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Institute for World Forestry

Forest Condition in Europe

2009 Technical Report of ICP Forests

by

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2009 Technical Report of ICP Forests

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CONTENTS

PREFACE

The countries of Europe consider the monitoring of forest condition as an indispensable source of scientific information for several processes of international environmental and forest politics. Forest condition in Europe has been monitored since 1986 by the International Co-operative Programme on the Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) in the framework of the Convention on Long-range Transboundary Air Pollution (CLRTAP) under the United Nations Economic Commission for Europe (UNECE). The number of countries participating in ICP Forests has meanwhile grown to 41 including Canada and the United States of America, rendering ICP Forests one of the largest biomonitoring networks of the world. ICP Forests has been chaired by Germany from the beginning on. Its activities are being coordinated by the Programme Coordinating Centre (PCC) at the Institute for World Forestry of the Johann Heinrich von Thünen-Institute (vTI).

Aimed mainly at the assessment of effects of air pollution on forests, ICP Forests provides scientific information to CLRTAP as a basis of legally binding protocols on air pollution abatement policies. For this purpose ICP Forests developed a harmonised monitoring approach comprising a large-scale (Level I) as well as an intensive (Level II) monitoring approach laid down in the ICP Forests Manual. The participating countries have obliged themselves to submit their monitoring data to PCC for validation, storage, and analysis.

In view of its obligations under CLRTAP ICP Forests will continue to focus on air pollution effects on forests, but its well developed monitoring system is useful also for other processes of international environmental politics. In particular it may provide information on several indicators for sustainable forest management laid down by the Ministerial Conference on the Protection of Forests in Europe (MCPFE). It may also provide information on species diversity and carbon sequestration as requested by the United Nations Framework Conventions on Climate Change (UNFCCC) and on Biological Diversity (CBD). Moreover, this information is useful for several bodies of the European Commission (EC), including DG Environment (DG Env), the Joint Research Centre (DG JRC), and the European Forest Data Centre (EFDAC). For this reason, ICP Forests has started to further develop forest monitoring in Europe in close cooperation with another project conducted in 2009 and 2010 by vTI with 37 partners from almost all EU-Member States. This project is named “Further Development and Implementation of an EU-level Forest Monitoring System” (FutMon) and is co-financed by EC under Regulation “LIFE+”.

SUMMARY

Of the 41 countries participating in ICP Forests, 27 countries reported national results of crown condition surveys in the year 2008 for 210 964 trees on 14 786 plots. The transnational result on the European-wide scale relied on 111 560 trees on 5 002 plots of the 16 x 16 km grid in 25 out of 35 participating countries.

Mean defoliation of all sample trees of the transnational survey was 20.2%. Of the main species, *Quercus robur* and *Q. petraea* had by far the highest mean defoliation (24.9%), followed by *Fagus sylvatica* (19.4%), *Picea abies* (19.3%) and *Pinus sylvestris* (18.2%). These figures are not comparable to those of previous reports because of fluctuations in the plot sample, mainly due to changes in the participation of countries. Therefore, the long-term development of defoliation was calculated from the monitoring results of those countries which have been submitting data since 1990 every year without interruption. In the period of observation the species group *Quercus ilex* and *Quercus rotundifolia* shows the severest increase in defoliation, with 10.3% in 1990 and 21.2% in 2008. A similar increase in defoliation, namely from 11.1% to 20.4%, was experienced by *Pinus pinaster*. Defoliation of these Mediterranean species is largely attributed to several summer drought events. Defoliation of *Fagus sylvatica* increased from 17.9% to 19.7%. In contrast, *Picea abies*, *Quercus robur* and *Quercus petraea* and in particular of *Pinus sylvestris* recuperated from peaks in defoliation in the mid 1990s.

The spatial and temporal variation of bulk deposition and throughfall of sulphate, nitrate, ammonium, calcium, sodium and chlorine was analysed as a basis of ongoing and future studies. Between 174 and 302 intensive monitoring plots were involved in the study. Mean deposition of the years 2004 - 2006 shows spatial patterns reflecting partly regional emission situations. The temporal variation was calculated for the period 2001 - 2006. Sulphur throughfall decreased from 6.0 kg ha^{-1} yr^{-1} in 2001 to 4.5 kg ha^{-1} yr^{-1} in 2006. Bulk deposition of sulphur shows a similar decrease at a lower level, namely from 4.9 kg ha^{-1} yr^{-1} in 2001 to 3.6 kg ha^{-1} yr^{-1} in 2006 (corrected for sea salt input). Nitrogen deposition shows a less pronounced rate of decrease.

1. INTRODUCTION

By means of its annual Technical Report on Forest Condition in Europe ICP Forests presents its results of the large-scale transnational survey (Level I) and of analyses of the data of the intensive monitoring (Level II). The present issue is structured as follows:

Chapter 2 describes plot and tree samples as well as the methods and results of the crown condition survey at Level I in the year 2008. The description of the spatial and temporal variation of crown condition at the European-wide scale emphasizes the current status and the development of crown condition. For the first time the results are presented according to forest types instead of the previous climatic regions.

Chapter 3 provides an update of the annually reported results of the measurements of bulk deposition, throughfall deposition and their trends for ammonium, nitrate, and sulphate. For the first time chloride depositions are considered and sulphate depositions are corrected for sea salt inputs.

Chapter 4 consists of national reports by the participating countries, focussing on crown condition in 2008 as well as its development and its causes.

In Annexes I and II maps, graphs and tables concerning the transnational and the national results are presented. Annex III provides a list of tree species with their botanical names and their names in the official UNECE and some of the EU languages. The statistical procedures used in the evaluations are described in Annex IV. Annex V provides a list of addresses.

The cooperation of ICP Forests and the FutMon project under the LIFE+ Regulation of the European Commission foresees partly joint reporting. For this reason the contents of the present Technical Report will also be reflected in the 2009 Executive Report which is a joint ICP Forests and FutMon report in laymen's language. Moreover the scientific final report of FutMon due in early 2011 will synthesise the results presented in the 2009 and 2010 Technical Reports.

2. LARGE SCALE CROWN CONDITION SURVEYS

2.1 Methods of the surveys in 2008

2.1.1 Background

The complete methods of forest condition monitoring by ICP Forests are described in detail in the "Manual on methods and criteria for harmonized sampling, assessment, monitoring and analysis of the effects of air pollution on forests" (ANONYMOUS, 2004). The following sections describe the selection of sample plots, the assessment of stand and site characteristics and the assessment of crown condition within the large scale survey (Level I).

2.1.2 Selection of sample plots

2.1.2.1 The transnational survey

The aim of the transnational survey is a description of the spatial and temporal variation of forest condition at the European-wide scale in relation to natural as well as anthropogenic stress factors - in particular air pollution. It is based on a large-scale 16 x 16 km transnational grid of sample plots. The coordinates of this grid were calculated and provided to the participating countries by EC. In case of already existing plots in a country, these were accepted if the mean plot density resembled that of a 16 x 16 km grid, and if the assessment methods corresponded to those of the ICP Forests Manual and the relevant Commission Regulations. In many countries the plots of the transnational grid constitute a sub-sample of a denser national grid (Chapter 2.1.2.2).

In contrast to previous reports, Level I plots were for the first time classified according to forest types following a newly developed classification scheme of the European Environment Agency (EEA 2007). For an explanation of these forest types see Annex I–1. The forest type classification has been applied in the context of the BioSoil project of the European Commission. National validation of the classification is still ongoing. Percentages of plots in the 14 different regions are given in Table 2.1.2.1-1. The spatial distribution of the plots assessed in 2008 in these regions is shown in Figure 2.1.2.1-1. Following the methodology of previous reports, the plots on the Canary Islands are not included in the transnational evaluation.

Table 2.1.2.1-1: Distribution of the sample plots assessed in 2007 over the climatic regions.

Forest Type	Number of plots	Percentage of plots
Not yet classified	727	14.5
Boreal forests	757	15.1
Hemiboreal/Nemoral/Coniferous/Mixed forests	730	14.6
Alpine coniferous forests	205	4.1
Acidophilous oak/oak-birch forests	49	1.0
Mesophytic deciduous forests	244	4.9
Beech forests	229	4.6
Montane beech forests	147	2.9
Thermophilous deciduous forests	406	8.1
Evergreen broadleaved forests	191	3.8
Mediterranean coniferous forests	611	12.2
Mire and swamp forests	83	1.7
Floodplain forests	38	0.8
Non-riverine alder birch/aspen forests	280	5.6
Plantations/self-sown exotic forests	305	6.1

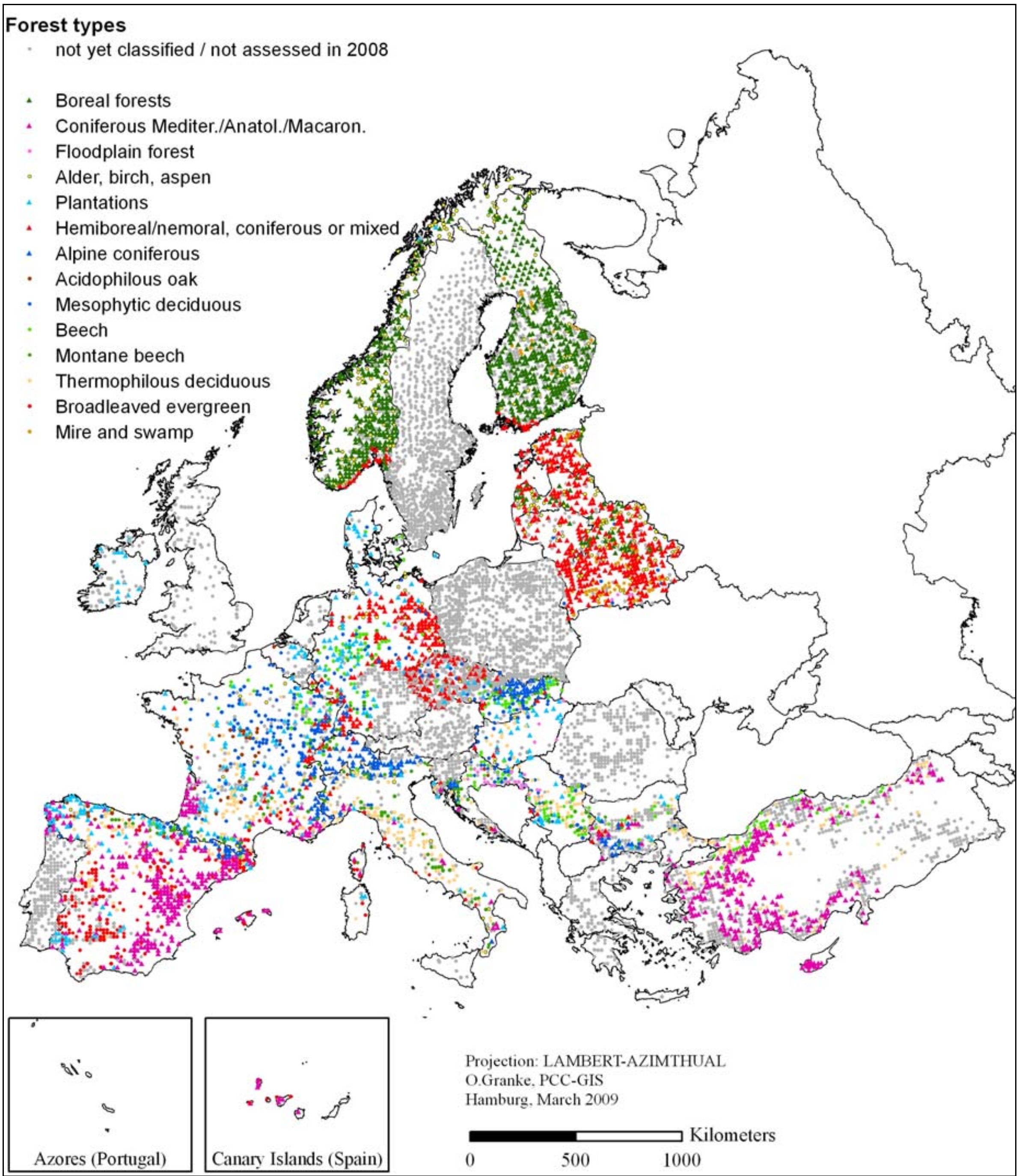

Figure 2.1.2.1-1: Plots according to forest types[1]

Within the transnational survey of the year 2008 crown condition was assessed on 5 002 plots in 25 countries (Table 2.1.2.1-2). As already in 2007 the number of plots was by about one fifth lower than in previous years because some countries did not assess crown condition in 2007 and 2008, mainly because of lacking funds. On the other hand, Turkey continued the installation of Level I plots and submitted data from 398 mostly new plots. The figures in Table 2.1.2.1-2 are not necessarily identical to those published in previous reports, because previous data may in principle be changed due to consistency checks and subsequent data corrections as well as new data submitted by countries.

[1] Classification as carried out based on data base information. Results of national validation as carried out in the frame of the BioSoil project not yet included.

Table 2.1.2.1-2: Number of sample plots assessed for crown condition from 1996 to 2008.

Country	Number of sample plots assessed												
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Austria	130	130	130	130	130	130	133	131	136	136	135		
Belgium	29	29	29	30	29	29	29	29	29	29	27	27	26
Bulgaria	119	119	134	114	108	108	98	105	103	102	97	104	98
Cyprus						15	15	15	15	15	15	15	15
Czech Republic	196	196	116	139	139	139	140	140	140	138	136	132	136
Denmark	23	22	23	23	21	21	20	20	20	22	22	19	19
Estonia	91	91	91	91	90	89	92	93	92	92	92	93	92
Finland	455	460	459	457	453	454	457	453	594	605	606	593	475
France	540	540	537	544	516	519	518	515	511	509	498	506	508
Germany	420	421	421	433	444	446	447	447	451	451	423	420	423
Greece	95	94	93	93	93	92	91			87			
Hungary	60	58	59	62	63	63	62	62	73	73	73	72	72
Ireland	21	21	21	20	20	20	20	19	19	18	21	30	31
Italy	207	181	177	239	255	265	258	247	255	238	251	238	236
Latvia	99	96	97	98	94	97	97	95	95	92	93	93	92
Lithuania	67	67	67	67	67	66	66	64	63	62	62	62	70
Luxembourg	4	4	4	4	4		4	4	4	4	4	4	4
The Netherlands	12	11	11	11	11	11	11	11	11	11	11		
Poland	431	431	431	431	431	431	433	433	433	432	376	458	453
Portugal	142	144	143	143	143	144	145	136	133	119	118		
Romania	224	237	235	238	235	232	231	231	226	229	228	218	
Slovak Republic	110	110	109	110	111	110	110	108	108	108	107	107	108
Slovenia	42	42	41	41	41	41	39	41	42	44	45	44	
Spain	447	449	452	598	607	607	607	607	607	607	607	607	607
Sweden	766	758	764	764	769	770	769	776	775	784	790		
United Kingdom	79	82	88	85	89	86	86	86	85	84	82	32	
EU	4809	4793	4732	4965	4963	4985	4978	4868	5020	5091	4919	3877	3465
Andorra									3		3	3	3
Belarus		416	416	408	408	408	407	406	406	403	398	400	400
Croatia	83	86	89	84	83	81	80	78	84	85	88	83	84
Moldova	10	10	10	10	10	10							
Norway	387	386	386	381	382	408	414	411	442	460	463	476	481
Russian Fed.													
Serbia								103	130	129	127	125	123
Switzerland	49	49	49	49	49	49	49	48	48	48	48	48	48
Turkey												46	398
Total Europe	5338	5740	5682	5897	5895	5941	5928	5914	6133	6216	6046	5058	5002

2.1.2.2 National surveys

National surveys are conducted in many countries in addition to the transnational surveys. The national surveys in most cases rely on denser national grids and aim at the documentation of forest condition and its development in the respective country. Since 1986, densities of national grids with resolutions between 1 x 1 km and 32 x 32 km have been applied due to differences in the size of forest area, in the structure of forests and in forest policies. Results of crown condition assessments on the national grids are tabulated in Annexes II-1 to II-7 and are displayed graphically in Annex II-8. Comparisons between the national surveys of different countries should be made with great care because of differences in species composition, site conditions and methods applied.

2.1.3 Assessment parameters

2.1.3.1 Stand and site characteristics

The following stand and site characteristics are reported on the transnational plots: Country, plot number, plot coordinates, altitude, aspect, water availability, humus type, soil type (optional), and mean age of dominant storey. Besides defoliation and discolouration, the tree related data reported are the tree numbers, tree species and identified damage types. (Table 2.1.3.1-1). Also recorded is the date of observation. The demonstration project "BioSoil" under the programme "Forest Focus" of EC at Level I included a repetition of the soil survey using a more differentiated classification of soil types than the one reproduced in Table 2.1.3.1-1.

Table 2.1.3.1-1: Stand and site parameters given within the crown data base.

Registry and location	country	state in which the plot is assessed [code number]
	plot number	identification of each plot
	plot coordinates	latitude and longitude [degrees, minutes, seconds] (geographic)
	date	day, month and year of observation
Physiography	altitude [m a.s.l.]	elevation above sea level, in 50 m steps
	aspect [°]	aspect at the plot, direction of strongest decrease of altitude in 8 classes (N, NE, ... , NW) and "flat"
Soil	water availability	three classes: insufficient, sufficient, excessive water availability to principal species
	humus type	mull, moder, mor, anmor, peat or other
	soil type	optional, according to FAO (1990) xx
Forest type	Forest type	10 climatic regions according to WALTER et al. (1975)
Stand related data	mean age of dominant storey	classified age; class size 20 years; class 1: 0-20 years, ..., class 7: 121-140 years, class 8 irregular stands
Additional tree related data	tree number	number of tree, allows the identification of each particular tree over all observation years
	tree species	species of the observed tree [code]
	identified damage types	treewise observations concerning damage caused by game and grazing, insects, fungi, abiotic agents, direct action of man, fire, known regional pollution, and other factors

Nearly all countries submitted data on water availability, humus type, altitude, aspect, and mean age (Table 2.1.3.1-2). After having increased gradually over the years, the numbers of plots for which these site parameters were reported had reached almost completeness in 2006. It decreased in 2007 and 2008, however, because of the non-submission of data by some countries.

Table 2.1.3.1-2: Number of sample plots assessed for crown condition and plots per site parameter.

Country	Number of plots	Number of plots per site parameter					
		Water	Humus	Altitude	Aspect	Age	Soil
Austria							
Belgium	26	26	26	26	26	26	24
Bulgaria	98	98	98	98	98	98	73
Cyprus	15	15	15	15	15	15	0
Czech Republic	136	136	57	136	136	136	57
Denmark	19	19	19	19	19	19	19
Estonia	92	92	92	92	92	92	92
Finland	475	475	475	475	475	475	475
France	508	507	508	507	507	508	508
Germany	423	423	401	423	423	423	309
Hungary	72	60	40	60	60	72	60
Ireland	31	31	19	31	31	31	16
Italy	236	235	235	236	235	236	0
Latvia	92	92	0	92	92	92	92
Lithuania	70	70	70	70	70	70	62
Luxembourg	4	4	4	4	4	4	4
Poland	453	453	453	453	453	453	365
Slovak Republic	108	0	108	108	108	105	108
Spain	607	607	607	607	607	607	431
EU	3465	3343	3227	3452	3451	3462	2695
Percent of EU plot sample		96.5	93.1	99.6	99.6	99.9	77.8
Andorra	3	3	3	3	3	3	3
Belarus	400	400	400	400	400	400	393
Croatia	84	84	84	84	84	84	59
Norway	481	0	447	481	481	481	368
Serbia	123	123	41	123	123	123	123
Switzerland	48	0	0	48	48	48	45
Turkey	398	198	24	398	23	398	0
Total Europe	5002	4151	4226	4989	4613	4999	3686
Percent of total plot sample		83.0	84.5	99.7	92.2	99.9	73.7

2.1.3.2 Defoliation

On each sampling point of the national and transnational grids situated in forests, at least 20 sample trees are selected according to standardised procedures. Predominant, dominant, and co-dominant trees (according to the system of Kraft) of all species qualify as sample trees, provided that they have a minimum height of 60 cm and that they do not show significant mechanical damage. Trees removed by management operations or blown over by wind must be replaced by newly selected trees. Due to the small percentage of removed trees, this replacement does not distort the survey results, as has been shown by respective analyses.

The variation of crown condition is mainly the result of intrinsic factors, age and site conditions. Moreover, defoliation may be caused by a number of biotic and abiotic stressors. Defoliation assessment attempts to quantify foliage missing as an effect of stressors including air pollutants and not as an effect of long lasting site conditions. In order to compensate for site conditions, local reference trees are used, defined as the best tree with full foliage that could grow at the particular site. Alternatively, absolute references are used, defined as the best possible tree of a genus or a species, regardless of site conditions, tree age etc. depicted on regionally applicable photos, e.g. photo guides. Changes in defoliation and discolouration attributable to air pollution cannot be differentiated from those caused by other factors.

Consequently, defoliation due to factors other than air pollution is included in the assessment results. Trees showing mechanical damage are not included in the sample. Should mechanical damage occur to a sample tree, any resulting loss of foliage is not counted as defoliation. In this way, mechanical damage is ruled out as a cause as far as possible.

Defoliation is assessed in 5% steps. This permits studies of the annual variation of defoliation with far greater accuracy than using the traditional system of only 5 classes of uneven width (Chapter 2.1.4). Discolouration is reported both in the transnational and in the national surveys using the traditional classification. More detailed discolouration assessments based on the revised damage cause assessment methodology are not presented in this year's report.

In 2008 the number of trees assessed was 111 560. Table 2.1.3.2-1 shows the total numbers of trees assessed in each participating country since 1995. The figures in the table are not necessarily identical to those published in previous reports for the same reasons explained in Chapter 2.1.2.1.

59.7% of the plots assessed in 2008 were dominated by conifers and 40.3% by broadleaves (Annex I-2). Plots in mixed stands were assigned to the species group which comprised the majority of the sample trees. The number of species of the tree sample was 118. Most abundant were *Pinus sylvestris* with 25.7% followed by *Picea abies* with 13.9%, *Fagus sylvatica* with 7.7%, and *Quercus robur* with 3.9% of the total tree sample (Annex I-3).

Table 2.1.3.2-1: Number of sample trees from 1996 to 2008 according to the current database.

Country	Number of sample trees												
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Austria	3670	3604	3577	3535	3506	3451	3503	3470	3586	3528	3425		
Belgium	684	683	692	696	686	682	684	684	681	676	618	616	599
Bulgaria	4749	4748	5349	4344	4197	4174	3720	3836	3629	3592	3510	3569	3304
Cyprus						360	360	360	360	361	360	358	360
Czech Rep	4853	4844	2899	3475	3475	3475	3500	3500	3500	3450	3425	3300	3400
Denmark	552	528	552	552	504	504	480	480	480	528	527	442	452
Estonia	2184	2184	2184	2184	2160	2136	2169	2228	2201	2167	2191	2209	2196
Finland	8732	8788	8758	8662	8576	8579	8593	8482	11210	11498	11489	11199	8812
France	10800	10800	10740	10883	10317	10373	10355	10298	10219	10129	9950	10074	10138
Germany	10980	10990	13178	13466	13722	13478	13534	13572	13741	13630	10327	10241	10347
Greece	2248	2224	2204	2192	2192	2168	2144			2054			
Hungary	1298	1257	1383	1470	1488	1469	1446	1446	1710	1662	1674	1650	1661
Ireland	441	441	441	417	420	420	424	403	400	382	445	646	679
Italy	5836	4873	4939	6710	7128	7350	7165	6866	7109	6548	6936	6636	6579
Latvia	2368	2297	2326	2348	2256	2325	2340	2293	2290	2263	2242	2228	2184
Lithuania	1643	1634	1616	1613	1609	1597	1583	1560	1487	1512	1505	1507	1688
Luxembourg	96	96	96	96	96	-	96	96	96	97	96	96	96
The Netherlands	237	220	220	225	218	231	232	231	232	232	230		
Poland	8620	8620	8620	8620	8620	8620	8660	8660	8660	8640	7520	9160	9036
Portugal	4260	4319	4290	4290	4290	4320	4350	4080	3990	3569	3539		
Romania	5375	5687	5637	5712	5640	5568	5544	5544	5424	5496	5472	5232	
Slovak Rep.	5018	5033	5094	5063	5157	5054	5076	5116	5058	5033	4808	4904	4956
Slovenia	1008	1008	984	984	984	984	936	983	1006	1056	1069	1056	
Spain	10728	10776	10848	14352	14568	14568	14568	14568	14568	14568	14568	14568	14568
Sweden	10925	10910	11044	11135	11361	11283	11278	11321	11255	11422	11186		
United Kingdom	1896	1968	2112	2039	2136	2064	2064	2064	2040	2016	1968	768	
EU	109201	10853	109783	115063	115306	115233	114804	112141	114932	116109	109085	90459	81055
Andorra									72		74	72	72
Belarus		9974	9896	9745	9763	9761	9723	9716	9682	9484	9373	9424	9456
Croatia	1974	2030	2066	2015	1991	1941	1910	1869	2009	2046	2109	2013	2015
Moldova	236	253	234	259	234	234							
Norway	3948	4028	4069	4052	4051	4304	4444	4547	5014	5319	5525	5824	6085
Russian Fed.													
Serbia								2274	2915	2995	2902	2860	2788
Switzerland	854	880	868	857	855	834	827	806	748	807	812	790	773
Turkey												911	9316
Total Europe	116213	125697	126916	131991	132200	132307	131708	131353	135372	136760	129875	112353	111560

2.1.4 Analysis, presentation and interpretation of the survey results

2.1.4.1 Scientific background

The interpretation of the results of the crown condition assessments has to take into account the following limitations:

Defoliation has a variety of causes. It would therefore be inappropriate to attribute it to a single factor such as air pollution without additional evidence. As the true influence of site conditions and the share of tolerable defoliation can not be quantified precisely, damaged trees can not be distinguished from healthy ones only by means of a certain defoliation threshold. Consequently, the 25% threshold for defoliation does not necessarily identify trees damaged in a physiological sense. Some differences in the level of damage across national borders may be at least partly due to differences in standards used. This restriction, however, does not affect the reliability of trends over time.

Natural factors strongly influence crown condition. As also stated by many participating countries, air pollution is thought to interact with natural stressors as a predisposing or accompanying factor, particularly in areas where deposition may exceed critical loads for acidification (CHAPPELKA and FREER-SMITH, 1995, CRONAN and GRIGAL, 1995, FREER-SMITH, 1998).

It has been suggested that the severity of forest damage has been underestimated as a result of the replacement of dead trees by living trees. However, detailed statistical analyses of the results of 10 monitoring years have revealed that the number of dead trees has remained so small that their replacement has not influenced the results notably (LORENZ et al., 1994).

2.1.4.2 Classification of defoliation data

The national survey results are submitted to PCC as country related mean values, classified according to species and age classes. These data sets are accompanied by national reports providing explanations and interpretations. All tree species are referred to by their botanical names, the most frequent of them listed in 12 languages in Annex III.

The results of the evaluations of the crown condition data are preferably presented in terms of mean plot defoliation or the percentages of the trees falling into 5%-defoliation steps. However, in order to ensure comparability with previous presentations of survey results, partly the traditional classification of both defoliation and discolouration has been retained for comparative purposes, although it is considered arbitrary by some countries. This classification (Table 2.1.4.2-1) is a practical convention, as real physiological thresholds cannot be defined.

Table 2.1.4.2-1: Defoliation and discolouration classes according to UNECE and EU classification

Defoliation class	needle/leaf loss	degree of defoliation
0	up to 10 %	none
1	> 10 - 25 %	slight (warning stage)
2	> 25 - 60 %	moderate
3	> 60 - < 100 %	severe
4	100 %	dead
Discolouration class	foliage discoloured	degree of discolouration
0	up to 10 %	none
1	> 10 - 25 %	slight
2	> 25 - 60 %	moderate
3	> 60 %	severe
4		dead

In order to discount background perturbations which might be considered minor, a defoliation of >10-25% is considered a warning stage, and a defoliation > 25% is taken as a threshold for damage. Therefore, in the present report a distinction has sometimes only been made between defoliation classes 0 and 1 (0-25% defoliation) on the one hand, and classes 2, 3 and 4 (defoliation > 25%) on the other hand.

Classically, trees in classes 2, 3 and 4 are referred to as "damaged", as they represent trees of considerable defoliation. In the same way, the sample points are referred to as "damaged" if the mean defoliation of their trees (expressed as percentages) falls into class 2 or higher. Otherwise the sample point is considered as "undamaged".

Attention must be paid to the fact that *Quercus robur* and *Quercus petraea* are evaluated together and referred to as "*Quercus robur* and *Q. petraea*". Similarly, *Quercus ilex* and *Quercus rotundifolia* are evaluated together and noted as "*Quercus ilex* and *Q. rotundifolia*".

The most important results have been tabulated separately for all countries having participated (called "total Europe") and for the 26 EU-Member States.

2.1.4.3 Mean defoliation and temporal development

For all evaluations related to a particular tree species a criterion had to be set up to be able to decide if a given plot represents this species or not. This criterion was that the number of trees of the particular species had to be three or more per plot ($N \geq 3$). The mean plot defoliation for the particular species was calculated as the mean defoliation of the trees of the species on that plot.

The temporal development of defoliation is expressed on maps as the slope, or regression coefficient, of a linear regression of mean defoliation against the year of observation. It can be interpreted as the mean annual change in defoliation. These slopes were considered as "significant" only if there was at least 95% probability that they are different from zero.

Besides the temporal development, also the change in the results from 2007 to 2008 was calculated (Annex I-7). In this case, changes in mean defoliation per plot are called "significant" only if both,

the change ranges above the assessment accuracy, i.e. is higher than 5%,

and the significance at the 95% probability level was proven in a statistical test.

For detailed information on the respective calculation see Annex IV.

2.2 Results of the transnational survey in 2008

2.2.1 Crown condition in 2008

In 2008 crown condition was assessed on 5 015 plots comprising 111 872 sample trees. These include 312 trees on plots on the Canary Islands which are not included in the calculation of the European mean values. Of the remaining 111 560 trees a share of 21.1% was scored as damaged, i.e. had a defoliation of more than 25% (Table 2.2.1-1). The share of damaged broadleaves exceeded with 24.1% the share of damaged conifers with 18.8%. In Annex I-4 the percentages of damaged trees are mapped for each plot. Table 2.2.1-1 shows also the mean and the median of defoliation. Mean defoliation in total Europe in 2008 was 20.2%. Annex I-5 shows a map of mean plot defoliation for all species. Because of different numbers of participating countries (Chapter 2.2.2.1), defoliation figures of 2008 are not comparable to those of previous reports. The development of defoliation over time is derived from tree and plot samples of defined sets of countries (Chapter 2.2.2).

Table 2.2.1-1: Percentages of trees in defoliation classes and mean defoliation for broadleaves, conifers and all species.

	Species type	Percentage of trees in defoliation class							Defoliation		No. of trees
		0-10%	>10-25%	0-25%	>25-60%	>60%	dead	>25%	Mean	Median	
EU	Broad-leaves	25.1	49.9	75.0	22.2	2.1	0.7	25.0	22.1	20	35965
	Conifers	31.7	47.1	78.8	19.5	1.2	0.5	21.2	19.7	15	45090
	All species	28.8	48.3	77.1	20.7	1.6	0.6	22.9	22.8	20	81055
Total Europe	*Fagus sylv.*	32.8	47.5	80.3	18.2	1.1	0.4	19.7	19.4	15	8550
	Quercus robur + Q. petraea	17.4	48.4	65.8	31.4	2.2	0.6	34.2	24.9	20	7497
	Broadleaves	28.0	47.9	75.9	21.2	2.3	0.7	24.1	21.6	20	48760
	Picea abies	37.9	37.1	75.0	23.0	1.7	0.3	25.0	19.3	15	15475
	Pinus sylv.	32.7	52.4	85.1	13.6	0.9	0.4	14.9	18.2	15	28638
	Conifers	32.7	48.5	81.2	17.2	1.2	0.5	18.8	19.0	15	62800
	All species	30.6	48.2	78.8	19.0	1.7	0.5	21.1	20.2	15	111560

Frequency distributions of the sample trees in 5% classes are shown for the broadleaved trees, for the coniferous trees and for the total of all trees in Figures 2.2.1-1a and 2.2.1-1b for each forest type as well as for the total of all forest types. Also given are the number of trees, the mean defoliation and the median. Mean defoliation is highest with 25.5% on plots classified as thermophilous deciduous forest types and is lowest with 15.1 % on plots in the Boreal forests.

Figures 2.2.1-2 to 2.2.1-5 show maps of mean plot defoliation for *Pinus sylvestris*, *Picea abies*, *Fagus sylvatica*, and *Quercus robur* and *Q. petraea*. The maps reflect partly the differences in crown condition between species and regions seen in Table 2.2.1-1 and in Figures 2.2.1-1a and 2.2.1-1b: With 24.9% mean defoliation on the assessed plots the value was highest for *Quercus robur* and *Quercus petraea*. For *Fagus sylvatica*, mean defoliation of 8 550 assessed trees was 19.4%. *Fagus sylvatica* as well as *Quercus robur* and *Quercus petraea,* show highly defoliated plots throughout their range. Of the four main tree species assessed, *Pinus sylvestris* showed the lowest mean defoliation. Clusters of plots with mean defoliation of *Pinus sylvestris* and *Picea abies* above 30% are located in central Europe.

Specifically for *Pinus sylvestris* mean defoliation is lower on plots the boreal and hemiboreal regions.

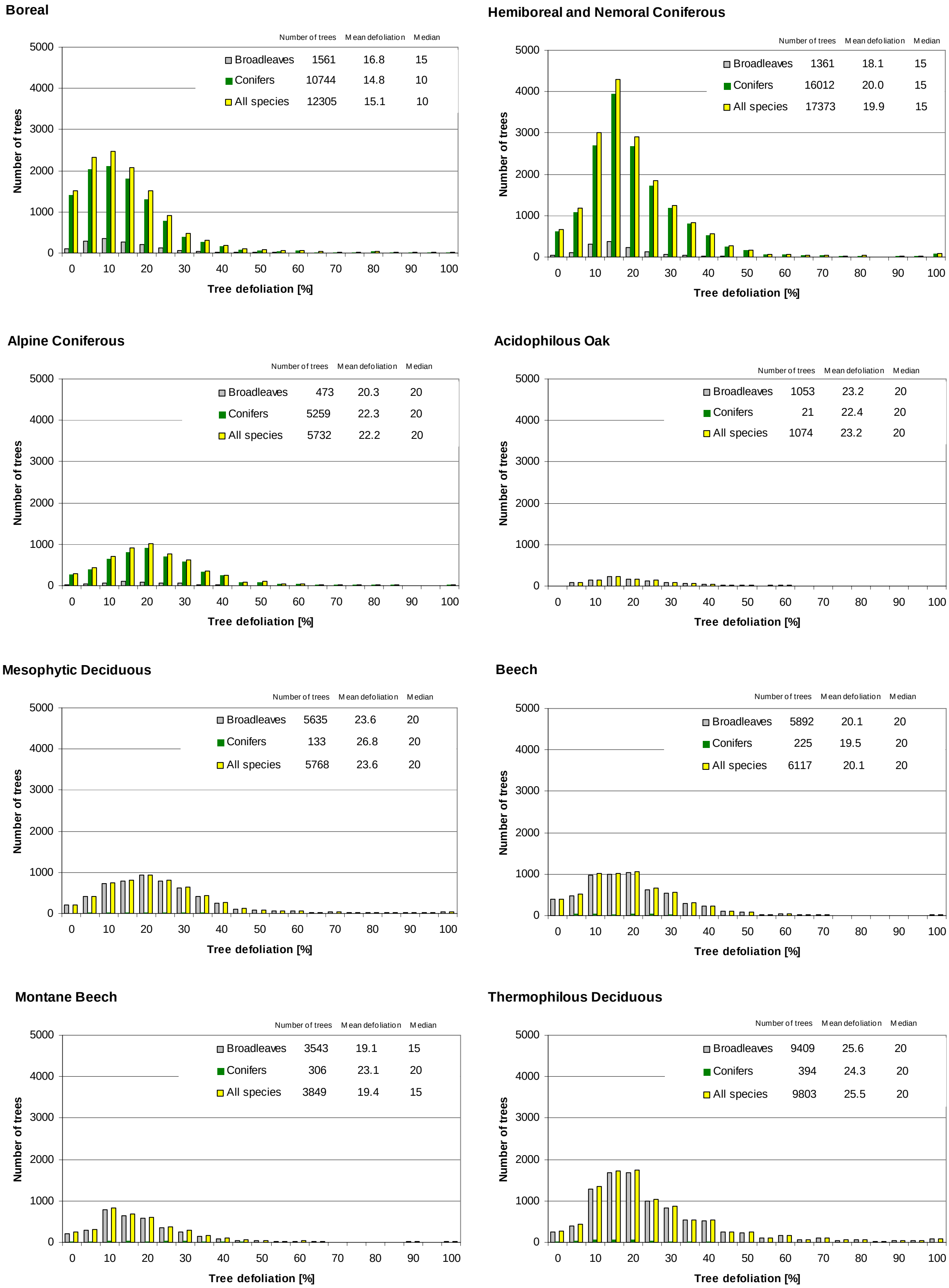

Figure 2.2.1-1a: Frequency distribution of trees in 5%-defoliation steps.

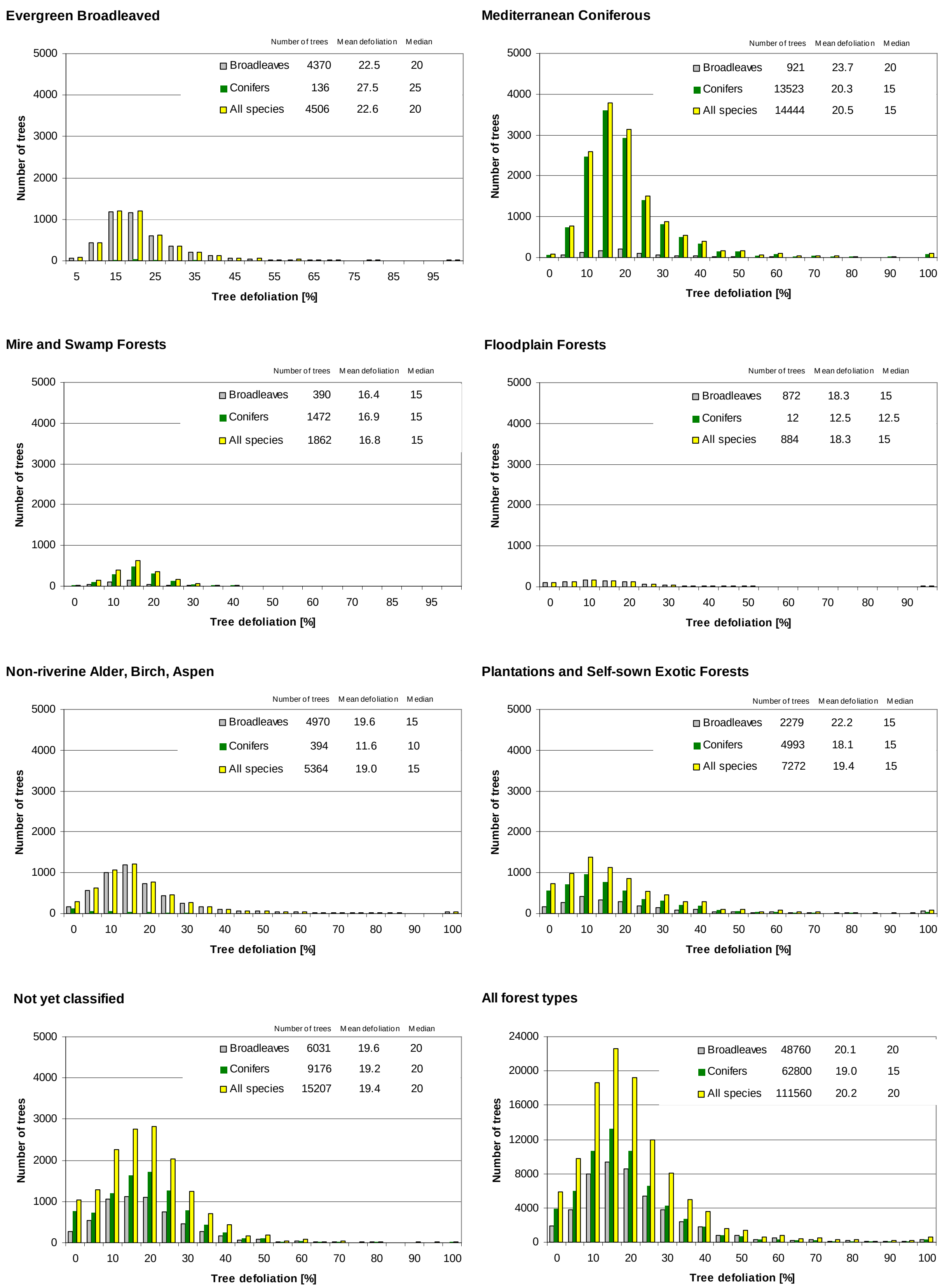

Figure 2.2.1-1b: Frequency distribution of trees in 5%-defoliation steps.

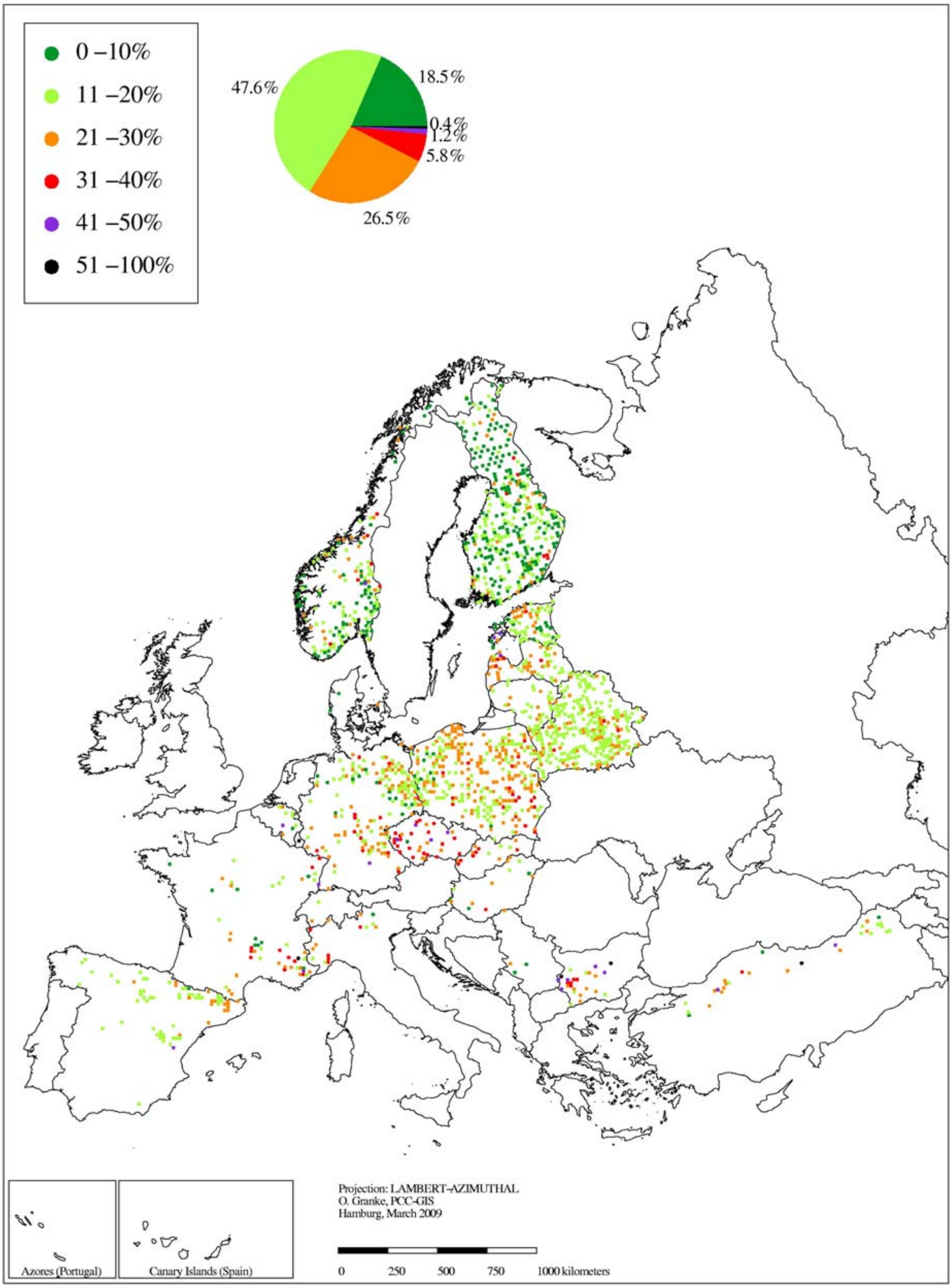

Figure 2.2.1-2: Mean plot defoliation of *Pinus sylvestris.*

Note that some differences in the level of defoliation across national borders may be at least partly due to differences in standards used.

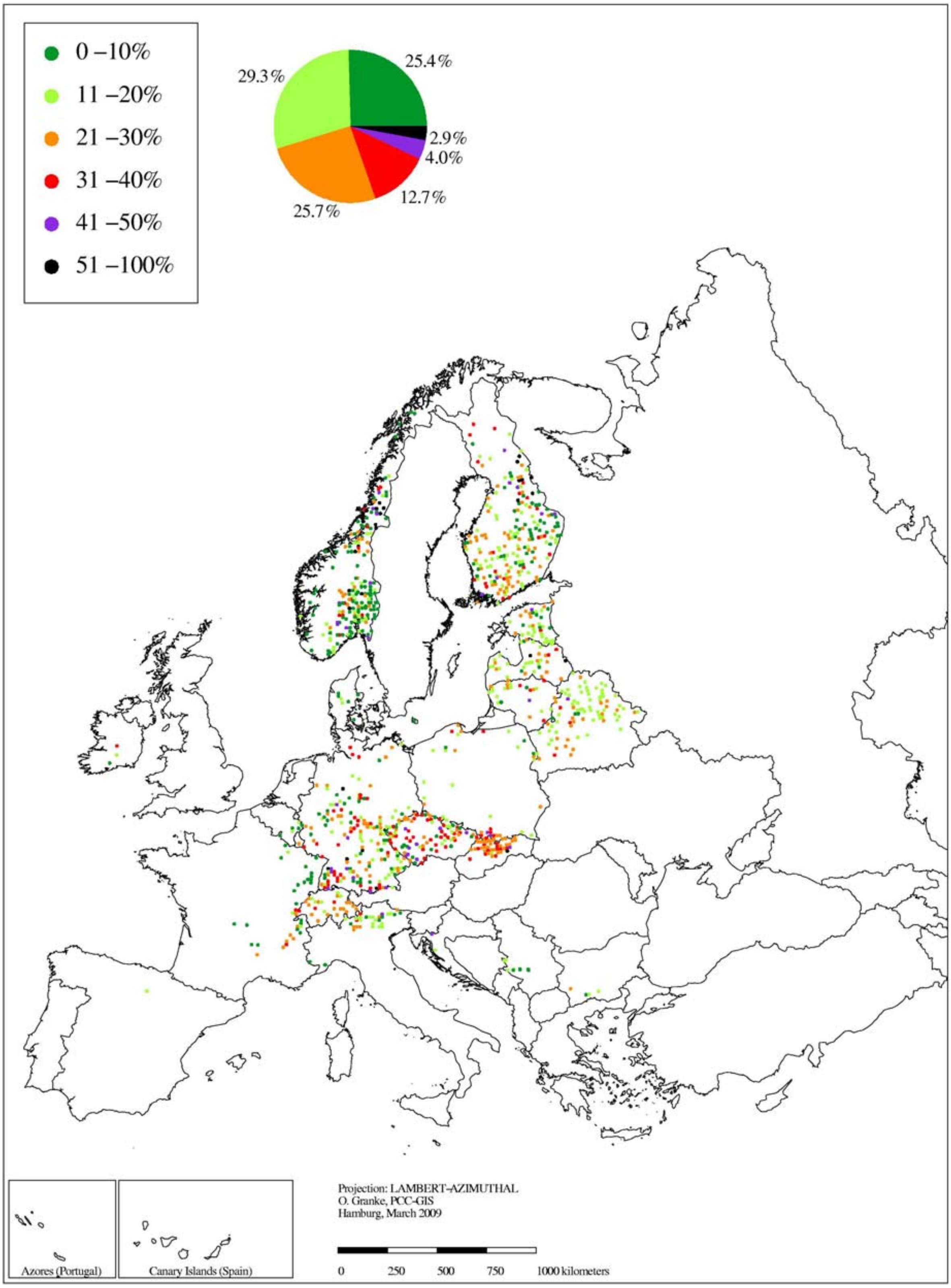

Figure 2.2.1-3: Mean plot defoliation of *Picea abies.*

Note that some differences in the level of defoliation across national borders may be at least partly due to differences in standards used.

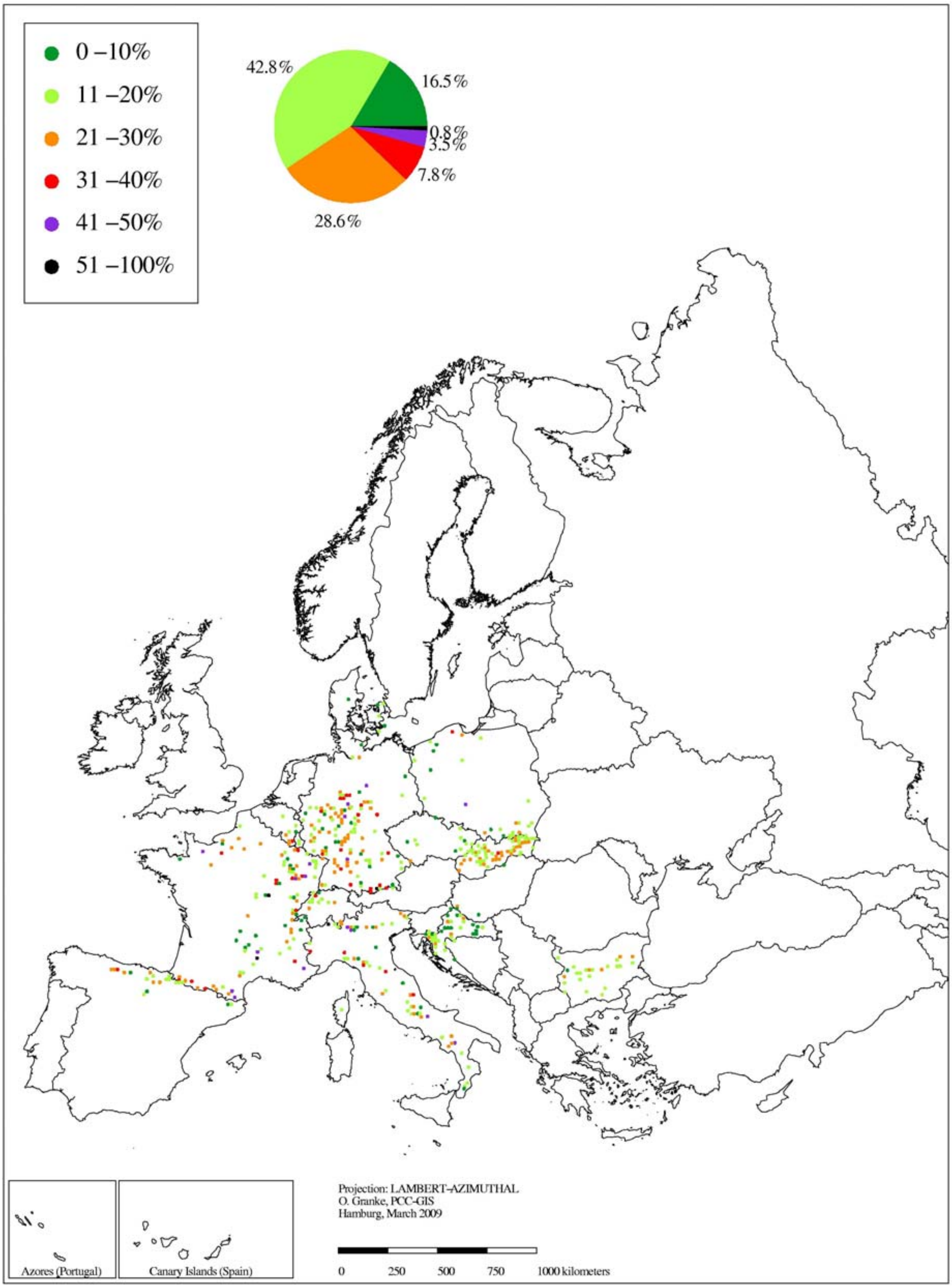

Figure 2.2.1-4: Mean plot defoliation of *Fagus sylvatica.*

Note that some differences in the level of defoliation across national borders may be at least partly due to differences in standards used.

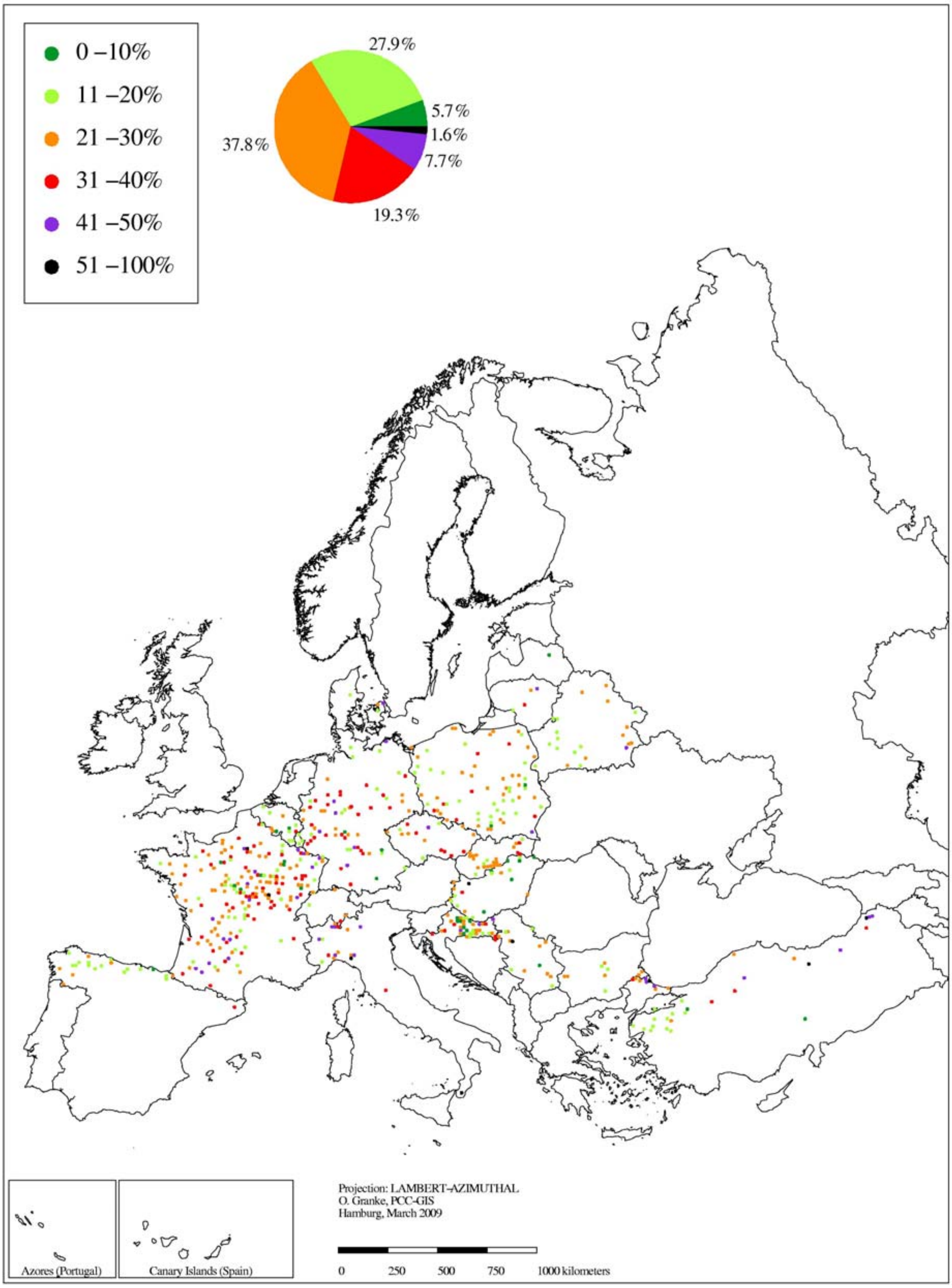

Figure 2.2.1-5: Mean plot defoliation of *Quercus robur* and *Quercus petraea.*

Note that some differences in the level of defoliation across national borders may be at least partly due to differences in standards used.

For 105 399 trees discolouration was assessed (Table 2.2.1-2). A share of 7.9% of the trees was discoloured, i.e. had a discolouration of more than 10%. A map of mean plot discolouration is shown in Annex I-6.

Table 2.2.1-2: Percentages of trees in discolouration classes and mean defoliation for broad-leaves, conifers and all species.

	Species type	Discolouration						No. of trees
		0-10%	>10-25%	>25-60%	>60%	dead	>10%	
EU	Broad-leaves	92.0	5.4	1.6	0.2	0.8	8.0	32027
	Conifers	94.3	4.1	1.0	0.1	0.5	5.7	43535
	All species	93.3	4.6	1.3	0.2	0.6	6.7	75562
Total Europe	Broad-leaves	91.7	5.8	1.7	0.2	0.6	8.3	44711
	Conifers	92.4	5.6	1.4	0.1	0.4	7.5	60688
	All species	92.1	5.7	1.5	0.2	0.5	7.9	105399

2.2.2 Defoliation trends

2.2.2.1 Approach

The development of defoliation is calculated assuming that the sample trees of each survey year represent forest condition. Studies of previous years show that the fluctuation of trees in this sample due to the exclusion of dead and felled trees as well as due to inclusion of replacement trees does not cause distortions of the results over the years. But fluctuations due to the inclusion of newly participating countries must be excluded, because forest condition among countries can deviate greatly. For this reason, the development of defoliation can only be calculated for defined sets of countries. Different lengths of time series require different sets of countries, because at the beginning of the surveys the number of participating countries was much smaller than it is today. For the present evaluation the following two time series and respectively, the following countries were selected for tracing the development of defoliation:

Period 1990-2008:
Belgium, Denmark, Germany, Hungary, Ireland, Latvia, Poland, Slovak Republic, Spain, and Switzerland.

Period 1997-2008:
Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, Norway, Poland, Slovak Republic, Spain, Switzerland.

Several countries could not be included in one or both time series because of changes in their tree sample sizes, changes in their assessment methods or missing assessments in certain years. Development of defoliation is presented in graphs and in maps. Graphs show the fluctuations of either mean defoliation or shares of trees in defoliation classes over time. Maps indicate trends in mean defoliation calculated as described in Chapter 2.1.4.3.

The spatial pattern of the changes in mean defoliation from 2007 to 2008 across Europe is shown in Annex I-7. The pie diagram shows that on over 80% of the plots there was no change in defoliation detected. The share of plots with increasing defoliation equals the share of plots with a decrease. There are hardly any spatial clusters of plots with a recorded decrease or increase.

Chapter 2.2.2.2 presents trends in defoliation for the six most frequent tree species. For each of these species, Chapters 2.2.2.3 to 2.2.2.8 describe the trends in different forest types. In each of these chapters the development of defoliation of the respective species is visualised for the total tree sample of all forest types in one graph. Additional graphs reflect particular developments in selected forest types. Each chapter contains also a map indicating trends of mean plot defoliation. Annexes I-8 and I-9 provide for each of the two time series and each of the six species the number of sample trees and their distribution over the defoliation classes for each year. This information is given for the total of all forest types and for each type separately. In addition, the same information is provided for three more species, namely *Abies alba*, *Picea sitchensis* and *Quercus suber* because of their ecological and economical importance in some regions.

2.2.2.2 Main tree species

Of the main tree species *Pinus sylvestris* shows a clearly decreasing defoliation for both time series. Being less susceptible to drought *Pinus sylvestris* showed no rise in defoliation even after the dry summer of the year 2003. For the mean of all plots assessed, mean defoliation of *Picea abies* is fluctuating in the observation period. There was a peak in mean defoliation in the mid 1990s and after the dry and hot summer in 2003. *Fagus sylvatica* showed a constant increase in mean defoliation from the end of the 1990s until 2004. This peak has been described as a response to the drought in central Europe in 2003. Since then a constant recuperation has been observed. The development of *Quercus robur* and *Quercus petraea* resembles the crown condition of *Fagus sylvatica.* However, in almost all years the deciduous oak species show the highest level of defoliation among the main tree species. *Quercus ilex* is characterized by peaks in mean plot defoliation in 1995 and 2005/06. In the last two years mean defoliation decreased. This development mainly reflects the situation in Spain where most of the observed trees are located. With some fluctuations defoliation of *Pinus pinaster* showed an increase until 2004. Since then a slight recuperation has been observed.

Trends in mean plot defoliation for the period 1997-2007 are mapped in Figure 2.2.2.2-3. This map is not confined to the main species but includes all species. The share of plots with distinctly increasing defoliation (29.1%) surmounts the share of plots with decreasing defoliation (10.9%). Plots showing a deterioration are scattered across Europe, but their share is particularly high in mid and southern Finland and at the eastern edge of the Pyrenean mountains.

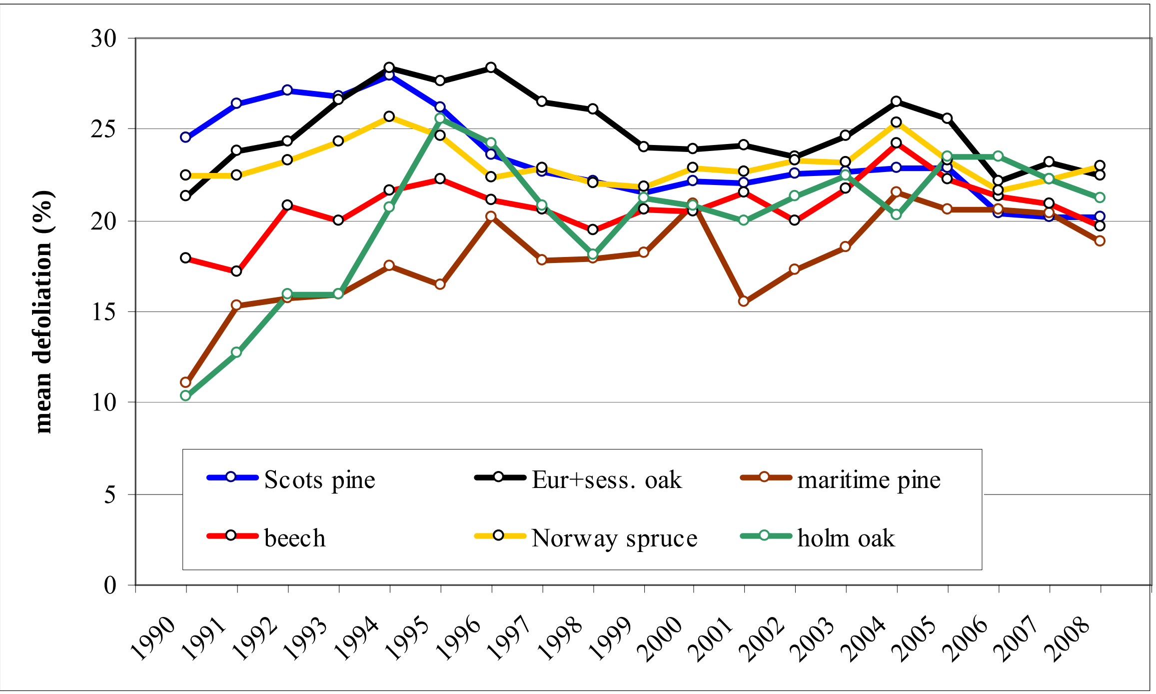

Figure 2.2.2.2-1: Mean defoliation of main species 1990-2008.

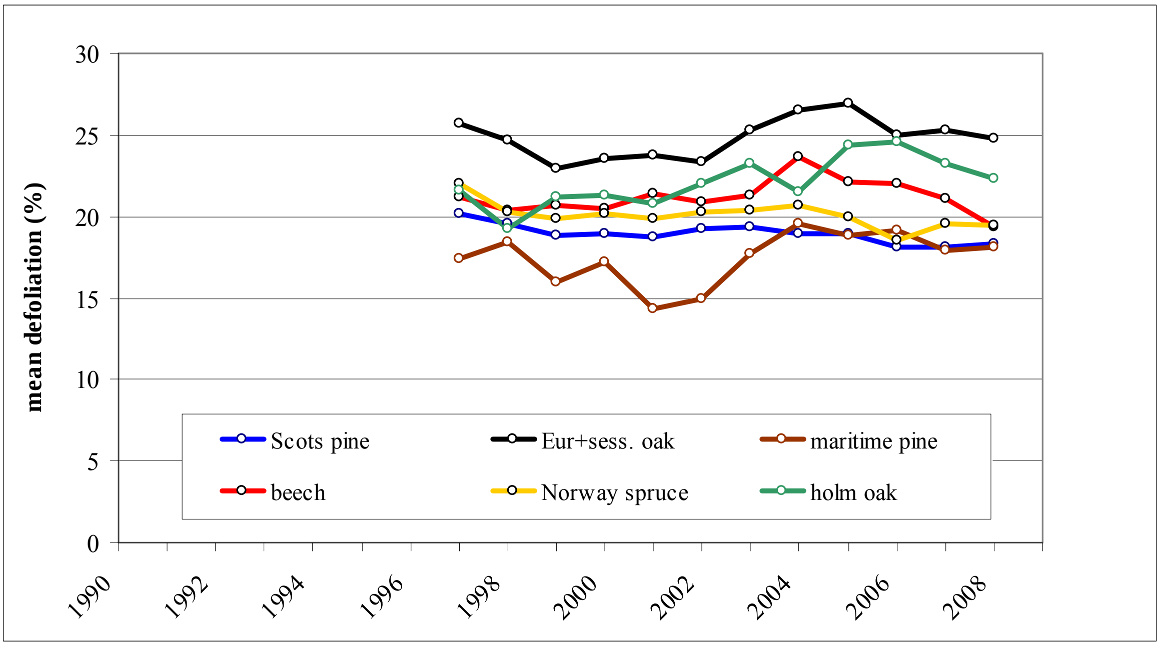

Figure 2.2.2.2-2: Mean defoliation of main species 1997-2008.

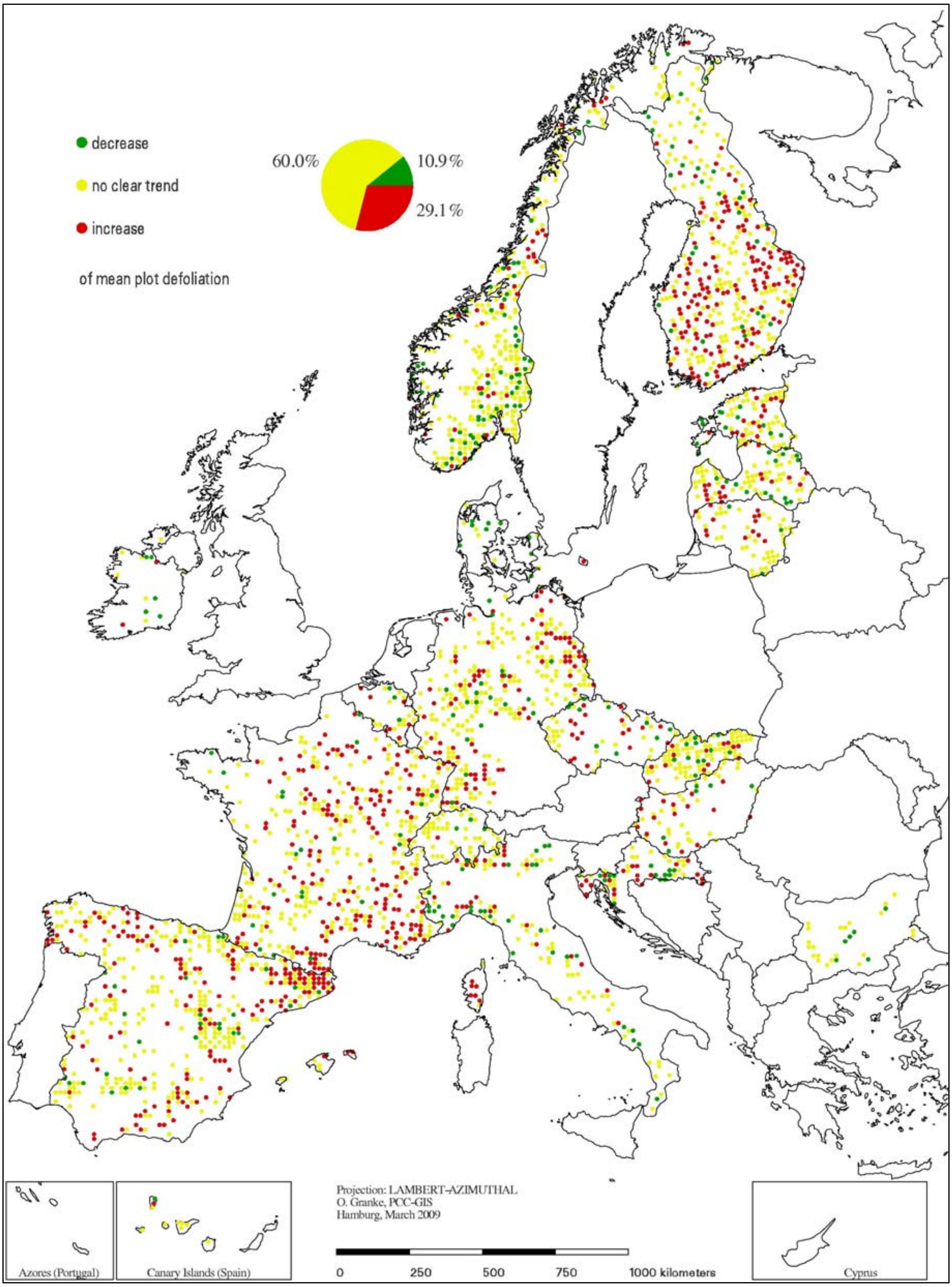

Figure 2.2.2.2-3: Trends of mean plot defoliation of all species over the years 1997 to 2008.

2.2.2.3 Pinus sylvestris

With up to 26 258 trees for the period 1997 – 2008 and up to 11 780 trees for the period 1990 – 2008 *Pinus sylvestris* is the tree species with the largest number of trees in the sample. It covers most regions in Europe, but largest numbers of trees occur in the boreal, hemiboreal and nemoral forest types. In the total of all forest types, the portion of damaged *Pinus sylvestris* trees shows a pronounced decrease from a peak at 46.7% in 1994 to 17.2% in 2008. This reflects the improvement of health status mainly on plots of the hemiboreal and nemoral forest type which comprises the largest share of the trees. (Figure 2.2.2.3-1).

In boreal forests there are only around three hundred trees mostly located in Latvia which were continuously assessed since 1990. Of these there is a considerably higher share in defoliation class 1 as compared to the much larger sample of around 6 000 trees in the boreal region of Norway and Finland which are the basis of the shorter time series depicted. On these plots crown condition of *Pinus sylvestris* fluctuated with shares of damaged trees varying between 5% and 10%. Also on plots of the hemiboreal and nemoral forest type and in plantation forests there was not much change over the years; however, the shares of damaged trees were higher in these forest types, namely between 15% and 20% of the trees. Mire and swamp forests had the lowest defoliation with a share of damaged trees constantly below 5%. However, sample size was only up to 483 trees.

In alpine coniferous forests *Pinus sylvestris* showed highest defoliation. Here, the share of damaged trees frequently exceeded 30%. Also, there were stronger inter-annual variations which may indicate more variations in environmental conditions (Figure 2.2.2.3-1).

The map of plots continuously monitored since 1997 shows clusters of plots with increasing defoliation specifically in southern Finland and eastern Germany. Improvements prevail in Norway and northern Finland (Figure 2.2.2.3-2).

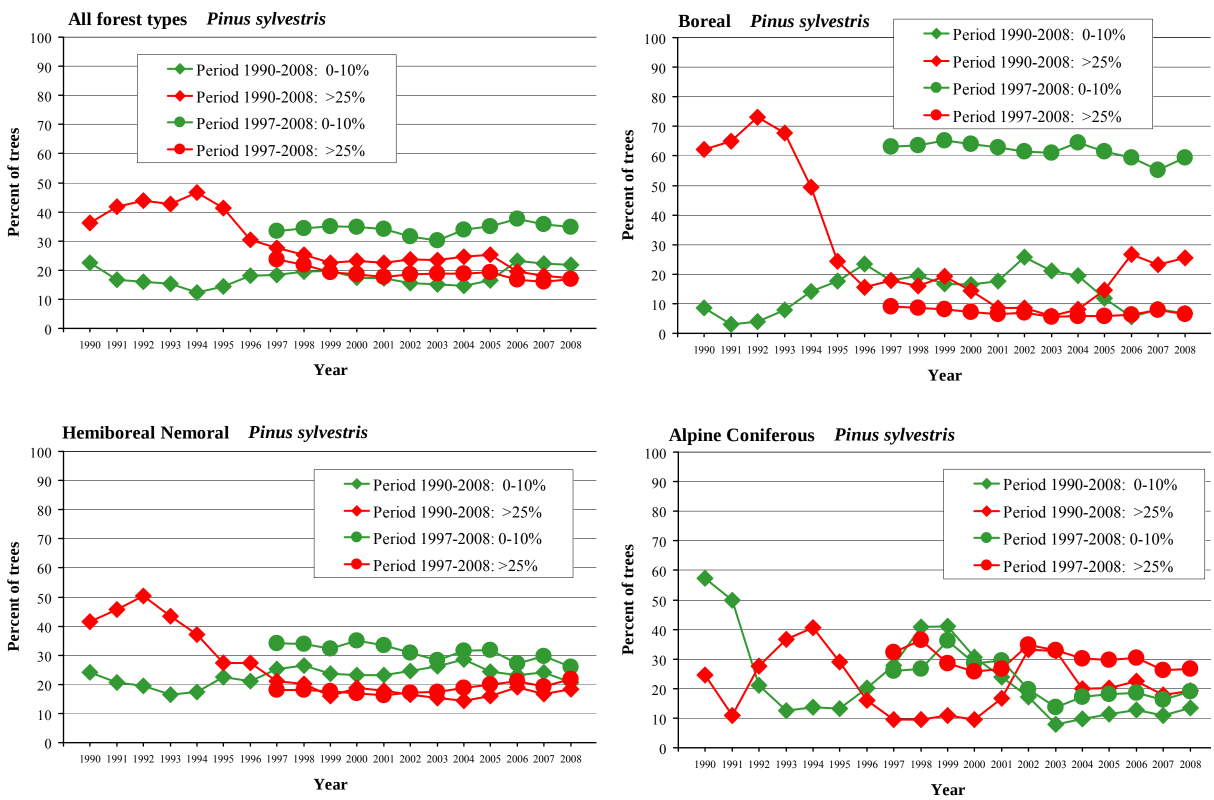

Figure 2.2.2.3-1: Shares of trees of defoliation 0-10% and >25% in two periods (1990-2008 and 1997-2008).

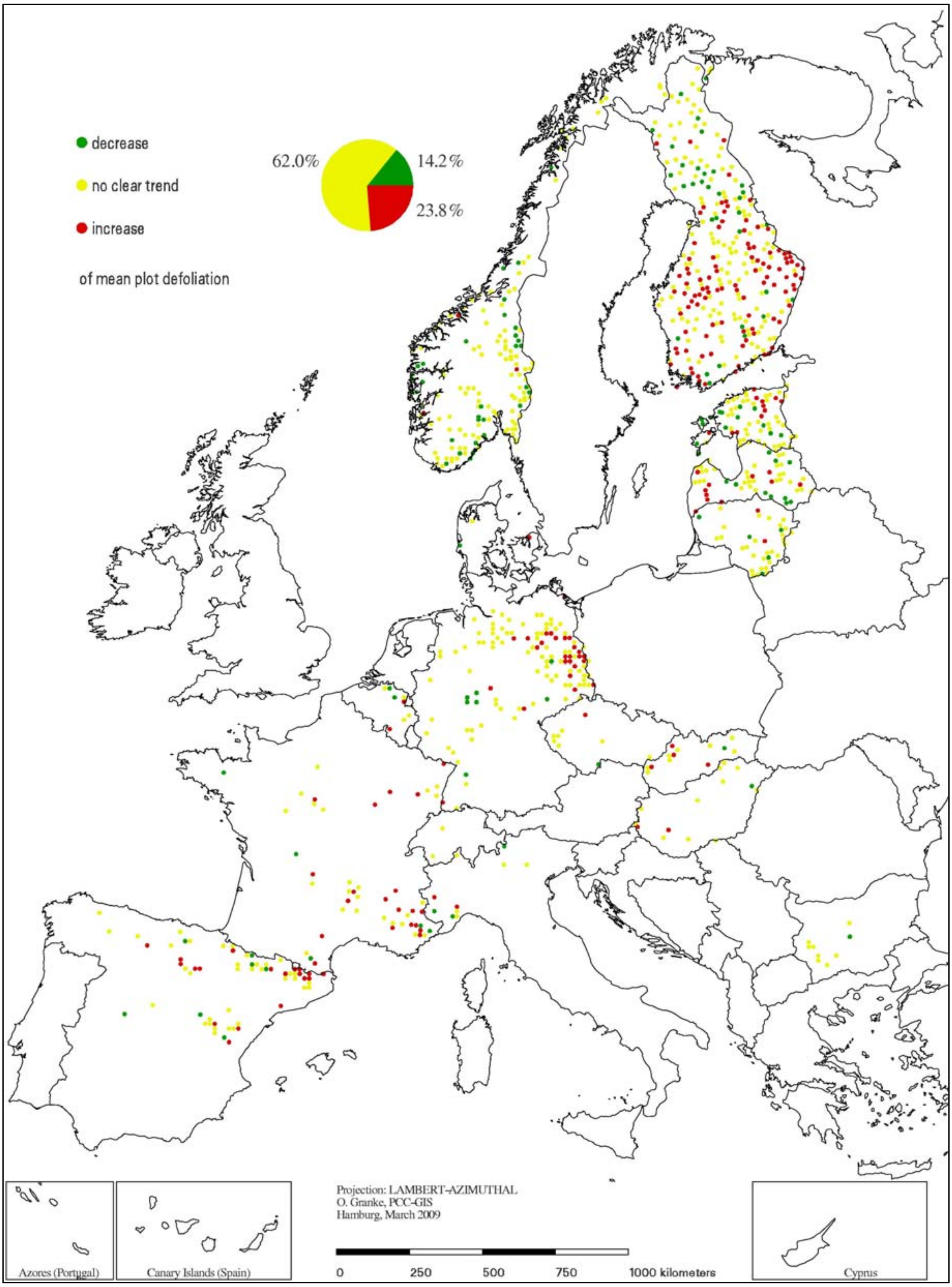

Figure 2.2.2.3-2: Trend of mean plot defoliation (slope of linear regression) of *Pinus sylvestris* over the years 1997 to 2008.

2.2.2.4 Picea abies

In both time series, *Picea abies* constitutes the second largest share of trees behind *Pinus sylvestris*. In the period 1990-2008, the share of damaged trees in the total of all forest types decreased from its peak of 38.2% in 1994 to 29.0% in 2007. In 2008, the respective share was 31.6% (Figure 2.2.2.4-1). This general development is the result of differing trends on plots in the various forest types.

Like for the total of all forest types, defoliation on the plots in the boreal zone is characterized by a decrease of the share of damaged trees. On plots classified as hemiboreal and nemoral forest type there was an increase in the share of damaged trees from 20.3% in 1990 to 30.5% which constitutes the highest value within this observation period. Despite some fluctuations, defoliation of *Picea abies* on plots of the alpine coniferous type shows a general decrease. Like for *Pinus sylvestris*, the absolute defoliation level on the alpine plots is considerably above the specie’s average. Due to the fact that montane beech plots comprise a number of mixed stands, *Picea abies* is occurring within this forest type as well, even though with a smaller number of trees. In this forest type, the sample that is assessed since 1997 shows an alarming increase in the share of damaged trees from 28.0% in 2004 to 48.4% in 2008. In plantation forests the share of damaged trees is comparably low and hardly exceeds 20.0%. This may be due to the fact that mostly younger stands are classified as plantations and that these are mostly occurring in the lowlands. However, there is an almost constant increase in the share of damaged trees (Figure 2.2.2.4-1).

The map shows that in southern Norway plots with decreasing defoliation prevail. In Finland there are more plots with an increase than plots with a decrease. In the other countries and regions there is no clear spatial trend (Figure 2.2.2.4-2).

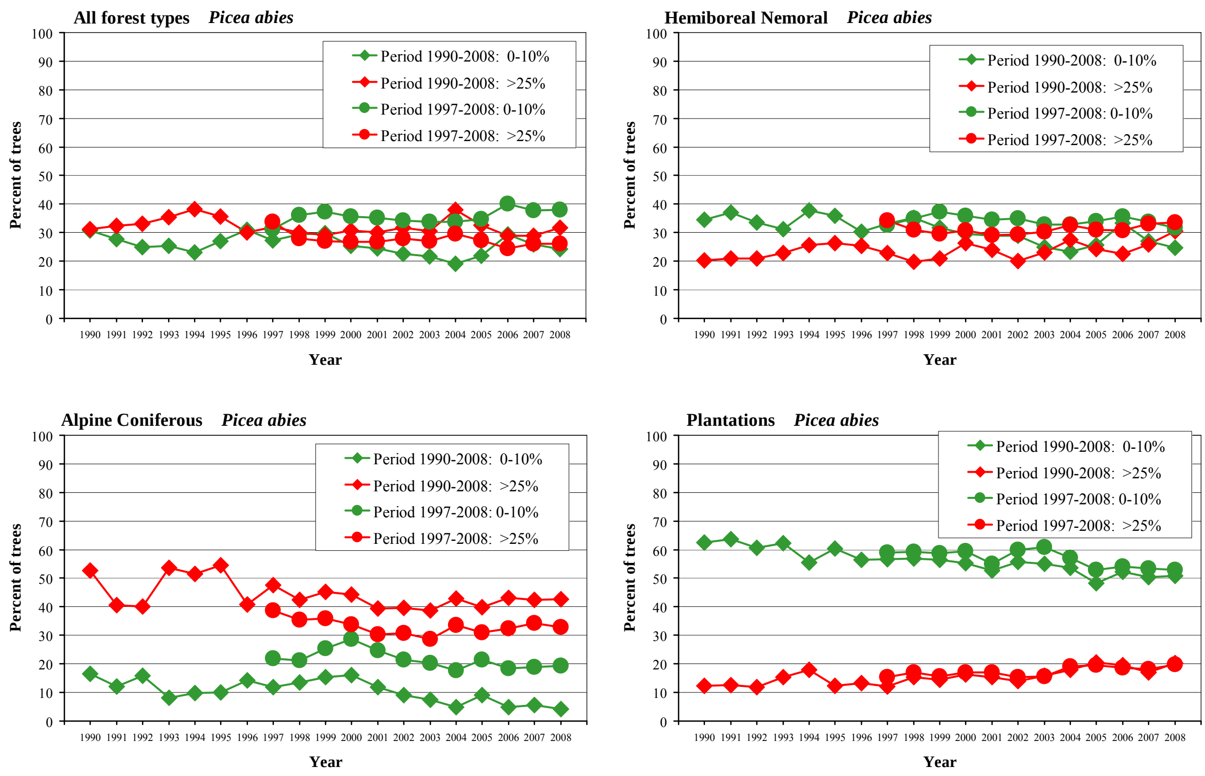

Figure 2.2.2.4-1: Shares of trees of defoliation 0-10% and >25% in two periods (1990-2008 and 1997-2008).

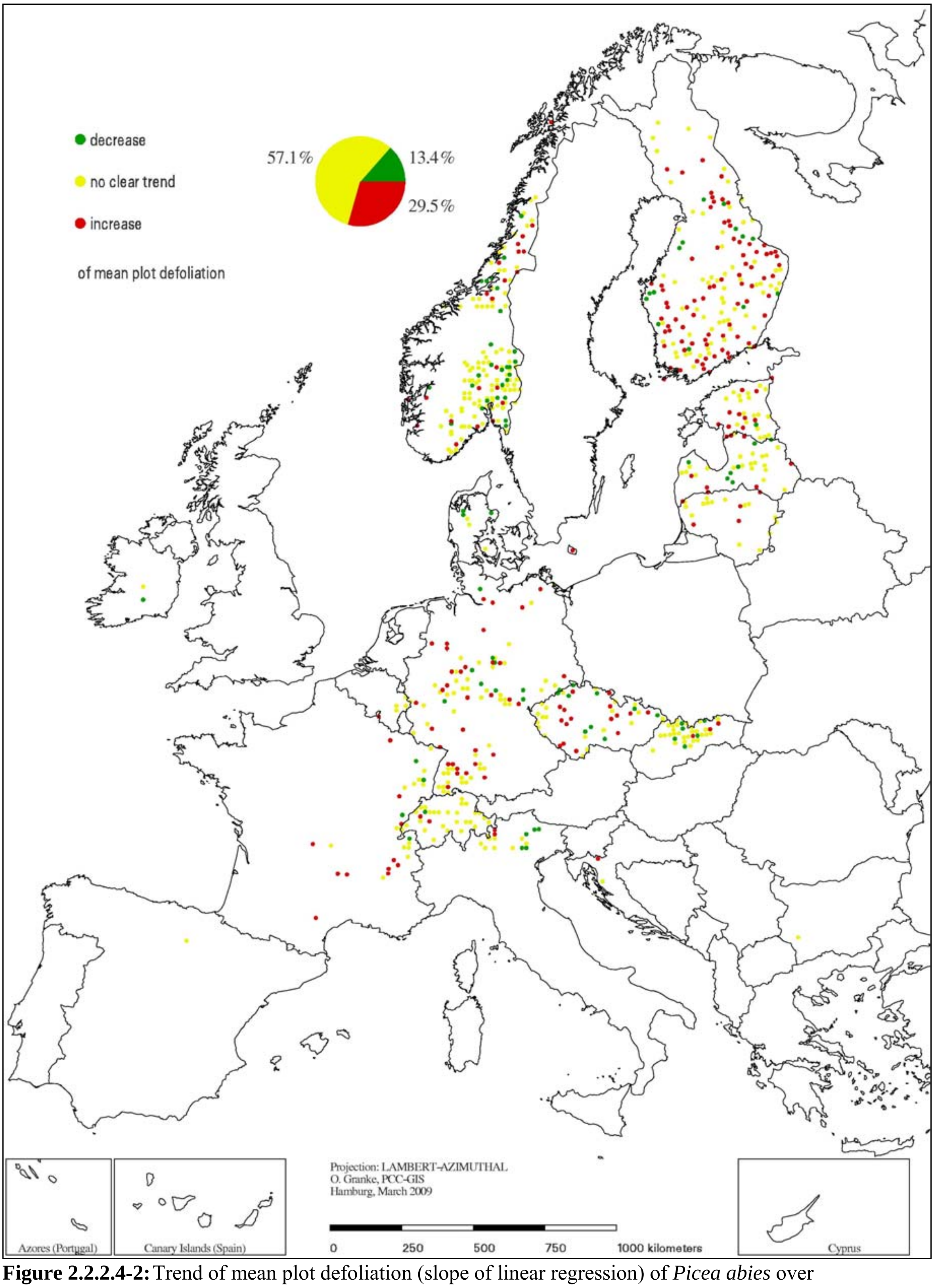

Figure 2.2.2.4-2: Trend of mean plot defoliation (slope of linear regression) of *Picea abies* over the years 1997 to 2008.

2.2.2.5 Fagus sylvatica

Fagus sylvatica is the most frequent tree species among all broadleaves. Over the years crown condition was fluctuating with a share of damaged trees mostly between 20% and 30%. For the year 2008, the sample of trees surveyed since 1997 revealed the lowest share of damaged trees, namely 19.7%.

The largest numbers of *Fagus sylvatica* trees occur on plots classified as beech or montane beech forests. In the latter deterioration has been observed in the 1990s, followed by ups and downs since then. In 2008, a distinct worsening was registered in mountain beech forests. Defoliation in beech forests was specifically high in 2004, 2005, 2006, which are the years following the drought in 2003. Recuperation has been observed since then.

The map reflecting temporal changes on beech plots reveals that on most plots there are no changes in mean defoliation over the period 1997 – 2008. There are, however, minor regional differences. Deteriorating plots are more frequent in France and southern Germany. Improvements prevail in Slovakia and Bulgaria, whereas in Croatia plots with improvements and such with a worsening trend are located comparably close to each other.

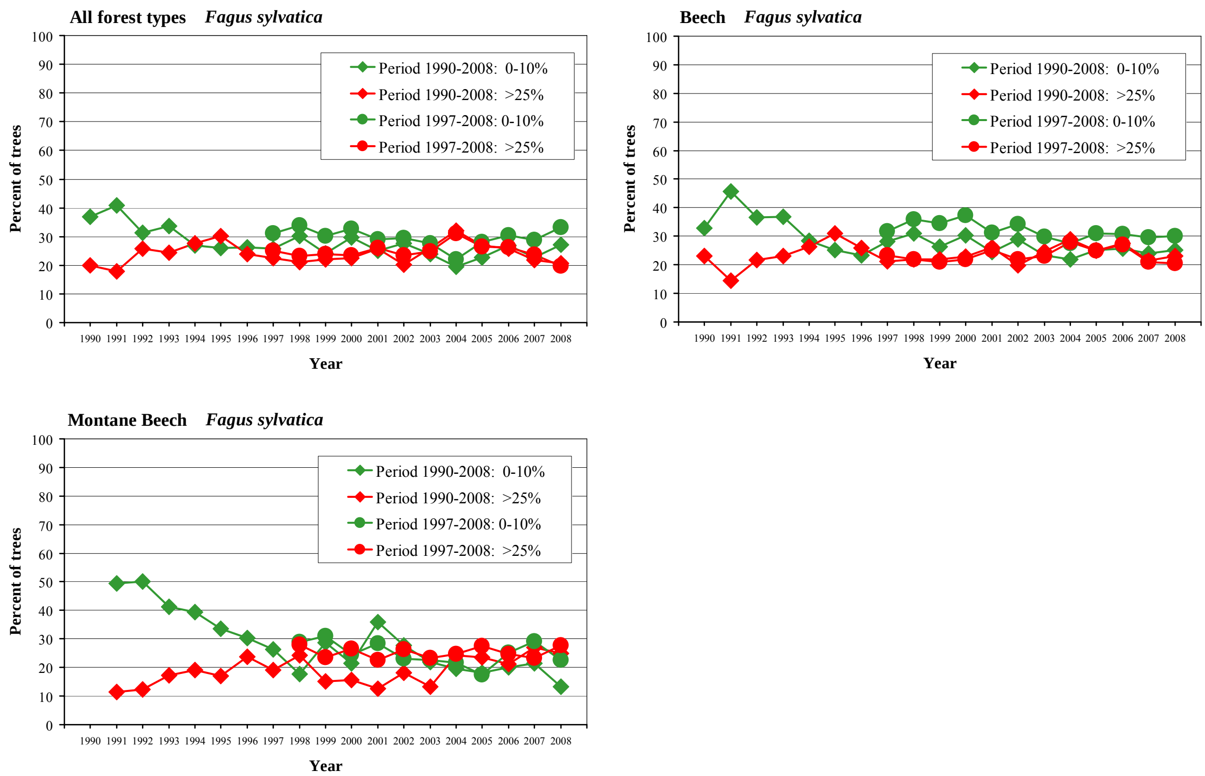

Figure 2.2.2.5-1: Shares of trees of defoliation 0-10% and >25% in two periods (1990-2008 and 1997-2008).

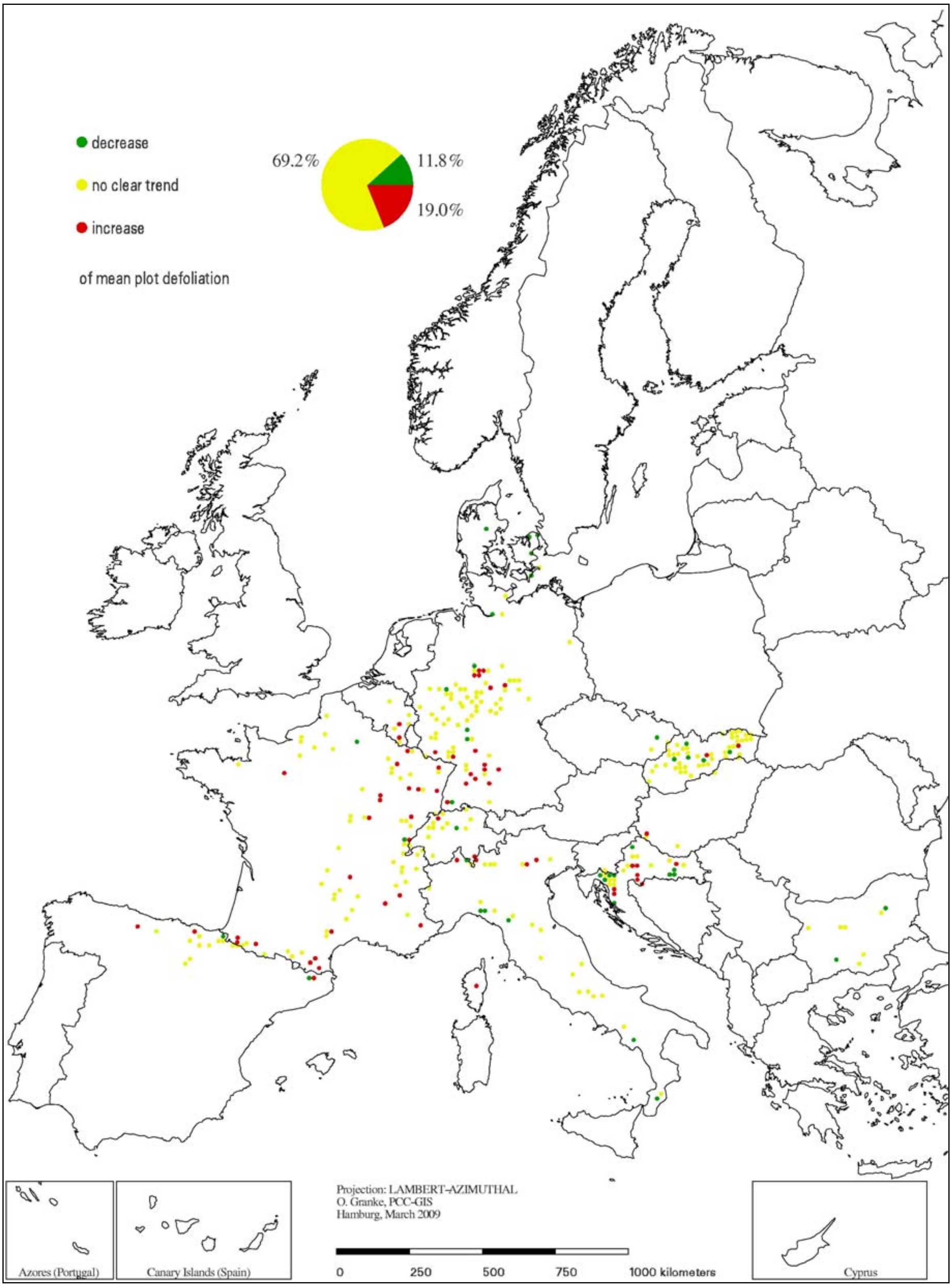

Figure 2.2.2.5-2: Trend of mean plot defoliation (slope of linear regression) of *Fagus sylvatica* over the years 1997 to 2008.

2.2.2.6 Quercus robur and Q. petraea

Across all forest types, defoliation of *Quercus robur* and *Quercus petraea* had two peaks since 1990. The share of damaged trees amounted to 48.1% in 1994 and in 2004 it reached 37.8%. A continued recuperation has been observed during the last three years.

This general development mainly reflects the situation on plots classified as mesophytic deciduous forest type, which comprises nearly half of the assessed oak trees. On plots of this forest type the second peak occurred in 2005 with a share of 34.4% of trees registered as damaged. On plots of the acidophilous oak forest type there is a remarkable decrease in the share of undamaged trees and a fluctuation in the share of damaged trees. This indicates that a large part of the trees shifted from defoliation class 0 to defoliation class 1 (slightly defoliated). *Quercus robur* and *Quercus petraea* trees growing in beech dominated forests show some deterioration in the last two years (Figure 2.2.2.6-1).

A deterioration in health of both oak species was found on 32.4% of the plots in the map whereas on only 8.8% plots health status improved in the year 1997 to 2007. Most *Quercus robur* and *Quercus petraea* plots occur in France. Here plots with deteriorating defoliation are more frequent than plots with improvements. This trend is reverse in Eastern Europe (Figure 2.2.2.6-2).

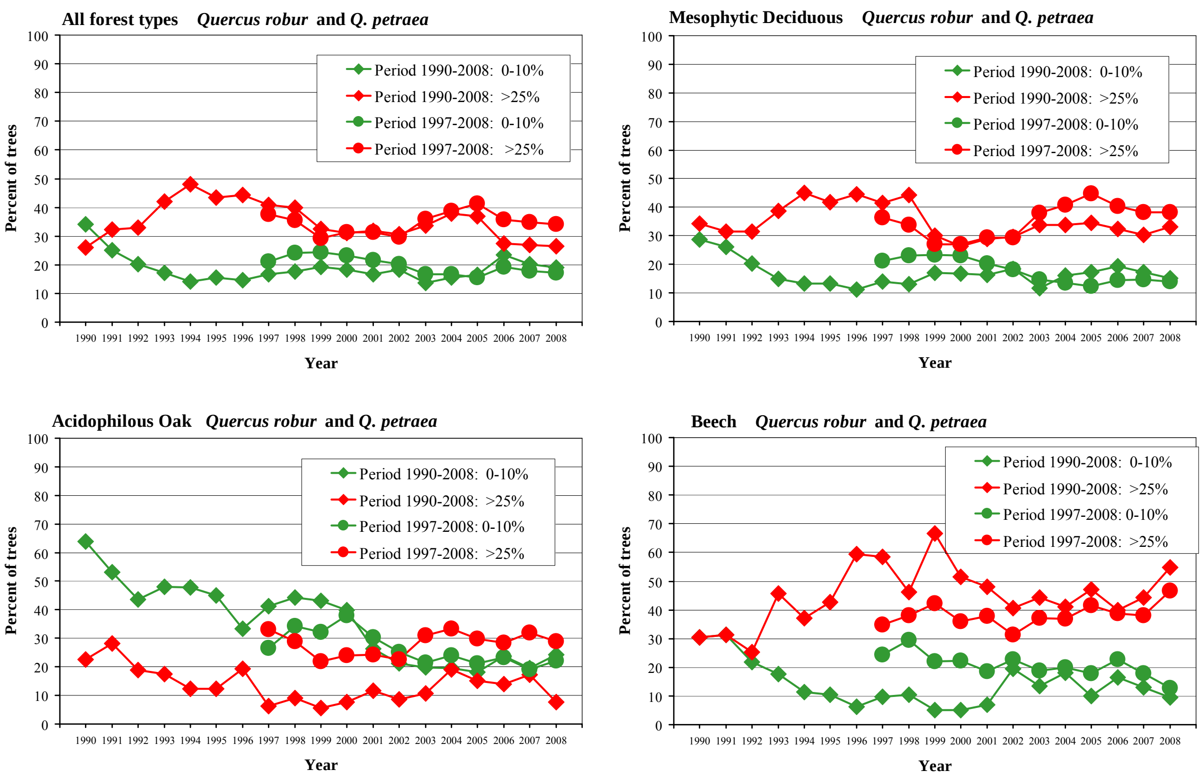

Figure 2.2.2.6-1: Shares of trees of defoliation 0-10% and >25% in two periods (1990-2008 and 1997-2008). (Bottom right: defoliation of *Quercus robur* and *petraea* trees growing in beech forests.)

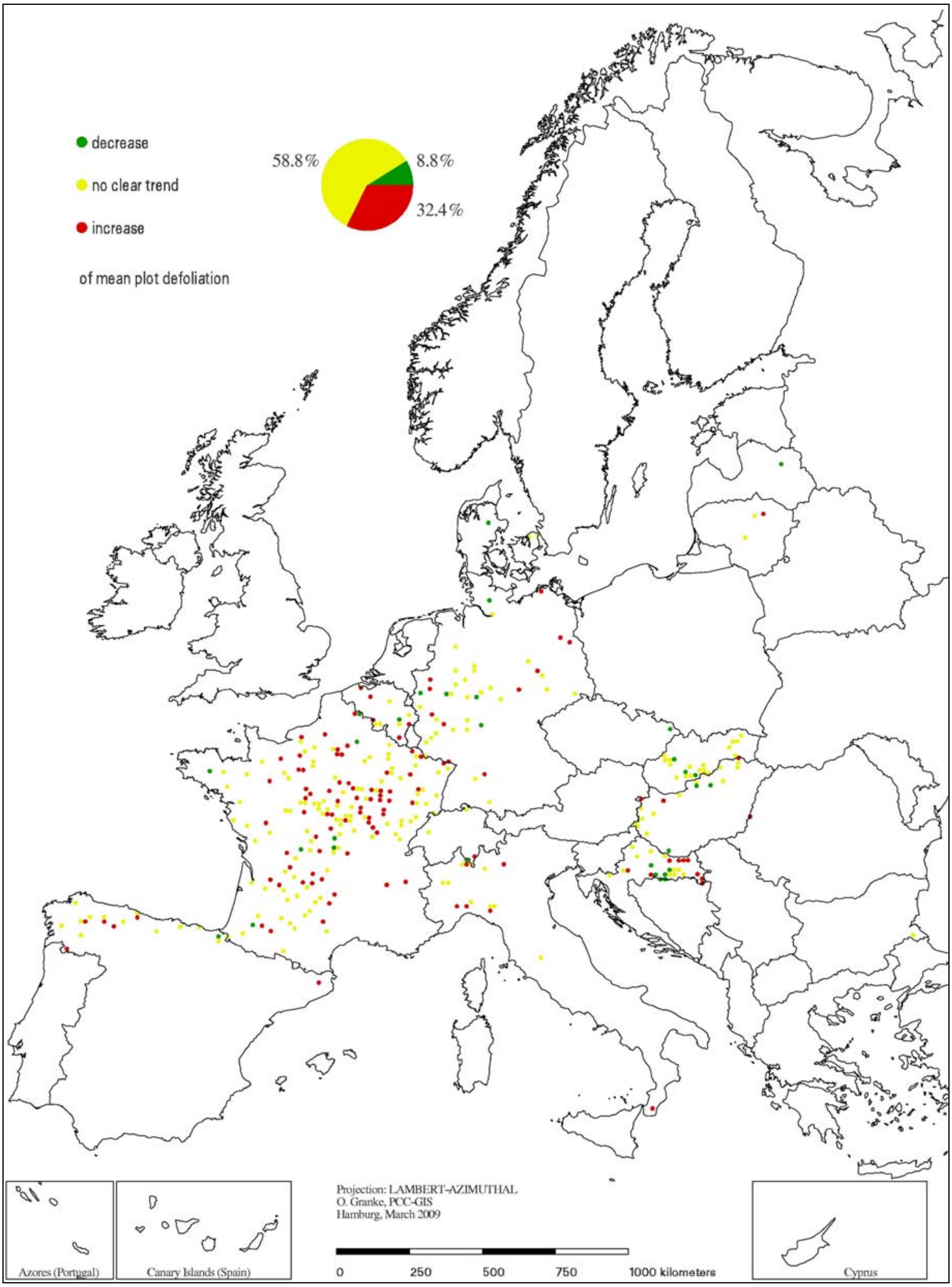

Figure 2.2.2.6-2: Trend of mean plot defoliation (slope of linear regression) of *Quercus robur* and *Quercus petraea* over the years 1997 to 2008.

2.2.2.7 Quercus ilex and Q. rotundifolia

95% of the *Quercus ilex* and *Quercus rotundifolia* trees occur on plots of the evergreen broadleaved forest type. Thus, the trends for all forest types and for the broadleaved evergreen forest type are nearly identical. There is a remarkable deterioration in defoliation at the beginning of the observation period from 1990 when only 2.5% of the trees were rated as damaged to 1995 when 32.8% of the trees were in the respective defoliation class. After a period with fluctuating defoliation, the share of damaged trees nearly reached the 30% mark in 2005 and 2006 again. Since then there is some recuperation recorded which might be attributed to favorable weather conditions reported from Spain, which is the country with the largest occurrence of *Quercus ilex* and *Quercus rotundifolia* (Figure 2.2.2.7-1).

The map clearly shows the importance of Spain with respect to the evergreen oak species, since there are no data from Portugal reported. There are hardly any plots with improvements in mean defoliation (Figure 2.2.2.7-2).

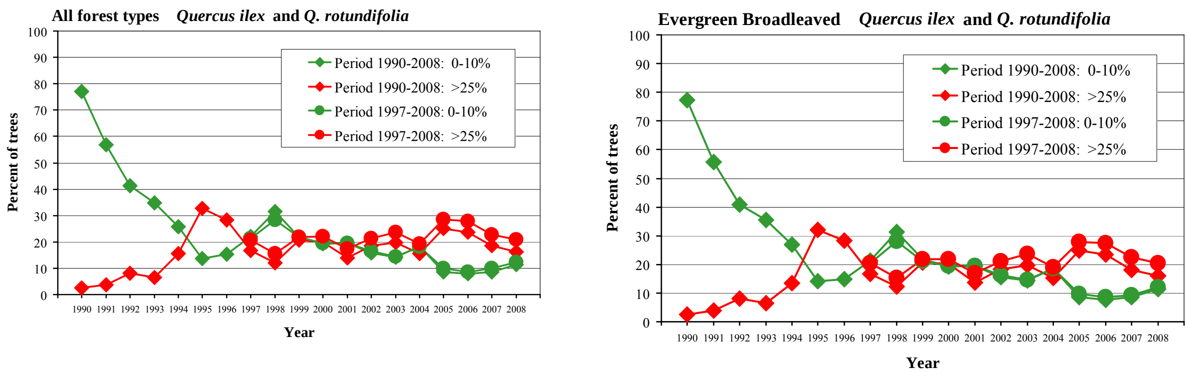

Figure 2.2.2.7-1: Shares of trees of defoliation 0-10% and >25% in two periods (1990-2008 and 1997-2008).

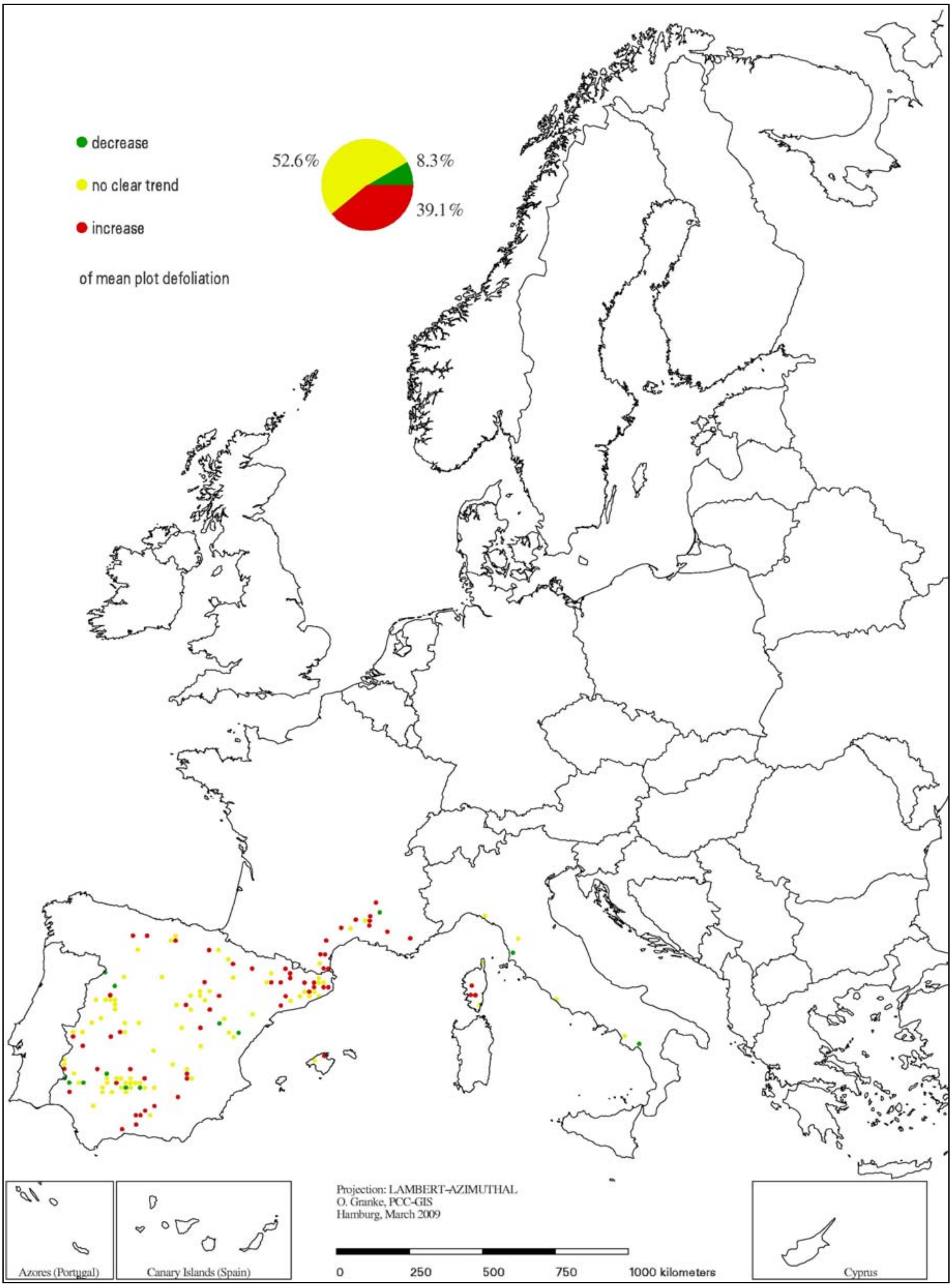

Figure 2.2.2.7-2: Trend of mean plot defoliation (slope of linear regression) of *Quercus ilex* and *Quercus rotundifolia* over the years 1997 to 2008.

2.2.2.8 Pinus pinaster

Nearly all of the *Pinus pinaster* trees are growing on plots of the Mediterranean coniferous forest type. Thus, the trends for this forest type are nearly identical to the trend for all forest types. For the latter there was a deterioration in defoliation which is characterized by a strongly decreasing share of undamaged trees from 78.5% of the trees in 1990 to 31.3% in 2006. Whereas there was only a minor increase in the share of damaged trees, there was a considerable increase in the share of slightly damaged trees (10-25% defoliation). This shows that a large share of trees shifted from undefoliated to slightly defoliated over the years. For the considerably smaller sample of *Pinus pinaster* in plantations the deterioration is characterized by decreasing shares of undamaged and increasing shares of damaged trees. (Figure 2.2.2.8-1).

The map does not reveal a specific spatial trend. There are only three plots with decreasing mean defoliation over the years 1997 – 2008 (Figure 2.2.2.8-2).

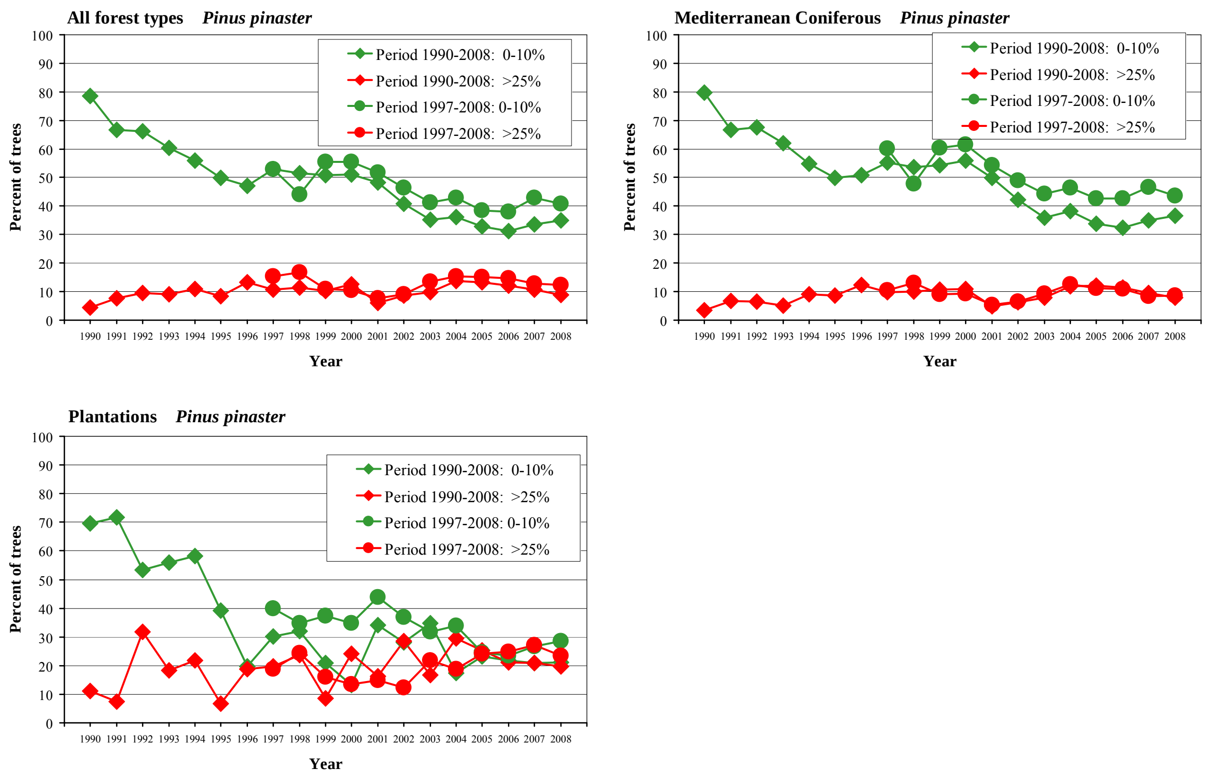

Figure 2.2.2.8-1: Shares of trees of defoliation 0-10% and >25% in two periods (1990-2008 and 1997-2008).

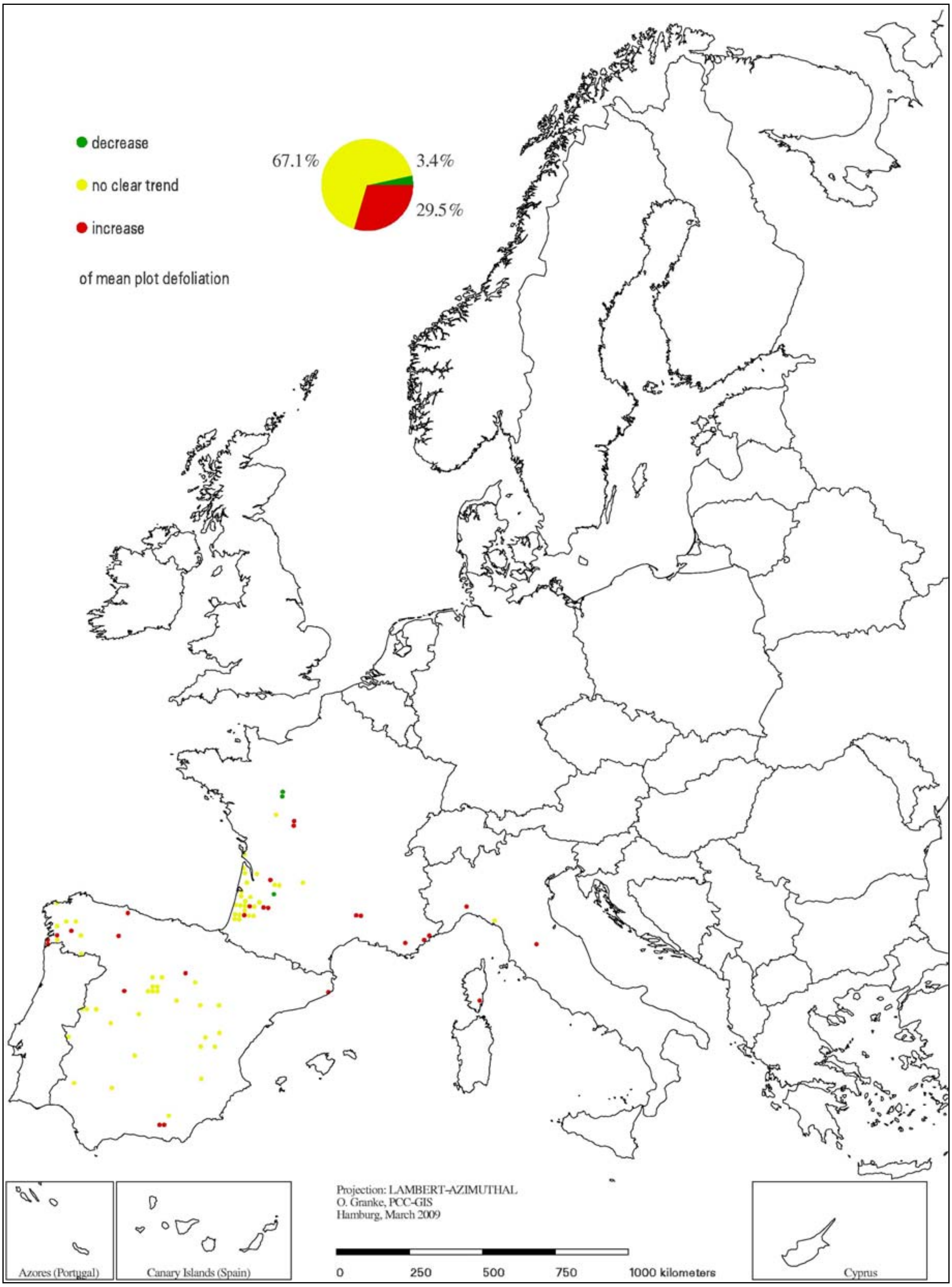

Figure 2.2.2.8-2: Trend of mean plot defoliation (slope of linear regression) of *Pinus pinaster* over the years 1997 to 2008.

2.3 Spruce forests in Russia

2.3.1 Introduction

Forest condition in Europe varies between regions, years and tree species. Taking this into account, each of the Forest Condition Reports of ICP Forests and EU has since 1999 presented the development and condition of one specific tree species or - since 2005 - of one specific forest type. Following the special foci on “Carpathian montane beech forests” in 2007 and “Brutia pine forests in the Mediterranean basin” in 2008, “Spruce forests in Russia” are in more detail presented in this report.

2.3.2 Geographic extent

Spruce forests are evergreen, dark-coniferous forests growing under cold and temperate climatic conditions. The area of spruce forests in Russia is 78 million ha, with a volume of spruce wood of 11 billion m^3. These forests account for more than 30 % of the total national wood volume, and provide considerable non-wood resources (mushrooms, berries, pharmaceutical plants).

Spruce forests are the predominant form of forest in European Russia and Ural. They form taiga landscapes to the north of the Russian plain, in the Urals, the Khabarovskyi territory (lower reaches of the River Amur), Sakhalin, and in Western Siberia and Altai.

Spruce forests form major vegetation zones over significant parts of both European and Asian Russia. There is also a high proportion of spruce in the hemiboreal forests in Russia, which form a narrow band stretching along the southern boundary of the taiga zone and represent the transitional zone between the boreal and nemoral forests. In mountainous areas, including the southern part of the temperate zone (the Krasnoyarsk and Altai territories) and the sub-tropical zone (Northern Caucasus), there are forests with a high proportion of spruce that form altitudinal vegetation belts analogous to the climatic conditions between the boreal and hemiboreal zones.

2.3.3 Tree species

In Russia the genus *Picea* is represented by a number of indigenous species with distinct distribution ranges. Norway spruce (*Picea abies*) is the predominant species in all the boreal and hemiboreal forests of European Russia, and it extends up to the Pre-Ural region (the eastern boundary stretches along the River Kama).

The main species of spruce in Asian Russia is Siberian spruce (*Picea obovata)*, or *Picea abies* ssp. *obovata*. Siberian spruce also extends into European Russia, across the Ural Mountains, and forms a gradually diminishing zone reaching as a far as the Kola Peninsula (in the Murmansk region).

Thus, in the northern and central taiga of European Russia (and in the southern taiga of the central Pre-Volga and Pre-Ural areas) there is a contact zone between Norway and Siberian spruce where, according to the opinions of Russian taxonomists, there is introgressive hybridization. The product of this hybridization is a form of spruce called Finnish spruce (*Picea fennica*).

The only species of spruce growing in the dark-coniferous mountain forests of the Caucasus, e.g. in northern Turkey, is the oriental spruce (*Picea orientalis*); no other spruce species are known in the Russian part of the Caucasus. In the southern taiga and hemiboreal forests of the

Far East (Primorsky Territory and Kamchatka Peninsula) Jeddo (or Jezo) spruce (*Picea ajanensis)* is the predominant species.

Spruce forests refer to dark coniferous forest because, in the forestry classification of tree species, spruce together with Siberian fir (*Abies sibirica*) and Siberian pine (*Pinus sibirica*), or *Pinus cembra ssp. Sibirica* form the dark coniferous group. All the dark coniferous species have similar requirements for climate, soil and hydrology and, as they are also equal competitors, they readily co-exist in mixed tree stands. Nowadays *Picea* species are the most widely distributed dark coniferous trees in the boreal zone.

In actual fact, the dark-coniferous forests in the westernmost part of European Russia (Murmansk, Leningrad, Pskov, Novgorod regions, Karelia and western part of the Arkhangelsk region) consist almost solely of spruce. Starting from the eastern part of European Russia (eastern part of the Arkhangelsk, Vologda and Kostroma regions) and further to the Ural Mountains, and in Asian Russia, Siberian fir is present in almost all tree stands, as well to a lesser extent also Siberian pine.

The decrease in the number of dark-coniferous tree species when moving to the west may be related to the higher intensity of land use and exploitation of forest resources, during the course of which the indigenous populations of Siberian fir and Siberian pine have gradually become eliminated.
In European Russia Scots pine (*Pinus sylvestris*) forms tree stands in spruce forests. The trees occurring in the taiga also include birch (*Betula pubescens* and *Betula pendula*) and aspen (*Populus tremula L.*), in the hemiboreal forests oak (*Quercus robur L*), lime (*Tilia cordata Mill.*) and aspen (*Populus tremula L.*), in the Northern Caucasus Siberian fir (*Abies sibirica*) and beech (*Fagus orientalis*), in the Far East Korean cedar pine (*Pinus koraensis Sieb. et Zucc.*), ash (*Fraxinus mandschurica Rupr.*), and Siberian fir (*Abies sibirica*).

2.3.4 Spruce tolerance and adaptation

Spruce dominance in the boreal climate is explained by the adaptation of this species to the relatively low temperatures through elongation of its growing period. The adaptive characteristics are not only perennial leaves that are resistant to the freezing temperatures in winter, but also an ability to photosynthesis at temperatures close to zero. The large number of spruce populations in the taiga is due to its high competitiveness in comparison with other tree species common in the taiga, e.g. pine and birch. Spruce seedlings and saplings especially have a high tolerance to shading, and they survive in the forest for a longer period of time compared to young pine and birch trees. Pine or birch can only become dominant during the regeneration period following the abrupt occurrence of unfavourable ecological conditions or the massive destruction of young spruce generations.

Spruce trees are sensitive to drought and subjected to windthrow because of their very superficial root system. They are sensitive not only to crown fires but also to ground fires because of damage to their thin bark. They cannot withstand water logging. Young trees suffer from late (spring) frost, while old trees can be subjected to fungal diseases and windbreak.

2.3.5 Types of forest

Fifteen forest type groups and more than 100 types of spruce forest have been identified in the northern, middle and southern taiga of Russia.

The northern and middle taiga are characterized by spruce forests with dwarf shrubs and green mosses (classified as *Piceeta fruticuloso-hylocomiosa)* growing on podzol or podzolic soils (Figure 2.3.5-1). In these forests the ground vegetation is dominated by *Vaccinium myrtillus L.*, *V. vitis-idaea L.* and *Empetrum nigrum L.*, and the bottom layer by *Pleurozium schreberi*, *Hylocomium splendens*, and *Dicranum* spp.

The wide distribution of these types of spruce forest, in which the trees can reach a maximum age of 200 years, has led researchers to conclude that they are representatives of the latest stages of succession, or even of the climax stage. However, field observations show that practically all these types of spruce forest have been subjected, at one stage or another, to fires of varying intensity. Old-growth spruce forests with a higher diversity of herbs and low abundance of green mosses and boreal dwarf shrubs have been found on similar types of relief and underlying bedrock (Figure 2.3.5-2). The herbs dominating in these types of forest are not only widely distributed species of boreal low herbs (e.g. *Oxalis acetosella* L., *Trientalis europaea* L., *Maianthemum bifolium* L.), but also tall boreal herbs (*Aconitum lycoctonum* ssp. *septentrionale*, *Crepis sibirica* L., *Paeonia anomala* L. etc.), and several herb species characteristical for hemiboreal and even nemoral forests (*Lathyrus vernus* L.), *Melica nutans* L., *Viola mirabilis* L). In the forests with herbs (*Piceetum hylocomioso-parviherbosum* and *Piceetum hylocomioso-magnoherbosum*), the signs of fires are either less pronounced or were initially less damaged by fires.

Mixed, dark coniferous forests (comprising spruce, fir (*Abies sibirica*) and cedar pine (*Pinus sibirica*) are represented by the same types (*Fruticuloso-hylocomioosum*, *Hylocomioso-parviherbosum* and *Hylocomioso-magnoherbosum)* depending on the time elapsed since the last fire.

Figure 2.3.5-1: Piceetum fruticuloso-hylocomiosum, Pechoro- Ilych reserve, middle taiga, photo by O.Smirnova

Figure 2.3.5-1: Piceetum magnoherbosum, Pechoro- Ilych reserve, middle taiga, photo by O.Smirnova

In the northern and middle taiga, spruce forests and mixed dark coniferous forests with herbs are found close to or in mountainous regions (e.g. the Khibiny mountains, Pre-Ural). The soil in these forests are cambic podzols or cambisoils.

In the *Piceeta fruticuloso-hylocomiosa* types of southern taiga and hemiboreal forests on well-drained interfluvial deposits, almost 30 years of research have demonstrated the occurrence of succession stages with boreal and nemoral herbs.

Nowadays, spruce forests with herbs (*Piceetum parviherbosum* and *Piceetum magnoherbosum*) are mainly found on drained river flood plains, e.g. on high river banks where fire rarely occurs. These floristically rich communities, which are strongly dependent on the hydrological conditions, are found throughout the boreal zone and fulfill an important role in biodiversity by providing refugia for the pool of species occurring in different succession stages.

Special types of spruce forest can form under extreme ecological conditions, e.g. when there is a deficiency or excess of water. In the northern taiga, spruce forests with lichens or with lichens and mosses (*Piceetum cladinosum, Piceetum cladinoso-hylocomiosum*) occur on podzols that have developed on stony or sandy till (Figure 2.3.5-3). The ground vegetation in these forests is dominated by *Cladonia* and *Cetraria* lichens and by green mossess (*Pleurozium schreberi*, *Hylocomium splendens*, *Dicranum* spp.). The tree canopy is very sparse and open and the number of vascular plant species is very low. These forests have formed through the influence of severe climatic conditions, combined with human activities (removal of pines, fire, reindeer grazing etc.).

Figure 2.3.5-3: Piceetum cladinosum, Lapland reserve, northern taiga, photo by L.Isaeva

Figure 2.3.5-4: Piceetum sphagnosum with low herbs, middle taiga, photo by T.Braslavskaya

On peaty, waterlogged soils, spruce can also form sparse forests in which the ground layer is dominated by *Sphagnum* mosses (Figure 2.3.5-4). However, the species composition of these mosses (*Sphagnum girgensohnii*, *S. russowii*, *S. squarrosum*) indicates that paludification has either a mesotrophic (in the northern and middle taiga), or an eutrophic (southern taiga) character. Spruce species cannot grow successfully under oligotrophic paludification. The sparse character of the tree cover under mesotrophic and eutrophic conditions is due to the fact that spruce seedlings can only grow and develop on elevated parts of the relief (e.g. stumps, fallen trees etc.) because of excess of water. Herbs are represented here by hydrophilic species, e.g. *Carex globularis* L., *Rubus chamaemorus* L., and graminoids of *Calamagrostis* genus.

2.3.6 Disturbance factors

The overall structure of spruce forests was only marginally affected during the preindustrial period by, for instance, the slash-and-burn agriculture that developed in the forests of European Russia and the Urals. During the past couple of centuries, however, there has been a considerable increase in the impact of human activities arising from the extensive exploitation of forests during the industrial revolution and subsequent development of the forest industries.

Nowadays the main disturbance factors affecting the forests are fire, clear cutting, air pollution, changes in the weather, windthrow and snow-break, and outbreaks of insect pests and fungal diseases. The spruce forests are subjected to multiple stresses: one factor acting as a trigger, resulting in the subsequent involvement of other factors.

A number of catastrophic events have recently occurred in spruce forests in the northern part of European Russia (Figures 2.3.6-1 and 2.3.6-2). The area of damaged forests has reached more than 6 million hectares, and the damage has mainly affected forests in the Arkhangelsk region, and also in the south-western part of the Komi Republic and north-eastern part of the Vologda region. The damage outbreak started in the hot dry summer of 1997, when defoliation and discolouration of 160- to 180-year-old spruce were observed in even-aged spruce stands. The weakened and damaged trees have subsequently suffered from windthrow and windbreak (from 10 to 80 m^3 per hectare), and then from massive attack by bark beetles.
Similar events, but not at such a large scale, have occurred several times during the last century, and not only in the north of European Russia, but also in Siberia, the Urals, and the Moscow, Kostroma and Nizhegorod regions.

Figures 2.3.6-1 and 2.3.6-2: Forest decline in Arkhangelsk region, photo by A. Bobrinsky

It has been suggested that large-scale cuttings along the rivers during the 1920's to the 1940's caused considerable changes in the hydrological regime in forest catchments. Spruce, with its very superficial root system, is highly susceptible to the negative effects of drought. During the last century this phenomenon was also frequently reported in Belorussia, where extensive peatland drainage was carried out.

Nowadays, clear cuttings also contribute to this phenomenon, especially in areas with a ‘mosaic’ of felling sites, as they cause disturbances in the hydrological and light regimes. In addition, there was a considerable amount of snow-break caused by the accumulation of wet snow on the tree crowns during the winters in 2001-2003.

Thus the primary factor, i.e. the trigger, is clear-cutting because it causes considerable disturbances in the hydrological regime of forest catchments. The earlier occurrence of extensive forest fires may have also resulted in the formation of relatively even-aged stands, which are significantly less tolerant to disturbing factors than uneven-aged spruce stands. Extreme weather conditions like drought, and/or an increase in amount of wet snowfall, result in damage to the trees. The weakened trees are then susceptible to windthrow and windbreak, and damaged and fallen trees provide favourable substrates for the reproduction of insect pests. The pioneer insect species is *Ips typographus,* followed by *Monochamus spp., Trypodendron lineatum, Pityogenes chalcographus, Poligraphus poligraphus, Urocerus gigas (Sirex gigas) Linnaeus Buprestidae, Paururus dux, Buprestidae* etc.

Air pollution is a factor having a considerable effect on the spruce forests in Russia. During the past 60 years, two Ni-Cu smelters (“Pechenganikel” and “Severonikel”) have been operating in the Murmansk region on the Kola Peninsula. The smelters are the major source of air pollution in Northern Europe, and the total area where the critical deposition of sulphur (0.3 $gS/m^2/g$) is exceeded is more than 90 000 km^2 in the region. Forest ecosystems with signs of visible damage occur over an area of 39 000 km^2, and completely destroyed forest ecosystems on an area of over 1 000 km^2. Spruce forests occupy more than 30 % of the total forest area. Air pollution in the area acts as a trigger, causing the outbreak of severe fires. The frequency of fires in severely polluted areas increases dramatically owing to the accumulation of large amounts of dead, combustible plant material. The combined effects of pollution and fire have resulted in the replacement of spruce forests by deciduous (usually birch) forests.

The combined effects of clear cutting and fires have resulted in the replacement of spruce forests by deciduous forests in the central part of European Russia, and forest fires have caused the replacement of spruce forests by pine forests in the north-western part of Russia.

The spruce forests in Russia represent the most important stock of carbon in Northern Eurasia. Fire, clear cutting, air pollution and insect pests affecting spruce forests have caused changes in the carbon cycle, the reflectivity of the ground surface and thermal fluxes and, as a result, increased the threat of climate change

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3. INTENSIVE MONITORING

3.1 Introduction

For assessments of cause-effect relationships at the forest ecosystem scale more than 860 plots were (Level II) selected in the most important forest ecosystems of 28 participating countries. The intensive monitoring comprises 11 surveys, but not all of them are conducted on every plot. Also, not all surveys are conducted continuously or annually, but need to be conducted only every few years. For each of the surveys Table 3.1-1 shows the number of installed plots, the number of plots assessed in 2005, and the assessment frequency. The map in Annex I-7 shows the locations of the installed plots. The complete methods of the intensive monitoring are laid down in the "Manual on methods and criteria for harmonized sampling, assessment, monitoring and analysis of the effects of air pollution on forests" (ANONYMOUS, 2004).

Table 3.1-1: Surveys, numbers of Level II plots and assessment frequencies.

Survey	Number of plots		Assessment frequency
	Installed	Data submitted for 2006	
Crown condition	822	662	Annually
Foliar chemistry	795	150	Every two years
Soil condition	742	0	Every ten years
Soil solution chemistry	262	241	Continuously
Tree growth	781	77	Every five years
Deposition	558	473	Continuously
Ambient air quality	121	121	Continuously
Ozone induced injury	99	42	Annually
Meteorology	235	235	Continuously
Phenology	152	152	Several times per year
Ground vegetation	757	119	Every five years
Litterfall	145	145	Continuously

Chapter 3.2 presents the spatial and temporal variation of sulphur, ammonium, and nitrate deposition as assessed at Level II by the year 2006.

3.2 Sulphur and nitrogen deposition and its trends

3.2.1 Canopy interactions and canopy budget models

Deposition data are collected and analysed on Level II plots according to the ICP Forests Manual (ANONYMOUS 2004), both in the open field (bulk deposition) and under canopy (throughfall). Bulk deposition reflects the local air pollution situation and is a basis for estimates of total atmospheric deposition rates in open fields. Throughfall and in some cases stemflow (deciduous tree species) constitute element fluxes in forest ecosystems. Owing to wash off of dry deposition in the canopy and element absorption by the foliage, throughfall rates typically differ from bulk deposition which makes up the Net canopy effect. With respect to element fluxes in the forest canopy, formally two major processes can be described for the passage of the deposition through the canopy:

1. Canopy leaching: The solution of elements, mostly of nutrients from the canopy into the precipitation water, which leads to an enrichment of the particular element in the throughfall deposition compared to bulk deposition.
2. Canopy uptake: The absorption, in particular of nitrogen compounds, by the foliage which reduces the element fluxes of bulk and dry deposition passing through the canopy.

In the present study canopy exchange was not taken into account and throughfall does not reflect total deposition. Moreover, throughfall deposition may have been underestimated especially in beech stands because stemflow was not taken into account as it had not been measured continuously from 2001 to 2006 on most plots. These restrictions are not in conflict with the aim of the present study to assess spatial and temporal variation of depositions. However, care must be taken when comparing the results of the study with results published in the literature.

In a case study based on a beech Level II plot in Northern Germany the canopy budget model of Ulrich (1983) has been applied and tested. The results point to the fact that throughfall deposition is an inadequate indicator for total deposition in a forest, but on the other hand, substantial method development is necessary to improve existing models.

Atmospheric deposition rates are of key importance to understand biogeochemical cycling and to calculate valid element budgets of ecosystems. There is, however, no sampling technique for direct measurements of total atmospheric deposition. Presently, open-top samplers for throughfall and sampling devices for stemflow are used, which both account for the fluxes beneath the canopy. Sampling of these fluxes includes dry and wet deposition but they are also modified through element leaching and uptake by leaves and needles (Net canopy effect). In the canopy budget model applied (Ulrich, 1983), sodium is used as a tracer element assuming negligible canopy interactions of this element. Thus, sodium fluxes measured beneath the canopy (througfall incl. stemflow) approximate a valid estimate of total atmospheric sodium deposition. This is the basis for the common principle of the canopy model in which the deposition factor serves for calculating dry particulate deposition rates for various other elements:

$$DD_{part} = \frac{CD_{Na}}{WD_{Na}} WD_x$$

CD	Canopy difference (between the fluxes beneath canopy and wet deposition)
DD	*Dry deposition*
WD	*Wet deposition of sodium (Na) or respective component (x) in the open or bulk deposition as an alternative)*

The approach additionally assumes similar behaviour of sodium and the respective air pollutant during deposition regardless different chemical and physical properties i.e. particle sizes. When interpreting the results of the model application it has to be taken into account that these basic assumptions are not always valid. Thus, the application of the canopy model might yield a better approximation of total deposition as compared to throughfall and stemflow measurements, but it is still a very rough estimate of total atmospheric deposition in particular for elements like potassium and nitrogen compounds (NH_3/NH_4^+ and NO_2/NO_3^-). Analysis of time series (Fig. 3.2.1-1) evaluated from data attained at the beech forest on the Level II-plot 4101 in North Germany (Schleswig-Holstein) indicate the excessive

overestimates of atmospheric potassium deposition by throughfall (incl. stemflow) measurements in comparison with the sum of bulk and dry potassium deposition rates. For magnesium and calcium, throughfall depicts better approximations of total deposition.
Beyond particle deposition of air pollutants, dry deposition of gaseous compounds substantially adds to sulfur and nitrogen deposition which can be calculated as follows:

$$DD_{gas} = TF - DD_{part}$$

TF *Throughfall (incl. stem flow) of respective compound)*

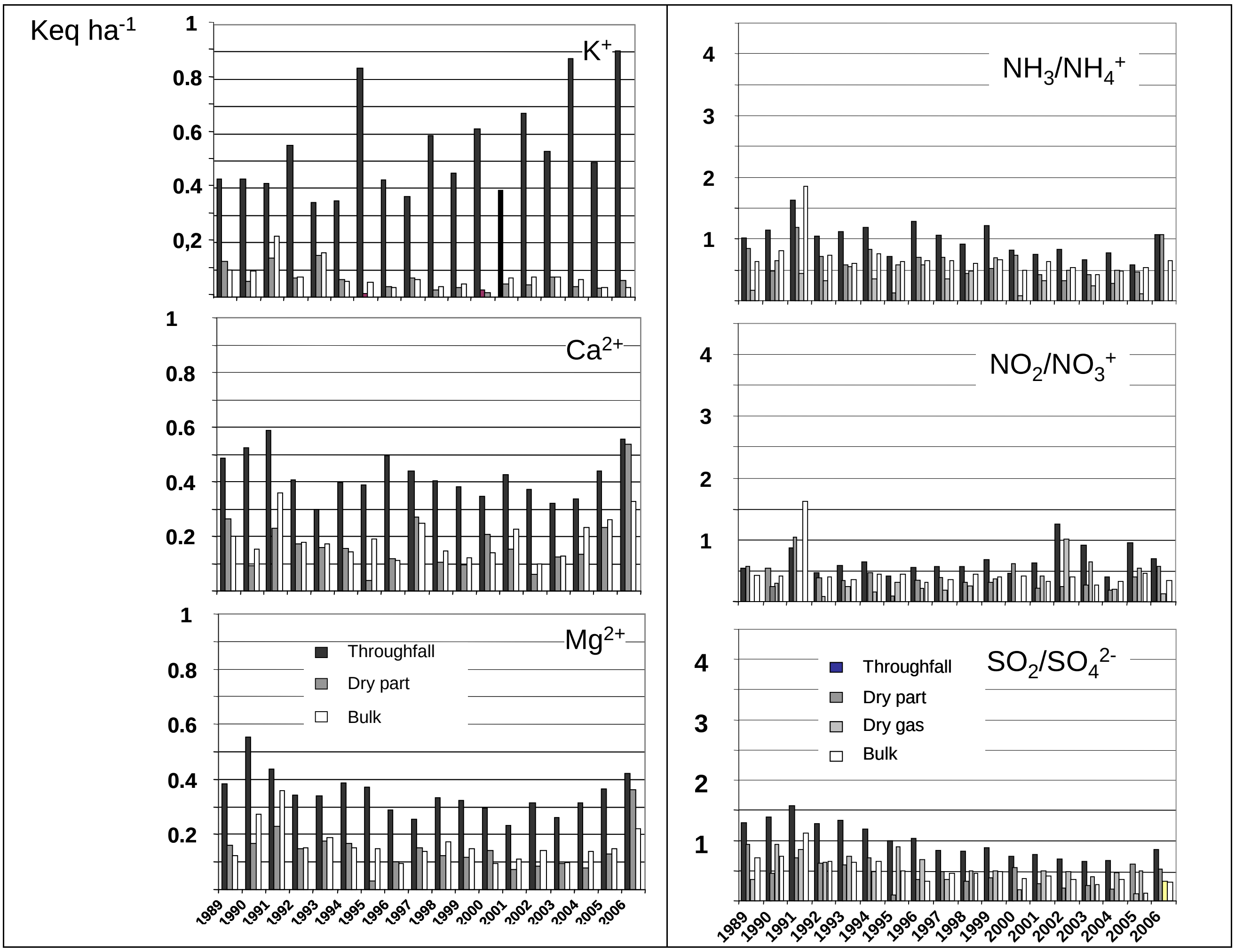

Figure 3.2.1-1: Throughfall and bulk deposition in a beech forest (level II-plot 04101, see also Fränzle et al. 2008) compared with dry deposition rates calculated by the canopy model approach (after Ulrich 1983).

Due to different climatic, chemical, physical as well as physiological factors of deposition and canopy processes, relations between the fluxes show a great variation over the years. For sulphur, througfall and stemflow offer a reasonable approximation for the modelled total deposition rates. However, this is not true for the nitrogen components because uptake by leafs is known to contribute to the net canopy effect which leads to an underestimation of total deposition of nitrogen

These specific results question the validity of canopy modelling in the frame of assessing ecosystem functioning. These restrictions and other implications have lead to extended canopy modelling which takes into account further nitrogen interactions within the canopy (UNECE, 2004). The application of these modelling approaches to comprehensive Level II data is planned for the near future. A working group of the German ICP Forests programme (Gehrmann et al., 2001) evaluated deposition fluxes data of Level II-plots in Germany and proposed comparisons of canopy model results with process-based modelling (resistance models) related to the ecosystem scale.

3.2.2 Methods

For the present study, throughfall and bulk deposition of nitrate (NO_3^-), ammonium (NH_4^+), sulphate (SO_4^{2-}), calcium (Ca^{2+}), sodium (Na^+), and chlorine (Cl^-) were calculated as the arithmetic mean of the yearly sums of the deposition in the years 2004-2006 for each Level II plot in kg ha^{-1} yr^{-1}. Changes over time were calculated over the period 2001-2006. In the light of data availability the choice of this period permitted the inclusion of a maximum number of plots. Only those plots were involved in the study on which deposition had been measured continuously over that period, with maximally 30 days of measurements missing per year. Data of missing days were replaced by the average daily deposition of the respective year. Table 3.2.1.-1 shows the numbers of plots included in the study for each substance according to the above-mentioned criteria. Depending on the pollutant considered, throughfall data were available for 209-254 plots. For a large share of these plots bulk deposition was also available.

Table 3.2.1-1: Number of plots which fulfilled the selection criteria.

No. of observations		Na^+	Cl^-	Ca^{2+}	N- NH_4^+	N- NO_3^-	S- SO_4^{2-}
Trend 2001 – 2006	Bulk	187	187	187	186	187	179
	Throughfall	222	222	222	221	222	214
Mean 2004 – 2006	Bulk	308	308	308	308	308	308
	Throughfall	260	259	260	260	260	260

For mapping and quantifying temporal developments, the slope of plot-specific linear regression over the years of observation was used. Thus, with the years of assessment as predictor and annual deposition as target variable for each plot, linear relationships were obtained. The slopes of the linear equations were statistically tested and depicted in maps according to the following classification:

Decrease: negative slope, error probability lower or equal 5% (green)

No change: negative slope with error probability greater than 5%, or same deposition in each year, or positive slope with error probability greater than 5%

Increase: positive slope, error probability lower or equal 5% (red)

Given the time span of only six years, results must be understood as a mere description of the changes over time rather than a trend analysis which would require a longer period. Bulk and throughfall depositions expressed in kg ha^{-1} yr^{-1} in the text and in the figures refer to the chemical element considered, e.g. to sulphur (S-SO_4^{2-}) instead of sulphate (SO_4^{2-}). No attempt is made to compare the depositions assessed in the study with threshold values, because of poor comparability due to individual site and stand properties. Instead, depositions measured by ICP Forests are used to calculate exceedances of critical loads (Lorenz et al. 2008).

Sulphate is an important constituent of sea salt, and in many coastal areas (e.g. western Norway) most sulphate in deposition may be from sea salt rather than anthropogenic sources. As the relationship between chloride and sulphate in sea water is almost constant and assuming that chloride is almost entirely derived from sea salt and hardly affected by biogeochemical processes (assumptions that are not always correct), measured sulphate concentrations can be easily corrected for the sea salt contribution using the formula: non-marine SO_4-S = total SO_4-S - (0.054 * Cl), where all values are in mg/l.

3.2.3 Results

3.2.3.1 Spatial variation

For the majority of the plots throughfall is clearly higher than bulk deposition, indicating the importance of dry deposition filtered from the air and washed off the leaves. Spatial variation of S-SO_4^{2-} bulk deposition is high on plots in central Europe (Figures 3.2.3.1-1 and 3.2.3.1-2). A particularly high share of plots receiving bulk deposition higher than 5.7 kg ha^{-1} a^{-1} is situated in Poland. S-SO_4^{2-} throughfall is all in all higher than bulk deposition. A high share of plots receiving throughfall above 5.7 kg ha^{-1} a^{-1} is also found in central Europe, particularly in Germany, in the Czech Republic, in Denmark, and in The Netherlands. Plots with lowest S-SO_4^{2-} bulk and throughfall deposition ranging from 0.2 to 3.3 kg ha^{-1} a^{-1} are mainly situated in the Nordic countries, in parts of southern Germany and in the Alps of Austria and Switzerland.

Along the coastlines the monitoring data reveal a high share of plots receiving Na^+ and Cl^- deposition resulting from sea spray. This suggests a relatively high input of S-SO_4^{2-} of maritime origin. Figures 3.2.3.1-3 and 3.2.3.1-4 show bulk and throughfall depositon of S-SO_4^{2-} after correction for sea salt input (Chapter 3.3). Despite this correction several of those plots receiving highest S-SO_4^{2-} deposition are located close to the sea. But deposition is greatly reduced by the correction on many coastal plots receiving high deposition in Norway, Sweden, Denmark and partly in Italy. The pie diagrams show that deposition is generally lower after the corrections.

Rough spatial patterns are also discernable for bulk and throughfall deposition of the nitrogen compounds (Figures 3.2.3.1-5 to 3.2.3.1-8). Plots with lowest N-NO_3^- and N-NH_4^+ bulk and throughfall deposition are located in the nordic countries and in the Alps. Plots with highest N-NO_3^- throughfall were found mainly in central Europe. High abundance of such plots in central Germany and northern Italy may partly reflect areas of high vehicle exhaust due to dense traffic. Also highest N-NH_4^+ throughfall is most abundant in central Europe, but less so in northern Italy.

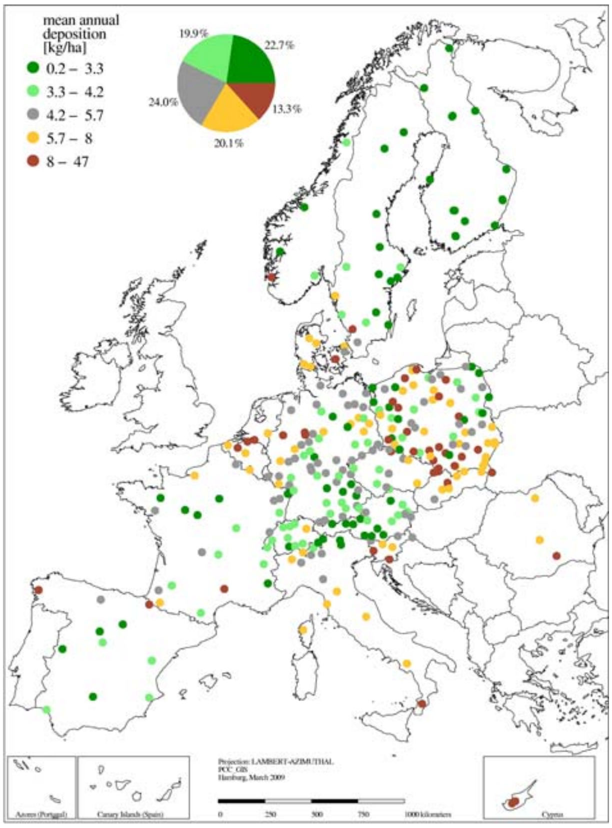

Figure 3.2.3.1-1: Mean annual sulphate sulphur (S-SO_4^{2-}) bulk deposition 2004 to 2006.

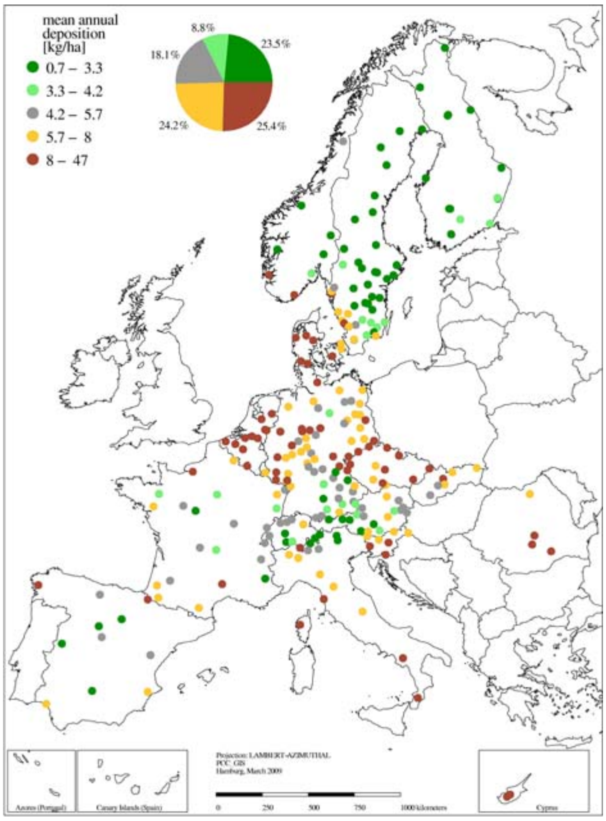

Figure 3.2.3.1-2: Mean annual sulphate sulphur (S-SO_4^{2-}) throughfall deposition 2004 to 2006.

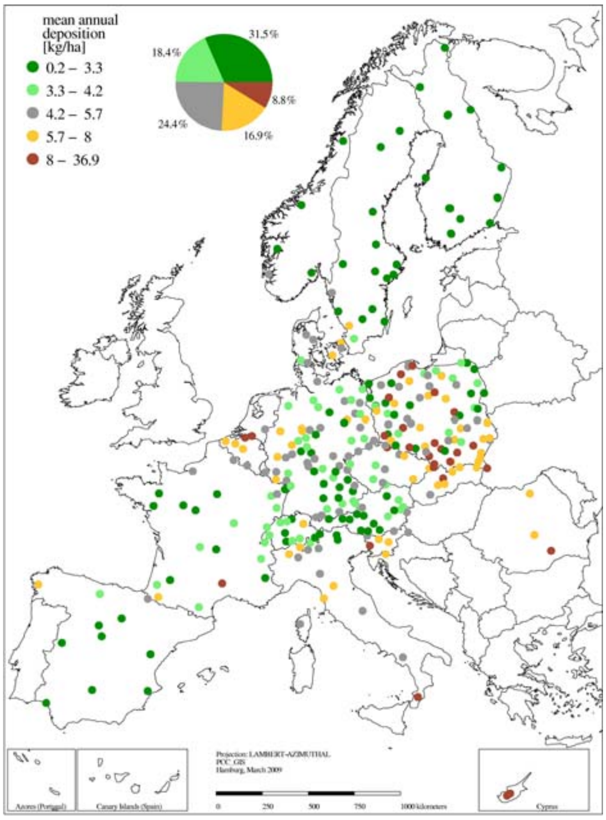

Figure 3.2.3.1-3: Mean annual sulphate sulphur (S-SO_4^{2-}) bulk deposition 2004 to 2006 (corrected for sea salt deposition).

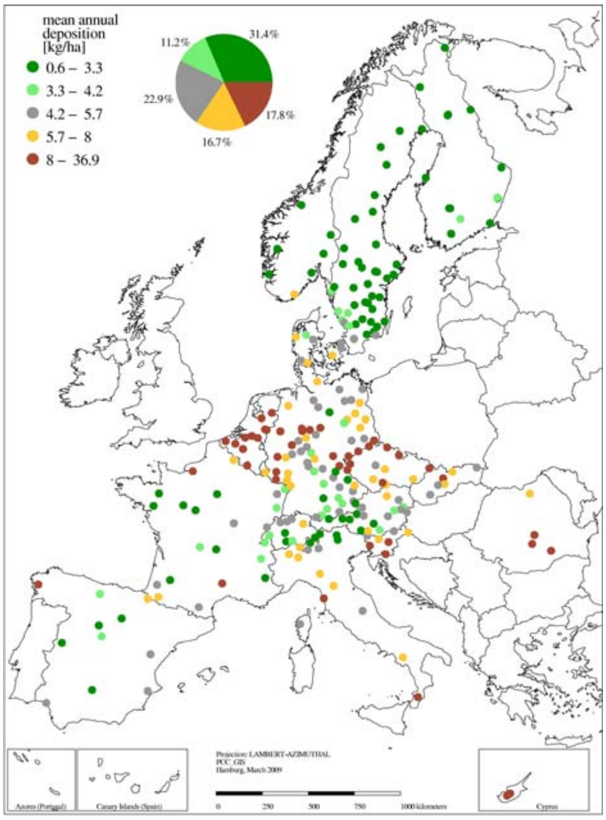

Figure 3.2.3.1-4 Mean annual sulphate sulphur (S-SO_4^{2-}) throughfall deposition 2004 to 2006 (corrected for sea salt deposition).

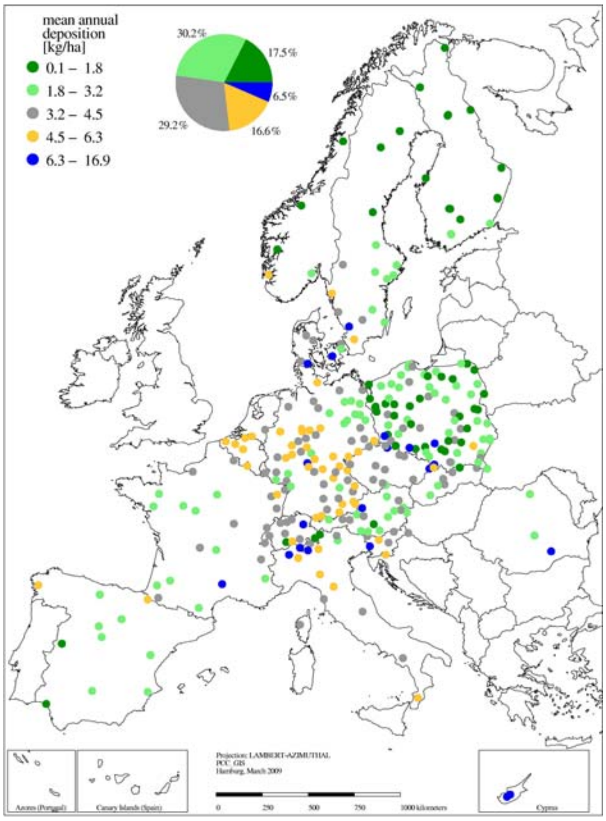

Figure 3.2.3.1-5: Mean annual nitrate nitrogen ($N\text{-}NO_3^-$) bulk deposition 2004 to 2006.

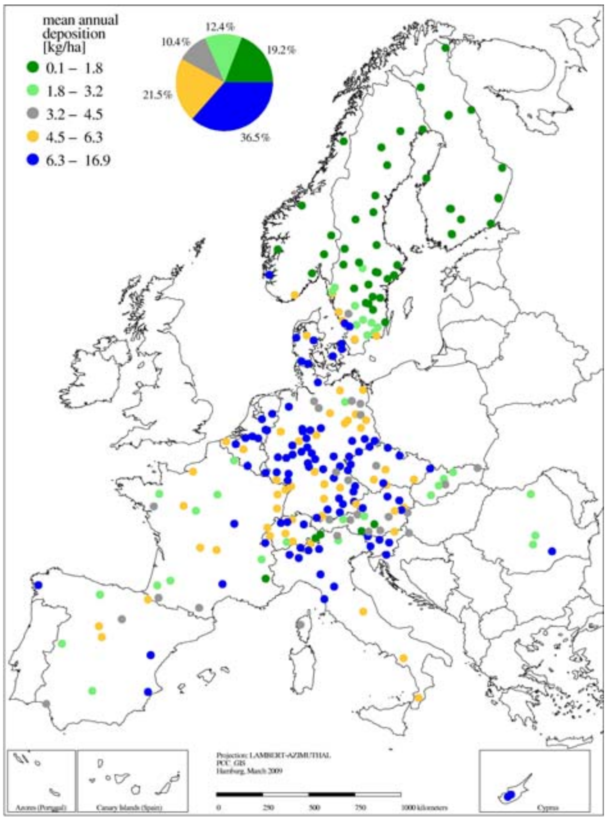

Figure 3.2.3.1-6: Mean annual nitrate nitrogen ($N\text{-}NO_3^-$) throughfall deposition 2004 to 2006.

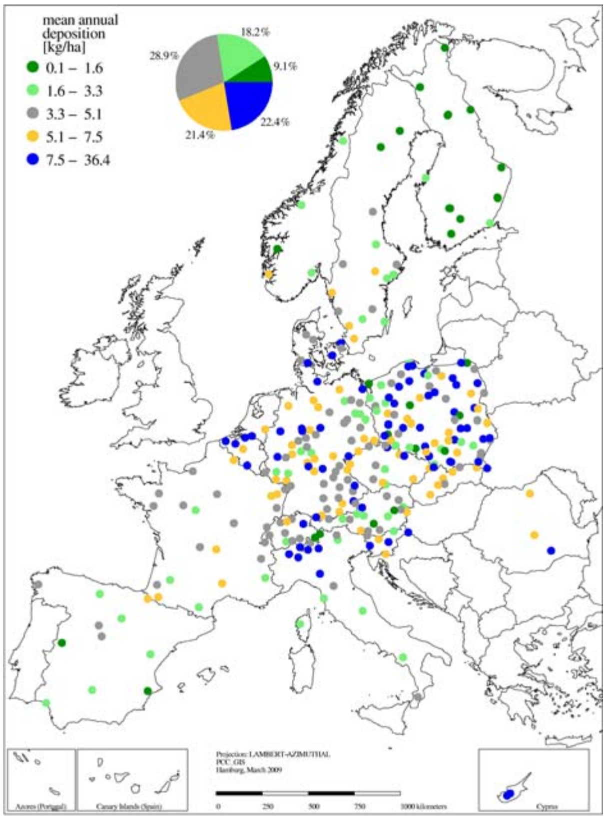

Figure 3.2.3.1-7: Mean annual ammonium nitrogen ($N\text{-}NH_4^+$) bulk deposition 2004 to 2006.

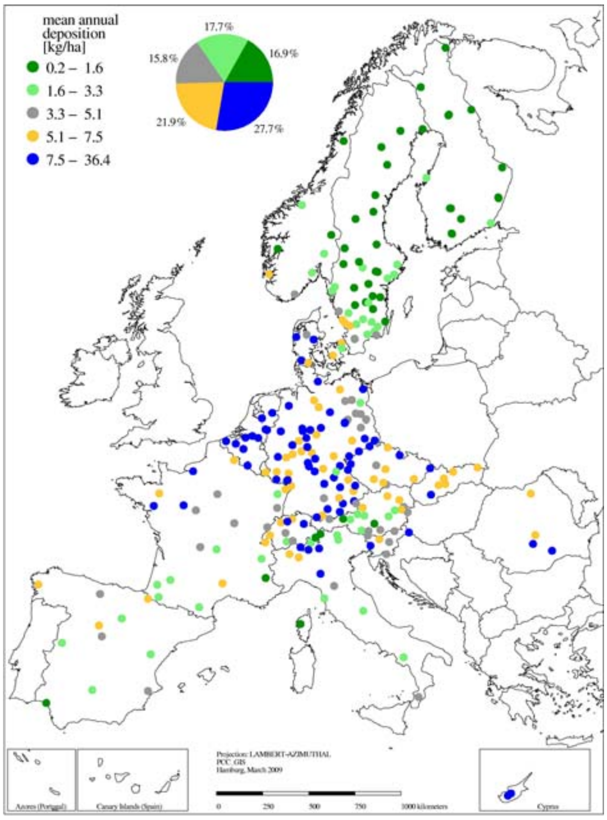

Figure 3.2.3.1-8: Mean annual ammonium nitrogen ($N\text{-}NH_4^+$) throughfall deposition 2004 to 2006.

3.2.3.2 Temporal variation

The notable decrease in S-SO_4^{2-} deposition described in earlier reports is confirmed by the present study of the temporal variation. Figure 3.2.3.2-1 shows the changes in mean annual bulk and throughfall deposition of S-SO_4^{2-} from 2001 to 2006, with and without correction for sea salt. For the above mentioned reasons, throughfall is higher than bulk deposition and correction for sea salt yields lower deposition. Sea-salt corrected S-SO_4^{2-} throughfall decreases by about a quarter from 6.3 in 2001 to 4.7 kg ha^{-1} a^{-1} in 2006. Bulk deposition of S-SO_4^{2-} shows a similar decrease at a lower level, namely from 5.6 to 4.3 kg $ha^{-1} a^{-1}$. Bulk and throughfall deposition of S-SO_4^{2-} show an exceptionally strong decrease in the dry year 2003. This reflects the high dependence of bulk deposition and throughfall of S-SO_4^{2-} from precipitation. Although the influence of precipitation on deposition is considerable, the observed decrease in deposition over several years described in previous reports is not a result of mainly decreasing precipitation (LORENZ et al. 2008).

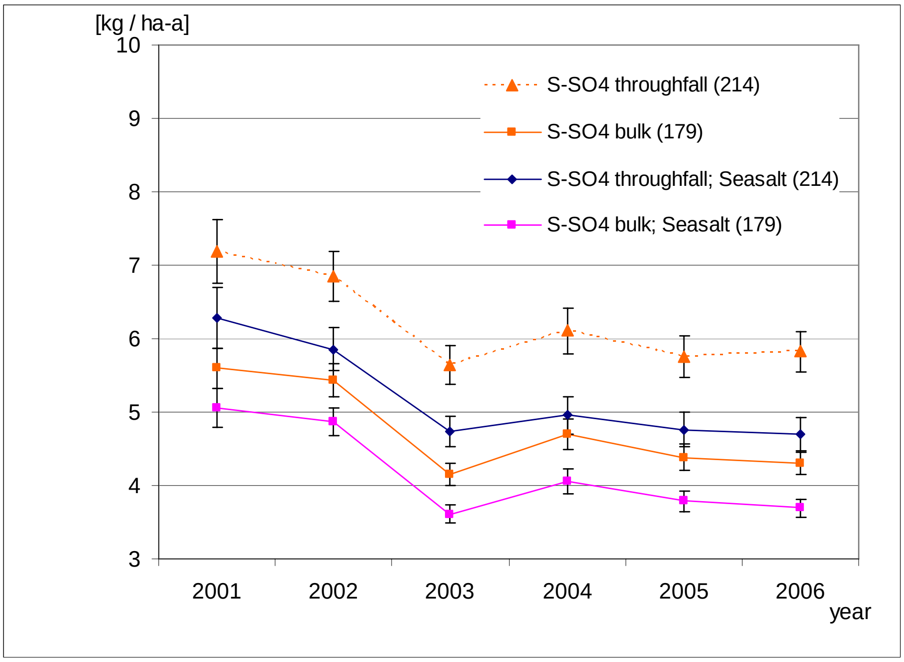

Figure 3.2.3.2-1: Changes in mean annual bulk and throughfall deposition of sulphate, with and without correction for sea salt, from 2001 to 2006.

Bulk and throughfall deposition of N-NH_4^+ and N-NO_3^- are shown in Figure 3.2.3.2-2.Bulk deposition of the two nitrogen compounds is in most years smaller than that of sulphate and shows a much less pronounced decrease. Throughfall of the two nitrogen compounds shows hardly any change over the period of observation. The spatial patterns of the changes in deposition over time are shown in Figures 3.2.3.2-3 to 3.2.3.2-8. Deposition changed only on a small share of the plots. The largest share is 11.7% for those plots showing a decrease in sulphate bulk deposition (Figure 3.2.3.2-3).

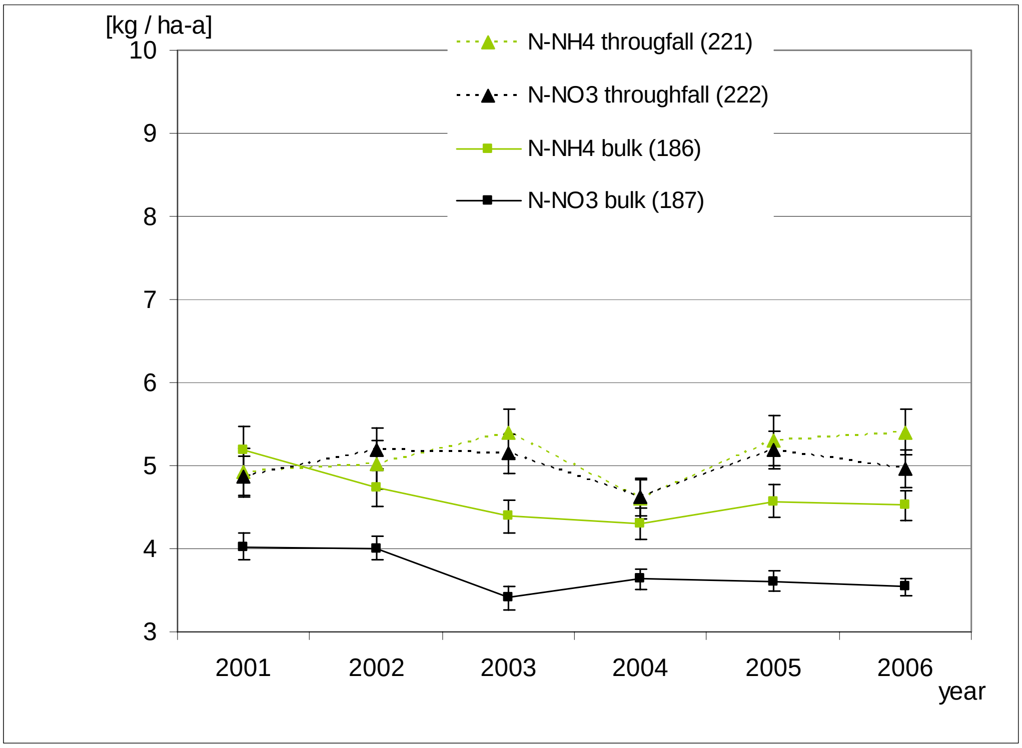

Figure 3.2.3.2-2: Changes in mean annual bulk and throughfall deposition nitrate nitrogen and ammonium nitrogen from 2001 to 2006.

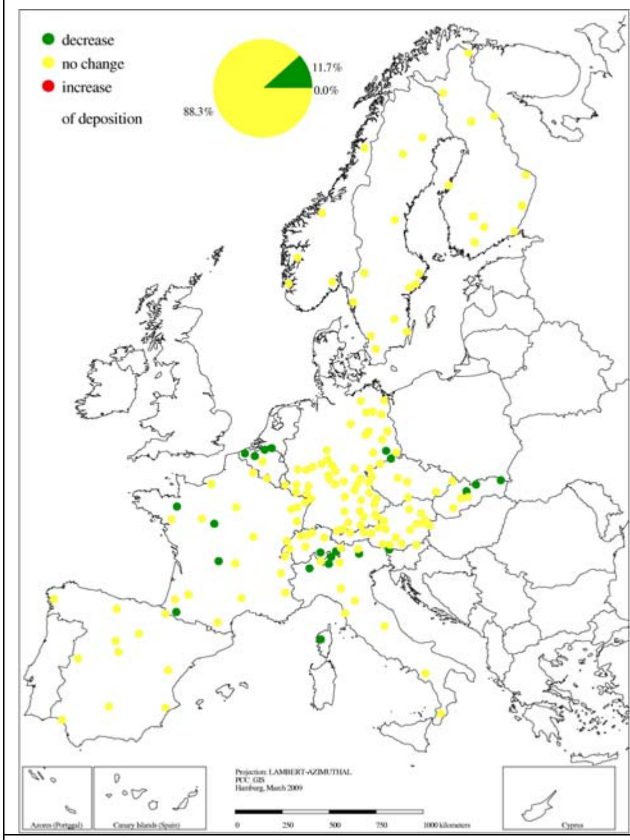

Figure 3.2.3.2-3: Trends in sulphur (S-SO_4^{2-}) in bulk deposition from 2001 to 2006.

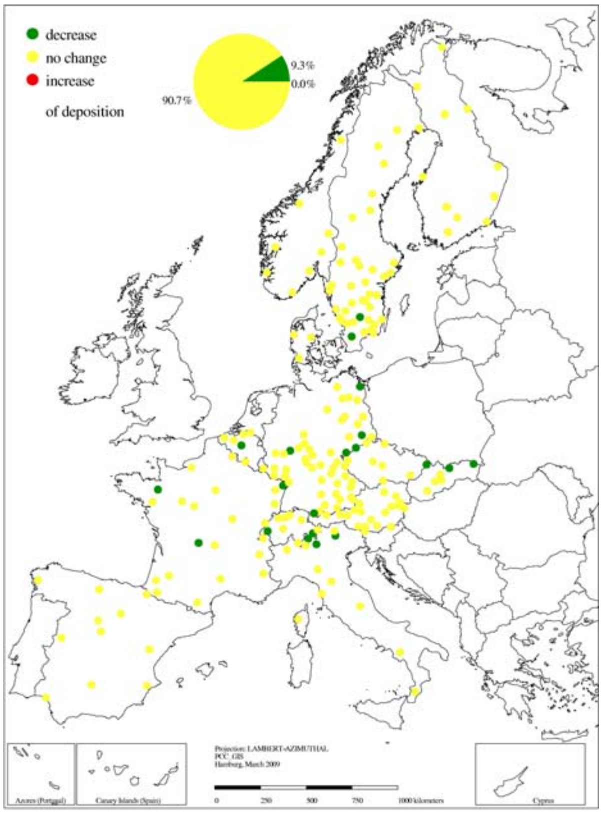

Figure 3.2.3.2-4: Trends in sulphur (S-SO_4^{2-}) in throughfall deposition from 2001 to 2006.

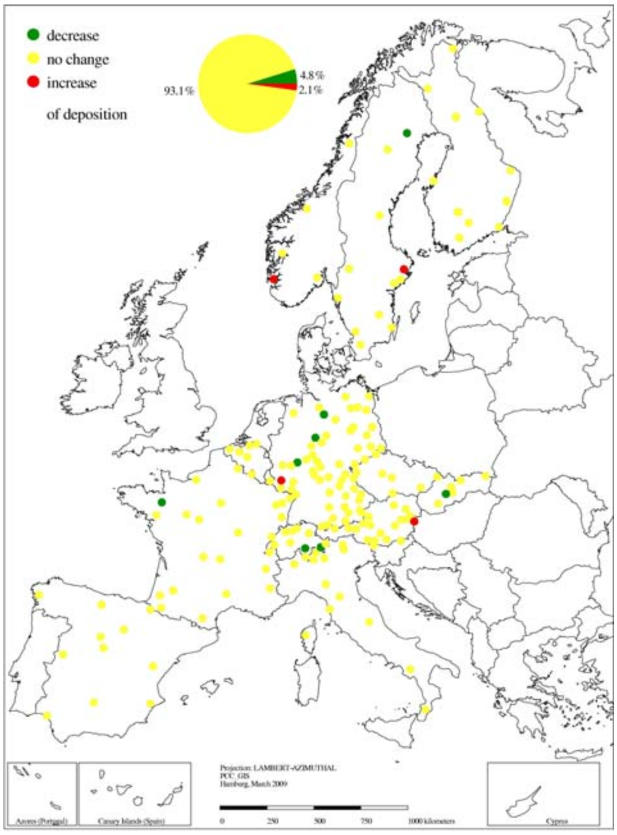

Figure 3.2.3.2-5: Trends in nitrate nitrogen (N-NO_3^-) in bulk deposition from 2001 to 2006.

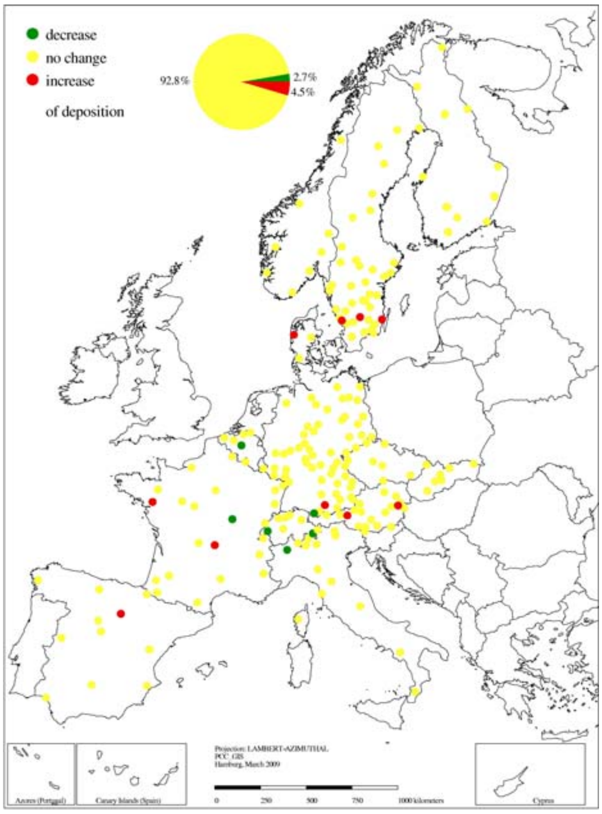

Figure 3.2.3.2-6: Trends in nitrate nitrogen (N-NO_3^-) in throughfall deposition from 2001 to 2006.

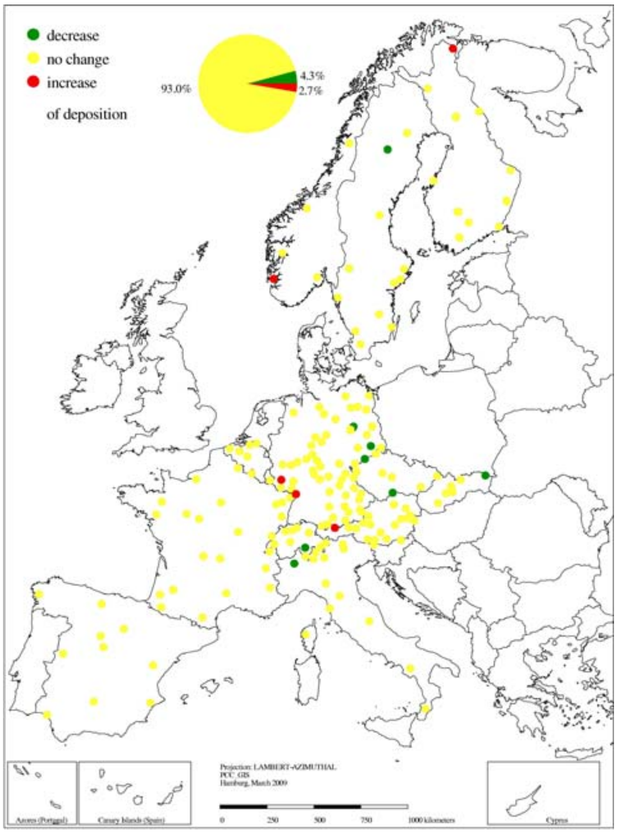

Figure 3.2.3.2-7: Trends in ammonium nitrogen (N-NH_4^+) in bulk deposition from 2001 to 2006.

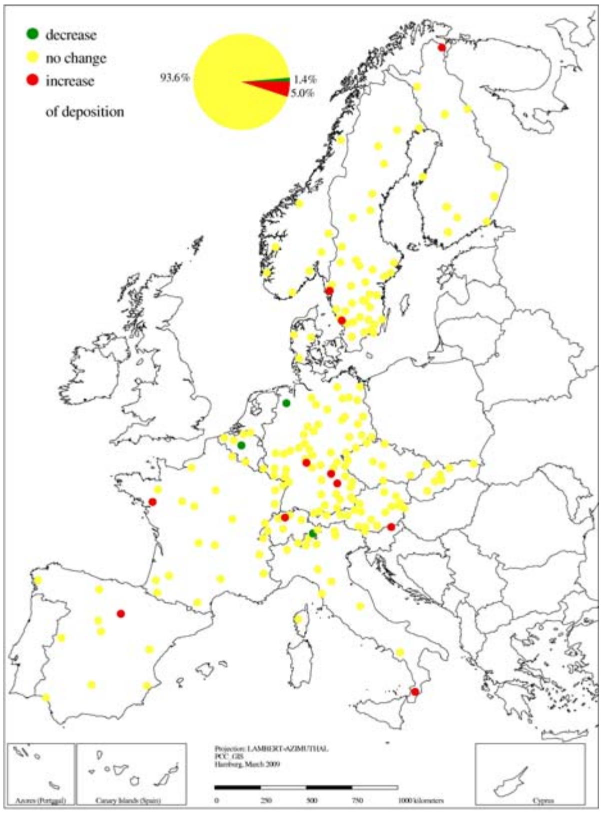

Figure 3.2.3.2-8: Trends in ammonium nitrogen (N-NH_4^+) in throughfall deposition from 2001 to 2006.

3.2.4 Conclusions

The Level II plots have been designed for monitoring on the ecosystem scale rather than on the European-wide scale. But as spatial patterns of deposition of N-NO_3^-, N-NH_4^+ and S-SO_4^{2-} vary over large distances the intensive monitoring programme is able to reveal these patterns and trends due to the high number of Level-II plots. The spatial patterns of depositions reflect partly regional emission situations. Deposition of S-SO_4^2 reflects partly regional industrial air pollution, but also input by sea salt in coastal areas. N-NO_3^- depositions are particularly high in some regions of dense traffic and high vehicle exhaust like central Germany and northern Italy. The spatial patterns of depositions of N-NO_3^-, N-NH_4^+ and S-SO_4^{2-} shown in the present study partly confirm those found by analyses of data measured in earlier years (Lorenz et al. 2008).

In addition to the spatial patterns, particularly S-SO_4^{2-} shows a clear temporal trend, namely a decrease over the five years period of observation. All in all, the results of deposition measurements at Level II reflect the reduction of sulphur emissions (by 70% since 1980) under CLRTAP politics over the last years and the less pronounced reduction of nitrogen emissions in Europe (Sliggers and Kakebeeke 2004).

3.3 Chloride deposition at ICP Forests Level II monitoring plots

Chlorine is an abundant element, occurring in nature either as chloride ions or as chlorinated organic compounds (OCls). Chlorinated organic substances were long considered purely anthropogenic products; however, they are in addition a commonly occurring and important part of natural ecosystems (e.g. Winterton 2000), produced by a wide variety of organisms (Gribble 2003). Formation of OCls in forest soils is to a large extent a microbial process and may affect the degradation of soil organic matter and thus the carbon cycle. Also, the occurrence of potentially toxic OCls in groundwater aquifers is of concern with regard to water quality. The fact that chlorine is not a purely conservative element means that the use of chloride concentrations for water budget calculations should be done very cautiously.

The occurrence of OCls in forest soil has shown to be influenced by chloride deposition, which in turn is affected by wind direction and precipitation amount, as well as distance from the sea (Johansson et al. 2003a). Seasonal chloride deposition patterns can be traced in the concentrations of organic chlorine in the soil (Johansson et al. 2003b). In forest areas near the coast, the most important source of chloride is sea salt deposition, which decreases exponentially with distance from the coastal zone. Chloride deposition to ICP Forests Level II sites in bulk precipitation and throughfall in 2003 is shown in Figures 3.3-1 and 3.3-2 respectively. The maritime/inland gradient can be clearly seen: the highest deposition in throughfall was at two coastal plots, one in western Norway and one in north-western Spain. Chloride deposition tended to be lowest in inland regions (e.g. southern Germany, Austria and Switzerland), rain shadows (e.g. eastern Norway) and around the Gulf of Bothnia (which has very low salinity). In addition to the maritime/inland gradient, there is smaller scale variation: in Norway, the chloride concentrations in conifer needles have been related to distance from the nearest fjord (r^2=0.34, Aamlid and Horntvedt 2002). Chloride deposition in throughfall is also affected by factors affecting canopy size and structure, such as tree species and stand age (Clarke et al. 2009).

Apart from coastal areas, relatively high chloride deposition was seen in bulk precipitation (but not throughfall) at three inland plots: two in the southern part of the Czech Republic and one near the Czech/German border (Figure 3.3-1). The origin of this chloride is unlikely to be sea salts, but might be combustion. Another possible source is de-icing salt, which can be a locally important chloride input near major roads.

Although most chlorine in deposition is inorganic, OCls are present in throughfall, probably due to canopy leaching and other internal processes (Asplund and Grimvall 1991). However, OCl deposition appears to be small; at Klosterhede in Denmark it was estimated to have a median value of only 0.037 g Cl/m^2/yr (Öberg et al. 1998).

Sea salt deposition may cause episodic acidification (Wigington et al. 1992). In these episodes, protons and aluminium are released as a result of cation exchange processes. In Denmark, Al^{3+} concentrations high enough to be toxic to Norway spruce have been reported following sea salt episodes (Pedersen & Bille-Hansen 1995). Sea-salt episodes often occur in autumn and winter and may have a particularly strong effect in areas where a long-lasting snow pack does not accumulate (Lydersen & Henriksen 1995). Afforested catchments may be particularly vulnerable because dense tree stands will tend to intercept larger amounts of sea salts than less dense stands (Hindar et al. 1995). Sea salt effects are generally believed to be short-term only and not to cause long-term acidification (Lydersen & Henriksen 1995). However, in some areas the severity of episodes has been increased by acidic deposition

(Wigington et al. 1992), and it has recently been suggested that a continuous input of sea salts could have more long-lasting effects (Laudon 2007).

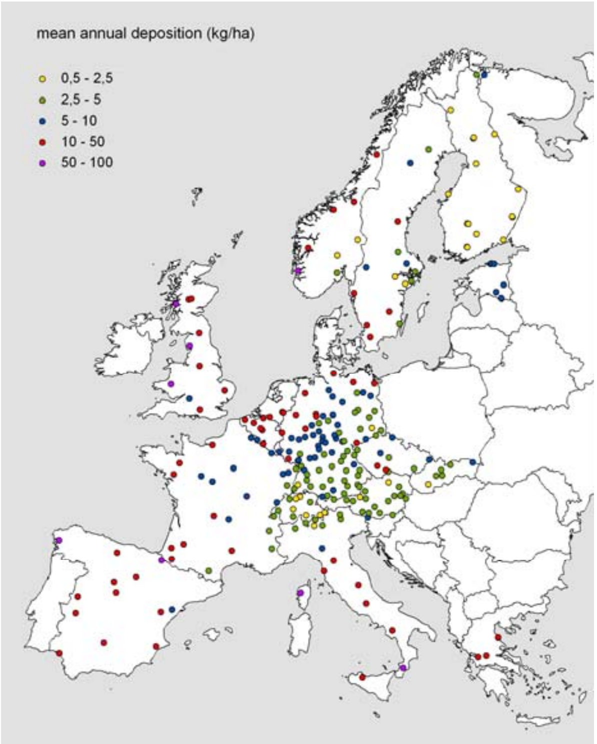

Figure 3.3-1: Chloride deposition in bulk precipitation at ICP Forests Level II sites in Europe in 2003.

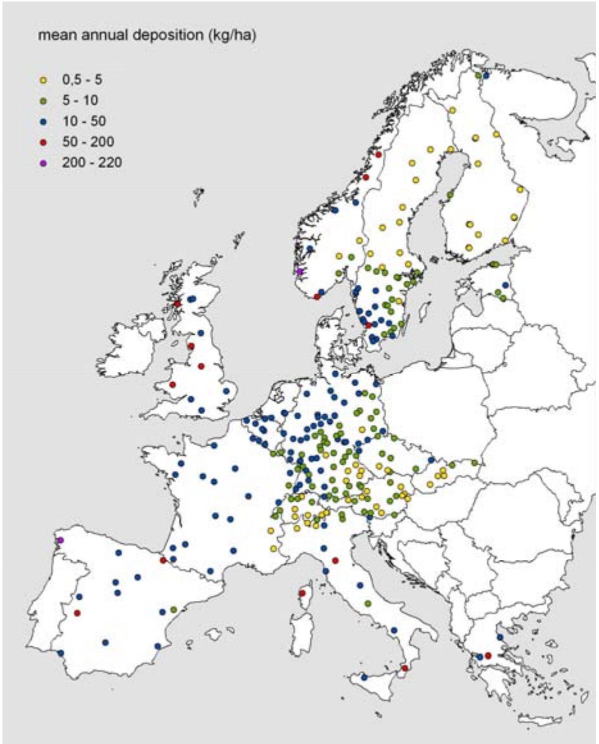

Figure 3.2-2: Chloride deposition in throughfall at ICP Forests Level II sites in Europe in 2003. Reproduced from Clarke et al. (2009) with the kind permission of Ecomed Publishers.

4. NATIONAL SURVEY REPORTS IN 2008

Reports on the results of the national crown condition surveys at Level I of the year 2008 were received from 28 countries. For these countries, the present chapter presents summaries. Besides that, numerical data on crown condition in 2008 were received from 27 countries. These results are tabulated in Annex II. In Annex II-1 basic information on the forest area and survey design of the participating countries is given. The distribution of the trees over the defoliation classes for all species is given in Annex II-2. Annexes II-3 and II-4 contain the data for conifers and for broad-leaved trees, respectively. The annual changes in crown condition are presented for all species in Annex II-5, for the coniferous trees in Annex II-6, and for broad-leaved trees in Annex II-7. Graphical presentations of the results are given in Annex II-8. It has to be noted, however, that it is not possible to directly compare the national survey results of individual countries. The sample sizes and survey designs may differ substantially and therefore conflict with comparisons. Gaps in the Annexes, both tabulated and plotted, may indicate that data for certain years are missing. Gaps also may occur if large differences in the samples were given e.g. due to changes in the grid, or the participation of a new country.

4.1 Andorra

In 2008, crown condition survey in Andorra was conducted on the 3 plots of the Level I 16*16 km transnational grid located in the country. The survey, which was undertaken at the end of September, included 72 trees, 42 *Pinus sylvestris* and 30 *Pinus uncinata*. The pure pine plots are representative for the Andorran forests.

The results obtained in 2008 for defoliation and discolouration show signs of recovery of forest condition after the light worsening reported in 2007, which was probably caused by the draught registered during the last year.

Related to defoliation, the results obtained in 2008 show an improvement of crown condition, compared to the 2007 results. Defoliation classes 2 and 3 have decreased. The most pronounced change occurred for class 2, which changed from 44.4% in 2007 to 13.9% in 2008. Shares of trees in classes 0 to 1 have increased summing up to 29.2% of not defoliated trees and 55.6% of slightly defoliated trees. These results are comparable to the results obtained in 2004 and 2006 where the largest part of trees was as well registered in classes 0 to 1.

Discolouration follows a similar pattern as defoliation with a decrease in the share of trees in classes 2-3 and an increase in classes 0-1. In 2008, the largest part of trees was classified in class 1 (slightly discoloured, 70.8%).

As in previous years, the assessment of damage causes revealed that the main causal agent was fungus *Cronartium flaccidum* affecting the 8% of the sampled trees, occurring on all plots.

4.2 Belarus

The 2008 forest condition survey comprised 9 534 sample trees on 400 permanent sample plots. Compared to 2007, mean defoliation of all tree species increased by 1.1 percent points to 17.7%. The share of trees without defoliation decreased by 6.6% percent points. In comparison to 2004, when 40.1% of the trees were assessed as not defoliated, the respective share of trees decreased to 27.4% in 2008. *Pinus sylvestris* constituted 62.6% of all observed trees. Crown condition of this species thus considerably influences the mean defoliation of the total sample.

As in previous years, the highest mean defoliation was recorded for *Quercus robur* and *Fraxinus excelsior.* For the oak species it was 21.2% and for *Fraxinus excelsior* it was 30.1%. These tree species had the highest share of trees in defoliation classes 2–4, namely 13.0% and 28.8%. These species also had the lowest share of trees without defoliation: 15.9% and 13.3% respectively.

15.1% of all observed trees had visible damage symptoms. The highest share of trees with visible damage symptoms was registered for *Populus tremula* (42.8%), *Fraxinus excelsior* (35.6%) and *Quercus robur* (35.3%), the lowest share was observed for *Pinus sylvestris* (10.1%). Most frequently recorded damages were caused by fungi (4.8%), direct action of man (3.0%) and abiotic agents (2.2%). The highest share of damage symptoms by fungi was assessed for *Populus tremula* (27.0%) and *Fraxinus excelsior* (20.0%). The highest share of damage by direct action of man was recorded for *Betula pendula* (4.8%) and *Picea abies* (4.7%). The highest share of damage by abiotic agents was recorded for *Betula pendula* (7.0%) and *Quercus robur* (6.4%).

4.3 Belgium

Flanders

The Level I survey in Flanders was conducted on 72 plots on a 4 x 4 km grid. In 2008, 1 731 trees were assessed. Because of a clear-cut on one international plot, only 9 international plots were reported. A new regional plot was installed to reach the same number of *Populus* trees as before.

The share of damaged trees was 14.3%, and 0.2% of the trees died. The mean defoliation amounted to 19.3%. 15.2% of the broadleaves showed more than 25% defoliation. The respective share of conifers was lower (12.4%). Average defoliation was, however, slightly higher in coniferous trees (19.9%) than in broadleaved species (19.0%).

Defoliation was highest in *Populus* spp., with 27.3% moderately to severely defoliated trees. The most affected coniferous species was *Pinus nigra* subsp. *Laricio* with a share of 20.8% damaged trees. *Quercus rubra* showed the lowest damage level with 6.2% of the trees in defoliation classes 2-4. *Pinus sylvestris* was the coniferous species with the best crown condition, and 10.1% of the trees being damaged. The share of trees with more than 25% defoliation was 17.5% for *Quercus robur* and 9.7% for *Fagus sylvatica*.

The mean defoliation decreased by 1.6 percent points and the proportion of damaged trees by 3.1 percent points. The main tree species showed an improvement in the crown condition. There was less insect damage, especially in *Quercus rubra* plots. Populations of oak processionary moth (*Thaumetopoea processionea*) were noticed in a few *Quercus robur* plots in the north-eastern part of Flanders. There were less damage records compared to 2007 and pest control in recreation areas was less intensive.

Most remarkable was the early and large-scale infection of *Populus* forests by rust disease (*Melampsora* sp.). Discolouration associated with rust infection was already visible in July but defoliation mainly occurred in August. Infection by *Phytophthora alni* caused defoliation in a young *Alnus glutinosa* stand.

Weather circumstances were rather good, without dry periods nor extreme temperatures. In contrast to 2007, there was hardly any storm damage.

Wallonia

The 2008 survey comprised 1 129 trees on 49 plots, on the regional 8x8 km systematic grid. The percentage of trees with defoliation >=25% shows different long term trends for conifers and broadleaved trees.

For conifers the share of damaged trees was twice as high in the beginning of the 1990s as compared to 2008 when the share was 14%. This is a lower percentage compared to the broadleaved trees.
The broadleaves showed an increasing share of damaged trees from 10% in 1990 to about 20% in 2005. These damages were mainly due to the degradation of *Fagus sylvatica* (mainly caused by *scolytidae* in 2000-2002, drought in 2003 followed by fruiting in 2004). With 15.2% the rates were lower in 2008. Also *Quercus robur* showed increased shares of damaged trees due to drought in 2003. Mean defoliation decreased for the main species since 2006, especially for *Fagus sylvatica* (15.8% in 2008) and *Quercus* ssp.. Mean defoliation of *Picea abies* fluctuated between 10-12% in the last years.

Discoloration continuously decreased both for broadleaves and conifers since the high levels observed in 2003, despite of the high temperatures in July 2006. Only in 2007 there was a small peak with about 12% of the broadleaves and conifers showing significant discolouration. In 2008, 10% of the broadleaved trees and 8.4% of the conifers showed more than 25% of discoloration, which is lower than before 2003.

No extraordinary event has been observed during 2008, neither related to forest health, nor concerning climate conditions.

4.4 Bulgaria

In 2008, the forest condition survey was carried out on 136 plots on a grid of 16 x 16 km, 8 x 8 km and 4 x 4 km. A total of 4 531 sample trees was assessed, 2 294 of them conifers and 2 237 broadleaves.

All tree species showed a stable level in crown condition. The share of moderately to severely damaged trees (defoliation classes 2-4) increased only insignificantly compared to the 2007 results. The share of trees without visible defoliation decreased from 20.5% in 2007 to 19.9% in 2008.

For conifers, the percentage of damaged trees remained almost the same. As compared to the previous year, the share of trees without visible defoliation decreased by 1.3 percent points. The share of severely defoliated and dead trees slightly decreased, while that of moderately damaged trees increased by 9.0 percent points.

For *Pinus sylvestris* and *Pinus nigra* some damage was caused by needle-rust and root rot fungi including *Lophodermium pinastry*, *Dothistroma septospora* and *Heterobasidion annosum.* Conifer stands were attacked by bud boring insects like *Rhyacionia buoliana.*

Defoliation of broadleaves (*Quercus* spp. and *Fagus sylvatica*) can be regarded as unchanged in 2008, compared to 2007. The share of the trees without any defoliation decreased by 2.0 percent points, compared to the 2007 results. The share of dead broadleaves decreased by 1.0 percent points. *Quercus* trees were attacked by pathogens such as *Nectria* spp.and defoliating insects like *Totrix viridana* and *Operophtera brumata*. *Fagus sylvatica* suffered from mining insects such as *Rhynchaenus fagi* and patogens like *Nectria* spp.

Abiotic agents like weather extremes (drought, snow, ice) and anthropogenic factors such as silvicultural operations at nearby trees were identified as damage causes. As in previous years, no specific damage factor was observed for more than half of the trees.

4.5 Canada

This report compiles information from regional surveys or initiatives with Natural Resources Canada’s (NRCan) partner agencies which contribute to the national picture of the status of forests in Canada.

National Forest Inventory
The new National Forest Inventory program introduced in 2000 provides a potential framework for national monitoring of forests and other land cover types. The reports on baseline statistics will be available in 2009 (http://nfi.nfis.org).

The Canadian Air and Precipitation Monitoring Network (CAPMoN)
The Canadian Air and Precipitation Monitoring Network is a non-urban air quality monitoring network designed to ensure that the measurement locations are regionally representative and not affected by local sources of air pollution. There are currently 28 measurement sites in Canada and 1 in the U.S.A.

Acid Rain
The most recent progress report on the 1991 Canada–United States Air Quality Agreement (2008) indicates that Canada has continued to reduce emissions of sulfur dioxide to 38% below the national cap for 2000 and beyond as identified in the Agreement (3.2 Mt/yr).Total NO_x emissions have remained relatively stable at 2.3 million tonnes.

In 2008 the Canadian Council of Ministers of the Environment published a report on critical loads and exceedances in forest soils. Three national maps were produced to inform policy.

They include a map of critical loads, a map of critical load exceedances and a third map using data generated from a 1 year simulation of 2002 data from Canada, USA and Mexico emissions inventories, with the AURAMS model (A Unified Regional Air Quality Modelling System). These preliminary results show that in every province there are upland forest soils that currently receive acid deposition levels greater than their long term critical load. Work is underway to validate the modelled results.

Ozone
The Canada wide standard for ozone is 65 ppb, 8 hr averaging time, based on the 4th highest measurement annually, averaged over three consecutive years. Three regions of Canada have elevated levels of ozone: the Fraser Valley in British Columbia, the Windsor to Quebec corridor and the southern Atlantic region.

Fire
While the number of fires and the area burned vary considerably from year to year the trend since 1975 has been relatively stable. In 2008, Canada experienced 6036 fires, 19% fewer than the 10-year average and 1.7 million hectares were burned, 16% less than the 10-year average (1998–2007).

Regional monitoring
Climate Change Impacts on the Productivity and Health of Aspen (CIPHA)
Extensive dieback and mortality of aspen (*Populus tremuloides* Michx.) forests was observed across parts of the west-central Canadian interior where there was a severe, regional drought during 2001-2003. Annual monitoring of aspen health was initiated in this region in 2000, as part of the NRCan led study, Climate Impacts on Productivity and Health of Aspen. Results show drought severity, expressed as a climate moisture index, is the best predictor of regional aspen mortality and dieback and that wood-boring insects and associated fungal pathogens may be amplifying and prolonging the impact of the drought. Changes observed over the past 8 years through this program appear to be part of a larger scale pattern of climate-related dieback episodes that have affected a wide range of forest types across western North America.

Terrestrial Wetlands Monitoring
A bi-national, multi-partner collaborative research effort is developing a monitoring network for terrestrial wetlands, consisting of an initial 15 sites across North America. The initiative is led by the United States Geological Survey with key involvement of NRCan (Canadian Forest Service; Canada Centre for Remote Sensing), Parks Canada and Environment Canada.

Insects
In terms of total area affected, insects are considered the leading cause of disturbances in Canadian forests. In 2006, 19.5 million hectares were impacted by insects. The three most important native insects in terms of removing tree foliage and consequently reducing growth were mountain pine beetle (*Dendroctonus ponderosae*, the spruce budworm (*Choristoneura occidentalis*) and the forest tent caterpillar (*Malacosoma disstria*).

As of 2008, the native mountain pine beetle (*Dendroctonus ponderosae*), will have invaded an estimated cumulative area of 13 million hectares of forest in British Columbia, an area about four times the size of Vancouver Island. The beetle is anticipated to kill up to 80 % of the provinces mature lodgepole pine (*Pinus contorta*) forest by the time the outbreak is expected to collapse (circa 2019). Although the beetles have now crossed the Rocky Mountains, an aggressive control program and colder winters appear to be having an impact on beetle populations.

Canada is also implementing strategies to battle recently arrived alien species that may prove to be serious threats to both urban and natural forests: the brown spruce longhorn beetle (*Tetropium fuscum*), Asian longhorn beetle (*Anoplophora glabripennis*), emerald ash borer (*Agrilus planipennis*), Oystershell scale (*Lepidosaphe ulmi*) and *Archips tsugana*.

4.6 Croatia

85 sample plots on the 16 x 16 km grid network were included in the forest condition survey in 2008. The percentage of trees of all species within classes 2-4 in 2008 (23.9%) is somewhat lower than in 2007 (25.1%) and comparable to the year 2006 (24.2%). For broadleaves the share of trees in classes 2-4 (19.1%) is somewhat lower than in 2007 (20.0%). For conifers, the percentage of damaged trees in classes 2-4 (59.1%) is lower than last year (61.1%), and than in 2005 (79.5%) and even lower than values reported in 2004 (70.6%). Although the percentage of moderately to severely damaged conifers is still high, it does not have a stronger impact on the overall percentage of trees of all species for the same damage class, due to the low representation of conifer trees in the sample (242 coniferous trees vs. 1797 broadleaves in the 2008 survey).

Encouraging defoliation data on Silver fir (*Abies alba*) received in 2006 have continued this year. Although Silver fir is still the most damaged tree species in Croatia, the percentage of moderately to severely damaged trees recorded in 2008 was 70.1%, compared to 67.9% in 2007. The lowest value, 36.6%, of moderately to severely damaged trees was recorded in 1988, whereas in 1993 the share was already 70.8%. In the year 2001 it reached 84.5%, and after a slight decrease in 2002 (81.2%), the trend of increasing defoliation has continued with 83.3% of moderately to severely damaged trees in 2003, 86.5% in 2004 and 88.5% in the year 2005.

The lowest damage in European oak trees (*Quercus robur*) was recorded in 1988 (8.1%), the highest in 1994 (42.5%), and it has been fairly constant later at around 25-30% until the year 2000. Afterwards it decreased to values below 20% (15.4% in 2003, 18.5% in 2004). In 2005 a slight increase was recorded with 22.1% of moderately to severely damaged oak trees. Last year it was slightly lower at 19.6%, and this year it is somewhat higher with 22.2% in defoliation classes 2-3.

Common beach (*Fagus sylvatica*) remains the least damaged tree species in Croatia. The maximum percentage of moderately to severely damaged beech trees was recorded in the year 2001 (12.5 %), and in subsequent years even lower values were recorded: 5.1% in 2003, 7.47% in 2004, 7.0% in 2005, 6.3 % in 2006, 7.6% in 2007 and 7.0% in 2008.

Overall, the state of crown defoliation in Croatia remained the same as in last year. Despite that, the condition of some important and sensitive tree species, such as Silver fir and European oak continues to improve.

4.7 Cyprus

The annual assessment of crown condition was conducted on 15 Level I plots, during the period September - November 2008. The assessment covered the main forest ecosystems of Cyprus and a total of 360 trees of *Pinus brutia, Pinus nigra* and *Cedrus brevifolia.*

A comparison of the results with those of the previous year shows significant differences for all species (*Pinus brutia, Pinus nigra* and *Cedrus brevifolia*). A significant discoloration has been observed as well.
From the total of all species there is a decrease in the percentages of classes 0 and 1 and an increase in the percentage of classes 2 and 3. This is mainly attributed to the severe drought of the last years, essentially in 2007-2008, which seriously affected crown condition.

For *Pinus brutia* and compared to 2007 there is a decrease by 7.2 percent points of the trees being in class 0 (not defoliated) and by 25.6 percent points of the trees being in class 1 (moderately defoliated). Respectively, an increase has been observed in the other two categories.

In *Pinus nigra*, a decrease by 2.8 percent points in class 0 and of 16.7 percent points for the trees being in class 1 (moderately defoliated) has been observed. In class 2 no changes have been detected. Respectively an increase by 16.7 percent points was detected in class 3.

In *Cedrus brevifolia*, 0% of the sample trees showed no defoliation, 79.2% of them were slightly defoliated, 16.7% were moderately defoliated and 4.2 were severely defoliated. Comparing with the previous year's results, a decrease by 12.5 percent points in class 0 was assessed. In class 1 no changes have been detected. An increase by 8.4 percent points in class 2 and 4.2 percent points in class 3 (severely defoliated) has been observed.

Discolouration has been observed as well. From the total number of trees assessed (360 trees), 69.4% were not discoloured, 25.6% were slightly discoloured and 5% were moderately discoloured. Comparing with the previous year's results, the 2008 results show that this is a clear increase in discolouration which is mainly attributed to the severe drought of the last years, specifically in 2007-2008, which seriously affected crown condition.

From the total number of sample trees surveyed, 31.4% showed signs of insect attack and 23.3% showed signs of attack by "other agents" (lichens, dead branches, and rats attacks). Also 34.4% showed signs of both, insect attack and other agents.

1.4% of the trees were damaged by *Thaumetopoea wilkinsoni*, 0.3% by *Tomicus* spp., 13.3% by *Leucaspis* spp. and 3.1 % by unspecified insect defoliators. Additionally, 0.3 % of the trees were affected by both *Thaumetopoea wilkinsoni* and *Leucaspis* spp., 0.6% by *Thaumetopoea wilkinsoni* and unspecified defoliator insects, 2.8% by *Tomicus* spp. and *Leucaspis* spp., 9.7% by unspecified defoliator insects and *Leucaspis* spp. 1.1% of the trees were attacked by both *Thaumetopoea wilkinsoni* and showed dead branches. For 10.6% of the trees unspecified defoliator insects and dead branches were recorded, for 15.6% there were records of *Leucaspis* spp. and dead branches, for 0.6% there were records of *Tomicus* spp. and dead branches, for 6.7% there were records of unspecified defoliator insects, *Leucaspis* spp. and dead branches.

The above preliminary analysis shows that the major abiotic factor causing defoliation during the year 2008 was the adverse climatic condition prevailing in Cyprus during the last years in combination with poor edaphic conditions. The unspecified insect defoliators and *Leucaspis* spp. are the major biotic factors causing defoliation during the year 2008. No damage was attributed to any of the known pollutants.

Forest fires are a serious problem for the forests in Cyprus due to drought conditions, low precipitation and high temperatures prevailing on the island. However, due to the effective system and infrastructure in preventing and suppressing forest fires, the annual burnt area is kept small. During 2008, 39 forest fires damaged 62.5 ha of state forests. From this burnt area 9.1 ha were coniferous forest, 0.3 ha were broadleaved forest, 3.1 ha were other wooded land and 50 ha other land. The main causes of fires were carelessness of forest visitors and farmers, malicious, unknown and natural causes. Forest fire didn't cause any damage to the Level I plots in 2008.

4.8 Czech Republic

In 2008, no important change in mean defoliation of all coniferous tree species in both age categories (stands up to 59 years and 60 years old and older) was observed when compared with the preceding year. However, certain differences occurred for particular coniferous tree species. In younger stands (up to 59 years) the most significant decrease in defoliation was registered for *Abies alba* with an increase of the share of trees in defoliation class 1 from 60% in 2007 to 84.2% in 2008 and with a concurrent decrease of the share of defoliation class 2 from 25.0% in 2007 to 5.3% in 2008. An improvement of defoliation in older *Abies alba* stands was manifested by a decrease of the share of trees in class 2 and an increase of class 1. A slight decrease of defoliation also occurred in younger *Picea abies* stands. On the other hand, the share of trees in defoliation class 2 increased in younger *Pinus sylvestris* and *Larix decidua* stands with concurrent decrease in classes 1 or 0. A worsening of defoliation also occurred in older larch stands where the share of trees in class 2 increased (from 56.1% in 2007 to 65.6% in 2008) with concurrent decrease in class 0 and mainly 1.

No important change occurred in the development of total defoliation in deciduous tree species in both age categories but differences were evident for particular species. A slight worsening of defoliation was observed in younger *Fagus sylvatica* stands. A slight improvement of defoliation occurred in older *Quercus* spp. and *Fagus sylvatica* stands.

In the mean of several years, younger coniferous tree species (up to 59 years) show lower defoliation as compared to younger deciduous tree species. On the contrary, older coniferous tree species are of markedly higher defoliation than stands with older deciduous tree species.

In the first days of March 2008, forest stands in some forest regions were mechanically damaged by strong wind. In 2008, monthly mean temperatures were above average in comparison with the long-term mean, average sums of precipitation were mostly below average. Only in spring months (March, April) precipitation was markedly above average. During the vegetation period occurrence of cambiophagous was observed in some forest areas, mainly in spruce stands.

In 2008 no important change was reported for the main pollutants (solid substances, SO_2, CO, VOC), total emission of most of these substances have been dropping since a number of years. Only NO_x emissions have slightly increased.

4.9 Denmark

The Danish forest condition monitoring in 2008 was carried out on the remaining Level I and II plots, and in the National Forest Inventory (NFI) data were collected for an increased number of tree species. Monitoring showed that most tree species had satisfactory health status. Exceptions were *Fraxinus excelsior* where the problem with extensive dieback of shoots has continued. Average defoliation was 33% for all monitored ash trees. After two years of severe aphid infestations (*Elatobium abietinum*) *Picea sitchensis* showed higher defoliation in 2008 (20%), and an increased level of *Dendroctonus micans* attacks was reported. Average defoliation scores of *Fagus sylvatica* and *Quercus* (*robur* and *petraea*) were lower than in previous years. *Picea abies* and *Pinus sylvestris* had increased defoliation, but not in an alarming degree.

Based on both NFI plots and Level I and Level II plots, the results of the crown condition survey in 2008 showed that 67% of all coniferous trees and 63% of all deciduous trees were undamaged. 23% of all conifers and 27% of all deciduous trees showed warning signs of damage, and 10% of all conifers and deciduous trees were damaged. The mean defoliation of *Picea abies* increased to 9% in 2008, but the share of damaged trees stayed at 7%. Mean defoliation of *Fagus sylvatica* decreased to 9%, and only 4% of the beech trees were damaged. The mean defoliation of *Quercus* spp. decreased markedly to 14 %, which is one of the best results since monitoring began, and the share of damaged trees was only 9%. One factor affecting forest health in Denmark, apart from those mentioned above, was lack of precipitation in late spring. The drought led to rapid dying of trees in stands that had been flooded during 2007, which was an extremely wet year.

4.10 Estonia

Forest condition in Estonia has been systematically monitored since 1988. In 2008 altogether 2196 trees were examined on 92 permanent Level I sample plots from July to October. 601 spruces, 1478 pines, 92 birches and 25 other broadleaves were assessed.

In general in 2008 a worsening of crown conditions was observed. In Estonia the most defoliated tree species has traditionally been Scots pine (*Pinus sylvestris*). Essential improvement of crown condition of Scots pine was observed in 1991–2000. Then a certain decline was registered up to 2003, and in 2004 noticeable improvement started again. During the last 2 years some worsening in crown condition occurred. In 2007, 46% and in 2008 only 37% of Scots pines were not defoliated (defoliation class 0).

The increase of defoliation of Norway spruce (*Picea abies*) which started in 1996 stopped in 2003 and remained on the same level up to 2005. In 2006, 2007 and 2008 some worsening in crown condition occurred. In 2006, 61%, in 2007 58% and in 2008 only 54% of the assessed Norway spruces were not defoliated (defoliation class 0).

Numerous factors determine the condition of forests. Climatic factors, disease and insect damage as well as other natural factors have an impact on tree vitality. Needle cast (422 trees damaged) and shoot blight (416 trees damaged) were the most significant reasons of biotic damage of trees.

However, the condition of deciduous species was estimated to be better than that of the conifers. In 2008, 53 % of the birches were not defoliated (defoliation class 0).

4.11 Finland

The 2008 forest condition survey was conducted on 475 mineral soil sample plots arranged on a 16 x 16 km in southern and central Finland and on 24 x 32 km grids in northern Finland. A slight decrease (less than 1%-unit) in the average defoliation level was observed between the years 2007 and 2008. Of the 8819 trees assessed in 2008, 53.4% of the conifers and 57.8% of the broadleaves were not suffering from defoliation (leaf or needle loss 0-10%). The proportion of slightly defoliated conifers (11- 25 %) was 36.5%, and that of moderately defoliated (over 26%) 10.1%. For broadleaves the corresponding proportions were 31.6% and 10.6%, respectively. In general, the average tree-specific degree of defoliation was 9.8% (10.4% in 2007) in Scots pine, 18.1% (18.3% in 2007) in Norway spruce, and 12.1% (12.6% in 2007) in broadleaves (mainly *Betula* spp.).

The proportion of discoloured Norway spruce increased from 7.3% to 11.6 % and that of Scots pine remained the same at 1.8% in 2008 (1.7% in 2007). Most of the discoloured spruces or pines belonged to the discolouration class 10 to 25%, and moderate or severe discolouration was rare. Leaf discoloration on broadleaves decreased from 3.7% to 2.4%. The most frequent discolouration symptoms on conifers were needle yellowing and browning, and the symptoms were mainly concentrated on needles older than current year ones.

Abiotic and biotic damage was also assessed in connection with the large-scale monitoring of forest condition. 36.5% of the Scots pines, 29.5% of the Norway spruces and 33.0% of the broadleaves were reported to have visible symptoms attributed to abiotic or biotic damaging agents. The proportion of Scots pines with damage symptoms has slightly increased over the previous year. This was due to a slight increase in both insect (*Tomicus* and *Neodiprion sertifer*) and fungal (*Gremmeniealla abietina*) damage. *Gremmeniella abietina* and *Tomicus* spp. (both 8.6%) and *Diprionidae*- species (5.6%) were the most abundant biotic damaging agents in pine, and *Chrysomyxa ledi* (4.9%) in spruce. The annual mortality of all trees was less than that during the two previous years (0.136%).

According to the observations of the Forest Damage Information Service *Neodiprion sertifer* had vast mass outbreaks in south-western and south-eastern Finland, as well as in Ostrobothnia. Defoliation was reported in more than 200,000 ha of forest, and control measures were carried out with nuclear polyhedral virus on 730 ha in SW Finland.

4.12 France

In 2008, the forest damage monitoring in the French part of the systematic European network comprised 10 138 trees on 508 plots.

The climatic conditions of the year were favourable to the forest vegetation except a special hot and sunny month of February which particularly affected young stands of *Pseudotsuga menziesii*.
Defoliation slightly decreased for most of the broadleaved species, whereas it remained stable for conifers. Nevertheless, broad-leaved trees still remained at a higher defoliation level than conifers. *Quercus pubescens* and evergreen oak, species which are frequent in the South East of France, still had the worst crown condition of all monitored species in 2008, and did not show any sign of improvement.

Death of sampled trees stayed at a relatively low level (about 0.3%). The mortality rate of branches remained stable compared to that of the year 2007. The number of discoloured trees was still low except for *Populus* spp., *Fagus sylvatica, Prunus avium* and *Pinus halepensis.*

Damage was reported on about a quarter of the sampled trees, mainly on broadleaved species. The most important causes of damage were mistletoe (*Viscum album*) on *Pinus sylvestris,* chestnut canker (*Cryphonectria parasitica*) and the oak buprestid (*Coroebus florentinus*) on *Quercus* spp. Abnormally small leaves were observed on different species, specifically on *Quercus* spp. (mainly on evergreen and pubescent oaks).

4.13 Germany

Compared to the results of the previous assessment in 2007, crown condition did not change dramatically in 2008. On average over all tree species, 25.8% of the sample trees were assessed as damaged (damage classes 2 – 4) in 2008 (2007: 24.9%). At the same time, mean defoliation decreased from 20.7% to 20.4%.

The main tree species show the following development: 30.3% of *Picea abies* were damaged in 2008 (2007: 28.2%). Mean defoliation remained unchanged at 20.8%. For *Pinus sylvestris* the share of damaged trees increased from 13.0% in 2007 to 17.5% in 2008, and mean defoliation increased from 17.8% to 18.9%. *Fagus sylvatica* showed further recovery; the share of damaged trees decreased from 38.7% to 30.3% and mean defoliation from 25.6% to 22.0%. This was favoured by the nearly total absence of fruiting in 2008. More than half of *Quercus petraea and Q. robur*, i.e. 52.1% were damaged in 2008 (2007: 49.1%). Mean defoliation further increased, from 28.0% in 2007 to 28.3% in 2008. The results of the crown condition assessment are presented in detail on the website of the Federal Ministry of Food, Agriculture and Consumer protection (www.bmelv.de).

In 2008, a study on the effects of drought and heat on forest condition in Germany was finalised. For this study, all in all 4 332 increment cores from 651 *Picea abies*, 750 *Pinus sylvestris*, 554 *Fagus sylvatica* and 211 *Quercus petraea and Q. robur* trees were sampled and analysed from all Level II plots. The raw data were detrended in order to remove the age trend and transformed to tree ring index series. Special regression models were applied to analyse possible relationships between index series and time series of meteorology data (daily mean temperature and daily precipitation).

It was shown that until the 1970s, growth reductions were mainly caused by low temperature during winter and late winter time. Since then, growth reductions have been mainly caused by drought and heat during the vegetation period (Fig. 4.12.1). Within the year 1976 both harmful weather courses - a long-lasting cold winter and an enduring heat and drought during summer - occurred consecutively. These comprehensive dendroecological investigations show the effects of climatic conditions on forests. The time series of forest growth reflect the changes of the environmental conditions evidently.

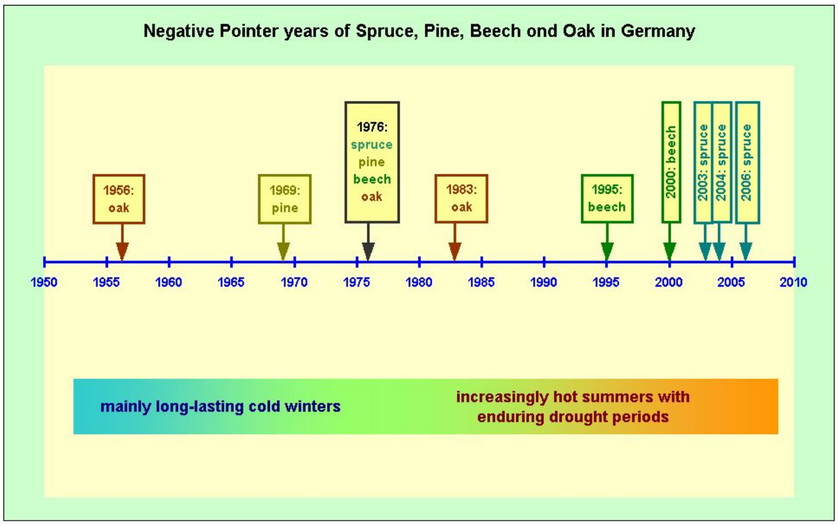

Figure 4.12.1: Appearance of negative pointer years as an expression of significant synchronous growth reductions of the main tree species of all Level II plots in Germany.

4.14 Ireland

The annual assessment of crown condition was conducted on the Level I plots in Ireland between June 13th and September 19th 2008. Overall mean defoliation and discolouration was 9.6% and 6.7%, respectively. This represents a slight worsening in crown condition of Irish forests between the 2007 and 2008 survey of approximately 1.4 percent points for defoliation (but a significant improvement from the 2005 value of some 16 percent points), and an unchanged discolouration. Defoliation levels recorded in 2008 were significantly below the long term average of 14.1% and discolouration levels in 2008 were also below the long term 20 year average of 7.7% points. In terms of species, defoliation decreased in the order of *Picea abies* (15.7%) > *Pinus contorta* (13%) > *Picea sitchensis* (6.9%), while the trend in discolouration was in the order of *Pinus contorta* (12.4%) > *Picea abies* (6.3%) > *Picea sitchensis* (3.8%). These trends and levels do not vary significantly from those recorded in the 2006 and 2007.

The number of Level I plots has increased in Ireland since the 2006 survey in line with increases in national afforestation rates over the past decade. At the start of the survey in 1987 forest cover in Ireland was some 6%. Today forest cover is more than 10% and so new Level I plots have been established to reflect this increase. The location of the new Level I plots has been selected objectively according to the methods outlined in the manual of ICP Forests and to coincide with the location of National Forest Inventory plots in Ireland. The result of the addition of these plots means an increase in the number of sample trees in the survey to 679 in 2008.

Exposure continued to be the greatest single cause of damage to the sample trees in 2008 with approximately one third of sample trees showing some damage attributable to the abiotic environment. The instances of observed aphid damage however were similar to recent years and much decreased since the 2002 outbreak, in particular for *Picea sitchensis*. The aphid responsible for damaging more than 20% of the sample trees in 2002 was *Elatobium abietinum*. Other damage types (shoot die-back, top-dying, nutritional problems, and grazing damage) accounted for damage in a smaller percentage of the trees. No instances of damage directly attributable to atmospheric deposition were recorded in the 2008 survey.

4.15 Italy

The 2008 Level I survey in Italy was based on 6 579 trees on 236 permanent plots. 38.9% of conifers and 21.9% of broadleaves were without any defoliation (class 0). 24.0% of the conifers and 35.8% of the broadleaves were in defoliation classes 2 to 4. Among the young conifers (<60 years), *Pinus sylvestris* and *Pinus pinea* had 29.8% and 77.8% of trees in the classes 2 to 4, followed by *Larix decidua* (16.7%), *Pinus nigra* (19.9%) and *Picea abies* (7.2%). Among the old conifers (60 years), highest shares of trees in defoliation classes 2-4 were recorded for *Larix decidua* (44.5%), followed by *Pinus sylvestris* (40%) and *Picea abies* (18.2%), *Abies alba (*13.7%), and *Pinus nigra* (9.3%).

Among the young broadleaves (<60 years), *Castanea sativa* and *Quercus pubescens* had 55.0% and 51.5% of trees in the classes 2 to 4, followed by *Quercus cerris* (17.6%), *Fagus sylvatica* (22.3%) and *Ostrya carpinifolia* (25.4%). Among the old broadleaves (60 years), *Castanea sativa* had 78.1% in the classes 2-4, followed by *Quercus pubescens* (41%), *Quercus cerris* (21.9%), and *Fagus sylvatica* (20%). *Quercus ilex* had the lowest share of trees in defoliation classes 2-4 (14.3%). 94.2% of the conifers and 94.3% of the broadleaves were without any discoloration.

Starting from 2005, a new methodology for a more detailed assessment of damage factors (biotic and abiotic) was introduced. The main results for 2008 are as follows: Most of the observed symptoms were attributed to insects (25.5%), subdivided in "needle mining" (2.5% of the interested trees), and defoliators (18.6%). Fungi were recorded for 9.7% of the sample. Abiotic agents included hail (1.8%) and dryness (2.3%).

4.16 Latvia

The forest condition survey of 2008 comprised 8090 sample trees on 342 permanent sample plots on the national grid (8 x 8 km), including 92 plots on the transnational grid (16 x 16 km). Of all assessed trees *Pinus sylvestris* account for 50.1%, *Picea abies* 22.4%, *Betula* spp. 21.6%, and other species 5.9%.

Mean defoliation for conifers is 21.6%, and for broadleaves 18.6%, which is nearly the same as in the previous years. The distribution of all tree species following defoliation classes is also very close to that of the 2007 survey. In 2008, 17.8% of all trees showed no defoliation, 66.9% were assessed as slightly defoliated, and 15.3% moderately to severely defoliated or dead. The changes in mean defoliation are statistically insignificant for both conifers and broadleaves.

Mean defoliation of the most common coniferous species, *Pinus sylvestris* and *Picea abies*, are 21.8% and 21.2%, respectively, and the share of moderately damaged to dead trees constitutes 16.7% for both species. An approximately similar defoliation level with slight fluctuations has prevailed during the last decade. The defoliation of *Pinus sylvestris* has slightly increased since 2005 mostly due to quite extensive attacks of European pine sawfly *Neodiprion sertifer* in some regions of Latvia; however, the level of damage caused has been gradually decreasing. The defoliation level of the most common deciduous species in the sample plots - *Betula* spp. and *Populus tremula*, is quite similar – mean defoliation 18.8% for both species and the share of trees in classes 2-4 is 11.7% and 11.8%, respectively. No significant changes are observed in comparison to 2007.

Damage symptoms were observed for 18.8% of the assessed trees. Most frequently recorded damages were caused by insects (35.9% of all cases), followed by others – abiotic factors (mostly wind) (10.8%), direct action by man (10.7%), competition (10.0%) and fungi (9.6%). *Pinus sylvestris* stands. Mostly western regions continue to suffer from the *Neodiprion sertifer* attacks, which are less severe than 2-3 years ago, but still are recorded over quite large areas. Not fully recovered crowns from 2006 and 2007, as well as new damage from 2008 contribute to the increased defoliation level of *Pinus sylvestris* in western Latvia. The population density of bark beetle *Ips typographus*, which reached a high level in a number of Latvia's regions after the 2005 windstorm, decreased considerably in 2008. The 2008 monitoring data show higher mortality rate for spruce (1.4%) as a result of the bark beetle attacks last year. In 2008 an outbreak of *Lymantria dispar* was detected in south-western Latvia over an area of 40 ha. The outbreak of this insect was observed for the first time in Latvia.

4.17 Lithuania

In 2008, the forest condition survey was carried out on 1 342 sample plots. It was the first year in which the national forest inventory network (4 × 4 km grid) was used for forest health monitoring (regional level) in Lithuania. The transnational grid (16 × 16 km) of Level I plots was left unchanged. There were 70 plots on the Level I transnational grid (16 × 16 km) and 1 272 sample plots on the national forest inventory grid (4 × 4 km). In total, 7 539 sample trees representing 19 tree species were assessed. The main tree species assessed were *Pinus sylvestris, Picea abies, Betula pendula, Betula pubescens, Populus tremula, Alnus glutinosa, Alnus incana, Fraxinus excelsior, Quercus robur.*

The change of mean defoliation of all tree species was very insignificant. Already since 1997 there have been only minor fluctuations of mean defoliation. Mean defoliation of all tree species slightly increased up to 20.5% in 2008 (19.9% in 2007). 23.9% of all sample trees were not defoliated (class 0), 56.6% were slightly defoliated and 19.6% were assessed as moderately defoliated, severely defoliated or dead (defoliation classes 2-4). Mean defoliation of conifers was 20.3% (18.8% in 2007) and 20.8% for broadleaves (22.4% in 2007).

The mean defoliation of *Pinus sylvestris* was 20.3% (18.7% in 2007). Since 1998 mean defoliation of *Pinus sylvestris* did not exceed 21.0%. The number of trees in defoliation classes 2-4 has increased up to 16.4% (8.6% in 2007). The mean defoliation of *Picea abies* was 1.2 percent points higher than in 2007 (19.1%) and the number of trees in defoliation classes 2-4 increased up to 24.5% (14.5% in 2007).

Populus tremula had the lowest mean defoliation and the lowest number of trees in defoliation classes 2-4. The mean defoliation of *Populus tremula* was 16.3% (17.1% in 2007) and the number of trees in defoliation classes 2-4 was 10.3% (7.5% in 2007). The mean defoliation of *Alnus glutinosa* was 18.5% (18.8% in 2007) and the number of trees in defoliation classes 2-4 was 16.5% (10.6% in 2007). The mean defoliation of *Betula* spp. was 1.9 percent points lower than in 2007 (21.0%) and the number of trees in defoliation classes 2-4 was 16.5% (15.2% in 2007).

The condition of *Fraxinus excelsior* remained the worst. This tree species had the highest defoliation since 2000. The mean defoliation of *Fraxinus excelsior* has been gradually decreasing over the last few years. It reached 39.5% in 2007 and was 36.5% in 2008. The number of not defoliated trees (class 0) increased up to 14.5% (11.9% in 2007), and the number of trees in defoliation classes 2-4 increased up to 50.7% (45.6% in 2007). Mean defoliation of *Quercus robur* was 1.3 percent points lower than in 2007 (22.6%) and the number of trees in defoliation classes 2-4 was 23.0% (22.0% in 2007).

The condition of Lithuanian forests can be defined as relatively stable, because mean defoliation of all tree species has only inconsiderably varied already since 1997.

4.18 Republic of Moldova

In comparison with last year, climate conditions within the vegetation period were favorable for the development of trees and bushes. Consequently, spring season was rich in precipitation; this resulted in accumulation of productive moisture within the upper soil layer (1 m depth). As a result, insignificant improvement of the forest condition was observed in comparison to the year 2007. Thus, the share of trees without any damage (defoliation class 0) is 42.8% in comparison to 36.1% last year. The percentage of trees in defoliation classes 2-4 has not changed significantly, 33.6% in 2008 compared to 32.5% in 2007. In 2008, also a decrease in discoloration was observed, with 12.6% of the trees in discoloration classes 2-4 against 20.2% in 2007.

Significant increase of trees in defoliation classes 2-4 was observed for Robinia (*Robinia pseudoacacia)* with 58.0% of the trees in 2008, compared to 51.1% in 2007. For *Quercus robur,* 38.3% of the trees were in defoliation classes 2-4. For *Fraxinus excelsior* an increase of the tree number in damage classes 2-4 up to 33.5% was observed. Significant worsening occurred also in Acacia and Ash stands. Data analysis demonstrates insignificant stabilization of the degrading processes within the stands.
The number of trees with identified damage type constituted 909 trees or 9.1%. The most often type of injury is that caused by pests, they constitute 78.6% from the total number of damaged trees.

4.19 Norway

The results for 2008 show a general decrease in crown defoliation for all tree species compared to the year before. The mean defoliation for both *Picea abies* and *Pinus sylvestris* was 15.9%, and for *Betula* spp. 24.0%. After a peak with low defoliation for both Norway spruce and Scots pine in 2004, the last years represent a deterioration in defoliation. Birch had the lowest defoliation in 2001. Since then, defoliation has increased.

Of all the coniferous trees, 47.3% were rated not defoliated in 2008, which is an increase by about 5 percent points compared to the year before. Only 37.2% of the *Pinus sylvestris* trees were rated as not defoliated, while 54.3% of all Norway spruce trees were not defoliated. For *Betula* spp. 22.4% of the trees were observed in the class not defoliated, representing about the same percentage compared to the year before. The percentage of moderately and severely defoliated birch trees was 32.3%, representing a decrease compared to the year before. Birch had a higher percentage of trees with severe defoliation in 2008 than spruce.

A slight deterioration in discoloration for *Picea abies* has been observed. 10.2% of the spruce trees showed signs of discoloration, compared to 8.5% in 2007. For *Pinus sylvestris*, only 3.1% of the assessed trees were discoloured, reflecting a continuous improvement since 2001 when discolouration was as high as 11.3%. For *Betula* spp., a decrease in discolouration was observed with 95.6% of the birch trees having no signs of discolouration in 2008.

The mean mortality rate for all species was 0.5%. The mortality rate was 0.2%, 0.1% and 1.4% for spruce, pine and birch, respectively. No serious attacks by pests or pathogens were recorded.

In general, the observed crown condition values result from interactions between climate, pests, pathogens and general stress. According to The Norwegian Meteorological Institute the summer (June, July and August) of 2008 was regarded as relatively warm and dry. The middle temperature for the whole country was 0.5°C above normal, and precipitation was 95% of the normal quantity for these months. There are of course large climatic variations between the regions in Norway.

4.20 Poland

In 2008, the forest condition survey was carried out on 1 916 plots. 24.4% of all sample trees were without any symptoms of defoliation. 18.0% of all trees were classified as severely damaged or dead (classes 2-4).

22.9% of the conifers were assessed as not defoliated. For 17.4% of the conifers, defoliation of more than 25% (classes 2-4) was observed. With regard to the three main coniferous species, *Picea abies* remained the species with the highest defoliation. For *Picea abies* trees of an age up to 59 years a share of 22.3% was in defoliation classes 2-4. For the older trees this share was 28.5%.

27.5% of all assessed broadleaved trees were not defoliated. The proportion of trees with more than 25% defoliation (classes 2-4) amounted to 19.1%. As in the previous survey, the highest defoliation amongst broadleaved trees was observed for *Quercus* spp. In 2008, a share of 17.7% of *Quercus* trees up to 59 years old and 34.9% of trees aged 60 years old and older were in defoliation classes 2-4.

In 2008, discolouration (classes 1-4) was observed on 0.9% of the conifers and 2.0% of the broadleaves.

4.21 Serbia

In the Republic of Serbia, the 16 x 16 km grid of the forest condition survey consists of 103 sampling plots and 27 new plots on a 4 x 4 km grid. AP Kosovo and Metohija are not included. The total number of trees assessed on all sampling points was 2 789 trees in 2008, 331 conifers and 2 458 broadleaved trees. The coniferous tree species are: *Abies alba, Picea abies, Pinus nigra* and *Pinus silvestris,* and the most important broadleaved tree species are *Carpinus betulus, Fagus moesiaca, Quercus cerris, Quercus frainetto* and *Quercus petraea.*

The degree of defoliation calculated for all coniferous trees was as follows: no defoliation on 63.4% of the trees, slight defoliation on 23.6% of the trees, moderate defoliation on 10.0% of the trees, and severe defoliation on 3.0% of the trees.
The degree of defoliation calculated for all broadleaved species is as follows: no defoliation on 61.0% of the trees, slight defoliation on 27.7% of the trees, moderate defoliation on 9.9% of the trees, severe defoliation on 1.0% of the trees and 0.4% dead trees.

81.9% of the coniferous and 93.8% of the broadleaved trees did not show any sign of discolouration

Moderate and severe defoliation do not necessarily signify reduced vitality caused by adverse agents such as climate stress, insect pests, or pathogenic fungi. Increased defoliation can also be a temporary phase of natural variability of crown density.

4.22 Slovak Republic

The 2008 national crown condition survey was carried out on 108 Level I plots on the 16 x 16 km grid net. The assessments covered 5 003 trees, 4 083 of which being assessed as dominant or co-dominant trees according to Kraft. Of the 4 083 assessed trees, 29.3% were damaged (defoliation classes 2-4). The respective figures were 41.1% for conifers and 20.8% for broadleaves. Compared to 2007, the share of trees that showed a defoliation of more than 25% increased by 3.7 percent points. Mean defoliation for all tree species together was 23.6%, with 27.0% for conifers and 21.2% for broadleaves. Results show that defoliation in the Slovak Republic is above the European average. This is mainly due to the higher defoliation of coniferous species.

Compared to the 2007 survey, worsening (increase of average defoliation) was observed in *Fagus silvatica, Pinus sivestris* and *Larix decidua*. Improvements were observed in *Robinia pseudacacia* and *Quercus* sp. Since 1987, the lowest damage was observed for *Fagus sylvatica* and *Carpinus betulus*, with exception of fructification years. The most severe damage was observed in *Abies alba*, *Picea abies* and *Robinia pseudacacia*.

From the beginning of the forest condition monitoring in 1987 until 1996 results show a significant decrease in defoliation and visible forest damage. Since 1996, the share of damaged trees (25-32%) and mean defoliation (22-25%) has been relatively stable. The recorded fluctuation of defoliation depends mostly on meteorological conditions.

As a part of the crown condition survey, damage types were assessed. 32.4% of all sample trees (5 003) had some kind of damage symptoms. The most frequent damage was caused by insects (15.4%) and logging activities (12.9%) at tree stems. Additional damage causes were fungi (12.2%), and abiotic agents (3.2%). Epiphytes had the most important influence on defoliation. 63% of trees with epiphytes revealed defoliation above 25%. In addition, abiotic agents had a direct link to defoliation.

4.23 Spain

Results obtained within the 2008 inventory show that the general improvement already recorded in 2007 has still continued. 84.4% of the surveyed trees look healthy (defoliation classes 1 or 2). This is a similar percentage compared to the one recorded at the beginning of the present decade. Only 14.2% of the trees were in classes 2 and 3, indicating defoliation levels higher than 25% and thus a clear devitalisation. There was a remarkably low percentage of 1.4% of dead trees. In previous years the figure was between 2% and 3%. Most of the dead trees occurred in sanitary cuts and felling operations.

During the year 2008, three of the four most frequently surveyed tree species showed lower mean defoliation compared to the previous year. The fourth main tree species, *Quercus pyrenaica,* worsened slightly. Among the conifers, *Pinus halepensis* improved more significantly, whereas *Pinus sylvestris* showed a less distinct improvement. For *Quercus ilex* a recovery which started in 2006 has continued.

With respect to causal agents, the occurrence of spring defoliators on broadleaves and a slight increase of pine processionary caterpillar are the most important ones, followed by *Escolitidae,* defoliating fungi and *Gonipterus* and foliar fungi infestations in Eucalyptus stands. There was increasing damage due to *Viscum album* infestations in certain areas as well as a mortality processes related to the Dutch elm disease. A new decline process caused by a still unknown agent seems to affect *Alnus* stands near the Cantabrian coasts.

The importance of atmospheric pollution in the evolution of forest condition is a factor which can not be quantified directly, as it is frequently disguised by other processes which are more apparent. However, in combination with other agents it can contribute to the degradation processes of forests.

4.24 Sweden

The national results are based on the assessment of the main tree species *Picea abies* and *Pinus sylvestris* in the National Forest Inventory (NFI), and concern, as in previous years, only forests in thinning age or older. In total, 6 890 trees on 3 464 sample plots were assessed. The Swedish NFI is carried out on permanent as well as on temporary sample plots. The permanent sample plots, which are two thirds of the total sample, are remeasured every 5th year. A new concept for forest health monitoring has been introduced in Sweden including special inventories. The aim of the inventories is to provide data for operational decision making, linked to specific pest events.

The proportion of trees with more than 25% defoliation is 26.2% in *Picea abies* (26.4% in 2007) and 9.7% in *Pinus sylvestris* (10.2% in 2007). The share of discoloured *Picea abies* trees has increased and is 7.1%. In *Pinus sylvestris* discolouration is rare, 0.8%.

The forests in southern Sweden are still affected by large bark beetle populations. The volume of *Picea abies* killed by the European spruce bark beetle (*Ips typographus*) in 2008 was estimated at 700 000 m^3. This is less than in previous years and it might indicate decreasing populations of bark beetles. However, the weather is crucial and new storms and long hot summers could easily change the situation. A changing climate towards longer and warmer summers increases the risk of damage by insects. The two most harmful insects, *Ips typographus* and *Hylobius abietis*, in Swedish forests can, with a changing climate, more regularly take advantage of an annual second generation. Outbreaks of the European pine sawfly *(Neodiprion sertifer)* has for some years been noticed in the western part of central Sweden. Increasing amounts of damage on *Fraxinus excelsior* has been observed in southern Sweden.

Monitoring the outbreak of the resin top disease (*Cronartium flaccidum)* in northern Sweden was carried out also in 2008 by a special inventory. The results showed that the rust occurred all over northern Sweden, but is more frequent in the northeastern part. The affected area was estimated to 131 000 ha, which corresponds to 34% of all young pine stands. No increase of affected area was observed compared to 2007.

4.25 Switzerland

In 2008 the Swiss national forest health inventory was carried out on 48 plots of the 16 x 16 km grid using the same sampling and assessment methods as in the previous years.
Crown condition in 2008 improved slightly in comparison to the last two years. In 2008, 19.0% of the trees had more than 25% unexplained defoliation (i.e. subtracting the known

causes such as insect damage, or frost damage; 2007: 22.4%) and 26.4% of the trees had more than 25% total defoliation (2006: 30.7%). Annual mortality rates were average (4 out of 1000 trees). Although mortality rates are usually low in Switzerland, the proportion of dead trees, which remain in the Swiss inventory, have more than doubled over the last two decades accounting for roughly 40% of the trees with high defoliation.

Mainly deciduous trees, in particular beech, had reduced defoliation in 2008. This can be partially attributed to the wet, but not cool, weather conditions which prevailed during the summers 2007 and 2008. One other reason is the exceptionally low seed production in beech and other species. In 2006, 54% (43%) of the beech trees on Level I (Level II) were reported with seeds, in 2007, 38% (23%) and in 2008 only 2% (8%), which is one of the lowest percentages ever reported. For Norway spruce the percentage of trees with cones was 57% (22%) in 2006, 54% (58%) in 2007 and only 14% (3%) in 2008, which was also unusually low.

4.26 Turkey

In 2008, the Forest Service has continued to install Level I plots on the 16 x 16 km grid. 393 plots were installed in 2008, raising the total to 721 plots. On 182 plots there were insufficient trees for plot installation. On 398 Level I plots out of the 539 plots (9 317 trees) the crown condition assessment has been conducted. Discolouration was assessed on 363 plots (8 559 trees).

The total mean defoliation in 2008 was 22.3% percent in Turkey. In total, 24.5% of the trees showed defoliation above 25% and are thus considered to be damaged. Mean percentages of conifers such as *Pinus brutia* (21.6%), *Pinus nigra* (18.0%), *Pinus sylvestris* (19.9%), *Juniperus excelsa* (18.5%), *Abies nordmanniana* (16.2%) and *Cedrus libani* (16.5%) were lower than the shares of broadleaved trees with defoliation above 25% such as *Fagus orientalis* (26.8%), *Quercus cerris* (25.7), *Quercus petraea* (33.1%), *Quercus robur* (18.1%) and *Carpinus orientalis* (31.2%). Most damaged plots were located in the Northern part of Turkey. In five Regional Forest Directorates in Marmara and Blacksea regions the mean defoliation was above 30%. In the hot and dry Mediterranean region mean defoliation remained well below the 20%.

In 2008, 4 more Level II plots were installed. In total there are now 15 Level II plots. 8 Level II plots were selected as key plots where the monitoring of deposition, litterfall, phenology, etc. has started. A main drawback at present is the lack of good laboratory facilities but training and test wise assessments on existing plots are implemented. Crown condition and ground vegetation were assessed on 11 Level II plots and deposition samplers were installed on 6 plots while litterfall collectors are installed on only 3 plots. Furthermore, ozone induced injury on vegetation was investigated in stands nearby 5 Level II plots and soil and litter samples were taken from 4 plots.

It is foreseen that the laboratory becomes operational in 2009. The remaining Level I points on the systematic grid net are planned to be installed in 2009 and work will continue on the improvement of data collection, data management and quality control. For the intensive monitoring further installation of equipment (deposition, litterfall and meteorological stations) is foreseen for 2009.

4.27 Ukraine

In 2008, 33 986 sample trees were assessed on 1 465 forest monitoring plots covering all administrative regions of Ukraine. Mean defoliation of conifers was 10.8% and for broadleaved trees it was 12.5%. For the total sample, some deterioration of tree condition was observed compared to the previous year. In 2008, the percentage of healthy trees decreased (66.5% against 68.6% in 2007). At the same time, the share of slightly to moderately defoliated trees increased from 30.1% to 32.3%. These changes may be considered, however, as being related to a change of the sample.

For the common sample trees (CSTs) (33 015 trees) insignificant changes with a tendency to deterioration were observed. Mean defoliation of all species in 2007 (10.8%) was lower than in 2008 (11.5%). At the same time there was a decrease of shares of trees in defoliation classes 0 (by 2.0 percent points) and an increase in all the other classes.

Some deterioration of tree condition was registered for the CST of *Quercus robur*. Statistically significant changes were observed in class 0 (decrease by 2.8 percent points) and class 1 (decrease by 2.2 percent points). A similar tendency was observed for the CSTs of *Pinus sylvestris* which revealed an increase in the shares of trees in classes 1, 2 and 3 and a decrease in class 0. Nevertheless, these changes were insignificant. Some deterioration in tree condition may be explained by the hot and dry weather condition in summer (July and August) 2008 and by an increasing impact of defoliating insects.

4.28 United States of America

Efforts and research related to critical loads (CL) in the U.S. are presently increasing in scope and extent. European ICP modelling and mapping approaches are being applied to estimate critical loads (CL) of eutrophication and acidification in the San Bernardino National Forest in southern California. This work complements ongoing work on empirical CL for mixed conifer forests in California based on nitrate leaching and lichen community shifts in response to N deposition. Empirical CL for N eutrophication responses have also been developed for chaparral, coastal sage scrub and desert ecosystems in southern California. Based on this work areas of CL exceedances are being mapped. Critical loads based on N deposition effects on lichen communities and functional groups are also being developed for forests in the Pacific Northwest region, including Alaska, and lichen survey data from other regions of the United States indicate the potential to expand this work.

Recently the Critical Loads Ad-Hoc (CLAD) Sub-Committee of the National Atmospheric Deposition Program (NADP) was formed. CLAD meets twice a year at the semi-annual NADP technical committee meetings. The purpose of the CLAD meetings is to discuss current CL programs and efforts in the United States and opportunities for future collaborative work, and to share technical presentations describing the results of critical loads studies. Many of the presentations discuss the role of CL studies in air quality policy. CLAD will also attempt to keep abreast of CL efforts in Europe and Canada, and when feasible will either send a representative to key international meetings, or will invite international participants to share recent findings and progress.

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6. ANNEXES

Annex I

Transnational Surveys

Annex I-1
Forest types

The definition of the forest types applied in this report follows EEA (2007)[1]. The classification of single plots has been carried out on the basis of the existing data base. National validation is still ongoing.

1. Boreal forest.

The temperature and length of the growing season are the main climatic variables which determine forest productivity in the boreal climate zone. The harsh climatic conditions affect forest composition, dominated by two conifer species (*Picea abies, Pinus sylvestris*) in the late stages of the forest succession; their relative distribution in the boreal climate zone is driven mainly by edaphic conditions. Deciduous tree species including birches (*Betula* spp.), aspen (*Populus tremula*), rowan (*Sorbus aucuparia*) and willows (*Salix* spp.) tend to occur as early colonisers of bare ground or in the early stages of forest succession. Under natural conditions, forest fires ignited by lightning and repeatedly occurring with cyclical frequency regulate the dynamics of boreal coniferous forests. Nowadays these wildfires have been almost completely prevented by forest management. Most of the boreal forest is managed as even-aged forest for commercial forestry. Forestry has further increased, during the 20th century, the range of conifers in the boreal zone, by favouring conifers over deciduous tree species.

2. Hemiboreal forest and nemoral coniferous and mixed broadleaved coniferous forest.

The category has a double-faced origin: it includes the latitudinal mixed forests located between the boreal and nemoral forest zones (hemiboreal forest or forest of the boreo-nemoral zone, *sensu* Ozenda[2], 1994) and anthropogenic coniferous forest in the nemoral zone. The light regime and length of the growing season are the main climatic variables controlling forest productivity; these factors differ considerably from the northern to the southern part of the hemiboreal zone. Anthropogenic impact has greatly reduced the extent of hemiboreal forest and altered its original tree species composition. The hemiboreal forest is featured by the coexistence of boreal coniferous species with temperate broadleaved tree species (*Quercus robur, Fraxinus excelsior, Ulmus glabra, Tilia cordata*).

3. Alpine coniferous forest.

This category occurs in climatic conditions similar to those of the boreal zone, except for the light regime and length of the day. Cold and harsh climate (short growing seasons) characterises the high altitudes of the Alpine region of Europe. This determines similar altitudinal vegetation belts, though at differing altitudes, on all alpine mountain ranges. Forest tree species composition varies with the vegetation belts (mountainous/subalpine) and site ecological conditions. In addition to boreal conifers, *Larix decidua, Pinus cembra, P. nigra* and *P. mugo* are the naturally dominant species. Variation in regeneration patterns and horizontal clustering is also related to these forest types. Traditional pastoral farming practices, the mainstay of the mountain economy for centuries, have modified the natural distribution of subalpine forests; pasturing, however is now rapidly disappearing under the combined pressure of land abandonment and intensification. The management of even-aged stands predominates in the Alpine region; selection cutting management is practised only in small areas of productive forest characterised by mixed forest spruce, fir and beech composition.

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[2] Ozenda, P. (1988). Die Vegetation der Alpen im Europäischen Gebirgsraum. Stuttgart, New York: Gustav Fischer.

4. Acidophilous oak and oak-birch forest.

The category is related to oligotrophic soils of the nemoral forest zone; the tree species composition is poor (1–2 species) and characterised by acidophilous oaks (*Q. robur, Q. petraea*) and birch (*Betula pendula*). Oakwoods stocking on poor, acid soils have been managed for a long time for coppice and grazing. Many coppice forests were converted to high forests during the past decades or otherwise abandoned or converted to conifer forest plantations.

5. Mesophytic deciduous forest.

The category is related to meso- and eutrophic soils of the nemoral zone; canopy composition is often mixed, and characterised by mixtures of *Carpinus betulus, Quercus petraea, Quercus robur, Fraxinus, Acer* and *Tilia cordata*. Due to the association with fertile soils, most of the original mesophytic deciduous forest area has been cleared and soils converted to very productive agricultural land. The management of even-aged stands predominates in the category.

6. Beech forest.

The category has a very wide geographic distribution from lowland to submountainous regions in Europe. It is characterised by the dominance of European beech *Fagus sylvatica* or of *Fagus orientalis* in the eastern and southern parts of the Balkan Peninsula. Locally important additional trees are *Betula pendula* and mesophytic deciduous species. The wide distribution is due to the wide climatic and edaphic amplitude of beech and to its competitive strength. At its northern and eastern boundaries (and in high altitudes, c.f. category 7) beech is limited by low winter temperatures causing either direct damage (extreme winter cold or late frosts in spring) or too short growing season. To the south and at lower altitudes water deficiency can limit beech distribution. Most of beech forests are managed as even-aged forest, although traditional management practices (like wood pastures, coppice with standards) are still in place in especially in rural areas.

7. Mountainous beech forest.

The category is related to the mountainous altitudinal belt of the main European mountain ranges. In the mountainous vegetation belt coniferous species (spruce, fir) become more competitive compared to beech. Mountainous beech forest is thus characterised by the presence of conifers as additional important forest species. As for category 6, locally important additional tree species include *Betula pendula* and mesophytic deciduous species. Traditionally mountainous beech forest have been intensively managed for fuel wood purposes, in mining areas and in some mountain areas of Apennines and Alps. Beech was coppiced for firewood and charcoal. Most of these stands were turned to high forest in the 20th century.

8. Thermophilous deciduous forest.

The deciduous forests under this category mainly occur in the supra-Mediterranean vegetation belt, the altitudinal belt of Mediterranean mountains corresponding to the mountainous level of middle European mountains. Thermophilous deciduous forests are limited to the north (or upslope) by temperature and to the south (or downslope) by drought. The mild climatic conditions of the supra-Mediterranean level determine the predominance of mixed deciduous and semi-deciduous forest of thermophilous species, mainly of *Quercus*. *Acer, Ostrya, Fraxinus, Carpinus* species are frequent as associated secondary trees. Anthropogenic exploitation has modified the natural mixed composition of thermophilous deciduous forests, leading in most cases to the elimination of natural species without a commercial interest or with poor resprouting capacity or, conversely, the introduction of forest species that would not occur naturally (e.g. chestnut). Simplified forest structures shaped by traditional silvicultural systems predominate (coppice, coppice with standards, mixed coppice/high forest). Also chestnut-groves are of purely cultural origin. Today, these are largely replaced by coppice-woods or left unmanaged. High forest-like structures developing from abandoned land are relatively frequent in the category.

9. Broadleaved evergreen forest.

Forests under this category are related to the thermo- and meso-Mediterranean vegetation belt and to the warm-temperate humid zones of Macaronesia. There, climates determine a forest physiognomy characterised by the dominance of broadleaved sclerophyllous or lauriphyllous evergreen trees. Water availability varies considerably between the Macaronesia and thermo- and meso-Mediterranean vegetation belts and it is the main climatic factor limiting tree-growth. In the Mediterranean, the structure of broadleaved evergreen forest has been profoundly shaped by traditional agro-forestry (*dehesas*, *montados*) and coppice cultivation systems. Forest degradation is a very common phenomenon, due to a complex historical interplay of harsh environmental conditions (drought, aridity, soils prone to erosion) and anthropogenic influences (fire, grazing, intensive forest exploitation).

10. Coniferous forests of the Mediterranean, Anatolian and Macaronesian regions.

This category includes a large group of coniferous forests, mainly xerophytic forest communities, distributed throughout southern Europe from coastal regions to high mountain ranges. Forest physiognomy is mainly dominated by species of *Pinus*, *Abies* and *Juniper*, that are variously distributed according to altitudinal vegetation belts. The relation with dry and, often, with poor or poorly developed soils limits tree growth. Although some pine forests under this category are adapted to fire (e.g. *P. halepensis*, *P. canariensis*), in the Mediterranean region repeated forest fires of anthropogenic origin seriously threaten these coniferous forests, by triggering forest degradation. Even-aged forests characterise the category.

11. Mire and swamp forest.

Waterlogged peaty soils determine these wetland forests mainly distributed in the boreal zone. Changes in forest physiognomy are due to the micro-topographic variability of wetland areas and associated variations in edaphic conditions and water regimes. *Picea abies* and *Pinus sylvestris* build up mire forests; species of *Alnus*, *Betula*, *Quercus* and *Populus* dominate the deciduous swamp forest. Due to its poor economic value, most of the potential area of swamp forest has been drained and converted to agricultural land or productive coniferous forest plantations. Present management is targeted to the protection and restoration of these wetland forests.

12. Floodplain forest.

The riparian or alluvial hydrological regime (high water table subject to occasional flooding) determines the appearance of forests under this category, distributed along the main European river channels. Floodplain forests are species-rich, often multi-layered communities characterised by different assemblages of species of *Alnus*, *Betula*, *Populus*, *Salix*, *Fraxinus*, *Ulmus*. In the Mediterranean and Macaronesian regions local species are also found (e.g. *Fraxinus angustifolia*, *Nerium Oleander*, *Platanus orientalis*, *Tamarix*). Forest composition and structure largely depends on the frequency of flooding. Anthropogenic activities like the river damming and canalisation, drainage of riparian areas to provide agricultural land have brought significant changes in the area of floodplain forest during the last century. The conservation and restoration of these riparian forests is the main focus of forest management today.

13. Non riverine alder, birch, or aspen forest.

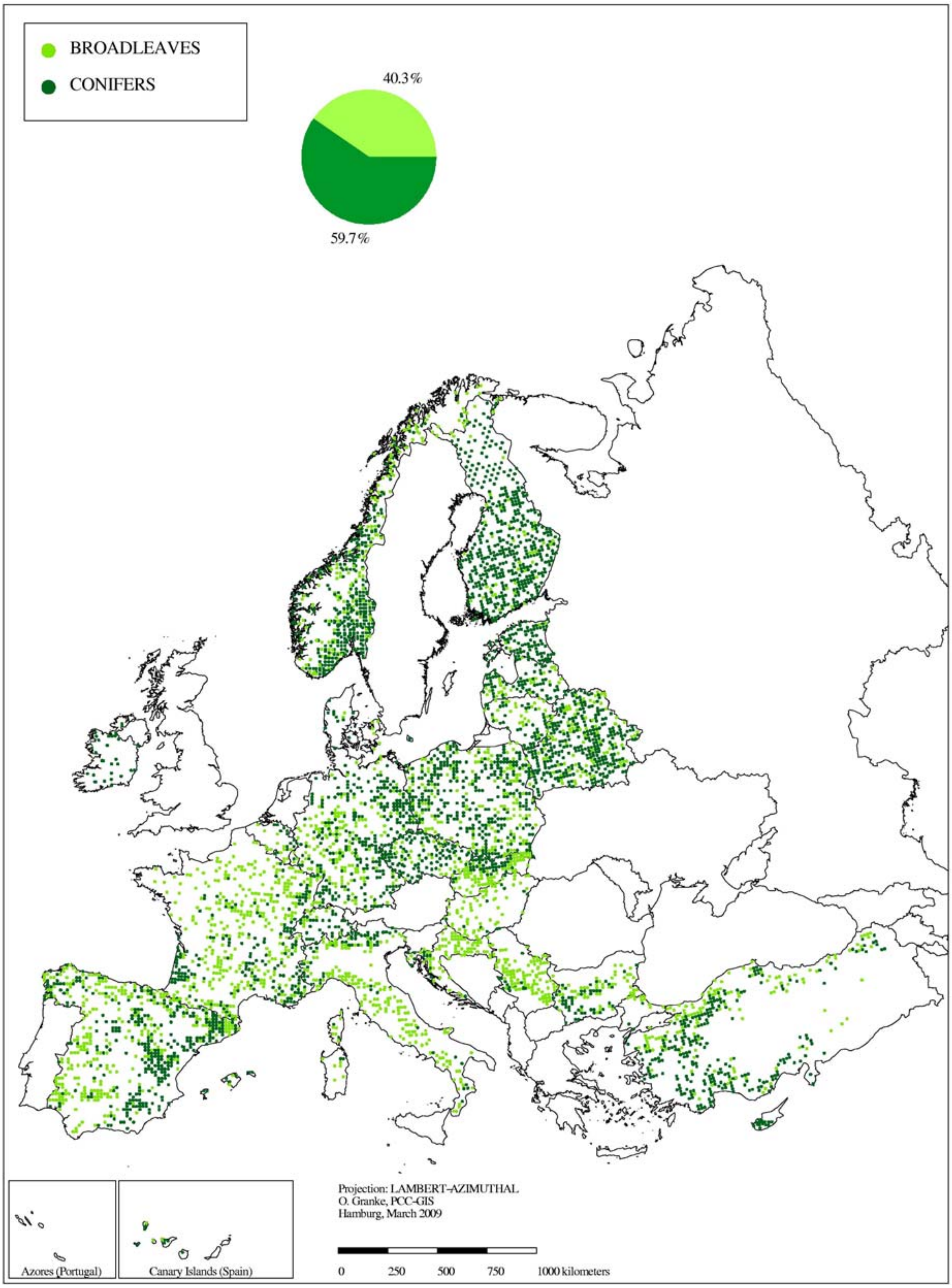
The category includes a number of non-riparian, non-marshy often pioneer forest formations dominated by *Alnus*, *Betula* or *Populus*. These communities are related to specific ecological conditions (mountain birch formations) or occur as pioneer stages of the forest succession and/or are related to traditional land use, e.g. grazing.

14. Plantations and self-sown exotic forest.

The category includes forests with lowest level of naturalness in Europe, because:

- the extent of human influence in the establishment and/or management of the forests is higher than in any other category; these are the forest plantations established and intensively managed for production or, otherwise, for the rehabilitation of degraded land (in which case management may be less obvious or intensive);
- the forest predominantly consists of self-sown non-native, often invasive, tree species.

Annex I-2
Broadleaves and conifers (2008)



Annex I-3

Species assessed (2008)

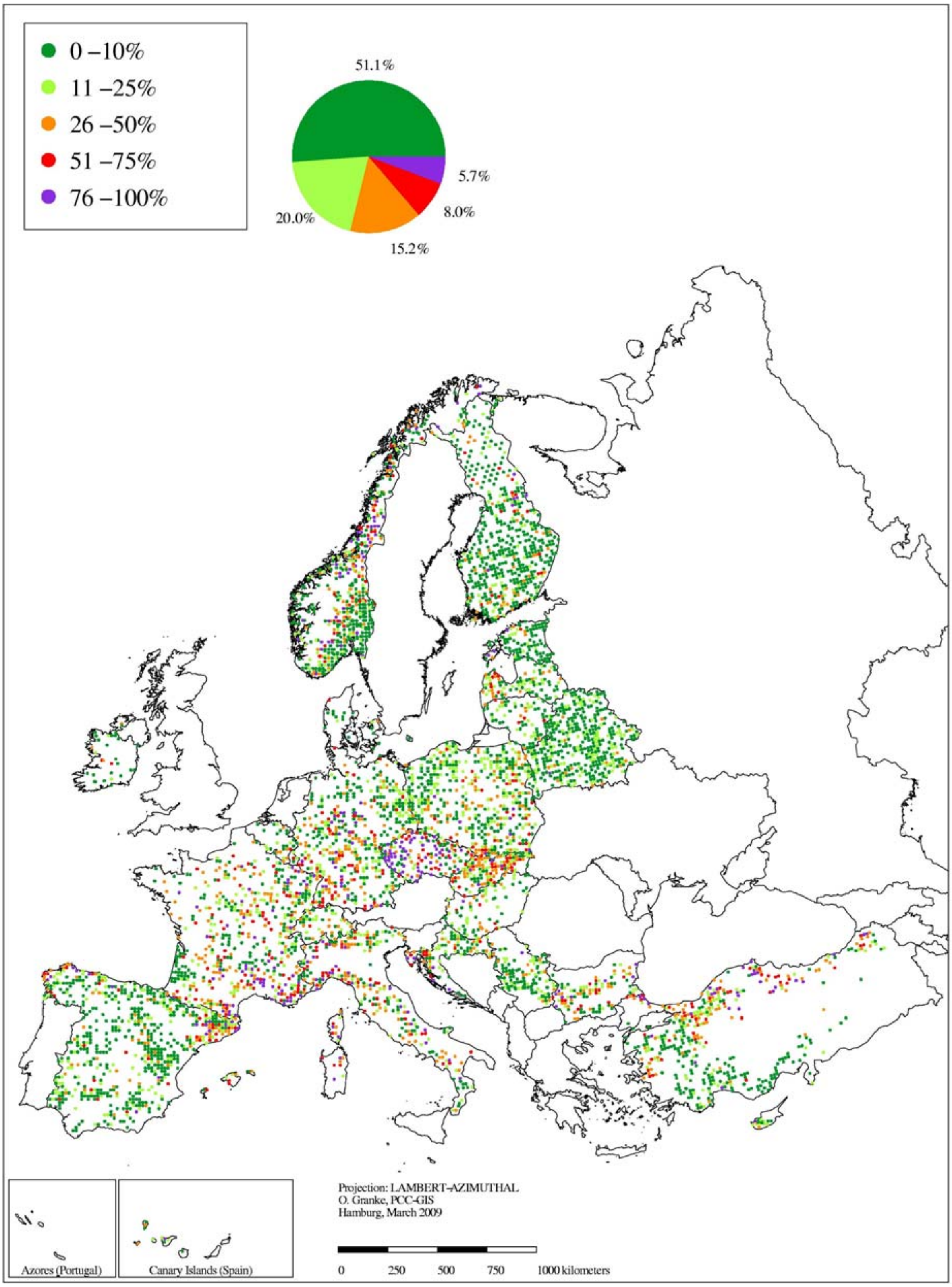
Species	Observed trees		Observed plots	
	Number	%	Number	%
Pinus sylvestris	28638	25.67	1602	16.70
Picea abies	15475	13.87	1077	11.23
Fagus sylvatica	8550	7.66	561	5.85
Quercus robur	4335	3.89	470	4.90
Pinus nigra	4271	3.83	245	2.55
Betula pendula	4166	3.73	660	6.88
Quercus ilex	3920	3.51	228	2.38
Betula pubescens	3316	2.97	486	5.07
Quercus petraea	3162	2.83	313	3.26
Pinus halepensis	2461	2.21	125	1.30
Pinus brutia	2392	2.14	121	1.26
Quercus cerris	2389	2.14	209	2.18
Pinus pinaster	2379	2.13	144	1.50
Quercus pubescens	2101	1.88	168	1.75
Abies alba	1761	1.58	176	1.83
Alnus glutinosa	1592	1.43	167	1.74
Carpinus betulus	1358	1.22	200	2.08
Castanea sativa	1196	1.07	136	1.42
Populus tremula	1068	0.96	235	2.45
Larix decidua	1062	0.95	155	1.62
Fraxinus excelsior	1048	0.94	197	2.05
Quercus pyrenaica	868	0.78	51	0.53
Fagus moesiaca	848	0.76	50	0.52
Fagus orientalis	842	0.75	60	0.63
Eucalyptus spp.	837	0.75	42	0.44
Quercus frainetto	826	0.74	58	0.60
Robinia pseudoacacia	740	0.66	71	0.74
Acer pseudoplatanus	585	0.52	150	1.56
Pseudotsuga menziesii	530	0.48	48	0.50
Pinus pinea	511	0.46	33	0.34
Juniperus excelsa	492	0.44	47	0.49
Picea sitchensis	485	0.43	27	0.28
Quercus suber	464	0.42	41	0.43
Populus hybrides	381	0.34	19	0.20
Ostrya carpinifolia	369	0.33	56	0.58
Quercus faginea	365	0.33	44	0.46
Other broadleaves	340	0.30	65	0.68
Pinus radiata	325	0.29	16	0.17
Juniperus thurifera	278	0.25	22	0.23
Alnus incana	266	0.24	40	0.42
Tilia cordata	238	0.21	65	0.68

Species	Observed trees		Observed plots	
	Number	%	Number	%
Abies nordmanniana	215	0.19	21	0.22
Pinus contorta	206	0.18	12	0.13
Juniperus communis	198	0.18	30	0.31
Olea europaea	186	0.17	18	0.19
Fraxinus angustifolia	185	0.17	21	0.22
Prunus avium	179	0.16	89	0.93
Pinus uncinata	177	0.16	16	0.17
Quercus rubra	170	0.15	25	0.26
Cedrus libani	157	0.14	13	0.14
Acer campestre	156	0.14	66	0.69
Carpinus orientalis	141	0.13	19	0.20
Fraxinus ornus	135	0.12	46	0.48
Central Anatolian oaks	131	0.12	16	0.17
Acer platanoides	130	0.12	46	0.48
Quercus coccifera	126	0.11	21	0.22
Tilia platyphyllos	117	0.10	22	0.23
Juniperus oxycedrus	117	0.10	38	0.40
Picea orientalis	91	0.08	11	0.11
Populus nigra	89	0.08	14	0.15
Alnus cordata	87	0.08	4	0.04
Pinus cembra	83	0.07	10	0.10
Larix kaempferi	80	0.07	11	0.11
Pinus strobus	76	0.07	11	0.11
Juniperus foetidissima	76	0.07	7	0.07
Abies cilicica	63	0.06	9	0.09
Other conifers	61	0.05	10	0.10
Sorbus aucuparia	57	0.05	20	0.21
Acer opalus	50	0.04	19	0.20
Sorbus aria	47	0.04	29	0.30
Quercus macrolepsis	44	0.04	3	0.03
Populus alba	42	0.04	10	0.10
Populus canescens	39	0.03	4	0.04
Ulmus glabra	38	0.03	21	0.22
Acer monspessulanum	33	0.03	12	0.13
Platanus orientalis	33	0.03	2	0.02
Cupressus sempervirens	33	0.03	4	0.04
Cedrus atlantica	32	0.03	3	0.03
Sorbus torminalis	31	0.03	24	0.25
Pistacia terebinthus	29	0.03	9	0.09
Ulmus minor	27	0.02	14	0.15
Salix alba	26	0.02	9	0.09
Salix spp.	24	0.02	13	0.14
Cedrus brevifolia	24	0.02	1	0.01
Pyrus communis	23	0.02	10	0.10

Species	Observed trees		Observed plots	
	Number	**%**	**Number**	**%**
Salix caprea	22	0.02	13	0.14
Juniperus phoenicea	22	0.02	9	0.09
Buxus sempervirens	21	0.02	3	0.03
Juglans regia	21	0.02	8	0.08
Corylus avellana	19	0.02	10	0.10
Quercus fruticosa	19	0.02	1	0.01
Phillyrea latifolia	18	0.02	6	0.06
Quercus trojana	17	0.02	1	0.01
Arbutus unedo	10	0.01	5	0.05
Tsuga spp.	9	0.01	1	0.01
Ilex aquifolium	8	0.01	5	0.05
Sorbus domestica	8	0.01	7	0.07
Cupressus lusitanica	8	0.01	1	0.01
Arbutus andrachne	7	0.01	3	0.03
Phillyrea angustifolia	7	0.01	2	0.02
Ulmus laevis	6	0.01	3	0.03
Prunus serotina	5	0.00	1	0.01
Crataegus monogyna	5	0.00	2	0.02
Quercus rotundifolia	4	0.00	3	0.03
Pistacia lentiscus	4	0.00	1	0.01
Cedrus deodara	4	0.00	1	0.01
Ceratonia siliqua	3	0.00	2	0.02
Laurus nobilis	3	0.00	3	0.03
Abies grandis	3	0.00	1	0.01
Thuya spp.	3	0.00	1	0.01
Salix fragilis	2	0.00	2	0.02
Cercis siliquastrum	2	0.00	1	0.01
Chamaecyparis lawsonia	2	0.00	1	0.01
Malus domestica	1	0.00	1	0.01
Prunus padus	1	0.00	1	0.01
Salix cinerea	1	0.00	1	0.01
Salix eleagnos	1	0.00	1	0.01
Chamaecyparis lawsonia	2	0.00	1	0.01
All species	111560	99.95	9594	99.97

Annex I-4
Percentage of trees damaged (2008) [1)]

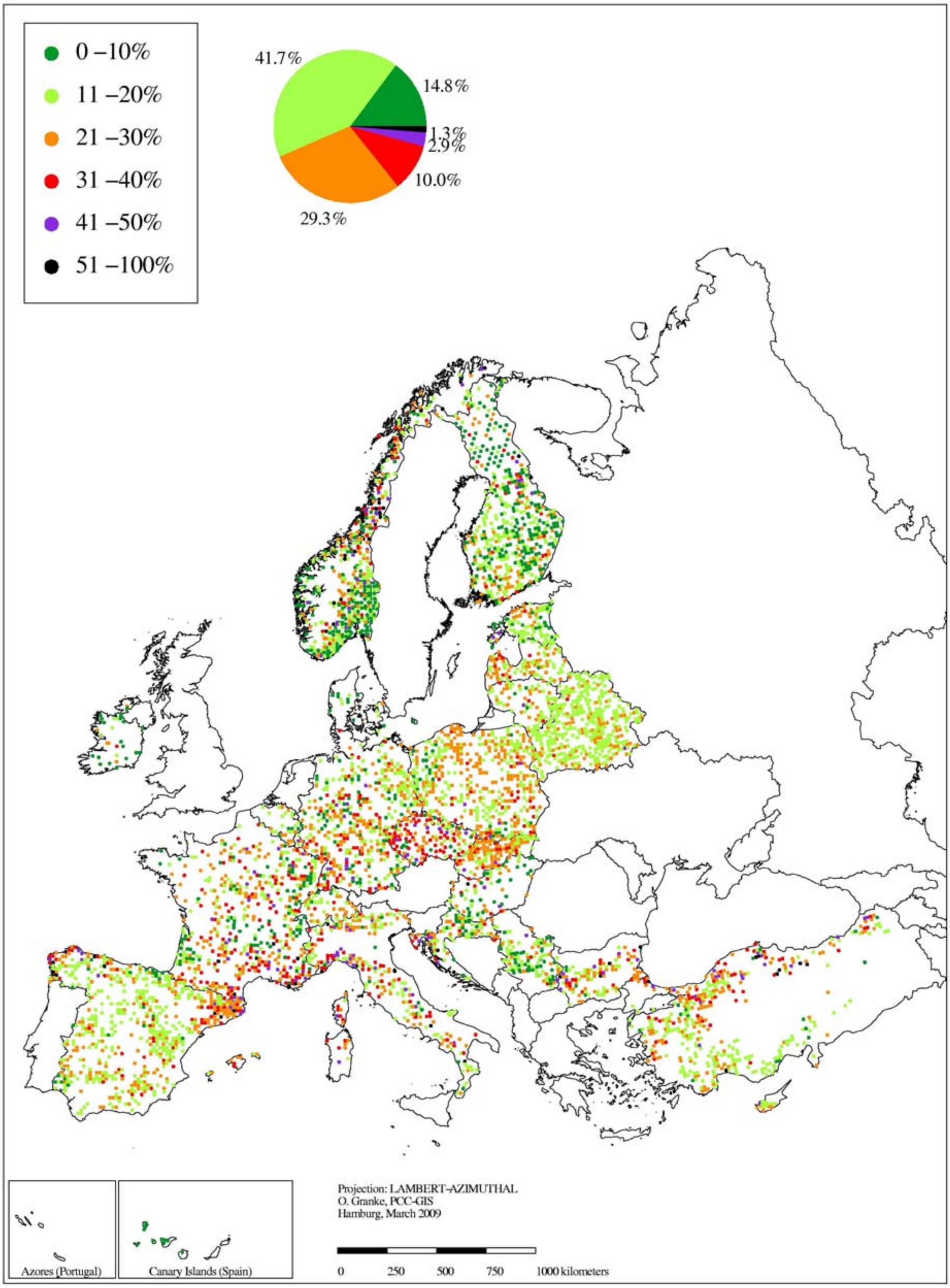
Note that some differences in the level of damage across national borders may be at least partly due to differences in standards used. This restriction however does not affect the reliability of the trends over time.



[1)] trees with defoliation larger than 25%

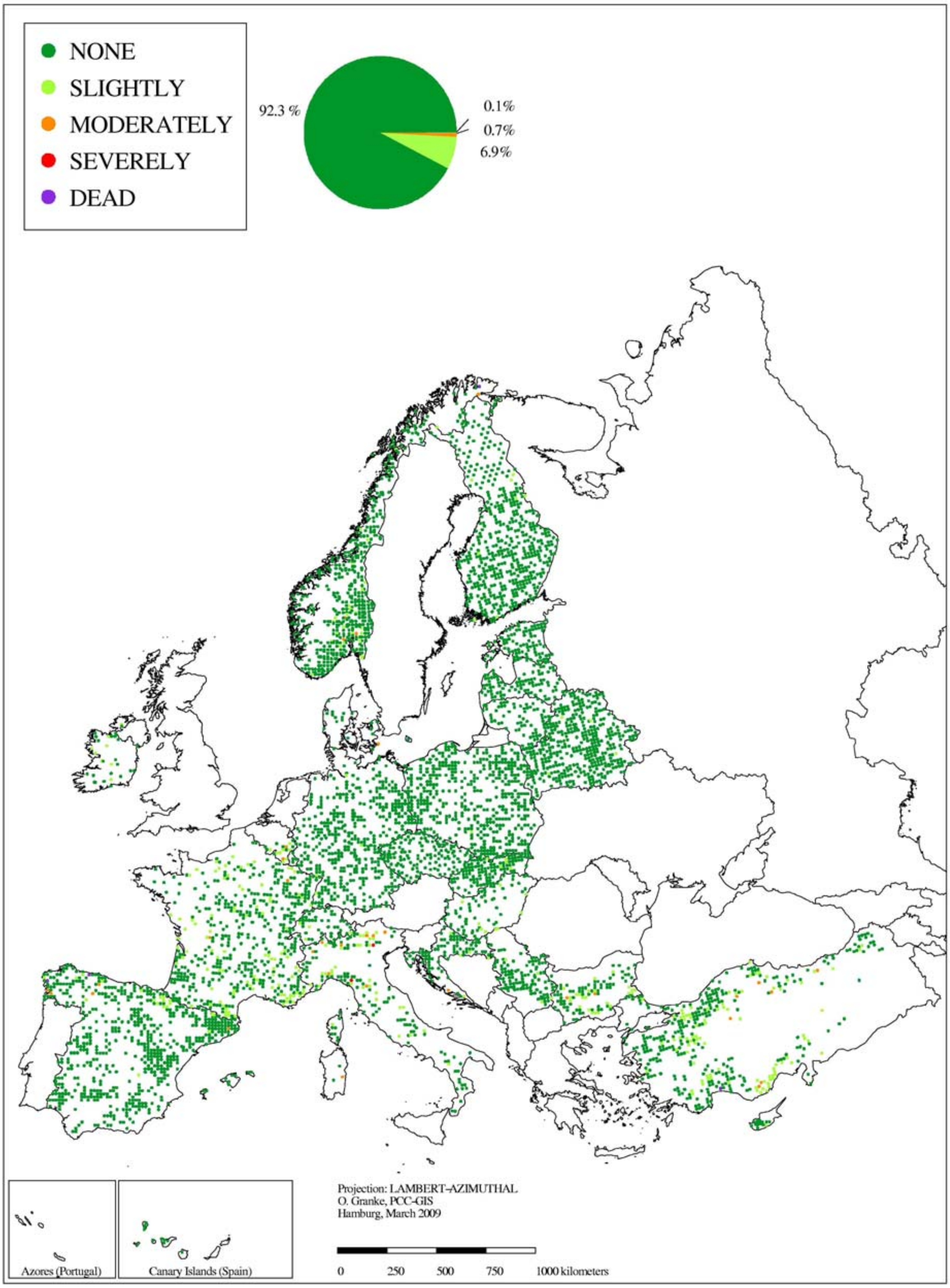
Annex I-5
Mean plot defoliation of all species (2008)

Note that some differences in the level of damage across national borders may be at least partly due to differences in standards used. This restriction however does not affect the reliability of the trends over time.

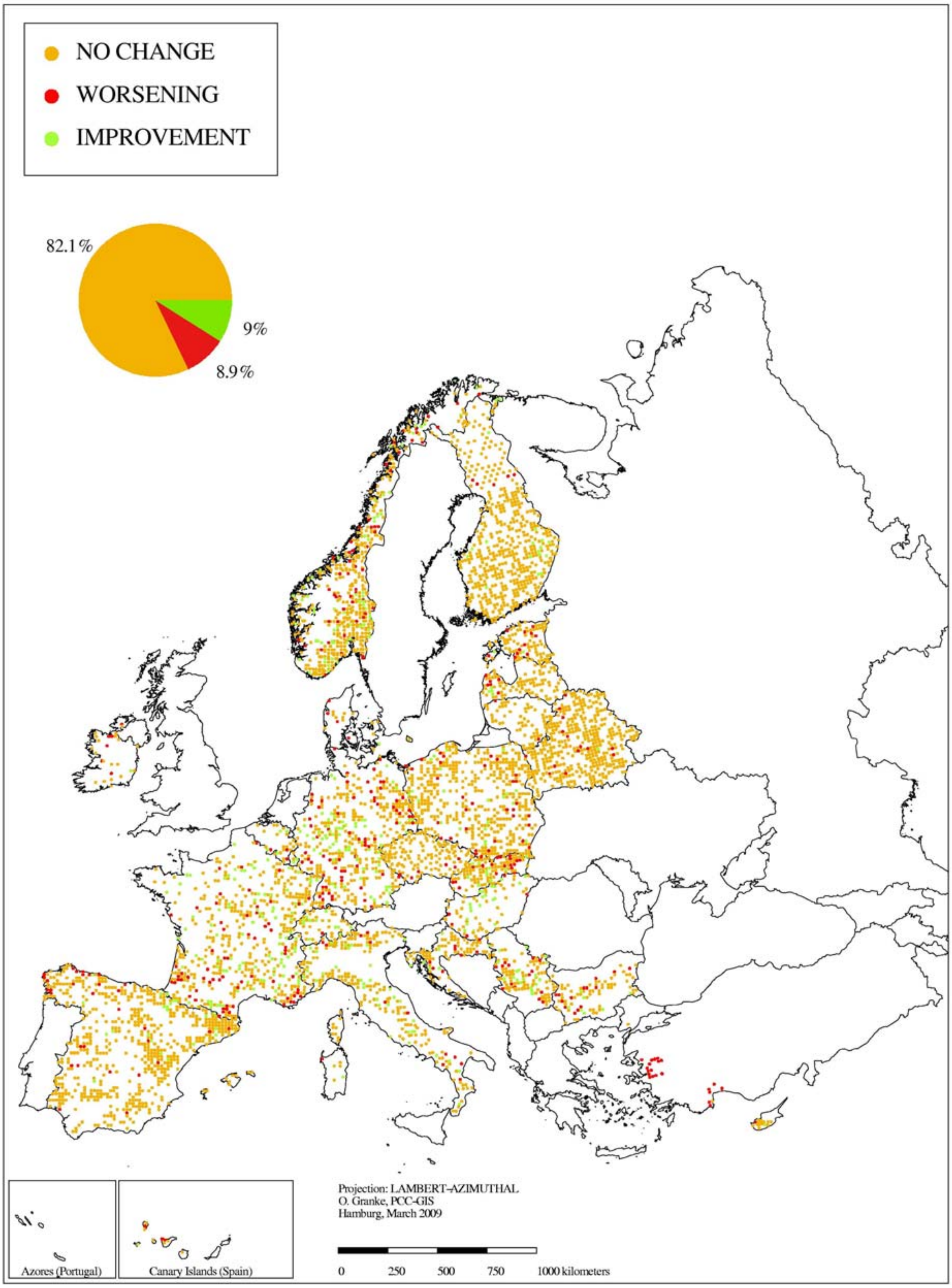


Annex I-6
Plot discolouration (2008)

Note that some differences in the level of damage across national borders may be at least partly due to differences in standards used. This restriction however does not affect the reliability of the trends over time.



Annex I-7
Changes in mean plot defoliation (2007-2008)



Annex I-8
Development of defoliation of most common species (1990-2008).

Picea abies

HEMIBOREAL NEMORAL	Number of trees	0-10%	>10-25%	>25%	ALPINE CONIFEROUS	Number of trees	0-10%	>10-25%	>25%
1990	965	34.5	45.2	20.3	1990	1459	16.5	30.8	52.7
1991	1048	37.0	42.1	20.9	1991	1452	12.2	47.2	40.6
1992	1075	33.5	45.6	20.9	1992	1429	15.9	44.1	40.0
1993	1075	31.2	46.0	22.8	1993	1396	8.1	38.4	53.5
1994	1030	37.7	36.7	25.6	1994	1396	9.7	38.9	51.4
1995	1090	35.9	37.8	26.3	1995	1466	10.0	35.5	54.5
1996	1095	30.2	44.3	25.5	1996	1468	14.3	45.0	40.7
1997	1090	33.0	44.2	22.8	1997	1429	12.0	40.4	47.6
1998	1103	35.1	45.0	19.9	1998	1484	13.6	43.9	42.5
1999	1101	31.7	47.4	20.9	1999	1457	15.5	39.3	45.2
2000	1133	29.7	43.9	26.4	2000	1507	16.1	39.6	44.3
2001	1133	28.8	47.1	24.1	2001	1491	11.9	48.6	39.5
2002	1130	28.9	51.0	20.1	2002	1491	9.0	51.3	39.7
2003	1136	24.9	52.0	23.1	2003	1540	7.5	53.8	38.7
2004	1118	23.3	49.1	27.6	2004	1516	4.9	52.2	42.9
2005	1146	25.7	50.1	24.2	2005	1527	9.0	51.1	39.9
2006	1108	33.4	44.1	22.5	2006	1446	5.0	51.9	43.1
2007	1087	27.0	47.2	25.8	2007	1470	5.6	52.0	42.4
2008	1084	24.8	44.7	30.5	2008	1446	4.3	53.0	42.7

MONTANE BEECH	Number of trees	0-10%	>10-25%	>25%	PLANTATIONS	Number of trees	0-10%	>10-25%	>25%
1990	102	21.6	27.5	50.9	1990	838	62.5	25.2	12.3
1991	106	15.1	46.2	38.7	1991	835	63.7	23.7	12.6
1992	104	16.3	45.2	38.5	1992	835	60.6	27.4	12.0
1993	104	11.5	34.6	53.9	1993	832	62.3	22.2	15.5
1994	104	22.1	29.8	48.1	1994	830	55.4	26.6	18.0
1995	109	16.5	35.8	47.7	1995	831	60.3	27.3	12.4
1996	109	12.8	37.6	49.6	1996	843	56.3	30.4	13.3
1997	108	25.0	38.9	36.1	1997	846	56.6	31.2	12.2
1998	100	23.0	43.0	34.0	1998	866	56.8	27.7	15.5
1999	100	23.0	47.0	30.0	1999	861	56.4	29.2	14.4
2000	99	26.3	43.4	30.3	2000	853	55.2	28.4	16.4
2001	99	24.2	42.5	33.3	2001	865	52.6	32.1	15.3
2002	98	25.5	43.9	30.6	2002	865	55.7	30.2	14.1
2003	124	25.0	39.5	35.5	2003	859	54.9	29.2	15.9
2004	114	28.1	31.6	40.3	2004	859	53.7	28.4	17.9
2005	111	21.6	39.7	38.7	2005	857	48.3	31.3	20.4
2006	108	35.2	25.0	39.8	2006	858	52.3	28.1	19.6
2007	100	22.0	37.0	41.0	2007	818	50.4	32.6	17.0
2008	104	23.1	39.4	37.5	2008	837	50.8	29.0	20.2

NOT YET CLASSIFIED	Number of trees	0-10%	>10-25%	>25%	ALL FOREST TYPES				
1990	2982	26.9	43.4	29.7	1990	6488	30.7	38.0	31.3
1991	3072	22.7	39.2	38.1	1991	6632	27.8	39.8	32.4
1992	3103	16.7	43.1	40.2	1992	6658	24.9	41.9	33.2
1993	3064	21.4	41.7	36.9	1993	6582	25.4	39.2	35.4
1994	3078	15.4	42.7	41.9	1994	6551	23.0	38.8	38.2
1995	3073	22.7	40.8	36.5	1995	6698	27.1	37.2	35.7
1996	3064	32.6	36.4	31.0	1996	6704	30.9	39.0	30.1
1997	3014	23.6	42.5	33.9	1997	6614	27.2	40.9	31.9
1998	4206	27.7	40.4	31.9	1998	7886	29.4	40.5	30.1
1999	4187	28.6	42.0	29.4	1999	7854	29.8	41.0	29.2
2000	4080	21.1	48.7	30.2	2000	7780	25.4	43.9	30.7
2001	3806	21.3	46.6	32.1	2001	7505	24.4	45.5	30.1
2002	3828	18.4	45.0	36.6	2002	7524	22.7	45.7	31.6
2003	3795	18.5	48.1	33.4	2003	7569	21.7	47.7	30.6
2004	3764	15.3	40.3	44.4	2004	7485	19.2	42.8	38.0
2005	3648	19.7	44.9	35.4	2005	7401	22.0	45.4	32.6
2006	714	43.7	34.6	21.7	2006	4344	29.3	41.7	29.0
2007	674	39.2	42.0	18.8	2007	4256	25.9	45.1	29.0
2008	647	35.2	42.7	22.1	2008	4217	24.3	44.1	31.6

Pinus sylvestris

BOREAL	Number of trees	0-10%	>10-25%	>25%	HEMIBOREAL NEMORAL	Number of trees	0-10%	>10-25%	>25%
1990	325	8.6	29.2	62.2	1990	1425	24.1	34.3	41.6
1991	325	3.1	32.0	64.9	1991	1620	20.7	33.6	45.7
1992	325	4.0	22.8	73.2	1992	1597	19.4	30.3	50.3
1993	325	8.0	24.3	67.7	1993	1622	16.5	40.1	43.4
1994	327	14.1	36.4	49.5	1994	1583	17.4	45.5	37.1
1995	307	17.6	58.0	24.4	1995	1573	22.6	50.1	27.3
1996	307	23.5	60.9	15.6	1996	1608	21.1	51.5	27.4
1997	307	17.9	64.2	17.9	1997	1591	25.3	53.5	21.2
1998	308	19.5	64.6	15.9	1998	1605	26.5	53.4	20.1
1999	328	16.8	64.0	19.2	1999	1669	23.7	60.4	15.9
2000	285	16.5	69.1	14.4	2000	1643	23.2	58.1	18.7
2001	319	17.6	73.9	8.5	2001	1665	23.2	59.0	17.8
2002	329	25.8	65.7	8.5	2002	1668	24.7	58.9	16.4
2003	328	21.0	73.2	5.8	2003	1667	26.2	58.6	15.2
2004	328	19.5	72.3	8.2	2004	1668	28.5	57.2	14.3
2005	329	11.9	73.5	14.6	2005	1655	24.3	59.6	16.1
2006	329	5.5	67.8	26.7	2006	1651	23.2	57.8	19.0
2007	329	8.2	68.7	23.1	2007	1647	24.1	59.3	16.6
2008	324	6.8	67.6	25.6	2008	1652	20.7	61.0	18.3
ALPINE CONIFEROUS	Number of trees	0-10%	>10-25%	>25%	MEDITERR. CONIFEROUS	Number of trees	0-10%	>10-25%	>25%
1990	368	57.3	18.2	24.5	1990	814	87.1	10.6	2.3
1991	367	49.9	39.2	10.9	1991	813	74.8	20.9	4.3
1992	364	21.2	51.1	27.7	1992	854	66.8	24.2	9.0
1993	358	12.6	50.8	36.6	1993	847	58.2	27.3	14.5
1994	338	13.6	45.9	40.5	1994	823	53.0	30.1	16.9
1995	353	13.3	57.8	28.9	1995	848	44.0	45.3	10.7
1996	357	20.2	63.8	16.0	1996	841	44.3	43.9	11.8
1997	345	27.8	62.6	9.6	1997	841	46.0	44.6	9.4
1998	346	40.8	49.7	9.5	1998	841	44.6	47.8	7.6
1999	344	41.0	48.0	11.0	1999	945	52.7	41.9	5.4
2000	360	30.6	60.0	9.4	2000	945	54.7	40.2	5.1
2001	359	24.0	59.3	16.7	2001	946	52.4	39.9	7.7
2002	363	17.1	49.8	33.1	2002	942	43.6	44.4	12.0
2003	402	8.0	59.4	32.6	2003	943	43.2	47.6	9.2
2004	401	9.7	70.3	20.0	2004	943	38.9	52.5	8.6
2005	399	11.3	68.4	20.3	2005	942	33.4	55.6	11.0
2006	398	12.8	64.8	22.4	2006	943	31.4	56.7	11.9
2007	402	10.9	71.2	17.9	2007	938	34.8	58.4	6.8
2008	395	13.4	67.4	19.2	2008	937	37.4	57.2	5.4
PLANTATIONS	Number of trees	0-10%	>10-25%	>25%	NOT YET CLASSIFIED	Number of trees	0-10%	>10-25%	>25%
1990	390	52.5	37.2	10.3	1990	7960	13.3	47.4	39.3
1991	395	47.1	35.4	17.5	1991	8011	7.2	46.4	46.4
1992	382	54.5	30.6	14.9	1992	8021	8.1	44.8	47.1
1993	389	44.5	41.9	13.6	1993	8044	9.3	44.5	46.2
1994	393	42.8	39.9	17.3	1994	7491	5.1	41.3	53.6
1995	393	42.3	38.9	18.8	1995	7318	7.8	41.9	50.3
1996	396	32.3	46.2	21.5	1996	7318	13.4	52.0	34.6
1997	396	36.4	45.4	18.2	1997	7309	12.1	55.2	32.7
1998	401	37.9	42.6	19.5	1998	7777	13.2	57.2	29.6
1999	449	42.1	41.4	16.5	1999	7770	12.7	60.7	26.6
2000	450	42.2	38.0	19.8	2000	7760	9.7	62.8	27.5
2001	452	37.2	48.0	14.8	2001	7727	9.9	63.6	26.5
2002	452	35.4	46.2	18.4	2002	7592	8.2	64.9	26.9
2003	451	37.0	48.8	14.2	2003	7602	7.8	64.6	27.6
2004	452	37.4	49.3	13.3	2004	7643	7.1	62.5	30.4
2005	452	38.9	49.2	11.9	2005	7604	11.7	57.7	30.6
2006	451	39.2	48.4	12.4	2006	4435	21.7	57.1	21.2
2007	452	40.5	50.2	9.3	2007	5188	19.7	59.3	21.0
2008	448	40.2	45.5	14.3	2008	5106	19.3	62.4	18.3

Pinus sylvestris

ALL FOREST TYPES	Number of trees	0-10%	>10-25%	>25%
1990	11486	22.5	41.4	36.1
1991	11733	16.6	41.7	41.7
1992	11743	15.9	40.3	43.8
1993	11780	15.3	41.9	42.8
1994	11148	12.4	40.9	46.7
1995	10970	14.5	44.3	41.2
1996	11012	18.2	51.5	30.3
1997	10970	18.3	54.2	27.5
1998	11463	19.6	55.1	25.3
1999	11697	19.8	57.8	22.4
2000	11618	17.5	59.3	23.2
2001	11644	17.1	60.4	22.5
2002	11519	15.5	60.9	23.6
2003	11558	15.1	61.5	23.4
2004	11590	14.6	60.9	24.5
2005	11534	16.5	58.2	25.3
2006	8358	23.1	57.4	19.5
2007	9110	22.3	59.5	18.2
2008	9012	21.8	61.1	17.1

Fagus sylvatica

ALPINE CONIFEROUS	Number of trees	0-10%	>10-25%	>25%	BEECH	Number of trees	0-10%	>10-25%	>25%
1990	141	34.0	46.9	19.1	1990	1976	32.8	44.1	23.1
1991	141	38.3	50.4	11.3	1991	2004	45.7	39.8	14.5
1992	140	24.3	46.4	29.3	1992	2042	36.5	41.9	21.6
1993	143	24.5	44.7	30.8	1993	2028	36.8	40.1	23.1
1994	136	18.4	39.0	42.6	1994	1999	28.4	45.3	26.3
1995	150	22.0	46.7	31.3	1995	2015	25.1	43.9	31.0
1996	152	27.0	38.8	34.2	1996	1991	23.3	50.8	25.9
1997	150	26.7	51.3	22.0	1997	2030	28.1	50.7	21.2
1998	143	36.4	48.9	14.7	1998	2083	31.0	47.1	21.9
1999	138	39.9	44.9	15.2	1999	2160	26.3	51.8	21.9
2000	157	48.4	42.7	8.9	2000	2178	30.2	46.9	22.9
2001	156	19.2	45.5	35.3	2001	2196	24.4	49.6	26.0
2002	160	34.4	51.8	13.8	2002	2196	28.8	51.3	19.9
2003	168	19.6	51.2	29.2	2003	2190	23.4	51.9	24.7
2004	162	17.3	64.2	18.5	2004	2184	22.0	49.1	28.9
2005	162	22.8	66.1	11.1	2005	2185	25.1	50.0	24.9
2006	156	16.7	67.9	15.4	2006	2139	25.7	46.9	27.4
2007	159	15.1	69.2	15.7	2007	2186	23.9	54.7	21.4
2008	161	9.9	71.5	18.6	2008	2188	25.1	51.8	23.1
MONTANE BEECH	Number of trees	0-10%	>10-25%	>25%	NOT YET CLASSIFIED	Number of trees	0-10%	>10-25%	>25%
1990	743	49.4	39.2	11.4	1990	991	36.4	43.2	20.4
1991	749	50.1	37.5	12.4	1991	1001	24.8	44.6	30.6
1992	725	41.2	41.6	17.2	1992	1015	15.2	45.2	39.6
1993	751	39.4	41.6	19.0	1993	1011	23.9	46.5	29.6
1994	665	33.5	49.5	17.0	1994	970	21.0	44.2	34.8
1995	785	30.4	45.8	23.8	1995	996	23.7	41.1	35.2
1996	791	26.4	54.5	19.1	1996	995	29.8	46.8	23.4
1997	805	17.8	57.9	24.3	1997	1001	25.2	49.6	25.2
1998	816	28.6	56.2	15.2	1998	1197	28.0	47.4	24.6
1999	883	21.5	62.8	15.7	1999	1202	20.2	52.9	26.9
2000	905	35.8	51.7	12.5	2000	1207	22.6	47.8	29.6
2001	908	27.8	54.1	18.1	2001	1192	23.0	46.4	30.6
2002	897	22.0	64.7	13.3	2002	1206	26.9	46.2	26.9
2003	912	19.5	56.3	24.2	2003	1218	25.4	44.4	30.2
2004	914	18.2	58.3	23.5	2004	1245	14.8	41.2	44.0
2005	902	20.0	58.8	21.2	2005	1269	19.1	43.9	37.0
2006	910	21.5	51.4	27.1	2006	442	48.6	35.3	16.1
2007	913	13.4	61.6	25.0	2007	487	35.7	44.8	19.5
2008	920	25.1	56.9	18.0	2008	459	41.4	43.1	15.5

Fagus sylvatica

ALL FOREST TYPES	Number of trees	0-10%	>10-25%	>25%
1990	4015	37.0	43.0	20.0
1991	4064	40.9	41.2	17.9
1992	4091	31.4	42.8	25.8
1993	4109	33.6	42.0	24.4
1994	3948	27.0	45.4	27.6
1995	4127	25.9	44.0	30.1
1996	4092	26.2	49.9	23.9
1997	4163	25.8	51.6	22.6
1998	4417	30.2	48.7	21.1
1999	4568	24.1	53.9	22.0
2000	4637	29.7	47.8	22.5
2001	4640	25.0	49.2	25.8
2002	4649	27.6	52.3	20.1
2003	4678	23.9	50.0	26.1
2004	4694	19.4	48.5	32.1
2005	4720	22.7	50.4	26.9
2006	3844	26.8	47.5	25.7
2007	3941	22.7	55.6	21.7
2008	3933	27.1	52.3	20.6

Quercus ilex **and** ***Q. rotundifolia***

EVERGREEN BROADLEAVED	Number of trees	0-10%	>10-25%	>25%	MEDITERR. CONIFEROUS	Number of trees	0-10%	>10-25%	>25%
1990	2160	77.2	20.2	2.6	1990	121	79.3	18.2	2.5
1991	2184	55.7	40.4	3.9	1991	119	71.4	26.1	2.5
1992	2209	40.8	51.1	8.1	1992	119	59.6	30.3	10.1
1993	2209	35.4	58.0	6.6	1993	119	33.6	57.2	9.2
1994	2185	26.8	59.8	13.4	1994	117	14.5	50.5	35.0
1995	2227	14.2	53.7	32.1	1995	107	11.2	45.8	43.0
1996	2226	14.9	56.7	28.4	1996	105	21.0	45.7	33.3
1997	2227	21.4	61.8	16.8	1997	105	32.4	49.5	18.1
1998	2227	31.3	56.5	12.2	1998	97	35.1	53.6	11.3
1999	3013	21.8	57.6	20.6	1999	102	24.5	52.0	23.5
2000	3051	19.3	60.4	20.3	2000	95	22.1	67.4	10.5
2001	3053	19.4	66.9	13.7	2001	95	21.1	58.9	20.0
2002	3053	15.5	66.1	18.4	2002	99	17.2	64.6	18.2
2003	3053	14.3	66.0	19.7	2003	100	11.0	69.0	20.0
2004	3053	18.6	66.1	15.3	2004	96	12.5	65.6	21.9
2005	3055	8.6	66.6	24.8	2005	99	12.1	53.6	34.3
2006	3057	7.7	68.9	23.4	2006	100	12.0	59.0	29.0
2007	3059	8.7	73.1	18.2	2007	98	9.2	64.3	26.5
2008	3062	11.4	72.6	16.0	2008	99	8.1	73.7	18.2

ALL FOREST TYPES	Number of trees	0-10%	>10-25%	>25%
1990	2392	77.1	20.4	2.5
1991	2373	56.8	39.4	3.8
1992	2398	41.4	50.4	8.2
1993	2397	34.8	58.6	6.6
1994	2371	25.7	58.8	15.5
1995	2396	13.8	53.4	32.8
1996	2379	15.2	56.5	28.3
1997	2380	22.1	61.2	16.7
1998	2372	31.5	56.4	12.1
1999	3166	21.9	57.5	20.6
2000	3196	19.3	60.8	19.9
2001	3197	19.4	66.7	13.9
2002	3201	15.7	65.8	18.5
2003	3202	14.1	66.1	19.8
2004	3198	18.3	66.2	15.5
2005	3204	8.7	66.2	25.1
2006	3210	7.9	68.5	23.6
2007	3212	8.7	72.8	18.5
2008	3224	11.3	72.5	16.2

Pinus pinaster

MEDITERR. CONIFEROUS	Number of trees	0-10%	>10-25%	>25%
1990	784	79.8	16.8	3.4
1991	759	66.7	26.6	6.7
1992	805	67.5	26.0	6.5
1993	805	62.0	32.8	5.2
1994	806	54.8	36.0	9.2
1995	806	50.0	41.3	8.7
1996	805	50.8	36.9	12.3
1997	820	55.3	34.8	9.9
1998	818	53.6	36.3	10.1
1999	1309	54.3	34.9	10.8
2000	1310	55.9	33.1	11.0
2001	1300	49.9	45.3	4.8
2002	1297	42.3	51.5	6.2
2003	1292	35.8	56.3	7.9
2004	1292	38.3	49.7	12.0
2005	1306	33.8	54.1	12.1
2006	1310	32.3	56.3	11.4
2007	1307	35.0	55.4	9.6
2008	1286	36.6	55.5	7.9

PLANTATIONS	Number of trees	0-10%	>10-25%	>25%
1990	125	69.6	19.2	11.2
1991	120	71.7	20.8	7.5
1992	120	53.3	15.0	31.7
1993	120	55.9	25.8	18.3
1994	120	58.3	20.0	21.7
1995	117	39.3	53.9	6.8
1996	117	19.7	61.5	18.8
1997	106	30.2	50.0	19.8
1998	106	32.1	44.3	23.6
1999	172	20.9	70.4	8.7
2000	174	13.2	62.7	24.1
2001	167	34.1	49.7	16.2
2002	168	28.0	43.4	28.6
2003	144	34.7	48.6	16.7
2004	143	17.5	53.1	29.4
2005	134	23.1	51.5	25.4
2006	133	21.8	57.1	21.1
2007	134	20.9	58.2	20.9
2008	137	21.2	59.1	19.7

ALL FOREST TYPES	Number of trees	0-10%	>10-25%	>25%
1990	966	78.5	17.0	4.5
1991	936	66.7	25.6	7.7
1992	981	66.1	24.3	9.6
1993	980	60.3	30.7	9.0
1994	959	55.9	33.2	10.9
1995	953	49.8	41.9	8.3
1996	952	47.2	39.6	13.2
1997	951	53.0	36.3	10.7
1998	949	51.4	37.2	11.4
1999	1508	50.7	39.0	10.3
2000	1511	51.0	36.4	12.6
2001	1494	48.2	45.7	6.1
2002	1492	40.9	50.5	8.6
2003	1463	35.2	55.0	9.8
2004	1454	36.2	50.0	13.8
2005	1462	32.9	53.9	13.2
2006	1465	31.3	56.5	12.2
2007	1462	33.6	55.6	10.8
2008	1441	35.0	56.1	8.9

Quercus suber

EVERGREEN BROADLEAVED	Number of trees	0-10%	>10-25%	>25%
990	211	82.0	16.6	1.4
1991	187	72.2	25.1	2.7
1992	253	44.3	51.4	4.3
1993	253	41.9	54.1	4.0
1994	253	22.5	46.7	30.8
1995	253	2.8	28.9	68.3
1996	253	17.8	49.4	32.8
1997	253	15.4	66.4	18.2
1998	253	21.7	61.7	16.6
1999	353	17.3	65.1	17.6
2000	375	13.3	71.5	15.2
2001	374	19.3	59.3	21.4
2002	373	11.5	67.9	20.6
2003	373	7.2	69.2	23.6
2004	388	9.8	73.4	16.8
2005	388	3.6	68.3	28.1
2006	388	4.6	69.9	25.5
2007	388	10.6	71.6	17.8
2008	388	10.6	70.8	18.6

ALL FOREST TYPES	Number of trees	0-10%	>10-25%	>25%
1990	273	83.1	15.4	1.5
1991	248	72.6	25.0	2.4
1992	315	48.9	46.7	4.4
1993	268	41.8	53.7	4.5
1994	268	22.4	46.6	31.0
1995	268	2.6	31.3	66.1
1996	269	16.7	51.0	32.3
1997	269	14.9	66.9	18.2
1998	269	21.2	62.1	16.7
1999	369	16.5	65.3	18.2
2000	391	13.0	70.6	16.4
2001	392	18.6	59.2	22.2
2002	392	11.0	68.1	20.9
2003	392	6.9	67.1	26.0
2004	407	9.3	71.3	19.4
2005	397	3.5	67.5	29.0
2006	394	4.6	69.0	26.4
2007	394	10.4	71.3	18.3
2008	403	10.9	70.5	18.6

Quercus robur and ***Q. petraea***

ACIDOPH. OAK	Number of trees	0-10%	>10-25%	>25%
1990	191	63.9	13.6	22.5
1991	192	53.1	18.8	28.1
1992	170	43.6	37.6	18.8
1993	171	48.0	34.5	17.5
1994	171	47.9	39.8	12.3
1995	187	44.9	42.8	12.3
1996	186	33.3	47.3	19.4
1997	187	41.2	52.4	6.4
1998	187	44.4	46.5	9.1
1999	232	43.1	51.3	5.6
2000	231	39.8	52.4	7.8
2001	231	26.4	61.9	11.7
2002	231	21.2	70.1	8.7
2003	231	19.9	69.3	10.8
2004	231	19.5	61.5	19.0
2005	231	18.2	66.6	15.2
2006	231	23.8	62.3	13.9
2007	231	19.5	63.2	17.3
2008	231	24.2	68.0	7.8

MESOPH. DECIDUOUS	Number of trees	0-10%	>10-25%	>25%
1990	923	28.6	37.2	34.2
1991	936	26.0	42.6	31.4
1992	930	20.3	48.2	31.5
1993	934	15.0	46.2	38.8
1994	892	13.2	41.9	44.9
1995	949	13.3	45.0	41.7
1996	954	11.1	44.3	44.6
1997	983	14.0	44.4	41.6
1998	1016	13.0	42.7	44.3
1999	1029	17.0	52.9	30.1
2000	1033	16.7	56.9	26.4
2001	1029	16.3	54.7	29.0
2002	1030	18.5	52.0	29.5
2003	1044	11.6	54.5	33.9
2004	1083	16.1	50.1	33.8
2005	1075	17.2	48.4	34.4
2006	1066	19.3	48.3	32.4
2007	1063	17.3	52.4	30.3
2008	1069	15.2	51.6	33.2

BEECH	Number of trees	0-10%	>10-25%	>25%
1990	161	30.4	39.2	30.4
1991	150	31.3	37.4	31.3
1992	151	21.9	52.9	25.2
1993	153	17.6	36.6	45.8
1994	140	11.4	51.5	37.1
1995	143	10.5	46.8	42.7
1996	143	6.3	34.3	59.4
1997	144	9.7	31.9	58.4
1998	143	10.5	43.4	46.1
1999	153	5.2	28.1	66.7
2000	159	5.0	43.4	51.6
2001	160	6.9	45.0	48.1
2002	160	19.4	40.0	40.6
2003	156	13.5	42.3	44.2
2004	161	18.0	41.0	41.0
2005	161	9.9	42.9	47.2
2006	158	16.5	43.6	39.9
2007	162	13.0	42.6	44.4
2008	157	9.6	35.7	54.7

NOT YET CLASSIFIED	Number of trees	0-10%	>10-25%	>25%
1990	1101	32.5	47.5	20.0
1991	1109	16.9	48.5	34.6
1992	1102	13.0	49.0	38.0
1993	1100	11.1	38.8	50.1
1994	1107	7.5	32.1	60.4
1995	1105	9.9	36.7	53.4
1996	1078	12.5	38.2	49.3
1997	1072	13.0	39.8	47.2
1998	1149	16.1	40.3	43.6
1999	1159	15.6	47.1	37.3
2000	1153	13.9	46.6	39.5
2001	1160	14.2	47.0	38.8
2002	1168	14.4	48.5	37.1
2003	1173	12.0	48.6	39.4
2004	1179	10.9	42.6	46.5
2005	1209	12.6	42.1	45.3
2006	614	23.5	50.3	26.2
2007	761	22.2	52.6	25.2
2008	854	18.4	60.9	20.7

ALL FOREST TYPES	Number of trees	0-10%	>10-25%	>25%
1990	2539	34.2	39.7	26.1
1991	2549	25.1	42.6	32.3
1992	2518	20.1	47.0	32.9
1993	2524	17.1	41.0	41.9
1994	2468	14.1	37.8	48.1
1995	2552	15.6	40.9	43.5
1996	2528	14.7	41.1	44.2
1997	2560	16.6	42.5	40.9
1998	2673	17.7	42.3	40.0
1999	2748	19.3	48.2	32.5
2000	2749	18.3	50.5	31.2
2001	2759	16.8	51.5	31.7
2002	2769	18.4	51.0	30.6
2003	2783	13.7	52.6	33.7
2004	2878	15.5	46.7	37.8
2005	2901	16.4	46.8	36.8
2006	2298	23.4	49.2	27.4
2007	2448	20.3	52.8	26.9
2008	2551	19.0	54.6	26.4

Abies alba

ALPINE CONIFEROUS	Number of trees	0-10%	>10-25%	>25%
1990	362	21.8	24.6	53.6
1991	370	24.1	31.6	44.3
1992	372	16.1	38.2	45.7
1993	370	13.0	27.3	59.7
1994	367	15.8	34.6	49.6
1995	391	13.6	34.8	51.6
1996	397	11.6	32.5	55.9
1997	390	13.3	36.9	49.8
1998	353	19.0	35.4	45.6
1999	359	15.9	40.4	43.7
2000	391	19.9	39.9	40.2
2001	386	18.1	42.3	39.6
2002	436	15.6	47.5	36.9
2003	439	13.4	45.8	40.8
2004	438	13.7	47.5	38.8
2005	442	19.2	51.4	29.4
2006	441	18.4	41.9	39.7
2007	442	14.7	54.8	30.5
2008	439	13.2	49.0	37.8

NOT YET CLASSIFIED	Number of trees	0-10%	>10-25%	>25%
1990	332	6.9	31.9	61.2
1991	330	4.5	24.8	70.7
1992	329	8.8	25.5	65.7
1993	329	3.6	29.2	67.2
1994	329	5.8	27.7	66.5
1995	332	7.5	31.0	61.5
1996	332	9.9	37.3	52.8
1997	323	7.7	39.6	52.7
1998	381	8.9	35.4	55.7
1999	375	8.3	36.5	55.2
2000	353	4.2	37.4	58.4
2001	339	5.9	27.7	66.4
2002	378	11.1	31.0	57.9
2003	382	8.6	33.0	58.4
2004	391	11.0	35.0	54.0
2005	388	15.7	39.4	44.9
2006	241	33.6	43.2	23.2
2007	248	33.1	46.3	20.6
2008	235	38.3	41.3	20.4

ALL FOREST TYPES	Number of trees	0-10%	>10-25%	>25%
1990	748	15.6	28.9	55.5
1991	761	16.0	28.6	55.4
1992	761	13.8	32.9	53.3
1993	757	9.5	29.2	61.3
1994	756	12.4	31.2	56.4
1995	785	11.1	34.1	54.8
1996	795	11.8	35.0	53.2
1997	780	11.4	39.4	49.2
1998	802	14.6	36.8	48.6
1999	804	12.9	39.6	47.5
2000	816	13.0	39.5	47.5
2001	792	13.0	37.4	49.6
2002	883	14.7	40.5	44.8
2003	897	11.9	41.5	46.6
2004	902	12.6	42.5	44.9
2005	910	17.7	47.2	35.1
2006	763	24.8	41.4	33.8
2007	776	22.0	51.8	26.2
2008	758	22.7	45.1	32.2

Picea sitchensis

PLANTATIONS	Number of trees	0-10%	>10-25%	>25%
1990	226	56.7	29.6	13.7
1991	218	38.5	32.6	28.9
1992	218	41.3	28.0	30.7
1993	218	32.6	24.8	42.6
1994	197	31.0	38.5	30.5
1995	190	34.7	32.1	33.2
1996	197	51.3	28.4	20.3
1997	201	60.2	24.4	15.4
1998	224	54.0	27.2	18.8
1999	202	72.3	16.8	10.9
2000	205	70.3	19.0	10.7
2001	219	65.7	19.2	15.1
2002	222	51.8	30.6	17.6
2003	222	62.2	26.1	11.7
2004	227	58.1	22.5	19.4
2005	228	61.9	21.9	16.2
2006	229	68.2	21.8	10.0
2007	230	70.0	17.0	13.0
2008	228	71.9	11.0	17.1

ALL FOREST TYPES	Number of trees	0-10%	>10-25%	>25%
1990	312	60.9	29.2	9.9
1991	302	47.0	30.5	22.5
1992	303	45.5	31.4	23.1
1993	304	31.6	30.6	37.8
1994	283	35.7	39.9	24.4
1995	276	38.4	34.8	26.8
1996	282	53.2	29.1	17.7
1997	286	61.5	25.2	13.3
1998	288	51.7	29.5	18.8
1999	266	72.9	16.2	10.9
2000	268	66.0	22.4	11.6
2001	261	62.5	22.2	15.3
2002	264	50.4	31.4	18.2
2003	243	62.1	27.2	10.7
2004	248	61.3	21.0	17.7
2005	249	63.8	21.3	14.9
2006	313	75.8	16.9	7.3
2007	437	79.2	12.6	8.2
2008	464	77.0	9.9	13.1

All species

BOREAL	Number of trees	0-10%	>10-25%	>25%
1990	408	15.7	30.1	54.2
1991	408	10.3	34.6	55.1
1992	408	7.4	28.7	63.9
1993	408	11.8	29.7	58.5
1994	409	16.4	40.3	43.3
1995	385	23.4	54.3	22.3
1996	384	27.6	57.0	15.4
1997	384	22.1	60.7	17.2
1998	385	24.4	60.0	15.6
1999	409	20.5	60.9	18.6
2000	360	16.4	64.7	18.9
2001	397	19.4	70.3	10.3
2002	410	26.8	64.7	8.5
2003	409	22.2	71.0	6.8
2004	409	21.8	68.9	9.3
2005	411	15.3	69.9	14.8
2006	411	11.2	65.4	23.4
2007	410	12.2	68.0	19.8
2008	399	9.0	68.7	22.3

HEMIBOREAL NEMORAL	Number of trees	0-10%	>10-25%	>25%
1990	2587	29.4	38.9	31.7
1991	2914	28.2	37.1	34.7
1992	2917	25.8	36.9	37.3
1993	2942	23.4	42.4	34.2
1994	2848	26.1	42.0	31.9
1995	2917	28.7	44.8	26.5
1996	2968	25.6	48.2	26.2
1997	2946	29.5	49.1	21.4
1998	2982	30.8	49.2	20.0
1999	3042	26.7	55.2	18.1
2000	3063	25.5	52.0	22.5
2001	3083	25.6	54.2	20.2
2002	3087	26.6	55.7	17.7
2003	3089	25.4	56.2	18.4
2004	3061	26.0	54.0	20.0
2005	3092	25.4	55.0	19.6
2006	3064	28.2	51.6	20.2
2007	3040	26.4	53.7	19.9
2008	3064	24.1	53.3	22.6

ALPINE CONIFEROUS	Number of trees	0-10%	>10-25%	>25%
1990	2593	27.2	28.9	43.9
1991	2593	24.8	43.0	32.2
1992	2568	19.5	44.6	35.9
1993	2529	12.5	39.0	48.5
1994	2495	12.7	39.7	47.6
1995	2648	13.0	40.5	46.5
1996	2666	17.4	46.4	36.2
1997	2600	16.8	44.9	38.3
1998	2626	21.3	44.7	34.0
1999	2590	21.8	42.5	35.7
2000	2715	21.3	44.7	34.0
2001	2693	15.4	50.5	34.1
2002	2761	13.1	51.5	35.4
2003	2872	9.9	54.6	35.5
2004	2827	8.3	56.4	35.3
2005	2852	12.5	56.1	31.4
2006	2755	10.2	54.9	34.9
2007	2796	8.8	58.8	32.4
2008	2756	8.1	57.6	34.3

ACIDOPH. OAK	Number of trees	0-10%	>10-25%	>25%
1990	265	64.9	15.5	19.6
1991	265	59.2	16.6	24.2
1992	241	47.3	34.0	18.7
1993	241	51.4	32.8	15.8
1994	241	49.3	40.7	10.0
1995	265	49.1	41.1	9.8
1996	265	36.2	48.0	15.8
1997	265	46.0	48.7	5.3
1998	265	45.6	45.6	8.7
1999	313	44.1	50.5	5.4
2000	313	39.9	50.8	9.3
2001	313	30.0	59.5	10.5
2002	313	21.7	70.3	8.0
2003	313	18.5	70.6	10.9
2004	313	20.8	62.3	16.9
2005	313	18.5	67.1	14.4
2006	313	21.4	65.2	13.4
2007	313	18.8	63.3	17.9
2008	313	22.4	68.3	9.3

MESOPH. DECIDUOUS	Number of trees	0-10%	>10-25%	>25%
1990	1721	32.8	34.0	33.2
1991	1678	31.0	39.4	29.6
1992	1701	28.4	42.4	29.2
1993	1684	23.2	42.1	34.7
1994	1641	20.2	39.2	40.6
1995	1761	21.4	44.0	34.6
1996	1766	20.9	45.0	34.1
1997	1831	28.4	42.3	29.3
1998	1896	27.3	39.9	32.8
1999	1957	28.8	46.6	24.6
2000	1962	30.2	49.2	20.6
2001	1941	27.5	47.2	25.3
2002	1964	25.8	48.9	25.3
2003	1956	21.5	49.6	28.9
2004	2025	24.6	46.1	29.3
2005	2020	27.7	45.0	27.3
2006	2014	25.4	44.5	30.1
2007	2007	23.6	48.1	28.3
2008	2010	24.1	46.7	29.2

BEECH	Number of trees	0-10%	>10-25%	>25%
1990	2594	31.8	44.2	24.0
1991	2616	44.1	39.6	16.3
1992	2667	34.8	41.7	23.5
1993	2654	34.0	39.8	26.2
1994	2597	27.3	44.4	28.3
1995	2645	23.7	44.4	31.9
1996	2618	22.6	49.6	27.8
1997	2646	27.4	50.1	22.5
1998	2696	30.5	46.7	22.8
1999	2778	25.7	50.8	23.5
2000	2794	30.0	47.2	22.8
2001	2816	23.7	49.8	26.5
2002	2807	28.9	50.2	20.9
2003	2794	22.1	52.1	25.8
2004	2779	21.5	49.2	29.3
2005	2779	24.1	50.0	25.9
2006	2725	24.7	47.9	27.4
2007	2773	21.7	55.6	22.7
2008	2759	23.3	51.7	25.0

All species

MONTANE BEECH	Number of trees	0-10%	>10-25%	>25%	THERMOPH. DECIDUOUS	0-10%	>10-25%	>25%	0-10%
1990	998	45.8	37.5	16.7	1990	1431	74.0	19.2	6.8
1991	1012	44.2	36.7	19.1	1991	1437	58.9	32.2	8.9
1992	986	37.5	41.3	21.2	1992	1487	38.1	47.7	14.2
1993	1004	35.2	41.4	23.4	1993	1492	34.7	47.9	17.4
1994	910	32.7	46.6	20.7	1994	1495	34.7	42.2	23.1
1995	1053	29.4	44.7	25.9	1995	1533	27.5	45.0	27.5
1996	1060	25.3	51.4	23.3	1996	1516	32.2	53.9	13.9
1997	1077	19.6	55.7	24.7	1997	1504	40.4	50.0	9.6
1998	1078	28.4	54.1	17.5	1998	1532	44.5	44.5	11.0
1999	1147	23.1	59.2	17.7	1999	1787	40.2	47.7	12.1
2000	1171	35.3	50.0	14.7	2000	1792	36.5	52.1	11.4
2001	1172	28.2	51.6	20.2	2001	1775	31.1	55.1	13.8
2002	1157	22.8	60.8	16.4	2002	1774	28.1	55.8	16.1
2003	1207	21.4	54.4	24.2	2003	1778	24.7	56.3	19.0
2004	1198	20.7	54.2	25.1	2004	1787	22.6	57.5	19.9
2005	1177	21.4	56.4	22.2	2005	1786	25.3	56.2	18.5
2006	1184	24.2	48.4	27.4	2006	1787	21.7	56.1	22.2
2007	1186	15.6	58.9	25.5	2007	1786	18.3	64.1	17.6
2008	1203	25.9	53.0	21.1	2008	1785	23.0	58.5	18.5
EVERGREEN BROADLEAVED	Number of trees	0-10%	>10-25%	>25%	MEDITERR. CONIFEROUS				
1990	2712	77.0	19.6	3.4	1990	4608	77.8	18.0	4.2
1991	2712	58.1	37.3	4.6	1991	4558	67.1	25.7	7.2
1992	2808	42.2	49.0	8.8	1992	4728	54.6	31.7	13.7
1993	2808	36.0	55.4	8.6	1993	4704	48.7	38.8	12.5
1994	2784	26.5	56.4	17.1	1994	4656	42.0	39.2	18.8
1995	2808	14.1	50.3	35.6	1995	4704	29.0	50.8	20.2
1996	2808	15.8	55.7	28.5	1996	4704	31.3	48.8	19.9
1997	2808	20.8	61.5	17.7	1997	4680	36.7	50.7	12.6
1998	2808	29.6	56.6	13.8	1998	4704	38.3	48.8	12.9
1999	3792	21.6	58.0	20.4	1999	6168	39.8	49.5	10.7
2000	3840	18.8	61.1	20.1	2000	6288	38.1	50.8	11.1
2001	3840	19.3	65.2	15.5	2001	6288	32.5	55.3	12.2
2002	3840	15.5	65.8	18.7	2002	6288	27.7	57.3	15.0
2003	3840	13.6	66.1	20.3	2003	6288	25.9	60.0	14.1
2004	3840	17.5	66.7	15.8	2004	6288	26.8	59.3	13.9
2005	3840	8.4	65.9	25.7	2005	6288	18.0	60.9	21.1
2006	3840	7.6	67.4	25.0	2006	6288	19.1	60.7	20.2
2007	3840	8.6	72.1	19.3	2007	6288	20.2	63.9	15.9
2008	3840	10.9	72.0	17.1	2008	6288	21.1	65.7	13.2
FLOODPLAIN FORESTS	Number of trees	0-10%	>10-25%	>25%	ALDER. BIRCH. ASPEN	0-10%	>10-25%	>25%	0-10%
1990	65	63.0	18.5	18.5	1990	619	61.2	24.1	14.7
1991	66	56.1	22.7	21.2	1991	695	52.9	30.4	16.7
1992	66	57.5	16.7	25.8	1992	693	43.9	33.9	22.2
1993	68	58.8	20.6	20.6	1993	695	49.5	31.1	19.4
1994	69	60.9	21.7	17.4	1994	695	58.5	31.9	9.6
1995	69	62.4	24.6	13.0	1995	695	68.2	24.6	7.2
1996	47	44.7	38.3	17.0	1996	716	57.8	32.7	9.5
1997	71	21.1	49.3	29.6	1997	717	53.6	39.7	6.7
1998	71	39.5	38.0	22.5	1998	697	52.3	40.5	7.2
1999	96	54.2	25.0	20.8	1999	745	51.4	38.8	9.8
2000	96	52.1	32.3	15.6	2000	746	34.3	47.2	18.5
2001	96	44.8	46.9	8.3	2001	770	39.0	48.9	12.1
2002	96	54.2	35.4	10.4	2002	760	38.2	50.6	11.2
2003	96	55.2	31.3	13.5	2003	759	34.8	54.3	10.9
2004	168	47.1	33.9	19.0	2004	805	36.5	51.6	11.9
2005	168	54.2	32.7	13.1	2005	805	41.6	47.1	11.3
2006	168	65.4	29.2	5.4	2006	806	42.1	45.4	12.5
2007	168	48.8	29.8	21.4	2007	806	31.9	51.8	16.3
2008	168	63.1	29.8	7.1	2008	807	31.8	51.8	16.4

All species

PLANTATIONS	Number of trees	0-10%	>10-25%	>25%
1990	3192	64.4	21.5	14.1
1991	3120	61.7	23.4	14.9
1992	3310	60.1	22.5	17.4
1993	3328	56.8	25.6	17.6
1994	3259	51.5	28.4	20.1
1995	3315	54.4	28.2	17.4
1996	3194	53.3	31.0	15.7
1997	3286	54.6	30.2	15.2
1998	3405	52.5	28.8	18.7
1999	4110	59.1	29.3	11.6
2000	4160	53.1	29.5	17.4
2001	4184	49.5	36.0	14.5
2002	4240	46.0	37.4	16.6
2003	4238	45.8	35.4	18.8
2004	4331	46.9	35.3	17.8
2005	4315	42.6	38.7	18.7
2006	4322	47.3	35.1	17.6
2007	4291	43.3	37.0	19.7
2008	4321	44.7	35.8	19.5

NOT YET CLASSIFIED	0-10%	>10-25%	>25%	0-10%
1990	15013	22.2	44.3	33.5
1991	15090	14.5	43.5	42.0
1992	15179	12.8	43.5	43.7
1993	15121	14.5	42.3	43.2
1994	14339	10.0	39.8	50.2
1995	14099	14.2	40.0	45.8
1996	14023	20.2	45.3	34.5
1997	13858	16.8	49.4	33.8
1998	16025	19.7	48.9	31.4
1999	16027	19.3	51.9	28.8
2000	15880	15.7	54.3	30.0
2001	15472	16.0	54.0	30.0
2002	15430	14.1	54.8	31.1
2003	15276	13.5	55.2	31.3
2004	15296	11.0	51.6	37.4
2005	15133	15.2	51.0	33.8
2006	8325	29.2	50.4	20.4
2007	10001	26.7	53.5	19.8
2008	9954	25.4	56.3	18.3

ALL FOREST TYPES	Number of trees	0-10%	>10-25%	>25%
1990	38830	41.5	33.9	24.6
1991	39188	35.2	37.3	27.5
1992	39783	29.6	39.9	30.5
1993	39702	28.0	40.8	31.2
1994	38462	24.3	40.6	35.1
1995	38921	23.7	42.1	34.2
1996	38759	25.9	46.3	27.8
1997	38697	26.9	48.3	24.8
1998	41194	29.2	46.8	24.0
1999	44985	29.1	49.2	21.7
2000	45204	26.9	50.5	22.6
2001	44864	24.8	52.8	22.4
2002	44951	22.8	54.1	23.1
2003	44939	21.0	54.7	24.3
2004	45151	20.8	52.9	26.3
2005	45003	20.5	53.2	26.3
2006	38026	25.1	52.3	22.6
2007	39729	23.2	56.2	20.6
2008	39691	23.9	56.2	19.9

Annex I-9
Development of defoliation of most common species (1997-2008).

Picea abies

BOREAL	Number of trees	0-10%	>10-25%	>25%	HEMIBOREAL NEMORAL	Number of trees	0-10%	>10-25%	>25%
1997	3535	49.0	28.0	23.0	1997	3564	32.7	33.1	34.2
1998	3571	48.1	29.5	22.4	1998	3944	34.9	34.1	31.0
1999	3595	47.8	30.9	21.3	1999	4226	37.2	33.1	29.7
2000	3616	44.9	35.2	19.9	2000	4250	35.9	33.3	30.8
2001	3817	46.3	33.1	20.6	2001	4284	34.6	36.3	29.1
2002	3924	45.8	32.8	21.4	2002	4296	34.9	35.8	29.3
2003	3913	46.4	32.9	20.7	2003	4313	32.9	36.8	30.3
2004	4376	49.9	33.1	17.0	2004	4365	32.8	34.6	32.6
2005	4376	48.5	33.4	18.1	2005	4365	34.0	34.9	31.1
2006	4376	48.2	34.3	17.5	2006	4365	35.7	33.5	30.8
2007	4371	44.6	34.4	21.0	2007	4291	33.7	33.3	33.0
2008	4376	44.9	35.1	20.0	2008	4365	31.8	34.7	33.5

ALPINE CONIFEROUS	Number of trees	0-10%	>10-25%	>25%	MONTANE BEECH	Number of trees	0-10%	>10-25%	>25%
1997	2066	22.0	39.2	38.8	1997	109	29.4	44.0	26.6
1998	2073	21.2	43.4	35.4	1998	120	28.3	45.0	26.7
1999	2242	25.4	38.8	35.8	1999	132	26.5	48.5	25.0
2000	2267	28.7	37.6	33.7	2000	137	26.3	48.9	24.8
2001	2308	24.6	45.2	30.2	2001	137	26.3	48.9	24.8
2002	2303	21.4	47.9	30.7	2002	137	28.5	46.0	25.5
2003	2424	20.2	51.1	28.7	2004	157	27.4	44.6	28.0
2004	2424	17.7	48.8	33.5	2004	157	26.8	45.2	28.0
2005	2424	21.5	47.6	30.9	2005	157	22.9	41.4	35.7
2006	2424	18.3	49.3	32.4	2006	157	30.6	36.9	32.5
2007	2383	18.9	46.9	34.2	2007	157	15.9	35.0	49.1
2008	2424	19.4	47.8	32.8	2008	157	17.8	33.8	48.4

ALDER. BIRCH. ASPEN	Number of trees	0-10%	>10-25%	>25%	PLANTATIONS	Number of trees	0-10%	>10-25%	>25%
1997	129	62.7	26.4	10.9	1997	1212	59.0	25.7	15.3
1998	131	54.2	37.4	8.4	1998	1281	59.1	23.8	17.1
1999	137	75.2	16.8	8.0	1999	1281	58.8	25.5	15.7
2000	137	56.2	29.9	13.9	2000	1281	59.4	23.6	17.0
2001	148	62.2	27.7	10.1	2001	1303	55.0	28.0	17.0
2002	181	66.9	25.4	7.7	2002	1303	60.0	24.7	15.3
2003	159	76.1	14.5	9.4	2003	1303	60.8	23.6	15.6
2004	218	82.5	11.5	6.0	2004	1321	57.0	23.9	19.1
2005	218	79.8	13.3	6.9	2005	1321	52.8	27.7	19.5
2006	218	73.4	17.9	8.7	2006	1321	54.1	27.3	18.6
2007	218	70.7	16.5	12.8	2007	1296	53.3	28.5	18.2
2008	218	76.2	11.9	11.9	2008	1321	53.0	27.3	19.7

NOT YET CLASSIFIED	Number of trees	0-10%	>10-25%	>25%	ALL FOREST TYPES	Number of trees	0-10%	>10-25%	>25%
1997	7637	19.7	38.9	41.4	1997	18420	31.3	34.8	33.9
1998	5408	28.3	41.4	30.3	1998	16696	36.1	35.9	28.0
1999	5418	28.8	42.2	29.0	1999	17208	37.2	35.7	27.1
2000	5466	25.9	45.5	28.6	2000	17331	35.7	37.5	26.8
2001	5264	26.0	42.9	31.1	2001	17438	35.2	38.1	26.7
2002	5201	23.2	41.7	35.1	2002	17532	34.3	37.7	28.0
2003	4945	22.7	45.6	31.7	2003	17401	33.8	39.2	27.0
2004	5177	21.0	39.7	39.3	2004	18225	33.9	36.6	29.5
2005	4788	22.7	43.9	33.4	2005	17836	34.8	38.0	27.2
2006	2747	45.1	32.4	22.5	2006	15795	40.2	35.3	24.5
2007	2490	41.0	39.6	19.4	2007	15393	37.7	36.2	26.1
2008	2000	46.4	34.9	18.7	2008	15048	38.0	36.0	26.0

Pinus sylvestris

BOREAL	Number of trees	0-10%	>10-25%	>25%	HEMIBOREAL NEMORAL	Number of trees	0-10%	>10-25%	>25%
1997	5260	63.0	27.9	9.1	1997	5732	34.0	47.9	18.1
1998	5281	63.5	28.0	8.5	1998	6118	33.8	48.2	18.0
1999	5332	65.1	26.7	8.2	1999	6228	32.3	50.1	17.6
2000	5350	64.0	28.7	7.3	2000	6281	35.1	47.9	17.0
2001	5534	62.8	30.7	6.5	2001	6386	33.4	50.3	16.3
2002	5631	61.5	31.6	6.9	2002	6409	30.9	52.0	17.1
2003	5687	61.1	33.3	5.6	2003	6493	28.3	54.3	17.4
2004	6239	64.5	29.8	5.7	2004	6588	31.5	49.8	18.7
2005	6239	61.6	32.5	5.9	2005	6573	31.7	48.3	20.0
2006	6239	59.4	34.3	6.3	2006	6505	27.1	51.9	21.0
2007	6236	55.2	37.0	7.8	2007	6548	29.6	51.2	19.2
2008	6239	59.5	33.9	6.6	2008	6588	25.9	52.3	21.8

ALPINE CONIFEROUS	Number of trees	0-10%	>10-25%	>25%	MEDITERR. CONIFEROUS	Number of trees	0-10%	>10-25%	>25%
1997	881	25.9	41.8	32.3	1997	1223	37.4	42.2	20.4
1998	880	26.6	36.9	36.5	1998	1223	37.0	40.1	22.9
1999	905	36.3	35.2	28.5	1999	1287	44.7	41.9	13.4
2000	867	28.5	45.7	25.8	2000	1248	46.0	41.3	12.7
2001	958	29.5	43.8	26.7	2001	1288	48.2	38.7	13.1
2002	916	19.8	45.4	34.8	2002	1344	37.6	43.4	19.0
2003	1042	13.6	53.5	32.9	2003	1344	36.2	46.2	17.6
2004	1042	17.2	52.7	30.1	2004	1344	31.3	47.1	21.6
2005	962	18.1	52.2	29.7	2005	1344	26.6	51.2	22.2
2006	1002	18.6	50.9	30.5	2006	1304	25.2	51.7	23.1
2007	1002	16.3	57.4	26.3	2007	1304	27.8	53.3	18.9
2008	1042	19.0	54.3	26.7	2008	1344	28.3	51.7	20.0

MIRE SWAMP	Number of trees	0-10%	>10-25%	>25%	PLANTATIONS	Number of trees	0-10%	>10-25%	>25%
1997	464	60.4	35.3	4.3	1997	599	43.6	36.2	20.2
1998	464	65.8	30.8	3.4	1998	616	41.9	39.6	18.5
1999	464	62.5	34.9	2.6	1999	674	44.2	39.2	16.6
2000	464	62.8	35.3	1.9	2000	673	46.3	35.7	18.0
2001	464	59.2	36.9	3.9	2001	674	39.5	44.3	16.2
2002	464	53.7	42.9	3.4	2002	674	34.3	47.2	18.5
2003	464	47.8	49.0	3.2	2003	674	36.9	45.4	17.7
2004	483	47.8	48.7	3.5	2004	676	35.9	46.9	17.2
2005	483	52.2	44.3	3.5	2005	676	40.1	42.9	17.0
2006	483	53.9	42.2	3.9	2006	676	39.1	42.6	18.3
2007	483	56.3	39.1	4.6	2007	676	35.9	48.9	15.2
2008	483	47.0	50.9	2.1	2008	676	39.6	42.6	17.8

NOT YET CLASSIFIED	Number of trees	0-10%	>10-25%	>25%	ALL FOREST TYPES	Number of trees	0-10%	>10-25%	>25%
1997	10103	16.0	48.9	35.1	1997	24546	33.4	42.9	23.7
1998	9577	16.9	52.2	30.9	1998	24448	34.4	43.9	21.7
1999	9471	16.6	56.1	27.3	1999	24655	35.1	45.7	19.2
2000	9129	13.9	58.9	27.2	2000	24319	34.7	46.7	18.6
2001	8888	13.6	60.5	25.9	2001	24505	34.2	48.2	17.6
2002	8671	11.6	62.3	26.1	2002	24423	31.6	49.8	18.6
2003	8722	10.7	62.0	27.3	2003	24739	30.1	51.2	18.7
2004	9560	17.0	56.2	26.8	2004	26258	33.9	47.2	18.9
2005	9845	22.1	51.1	26.8	2005	26448	35.1	45.6	19.3
2006	7074	31.9	49.2	18.9	2006	23609	37.6	45.7	16.7
2007	7714	28.3	52.9	18.8	2007	24289	35.8	48.1	16.1
2008	6087	21.1	58.1	20.8	2008	22785	34.7	48.4	16.9

Fagus sylvatica

HEMIBOREAL NEMORAL	Number of trees	0-10%	>10-25%	>25%	ALPINE CONIFEROUS	Number of trees	0-10%	>10-25%	>25%
1997	79	29.1	48.1	22.8	1997	268	31.7	37.7	30.6
1998	100	30.0	41.0	29.0	1998	271	35.4	35.1	29.5
1999	111	34.2	41.5	24.3	1999	276	35.9	34.8	29.3
2000	110	24.5	50.0	25.5	2000	280	43.2	34.3	22.5
2001	111	30.6	60.4	9.0	2001	280	31.1	38.9	30.0
2002	111	27.0	59.5	13.5	2002	290	32.1	40.7	27.2
2003	111	26.1	52.3	21.6	2003	302	22.8	40.4	36.8
2004	112	19.6	38.4	42.0	2004	302	18.5	49.7	31.8
2005	112	25.0	43.7	31.3	2005	302	24.5	54.6	20.9
2006	111	25.2	45.1	29.7	2006	302	19.5	61.0	19.5
2007	112	18.8	45.5	35.7	2007	302	19.9	57.6	22.5
2008	112	23.2	50.0	26.8	2008	302	21.5	61.9	16.6
MESOPHY. DECIDUOUS	Number of trees	0-10%	>10-25%	>25%	BEECH	Number of trees	0-10%	>10-25%	>25%
1997	252	28.6	44.4	27.0	1997	3175	31.6	45.0	23.4
1998	259	32.4	42.9	24.7	1998	3361	35.9	42.2	21.9
1999	259	29.0	42.8	28.2	1999	3416	34.5	44.6	20.9
2000	259	34.4	41.7	23.9	2000	3505	37.3	40.9	21.8
2001	259	34.4	40.1	25.5	2001	3527	31.3	43.6	25.1
2002	259	34.0	40.9	25.1	2002	3632	34.3	43.8	21.9
2003	259	33.2	39.4	27.4	2003	3634	29.8	47.1	23.1
2004	259	20.1	35.5	44.4	2004	3674	27.5	44.5	28.0
2005	259	26.6	40.2	33.2	2005	3537	31.0	44.0	25.0
2006	259	24.7	39.4	35.9	2006	3657	30.8	42.2	27.0
2007	259	29.3	41.0	29.7	2007	3647	29.6	49.5	20.9
2008	259	41.3	38.6	20.1	2008	3674	30.0	49.5	20.5
MONTANE BEECH	Number of trees	0-10%	>10-25%	>25%	NOT YET CLASSIFIED	Number of trees	0-10%	>10-25%	>25%
1997	2396	28.9	43.1	28.0	1997	2079	31.6	44.8	23.6
1998	2464	31.0	45.5	23.5	1998	1892	32.8	43.2	24.0
1999	2865	24.5	49.0	26.5	1999	1733	28.3	47.1	24.6
2000	2940	28.4	48.9	22.7	2000	1744	29.1	43.7	27.2
2001	2954	23.1	50.5	26.4	2001	1695	33.0	38.3	28.7
2002	2971	22.7	54.0	23.3	2002	1695	29.1	43.9	27.0
2003	2931	21.6	53.6	24.8	2003	1662	31.2	41.7	27.1
2004	3020	17.5	54.9	27.6	2004	1468	17.0	39.9	43.1
2005	2980	25.1	50.3	24.6	2005	1763	26.9	40.4	32.7
2006	2960	29.1	47.7	23.2	2006	1211	35.9	33.5	30.6
2007	2951	22.6	49.7	27.7	2007	1438	40.1	38.9	21.0
2008	3020	32.5	47.2	20.3	2008	1312	43.0	40.8	16.2

ALL FOREST TYPES	Number of trees	0-10%	>10-25%	>25%
1997	8437	31.0	43.9	25.1
1998	8535	33.9	42.9	23.2
1999	8853	30.1	45.9	24.0
2000	9032	32.8	43.8	23.4
2001	9020	29.1	44.8	26.1
2002	9147	29.5	47.0	23.5
2003	9086	27.5	47.6	24.9
2004	9030	22.0	46.9	31.1
2005	9147	28.1	45.5	26.4
2006	8695	30.4	43.4	26.2
2007	8904	28.7	47.7	23.6
2008	8874	33.1	47.2	19.7

Quercus ilex* and *Q. rotundifolia

EVERGREEN BROADLEAVED	Number of trees	0-10%	>10-25%	>25%
1997	2738	20.4	59.1	20.5
1998	2738	28.1	56.7	15.2
1999	3541	21.2	56.9	21.9
2000	3602	19.4	58.7	21.9
2001	3620	19.6	63.5	16.9
2002	3620	16.3	62.7	21.0
2003	3579	14.6	61.7	23.7
2004	3644	18.5	62.5	19.0
2005	3603	9.8	62.3	27.9
2006	3603	8.5	64.1	27.4
2007	3614	9.3	68.3	22.4
2008	3644	12.1	67.4	20.5

MEDITERR. CONIFEROUS	Number of trees	0-10%	>10-25%	>25%
1997	92	34.8	57.6	7.6
1998	92	35.9	50.0	14.1
1999	100	32.0	48.0	20.0
2000	100	26.0	61.0	13.0
2001	100	20.0	55.0	25.0
2002	100	16.0	56.0	28.0
2003	100	10.0	71.0	19.0
2004	100	13.0	62.0	25.0
2005	100	12.0	51.0	37.0
2006	100	12.0	58.0	30.0
2007	100	9.0	62.0	29.0
2008	100	8.0	73.0	19.0

ALL FOREST TYPES	Number of trees	0-10%	>10-25%	>25%
1997	3017	21.4	58.0	20.6
1998	2974	28.2	56.2	15.6
1999	3822	21.9	56.4	21.7
2000	3890	19.4	58.6	22.0
2001	3901	19.6	63.1	17.3
2002	3892	16.4	62.3	21.3
2003	3820	14.3	62.0	23.7
2004	3889	18.0	62.7	19.3
2005	3844	9.9	61.6	28.5
2006	3844	8.6	63.5	27.9
2007	3898	9.9	67.4	22.7
2008	3908	12.2	66.9	20.9

Pinus pinaster

MEDITERR. CONIFEROUS	Number of trees	0-10%	>10-25%	>25%
1997	1309	60.2	29.3	10.5
1998	1309	47.9	39.0	13.1
1999	1803	60.4	30.6	9.0
2000	1783	61.6	29.0	9.4
2001	1803	54.4	40.2	5.4
2002	1803	49.0	44.4	6.6
2003	1803	44.4	46.3	9.3
2004	1843	46.5	40.9	12.6
2005	1843	42.7	46.0	11.3
2006	1843	42.6	46.4	11.0
2007	1843	46.7	44.8	8.5
2008	1843	43.6	47.8	8.6

PLANTATIONS	Number of trees	0-10%	>10-25%	>25%
1997	328	39.9	41.2	18.9
1998	328	34.8	40.8	24.4
1999	378	37.3	46.6	16.1
2000	378	34.7	51.8	13.5
2001	378	43.9	41.3	14.8
2002	378	37.0	50.8	12.2
2003	378	31.7	46.6	21.7
2004	398	33.9	47.3	18.8
2005	398	24.6	51.3	24.1
2006	398	23.4	51.7	24.9
2007	398	26.6	46.3	27.1
2008	398	28.6	48.0	23.4

NOT YET SPECIFIED	Number of trees	0-10%	>10-25%	>25%
1997	232	37.9	28.9	33.2
1998	199	40.7	39.7	19.6
1999	186	55.4	34.9	9.7
2000	157	49.7	42.7	7.6
2001	157	53.5	36.9	9.6
2002	137	49.7	32.1	18.2
2003	137	39.4	32.1	28.5
2004	59	20.3	32.2	47.5
2005	39	2.6	43.6	53.8
2006	40	15.0	57.5	27.5
2007	60	75.0	23.3	1.7
2008	60	68.3	25.0	6.7

ALL FOREST TYPES	Number of trees	0-10%	>10-25%	>25%
1997	1928	53.0	31.5	15.5
1998	1899	44.1	39.2	16.7
1999	2432	55.4	33.7	10.9
2000	2383	55.5	33.9	10.6
2001	2403	51.8	40.4	7.8
2002	2383	46.4	44.6	9.0
2003	2383	41.3	45.1	13.6
2004	2365	42.8	41.7	15.5
2005	2345	38.4	46.5	15.1
2006	2346	37.9	47.5	14.6
2007	2366	43.0	44.2	12.8
2008	2366	40.7	47.0	12.3

Quercus suber

EVERGREEN BROADLEAVED	Number of trees	0-10%	>10-25%	>25%	ALL FOREST TYPES	Number of trees	0-10%	>10-25%	>25%
1997	304	13.8	61.2	25.0	1997	363	22.0	56.2	21.8
1998	304	21.4	59.5	19.1	1998	362	29.6	52.7	17.7
1999	406	16.0	62.1	21.9	1999	496	21.2	58.0	20.8
2000	406	13.5	72.0	14.5	2000	496	16.3	69.8	13.9
2001	406	20.2	56.4	23.4	2001	496	21.6	57.4	21.0
2002	406	14.3	63.3	22.4	2002	496	15.9	63.1	21.0
2003	405	6.9	64.7	28.4	2003	463	9.3	64.8	25.9
2004	406	9.1	74.2	16.7	2004	464	11.6	72.2	16.2
2005	405	3.2	69.9	26.9	2005	462	7.8	65.6	26.6
2006	405	4.4	70.2	25.4	2006	462	9.1	66.0	24.9
2007	406	10.1	70.9	19.0	2007	495	13.5	64.1	22.4
2008	406	10.3	70.5	19.2	2008	465	10.1	67.3	22.6

Quercus robur **and** ***Q. petraea***

HEMIBOREAL NEMORAL	Number of trees	0-10%	>10-25%	>25%	ACIDOPH. OAK	Number of trees	0-10%	>10-25%	>25%
1997	101	37.6	22.8	39.6	1997	713	26.5	40.5	33.0
1998	108	40.8	33.3	25.9	1998	762	34.3	36.7	29.0
1999	109	31.2	32.1	36.7	1999	806	32.1	46.1	21.8
2000	109	30.3	34.8	34.8	2000	782	38.0	38.1	23.9
2001	109	31.2	39.4	29.4	2001	782	30.2	45.6	24.2
2002	109	30.3	37.6	32.1	2002	782	25.2	52.3	22.5
2003	111	24.3	50.5	25.2	2003	782	21.5	47.6	30.9
2004	111	15.3	51.4	33.3	2004	806	23.9	42.7	33.4
2005	111	13.5	49.6	36.9	2005	806	21.3	48.9	29.8
2006	111	20.7	49.6	29.7	2006	806	23.2	48.4	28.4
2007	111	19.8	35.1	45.1	2007	806	19.1	48.9	32.0
2008	111	21.6	43.3	35.1	2008	806	22.2	48.9	28.9
MESOPH. DECIDUOUS	Number of trees	0-10%	>10-25%	>25%	BEECH	Number of trees	0-10%	>10-25%	>25%
1997	2917	21.1	42.6	36.3	1997	275	24.4	40.7	34.9
1998	3122	23.0	43.1	33.9	1998	286	29.4	32.5	38.1
1999	3176	23.4	49.5	27.1	1999	305	22.0	35.7	42.3
2000	3176	23.1	49.8	27.1	2000	315	22.2	41.9	35.9
2001	3195	20.3	50.3	29.4	2001	312	18.6	43.6	37.8
2002	3195	18.2	52.5	29.3	2002	312	22.8	45.8	31.4
2003	3195	14.7	47.3	38.0	2003	315	18.7	44.2	37.1
2004	3231	13.6	45.7	40.7	2004	315	20.0	43.2	36.8
2005	3191	12.3	42.9	44.8	2005	308	17.9	40.6	41.5
2006	3231	14.5	45.1	40.4	2006	308	22.7	38.7	38.7
2007	3231	14.8	46.9	38.3	2007	308	17.9	44.1	38.0
2008	3231	14.0	47.8	38.2	2008	315	12.7	40.6	46.7
THERMOPH. DECIDUOUS	Number of trees	0-10%	>10-25%	>25%	FLOODPL. FORESTS	Number of trees	0-10%	>10-25%	>25%
1997	189	33.3	33.9	32.8	1997	218	30.3	43.6	26.1
1998	191	29.8	39.3	30.9	1998	255	32.9	36.9	30.2
1999	199	38.2	39.7	22.1	1999	276	40.5	34.1	25.4
2000	194	32.0	45.3	22.7	2000	288	34.4	43.0	22.6
2001	205	38.5	41.0	20.5	2001	288	36.5	44.4	19.1
2002	205	28.3	44.9	26.8	2002	288	33.0	46.2	20.8
2003	205	24.4	34.1	41.5	2003	288	31.9	48.0	20.1
2004	205	23.4	42.0	34.6	2004	348	27.9	48.8	23.3
2005	205	21.5	40.5	38.0	2005	348	31.0	45.7	23.3
2006	205	12.2	47.3	40.5	2006	348	45.7	31.6	22.7
2007	204	11.3	50.5	38.2	2007	348	38.2	37.4	24.4
2008	205	13.7	45.3	41.0	2008	348	34.8	36.2	29.0

Quercus robur and ***Q. petraea***

PLANTATIONS	Number of trees	0-10%	>10-25%	>25%	NOT YET CLASSIFIED	Number of trees	0-10%	>10-25%	>25%
1997	122	30.3	47.6	22.1	1997	2086	15.5	40.5	44.0
1998	136	26.5	44.1	29.4	1998	1840	18.1	38.7	43.2
1999	138	21.7	52.9	25.4	1999	1699	18.1	46.1	35.8
2000	138	19.6	55.0	25.4	2000	1753	13.1	42.0	44.9
2001	142	22.5	55.0	22.5	2001	1631	14.3	44.0	41.7
2002	142	19.7	54.9	25.4	2002	1510	16.3	46.9	36.8
2003	142	19.0	46.5	34.5	2003	1503	12.9	49.7	37.4
2004	143	10.5	50.3	39.2	2004	1487	15.1	42.6	42.3
2005	143	9.8	53.1	37.1	2005	1591	14.0	39.8	46.2
2006	143	11.2	52.4	36.4	2006	1048	22.8	47.3	29.9
2007	143	9.1	43.4	47.5	2007	1184	21.0	52.6	26.4
2008	143	11.2	56.6	32.2	2008	1267	18.8	56.8	24.4

ALL FOREST				
TYPES	6730	21.2	41.3	37.5
1997	6809	24.1	40.4	35.5
1998	6846	24.4	46.4	29.2
1999	6895	23.2	45.4	31.4
2000	6805	21.6	47.0	31.4
2001	6684	20.2	50.0	29.8
2002	6682	16.8	47.2	36.0
2003	6788	16.8	44.4	38.8
2004	6845	15.5	43.2	41.3
2005	6342	19.3	45.0	35.7
2006	6477	17.8	47.3	34.9
2007	6568	17.1	48.8	34.1
2008	6730	21.2	41.3	37.5
1997	6809	24.1	40.4	35.5

Abies alba

ALPINE CONIFEROUS	Number of trees	0-10%	>10-25%	>25%	PLANTATIONS	Number of trees	0-10%	>10-25%	>25%
1997	1093	35.7	32.6	31.7	1997	108	23.1	37.0	39.9
1998	1036	35.8	33.5	30.7	1998	108	26.9	42.5	30.6
1999	1098	35.2	35.7	29.1	1999	108	22.2	51.9	25.9
2000	1118	35.7	34.3	30.0	2000	108	14.8	61.1	24.1
2001	1118	36.2	37.2	26.6	2001	104	41.4	41.4	17.3
2002	1171	36.0	36.5	27.5	2002	64	31.3	29.7	39.0
2003	1171	33.5	35.4	31.1	2003	104	21.2	50.9	27.9
2004	1171	34.6	33.5	31.9	2004	108	26.9	49.0	24.1
2005	1171	35.9	37.2	26.9	2005	108	36.1	39.8	24.1
2006	1131	31.1	34.0	34.9	2006	108	45.4	50.0	4.6
2007	1171	32.7	40.2	27.1	2007	108	67.6	27.8	4.6
2008	1171	33.8	34.9	31.3	2008	108	59.3	37.0	3.7

NOT YET CLASSIFIED	Number of trees	0-10%	>10-25%	>25%	ALL FOREST TYPES	Number of trees	0-10%	>10-25%	>25%
1997	486	20.2	33.7	46.1	1997	1873	31.7	33.2	35.1
1998	460	20.4	33.0	46.6	1998	1790	32.2	33.9	33.9
1999	472	20.6	35.4	44.0	1999	1868	31.9	36.0	32.1
2000	429	16.8	36.8	46.4	2000	1845	31.1	35.6	33.3
2001	377	10.6	30.8	58.6	2001	1789	32.0	35.9	32.1
2002	417	14.1	32.9	53.0	2002	1842	32.3	34.6	33.1
2003	417	12.5	34.5	53.0	2003	1885	29.0	36.5	34.5
2004	417	13.4	33.3	53.3	2004	1889	30.2	34.1	35.7
2005	396	15.7	39.1	45.2	2005	1868	32.3	37.7	30.0
2006	315	34.3	39.4	26.3	2006	1747	34.5	35.8	29.7
2007	303	34.0	44.2	21.8	2007	1775	36.1	40.0	23.9
2008	288	39.9	39.6	20.5	2008	1760	37.9	35.1	27.0

Picea sitchensis

PLANTATIONS	Number of trees	0-10%	>10-25%	>25%	ALL FOREST TYPES	Number of trees	0-10%	>10-25%	>25%
1997	228	63.6	21.5	14.9	1997	321	64.8	22.4	12.8
1998	253	57.7	25.7	16.6	1998	321	55.5	27.7	16.8
1999	232	75.0	15.5	9.5	1999	300	75.3	15.0	9.7
2000	232	72.8	17.7	9.5	2000	299	67.5	22.1	10.4
2001	246	69.1	18.3	12.6	2001	288	65.6	21.2	13.2
2002	246	52.9	31.7	15.4	2002	288	51.4	32.3	16.3
2003	246	62.2	26.8	11.0	2003	267	62.2	27.7	10.1
2004	253	59.7	22.5	17.8	2004	274	62.4	21.2	16.4
2005	253	66.4	19.4	14.2	2005	274	67.9	19.0	13.1
2006	253	64.0	24.9	11.1	2006	345	72.8	19.1	8.1
2007	253	64.4	17.0	18.6	2007	464	75.9	12.7	11.4
2008	253	66.8	10.3	22.9	2008	489	74.0	9.6	16.4

All species

BOREAL	Number of trees	0-10%	>10-25%	>25%	HEMIBOREAL NEMORAL	Number of trees	0-10%	>10-25%	>25%
1997	10110	57.6	28.1	14.3	1997	10152	33.5	42.2	24.3
1998	10171	57.8	28.2	14.0	1998	10973	34.4	42.4	23.2
1999	10256	58.5	28.1	13.4	1999	11404	34.0	43.6	22.4
2000	10311	56.5	31.1	12.4	2000	11480	35.2	42.1	22.7
2001	10716	56.3	31.5	12.2	2001	11623	33.7	44.9	21.4
2002	10950	55.0	32.2	12.8	2002	11671	32.6	45.6	21.8
2003	11006	55.0	33.0	12.0	2003	11784	30.0	47.5	22.5
2004	12199	58.1	31.1	10.8	2004	11940	31.3	44.3	24.4
2005	12199	56.2	32.7	11.1	2005	11915	32.3	43.4	24.3
2006	12199	54.1	34.5	11.4	2006	11856	30.6	44.9	24.5
2007	12189	49.8	36.2	14.0	2007	11825	31.3	44.3	24.4
2008	12199	52.7	34.8	12.5	2008	11940	28.6	45.5	25.9
ALPINE CONIFEROUS	Number of trees	0-10%	>10-25%	>25%	ACIDOPH. OAK	Number of trees	0-10%	>10-25%	>25%
1997	5216	28.1	37.8	34.1	1997	935	28.8	40.4	30.8
1998	5190	28.6	38.8	32.6	1998	984	34.5	38.3	27.2
1999	5531	31.3	37.9	30.8	1999	1032	32.8	45.3	21.9
2000	5579	31.9	39.6	28.5	2000	1008	36.1	39.2	24.7
2001	5830	29.3	42.7	28.0	2001	1008	29.9	45.7	24.4
2002	5799	26.2	44.3	29.5	2002	1008	24.4	52.9	22.7
2003	6140	23.6	46.7	29.7	2003	1008	20.6	48.2	31.2
2004	6140	22.9	45.8	31.3	2004	1032	23.3	44.0	32.7
2005	6020	25.7	46.4	27.9	2005	1032	21.4	48.6	30.0
2006	6020	23.1	46.4	30.5	2006	1032	22.5	48.7	28.8
2007	6059	22.3	48.8	28.9	2007	1032	20.1	48.7	31.2
2008	6140	23.6	47.4	29.0	2008	1032	22.6	49.3	28.1
MESOPH. DECIDUOUS	Number of trees	0-10%	>10-25%	>25%	BEECH	Number of trees	0-10%	>10-25%	>25%
1997	4824	27.6	41.4	31.0	1997	4069	31.9	45.1	23.0
1998	5142	29.3	40.5	30.2	1998	4297	36.4	41.5	22.1
1999	5269	29.9	45.6	24.5	1999	4356	34.3	44.1	21.6
2000	5269	30.7	46.0	23.3	2000	4468	37.4	41.2	21.4
2001	5289	27.4	46.5	26.1	2001	4493	30.6	43.8	25.6
2002	5313	24.9	48.8	26.3	2002	4598	33.9	44.5	21.6
2003	5313	21.5	44.7	33.8	2003	4618	29.1	47.2	23.7
2004	5409	19.7	43.3	37.0	2004	4658	27.0	44.3	28.7
2005	5369	20.1	41.3	38.6	2005	4514	30.1	44.3	25.6
2006	5409	19.7	42.9	37.4	2006	4634	29.8	43.0	27.2
2007	5409	20.1	44.7	35.2	2007	4610	27.9	49.8	22.3
2008	5409	22.3	44.6	33.1	2008	4658	28.3	49.0	22.7
MONTANE BEECH	Number of trees	0-10%	>10-25%	>25%	THERMOPH. DECIDUOUS	0-10%	>10-25%	>25%	0-10%
1997	2945	30.9	42.4	26.7	1997	5337	27.8	40.0	32.2
1998	3009	32.4	44.4	23.2	1998	5531	26.6	39.9	33.5
1999	3453	26.2	47.6	26.2	1999	6264	27.8	42.9	29.3
2000	3547	29.4	47.7	22.9	2000	6205	25.0	43.8	31.2
2001	3580	24.5	49.2	26.3	2001	6374	22.9	43.3	33.8
2002	3590	24.0	52.4	23.6	2002	6394	21.2	45.1	33.7
2003	3578	22.2	52.4	25.4	2003	6467	17.0	45.6	37.4
2004	3670	18.9	53.1	28.0	2004	6737	16.2	47.0	36.8
2005	3630	25.6	48.5	25.9	2005	6518	19.7	47.6	32.7
2006	3610	28.9	46.5	24.6	2006	6603	18.1	46.6	35.3
2007	3600	22.2	48.8	29.0	2007	6515	15.3	48.4	36.3
2008	3670	31.6	45.8	22.6	2008	6737	18.9	47.1	34.0

All species

EVERGRREN BROADLEAVED	Number of trees	0-10%	>10-25%	>25%	MEDITERR. CONIFEROUS	Number of trees	0-10%	>10-25%	>25%
1997	3385	20.0	59.0	21.0	1997	6121	36.9	46.0	17.1
1998	3385	27.3	56.3	16.4	1998	6185	35.2	46.0	18.8
1999	4396	21.1	57.2	21.7	1999	7820	38.9	47.1	14.0
2000	4467	18.9	59.6	21.5	2000	7855	37.8	48.0	14.2
2001	4487	19.6	61.9	18.5	2001	7915	33.7	51.3	15.0
2002	4487	16.1	62.6	21.3	2002	8038	28.8	53.0	18.2
2003	4437	13.9	62.3	23.8	2003	7953	27.1	55.0	17.9
2004	4511	17.4	63.5	19.1	2004	8104	27.6	54.5	17.9
2005	4461	9.4	62.4	28.2	2005	8104	20.8	55.4	23.8
2006	4461	8.3	63.2	28.5	2006	7984	22.2	54.3	23.5
2007	4481	9.1	67.6	23.3	2007	7984	23.2	56.7	20.1
2008	4511	11.5	67.2	21.3	2008	8104	22.6	58.8	18.6

MIRE SWAMP	Number of trees	0-10%	>10-25%	>25%	FLOODPLAIN FORESTS	Number of trees	0-10%	>10-25%	>25%
1997	637	64.3	30.8	4.9	1997	444	41.0	35.1	23.9
1998	637	69.7	26.4	3.9	1998	518	44.6	28.0	27.4
1999	637	65.3	31.1	3.6	1999	569	49.7	27.8	22.5
2000	637	60.8	36.4	2.8	2000	593	43.5	35.1	21.4
2001	637	58.2	36.9	4.9	2001	593	43.0	39.6	17.4
2002	648	53.2	41.2	5.6	2002	593	38.4	44.4	17.2
2003	648	49.2	45.2	5.6	2003	593	38.6	44.2	17.2
2004	668	49.4	44.2	6.4	2004	690	35.4	45.0	19.6
2005	668	55.3	39.2	5.5	2005	690	39.6	41.4	19.0
2006	668	55.4	37.7	6.9	2006	690	49.5	32.8	17.7
2007	668	55.7	38.3	6.0	2007	690	43.2	35.2	21.6
2008	668	47.7	47.2	5.1	2008	690	45.4	36.2	18.4

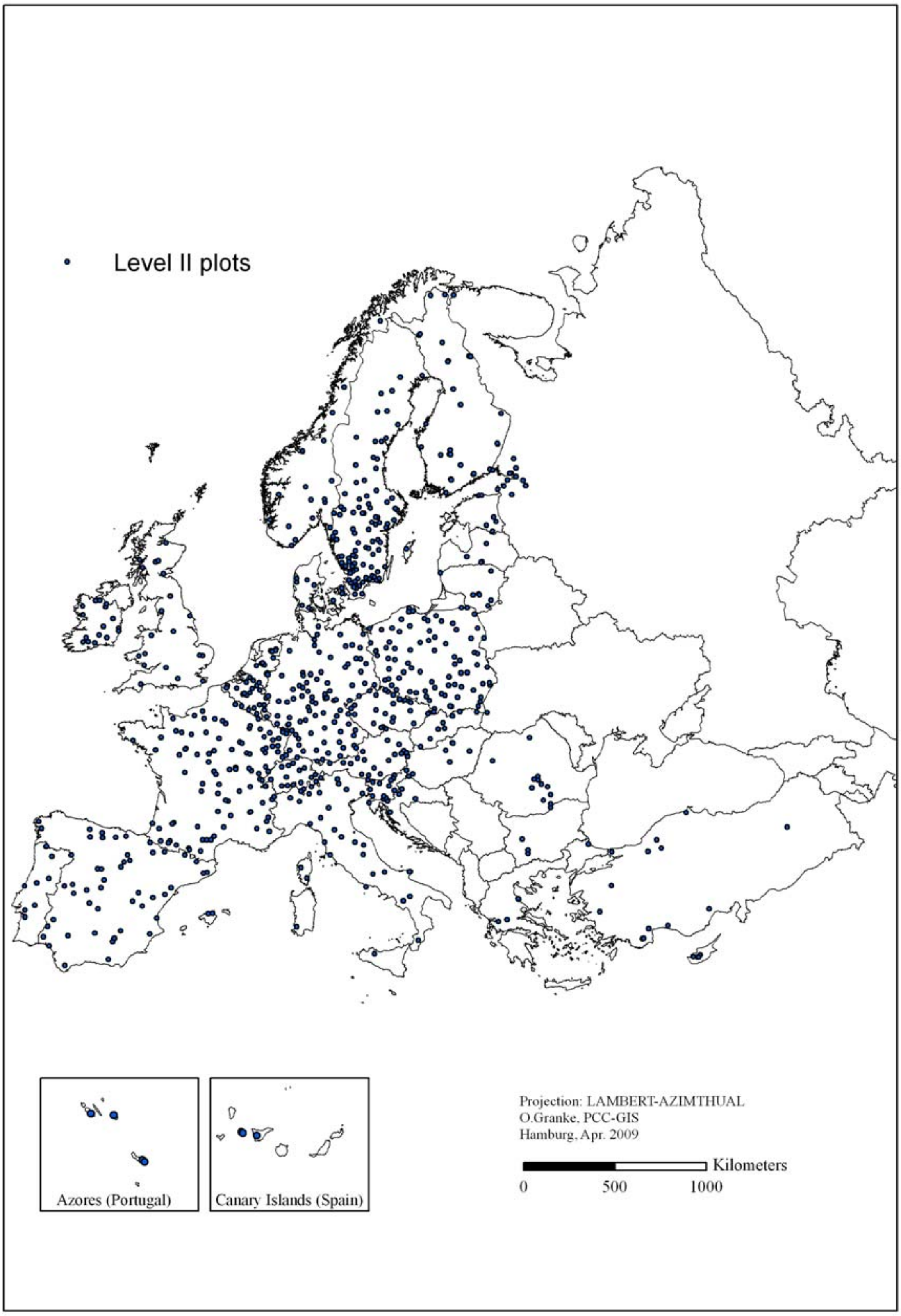
ALDER,BIRCH, ASPEN	Number of trees	0-10%	>10-25%	>25%	PLANTATIONS	Number of trees	0-10%	>10-25%	>25%
1997	3171	44.7	39.4	15.9	1997	5397	52.7	28.4	18.9
1998	3224	43.2	42.2	14.6	1998	5768	51.8	28.6	19.6
1999	3394	45.8	38.7	15.5	1999	6621	54.7	30.8	14.5
2000	3466	41.0	43.3	15.7	2000	6631	52.5	30.2	17.3
2001	3637	42.8	41.4	15.8	2001	6735	49.4	34.4	16.2
2002	3704	41.6	43.1	15.3	2002	6719	46.1	35.7	18.2
2003	3711	40.1	43.2	16.7	2003	6701	44.8	35.2	20.0
2004	4224	41.7	38.6	19.7	2004	6979	44.1	35.0	20.9
2005	4198	46.3	36.9	16.8	2005	6921	42.4	36.8	20.8
2006	4224	42.3	39.4	18.3	2006	6921	44.1	35.6	20.3
2007	4205	39.2	39.3	21.5	2007	6836	42.1	35.6	22.3
2008	4224	39.1	39.9	21.0	2008	6979	41.7	35.5	22.8

NOT YET CLASSIFED	Number of trees	0-10%	>10-25%	>25%	ALL FOREST TYPES	Number of trees	0-10%	>10-25%	>25%
1997	27403	20.6	42.8	36.6	1997	90146	32.6	40.4	27.0
1998	23812	23.8	44.5	31.7	1998	88826	34.7	40.5	24.8
1999	23288	23.8	47.3	28.9	1999	94290	35.0	42.5	22.5
2000	22723	20.2	49.1	30.7	2000	94239	33.8	43.3	22.9
2001	21998	20.7	48.7	30.6	2001	94915	32.4	44.6	23.0
2002	21093	18.3	51.2	30.5	2002	94605	30.4	46.3	23.3
2003	20192	17.8	52.0	30.2	2003	94149	28.7	46.9	24.4
2004	21033	19.2	47.6	33.2	2004	97994	29.6	44.8	25.6
2005	21519	23.3	46.2	30.5	2005	97758	30.4	44.4	25.2
2006	16757	35.2	42.5	22.3	2006	93068	32.4	43.8	23.8
2007	18348	32.6	47.4	20.0	2007	94451	30.6	46.2	23.2
2008	15242	30.0	49.9	20.1	2008	92203	31.0	46.4	22.6

	Period 1990 - 2008			Period 1997 - 2008		
Year	No. of trees N	Mean defoliation $\bar{x}$	Standard error $s_{\bar{x}} = s/\sqrt{N}$	No. of trees N	Mean defoliation $\bar{x}$	Standard error $s_{\bar{x}} = s/\sqrt{N}$
Pinus sylvestris						
1990	11486	24.5	0.15			
1991	11733	26.4	0.14			
1992	11743	27.1	0.14			
1993	11780	26.8	0.14			
1994	11148	27.9	0.14			
1995	10970	26.2	0.14			
1996	11012	23.6	0.13			
1997	10970	22.7	0.12	24546	20.2	0.10
1998	11463	22.1	0.12	24448	19.6	0.10
1999	11697	21.5	0.11	24655	18.8	0.09
2000	11618	22.1	0.12	24319	18.9	0.09
2001	11644	22.0	0.11	24505	18.7	0.09
2002	11519	22.6	0.12	24423	19.2	0.09
2003	11558	22.7	0.12	24739	19.4	0.09
2004	11590	22.9	0.12	26258	18.9	0.08
2005	11534	22.9	0.13	26448	18.9	0.09
2006	8358	20.4	0.13	23609	18.1	0.09
2007	9110	20.2	0.12	24289	18.1	0.09
2008	9012	20.2	0.12	22785	18.3	0.09
Picea abies						
1990	6488	22.4	0.22			
1991	6632	22.5	0.21			
1992	6658	23.3	0.20			
1993	6582	24.3	0.22			
1994	6551	25.7	0.23			
1995	6698	24.6	0.23			
1996	6704	22.3	0.21			
1997	6614	22.9	0.20	18420	22.0	0.12
1998	7886	22.0	0.18	16696	20.3	0.13
1999	7854	21.8	0.18	17208	19.9	0.12
2000	7780	22.9	0.18	17331	20.2	0.12
2001	7505	22.7	0.17	17438	19.9	0.12
2002	7524	23.3	0.18	17532	20.3	0.12
2003	7569	23.2	0.18	17401	20.4	0.12
2004	7485	25.3	0.19	18225	20.7	0.12
2005	7401	23.3	0.18	17836	20.0	0.12
2006	4344	21.6	0.24	15795	18.5	0.12
2007	4256	22.2	0.24	15393	19.6	0.13
2008	4217	23.0	0.24	15048	19.5	0.13
Quercus robur and ***Q. petraea***						
1990	2539	21.3	0.35			
1991	2549	23.8	0.33			
1992	2518	24.3	0.32			
1993	2524	26.6	0.33			
1994	2468	28.3	0.34			
1995	2552	27.6	0.34			
1996	2528	28.3	0.36			
1997	2560	26.5	0.32	6730	25.7	0.22
1998	2673	26.1	0.31	6809	24.7	0.22
1999	2748	24.0	0.29	6846	22.9	0.19
2000	2749	23.9	0.29	6895	23.5	0.20
2001	2759	24.1	0.28	6805	23.8	0.20
2002	2769	23.5	0.28	6684	23.3	0.18
2003	2783	24.6	0.27	6682	25.3	0.19
2004	2878	26.5	0.31	6788	26.5	0.20
2005	2901	25.6	0.30	6845	26.9	0.20
2006	2298	22.1	0.31	6342	25.0	0.20
2007	2448	23.2	0.34	6477	25.3	0.21
2008	2551	22.5	0.28	6568	24.8	0.19

	Period 1990 - 2008			Period 1997 - 2008		
Year	No. of trees N	Mean defoliation $\overline{x}$	Standard error $s_{\overline{x}} = s/\sqrt{N}$	No. of trees N	Mean defoliation $\overline{x}$	Standard error $s_{\overline{x}} = s/\sqrt{N}$
Fagus sylvatica						
1990	4015	17.9	0.22			
1991	4064	17.2	0.21			
1992	4091	20.8	0.23			
1993	4109	20.0	0.24			
1994	3948	21.6	0.22			
1995	4127	22.2	0.22			
1996	4092	21.1	0.21			
1997	4163	20.6	0.20	8437	21.2	0.18
1998	4417	19.5	0.20	8535	20.4	0.18
1999	4568	20.6	0.19	8853	20.7	0.16
2000	4637	20.5	0.21	9032	20.5	0.17
2001	4640	21.5	0.20	9020	21.4	0.16
2002	4649	20.0	0.19	9147	20.9	0.16
2003	4678	21.7	0.20	9086	21.3	0.15
2004	4694	24.2	0.22	9030	23.7	0.16
2005	4720	22.2	0.21	9147	22.1	0.17
2006	3844	21.3	0.22	8695	22.0	0.18
2007	3941	20.9	0.20	8904	21.1	0.15
2008	3933	19.7	0.19	8874	19.4	0.14
Pinus pinaster						
1990	966	11.1	0.49			
1991	936	15.3	0.68			
1992	981	15.7	0.65			
1993	980	15.9	0.63			
1994	959	17.5	0.67			
1995	953	16.5	0.51			
1996	952	20.2	0.73			
1997	951	17.8	0.66	1928	17.4	0.46
1998	949	17.9	0.65	1899	18.4	0.41
1999	1508	18.2	0.55	2432	16.0	0.38
2000	1511	20.9	0.68	2383	17.2	0.45
2001	1494	15.5	0.37	2403	14.3	0.27
2002	1492	17.3	0.40	2383	15.0	0.23
2003	1463	18.5	0.43	2383	17.7	0.34
2004	1454	21.5	0.59	2365	19.6	0.43
2005	1462	20.6	0.52	2345	18.8	0.36
2006	1465	20.6	0.52	2346	19.1	0.37
2007	1462	20.4	0.53	2366	17.9	0.37
2008	1441	18.8	0.48	2366	18.1	0.36
Quercus ilex and ***Q. rotundifolia***						
1990	2392	10.3	0.18			
1991	2373	12.7	0.15			
1992	2398	15.9	0.25			
1993	2397	15.9	0.19			
1994	2371	20.7	0.35			
1995	2396	25.6	0.34			
1996	2379	24.2	0.31			
1997	2380	20.8	0.30	3017	21.6	0.26
1998	2372	18.1	0.24	2974	19.3	0.23
1999	3166	21.2	0.25	3822	21.2	0.22
2000	3196	20.8	0.21	3890	21.3	0.20
2001	3197	20.0	0.20	3901	20.8	0.19
2002	3201	21.3	0.19	3892	22.0	0.19
2003	3202	22.4	0.24	3820	23.2	0.22
2004	3198	20.3	0.19	3889	21.5	0.20
2005	3204	23.5	0.19	3844	24.4	0.21
2006	3210	23.5	0.22	3844	24.6	0.22
2007	3212	22.2	0.21	3898	23.2	0.22
2008	3224	21.2	0.20	3908	22.3	0.20

Annex I-10
Level II plots



Annex II

National Surveys

Annex II-1

Forests and surveys in European countries (2008).

Participating countries	Total area (1000 ha)	Forest area (1000 ha)	Coniferous forest (1000 ha)	Broadleav. forest (1000 ha)	Area surveyed (1000 ha)	Grid size (km x km)	No. of sample plots	No. of sample trees
Albania	2875	1063	171	600	no survey in 2008			
Andorra	47	18	15	2	18	16 x 16	3	72
Austria	8385	3878	2683	798	no survey in 2008			
Belarus	20760	7879	4721	3158	7812	16 x 16	400	9460
Belgium	3035	700	281	324	700	4^2 / 8^2	121	2860
Bulgaria	11100	4108	1277	2831	4064	$4^2/8^2/16^2$	136	4531
Croatia	5654	2061	321	1740	2061	16 x 16	85	2039
Cyprus	925	298	172	0	138	16x16	15	360
Czech Republic	7886	2647	2014	633	2647	$8^2/16^2$	136	5477
Denmark	4310	527	288	224	486	$7^2/16^2$	19	452
Estonia	4510	2213	1446	1066	2213	16 x 16	92	2196
Finland	30415	20150	17974	1897	19871	16^2 / 24x32	475	8819
France	54883	15840	4041	9884	13100	16 x 16	508	10138
Germany	35702	11076	6048	4236	10320	16^2 / 4^2	423	10347
Greece	12890	2512	954	1080	no survey in 2008			
Hungary	9300	1869	231	1638	no survey in 2008			
Ireland	7028	680	399	37	399	16 x 16	31	679
Italy	30128	8675	1735	6940	8675	16 x 16	236	6579
Latvia	6459	3204	1481	1724	3204	8 x 8	342	8090
Liechtenstein	16	8	6	2	no survey in 2008			
Lithuania	6530	2143	1152	888	2030	4x4/16x16	1342	7539
Luxembourg	259	89	30	54	no survey in 2008			
Rep. of Macedonia					no survey in 2008			
Rep. of Moldova	3376	318	6	312	318	2x2/2x4	528	9841
The Netherlands	3482	334	158	52	no survey in 2008			
Norway	32376	12000	6800	5200	12000	$3^2/9^2$	1720	9495
Poland	31268	9200	6955	2245	9200	16 x 16	1916	38320
Portugal	8893	3234	1081	2153	no survey in 2008			
Romania	23839	6233	1873	4360	no survey in 2008			
Russian Fed.	11100	8125			no survey in 2008			
Serbia	8836	2360	179	2181	1868	16 x 16/4 x 4	130	2789
Slovak Republic	4901	1961	815	1069	1961	16 x 16	108	4083
Slovenia	2027	1099	410	688	1099	16 x 16	44	1056
Spain	50471	11588	5910	4056	11588	16 x 16	620	14880
Sweden	41000	28300	19600	900	20600	varying	3464	6890
Switzerland	4129	1186	818	368	1186	16 x 16	48	1008
Turkey	77846	21189	12773	8416	6945	16 x 16	398	8978
Ukraine	60350	9400	3969	5347	6033	16 x 16	1465	33986
United Kingdom	24291	2837	1640	1197	no survey in 2008			
TOTAL	651282	211002	110869	77921	156807	varying	14786	210964

Annex II-2

Percent of trees of all species by defoliation classes and class aggregates (2008).

Participating countries	Area surveyed (1000 ha)	No. of sample trees	0 none	1 slight	2 moderate	3+4 severe and dead	2+3+4
Albania			no survey in 2008				
Andorra	18	72	29.2	55.6	13.9	1.4	15.3
Austria			no survey in 2008				
Belarus	7879	9460	27.4	64.6	6.6	1.4	8.0
Belgium	700	2860	36.5	49.0	13.1	1.4	14.5
Bulgaria	4064	4531	19.9	48.2	27.1	4.8	31.9
Croatia	2061	2039	38.4	37.7	20.5	3.4	23.9
Cyprus	138	360	3.1	50.0	45.3	1.6	49.9
Czech Republic	2647	5477	11.9	31.4	54.8	1.9	56.7
Denmark	486	452	62.8	28.1	6.2	2.9	9.1
Estonia	2213	2196	42.6	48.4	8.1	0.9	9.0
Finland	19871	8819	54.1	35.7	9.1	1.1	10.2
France	13100	10138	30.9	36.6	29.5	2.9	32.4
Germany	10320	10347	30.7	43.6	24.5	1.2	25.7
Greece			no survey in 2008				
Hungary			no survey in 2008				
Ireland	680	679	74.6	15.4	9.0	1.0	10.0
Italy	436	6579	26.3	40.9	28.0	4.8	32.8
Latvia	3204	8090	17.8	66.9	13.0	2.3	15.3
Liechtenstein			no survey in 2008				
Lithuania	2040	7539	23.9	56.5	18.0	1.6	19.6
Luxembourg			no survey in 2008				
Rep. of Macedonia			no survey in 2008				
Rep. of Moldova	318	9841	42.8	23.6	26.1	7.5	33.6
The Netherlands			no survey in 2008				
Norway	12000	9495	41.4	35.9	18.7	4.0	22.7
Poland	9200	38320	24.5	57.5	17.1	0.9	18.0
Portugal			no survey in 2008				
Romania			no survey in 2008				
Russian Fed.			no survey in 2008				
Serbia	1868	2789	61.3	27.2	9.9	1.6	11.5
Slovak Republic	1961	4083	10.0	60.7	28.2	1.1	29.3
Slovenia	1099	1056	22.6	40.4	32.2	4.8	37.0
Spain	11588	14880	19.7	64.7	13.2	2.5	15.6
Sweden	20600	6890	52.5	30.2	14.9	2.4	17.3
Switzerland	1186	1008	35.1	45.9	9.9	9.1	19.0
Turkey	6945	8978	22.8	52.6	22.1	2.5	24.6
Ukraine	6033	33986	66.5	25.3	7.0	1.2	8.2
United Kingdom			no survey in 2008				

Cyprus: Only conifers assessed. *Moldova*: Only broadleaves assessed. *Sweden*: Only conifers assessed.

Note that some differences in the level of damage across national borders may be at least partly due to differences in standards used. This restriction, however, does not affect the reliability of the trends over time.

Annex II-3

Percent of conifers by defoliation classes and class aggregates (2008).

Participating countries	Coniferous forest (1000 ha)	No. of sample trees	0 none	1 slight	2 moderate	3+4 severe and dead	2+3+4
Albania			no survey in 2008				
Andorra	15	72	29.2	55.6	13.9	1.4	15.3
Austria			no survey in 2008				
Belarus	4721	6869	25.4	66.5	6.9	1.2	8.1
Belgium		939	32.0	54.8	11.4	1.8	13.2
Bulgaria	1277	2294	10.4	43.9	40.7	5.0	45.7
Croatia	321	242	9.1	31.8	47.9	11.2	59.1
Cyprus	172	360	3.1	50.0	45.3	1.7	46.9
Czech Republic	2014	4366	10.7	26.4	60.7	2.2	62.9
Denmark	288	263	69.6	20.5	6.1	3.8	9.9
Estonia	1146	2079	41.6	49.0	8.4	1.0	9.4
Finland	17974	7385	53.4	36.5	9.1	1.0	10.1
France	4041	3575	47.0	27.9	23.4	1.7	25.1
Germany	6084	6490	31.5	44.4	22.9	1.2	24.1
Greece			no survey in 2008				
Hungary			no survey in 2008				
Ireland	399	679	74.6	15.4	9.0	1.0	399
Italy	1735	1708	38.9	37.1	21.0	3.0	24.0
Latvia	1481	5864	12.8	70.5	14.4	2.3	16.7
Liechtenstein			no survey in 2008				
Lithuania	1152	4591	20.7	60.2	18.1	1.0	19.1
Luxembourg			no survey in 2008				
Rep. of Macedonia			no survey in 2008				
Rep. of Moldova			only broadleaves assessed				
The Netherlands			no survey in 2008				
Norway	6800	7218	47.3	33.5	16.3	2.9	19.2
Poland	6955	25440	22.9	59.7	16.7	0.7	17.4
Portugal			no survey in 2008				
Romania			no survey in 2008				
Russian Fed.			no survey in 2008				
Serbia	179	331	63.4	23.6	10.0	3.0	13.0
Slovak Republic	815	1703	3.0	55.9	39.7	1.4	41.1
Slovenia	410	405	25.7	33.6	35.8	4.9	40.7
Spain	5910	7502	23.5	63.6	10.7	2.2	12.9
Sweden	19600	6890	52.5	30.2	14.9	2.4	17.3
Switzerland	818	714	27.7	53.6	10.8	7.9	18.7
Turkey	12773	5584	27.4	56.4	15.0	1.2	16.2
Ukraine	3969	14356	71.2	21.7	6.5	0.6	7.1
United Kingdom			no survey in 2008				

Note that some differences in the level of damage across national borders may be at least partly due to differences in standards used. This restriction. however. does not affect the reliability of the trends over time.

Annex II-4

Percent of broadleaves by defoliation classes and class aggregates (2008).

Participating countries	Broadleav. forest (1000 ha)	No. of sample trees	0 none	1 slight	2 moderate	3+4 severe and dead	2+3+4
Albania			no survey in 2008				
Andorra	2		only conifers assessed				
Austria	798		no survey in 2008				
Belarus	3127	2591	32.8	59.6	5.9	1.4	7.3
Belgium	324	1921	38.6	46.1	14.0	1.3	15.3
Bulgaria	2831	2237	29.6	52.6	13.3	4.5	17.8
Croatia	1740	1797	42.4	38.5	16.8	2.3	19.1
Cyprus			only conifers assessed				
Czech Republic	633	1111	16.7	51.1	31.1	1.1	32.2
Denmark	224	189	53.4	38.6	6.4	1.6	8.0
Estonia	1066	117	59.0	37.6	3.4	0.0	3.4
Finland	1897	1434	57.8	31.6	9.2	1.4	10.6
France	9884	6563	22.2	41.3	32.9	3.6	36.5
Germany	4236	3857	29.4	42.2	27.3	1.1	28.4
Greece	1080		no survey in 2008				
Hungary	1638		no survey in 2008				
Ireland	37		only conifers assessed				
Italy	6940	4871	21.9	42.3	30.4	5.4	35.8
Latvia	1724	2226	31.0	57.5	9.2	2.3	11.5
Liechtenstein	2		no survey in 2008				
Lithuania	888	2948	28.8	50.9	17.8	2.5	20.3
Luxembourg	54		no survey in 2008				
Rep. of Macedonia			no survey in 2008				
Rep. of Moldova	312	9841	42.8	23.6	26.1	7.5	33.6
The Netherlands			no survey in 2008				
Norway	5200	2277	22.4	43.8	26.3	7.5	33.8
Poland	2245	12880	27.6	53.3	18.0	1.1	19.1
Portugal	2153		no survey in 2008				
Romania			no survey in 2008				
Russian Fed.	510		only conifers assessed				
Serbia	2181	2458	61.0	27.7	9.9	1.4	11.3
Slovak Republic	1069	2380	15.0	64.2	20.0	0.8	20.8
Slovenia	688	651	20.7	44.7	30.0	4.6	34.6
Spain	4056	7378	15.9	65.7	15.7	2.7	18.4
Sweden	900		only conifers assessed				
Switzerland	368	294	50.7	29.7	7.9	11.7	19.6
Turkey	8416	3394	15.4	46.3	33.7	4.6	38.3
Ukraine	5347	19630	63.1	27.8	7.5	1.6	9.1
United Kingdom			no survey in 2008				

Norway: Special study on birch.

Note that some differences in the level of damage across national borders may be at least partly due to differences in standards used. This restriction, however, does not affect the reliability of the trends over time.

Annex II-5
Percent of damaged trees of all species (1997-2008).

Participating countries	All species Defoliation classes 2-4												change % points
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2007/ 2008
Albania		9.8	9.9	10.1	10.2	13.1		12.2		11.1			
Andorra								36.1		23.0	47.2	15.3	-31.9
Austria	7.1	6.7	6.8	8.9	9.7	10.2	11.1	13.1	14.8	15.0			
Belarus	36.3	30.5	26.0	24.0	20.7	9.5	11.3	10.0	9.0	7.9	8.1	8.0	-0.1
Belgium	17.4	17.0	17.7	19.0	17.9	17.8	17.3	19.4	19.9	17.9	16.4	14.5	-1.9
Bulgaria	49.6	60.2	44.2	46.3	33.8	37.1	33.7	39.7	35.0	37.4	29.7	31.9	2.2
Croatia	33.1	25.6	23.1	23.4	25.0	20.6	22.0	25.2	27.1	24.9	25.1	23.9	-1.2
Cyprus					8.9	2.8	18.4	12.2	10.8	20.8	16.7	47.0	30.3
Czech Rep.	68.6	48.8	50.4	51.7	52.1	53.4	54.4	57.3	57.1	56.2	57.1	56.7	-0.4
Denmark	20.7	22.0	13.2	11.0	7.4	8.7	10.2	11.8	9.4	7.6	6.1	9.1	3.0
Estonia	11.2	8.7	8.7	7.4	8.5	7.6	7.6	5.3	5.4	6.2	6.8	9.0	2.2
Finland	12.2	11.8	11.4	11.6	11.0	11.5	10.7	9.8	8.8	9.7	10.5	10.2	-0.3
France	25.2	23.3	19.7	18.3	20.3	21.9	28.4	31.7	34.2	35.6	35.4	32.4	-3.0
Germany	19.8	21.0	21.7	23.0	21.9	21.4	22.5	31.4	28.5	27.9	24.8	25.7	0.9
Greece	23.7	21.7	16.6	18.2	21.7	20.9			16.3				
Hungary	19.4	19.0	18.2	20.8	21.2	21.2	22.5	21.5	21.0	19.2	20.7		
Ireland	13.6	16.1	13.0	14.6	17.4	20.7	13.9	17.4	16.2	7.4	6.0	10.0	4.0
Italy	35.8	35.9	35.3	34.4	38.4	37.3	37.6	35.9	32.9	30.5	35.7	32.8	-2.9
Latvia	19.2	16.6	18.9	20.7	15.6	13.8	12.5	12.5	13.1	13.4	15.0	15.3	0.3
Liechtenstein													
Lithuania	14.5	15.7	11.6	13.9	11.7	12.8	14.7	13.9	11.0	12.0	12.3	19.6	7.3
Luxembourg	29.9	25.3	19.2	23.4									
Rep. of Macedonia													
Rep. of Moldova				29.1	36.9	42.5	42.4	34.0	26.5	27.6	32.5	33.6	1.1
The Netherlands	34.6	31.0	12.9	21.8	19.9	21.7	18.0	27.5	30.2	19.5			
Norway	30.7	30.6	28.6	24.3	27.2	25.5	22.9	20.7	21.6	23.3	26.2	22.7	-3.5
Poland	36.6	34.6	30.6	32.0	30.6	32.7	34.7	34.6	30.7	20.1	20.2	18.0	-2.2
Portugal	8.3	10.2	11.1	10.3	10.1	9.6	13.0	16.6	24.3				
Romania	15.6	12.3	12.7	14.3	13.3	13.5	12.6	11.7	8.1	8.6	23.2		
Russian Fed.					9.8	10.9							
Serbia	7.7	8.4	11.2	8.4	14.0	3.9	22.8	14.3	16.4	11.3	15.4	11.5	-3.9
Slovak Rep.	31.0	32.5	27.8	23.5	31.7	24.8	31.4	26.7	22.9	28.1	25.6	29.3	3.7
Slovenia	25.7	27.6	29.1	24.8	28.9	28.1	27.5	29.3	30.6	29.4	35.8	36.9	1.1
Spain	13.7	13.6	12.9	13.8	13.0	16.4	16.6	15.0	21.3	21.5	17.6	15.6	-2.0
Sweden	14.9	14.2	13.2	13.7	17.5	16.8	19.2	16.5	18.4	19.4	17.9	17.3	-0.6
Switzerland	16.9	19.1	19.0	29.4	18.2	18.6	14.9	29.1	28.1	22.6	22.4	19.0	-3.4
Turkey											8.1	24.6	16.5
Ukraine	31.4	51.5	56.2	60.7	39.6	27.7	27.0	29.9	8.7	6.6	7.1	8.2	1.1
United Kingdom	19.0	21.1	21.4	21.6	21.1	27.3	24.7	26.5	24.8	25.9	26.0		

Andorra: observe the small sample size. *Austria*: From 2003 on. results are based on the 16x16 km transnational grid net and must not be compared with previous years. *Cyprus*: Only conifers assessed. *Czech Republic*: Only trees older than 60 years assessed until 1997. *Moldova*: only broadleaves assessed. *Poland*: Change of grid net since 2006. *Russian Federation:* North-western and Central European parts only. *Ukraine*: Change of gridnet in 2005. *Hungary, Romania*: comparisons not possible due to changing survey designs.

Note that some differences in the level of damage across national borders may be at least partly due to differences in standards used. This restriction, however, does not affect the reliability of the trends over time.

Annex II-6
Percent of damaged conifers (1997-2008).

Paticipating countries	Conifers Defoliation classes 2-4												change % points
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2007/ 2008
Albania		12.0	12.1	12.3	12.4	15.5		14.0		13.6			
Andorra								36.1		23.0	47.2	15.3	-31.7
Austria	6.3	6.3	6.4	9.1	9.6	10.1	11.2	13.1	15.1	14.5			
Belarus	41.2	33.9	28.9	26.1	23.4	9.7	9.5	8.9	8.4	7.5	8.1	8.1	0.0
Belgium	19.2	13.5	15.5	19.5	17.5	19.7	18.6	15.6	16.8	15.8	13.9	13.2	-0.7
Bulgaria	53.5	69.8	48.9	46.4	39.1	44.0	38.4	47.1	45.4	47.6	37.4	45.6	8.2
Croatia	68.7	45.8	53.2	53.3	65.1	63.5	77.4	70.6	79.5	71.7	61.1	59.1	-2.0
Cyprus					8.9	2.8	18.4	12.2	10.8	20.8	16.7	46.9	30.2
Czech Rep.	71.9	54.6	57.4	58.3	58.1	60.1	60.7	62.6	62.7	62.3	62.9	62.8	-0.1
Denmark	15.9	17.0	9.9	8.8	6.7	4.5	6.1	5.8	5.5	1.7	3.1	9.9	6.8
Estonia	11.4	9.0	9.1	7.5	8.8	7.9	7.7	5.3	5.6	6.0	6.7	9.3	2.6
Finland	12.8	12.2	11.9	12.0	11.4	11.9	11.1	10.1	9.2	9.6	10.4	10.1	-0.3
France	16.2	16.8	14.1	12.0	14.0	15.2	18.9	18.6	20.8	23.6	24.1	25.1	1.0
Germany	15.4	19.0	19.2	19.6	20.0	19.8	20.1	26.3	24.9	22.7	20.2	24.1	3.9
Greece	13.8	12.9	13.5	16.5	17.2	16.1			15.0				
Hungary	17.4	18.7	17.6	21.5	19.5	22.8	27.6	24.2	22.0	20.8	22.3		
Ireland	13.6	16.1	13.0	14.6	17.4	20.7	13.9	17.4	16.2	7.4	6.2	10.0	3.8
Italy	28.1	25.5	23.1	19.2	19.1	20.5	20.4	21.7	22.8	19.5	22.7	24.0	1.3
Latvia	21.9	18.9	20.6	20.1	15.8	14.3	12.2	11.9	13.2	15.2	16.2	16.7	0.5
Liechtenstein													
Lithuania	13.9	13.6	11.5	12.0	9.8	9.3	10.7	10.2	9.3	9.5	10.2	19.1	8.9
Luxembourg	8.0	10.5	8.7	7.0									
Rep. of Macedonia													
Rep. of Moldova							55.4	35.5	38.0	38.6	34.3		
The Netherlands	45.3	43.2	14.5	23.5	20.7	17.5	9.4	17.2	17.9	15.3			
Norway	28.5	27.5	24.3	21.8	25.1	24.1	21.2	16.7	19.7	20.2	23.0	19.2	-3.8
Poland	36.8	34.6	30.6	32.1	30.3	32.5	33.2	33.4	29.6	21.1	20.9	17.5	-3.4
Portugal	7.8	6.6	6.0	4.3	4.3	3.6	5.3	10.8	17.1				
Romania	10.3	9.0	9.1	9.8	9.6	9.9	9.8	7.6	4.7	5.2	21.8		
Russian Fed.	0.0				9.8	10.0							
Serbia	7.9	6.0	9.2	10.0	21.3	7.3	39.6	19.8	21.3	12.6	13.3	13.0	-0.3
Slovak Rep.	42.2	40.3	40.2	37.9	38.7	40.4	39.7	36.2	35.3	42.4	37.5	41.1	3.6
Slovenia	32.5	36.7	38.0	34.5	32.2	31.4	35.3	37.4	33.8	32.1	36.0	40.7	4.7
Spain	11.5	12.9	9.8	12.0	11.6	15.6	14.1	14.0	19.4	18.7	15.8	12.9	-2.9
Sweden	15.9	15.0	13.6	13.5	18.4	17.7	20.4	16.0	19.6	20.1	17.9	17.3	-0.6
Switzerland	19.9	19.7	18.3	33.0	19.1	19.9	13.3	27.4	28.2	22.5	20.7	18.7	-2.0
Turkey											8.1	16.2	8.1
Ukraine	32.7	64.9	50.0	47.3	16.8	14.6	15.4	11.4	8.1	6.9	7.1	7.1	0.0
United Kingdom	17.0	19.8	20.1	20.2	20.6	25.1	25.8	23.2	22.2	23.3	16.1		

Andorra: observe the small sample size. *Austria*: From 2003 on. results are based on the 16x16 km transnational grid net and must not be compared with previous years. *Czech Republic*: Only trees older than 60 years assessed until 1997. *Moldova*: Only broadleaves assessed. *Poland*: Change of grid net since 2006. *Russian Federation:* North-western and Central European parts only. *Ukraine*: Change of gridnet in 2005. *Hungary, Romania*: Comparisons not possible due to changing survey designs.

Note that some differences in the level of damage across national borders may be at least partly due to differences in standards used. This restriction, however, does not affect the reliability of the trends over time.

Annex II-7
Percent of damaged broadleaves (1997-2008).

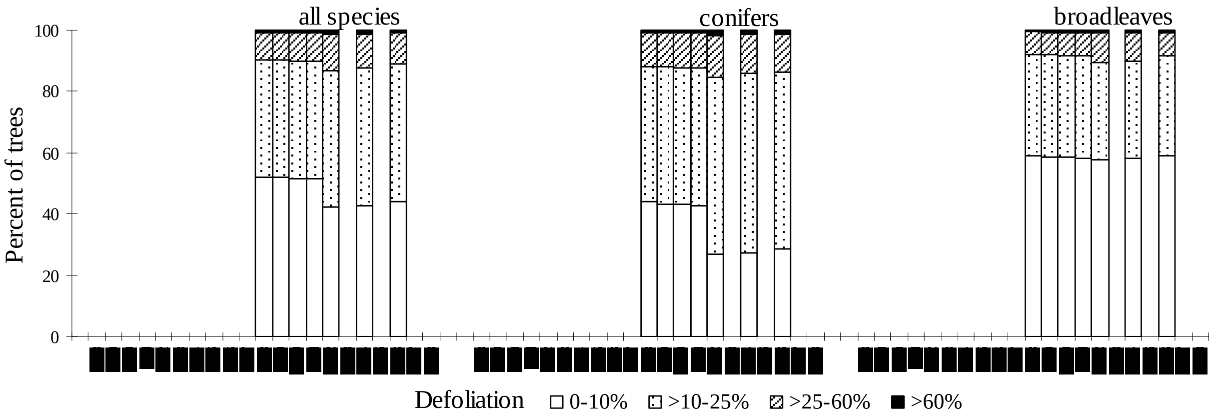
Paticipating countries	Broadleaves Defoliation classes 2-4												change % points
	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2007/ 2008
Albania		8.0	8.1	8.4	8.4	10.7		10.3		8.5			
Andorra										only conifers assessed			
Austria	12.2	9.6	9.4	7.6	10.4	11.3	10.2	13.6	12.9	20.1			
Belarus	23.0	19.3	17.0	16.9	13.3	9.0	15.8	12.9	10.6	8.9	8.2	7.6	-0.6
Belgium	16.1	19.2	19.1	18.8	18.3	17.0	16.6	21.3	21.4	18.8	17.5	15.3	-2.2
Bulgaria	43.9	48.4	35.9	45.8	26.0	29.0	27.2	30.1	23.1	36.4	21.1	17.8	-3.3
Croatia	27.8	21.9	16.8	18.3	18.7	14.4	14.3	17.2	19.2	18.2	20.0	19.1	-0.9
Cyprus								only conifers assessed					
Czech Rep.	26.5	13.5	17.1	21.4	21.7	19.9	24.4	31.8	32.0	31.2	33.5	32.2	-1.3
Denmark	28.4	30.1	18.8	13.9	8.5	15.4	16.6	19.1	14.4	14.8	10.3	8.0	-2.3
Estonia	7.4	1.0	1.1	9.5	2.1	2.7	6.7	5.3	3.4	8.6	7.6	3.4	-4.2
Finland	8.4	9.4	8.6	9.9	8.8	8.8	8.3	8.4	7.2	10.3	10.9	10.6	-0.3
France	29.9	26.9	22.9	21.6	23.6	25.5	33.5	38.7	41.3	42.0	41.6	36.5	-5.1
Germany	28.6	25.2	26.9	29.9	25.4	24.7	27.3	41.5	35.8	37.2	32.8	28.4	-4.4
Greece	34.9	31.7	20.2	20.2	26.6	26.5			17.9				
Hungary	19.7	19.0	18.2	20.8	21.5	20.8	22.0	21.0	20.9	19.0	20.6		
Ireland								only conifers assessed					
Italy	38.0	38.9	39.3	40.5	46.3	44.6	45.0	42.0	36.5	35.2	40.4	35.8	-4.6
Latvia	11.3	13.6	14.2	22.2	14.8	12.8	13.5	14.3	12.9	8.5	11.8	11.5	-0.3
Liechtenstein													
Lithuania	15.9	19.7	11.8	17.7	16.3	19.0	24.6	21.8	15.4	16.6	17.7	20.3	2.6
Luxembourg	41.8	33.3	25.8	33.5									
Rep. of Macedonia													
Rep. of Moldova	30.0		41.4	29.2	36.9	42.5	42.3	33.9	26.4	27.6	7.4	34.6	2.1
The Netherlands	17.8	14.0	10.0	18.8	18.5	29.6	33.7	46.9	53.1	26.2			
Norway	38.9	42.2	44.8	34.0	33.7	30.4	29.0	33.2	27.6	33.2	36.3	33.8	-2.5
Poland	35.8	34.8	31.1	32.0	31.4	33.1	39.6	38.7	34.1	18.0	18.9	19.1	0.2
Portugal	8.6	12.0	13.7	13.2	12.8	12.6	16.2	19.0	27.0				
Romania	16.9	13.3	14.0	15.8	14.7	14.8	13.3	13.0	9.3	9.9	23.5		
Russian Fed.						16.0							
Serbia	7.4	10.1	13.0	6.7	6.7	0.6	21.5	13.5	15.7	11.0	15.7	11.3	-4.4
Slovak Rep.	23.3	27.0	19.3	13.9	26.9	14.5	25.6	19.9	13.6	17.0	16.6	20.8	4.2
Slovenia	21.4	21.7	23.2	18.4	26.7	25.9	22.6	24.2	28.5	27.6	35.7	34.6	-1.1
Spain	15.8	14.4	16.1	15.7	14.4	17.3	19.1	16.1	23.3	24.4	19.5	18.4	-1.1
Sweden	6.1	7.4	8.7	7.5	14.1	9.6	11.1	8.3	9.2	10.8	only conifers		
Switzerland	12.5	18.1	20.4	22.1	16.3	16.0	18.1	32.8	27.9	22.6	26.1	19.6	-6.5
Turkey								only conifers assessed					
Ukraine	30.7	43.2	59.7	69.6	53.3	36.7	35.3	43.2	9.2	6.2	7.1	9.1	2.0
United Kingdom	22.0	22.9	23.2	23.8	21.9	30.3	23.2	30.6	28.2	29.2	35.3		

Andorra: observe the small sample size. *Austria*: From 2003 on. results are based on the 16x16 km transnational grid net and must not be compared with previous years. *Czech Republic*: Only trees older than 60 years assessed until 1997. *Moldova*: Only broadleaves assessed. *Poland*: Change of grid net since 2006.*Russian Federation:* North-western and Central European parts only. *Ukraine*: Change of gridnet in 2005. *Hungary, Romania*: Comparisons not possible due to changing survey designs.

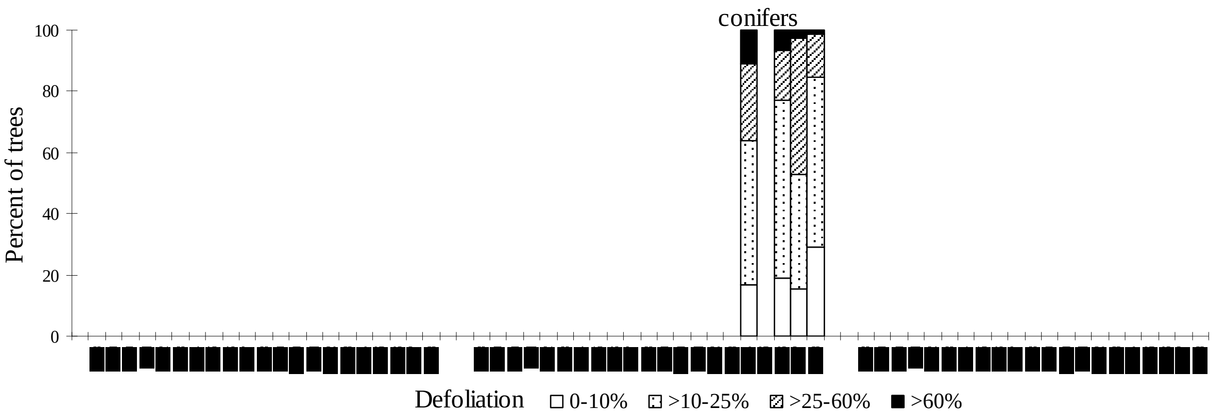
Note that some differences in the level of damage across national borders may be at least partly due to differences in standards used. This restriction, however, does not affect the reliability of the trends over time.

Annex II-8
Changes in defoliation (1988-2008)

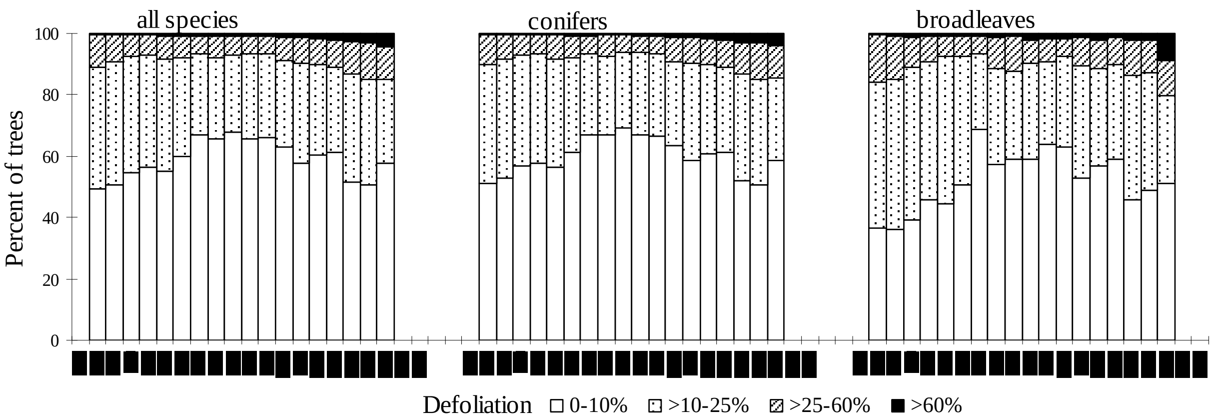
Albania



Andorra

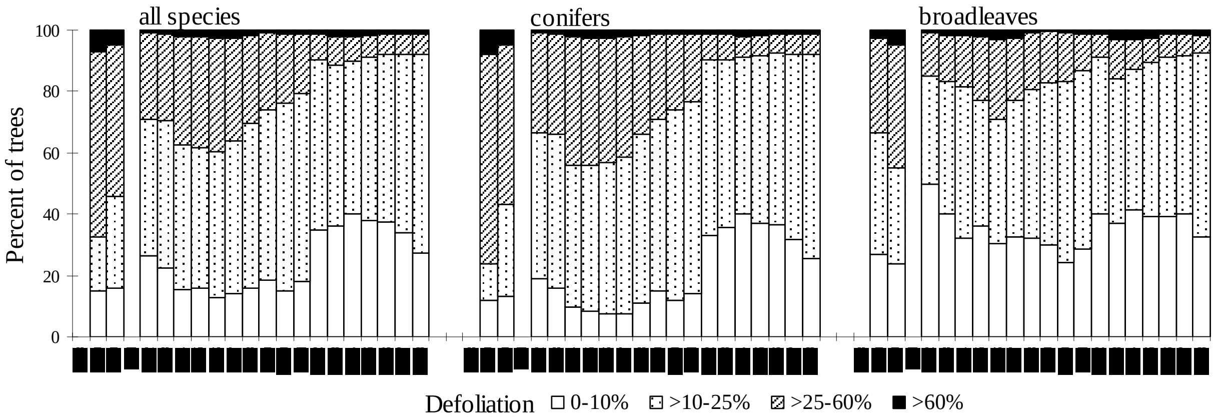


Austria *

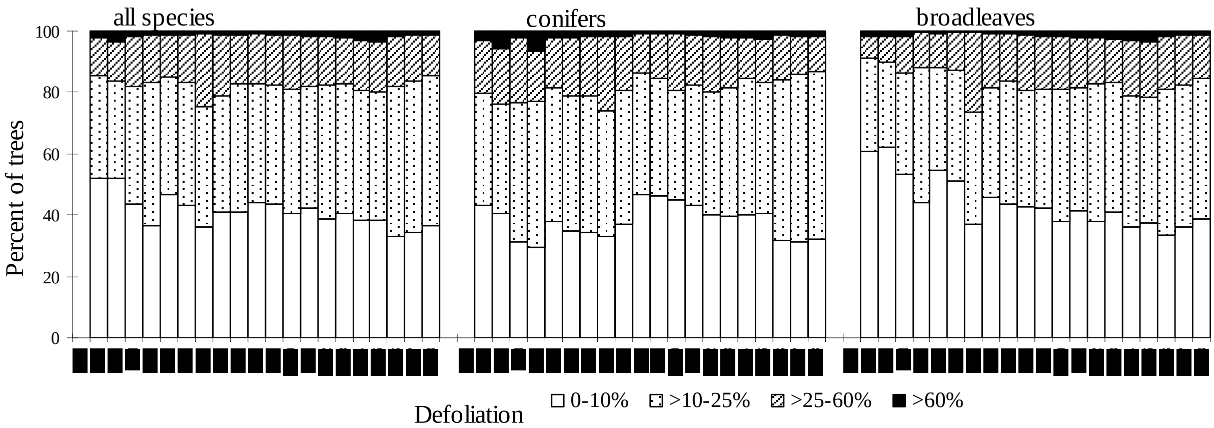


* from 2003 on, results are based on the 16x16 km transnational gridnet and must not be compared with previous years.

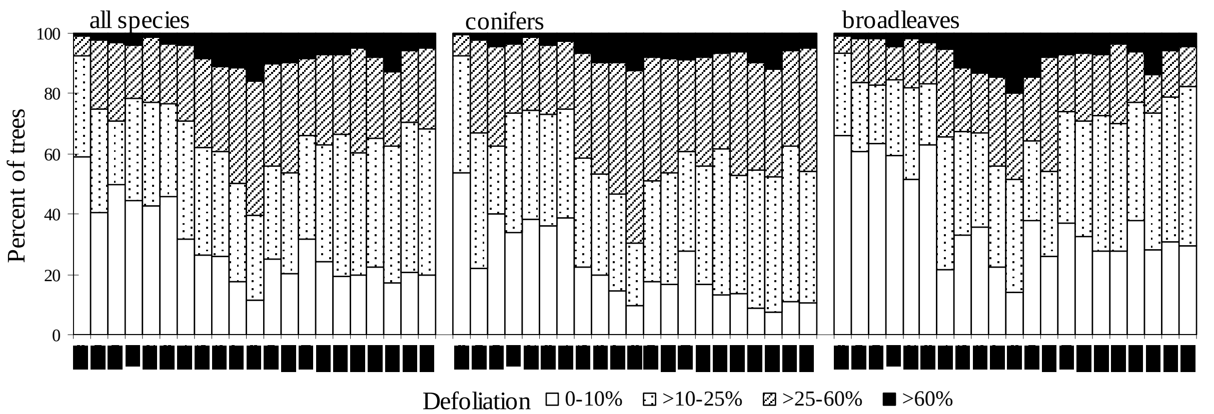
Belarus



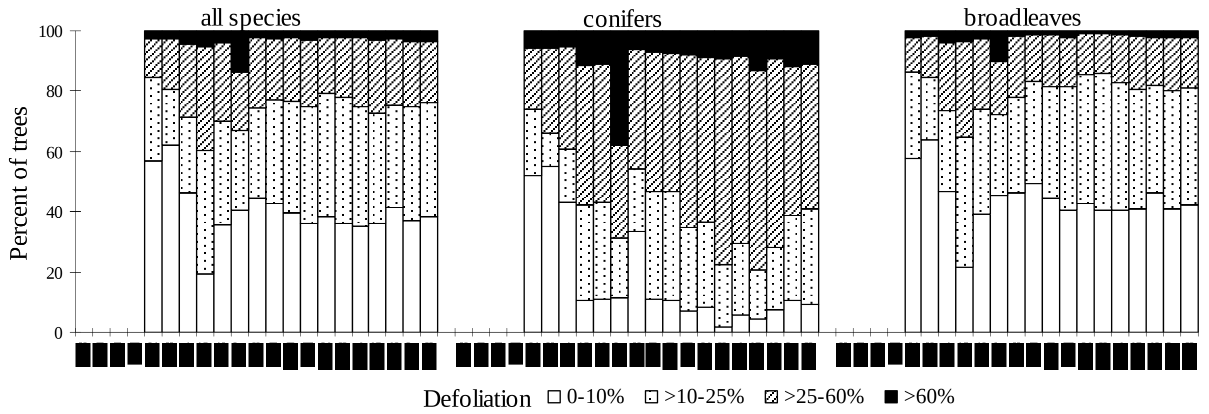
Belgium



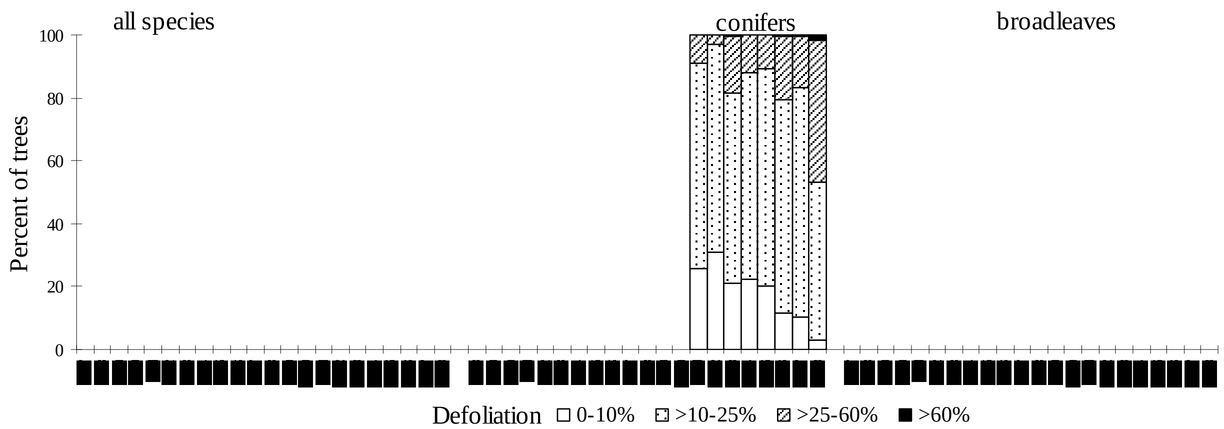
Bulgaria



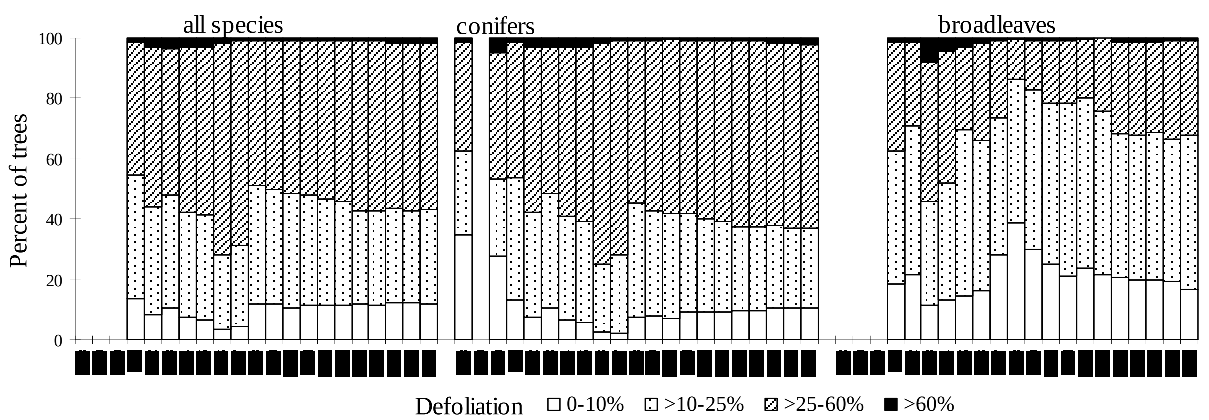
Croatia

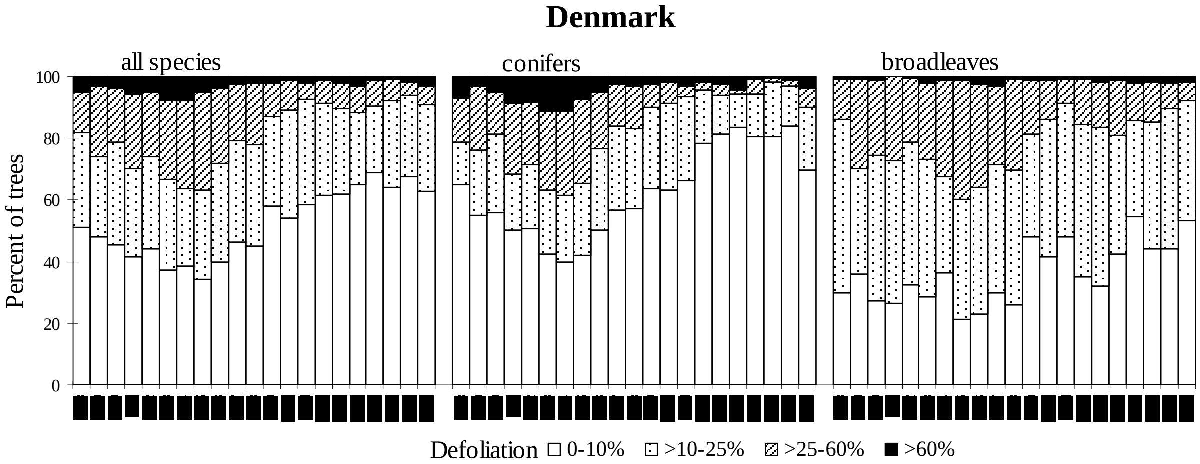


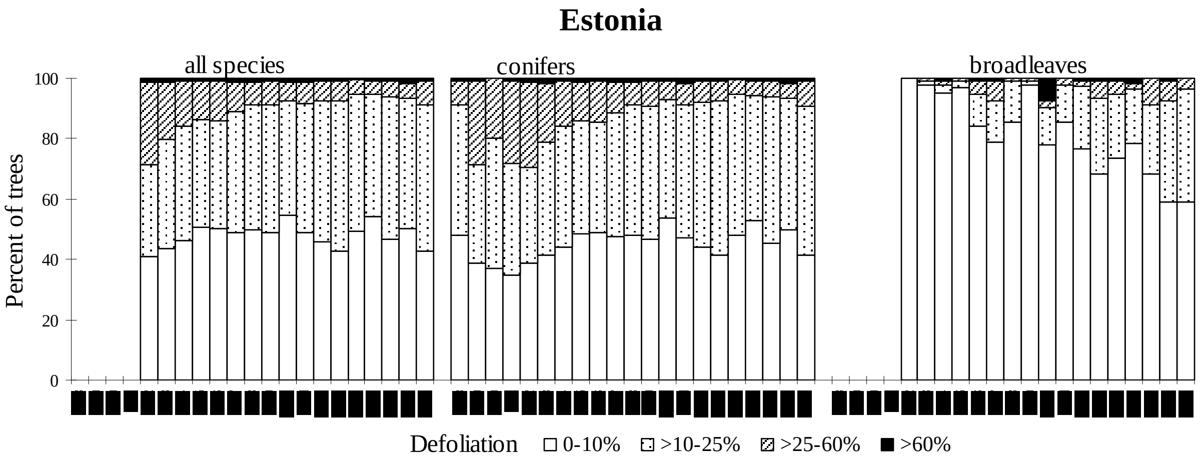
Cyprus

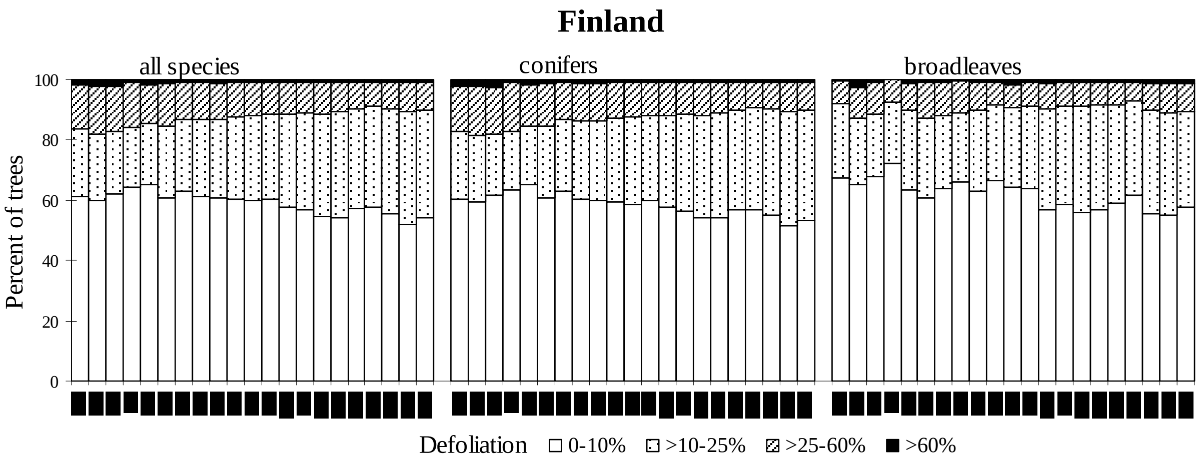


Czech Republic

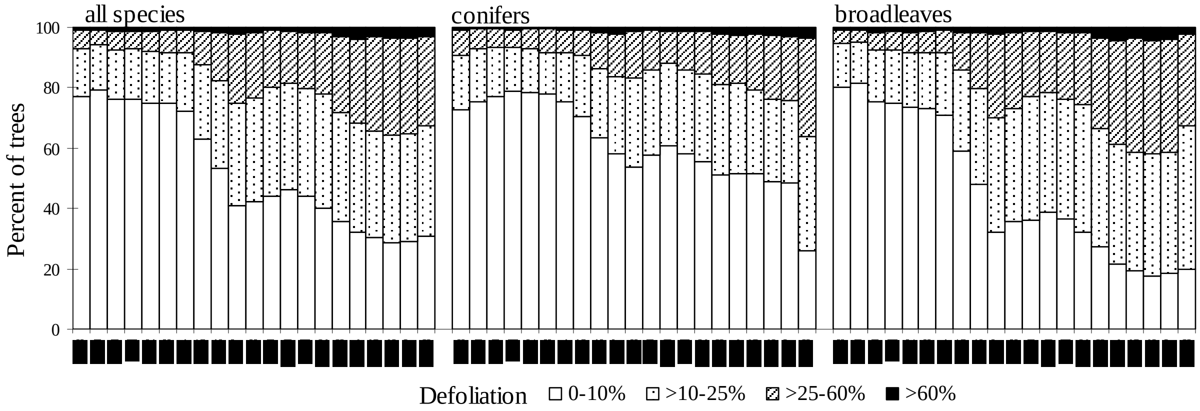



Denmark
all species
conifers
broadleaves
Percent of trees
100
80
60
40
20
0
Defoliation
0-10%
>10-25%
>25-60%
>60%


Estonia
all species
conifers
broadleaves
Percent of trees
100
80
60
40
20
0
Defoliation
0-10%
>10-25%
>25-60%
>60%

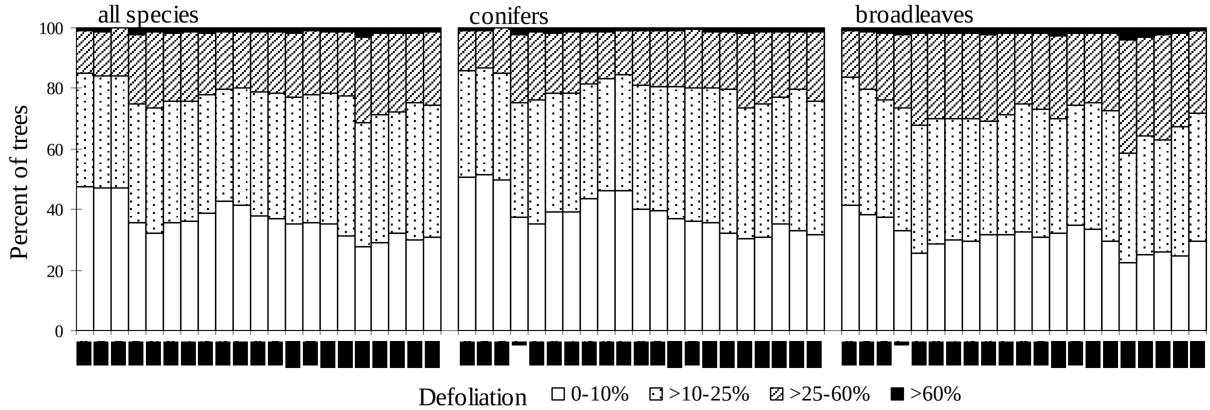

Finland
all species
conifers
broadleaves
Percent of trees
100
80
60
40
20
0
Defoliation
0-10%
>10-25%
>25-60%
>60%

France *



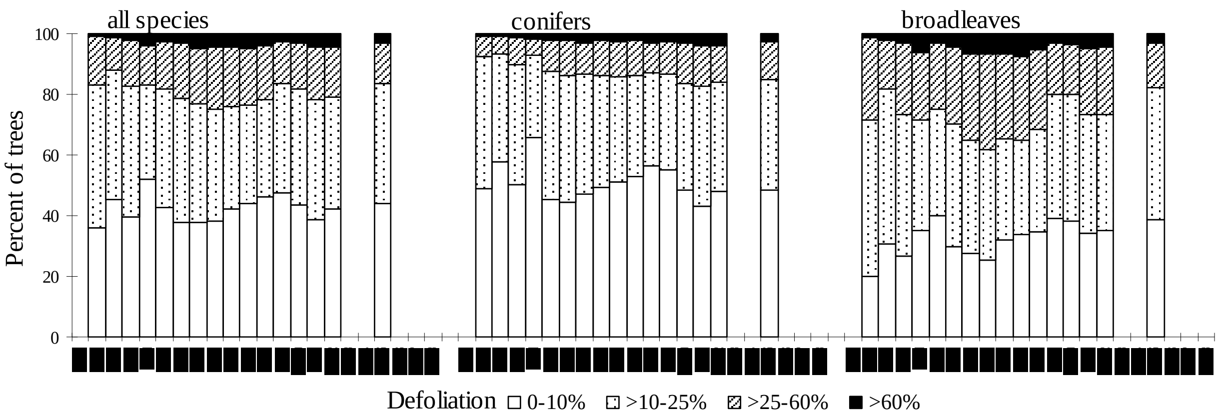
* due to methodological changes, only the time series 1988-94 and 1997-2008 are consistent, but not comparable to each other.

Germany

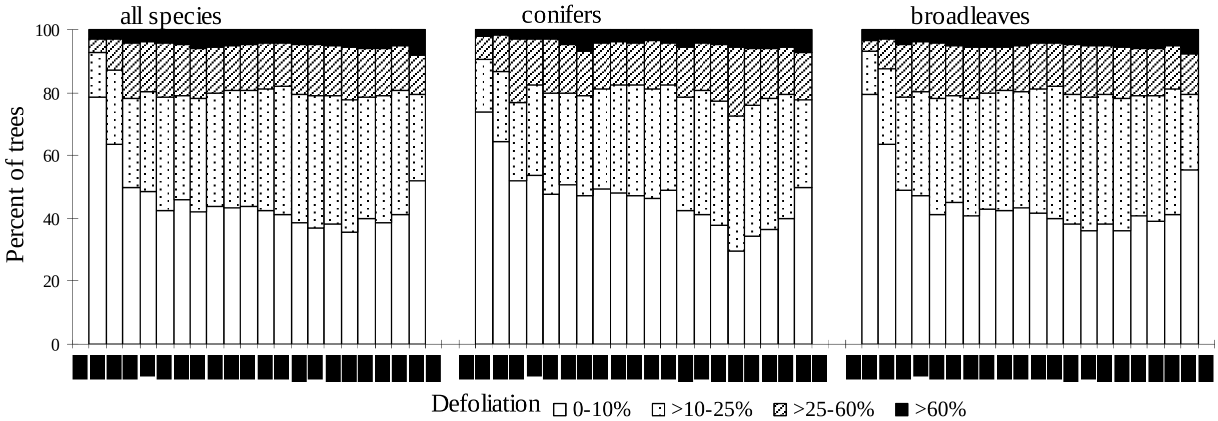


* since 1991 with former GDR

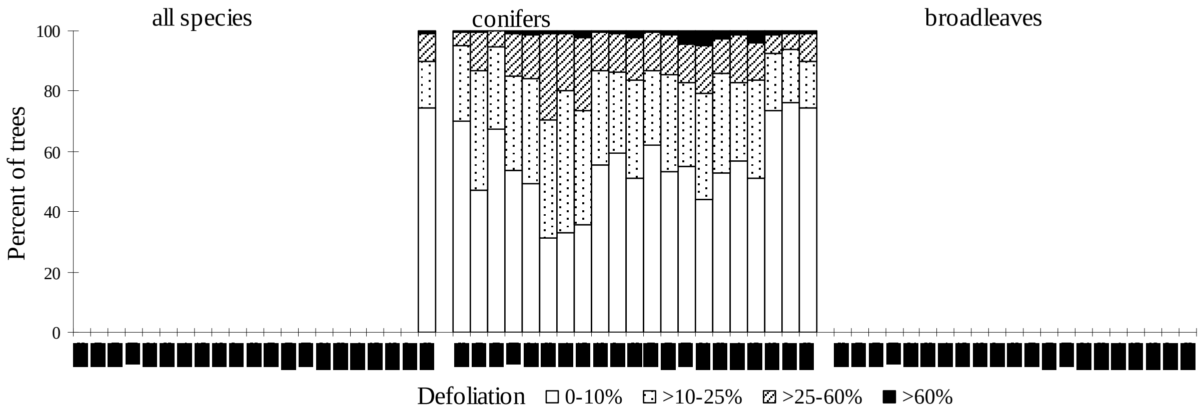
Greece



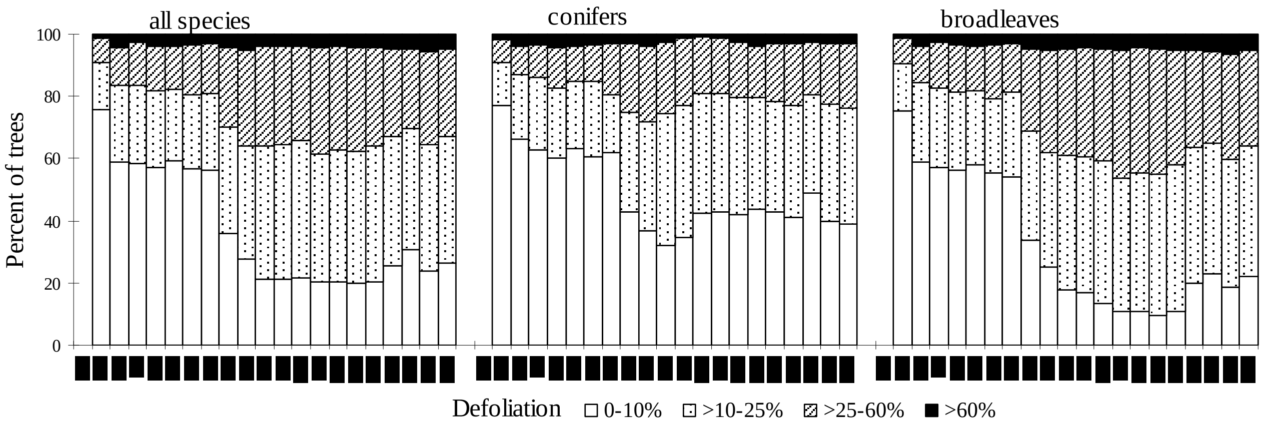
Hungary



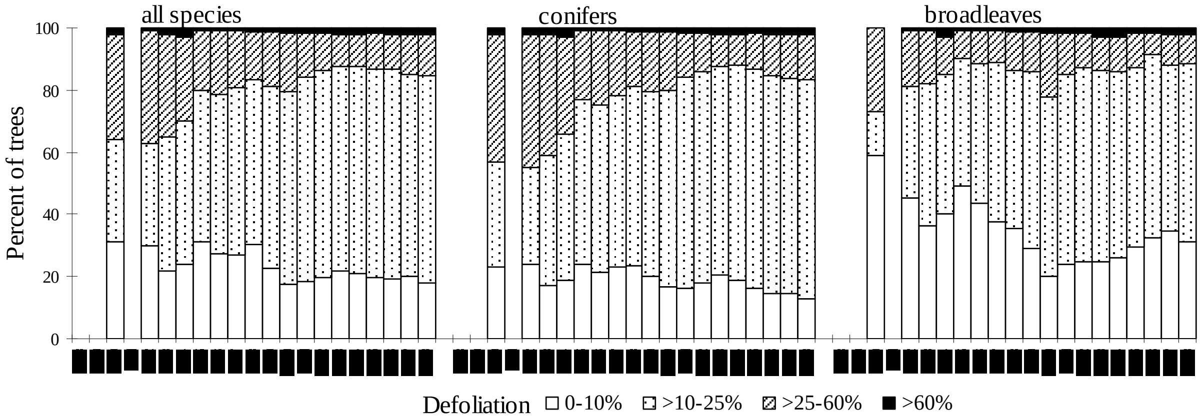
Ireland



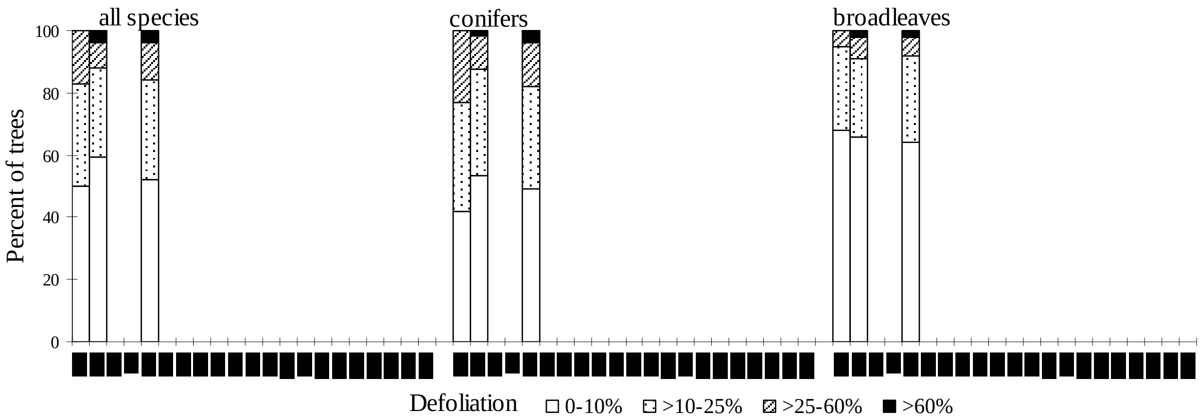
Italy



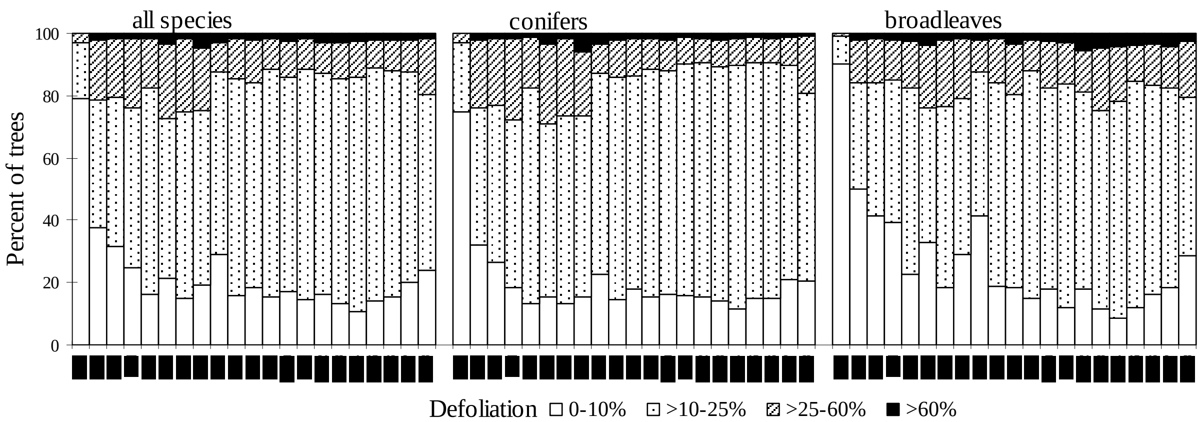
Latvia



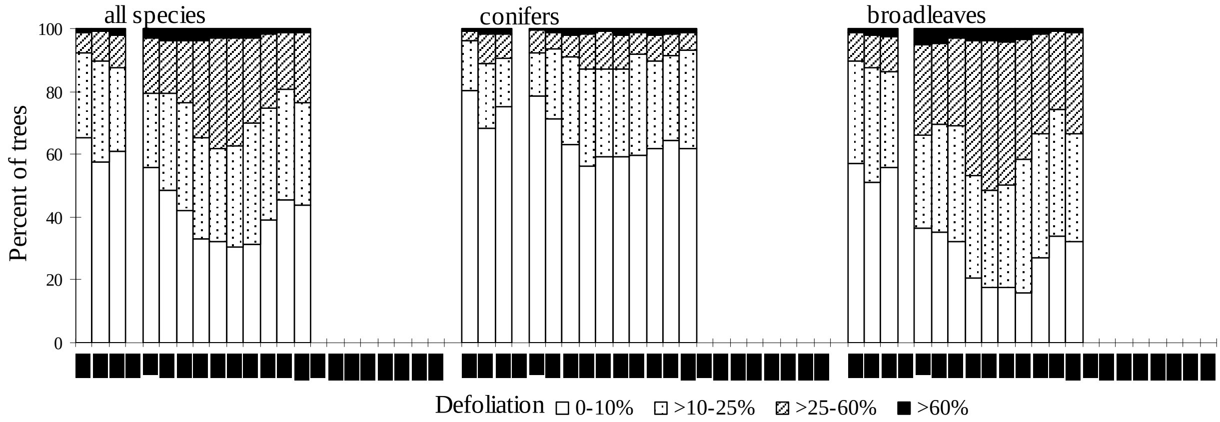
Liechtenstein



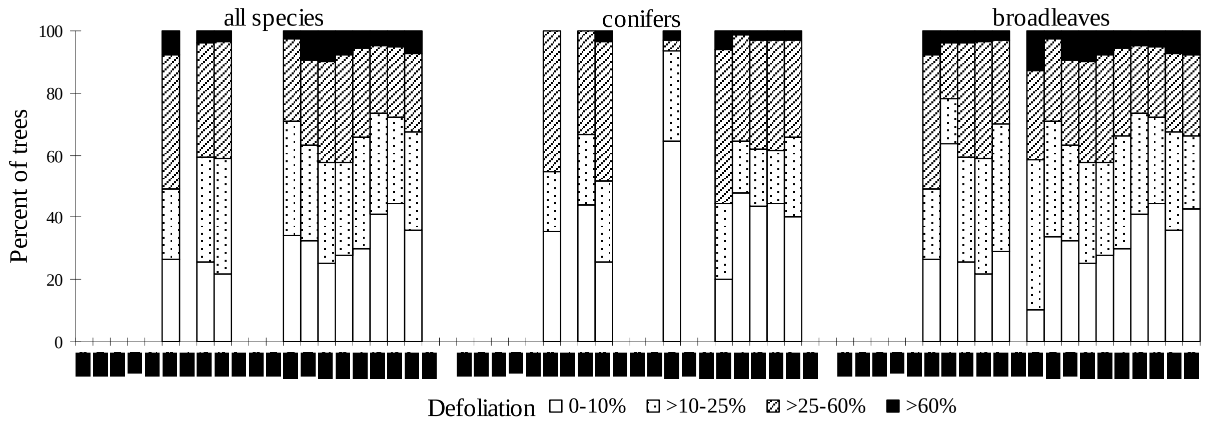
Lithuania



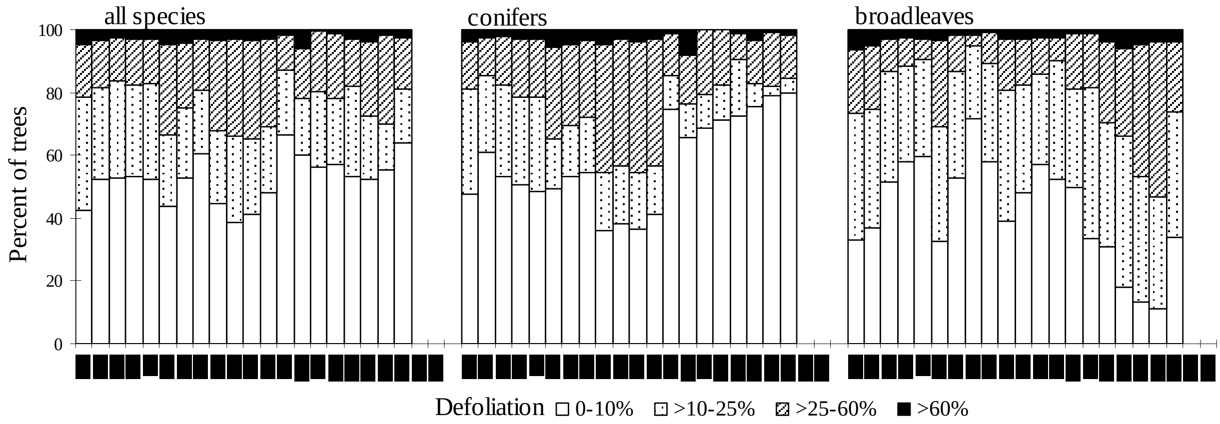
Luxembourg



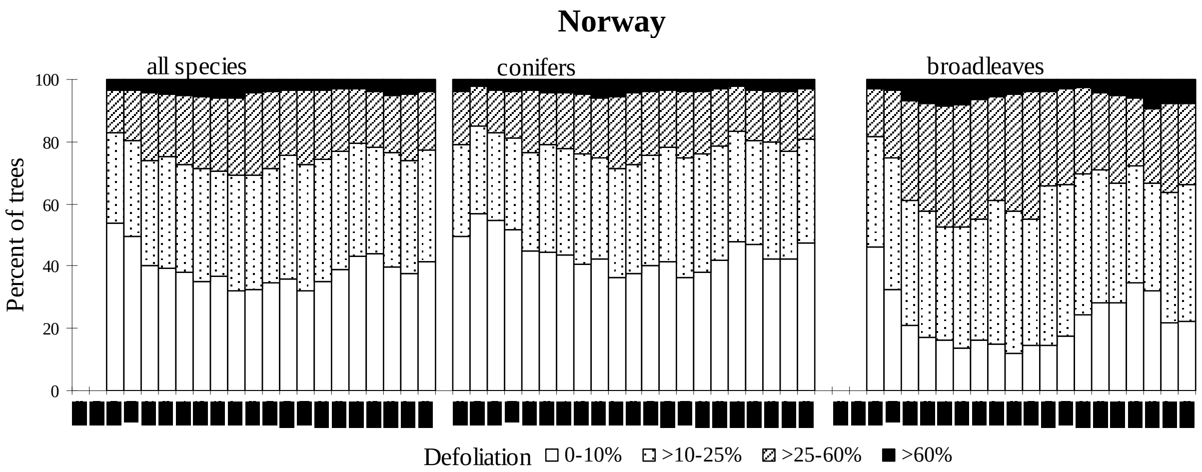
Republic of Moldova

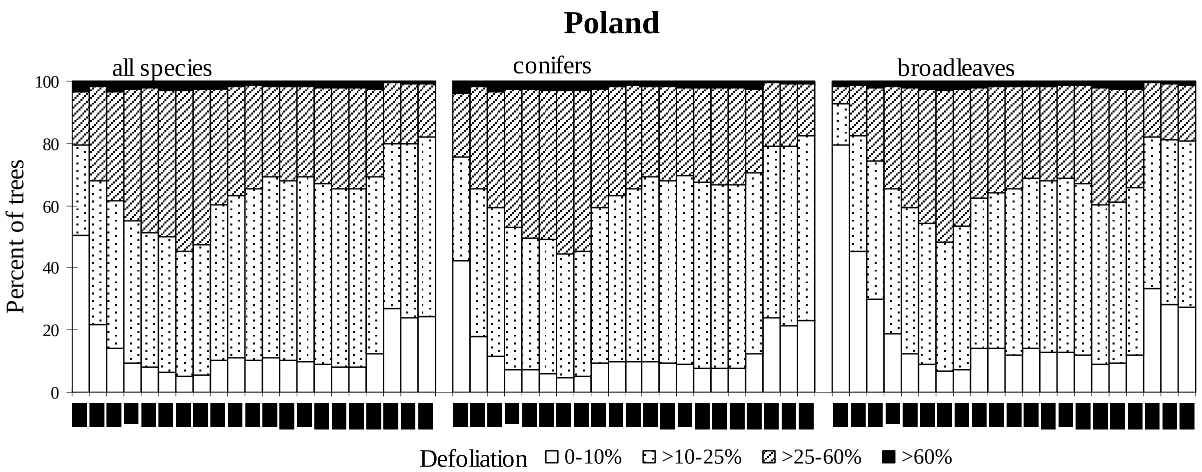


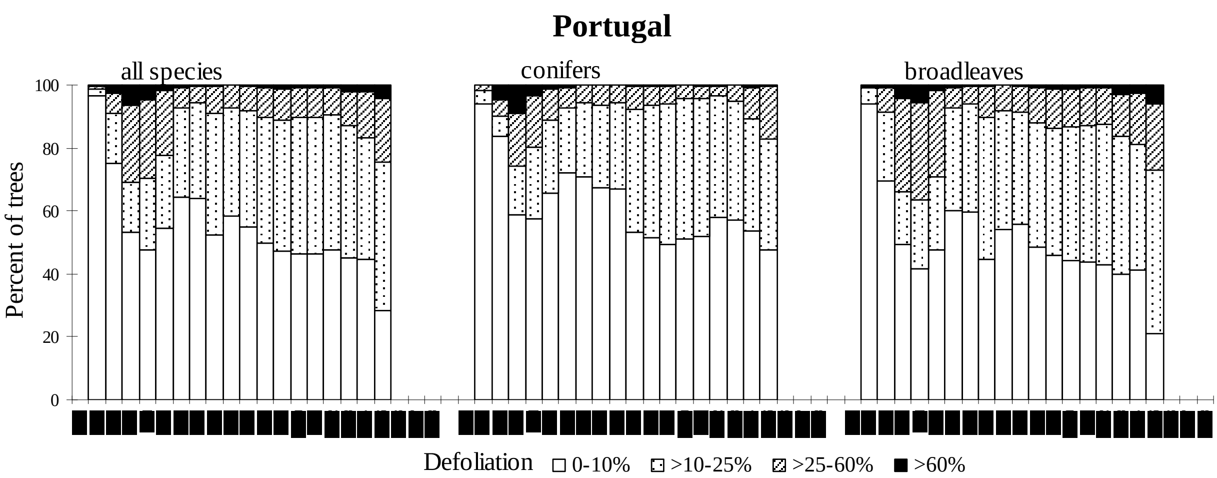
The Netherlands



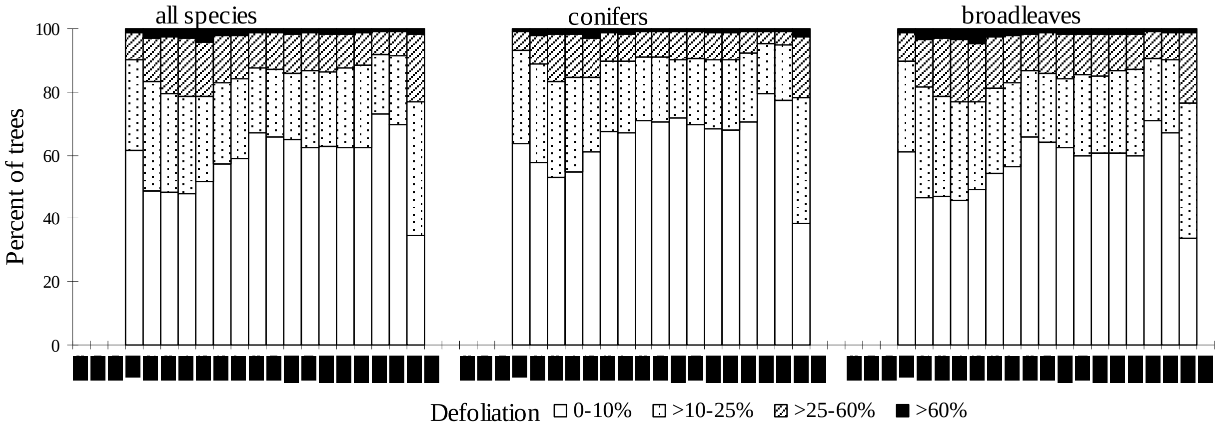
1989-1994: 1500 plots, 1995-1998: 200 plots, since 1999: 11 plots


Norway
all species
conifers
broadleaves
100
80
60
40
20
0
Percent of trees
Defoliation
0-10%
>10-25%
>25-60%
>60%


Poland
all species
conifers
broadleaves
100
80
60
40
20
0
Percent of trees
Defoliation
0-10%
>10-25%
>25-60%
>60%

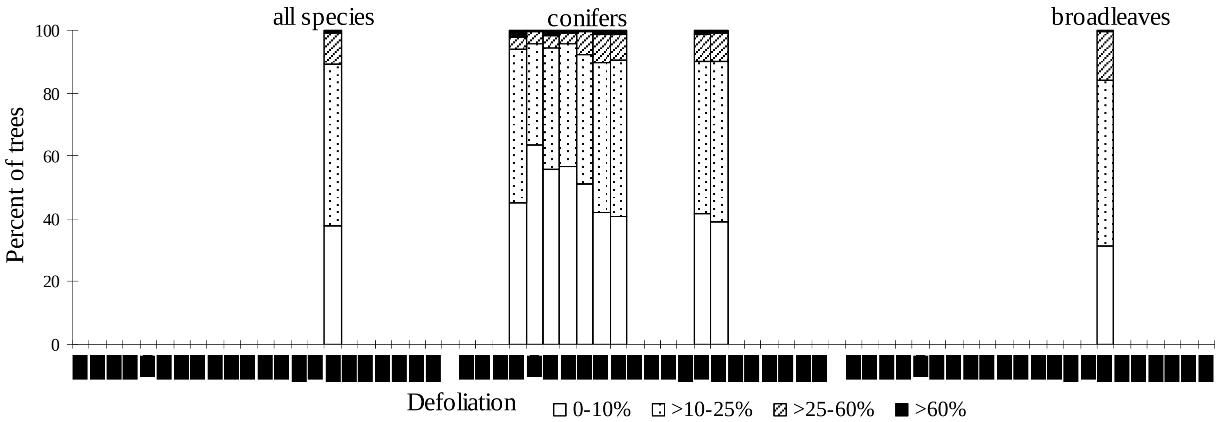

Portugal
all species
conifers
broadleaves
100
80
60
40
20
0
Percent of trees
Defoliation
0-10%
>10-25%
>25-60%
>60%

Romania *



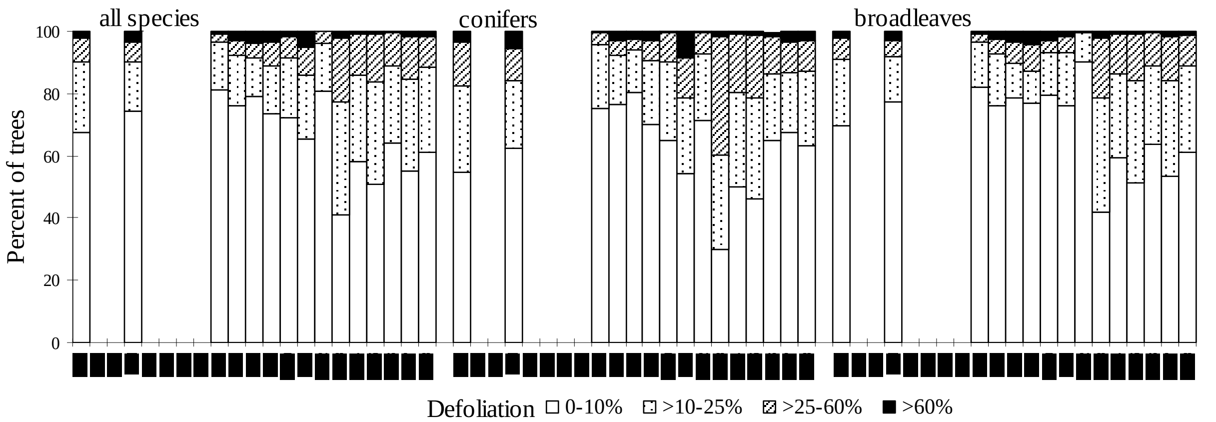
* from 2007 on, results are based on the 16x16 km transnational gridnet and must not be compared with previous years.

Russian Federation *

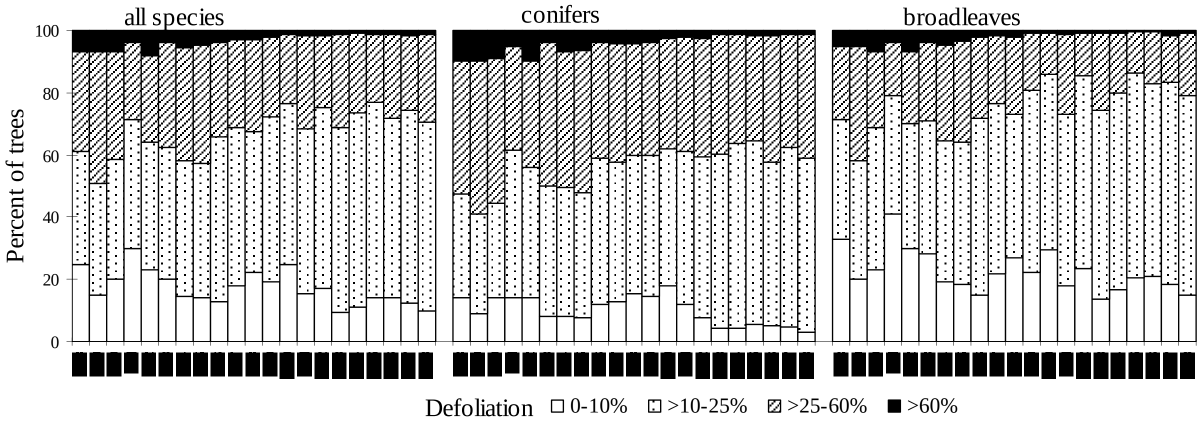


* Only regional surveys in north-western and Central European parts of Russia.

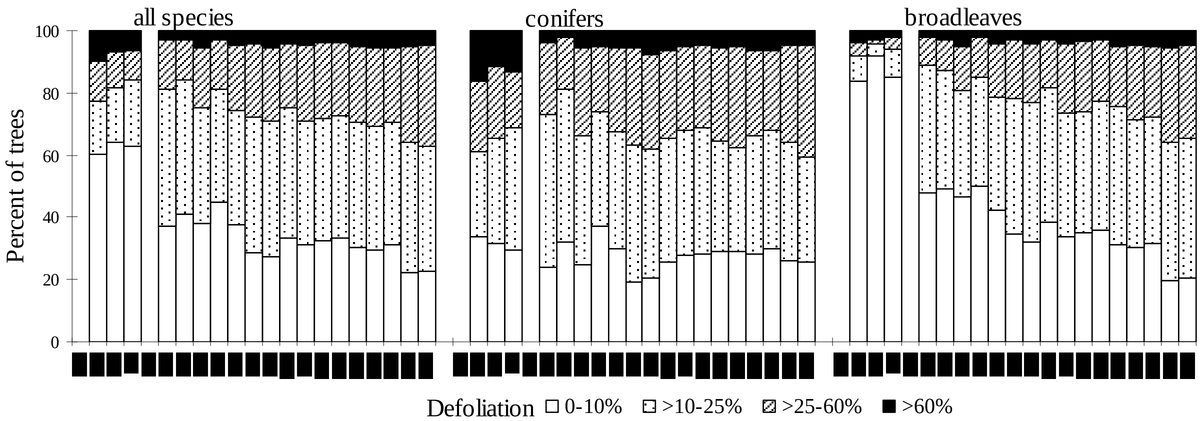
Serbia



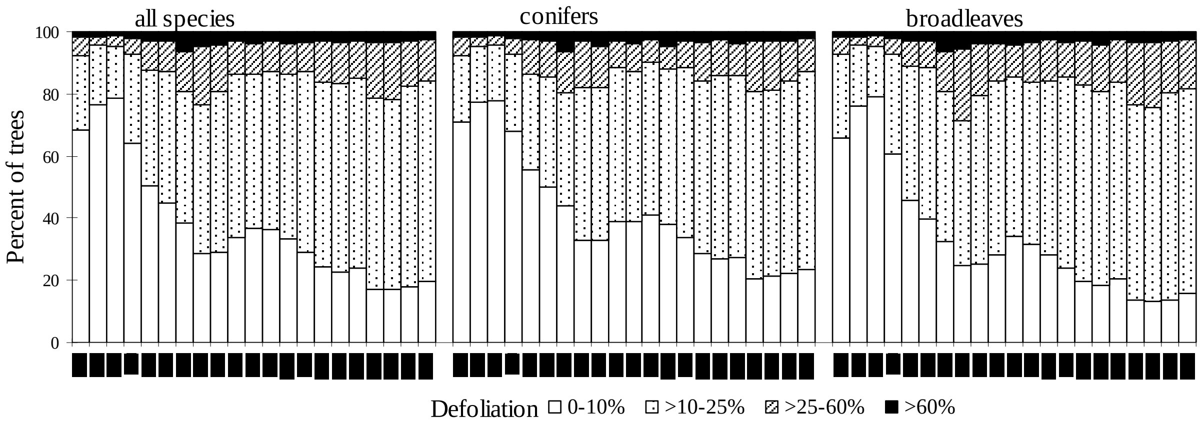
Slovak Republic



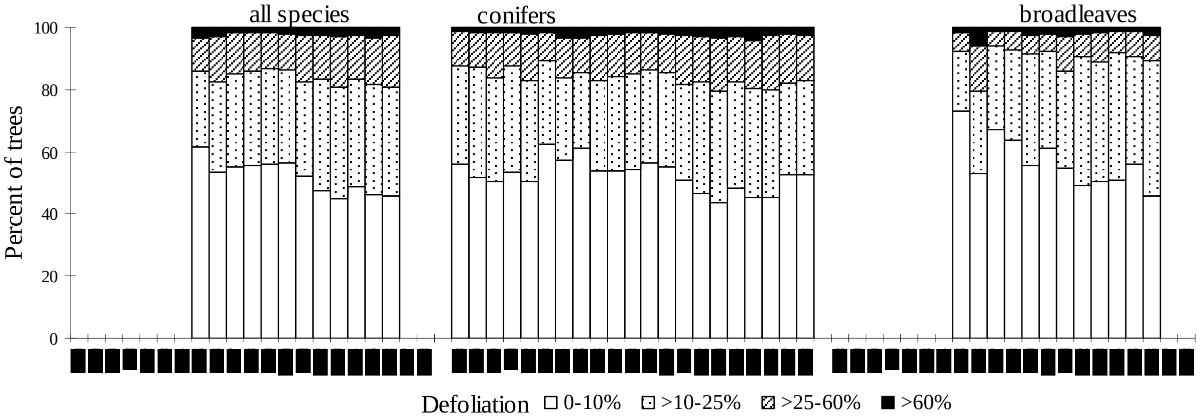
Slovenia



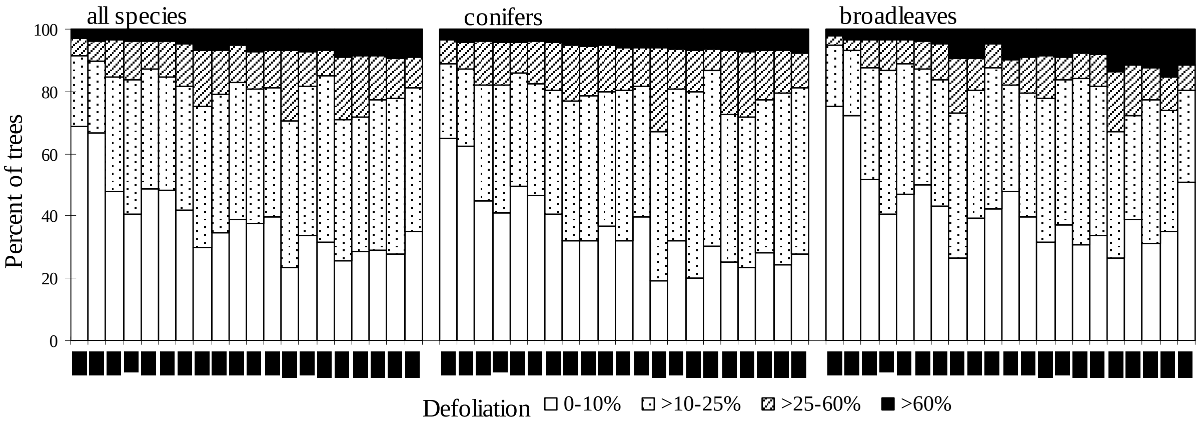
Spain



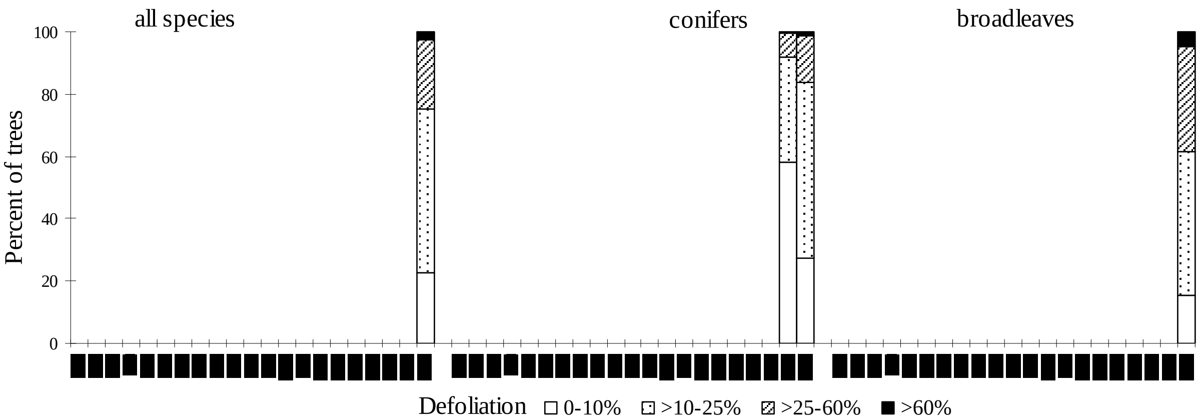
Sweden



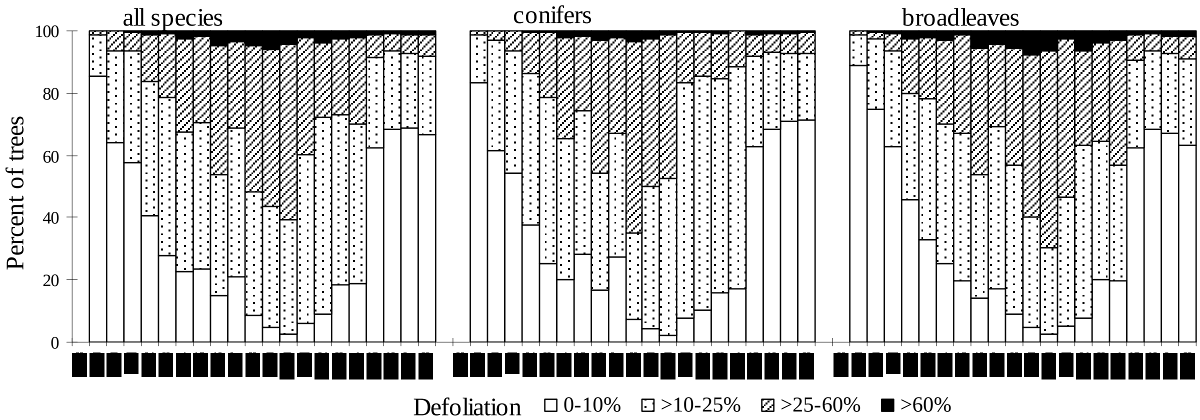
Switzerland



Turkey

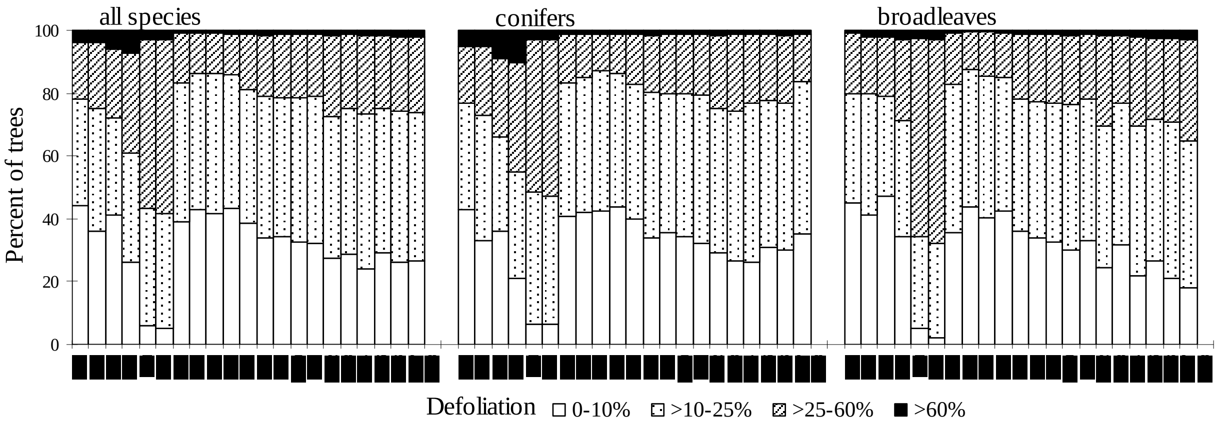


Ukraine



since 2005 change of assessment grid

United Kingdom



after 1992 change of assessment method in line with that used in other countries

Annex III
Main species referred to in the text

Botanical name	Danish	Dutch	English	Finnish	French	German
Fagus sylvatica	Bøg	Beuk	Common beech	Pyökki	Hêtre	Rotbuche
Quercus petraea	Vintereg	Wintereik	Sessile oak	Talvitammi	Chêne rouvre	Traubeneiche
Quercus robur	Stilkeg	Zomereik	European oak	Metsätammi	Chêne pédonculé	Stieleiche
Quercus ilex	Steneg	Steeneik	Holm oak	Rautatammi	Chêne vert	Steineiche
Quercus suber	Korkeg	Kurkeik	Cork oak	Korkkitammi	Chêne liège	Korkeiche
Pinus sylvestris	Skovfyr	Grove den	Scots pine	Metsämänty	Pin sylvestre	Gemeine Kiefer
Pinus nigra	Østrigsk fyr	Oostenrijkse Corsicaanse zwarte den	Corsican/ Austrian black pine	Euroopanmustamänty	Pin noir	Schwarzkiefer
Pinus pinaster	Strandfyr	Zeeden	Maritime pine	Rannikkomänty	Pin maritime	Seestrandkiefer
Pinus halepensis	Aleppofyr	Aleppoden	Aleppo pine	Aleponmänty	Pin d'Alep	Aleppokiefer
Picea abies	Rødgran	Fijnspar	Norway spruce	Metsäkuusi	Epicéa commun	Rotfichte
Picea sitchensis	Sitkagran	Sitkaspar	Sitka spruce	Sitkankuusi	Epicéa de Sitka	Sitkafichte
Abies alba	Ædelgran	Zilverden	Silver fir	Saksanpihta	Sapin pectiné	Weißtanne
Larix decidua	Lærk	Europese lariks	European larch	Euroopanlehtikuusi	Mélèze d'Europe	Europäische Lärche

Botanical name	Greek	Italian	Portuguese	Russian	Spanish	Swedish
Fagus sylvatica	Οξυά δασική	Faggio	Faia	бук лесной	Haya	Bok
Quercus petraea	Δρυς απόδισκος	Rovere	Carvalho branco Americano	дуб скальный	Roble albar	Bergek
Quercus robur	Δρυς ποδισκοφόρος	Farnia	Carvalho roble	дуб черещатый	Roble común	Ek
Quercus ilex	Αριά	Leccio	Azinheira	дуб каменный	Encina	Stenek
Quercus suber	Φελλοδρύς	Sughera	Sobreiro	дуб пробковый	Alcornoque	Korkek
Pinus sylvestris	Δασική πεύκη	Pino silvestre	Pinheiro silvestre	сосна обыкновенная	Pino silvestre	Tall
Pinus nigra	Μαύρη πεύκη	Pino nero	Pinheiro Austríaco	сосна чёрная	Pino laricio	Svarttall
Pinus pinaster	Θαλασσία πεύκη	Pino marittimo	Pinheiro bravo	сосна приморская	Pino negral	Terpentintall
Pinus halepensis	Χαλέπιος πεύκη	Pino d'Aleppo	Pinheiro de alepo	сосна алеппская	Pino carrasco	Aleppotall
Picea abies	Ερυθρελάτη υψηλή	Abete rosso	Picea	ель европейская	Abeto rojo	Gran
Picea sitchensis	Ερυθρελάτη	Picea di Sitka	Picea de Sitka	ель ситхинская	Picea de Sitka	Sitkagran
Abies alba	Λευκή ελάτη	Abete bianco	Abeto branco	пихта белая	Abeto común	Sivergran
Larix decidua	Λάριξ ευρωπαϊκή	Larice	Larício Europeu	литвенница европейская	Alerce	Europeisklärk

Annex IV

Testing statistical significance of the differences in mean plot defoliation between two years of assessment.

Differences between mean plot defoliation were statistically examined for Common Sample Plots (CSPs) using the following test statistic:

$$t = \frac{\left|\bar{x}_{2008} - \bar{x}_{2007}\right|}{\sqrt{\frac{s^2}{n_{2008}} + \frac{s^2}{n_{2007}}}}$$

where $\bar{x}_{2008} - \bar{x}_{2007}$ is the difference in mean plot defoliation between the assessments in 2007 and 2008,

s - the standard deviation of these differences,

n_{2008}, n_{2007} - number of sample trees on plots being tested.

The standard deviation s is calculated as follows

$$s = \sqrt{\frac{(n_{2008} - 1)s_{2008}^2 + (n_{2007} - 1)s_{2007}^2}{n_{2008} + n_{2007} - 2}}$$

with standard deviations s_{2008}, s_{2007} derived from the defoliation scores for the years 2008 and 2007 on the plots investigated.

The minimal difference for qualifying a plot as having changed its mean defoliation was 5% and more. This applies to the map in Annex I-7. This additional criterion to the formal statistical test was chosen since 5% is the highest accuracy in the assessment of defoliation in the field.

Annex V
Addresses

1. UN/ECE, ICP Forests and the European Union Scheme

UN/ECE	United Nations Economic Commission for Europe Environment and Human Settlements Division Air Pollution Unit Palais des Nations 1211 GENEVA 10 SWITZERLAND Phone: +41 22 91 71 234/-91 72 358 Fax: +41 22 917 05 05 e-mail: keith.bull@unece.org; Matti.Johansson@unece.org Mr Keith Bull Mr Matti Johansson
ICP Forests	International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests Johann Heinrich von Thünen-Institut Bundesforschungsinstitut für Ländliche Räume, Wald und Fischerei Leuschnerstr. 91 21031 Hamburg GERMANY Phone: +49 40 739 62 100/Fax: +49 40 739 62 299 e-mail: michael.koehl@vti.bund.de Mr Michael Köhl, Chairman of ICP Forests
ICP Forests Lead Country	International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz – Ref. 533 Postfach 14 02 70 53107 BONN GERMANY Phone: +49 228 99 529-4130/Fax: +49 228 99 529-4318 e-mail: sigrid.strich@bmelv.bund.de Ms Sigrid Strich
PCC of ICP Forests	Programme Coordinating Centre of ICP Forests Johann Heinrich von Thünen-Institut Bundesforschungsinstitut für Ländliche Räume, Wald und Fischerei Leuschnerstr. 91 21031 Hamburg GERMANY Phone: +49 40 739 62 140/Fax: +49 40 739 62 199 e-mail: martin.lorenz@vti.bund.de Internet: http://www.icp-forests.org Mr Martin Lorenz

2. Expert Panels, WG and other Coordinating Institutions

Expert Panel on Soil and Soil Solution	Research Institute for Nature and Forest Gaverstraat 4 9500 GERAARDSBERGEN BELGIUM Phone: +32 54 43 71 20/Fax: +32 54 43 61 60 e-mail: bruno.devos@inbo.be Mr Bruno De Vos, Chair
Working Group on Soil Solution	Finnish Forest Research Institute (METLA) Rovaniemi Research Unit P.O. Box 16 96301 ROVANIEMI FINLAND Phone: +358 10 211 45 52 / Fax: +358 10 211 44 01 e-mail: john.derome@metla.fi Mr John Derome, Co-Chair
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