the plot can be described as *intimate* and *non-intimate*: *Intimate* relates to a mixture of different tree species throughout the stand
Non-intimate, relates to a mixture of different tree species in small groups or clusters.

High forest
Type of forest where the trees are mainly grown from generative formation/multiplication (by seeds)

- ♦ ***Even-aged stand:*** A stand or forest type, in which no or relatively small age differences exist among individual trees within it, usually less than 20% of rotation length (IUFRO, 2000).
- ♦ ***Uneven-aged stand:*** Consisting of trees of a range of age classes, with age differences which are significant in relation to the stand structure management and rotation length (IUFRO, 2000).
- ♦ ***Femelschlag:*** **P**rogressive cutting. This is a type of regeneration in high forests in which parcels of different sizes or groups of trees are regenerated by combining different cuttings (progressive, shelter, lisiere) échelonnées in time and space and in a given order.
- ♦ ***Plenterwald*:** Forest with a layered structure, without a dominant development stage or a high forest with one to several layers with a structure by groups of trees. Trees of all diameter classes are growing together and where the same type of intervention is always applied,
- ♦ ***High forest homogeneous*:** High forest of homogeneous stands with delimitated area, with a uniform structure (with 1-several tree layers), in which the trees of the main stand have diameter at breast height of same size and are thus assimilated to the same stage of development.
- ♦ ***Young to medium forest*:** Class of forest defined by the mean or dominating size (diameter or height). Depending on the dominating diameter and the inventory different development stages can be distinguished increasing from young growth of dense vegetation with regeneration between 0,5 and 3 metres height, to rigid stems of a diameter less than 20 cm, to young forest defined as a group of trees, not coppices, grown in a way that some of them have reach or will reach the forest stage and having a diameter between 20 and 40 cm, middle forest (diameter of 40 to 50 cm) and old forest with a mean diameter of more than 50 cm.

Regeneration
Re-establishment of a forest stand by natural or artificial means following the removal of the previous stand by felling or as a result of natural causes, e.g. fire or storm (TBFRA 2000).

- ♦ ***Natural regeneration:*** Re-establishment of a forest stand by natural means, i.e. by natural seeding or vegetative regeneration. It may be assisted by human intervention, e.g. by scarification or fencing to protect against wildlife damage or domestic animal grazing (TBFRA 2000).

- ♦ ***Regeneration by planting and seeding:*** The act of establishing a forest stand (e.g. plantation) or re-establishing a forest stand by artificial means, either by planting of seedlings or by scattering seed. The material used may be of indigenous or introduced origin. Planting and seeding may take place on forest, other wooded land or other land (TBFRA 2000).

Stand
A community of trees possessing sufficient uniformity in composition, age, arrangement or condition to be distinguishable from the forest or other growth on adjoining areas, thus
forming a temporary silvicultural or management entity (IUFRO, 2000).

UTM coordinates
A position on the Earth is referenced in the UTM system by the UTM longitude zone, the projected distance of the position from the central meridian -- called the Easting -- and the projected distance of the point from the equator -- called the Northing.
The point of origin of each UTM zone is the intersection of the equator and the zone's central meridian. In order to avoid dealing with negative numbers, the central meridian of each zone is given a "false Easting" value of 500,000 meters. Thus, anything west of the central meridian will have an Easting less than 500,000 meters. For example, UTM Easting range from 167,000 meters to 833,000 meters at the equator (these ranges narrow towards the poles). In the northern hemisphere, positions are measured northward from the equator, which has an initial "Northing" value of 0 meters and a maximum "Northing" value of approximately 9,328,000 meters at the 84th parallel -- the maximum northern extent of the UTM zones.

DATA FILE STRUCTURE, FORM AND SUBMISSION PROCEDURE

Data preparation

Naming of the BioSoil biodiversity files

The files are named by survey, and follow the same rules as the Forest Focus surveys: CCYYYY.*ext*. The country code can be expressed in letters: e.g France FR or in numbers e.g for France 01, but according to the agreed codes.

File name includes information on country (CC) and year (YYYY) and on the survey (*EXT): CCYYYY.EXT*

File type	Extension
General plot description	GPL
Structural Biodiversity 1: DBH and species table	DBH
Structural Biodiversity 2: tree height and canopy base	THT
Structural Biodiversity 3: coarse woody debris, snags and stumps	DWD
Structural Biodiversity 4: stand and canopy characteristics	CAN
Ground Vegetation Assessment	GVG

File Structure

It was agreed to structure the data to be submitted according to common CSV file format standards. Each line, including the last, will be terminated by a Carriage Return [CR] and the data elements are delimited by commas in both BioSoil projects. A CSV file is an ASCII file consisting of multiple rows/lines of data. It may contain both text and numeric data, but no extra formatting information (e.g. bold text).

File Content

The data are to be submitted in a total of 6 individual files (contents given in detail in the next section). These comprise:

- General BioSoil plot description (.GPL). This contains general information about the name and location of the plot.
- Structural Biodiversity 1 (.DBH). Contains DBH, species and (optionally) locations of all the trees within sampling areas 1, 2 and 3.
- Structural Biodiversity 2 (.THT). Contains the tree heights for the selected largest DBH trees within subplots 1 and 2.
- Structural Biodiversity 3 (.DWD). Contains details of deadwood dimensions and status within subplots 1 and 2.
- Structural Biodiversity 4 (.CAN). Contains details of the state of canopy closure. Also the total number of trees within the sampling area and the percentage assessed for DBH (in those cases where a sample had to be assessed). Also within subplots 1 and 2.
- Ground Vegetation (GVG). Contains assessments of the ground vegetation species and cover within subplots 1 and 2.

The first row of each of the 6 files is the header record. Subsequent rows contain all information for each instance of a measurement. The minimum possible file size is a single row (i.e. a header row, with zero data rows: null return of data).

The header row is used to confirm the parameters represented within the CSV file, and the order in which they are provided. The header row must be constructed as a list of all the field names of the items contained in the file followed by a comma. The correct field names are specified in the reference tables and should be submitted in the order given in the tables. The data rows must follow the order given in the header and a comma must follow each field. A comma must follow null or empty fields.

Data are arranged in a consistent form with one observation per line and with individual values separated by commas. Except where information is actually missing, each line or observation should have all the values filled in.

NOTE: Where data items consisting of text include the comma delimiter character as part of the data, that data item must be included between "double quote" characters (typically ". Note that this is not the same as two single quotes ′′).

Example for the general plot file:

Line 1: SEQ, C_COUNTRY, PLOTID, DATE, C_GPSPLOT, DATUM, PROJECT, UTMZONE, C_ACCURACY, EASTSOIL, NORTHSOIL, EASTPLOT, NORTHPLOT, GPSELEV, C_ORIENT, AVSLOPE, C_PREVUSE, C_ORIGIN, C_MANAGE, C_FORTYPE, C_DWREMOV, C_TREEMIX, C_AGE, C_FENCE, C_EFTC, OTHER_OBS **[CR]**

Line 2-n: 1, 8, 1024, 01012007, Y, "ETRS89", "LAEA", 32, 2, 502536, 6163651, 502504, 6163612, 25.3, 4, 7, 3, 1, 3, 5, 4, 3, 2, 2, 7, "nothing to add" **[CR]**

Example for Structural Biodiversity 1 (DBH, and tree species composition):

Line 1: SEQ, C_COUNTRY, PLOTID, SUBPLOT, DATE, TREENO, DBH, C_TSTATUS, DISTANCE, AZIMUTH, C_TSPECIES, C_DECAY, OTHER_OBS **[CR]**

Line 2-n: 1, 8, 1024, 3, 01082007, 54, 23, 1, 2.6, 120, 051, , "nothing to add" **[CR]**

NOTES

- In the second example there is a null value (two consecutive commas) for DECAY (the tree is still alive and no decay code applies).
- Note leading zeros for the DATE values (These can be achieved in Excel by designating the cell as text format).
- It is not necessary to leave spaces between the data items (spaces in the examples above are for reasons of legibility only).
- Some of the assessments are codes rather than measured values (e.g. C_ORIGIN, C_MANAGE). In these cases only certain values are valid entries (e.g. 1-5 for C_ORIGIN). All coded variables in the study begin with the letter C_ and for each one there is an accompanying reference table giving the possible valid values. No other values may be used for these parameters.
- There must not be a Carriage Return **[CR]** character anywhere within a data record, except at the end. **[CR]** always signifies a new record.
- Missing data should be always represented by [NULL]. Do not use any other character (e.g. zero) to represent missing data. Reasons for why the value is missing may be given in the OTHER_OBS field or in the Data Accompanying Report (DAR).

Data accompanying report

Extra information about the plot layout, procedures followed, difficulties encountered and general background information will be supplied in the form of a Data Accompanying report (DAR). This will be in free format (e.g. Word document) and should be named CCYYYYDAR.DOC.

Data validation/submission

The data will be submitted by the NFCs by email to the Joint Research Centre to *tracy.houston@jrc.it* and the deadline for submission will be on June 15th, 2008.

The data will then go through verification procedures similar to those performed on the Forest Focus data:

1. Checks for compliance: whether the data comply with the formats of the data submission forms and whether the values are admissible in the case of categorical data.
2. Checks for conformity: whether the values of the variables are within a range expected for the particular variable (single plot, single parameter)
3. Checks for uniformity: checks whether plot values stand out compared with those around them.

After the checks have been made, a report will be sent to the NFC contact point detailing any irregularities or errors found. The NFC will be invited to confirm the validity of unusual values, and, if necessary, correct erroneous data. Corrected data should be resubmitted in full.

After verification of the validated data by the NFCs, the data will made available according to the same rules as for the Forest Focus data.

ANNEX 1

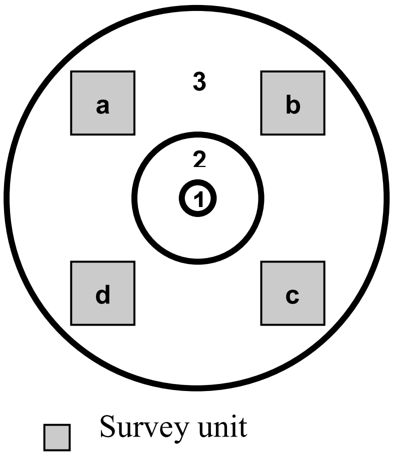
Procedure for establishment of alternative (optional) design of 4 random sampling units

Optional design for coarse woody debris, snags, stumps, ground vegetation, and canopy characteristics only

Optionally for the specific surveys of ground vegetation and coarse woody debris within the BioSoil biodiversity plot, 4 **randomly selected** squares of 10 m x 10 m (so called random sampling units a, b, c and d) may be established within the 2000 m^2 plot while respecting the overall BioSoil subplot layout 1, 2 and 3 for the other surveys e.g. DBH.

The random selection is carried out by first generating a random azimuth and random distance from the centre of the BioSoil plot to establish a corner of the random sampling unit a. From this first sampling unit the other three sampling units b, c and d may be established by using the same azimuth and distance as for plot ,a, but rotated through 90^o on each occasion. This ensures that the sampling units are not overlapping, see **F**.

The random sampling units a, b, c and d are used *optionally* instead of the recommended BioSoil subplots 1 and 2, where countries desire to do so. It is not mandatory to establish the random sampling Units a, b, c and d in the BioSoil plot and when established they may be used for ground vegetation, coarse woody debris, snags, stumps and canopy assessments only.



3.
Figure 7: *4 times 10 m x 10 m random sampling units may be installed for the specific surveys of ground vegetation, coarse woody debris (D >10 cm), snags, stumps, and canopy characteristics instead of using the recommended subplots 1 and 2 . Note that the combined sampling area of sampling units a, b, c, and d must be equivalent to subplots 1 and 2 (400m²).*

Table 4: ***Overview of measurements and assessments to perform if the optional alternative design, the randomly selected sampling units a, b, c, and d. Forest deadwood (incl. coarse woody debris, snags, and stumps), ground vegetation (vascular plant species list only, and canopy characteristics may be assessed in the randomly selected sample units a, b, c and . Each has the size of 10 m x 10 m each; the total sampling area is 400 m2.***

	Randomly selected sampling units a b c d
General plot description	-
Check of the European forest type classification	-
DBH and species of all woody plants taller than 130 cm (standing and lying, living and dead)	-
Top height and bottom of canopy layer	-
Coarse woody debris, stumps and snags	D > **10 cm**
Canopy closure (visual)	Yes
Tree layering (visual)	Yes
Ground vegetation – vascular species list only	Yes

REFERENCES

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12.2 Appendix 2: Data files and formats

GPL: General plot description

NAME	Description	Code	Format	Reference table
SEQ	Sequence number of plots (1 to 9999)		9999	
C_COUNTRY	Country code (France=01, Belgium=02, etc.)		999	REF_COUNTRY
PLOTID	Observation plot number of the BioSoil plot (max. 99999)	Number	99999	
DATE	Date of the assessment /measurements	Date	DDMMYYYY	
C_GPSPLOT	Georeferencing the BIOSOIL plot centre	N: No, Y: Yes	Text	
DATUM	Geodesic system WGS84, ETRS89	Text	Text	
PROJECT	Projection	Text	Text	
UTMZONE	UTM longitude and latitude zone, e.g. 32V, Europe includes 27V to 38S	Text	Text	
EASTSOIL	**Easting** of the BioSoil soil pit	Metres	999999	
NORTHSOIL	**Northing** of the BioSoil soil pit	Metres	9999999	
EASTPLOT	**Easting** of the BioSoil plot centre	Metres	999999	
NORTHPLOT	**Northing** of the BioSoil plot centre	Metres	9999999	
C_ACCURACY	Accuracy of GPS location estimate	1-3		REF_ACCURACY
GPSELEV	Elevation reading from the GPS of the plot centre in metres	Metres	9999.9	
C_ORIENT	Prevalent orientation of the BioSoil plot	1-9	9	REF_ORIENT
AVSLOPE	Prevalent slope of the BIOSOIL plot in percent	%	999	
C_PREVUSE	Previous land-use	1-5	9	REF_PREVUSE
C_ORIGIN	Origin of the actual stand	1-5	9	REF_ORIGIN
C_MANAGE	Forest management such as thinning and selective felling	1-4	9	REF_MANAGE
C_FORTYPE	Forest Type	1-8	9	REF_FORTYPE
C_DWREMOV	Removal of coarse woody debris	1-7	9	REF_DWREMOV
C_TREEMIX	Pattern of tree mixture	1-3	9	REF_TREEMIX
C_AGE	Mean age of the dominant storey (in 20 year classes from 1-8 and unknown (=9))	1-9	9	REF_AGE
C_FENCE	Fencing	1-3	9	REF_FENCE
C_EFTC	European Forest Type Classification	1-14	99	REF_EFTC
OTHER_OBS	Remarks	Text	Text	

DBH: Structural biodiversity: dbh, species composition

NAME	Description	Code	Format	Reference table
SEQ	Sequence number of plots (1 to 9999)		9999	
C_COUNTRY	Country code (France=01, Belgium=02, etc.)		99	REF_COUNTRY
PLOTID	Observation plot number of the BioSoil plot (max. 9999)	Number	99999	
SUBPLOT	BioSoil subplot	1,2,3	9	
DATE	Date of survey	Date	DDMMYYYY	
TREENO	Tree number	Number	9999	
DBH	DBH (at 130cm) in cm	cm	999	
C_TSTATUS	Status of trees: Standing and lying, living and dead trees: if branches are still present then standing dead tree; if without branches then snag (go to DWD table).	1-3	9	REF_TSTATUS
DISTANCE	If tree position is measured: Distance between the BioSoil plot centre and the tree (in metres)	metres	9999.9	
AZIMUTH	If tree position is measured: Azimuth (Compass direction) from the centre of the BioSoil plot to the tree (360 deg: North=0)	Degrees (0-359)	999	
C_TSPECIES	Tree species		999	REF_TSPECIES
C_DECAY	Only for standing and lying dead trees	1-5	9	REF_DECAY
OTHER_OBS	Remarks	Text	Text	

THT: Structural biodiversity: tree height and canopy base

NAME	Description	Code	Format	Reference table
SEQ	Sequence number of plots (1 to 9999)		9999	
C_COUNTRY	Country code (France=01, Belgium=02, etc.)	1-96	99	REF_COUNTRY
PLOTID	BioSoil plot number		9999	
SUBPLOT	BioSoil subplot (1, 2, 3)	1-3	9	
DATE	Date of survey	Date	DDMMYYYY	
TREENO	Tree number *		999	
C_TSPECIES	Tree species *		999	REF_TSPECIES
DBH	DBH (at 130cm) in cm *	cm	999	
TREHEIGHT	Height of the tree (in metres)	metres	99.9	
BASECAN	Height of the base of the canopy layer (in metres)	metres	99.9	
OTHER_OBS	Remarks	Text	Text	

[NB. These are a repetition of the measurements reported in the DBH file; included here for validation purposes)]

DWD: Coarse woody debris, snags and stumps

NAME	Description	Code	Format	Reference table
SEQ	Sequence number of plots (1 to 9999)		9999	
C_COUNTRY	Country code (France=01, Belgium=02, etc.)		99	REF_COUNTRY
PLOTID	BioSoil plot number		9999	
SUBPLOT	BioSoil subplot		9	
DATE	Date of survey	Date	DDMMYYYY	
C_DWTYPE	Type of the coarse woody debris, snag or stump.	1-5	9	REF_DWTYPE
C_DWSPE	Species code of the deadwood	1-3	9	REF_DWSPE
DWDIA	Median diameter for deadwood in **cm** (above D ≥ 10 cm)		99.9	
DWLEN	Length or height of the deadwood in **m** (above D ≥ 10 cm)		99.9	
C_DECAY	Decay class of the deadwood The degree of decay is assessed visually and by banking on the wood	1-5	9	REF_DECAY
OTHER_OBS	Remarks	Text	Text	

CAN: Structural biodiversity: stand and canopy characteristics

NAME	Description	Code	Format	Reference table
SEQ	Sequence number of plots (1 to 9999)		9999	
C_COUNTRY	Country code (France=01, Belgium=02, etc.)		99	REF_COUNTRY
PLOTID	BioSoil plot number		9999	
SUBPLOT	BioSoil subplot (1,2). In case of use of the random selected units use (3, 4, 5, and 6 for unit a ,b , c, and d, respectively).	1-2 or 3-6	9	
DATE	Date of survey	Date	DDMMYYYY	
C_CANCLO	Canopy closure score (Open is 0% and full closure is 100%)	1-5	99	REF_CANCLO
C_TREELAY	Number of tree layers	1-5	9	REF_TREELAY
NO_OF_TREES	Total number of trees within the subplot that are measured for DBH (ie all trees >130cm for subplot 1; all trees with a DBH>10 for subplot 2)		9999	
SAMP_PERC	Percentage of trees assessed for DBH (normally 100% unless total number of trees make this impractical)		999	
OTHER_OBS	Remarks	Text	Text	

GVG: Ground Vegetation Assessment

NAME	Description	Code	Format	Reference table
SEQ	Sequence number of plots (1 to 9999)		9999	
C_COUNTRY	Country code (France=01, Belgium=02, etc.)		99	REF_COUNTRY
PLOTID	BioSoil plot number		9999	
SUBPLOT	BioSoil subplot (1, 2). In case of use of the random selected units use (3, 4, 5, and 6 for unit a ,b , c, and d, respectively).	1-2 or 3-6	9	
DATE	Date of survey	Date	DDMMYYYY	
GVSPEC	Species code from the Flora Europeae		xxx.xxx.xxx	
C_LAYER	Surface layer	1-6	9	REF_LAYER
COVER	Percent cover	0-100%	999.99	
OTHER_OBS	Remarks	Text	Text	

Data Reference Tables

REF_ACCURACY

Code	Description
1	Less than 1 metre
2	1- 10 metres
3	10-50 metres

REF_AGE

Code	Description
1	0-20 years
2	21-40 years
3	41-60 years
4	61-80 years
5	81-100 years
6	101- 120 years
7	>120 years
8	Irregular stands
9	Unknown

REF_CANCLO

Code	Description
1	Open sky
2	1-25%
3	25-50%
4	50-75%
5	>75%

REF_COUNTRY

Code	Description
1	France
2	Belgium (all)
201	BE (Flanders)
4	Germany (all)
401	Baden-Württemberg
402	Bayern
404	Brandenburg-Berlin
407	Hessen
408	Mecklenburg-Vorpommern
409	Niedersachsen
410	Nordrhein-Westfalen
411	Rheinland-Pfalz
412	Saarland
413	Sachsen
414	Sachsen Anhalt
5	Italy

Code	Description
6	United Kingdom
7	Ireland
8	Denmark
9	Greece
11	Spain
13	Sweden
14	Austria
15	Finland
51	Hungary
53	Poland
54	Slovak Republic
56	Lithuania
58	Czech Republic
60	Slovenia
64	Latvia
66	Cyprus

REF_DECAY

Code	Description
1	No evidence of decay
2	Solid wood. Less than 10 % changed structure due to decomposition; the wood is solid at its surface. The wood is attacked only to a very small degree by wood decomposing organisms
3	Slightly decayed. 10-25% of the wood has a changed structure due to decomposition. This can be assessed by sticking the wood with a sharp object
4	Decomposed wood 26-75% of the wood is soft to very soft
5	Very decomposed wood. 76% - 100 % of the wood is soft

REF_DWREMOV

Code	Description
1	Yes, all stems and main branches have been removed
2	Yes, stems and main branches have been removed
3	No, stems and main branches are lying in the forest
4	partly, some stems and main branches have been removed, others still present
5	Unknown
6	Introduced
7	Presence of accumulation (branches have been stacked in piles or in rows)

REF_DWSPE

Code	Description
1	Deciduous
2	Conifer
3	Unknown

REF_DWTYPE

Code	Description
1	Coarse woody debris (D>10 cm) *Coarse woody debris includes stems, limbs, branches lying on the ground with a diameter of 10 cm*
2	Fine woody debris (5 cm <D<10 cm) *Fine woody debris includes wood pieces with a diameter between 5.0 and 10.0 cm*
3	Snag *Standing deadwood without branches, with a height > 130 cm and with a DBH > 10 cm.*
4	Stump (snag H<130 cm) *Stump is a snag with a height of less than 130 cm*
5	Other

REF_EFTC

Code	Description
1	Boreal forest
2	Hemiboreal and nemoral Scots pine forest
3	Alpine coniferous forest
4	Atlantic and nemoral oakwoods, Atlantic ashwoods and dune forest
5	Oak-hornbeam forest
6	Beech forest
7	Mountainous beech forest
8	Thermophilous deciduous forest
9	Broadleaved evergreen forest
10	Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions
11	Swamp forest
12	Floodplain forest
13	Native plantations
14	Exotic plantations and woodlands

REF_FENCE

Code	Description
1	Fenced
2	Not Fenced
3	Fenced in parts

REF_FORTYPE

Code	Description
1	High forest (even-aged) – Femelschlag
2	High forest (even aged) – Small groups
3	High forest (uneven aged) – Plenterwald
4	High forest (other)
5	Young/Medium forest (under development to high forest)
6	Coppice without standards
7	Coppice with standards
8	Other

REF_GPSPLOT

Code	Description
Y	Yes, georeferencing the BioSoil plot centre
N	No, no georeferencing of the BioSoil plot centre

REF_LAYER

Code	Description
1	Tree layer
2	Shrub layer
3	Herb layer
4	Moss layer
5	Lower Shrubs (FR)
6	Upper Shrubs (FR)

REF_MANAGE

Code	Description
1	Unmanaged (no evidence)
2	Abandoned Management (evidence but for more than 10 years ago)
3	Managed (within the last 10 years)
4	Unknown

REF_ORIENT

Code	Description
1	N
2	NE
3	E
4	SE
5	S
6	SW
7	W
8	NW
9	Flat

REF_ORIGIN

Code	Description
1	Planted
2	Seeded
3	Natural regeneration
4	Mixed
5	Unknown

REF_PREVUSE

Code	Description
1	Forested more than 300 years
2	Forested more than 100 years
3	Forested for 25 – 100 years ago
4	Forested in the past 25 years
5	No information

REF_TREELAY

Code	Description
1	1 layer (one dominant tree layer)
2	2 layers (dominant tree layer plus 1 sublayer)
3	3 layers (dominant plus 2 sublayers)
4	More than 3 layers
5	0 layer, no tree layer

REF_TREEMIX

Code	Description
1	Intimate (different tree species are mixed throughout the stand)
2	Non-intimate (different trees occur in clusters)
3	No mixture

REF_TSTATUS

Code	Description
1	Standing living tree
2	Standing dead tree
3	Lying dead tree

REF_TSPECIES

Code	Description
001	Acer campestre
002	Acer monspessulanum
003	Acer opalus
004	Acer platanoides
005	Acer pseudoplatanus
006	Alnus cordata
007	Alnus glutinosa
008	Alnus incana
009	Alnus viridis
010	Betula pendula
011	Betula pubescens
012	Buxus sempervirens
013	Carpinus betulus
014	Carpinus orientalis
015	Castanea sativa (C. vesca)
016	Corylus avellana
017	Eucalyptus sp.
018	Fagus moesiaca
019	Fagus orientalis
020	Fagus sylvatica
021	Fraxinus angustifolia spp. oxycarpa (F. oxyphylla)
022	Fraxinus excelsior
023	Fraxinus ornus
024	Ilex aquifolium
025	Juglans nigra
026	Juglans regia
027	Malus domestica
028	Olea europaea
029	Ostrya carpinifolia
030	Platanus orientalis
031	Populus alba
032	Populus canescens
033	Populus hybrides
034	Populus nigra
035	Populus tremula
036	Prunus avium
037	Prunus dulcis (Amygdalus communis)
038	Prunus padus
039	Prunus serotina
040	Pyrus coomunis
041	Quercus cerris
042	Quercus coccifera (Q. calliprinos)
043	Quercus faginea
044	Quercus frainetto (Q. conferta)

Code	Description
067	Tamarix africana
068	Tilia cordata
069	Tilia platyphyllos
070	Ulmus glabra (U. scabra, U. scaba, U. montana)
071	Ulmus laevis (U. effusa)
072	Ulmus minor (U. campestris, U. carpinifolia)
073	Arbutus unedo
074	Arbutus andrachne
075	Ceratonia siliqua
076	Cercis siliquastrum
077	Erica arborea
078	Erica scoparia
079	Erica manipuliflora
080	Laurus nobilis
081	Myrtus communis
082	Phillyrea latifolia
083	Phyllyrea angustifolia
084	Pistacia lentiscus
085	Pistacia terebinthus
086	Rhamnus oleoides
087	Rhamnus alaternus
088	Betula tortuosa
090	Crataegus monogyna
099	Other broadleaves
100	Abies alba
101	Abies borisii-regis
102	Abies cephalonica
103	Abies grandis
104	Abies nordmanniana
105	Abies pinsapo
106	Abies procera
107	Cedrus atlantica
108	Cedrus deodara
109	Cupressus lusitanica
110	Cupressus sempervirens
111	Juniperus communis
112	Juniperus oxycedrus
113	Juniperus phoenicea
114	Juniperus sabina
115	Juniperus thurifera
116	Larix decidua
117	Larix kaempferi (L.leptolepis)
118	Picea abies (P. excelsa)
119	Picea omorika
120	Picea sichensis

045	Quercus fruticosa (Q. lusitanica)
046	Quercus ilex
047	Quercus macrolepis (Q. aegilops)
048	Quercus petraea
049	Quercus pubescens
050	Quercus pyrenaica (Q. toza)
051	Quercus robur (Q. pedunculata)
052	Quercus rotundifolia
053	Quercus rubra
054	Quercus suber
055	Quercus trojana
056	Robinia pseudoacacia
057	Salix alba
058	Salix caprea
059	Salix cinerea
060	Salix eleagnos
061	Salix fragilis
062	Salix sp.
063	Sorbus aria
064	Sorbus aucuparia
065	Sorbus domestica
066	Sorbus torminalis

121	Pinus brutia
122	Pinus canariensis
123	Pinus cembra
124	Pinus contorta
125	Pinus halepensis
126	Pinus heldreichii
127	Pinus leucodermis
128	Pinus mugo (P. montana)
129	Pinus nigra
130	Pinus pinaster
131	Pinus pinea
132	Pinus radiata (P.insignis)
133	Pinus strobus
134	Pinus sylvestris
135	Pinus uncinata
136	Pseudotsuga menziesii
137	Taxus baccata
138	Thuya sp.
139	Tsuga sp.
140	Chamaecyparis lawsonia
141	Cedrus brevifolia
199	Other conifers

12.3 Appendix 3: Biodiversity Data Validation tests

Table Name	FIELD NAME	Test id	Test Description
GPL	SEQ	1.1	Should be unique within the file
GPL	C_COUNTRY	1.2	Check that right country code is applied
GPL	PLOTID	1.3	Plot ID should be unique within each country
GPL	DATE	1.4 1.4a	Test valid date Test plausible date (before submission date and after 1/1/2006)
GPL	C_GPSPLOT	1.5	Must be Y or N
GPL	DATUM	1.6	Should not be null
GPL	PROJECT	1.7	Should not be null
GPL	UTMZONE	1.8	Should not be null
GPL	EASTSOIL	1.9	If not null, should be close to EASTPLOT
GPL	NORTHSOIL	1.10	If not null, should be close to NORTHPLOT
GPL	EASTPLOT	1.11 1.11a	Should not be null Should be plausible easting (within country boundary)
GPL	NORTHPLOT	1.12 1.12a	Should not be null Should be plausible northing (within country boundary)
GPL	C_ACCURACY	1.13	Must be 1-3
GPL	GPSELEV	1.14	Test for plausible range (warn when >highest or <lowest LI plot for that country)
GPL	C_ORIENT	1.15	Must be 1-9
GPL	AVSLOPE	1.16	Test for plausible range
GPL	C_PREVUSE	1.17	Must be 1-5
GPL	C_ORIGIN	1.18	Must be 1-5
GPL	C_MANAGE	1.19	Must be 1-4
GPL	C_FORTYPE	1.20	Must be 1-8
GPL	C_DWREMOV	1.21	Must be 1-7
GPL	C_TREEMIX	1.22	Must be 1-3
GPL	C_AGE	1.23	Must be 1-9
GPL	C_FENCE	1.24	Must be 1-3
GPL	C_EFTC	1.25	Must be 1-14
DBH	SEQ	2.1	Should be unique within the file
DBH	C_COUNTRY	2.2	Check that right country code is applied
DBH	PLOTID	2.3	Plot number should occur in GPL file
DBH	SUBPLOT	2.4	Should be 1-3
DBH	DATE	2.5 2.5a	Test valid date Test plausible date (before submission date and after 1/1/2006)
DBH	TREENO	2.6	Should be unique within a plot
DBH	DBH	2.7	Test plausible range: warn if DBH=0, or if (DBH<=1 and C_AGE>1), or if DBH>=100
DBH	C_TSTATUS	2.8	Must be 1-3
DBH	DISTANCE	2.9	Should be plausible range (less than plot radius 25.24)
DBH	AZIMUTH	2.10	Must be between 0 and 359
DBH	C_TSPECIES	2.11	Must be valid code (ref table REF_TSPECIES)
DBH	C_DECAY	2.12 2.13	Test for presence if C_TSTATUS is 2 or 3. If present, must be 1-5
THT	SEQ	3.1	Should be unique within the file
THT	C_COUNTRY	3.2	Check that right country code is applied
THT	PLOTID	3.3	Plot number should occur in GPL file
THT	SUBPLOT	3.4	Should be 1-3
THT	DATE	3.5 3.5a	Test valid date Test plausible date (before submission date and after 1/1/2006)
THT	TREENO	3.6	Should be unique within a plot
THT	C_TSPECIES	3.7	Must be valid code (ref table REF_TSPECIES)
THT	DBH	3.8 3.9	Test plausible range (warn if DBH=0, or if DBH=1 and C_AGE>1, or if DBH>=100) Test ratio DBH/TREHEIGHT (Subjective assessment of outliers in

			DBH/HT graphs, taking into account species/age class)
THT	TREHEIGHT	3.10	Test plausible range (warn if =0 or >50, or <2 if C_AGE >1)
THT	BASECAN	3.11	Test plausible range (warn if more than tree height)
DWD	SEQ	4.1	Should be unique within the file
DWD	C_COUNTRY	4.2	Check that right country code is applied
DWD	PLOTID	4.3	Plot number should occur in GPL file
DWD	SUBPLOT	4.4	Should be 1-3
DWD	DATE	4.5 4.5a	Test valid date Test plausible date (before submission date and after 1/1/2006)
DWD	C_DWTYPE	4.6	Must be 1-5
DWD	C_DWSPE	4.7	Must be 1-3
DWD	DWDIA	4.8	Test plausible range (range depends on score for DWTYPE: type 1,3 or 4: warn if <10 or >100; type 2: warn if <5 or >10)
DWD	DWLEN	4.9	Test plausible range (range depends on score for DWTYPE: type 1: warn if >20; type 2: warn if >10; type 3: warn if <1.3 or >20; type 4: warn if >1.3
DWD	C_DECAY	4.10	Must be 1-5
CAN	SEQ	5.1	Should be unique within the file
CAN	C_COUNTRY	5.2	Check that right country code is applied
CAN	PLOTID	5.3	Plot number should occur in GPL file
CAN	SUBPLOT	5.4	Should be 1-3
CAN	DATE	5.5 5.5a	Test valid date Test plausible date (before submission date and after 1/1/2006)
CAN	C_CANCLO	5.6	Must be 1-5
CAN	C_TREELAY	5.7	Must be 1-5
CAN	NO_OF_TREES	5.8	Test plausible range (should match number of measured trees in DBH file when SAMP_PERC is taken into account; (e.g. if SAMP_PERC = 40 and 20 trees are measured in DBH file, NO_OF_TREES should be 50)
CAN	SAMP_PERC	5.9	Must be between 0 and 100
GVG	SEQ	6.1	Should be unique within the file
GVG	C_COUNTRY	6.2	Check that right country code is applied
GVG	PLOTID	6.3	Plot number should occur in GPL file
GVG	SUBPLOT	6.4	Should be 1-3
GVG	DATE	6.5 6.5a	Test valid date Test plausible date (before submission date and after 1/1/2006)
GVG	GVSPEC	6.6 6.7	Must be valid code (Flora Europea) If species name is supplied in OTHER_OBS, test that it matches the code
GVG	C_LAYER	6.8	Must be 1-6
GVG	COVER	6.9 6.9a	Must be between 0 and 100 Check that percentage is used rather than cover score (eg BB)

12.4 Appendix 4 Height-diameter relationships: parameters

formula: TREHEIGHT ~ 1.3 + (a * (1 - exp(b * (DBH^c))))										
Species	Country	Nb. of obs	Min DBH	Max DBH	Min height	Max height	Res. sum of squares	Parameters		
								a	b	c
Pinus sylvestris	PL HU	829	2	88	2	38	7972.336	27.35501	-0.005663957	1.602908
	LT LV SI SK DE	761	4	65	6.9	40.3	8813.895	28.33621	-0.01563672	1.335624
	UK IT DK	85	2.2	65.7	2	27	874.8468	20.53283	-0.04169438	0.9936854
	FI BE	1155	0.7	56.5	1.2	32.5	9411.019	22.01049	-0.003627211	1.805728
	AT	46	13.4	33.7	13	40.1	1119.091	44.44211	-0.07270449	0.7571152
	FR	178	15	87	4.7	36.8	3275.552	25.68339	-0.003830894	1.553762
	ES	72	10	49	5	18.5	495.5414	15.61705	-0.07035671	0.8363913
Pinus pinea	ES IT	24	11	65.3	3	14.1	80.91397	14.25571	-0.006907041	1.436566
Pinus nigra	AT BE CY DE ES FR HU IT SI SK UK	201	10	120	5.1	31	3534.428	29.9443	-0.02464234	0.9839695
Pinus pinaster	FR	230	10	67	4.6	33.5	1859.13	24.32417	-0.004965196	1.60902
	ES	68	9	77	7	22	907.5375	17.93022	-0.2066385	0.5095384
P.contorta	IE UK	95	13	45.5	5.1	27.5	2888.381	18.70329	-0.000139115	2.919443
Pinus halepensis	ES FR IT	180	5	66	3	27.7	2485.235	20.38729	-0.02142826	1.046184
Pinus brutia	CY	78	15.3	87.5	7	29	1672.136	16.7228	-0.009548546	1.392066
Picea abies	AT	350	1.2	58.5	1.5	47.4	7855.263	42.45301	-0.01406102	1.345632
	FI LT	512	0.8	64.8	1.5	33.8	4006.474	27.46121	-0.003672211	1.742259
	SI DE	319	3	84	4.2	43	3616.331	39.6209	-0.01151331	1.229795
	CZ DK FR IE IT LV PL SK UK	592	1	94	1.4	42	12271.46	30.66499	-0.01193853	1.358346
Picea sichensis	DK FR IE UK	294	1	77.9	1.5	34	5522.19	22.22041	-0.003427415	1.80742
Pseudotsuga menziesii	DE FR UK	128	2.2	103.3	3.1	42.6	1420.299	38.45379	-0.01826206	1.105664
Tsuga sp	FR UK	20	34	71.8	13.8	33.5	190.4331	29.47965	-0.000510887	2.107962
Quercus pubescens	ES FR HU IT	329	1	80	2	29.3	3779.053	27.20459	-0.01562479	1.103312
Quercus robur (Q. pedunculata)	UK ES	123	7.9	103.5	3.8	35	1672.586	23.96215	-0.01360392	1.239181
	AT BE DE DK FR HU IT LT LV PL SI	533	0.1	104	1.4	39.8	8247.002	28.45204	-0.0442293	0.9334791
Quercus petraea	AT DE ES FR HU IT PL SI SK UK	513	1	94	2	39.5	8615.609	28.87205	-0.03301924	1.03204
Quercus ilex	FR IT	118	4	77	3.9	22.6	761.5766	16.90347	-0.009380788	1.38163
Quercus cerris	FR HU IT SI SK	170	1	79	2	35	2308.952	44.21549	-0.01931573	0.9609554
Quercus suber	ES	17	19	60	5	9	11.36221	8.981003	-0.0617431	0.8087424
Quercus pyrenaica	ES FR	56	7	103	5	15	273.927	9.487653	-0.120076	1.104136
Castanea sativa (C. vesca)	DE ES FR IT SI	194	10	99	6.9	31.6	3587.615	18.47019	-0.01465883	1.557561

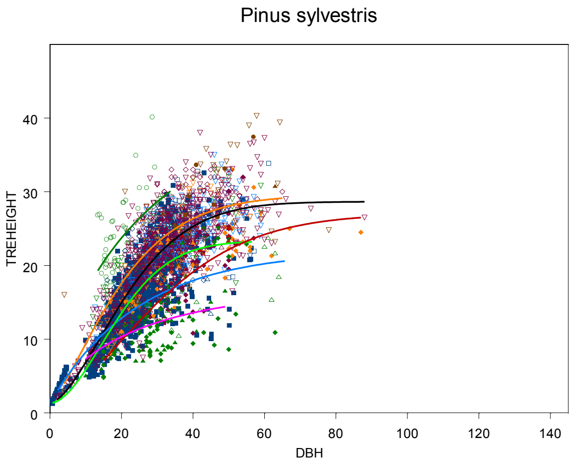
Fagus sylvatica	BE DE DK ES PL SI SK	669	3	117.5	2.6	43	18001.48	33.63106	-0.03145762	1.071102
	HU AT	77	3	73	3.6	38	967.1412	32.61835	-0.0381661	1.184138
	FR IT UK	483	8	130.5	7.3	43	13038.35	31.15658	-0.01131414	1.240442
Corylus avellana	DE FR IT UK	9	3	48	1.3	20.7	76.76652	14.9061	-0.0677877	1.133148
Platanus orientalis	ES IT	6	29	46	19	25	4.329818	23.84648	-0.0002275007	2.619586
Carpinus betulus	AT DE FR HU IT PL SI SK UK	101	0	70	1.58	34.8	1470.209	28.17319	-0.08667309	0.7998274
Robinia pseudoacacia	DE FR HU IT PL SI SK	85	1	54	2	31	987.8286	28.91604	-0.04969377	0.9489683
Ostrya carpinifolia	FR IT	21	12	32	5.8	18	58.52398	14.78565	-0.002806427	2.075959
Eucalyptus sp	ES IT	45	2	54	3	25	510.7607	22.88888	-0.02969825	1.198056
Abies (alba, grandis)	DE ES FR IT PL SI SK UK	261	14	98	8.2	47.6	4872.648	35.73718	-0.01084909	1.238683
Acer (campestre, monspessulanum, opalus, platanoides, pseudoplatanus)	AT DE FI FR HU IT LT PL SI SK UK	114	1	95	3	35.2	2538.32	44.18943	-0.05312303	0.6593365
Alnus (glutinosa, incana ,cordata)	AT DE ES FI FR HU IT LT LV PL UK	205	0.8	63.1	2	33.6	2059.288	26.65883	-0.04526534	0.9831696
Betula (pendula, pubescens)	LT LV	148	4	63	5	36	1901.032	27.62062	-0.007945167	1.658432
	DE FI FR IE IT PL SI SK UK	473	0	73	1.35	33.1	6416.349	31.72153	-0.03787669	0.9279324
Larix (decidua, kaempferi)	AT	55	1.5	44.9	3.8	45.3	1242.209	31.53744	-0.001187611	2.347414
	DE FR IT PL SI SK UK	232	10.8	102	3.2	42	7233.208	27.26037	-0.00980935	1.406163
Prunus (padus, avium, serotina)	DE FR HU IT PL SI	17	5	57	3.3	29.4	373.922	20.85796	-0.02840652	1.338835
Salix (alba, caprea, cinera, fragilis)	AT DE FI FR HU IT LT PL UK	31	5	59	4.9	21.7	320.8603	16.15713	-0.1683405	0.7201345
Sorbus (aria, aucuparia, tornalis, domestica)	DE FI FR IT PL UK	29	0	52	1.5	16.4	61.90858	14.41165	-0.05015277	1.177926
Tília (cordata, platyphyllos)	DE FR HU IT PL SI UK	36	9	70	8.1	28	405.7458	20.97041	-0.006018948	1.880275
Ulmus (glabra, minor, laevis)	DE FR IT PL UK	11	0	86	1.65	30.1	52.7663	26.6373	-0.02150092	1.117026
Fraxinus (excelcior, angustifolia, ornus)	AT DE ES FR HU IT LT PL SI SK UK	174	1	100.9	2	38.6	5051.319	37.29178	-0.06859297	0.7121763
Populus (alba, canescens, hybrides, nigra, tremula)	BE DE ES FI FR HU IT LT LV PL SI SK UK	212	3.4	70	6.5	43.6	3691.794	39.29295	-0.02103539	1.060601

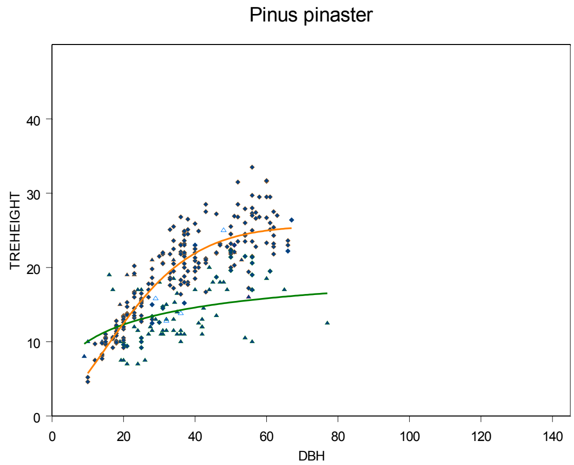
formula: TREHEIGHT ~ 1.3 + exp(a + (b/(DBH + 1)))									
Species	**Country**	**Min DBH**	**Max DBH**	**Min height**	**Max height**	**Nb. of obs**	**Res. sum of squares**	**Parameters**	
								a	**b**
Quercus ilex	ES	2	82	2.5	20.8	154	984.3139	2.015063	-7.26265
Quercus suber	FR IT	20	54	7	20	16	228.046	2.932099	-18.0703
Castanea sativa (C. vesca)	UK	24.4	140.7	18.6	28.5	12	120.7891	3.2609	-10.22366

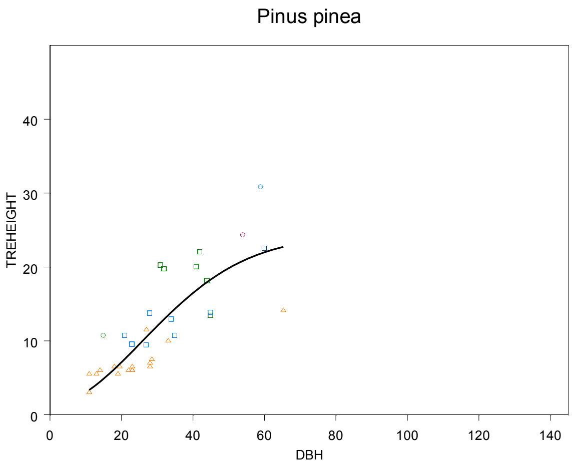
12.5 Appendix 5 Height-diameter relationships: curves

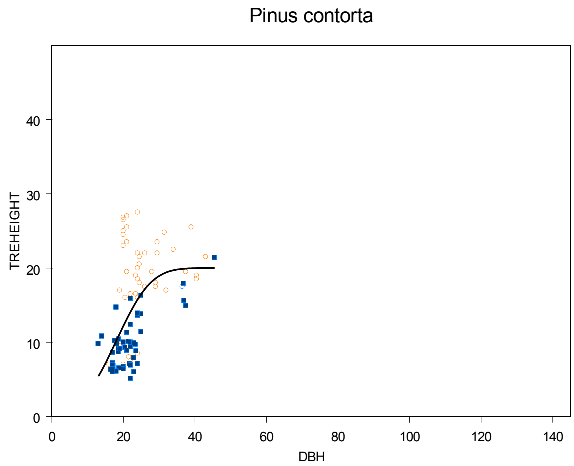
[Colours represent different countries; shapes represent different EFTC classes].

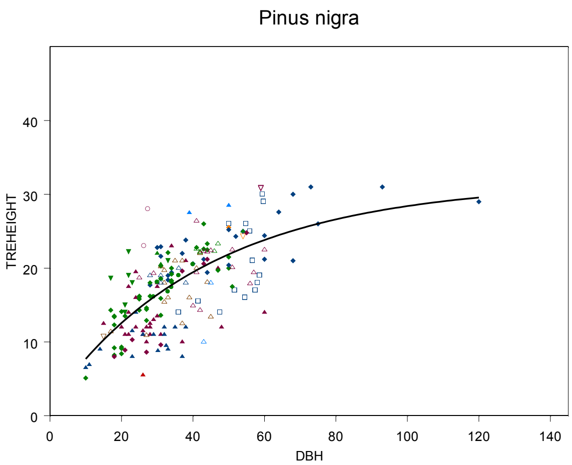
A. Individual Species

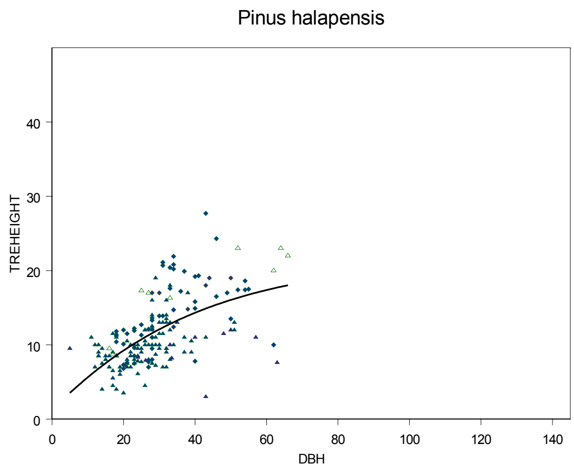




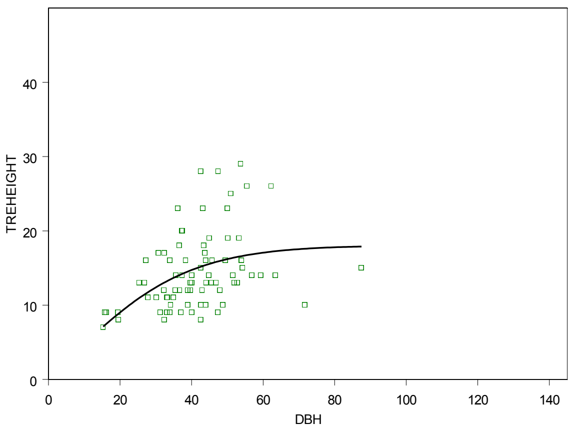




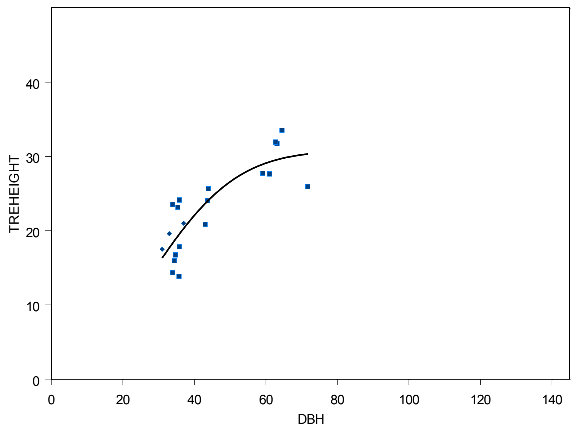




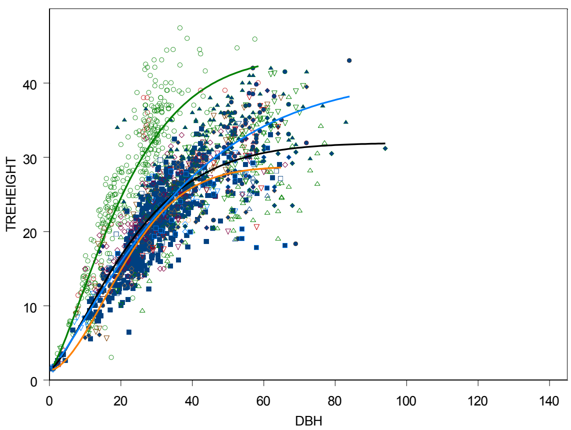
Pinus brutia



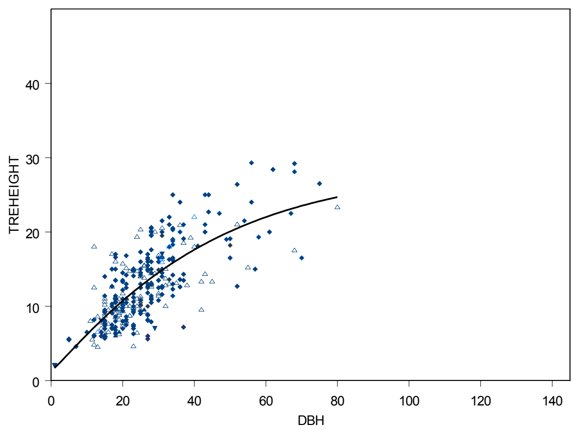
Tsuga sp



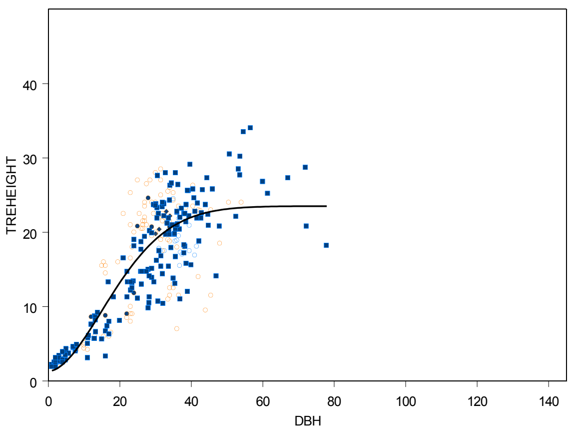
Picea abies



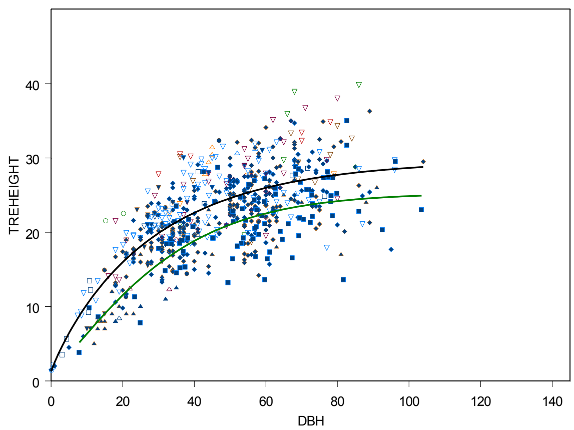
Quercus pubescens



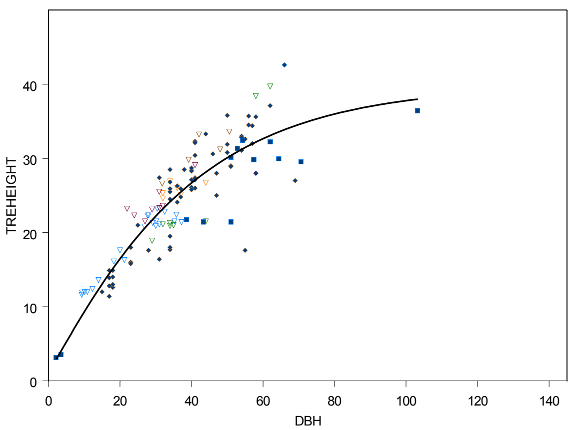
Picea sichensis



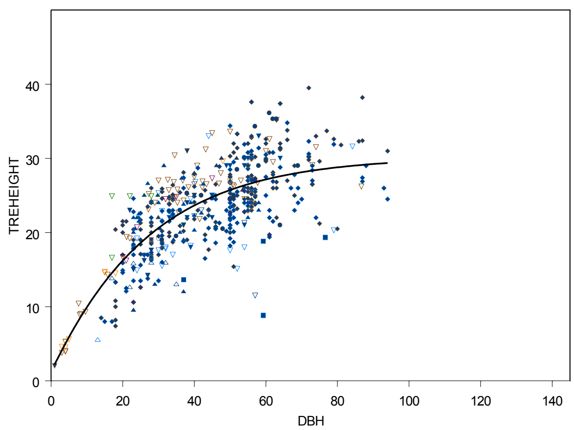
Quercus robur (Q. pedunculata)



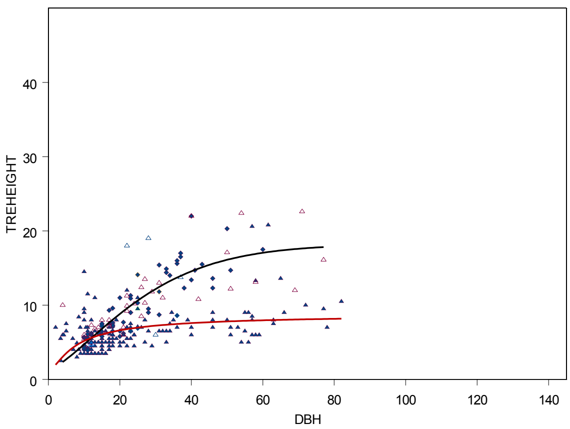
Pseudotsuga menziesii



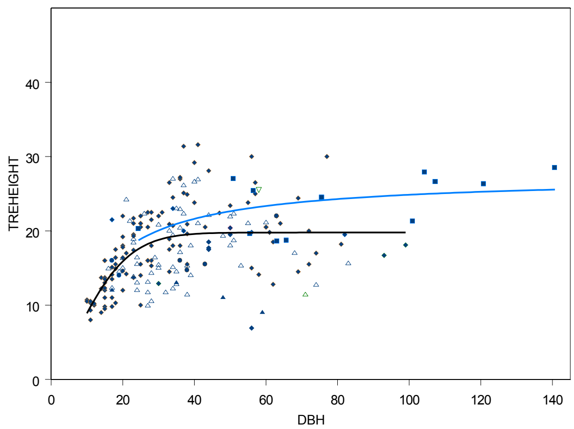
Quercus petraea



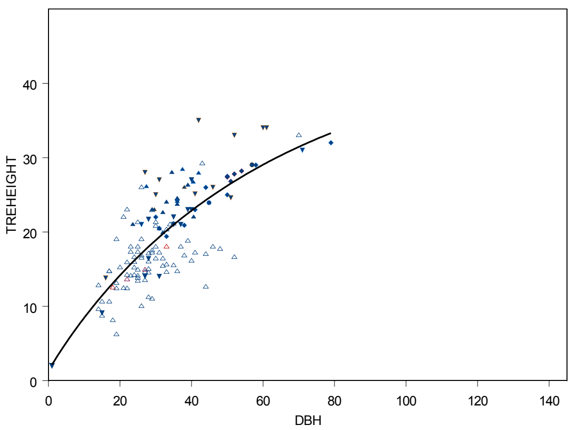
Quercus ilex



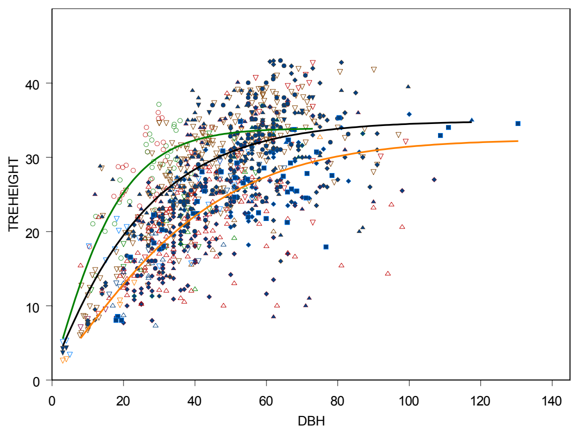
Castanea sativa (C. vesca)



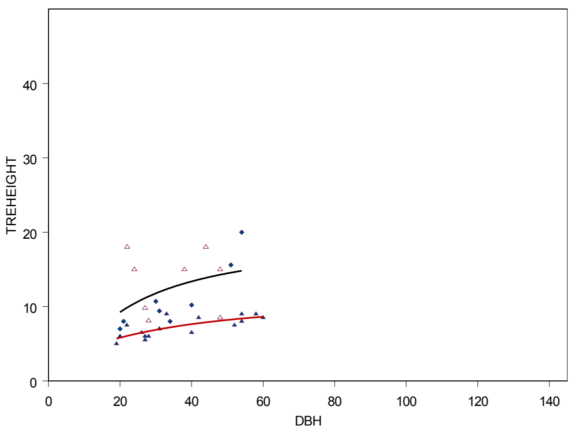
Quercus cerris



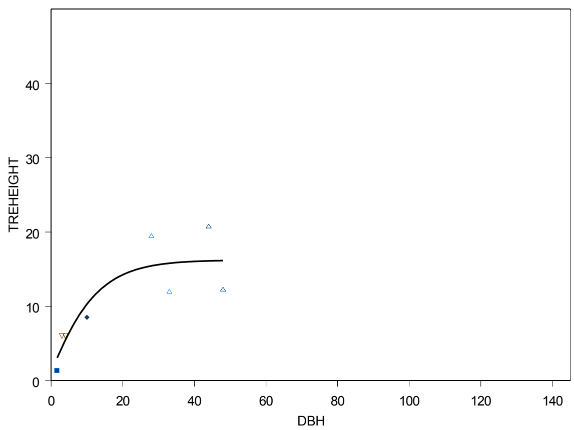
Fagus sylvatica



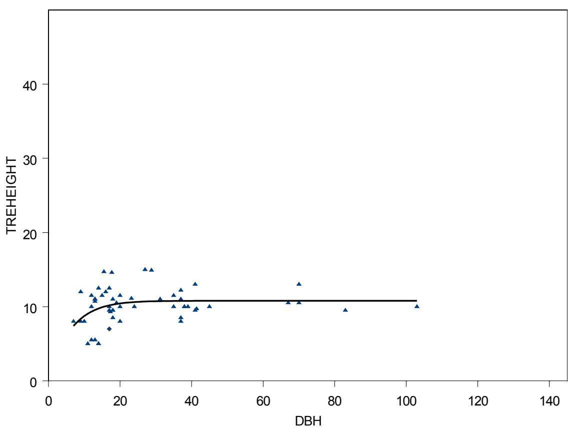
Quercus suber



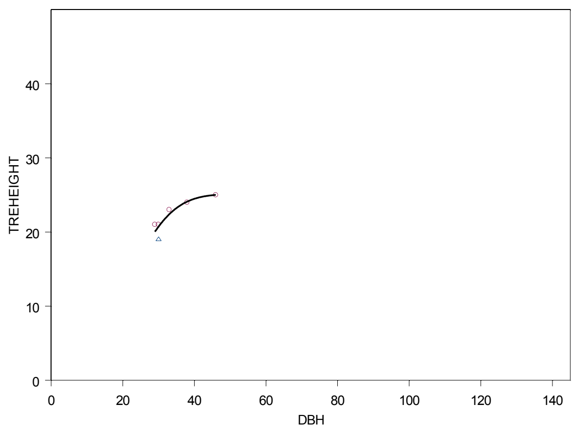
Corylus avellana

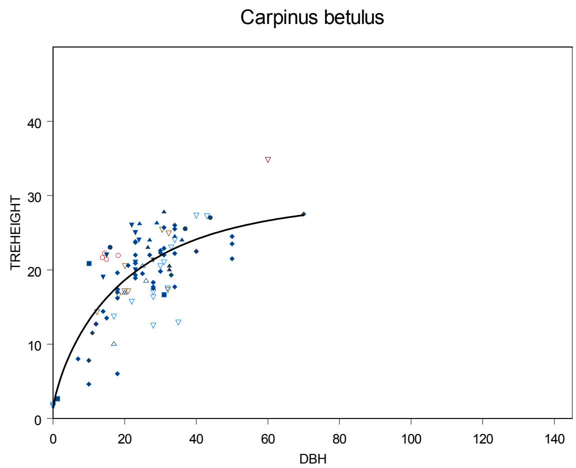


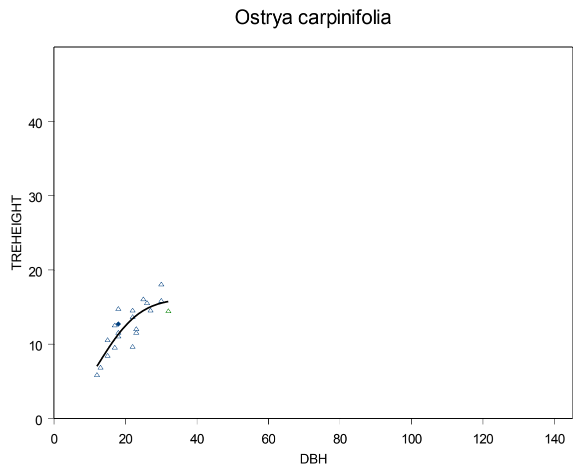
Quercus pyrenaica

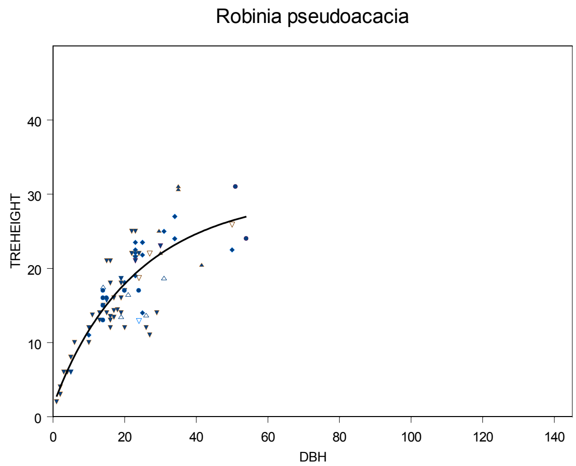


Platanus orientalis

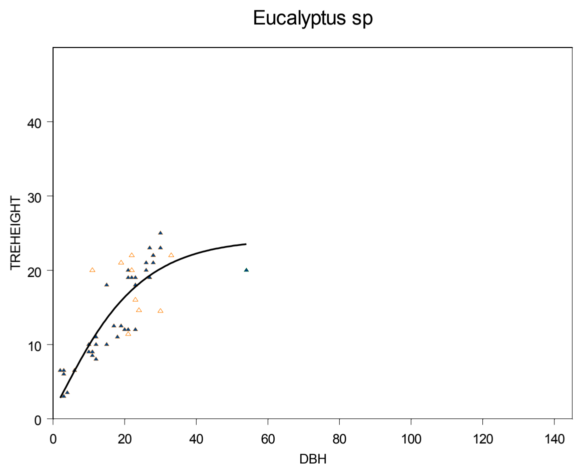


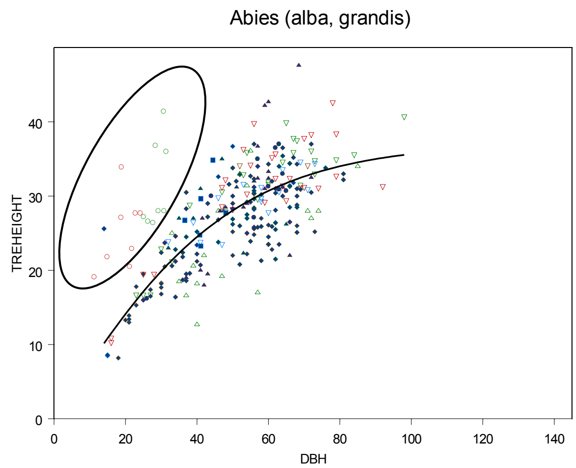






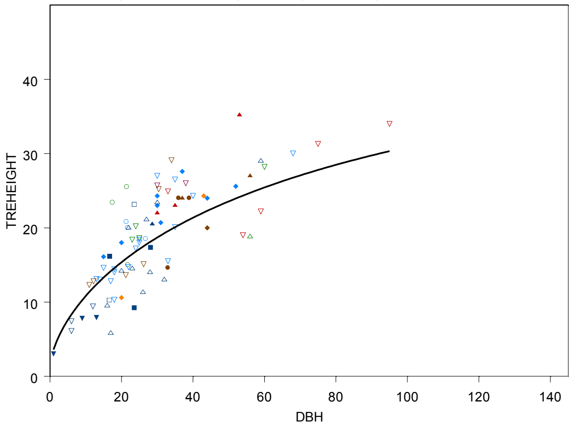
B. Genus curves



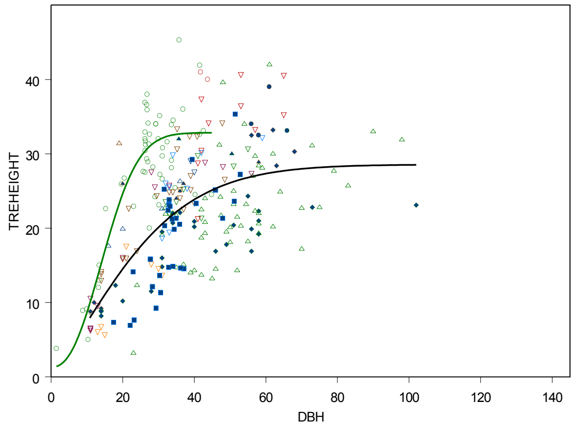


*AT data excluded from fit (16 obs - ringed, all outliers)

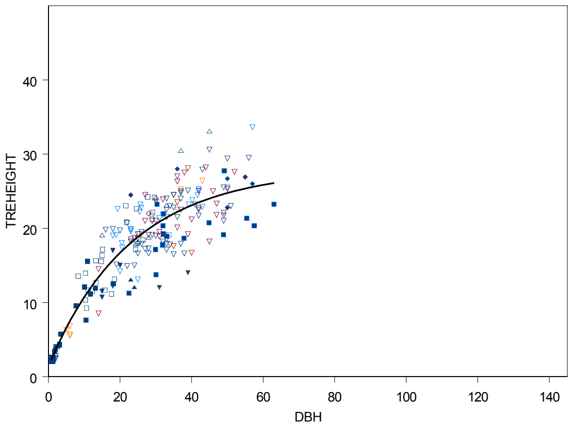
Acer (campestre, monspessulanum, opalus, platanoides, pseudoplatanus)



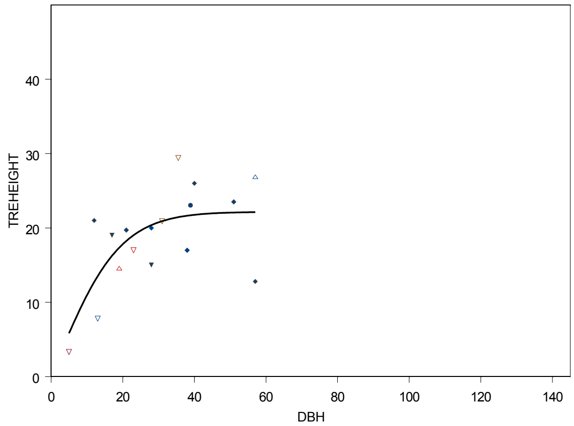
Larix (decidua, kaempferi)



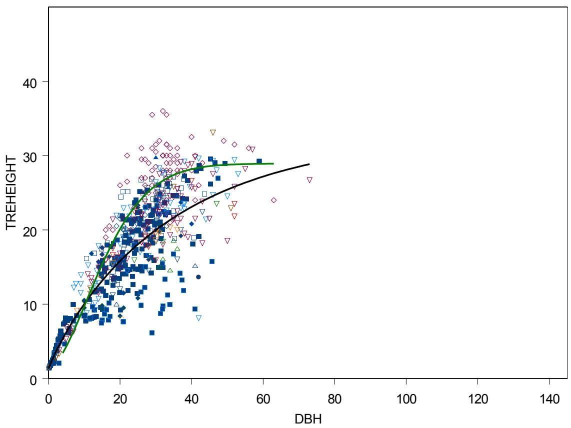
Alnus (glutinosa, incana, cordata)



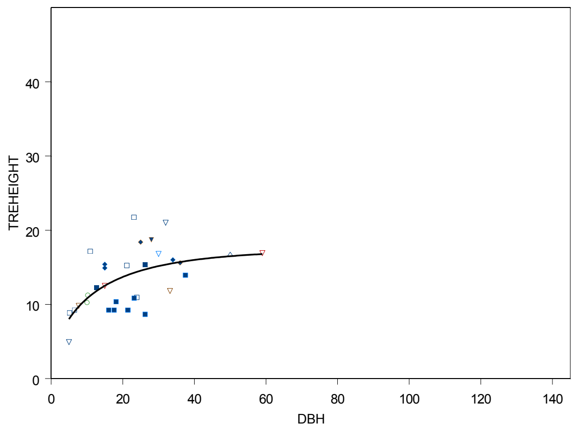
Prunus (padus, avium, serotina)



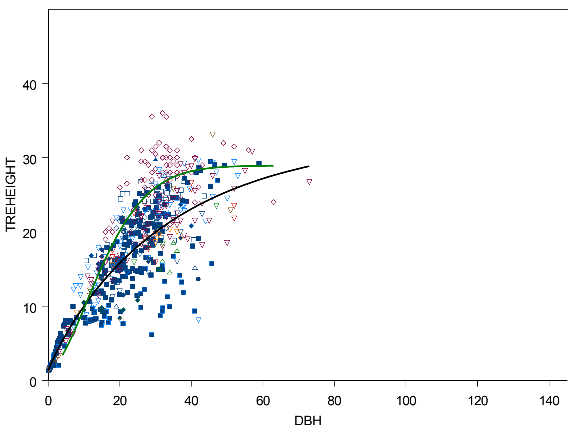
Betula (pendula, pubescens)



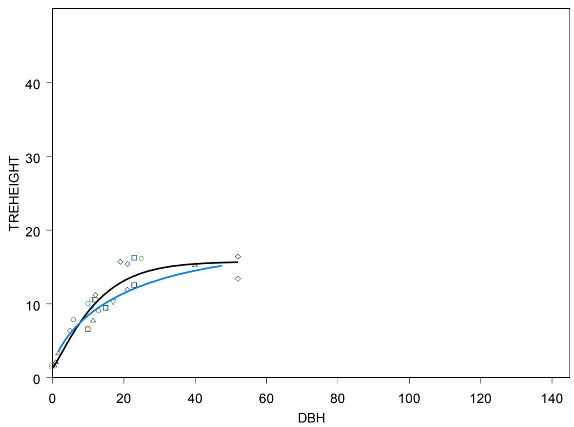
Salix (alba, caprea, cinera, fragilis, sp)

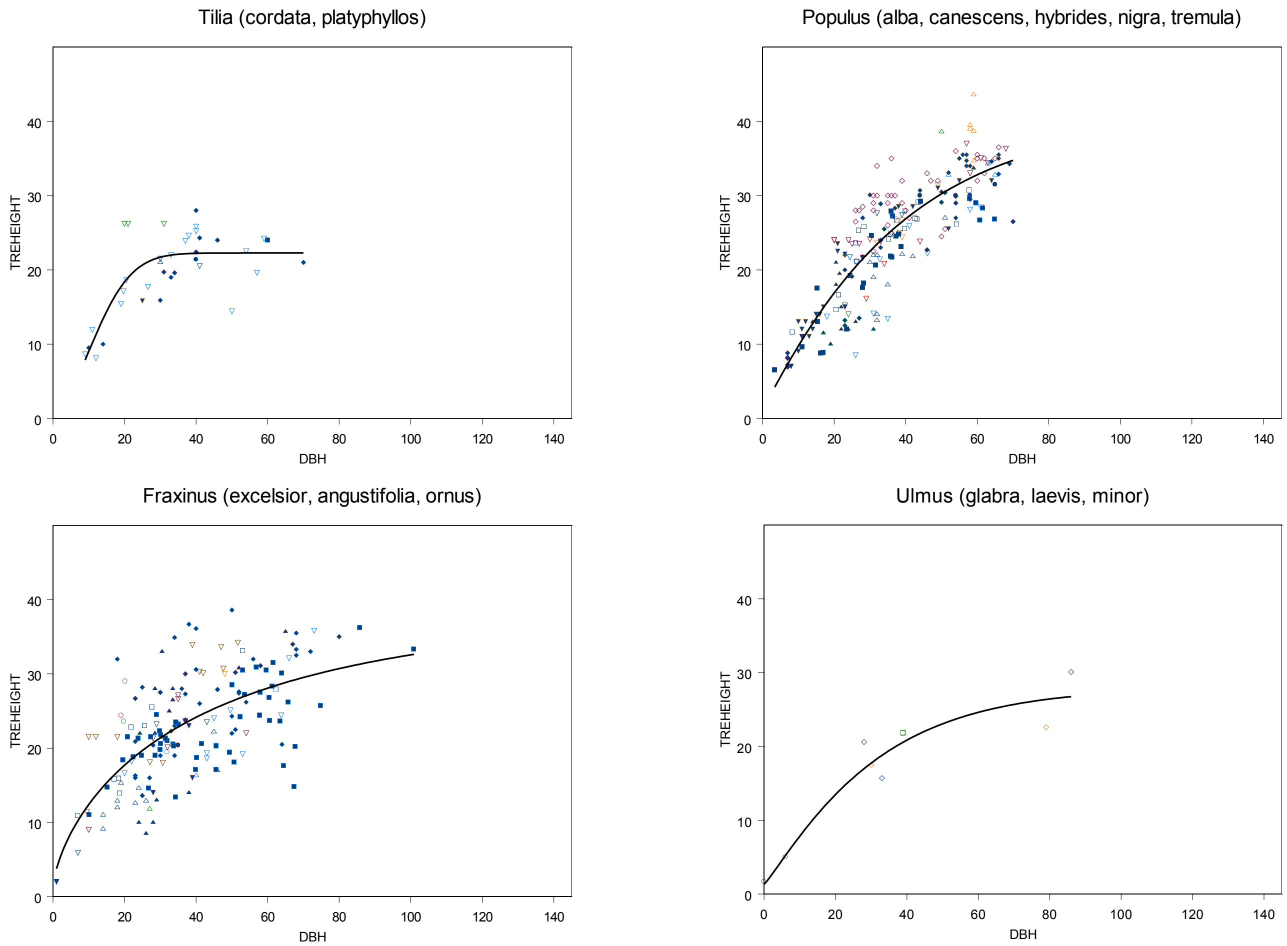


Betula (pendula, pubescens)



Sorbus (aria, aucuparia, domestica, torminalis)




Tilia (cordata, platyphyllos)
Populus (alba, canescens, hybrides, nigra, tremula)
Fraxinus (excelsior, angustifolia, ornus)
Ulmus (glabra, laevis, minor)
TREHEIGHT
DBH
0
10
20
30
40
60
80
100
120
140

12.6 Appendix 6: Distribution of the most commonly recorded tree species

The following pages show the distribution of some of the most widely recorded tree species (22 broadleaves and 10 conifers).

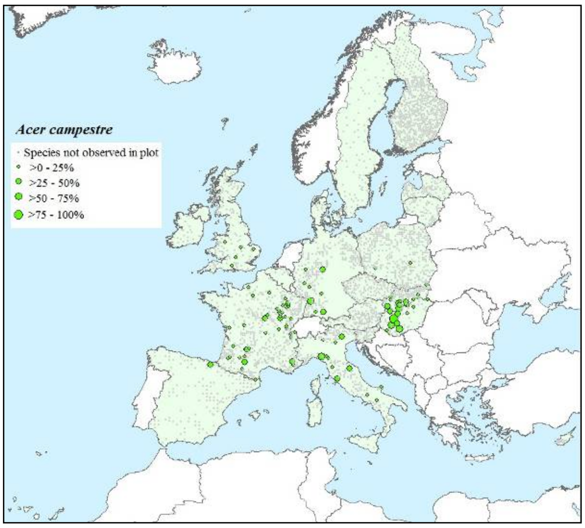
The sizes of the symbols signify the relative proportion of that species within the plot, relative to the total number of trees recorded in the same plot. The proportions are calculated on the estimated numbers of trees of each species in the plot, weighted to take into account the different sampling thresholds in each of the subplots (for a full description of the method, please refer to section 6.4).

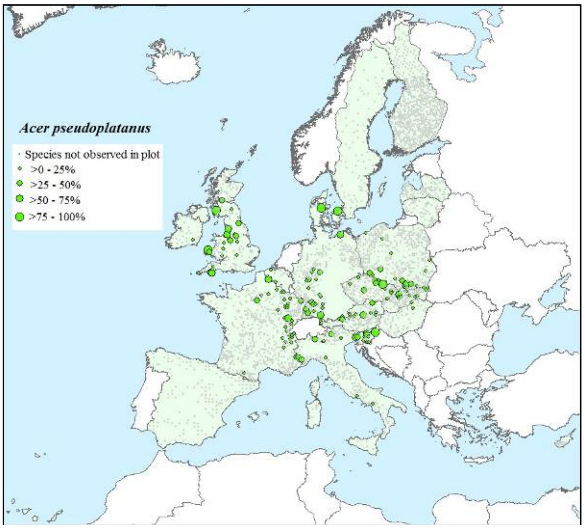
Broadleaves

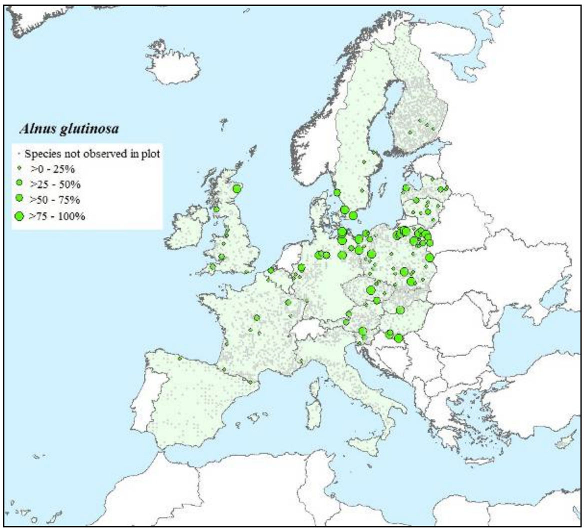
Acer campestre
Acer pseudoplatanus
Alnus glutinosa
Alnus incana
Betula pundula
Betula pubescens
Carpinus betulus
Crataegus monogyna
Castanea sativa
Corylus avellana
Fagus sylvatica
Fraxinus excelsior
Populus tremula
Prunus avium
Quercus cerris
Quercus ilex
Quercus petraea
Quercus pubescens
Quercus robur
Robinia pseudoacacia
Salix caprea
Sorbus aucuparia

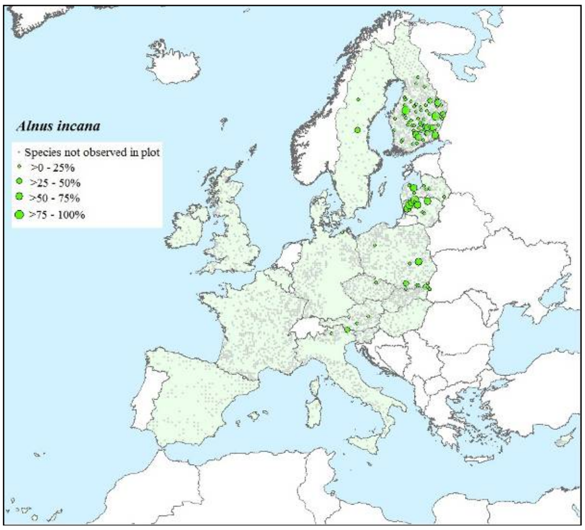
Conifers

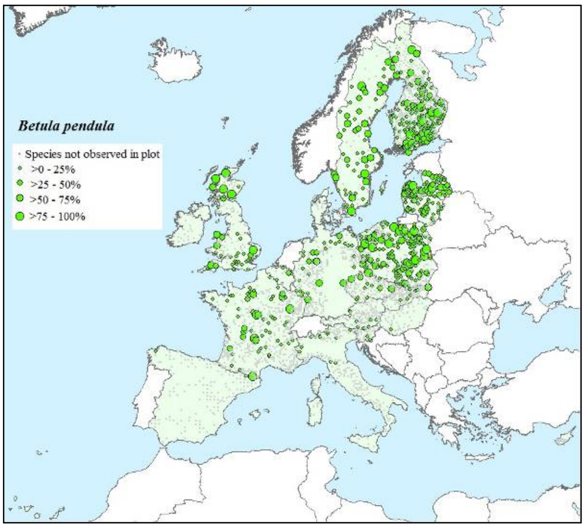
Abies alba
Juniperus communis
Larix decidua
Picea abies
Picea sichensis
Pinus halapensis
Pinus nigra
Pinus pinaster
Pinus sylvestris
Pseudotsuga menziesii

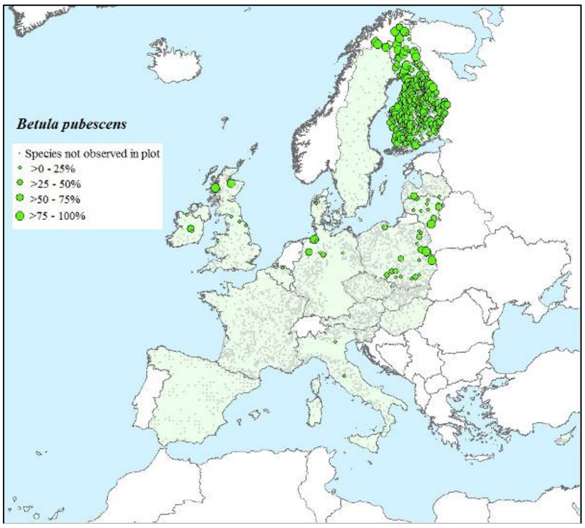

Acer campestre
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%

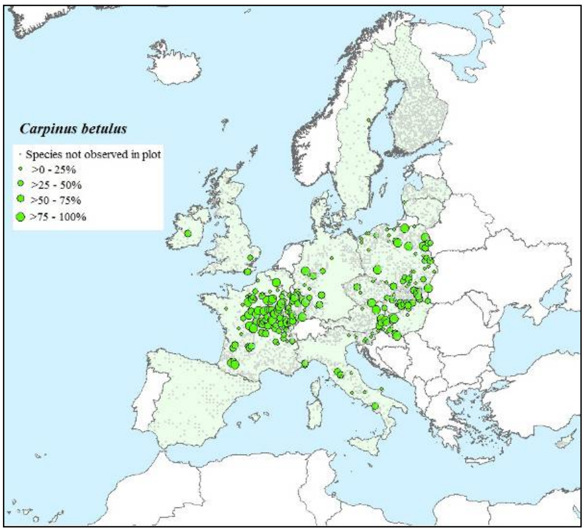

Acer pseudoplatanus
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%

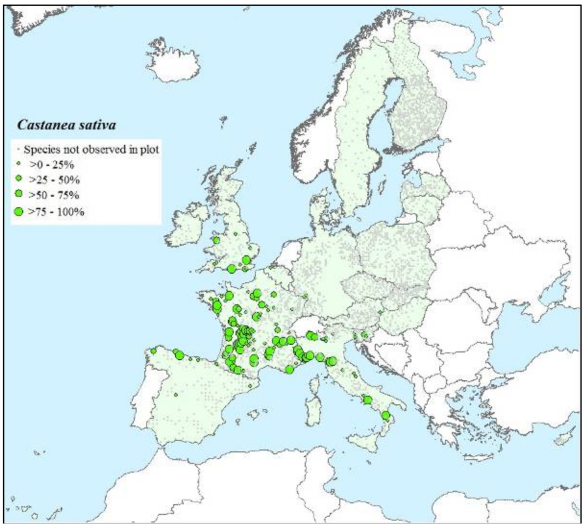

Alnus glutinosa
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%

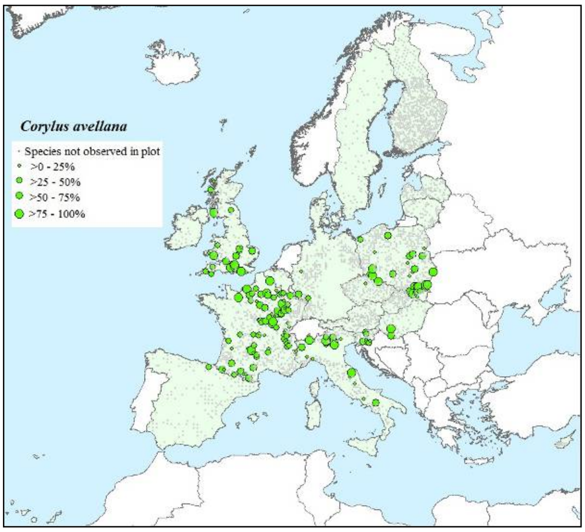

Alnus incana
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%

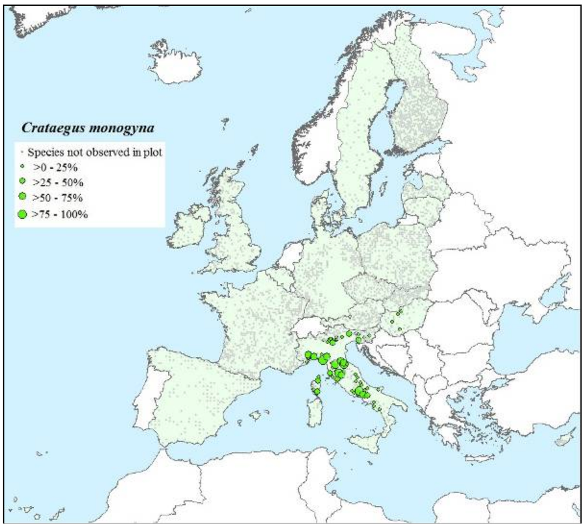

Betula pendula
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%

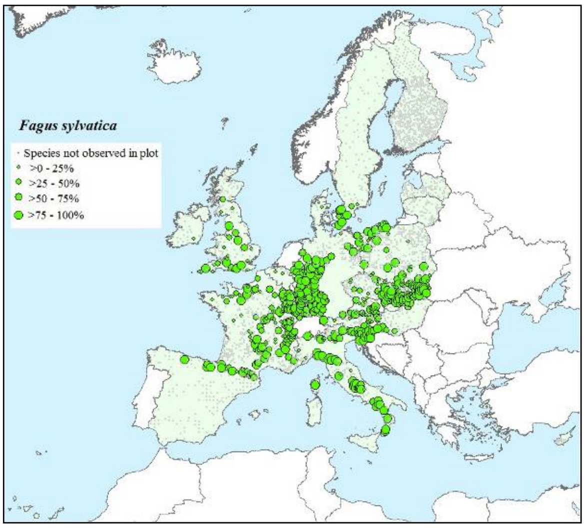

Betula pubescens
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%

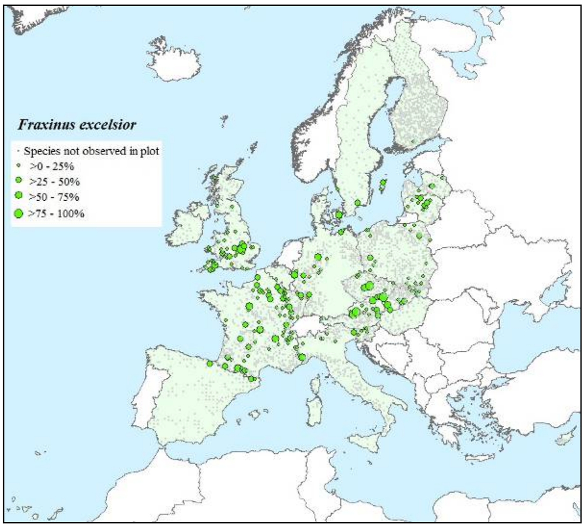

Carpinus betulus
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%

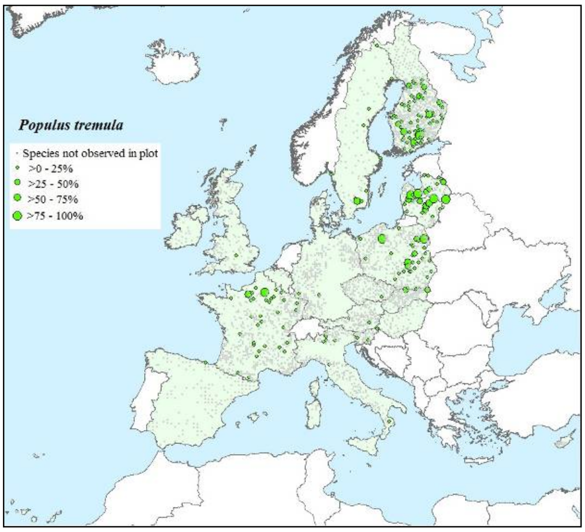

Castanea sativa
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%

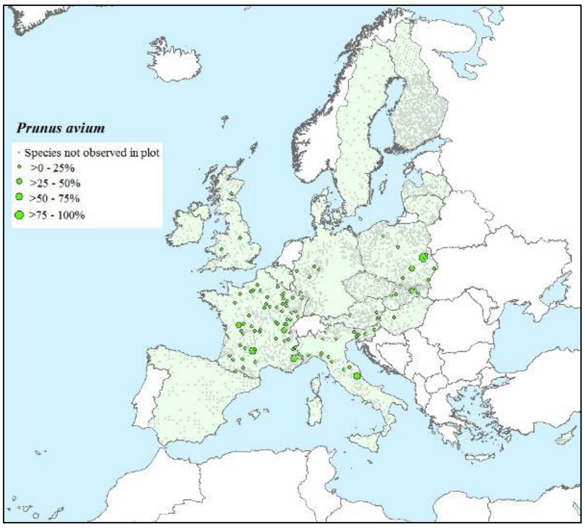

Corylus avellana
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%

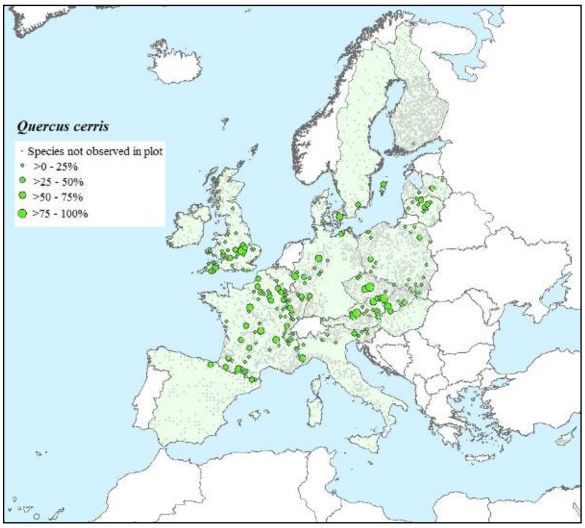

Crataegus monogyna
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%

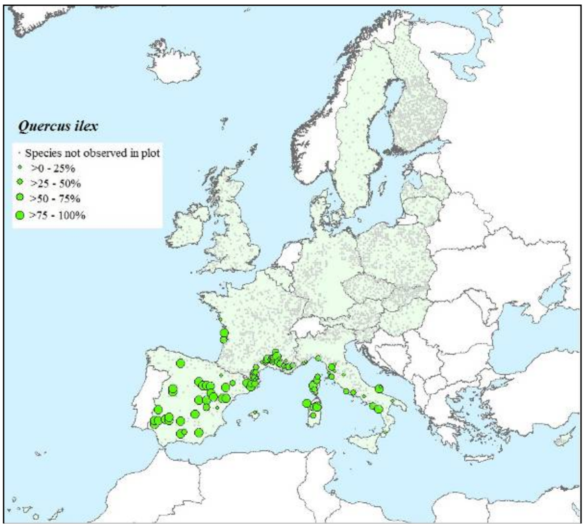

Fagus sylvatica
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%

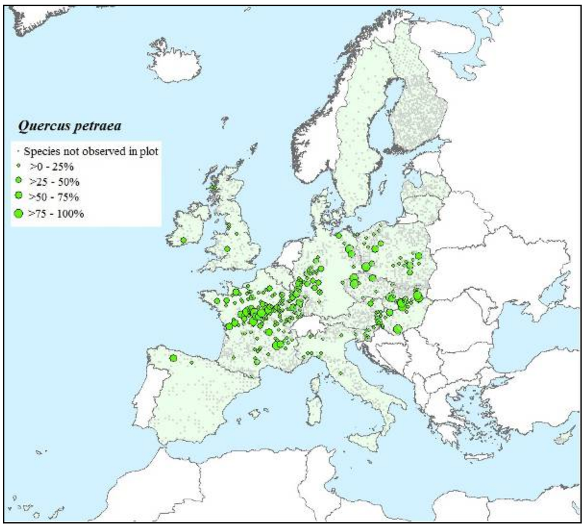

Fraxinus excelsior
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%

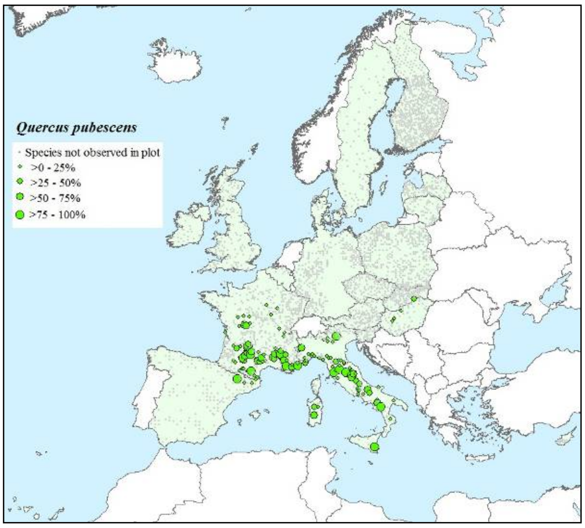

Populus tremula
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%

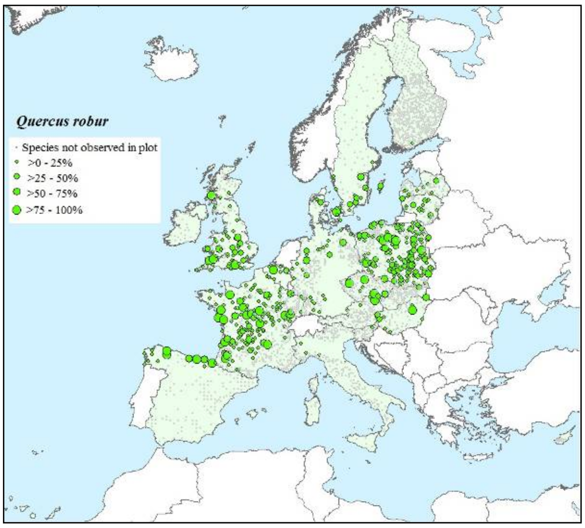

Prunus avium
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%

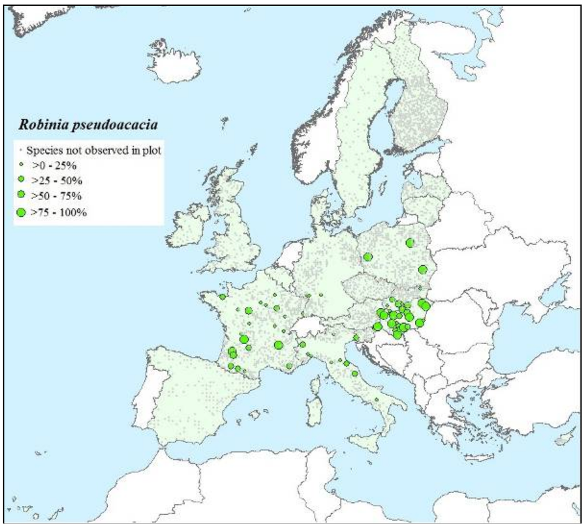

Quercus cerris
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%

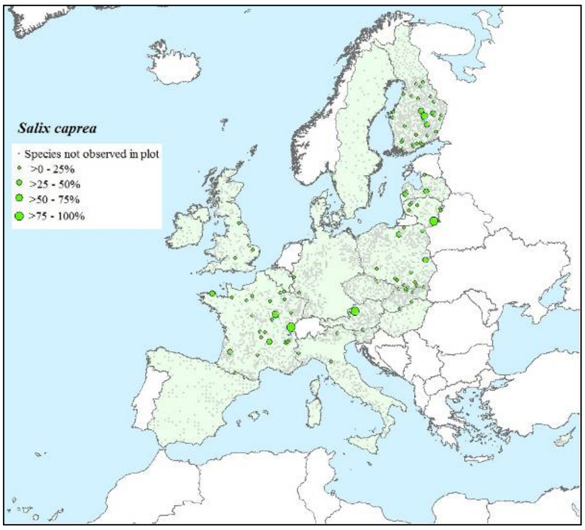

Quercus ilex
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%

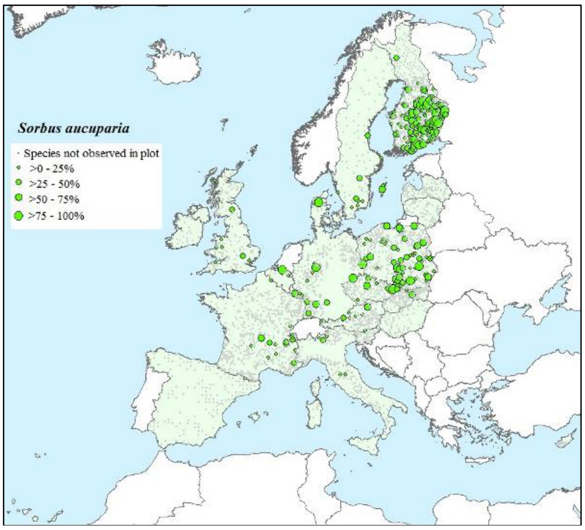

Quercus petraea
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%

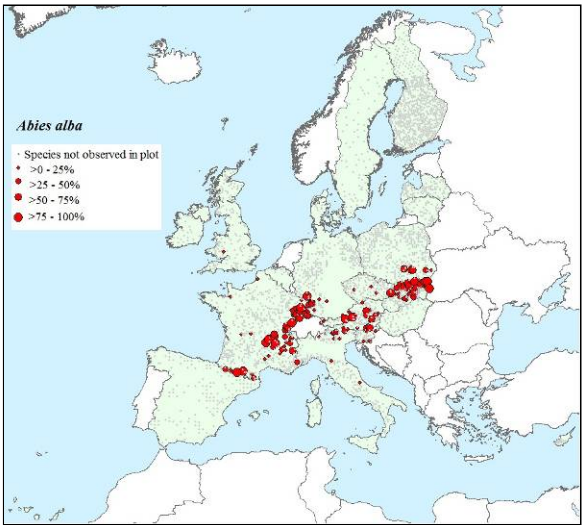

Quercus pubescens
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%

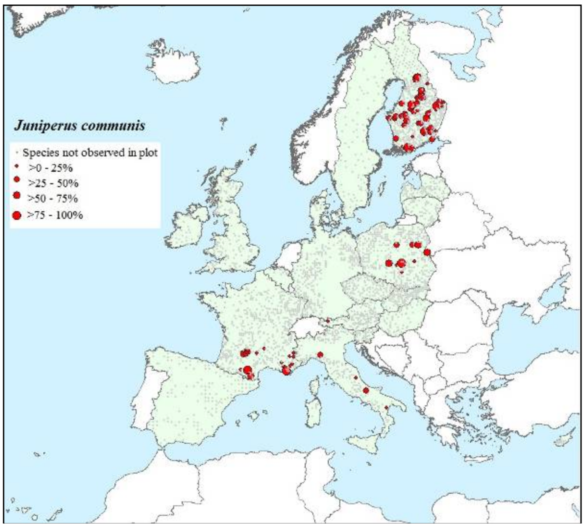

Quercus robur
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%

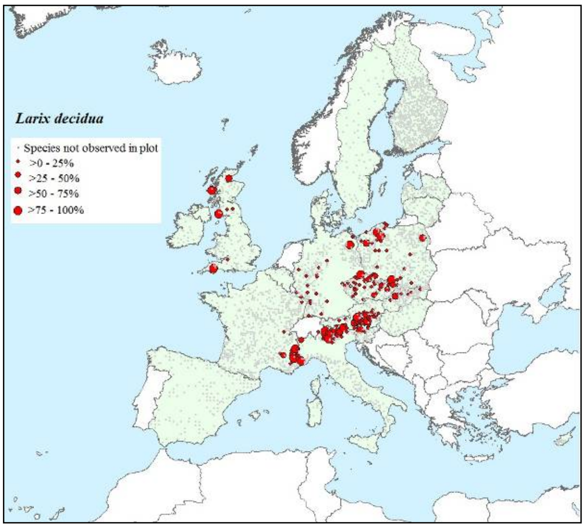

Robinia pseudoacacia
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%

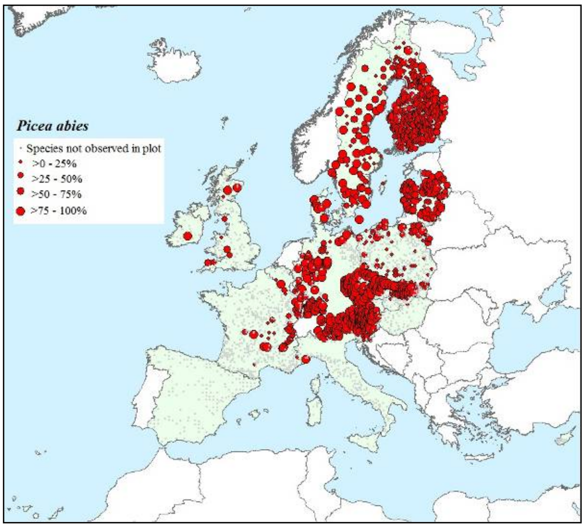

Salix caprea
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%

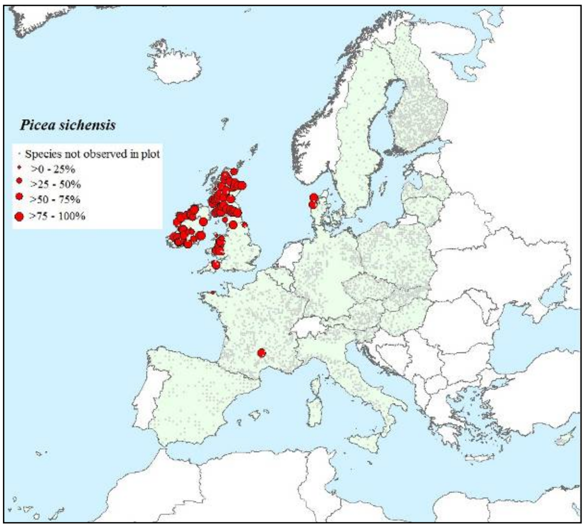

Sorbus aucuparia
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%

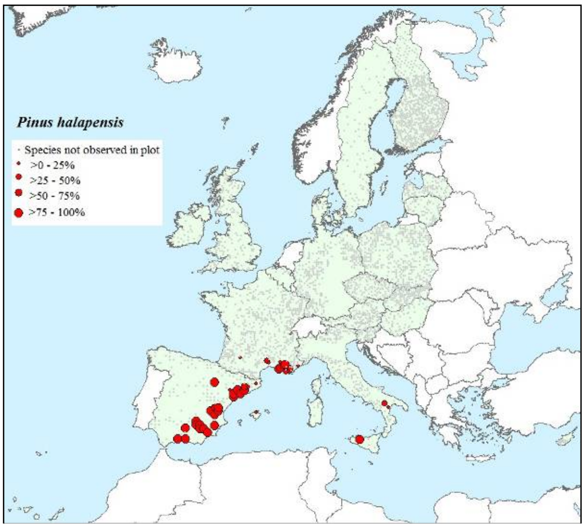

Abies alba
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%

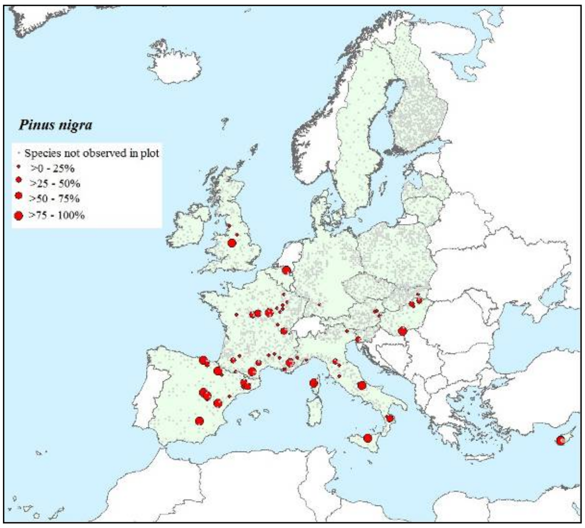

Juniperus communis
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%

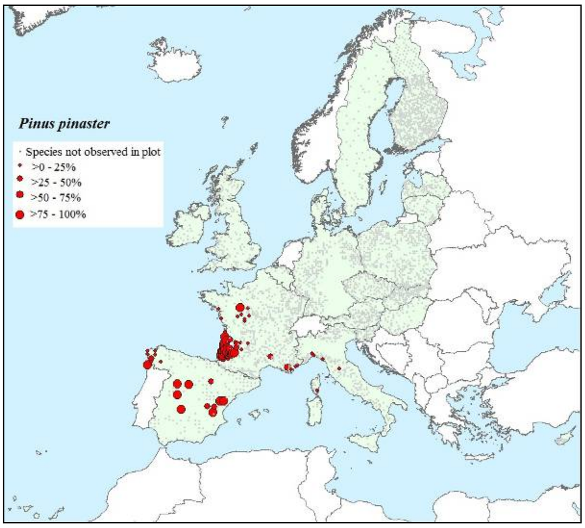

Larix decidua
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%

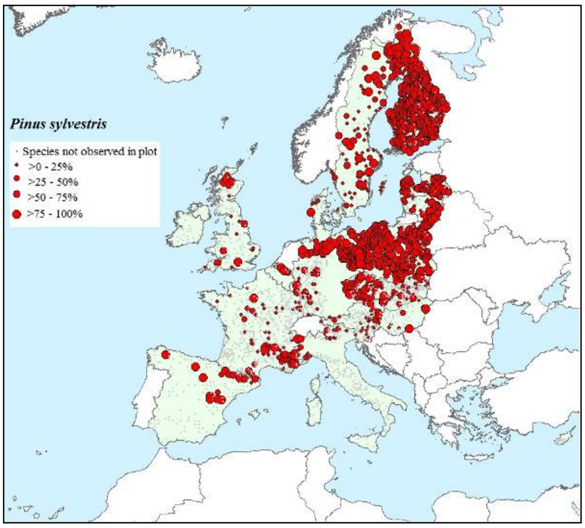

Picea abies
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%

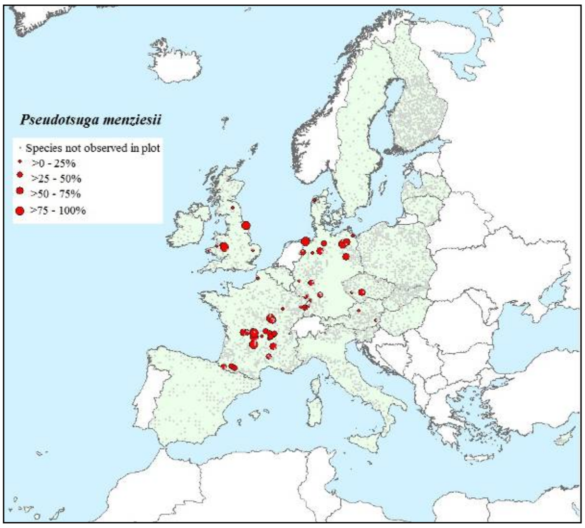

Picea sichensis
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%


Pinus halapensis
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%


Pinus nigra
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%


Pinus pinaster
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%

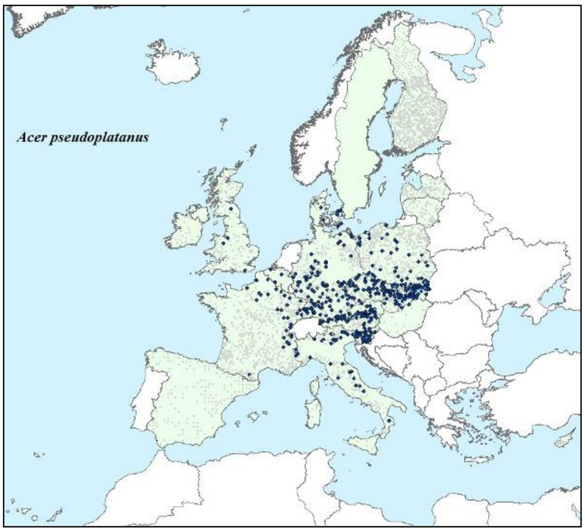

Pinus sylvestris
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%

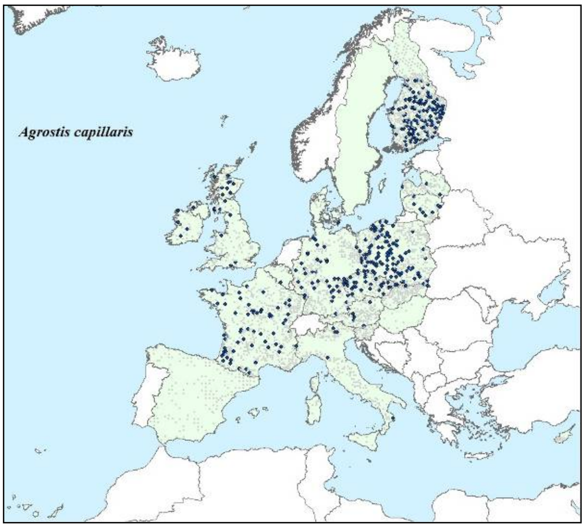

Pseudotsuga menziesii
Species not observed in plot
>0 - 25%
>25 - 50%
>50 - 75%
>75 - 100%

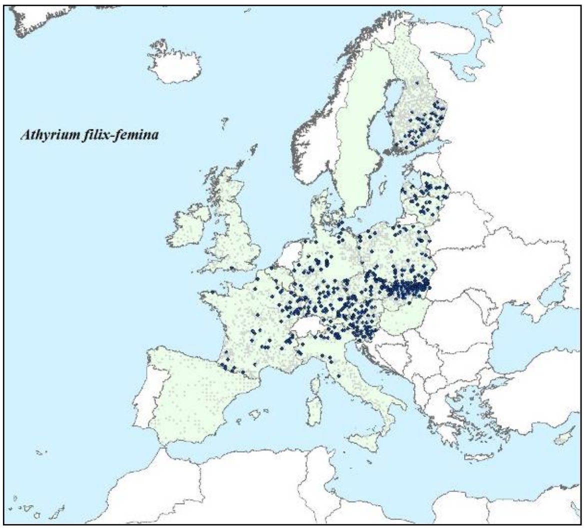
12.7 Appendix 7: Distribution of the most commonly found ground vegetation species

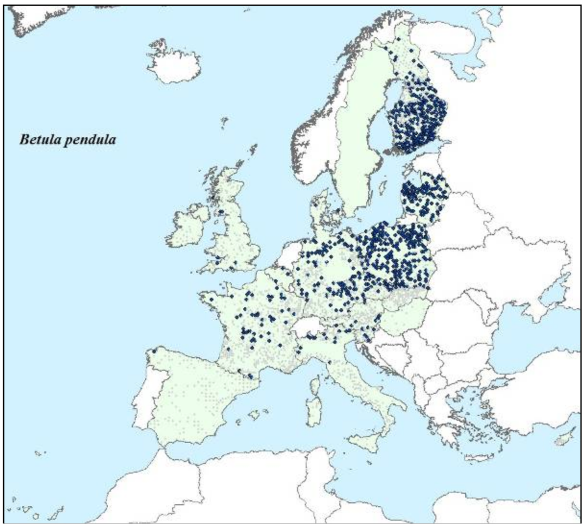
The following pages show maps of the distribution of the most widely recorded ground vegetation species:

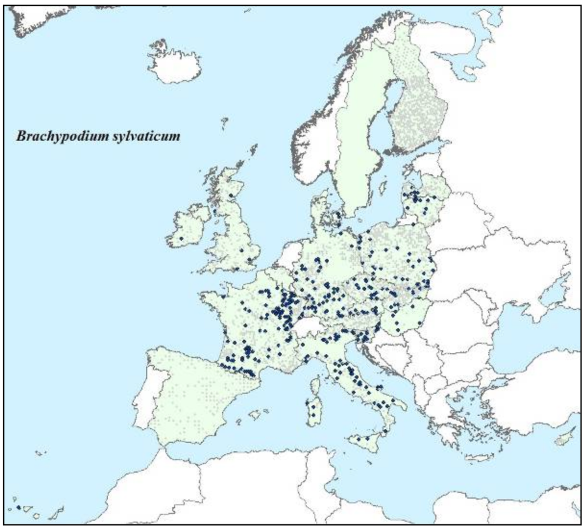
Acer pseudoplatanum
Agrostis capillaries
Athyrium filix-femina
Betula pendula
Brachypodium sylvaticum
Calamagrostis arundinacea
Calluna vulgaris
Carpinus betulus
Convallaria majalis
Corylus avellana
Crataegus monogyna
Dactylis glomerata
Deschampsia cespitosa
Deschampsia flexuosa
Dryopteris carthusiana
Dryopteris dilatata
Dryopteris filix-maas
Epilobium angustifolium
Fagus sylvatica
Fragaria vesca
Frangula alnus
Fraxinus excelsior
Hedera helix
Luzula pilosa
Maianthemum bifolium
Mycelis muralis
Oxalis acetosella
Picea abies
Pinus sylvestria
Populus tremula
Pteridium aquilinum
Quercus robur
Rubus idaeus
Salix caprea
Sambucus nigra
Solidago vigaurea
Sorbus aucuparia
Urtica dioica
Vaccinium myrtillus
Vaccinium vitis-idaea

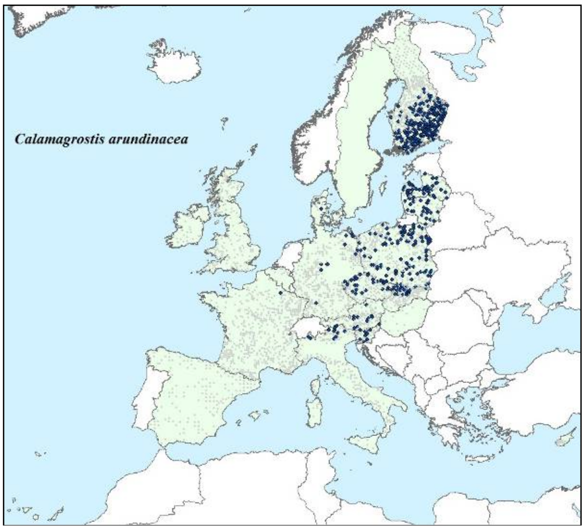

Acer pseudoplatanus

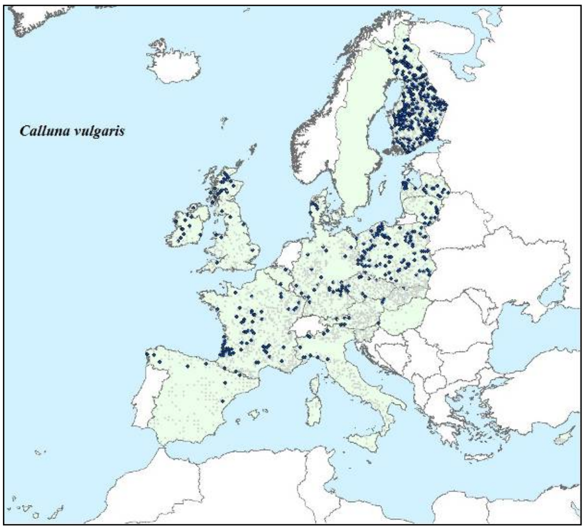

Agrostis capillaris

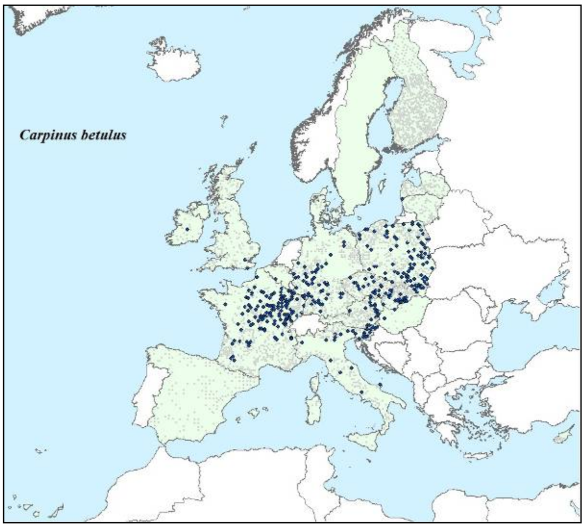

Athyrium filix-femina

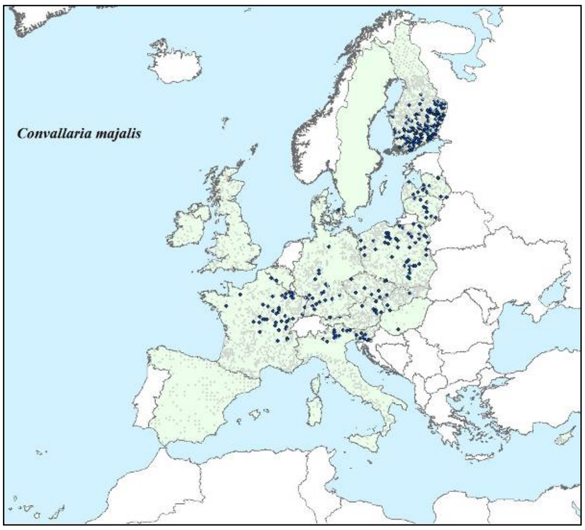

Betula pendula

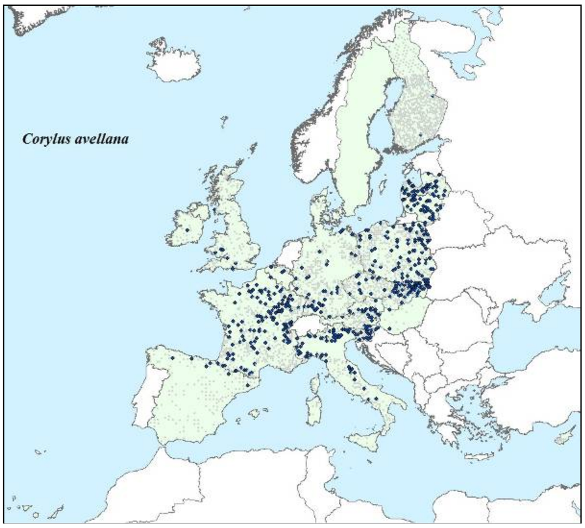

Brachypodium sylvaticum

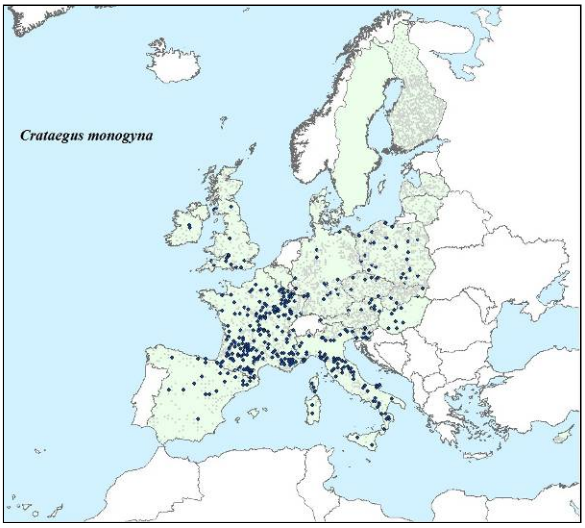

Calamagrostis arundinacea

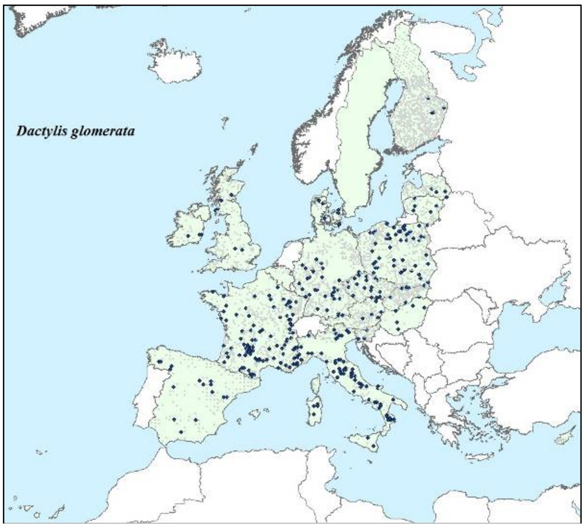

Calluna vulgaris

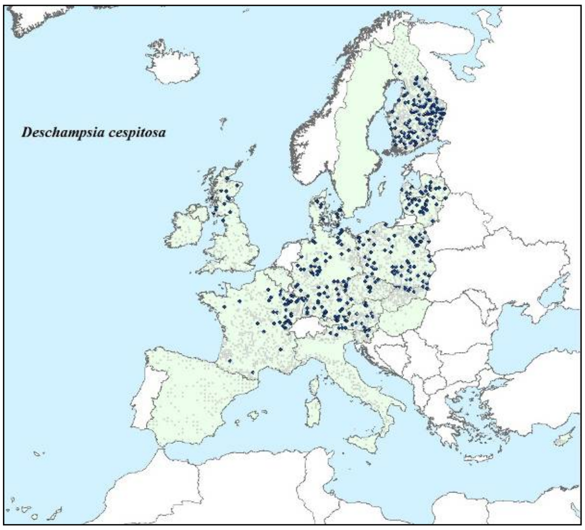

Carpinus betulus

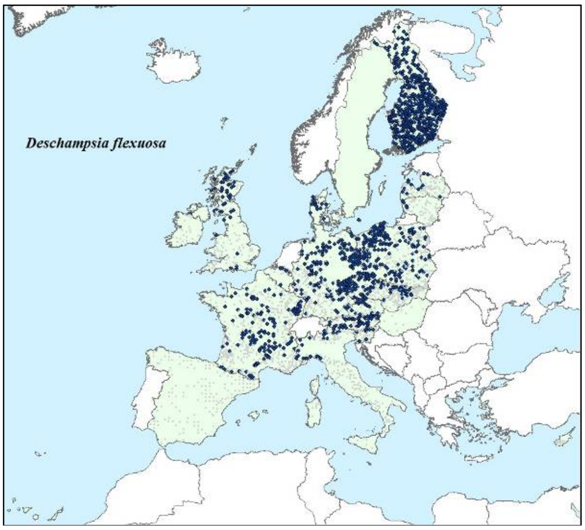

Convallaria majalis

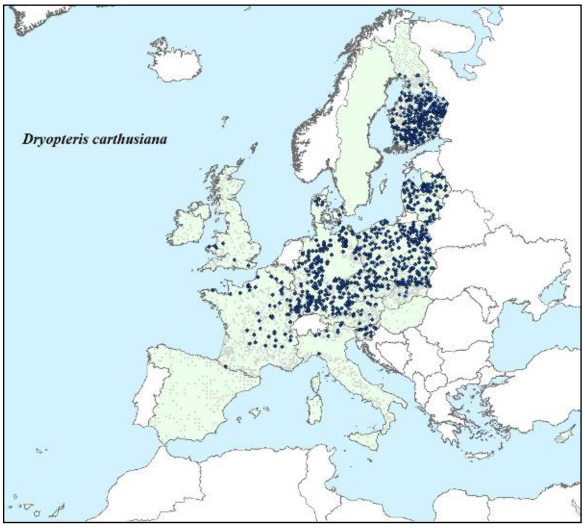

Corylus avellana

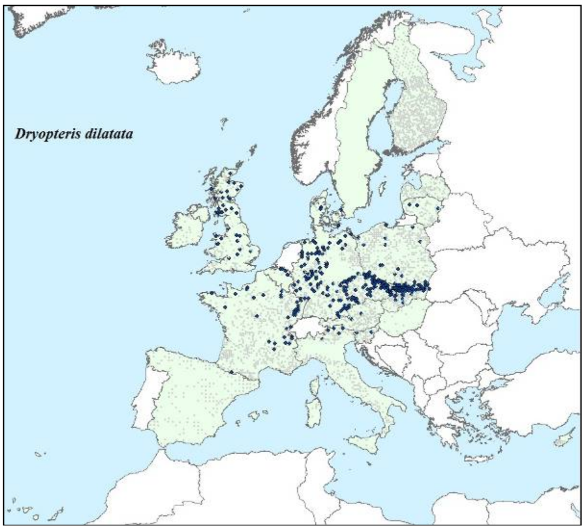

Crataegus monogyna

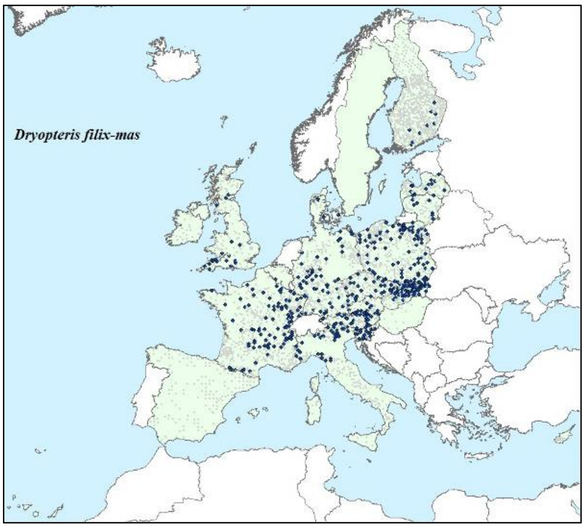

Dactylis glomerata

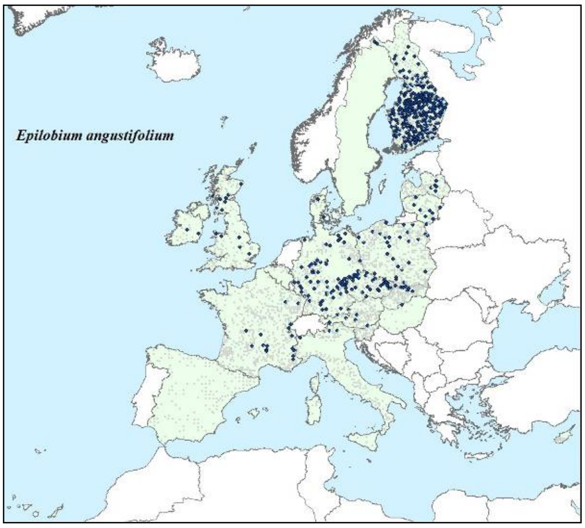

Deschampsia cespitosa

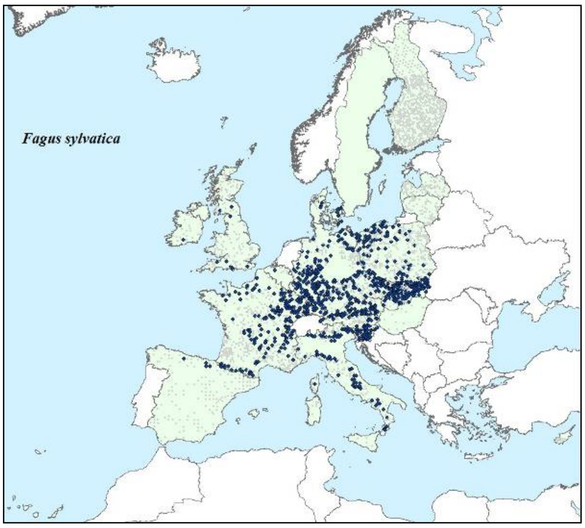

Deschampsia flexuosa

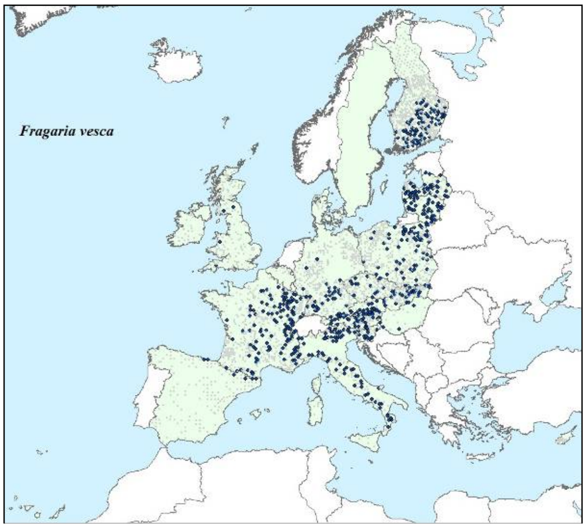

Dryopteris carthusiana

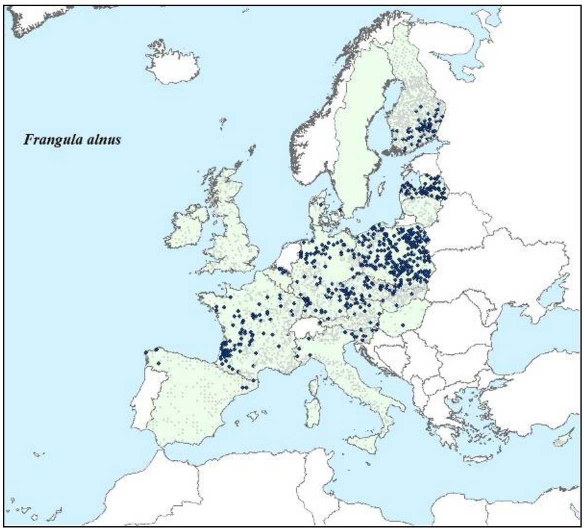

Dryopteris dilatata


Dryopteris filix-mas


Epilobium angustifolium


Fagus sylvatica


Fragaria vesca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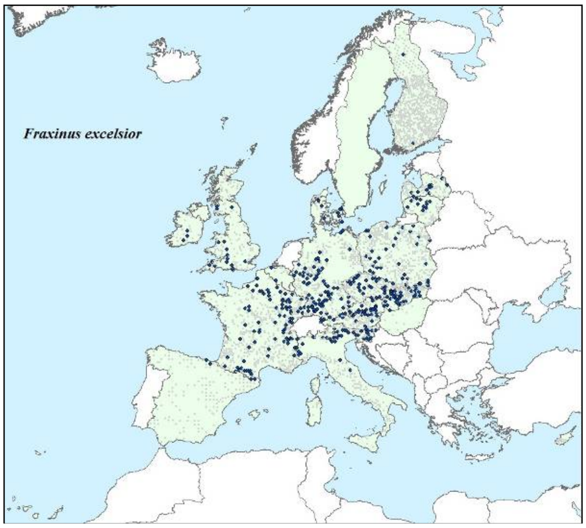
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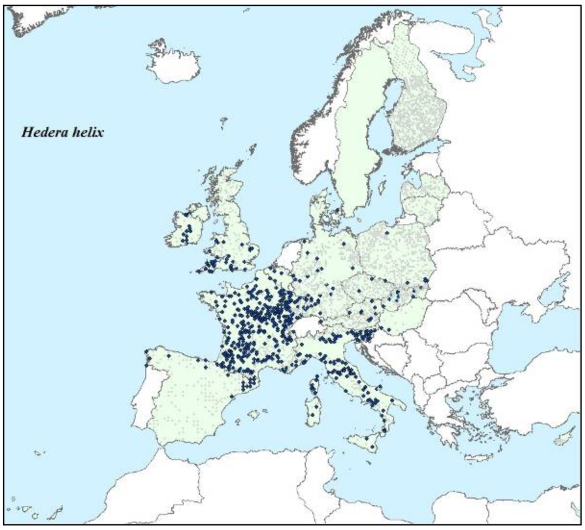
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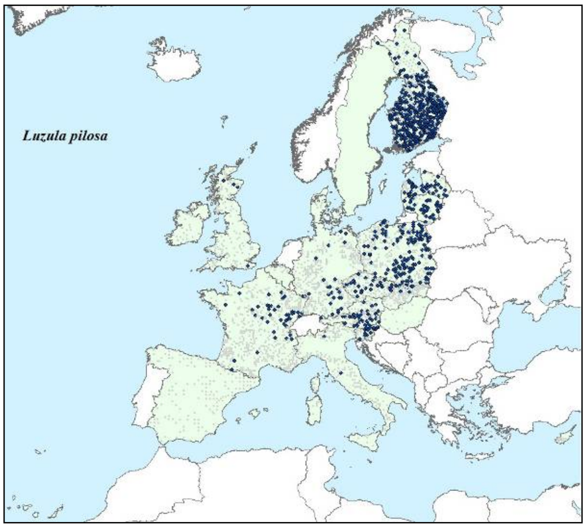
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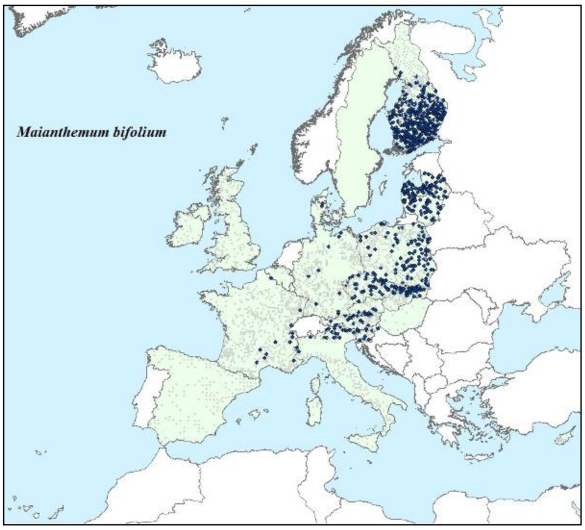
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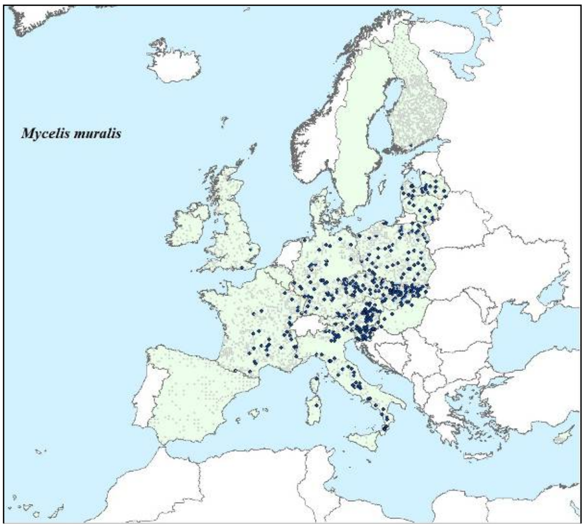
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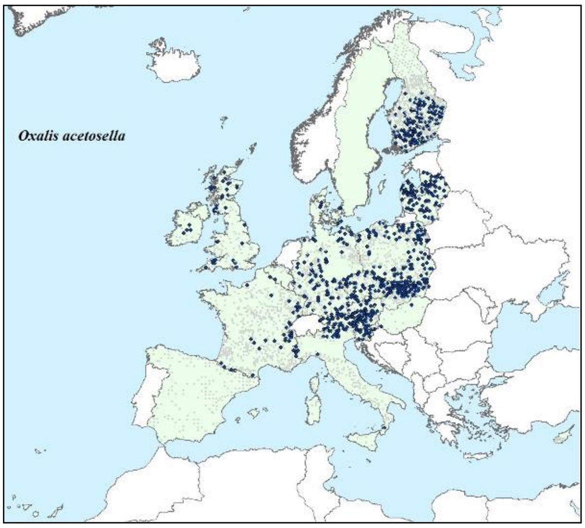
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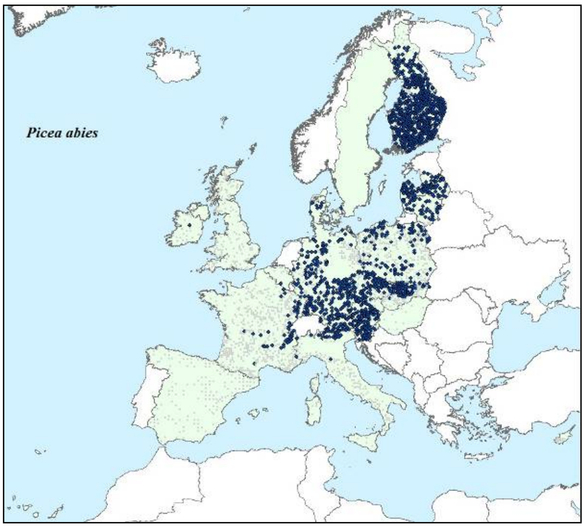
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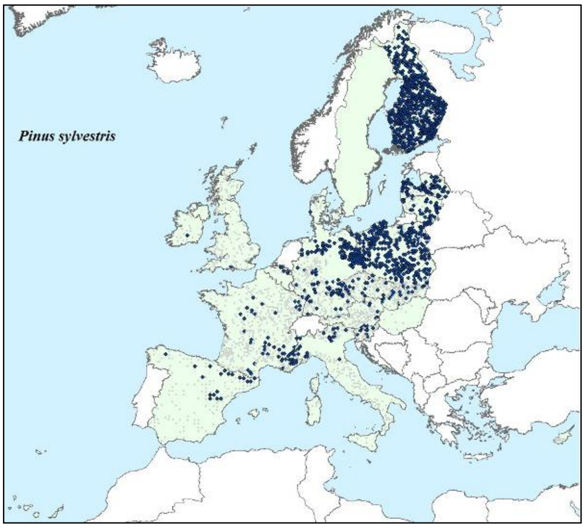
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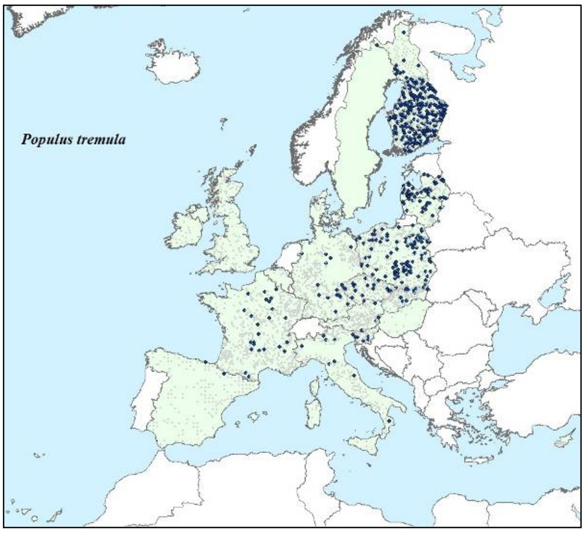
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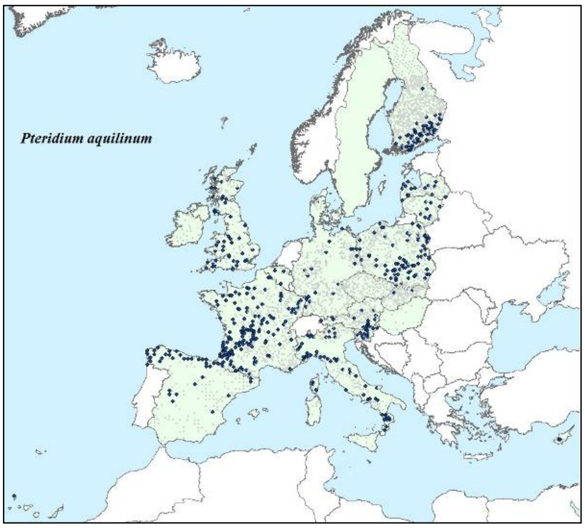
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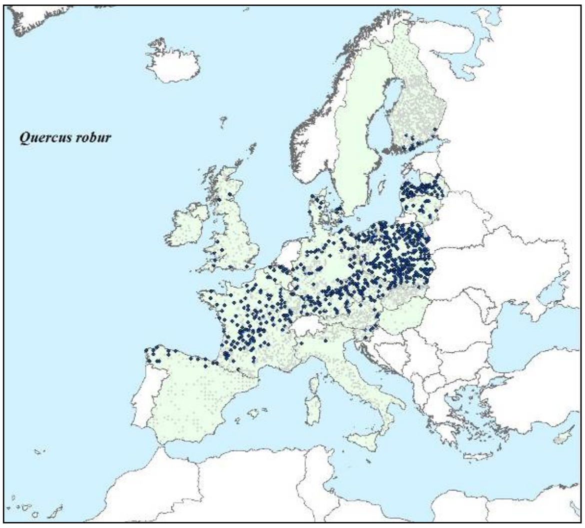
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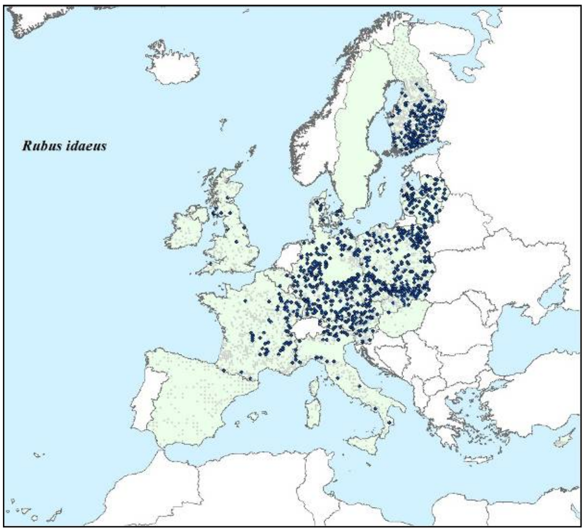
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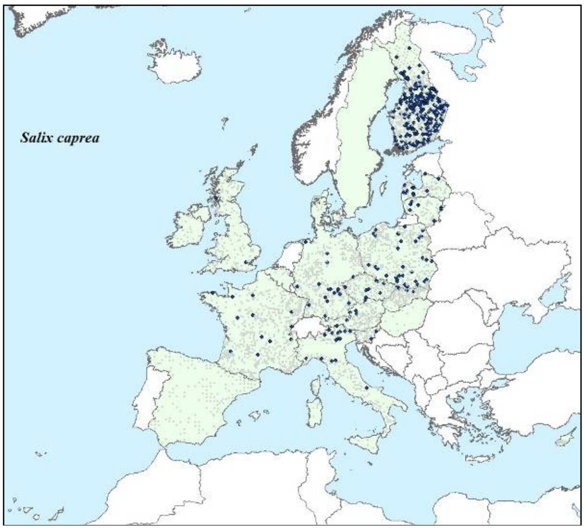
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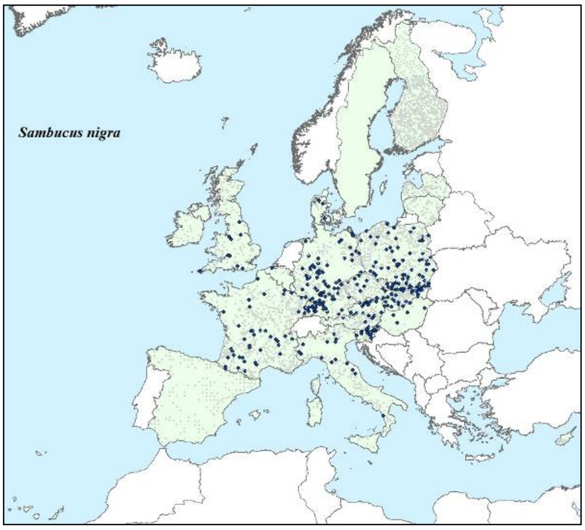
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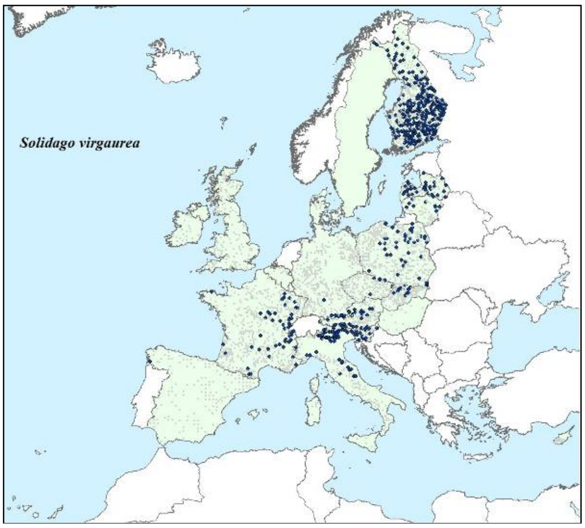
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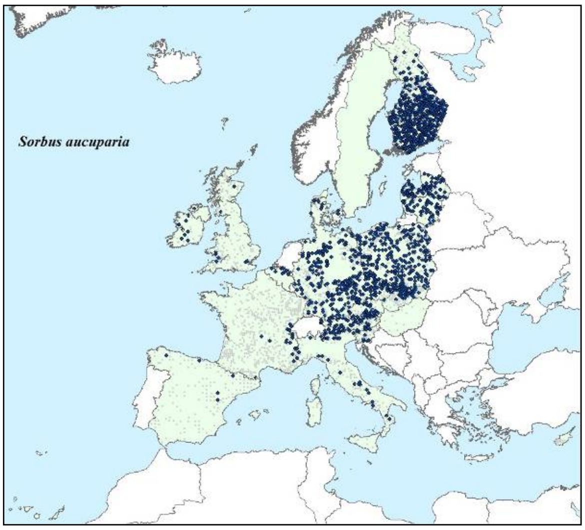
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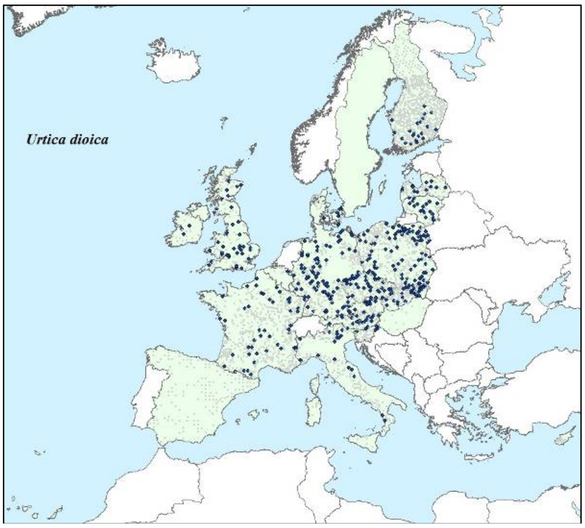
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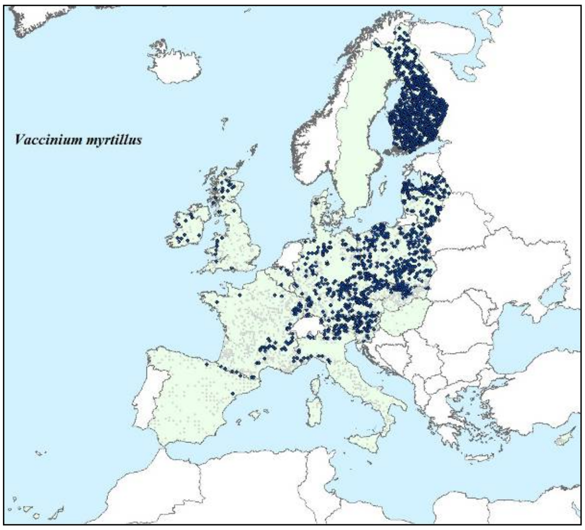
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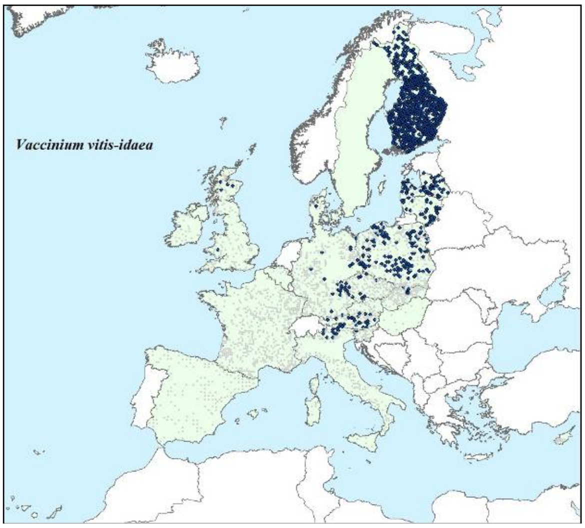
Vaccinium vitis-idaea

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Abstract
The BioSoil demonstration Project was initiated under the Forest Focus-Scheme (Regulation (EC) Nr. 2152/2003) concerning the monitoring of forests and environmental interactions in the Community, and aimed to broaden the scope of previous forest monitoring activities (on atmospheric pollution and forest fires) to the fields of soil characteristics and biodiversity indicators. The results presented here are from the Biodiversity module in which various aspects of forest biodiversity, including species composition, structural elements and deadwood, were assessed over 3379 plots in Europe.
As a test of practical indicators of forest biodiversity the project was successful, and the project has produced a common baseline on forest biodiversity information where changes over time and space can be monitored in the future. This is of particular relevance to the EU biodiversity policy and for the assessment of the new 2020 biodiversity goals. A number of recommendations can be made regarding the simplification and streamlining of procedures for future similar surveys.

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