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Institute for World Forestry

Forest Condition in Europe

2007 Technical Report of ICP Forests

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PREFACE

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 close cooperation with the European Commission (EC). ICP Forests is working under the Convention on Long-range Transboundary Air Pollution (CLRTAP) under the United Nations Economic Commission for Europe (UNECE). Within its 22 years of existence the number of its participating countries has grown to 40 including Canada and the United States of America, rendering it one of the largest biomonitoring networks of the world. From the beginning on, ICP Forests has been chaired by Germany and has been coordinated by the Federal Research Centre for Forestry and Forest Products in Hamburg.

Aimed to assess 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. The results obtained by ICP Forests reveal the extent and development of forest damage and contribute to the enlightenment of the complex causes and effects involved. Besides fulfilling its obligations under CLRTAP, ICP Forests will use its well developed monitoring system to also contribute to other processes of international environmental policies in close cooperation with EC. This will comprise the provision of 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 include the contribution of urgently needed information on species diversity and carbon sequestration as requested by the United Nations Framework Conventions on Climate Change and on Biological Diversity. The recent summer heat and drought events across large parts of Europe and the reactions of forests to them underline the need for monitoring and evaluation of the impact of climate change on forests.

The monitoring results of each year are summarized in annual Executive Reports. The methodological background and detailed results of the individual surveys are described in Technical Reports. The present Technical Report on Forest Condition in Europe refers to the results of the large-scale transnational survey of the year 2006 and presents results of individual studies of the intensive monitoring data made available by the year 2004.

SUMMARY

In the year 2006 crown condition was assessed by 31 of the 40 countries of ICP Forests on their national grids. These national assessments comprised 333 567 sample trees on 18 616 sample plots. Results on the European-wide scale were derived from 129 880 trees on 6 046 plots of the 16 x 16 km transnational grid in 31out of 34 participating countries.

The transnational survey revealed for all sample trees in Europe a mean defoliation of 19.9%. Of the main species, *Quercus robur* and *Q. petraea* had by far the highest mean defoliation (24.9%), followed by *Fagus sylvatica* (20.6%), *Picea abies* (18.5%) and *Pinus sylvestris* (17.4%). 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. *Pinus pinaster* shows the severest increases in defoliation in the period 1990-2006. In contrast, *Pinus sylvestris* continues its trend towards a decrease in defoliation. *Pinus sylvestris* is the only species showing clearly improving crown condition within the period of observation. Being less sensitive to drought, *Pinus sylvestris* showed no rise in defoliation even after the dry summer of the year 2003. *Picea abies* as well as *Quercus robur* and *Quercus petraea* continue their decrease in defoliation since their highs in 2004 which constituted a response to the drought of 2003. In 19 countries a newly introduced assessment of damage symptoms and causes was conducted. Devoured or missing leaves, dead branches and discolouration were the symptoms, and insects, fungi, and abiotic factors were the causes most frequently observed.

The spatial and temporal variation of bulk and throughfall deposition was analysed for sulphate, nitrate, ammonium, calcium, sodium and chlorine. Depending on data availability, between 198 and 252 intensive monitoring plots were involved in the study. Mean deposition of the years 2002-2004 shows spatial patterns which reflect partly the regional emission situation. High sulphate deposition in coastal areas is correlated with high sodium deposition, indicating sea salt as an origin. The temporal variation was calculated for the period 1999-2004. Bulk and throughfall deposition of sulphate are highest but show the most pronounced decrease. Throughfall decreases from 8.8 kg ha^{-1} a^{-1} in 1999 to 6.3 kg ha^{-1} a^{-1} in 2004. Bulk deposition shows a similar decrease at a lower level, namely from 6.7 kg ha^{-1} a^{-1} in 1999 to 4.9 kg ha^{-1} a^{-1} in 2004. The nitrogen depositions are lower than the depositions of sulphur in most years and show a less pronounced rate of decrease. Moreover, their response to the low precipitation in 2003 is different from that of sulphur. In 2003 bulk deposition of nitrate nitrogen shows an exceptional decrease. In contrast, throughfall of both nitrate and ammonium nitrogen are rather increased in the dry year. This suggests an indication for the notorious impact of canopy exchange on nitrogen throughfall.

Also on intensive monitoring plots the critical loads for acidification and eutrophication as well as their exceedances were calculated. The decrease in sulphur emissions over the past 20 years resulted in a reduced exceedance of critical loads for acid deposition. In the same period the reduction in the emissions of nitrogen oxides and ammonia remained insignificant. Therefore, emissions of nitrogen compounds have become relatively more important and will continue to threaten ecosystem function and stability. This fact, and the acidity already accumulated in forest soils, will continue to stress forest ecosystems. Dynamic model results show that recovery from pollutant stress will often be very slow and may sometimes even require one hundred years.

1. INTRODUCTION

In the present report the results of the 21^{st} European-wide crown condition survey conducted by ICP Forests and EC in the year 2006 are presented. Moreover, the report presents results of analyses of the intensive monitoring of ICP Forests and EC. The report is structured as follows:

Chapter 2 describes the sampling of the plots and the trees, the assessment of crown condition, the analyses of the monitoring data, and the results of the large-scale (Level I) survey. In the description of the spatial and temporal variation of crown condition at the European-wide scale, emphasis is laid upon the current status and the development of crown condition with respect to species and regions. This includes a brief overview of the results of a recently introduced assessment of symptoms, causes and extent of damage types.

Chapter 3 presents latest results of the intensive (Level II) monitoring. First of all, the annually reported results of the measurements of bulk deposition, throughfall deposition and their trends are updated for ammonium, nitrate and sulphate. Depositions of these substances as measured by ICP Forests are in a second step compared with the respective depositions modelled by the Co-operative Programme for Monitoring and Evaluation of the Long-range transmission of Air Pollutants in Europe (EMEP). Also in Chapter 3, critical loads for acidification and eutrophication as well as their exceedances are calculated for Level II plots. Finally dynamic modelling is applied aimed to estimate the future effects of acidifying depositions under clean air policies of CLRTAP.

Chapter 4 consists of national reports by the participating countries, focussing on crown condition in 2006 as well as its development and its causes.

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

2. LARGE-SCALE CROWN CONDITION SURVEYS

2.1 Methods of the surveys in 2006

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, 2004a). In the following sections, the selection of sample plots, the assessment of stand and site characteristics, the assessment of crown condition and the assessment of damage types are described. The sections also refer to the evaluation and presentation of the survey results.

2.1.2 Selection of sample plots

2.1.2.1 The transnational survey

The aim of the transnational survey is to reveal 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. This is accomplished by means of large-scale monitoring on a 16 x 16 km transnational grid of sample plots. In several countries, the plots of the transnational grid are a subsample of a denser national grid (Chapter 2.1.2.2). The coordinates of the transnational 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 the year 2006 crown condition was assessed on 6 046 plots in 31 countries (Table 2.1.2.1-1). The number of plots was lower than in 2005. This is mainly due to a reduced number of plots in Poland. In Poland the set of randomly selected plots were abandoned and a systematic 16 x 16 km grid system was installed which yielded a lower number of plots. In addition, 13 plots were assessed on the Canary Islands. They are shown in the respective maps, but not included in the transnational evaluation as they are not located in those geoclimatic regions to which all other plots were assigned. These geoclimatic regions are adapted from those defined by WALTER et al. (1975) and by WALTER and LIETH (1967). For an explanation of these regions see Annex I–1. Percentages of plots in the 10 different regions are given in Table 2.1.2.1-2. The spatial distribution of the plots assessed in 2006 in these regions is shown in Figure 2.1.2.1-1. The figures in Table 2.1.2.1-1 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. In 2006, corrections of previous data were only minor.

In Turkey around 800 plots are to be installed. Some of these plots will be assessed for defoliation for the first time in 2007 so that they are not yet shown in Table 2.1.2.1-1. They are, however, shown in the map in Annex I-2. After first crown condition assessments these plots are expected to render the plot sample of 2008 the largest one since the establishment of the transnational survey.

Table 2.1.2.1-1: Number of sample plots assessed for crown condition from 1994 to 2006.

Country	Number of sample plots assessed												
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Austria	76	76	130	130	130	130	130	130	133	131	136	136	135
Belgium	29	29	29	29	29	30	29	29	29	29	29	29	27
Bulgaria	108	119	119	119	134	114	108	108	98	105	103	102	97
Cyprus								15	15	15	15	15	15
Czech Republic	205	199	196	196	116	139	139	139	140	140	140	138	136
Denmark	25	24	23	22	23	23	21	21	20	20	20	22	22
Estonia	90	90	91	91	91	91	90	89	92	93	92	92	92
Finland	382	455	455	460	459	457	453	454	457	453	594	605	606
France	534	543	540	540	537	544	516	519	518	515	511	509	498
Germany	417	417	420	421	421	433	444	446	447	447	451	451	423
Greece	96	95	95	94	93	93	93	92	91	-	-	87	-
Hungary	62	63	60	58	59	62	63	63	62	62	73	73	73
Ireland	21	21	21	21	21	20	20	20	20	19	19	18	21
Italy	209	207	207	181	177	239	255	265	258	247	255	238	251
Latvia	94	94	99	96	97	98	94	97	97	95	95	92	93
Lithuania	73	73	67	67	67	67	67	66	66	64	63	62	62
Luxembourg	4	4	4	4	4	4	4	-	4	4	4	4	4
The Netherlands	13	13	12	11	11	11	11	11	11	11	11	11	11
Poland	441	432	431	431	431	431	431	431	433	433	433	432	376
Portugal	147	141	142	144	143	143	143	144	145	136	133	119	118
Romania	199	241	224	237	235	238	235	232	231	231	226	229	228
Slovak Republic	111	111	110	110	109	110	111	110	110	108	108	108	107
Slovenia	34	42	42	42	41	41	41	41	39	41	42	44	45
Spain	444	454	447	449	452	598	607	607	607	607	607	607	607
Sweden	340	726	766	758	764	764	769	770	769	776	775	784	790
United Kingdom	66	63	79	82	88	85	89	86	86	86	85	84	82
EU	4220	4732	4809	4793	4732	4965	4963	4985	4978	4868	5020	5091	4919
Andorra											3	-	3
Belarus				416	416	408	408	408	407	406	406	403	398
Croatia	88	82	83	86	89	84	83	81	80	78	84	85	88
Moldova	12	11	10	10	10	10	10	10					
Norway	384	386	387	386	386	381	382	408	414	411	442	460	463
Russian Fed.	7	134											
Serbia										103	130	129	127
Switzerland	45	47	49	49	49	49	49	49	49	48	48	48	48
Total Europe	4756	5392	5338	5740	5682	5897	5895	5941	5928	5914	6133	6216	6046

Table 2.1.2.1-2: Distribution of the sample plots assessed in 2006 over the climatic regions.

Climatic region	Number of plots	Percentage of plots
Boreal	1169	19.3
Boreal (Temperate)	935	15.5
Atlantic (North)	342	5.6
Atlantic (South)	275	4.5
Sub-atlantic	1044	17.4
Continental	338	5.6
Mountainous (North)	308	5.1
Mountainous (South)	709	11.7
Mediterranean (Higher)	364	6.0
Mediterranean (Lower)	562	9.3
All regions	6046	100.0

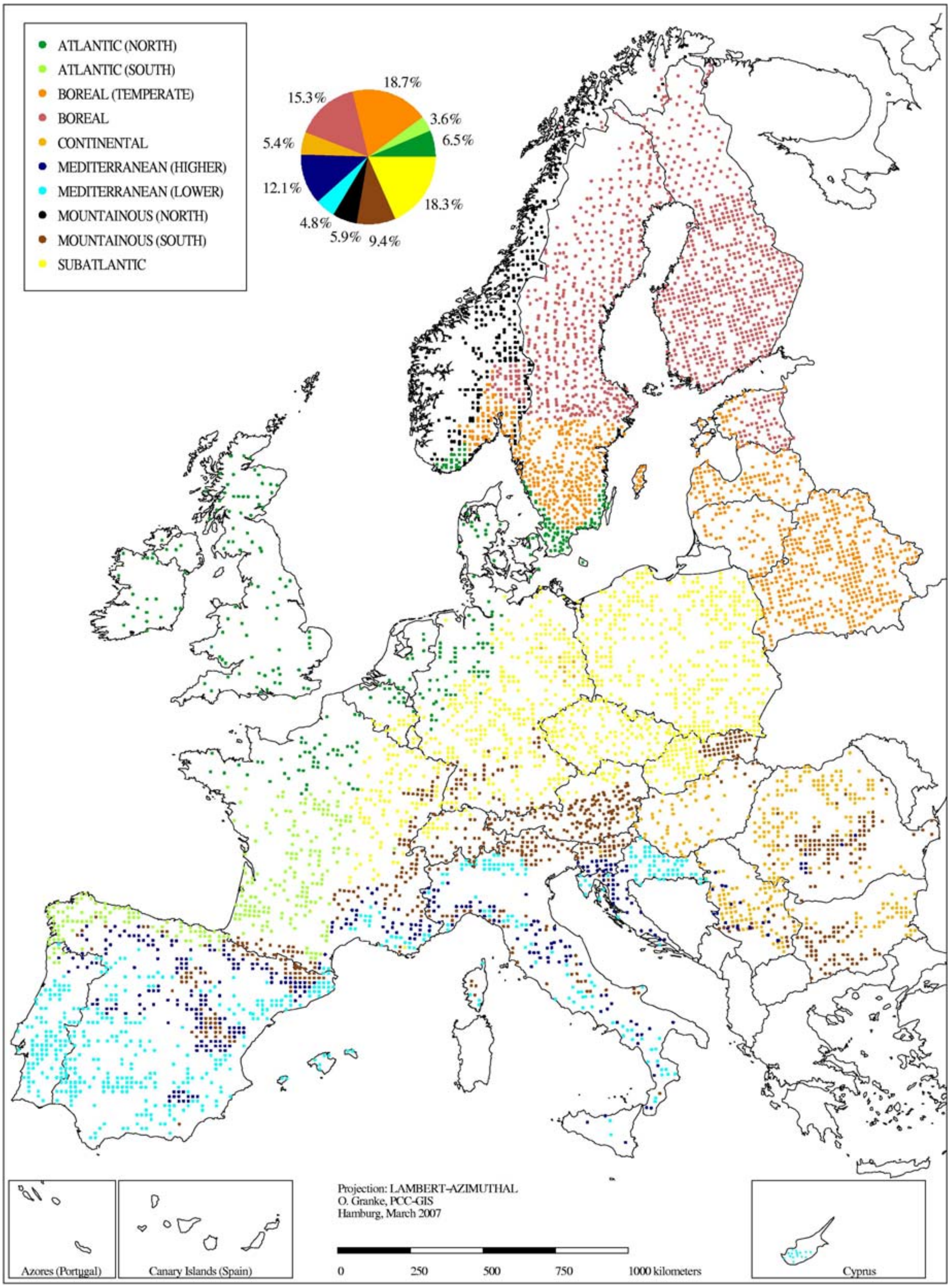


Figure 2.1.2.1-1: Plots according to climatic regions (2006).

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 plot and tree parameters are reported on the transnational plots in addition to defoliation and discolouration:
Country, plot number, plot coordinates, altitude, aspect, water availability, humus type, soil type (optional), mean age of dominant storey, tree numbers, tree species, identified damage types and date of observation (Table 2.1.3.1-1).
The demonstration project “BioSoil” under the programme “Forest Focus” of EC at Level I includes 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
Climate	climatic region	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. The numbers of plots for which these site parameters were reported increased distinctively in recent years (Table 2.1.3.1-2). The data set is now almost complete for these parameters.

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	135	135	129	135	135	135	129
Belgium	27	27	27	27	27	27	27
Bulgaria	97	97	97	97	97	97	97
Cyprus	15	15	15	15	15	15	0
Czech Republic	136	136	56	136	136	136	56
Denmark	22	22	22	22	22	22	22
Estonia	92	92	92	92	92	92	92
Finland	606	606	606	606	606	606	606
France	498	498	498	498	498	498	498
Germany	423	423	423	423	423	423	312
Hungary	73	61	40	61	61	73	61
Ireland	21	21	21	21	21	21	18
Italy	251	251	251	251	251	251	0
Latvia	93	93	93	93	93	93	93
Lithuania	62	62	62	62	62	62	62
Luxembourg	4	4	4	4	4	4	4
The Netherlands	11	11	11	11	11	11	11
Poland	376	376	376	376	376	376	376
Portugal	118	115	113	117	116	117	108
Romania	228	228	228	228	228	228	221
Slovak Republic	107	0	107	107	107	107	107
Slovenia	45	43	43	45	45	44	43
Spain	607	607	607	607	607	607	431
Sweden	790	790	782	790	790	790	760
United Kingdom	82	82	82	82	82	82	82
EU	4919	4795	4785	4906	4905	4917	4216
Percent of EU plot sample		97.5	97.3	99.7	99.7	100.0	85.7
Andorra	3	3	3	3	3	3	3
Belarus	398	398	398	398	398	398	398
Croatia	88	88	88	88	88	88	67
Norway	463	0	451	463	463	463	371
Serbia	127	127	41	127	127	127	127
Switzerland	48	45	45	48	48	48	45
Total Europe	6046	5456	5811	6033	6032	6044	5227
Percent of total plot sample		79.6	84.8	88.1	88.0	88.2	76.3

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 (Anonymus, 1986).

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.

In principle, the transnational survey results for defoliation are assessed in 5% steps. The assessment down to the nearest 5 or 10% 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.

The total numbers of trees assessed from 1994 to 2006 in each country are shown in Table 2.1.3.2-1. In 2006 the number of trees assessed was 129 880. 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.

Of the plot sample of the year 2006, 62.2% of the plots were dominated by conifers, 37.8% by broadleaves (Annex I-2). Plots in mixed stands were assigned to the species group which comprised the majority of the sample trees. Of the tree sample the number of tree species and species groups was 104. Most abundant were *Pinus sylvestris* with 26.5% followed by *Picea abies* with 18.9%, *Fagus sylvatica* with 8.7%, and *Quercus robur* with 3.6% of the total tree sample (Annex I-3).

Table 2.1.3.2-1: Number of sample trees from 1994 to 2006 according to the current database.

Country	Number of sample trees												
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Austria	2107	2101	3670	3604	3577	3535	3506	3451	3503	3470	3586	3528	3425
Belgium	684	678	684	683	692	696	686	682	684	684	681	676	618
Bulgaria	4330	4772	4749	4748	5349	4344	4197	4174	3720	3836	3629	3592	3510
Cyprus								360	360	360	360	361	360
Czech Rep	5087	4933	4853	4844	2899	3475	3475	3475	3500	3500	3500	3450	3425
Denmark	600	576	552	528	552	552	504	504	480	480	480	528	527
Estonia	2159	2160	2184	2184	2184	2184	2160	2136	2169	2228	2201	2167	2191
Finland	4261	8754	8732	8788	8758	8662	8576	8579	8593	8482	11210	11498	11489
France	10672	10851	10800	10800	10740	10883	10317	10373	10355	10298	10219	10129	9950
Germany	10866	10907	10980	10990	13178	13466	13722	13478	13534	13572	13741	13630	10327
Greece	2272	2248	2248	2224	2204	2192	2192	2168	2144	-	-	2054	-
Hungary	1322	1342	1298	1257	1383	1470	1488	1469	1446	1446	1710	1662	1674
Ireland	441	441	441	441	441	417	420	420	424	403	400	382	445
Italy	5791	5703	5836	4873	4939	6710	7128	7350	7165	6866	7109	6548	6936
Latvia	2257	2262	2368	2297	2326	2348	2256	2325	2340	2293	2290	2263	2242
Lithuania	1760	1776	1643	1634	1616	1613	1609	1597	1583	1560	1487	1512	1505
Luxembourg	93	96	96	96	96	96	96	-	96	96	96	97	96
The Netherlands	260	257	237	220	220	225	218	231	232	231	232	232	230
Poland	8820	8640	8620	8620	8620	8620	8620	8620	8660	8660	8660	8640	7520
Portugal	4414	4230	4260	4319	4290	4290	4290	4320	4350	4080	3990	3569	3539
Romania	4776	5688	5375	5687	5637	5712	5640	5568	5544	5544	5424	5496	5472
Slovak Rep.	5115	5091	5018	5033	5094	5063	5157	5054	5076	5116	5058	5033	4808
Slovenia	816	1008	1008	1008	984	984	984	984	936	983	1006	1056	1074
Spain	10656	10896	10728	10776	10848	14352	14568	14568	14568	14568	14568	14568	14568
Sweden	3989	10310	10925	10910	11044	11135	11361	11283	11278	11321	11255	11422	11186
United Kingdom	1584	1512	1896	1968	2112	2039	2136	2064	2064	2064	2040	2016	1968
EU	95132	107232	109201	108532	109783	115063	115306	115233	114804	112141	114932	116109	109085
Andorra											72		74
Belarus				9974	9896	9745	9763	9761	9723	9716	9682	9484	9373
Croatia	2150	1970	1974	2030	2066	2015	1991	1941	1910	1869	2009	2046	2109
Moldova	288	263	236	253	234	259	234	234					
Norway	3942	3905	3948	4028	4069	4052	4051	4304	4444	4547	5014	5319	5525
Russian Fed.	183	3180											
Serbia										2274	2915	2995	2902
Switzerland	509	824	854	880	868	857	855	834	827	806	748	807	812
Total Europe	102204	117374	116213	125697	126916	131991	132200	132307	131708	131353	135372	136760	129880

2.1.4 Evaluation and presentation 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 precisely quantified, 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. However, in many countries the natural growing conditions are most favourable in those areas receiving the highest depositions of air pollution. 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 11 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 the tree species a criterion had to be set up to be able to decide if a given plot represents this species or not. The number of trees with species being evaluated had to be three or more per plot ($N \geq 3$). The plot wise species specific mean defoliation was calculated as the mean of defoliation values of the trees of the selected species on the respective 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. A value of e.g. 3% means an increase by 3% defoliation per year on average. These slopes are called "significant" only if there was less than 5% probability that they are different from zero by random variation.

Besides the temporal development, also the change in the results from 2003 to 2004 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 method for the change from 2005 to 2006 see Annex IV.

2.2 Results of the transnational survey in 2006

2.2.1 Crown condition in 2006

Crown condition in 2006 was assessed on 6046 plots comprising 129 880 sample trees. Of these trees a share of 21.9% 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 21.6% the share of damaged conifers with 19.2%. 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 2006 was 19.9%. Annex I-5 shows a map of mean plot defoliation for all species.

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	27.8	44.6	72.4	23.9	2.5	1.2	27.6	22.6	20	46324
	Conifers	37.6	41.7	79.3	18.5	1.5	0.7	20.7	19.0	15	62761
	All species	33.4	43.0	76.4	20.8	1.9	0.9	23.6	20.5	15	109085
Total Europe	*Fagus sylv.*	34.1	42.3	76.4	21.1	1.4	1.1	23.6	20.6	15	11357
	Quercus robur + Q. petraea	19.6	45.5	65.1	31.8	2.3	0.8	34.9	24.9	20	8064
	Broadleaves	31.1	43.5	74.6	21.9	2.4	1.1	25.4	21.6	20	55618
	Picea abies	42.6	33.3	75.9	21.8	1.9	0.4	24.1	18.5	15	24517
	Pinus sylv.	39.1	47.1	86.2	12.3	0.9	0.6	13.8	17.4	15	34411
	Conifers	38.6	42.2	80.8	17.1	1.4	0.7	19.2	18.5	15	74262
	All species	35.4	42.7	78.1	19.2	1.8	0.9	21.9	19.9	15	129880

Frequency distributions of the sample trees were calculated for the 5% classes in which defoliation is reported because the defoliation classes have uneven widths. These frequency distributions 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 climatic region as well as for the total of all regions. Also given are the number of trees, the mean defoliation and the median. Mean defoliation is highest with 24.1% in the Mediterranean (higher) region and is lowest with 15.3% in the Boreal region.

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: Defoliation is highest for *Quercus robur* and *Quercus petraea* and it is lowest for *Pinus sylvestris*. For *Pinus sylvestris* the map shows large and partly well defined regions of both high and low defoliation. Particularly many plots with hardly defoliated *Pinus sylvestris* trees are situated in Finland and in northern and central Sweden, i.e. in the Boreal region. In contrast, *Picea abies* and especially the main broadleaved species, *Fagus sylvatica* as well as *Quercus robur* and *Quercus petraea*, show highly defoliated plots throughout their habitat.

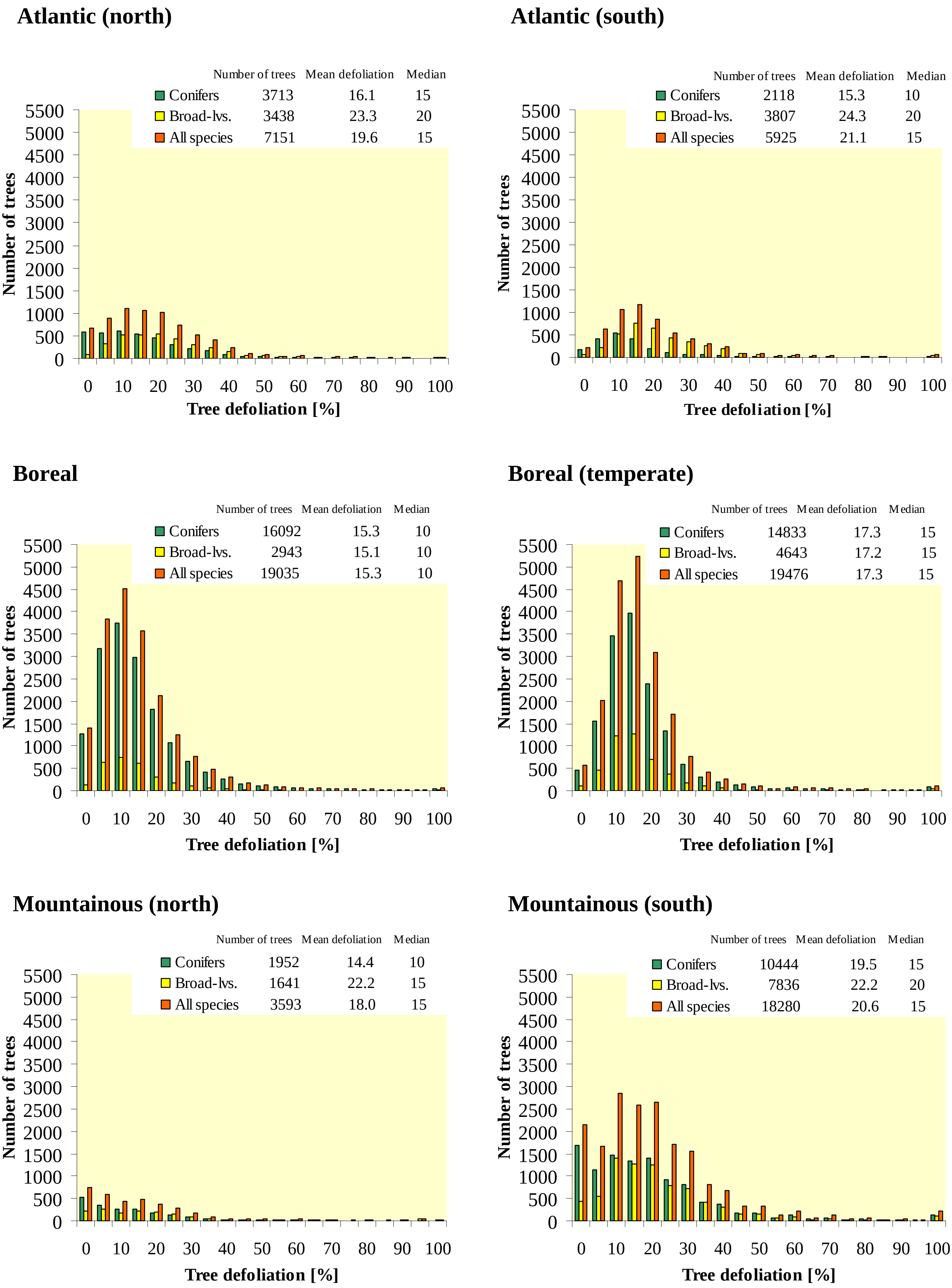
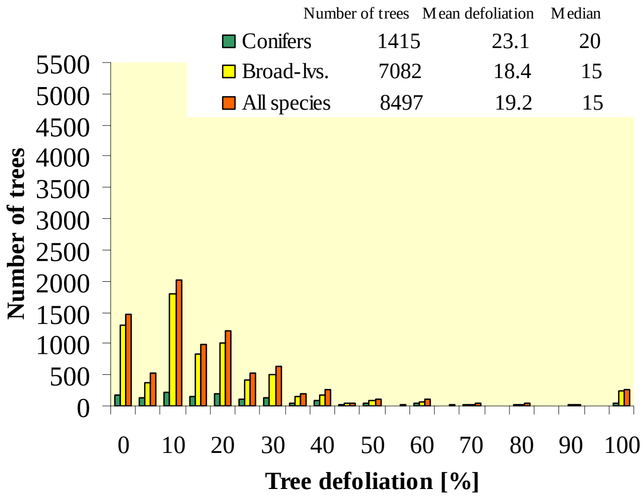
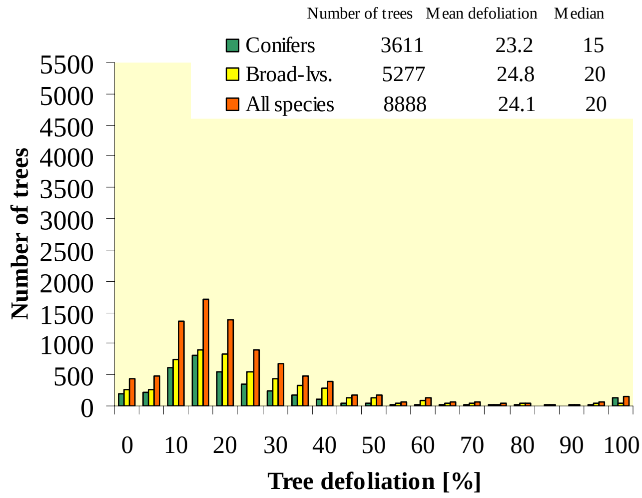


Figure 2.2.1-1a: Frequency distribution of trees in 5%-defoliation steps.

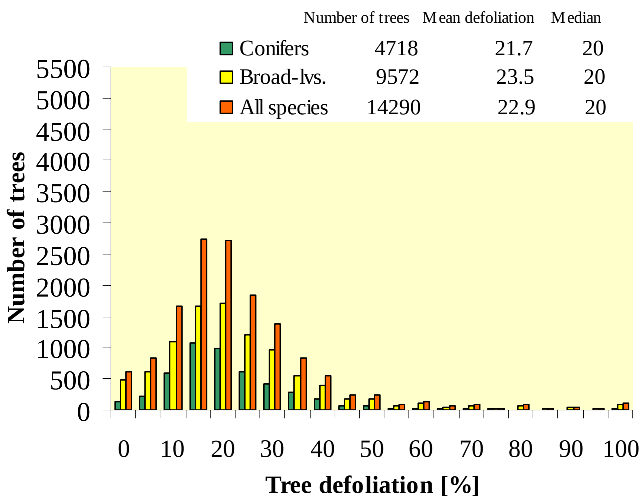
Continental



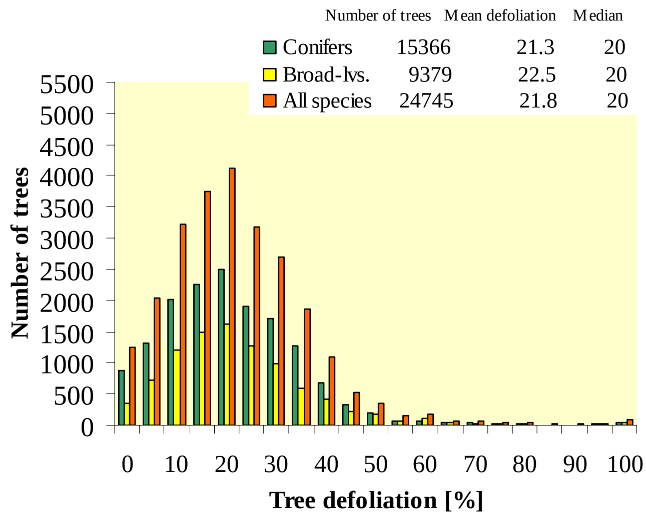
Mediterranean (higher)



Mediterranean (lower)



Sub-atlantic



All regions

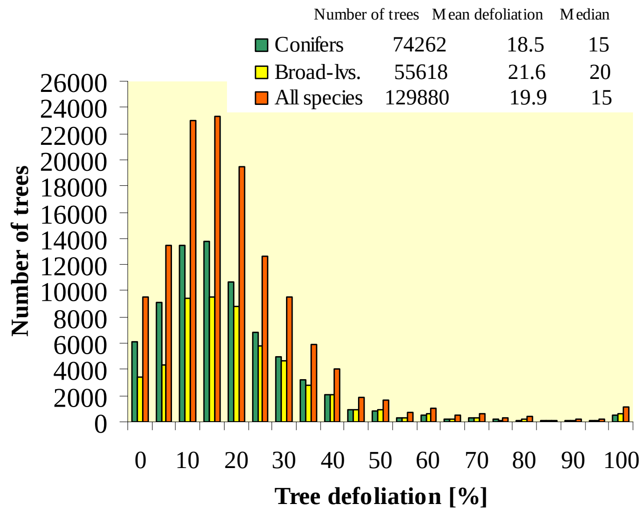


Figure 2.2.1-1b: Frequency distribution of trees in 5%-defoliation steps.

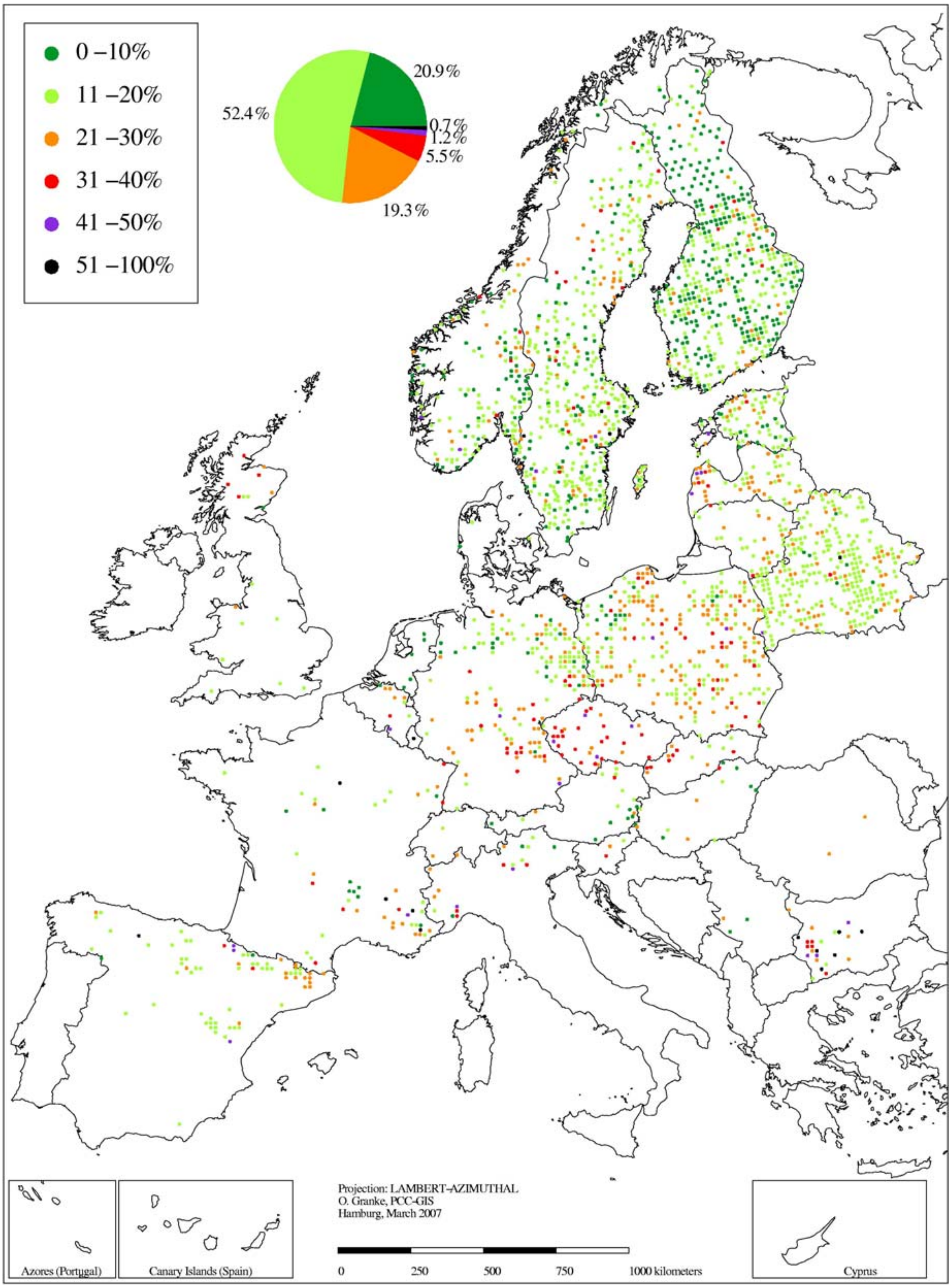


Figure 2.2.1-2: Mean plot defoliation of *Pinus sylvestris.*

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

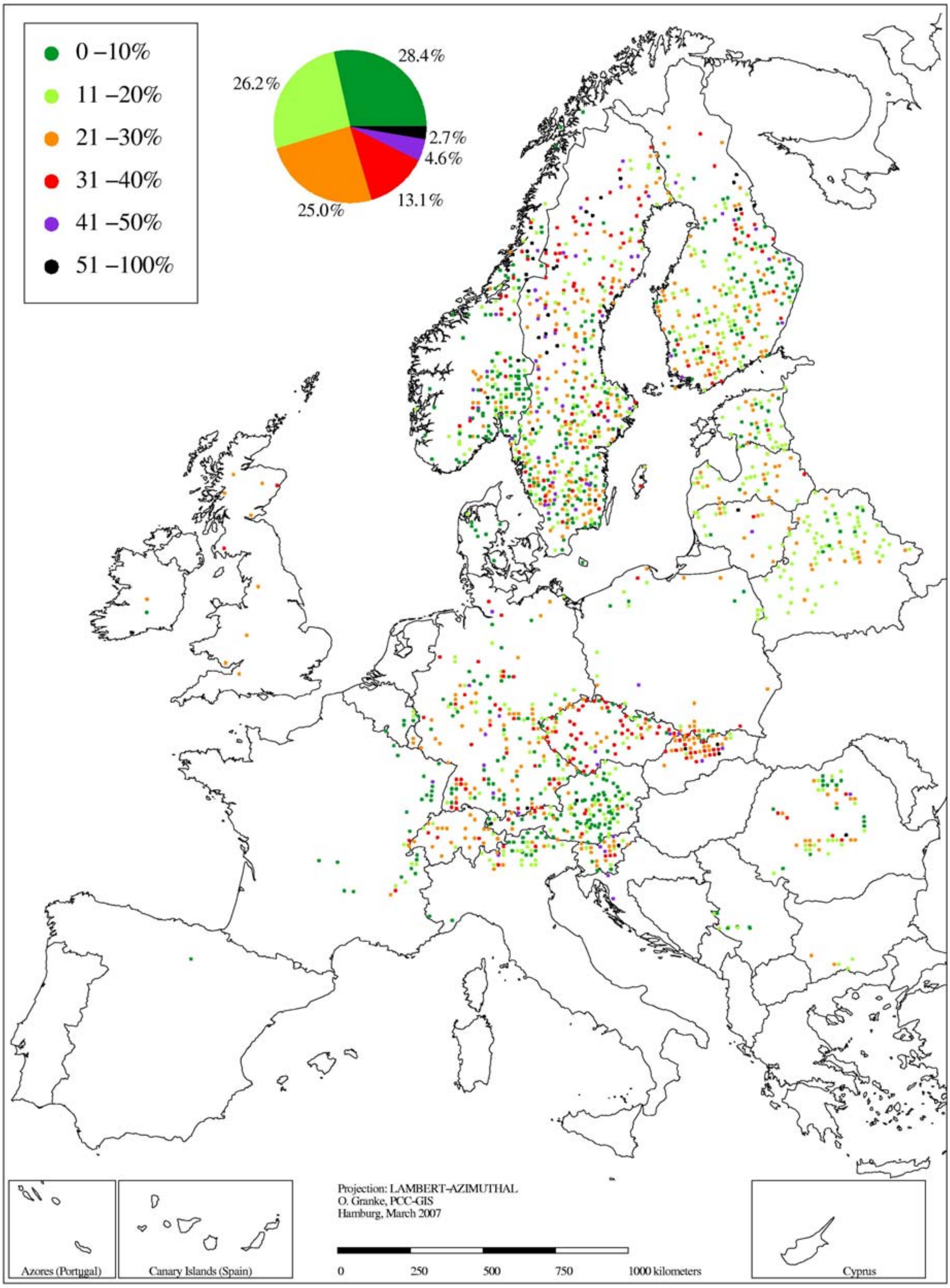


Figure 2.2.1-3: Mean plot defoliation of *Picea abies.*

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

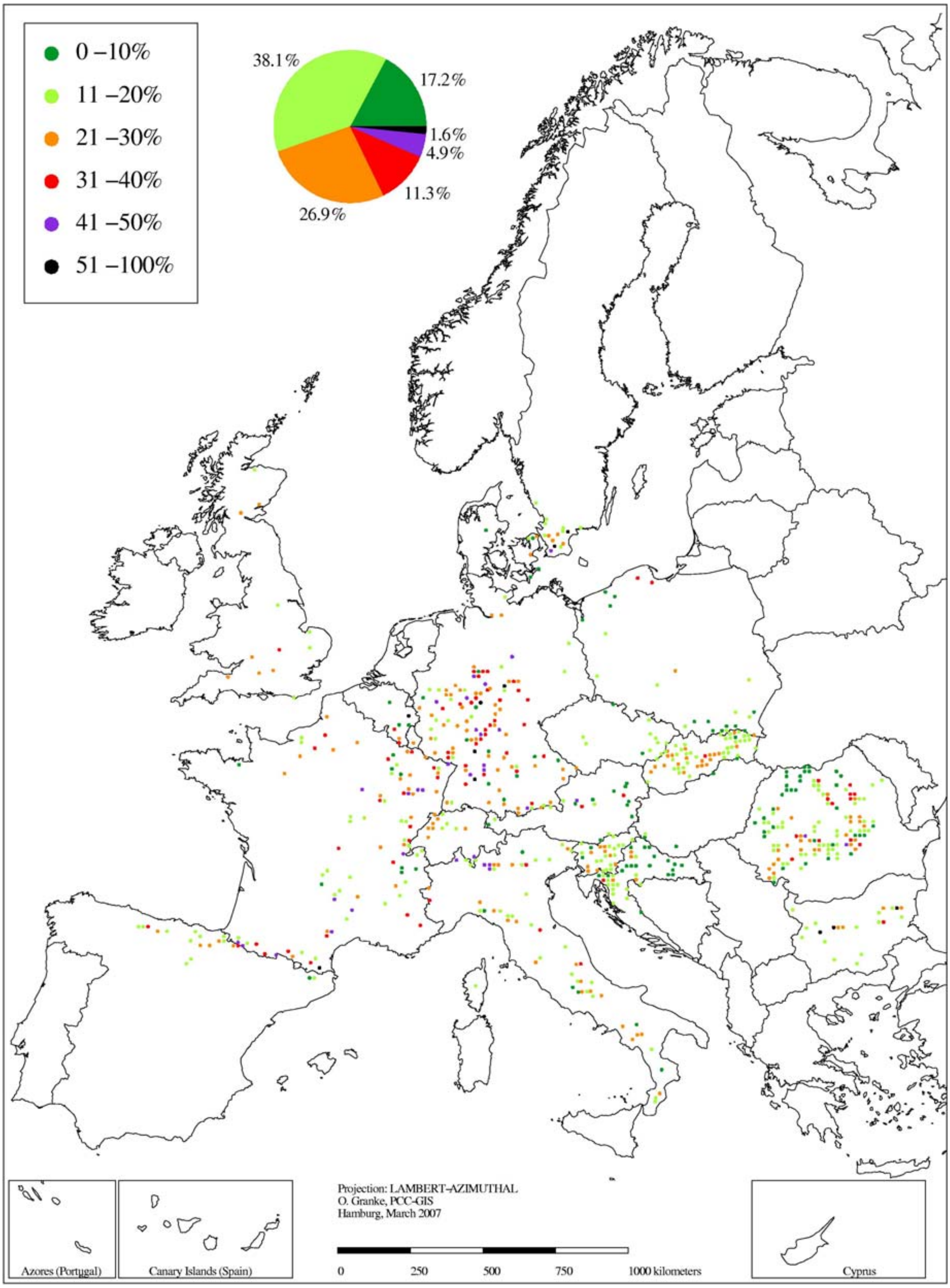


Figure 2.2.1-4: Mean plot defoliation of *Fagus sylvatica.*

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

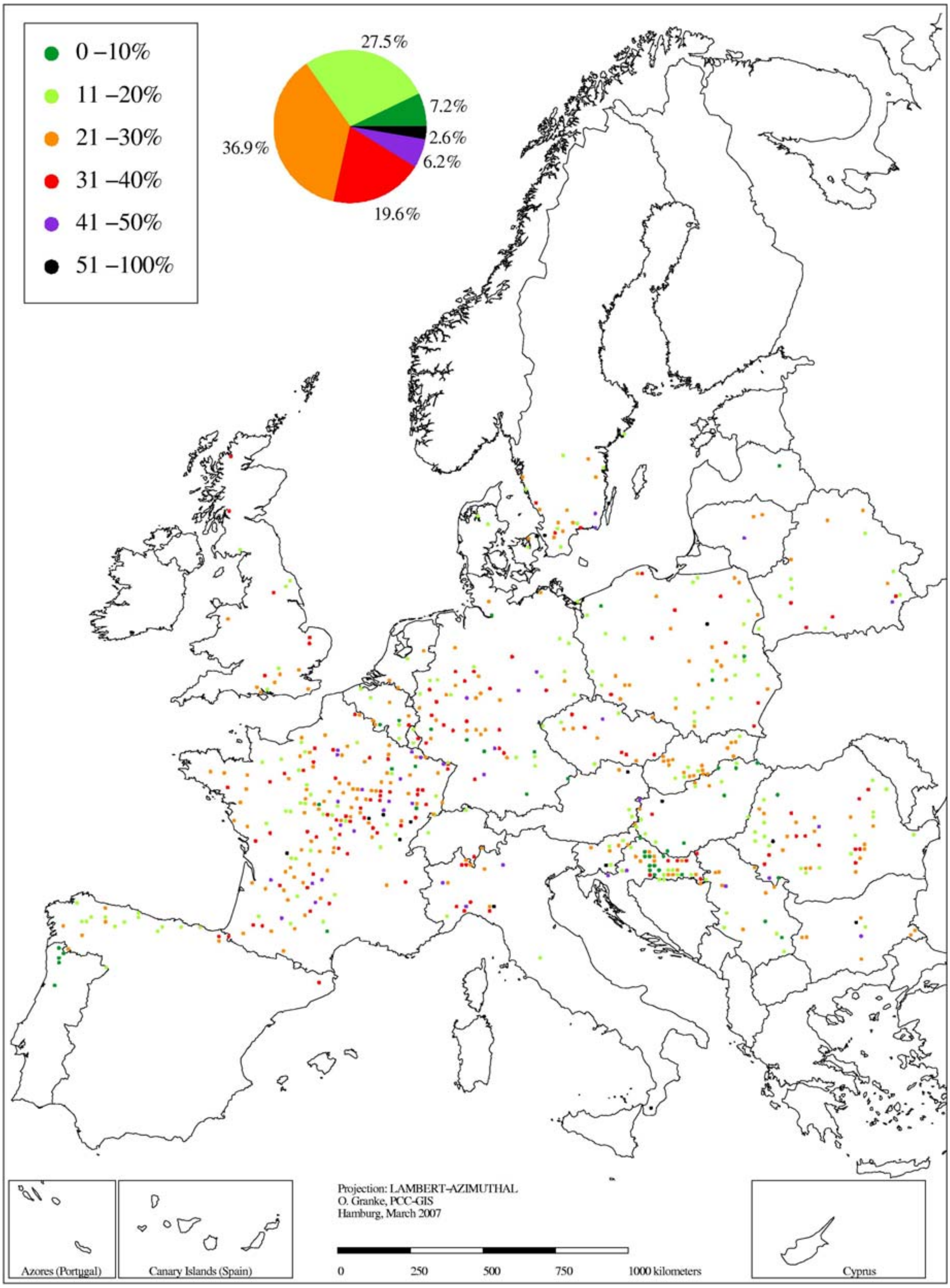


Figure 2.2.1-5: Mean plot defoliation of *Quercus robur* and *Quercus petraea.*

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

Discolouration of the 129 880 sample trees of the crown condition survey is shown in Table 2.2.1-2. A share of 6.2% 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	94.1	3.6	0.8	0.3	1.2	5.9	46324
	Conifers	94.3	4.1	0.8	0.2	0.6	5.7	62761
	All species	94.2	3.9	0.9	0.2	0.8	5.8	109085
Total Europe	Broad-leaves	93.6	4.1	1.0	0.3	1.0	6.4	55618
	Conifers	94.5	4.0	0.8	0.2	0.5	5.5	74262
	All species	94.1	4.1	0.9	0.2	0.7	5.9	129880

2.2.2 Development of defoliation

2.2.2.1 Approach

The calculation of the development of defoliation is based on the assumption 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 1990-2006:
  Belgium, Denmark, Germany (west), Hungary, Ireland, Latvia, Poland, Portugal, Slovak Republic, Spain, Switzerland, and The Netherlands.
- Period 1997-2006:
  Austria, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Italy, Latvia, Lithuania, Norway, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, The Netherlands, and United Kingdom.

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 2005 to 2006 across Europe is shown in Annex I-7. In many regions the number of plots showing increasing defoliation has become smaller as compared to recent years. Otherwise the map can not be compared with those of recent years because Poland and Germany (Bavaria) shifted their plots. The pie diagram shows that a significant increase in defoliation was found on 11.7% of the plots, whereas only 8.9% of the plots show a significant decrease.

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 climatic regions. In each of these chapters the development of defoliation of the respective species is visualised for the total tree sample of all climatic regions in one graph. Additional graphs reflect particular developments in selected climatic regions. 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 climatic regions and for each region 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 pinaster* shows the severest increases in defoliation in the period from 1990 to 2006 (Figure 2.2.2.2-1). In contrast, *Pinus sylvestris* continues its trend towards a decrease in defoliation. *Pinus sylvestris* is the only species with clearly decreasing defoliation since 1990. Its recovery particularly in Poland and in parts of the Baltic States since the mid 1990s renders this species in 2006 in a better condition than at the beginning of the time series. Being less susceptible to drought, *Pinus sylvestris* showed no rise in defoliation even after the dry summer of the year 2003. *Picea abies* as well as *Quercus robur* and *Quercus petraea* continue their decrease in defoliation since their highs in 2004 which constituted a response to the drought of 2003. The impact of and the recovery from the drought in 2003 is less pronounced in the time series from 1997 to 2006 (Figure 2.2.2.2-2). The reason is that the underlying tree sample covers a large number of countries, in many of which no drought occurred in 2003. Trends in mean plot defoliation for the period 1997-2006 are mapped in Figure 2.2.2.2-3. The share of plots with distinctly increasing defoliation (24.6%) surmounts the share of plots with decreasing defoliation (9.7%).

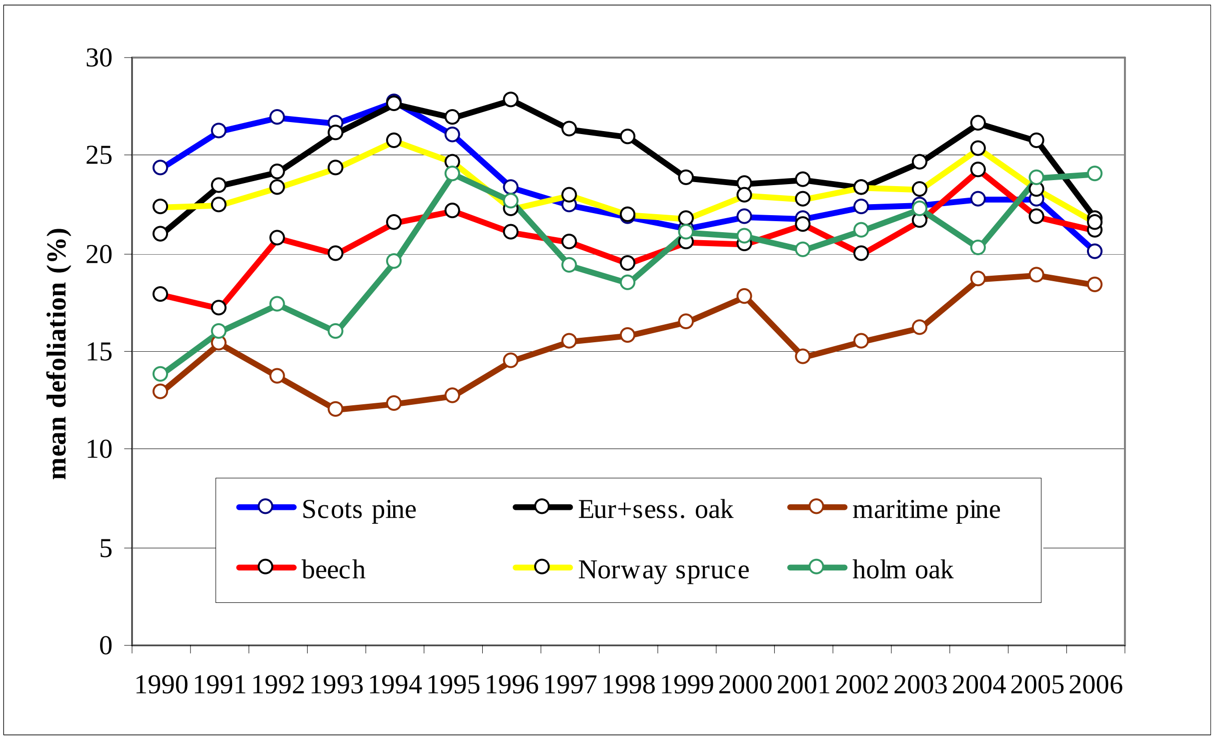


Figure 2.2.2.2-1: Mean defoliation of main species 1990-2006.

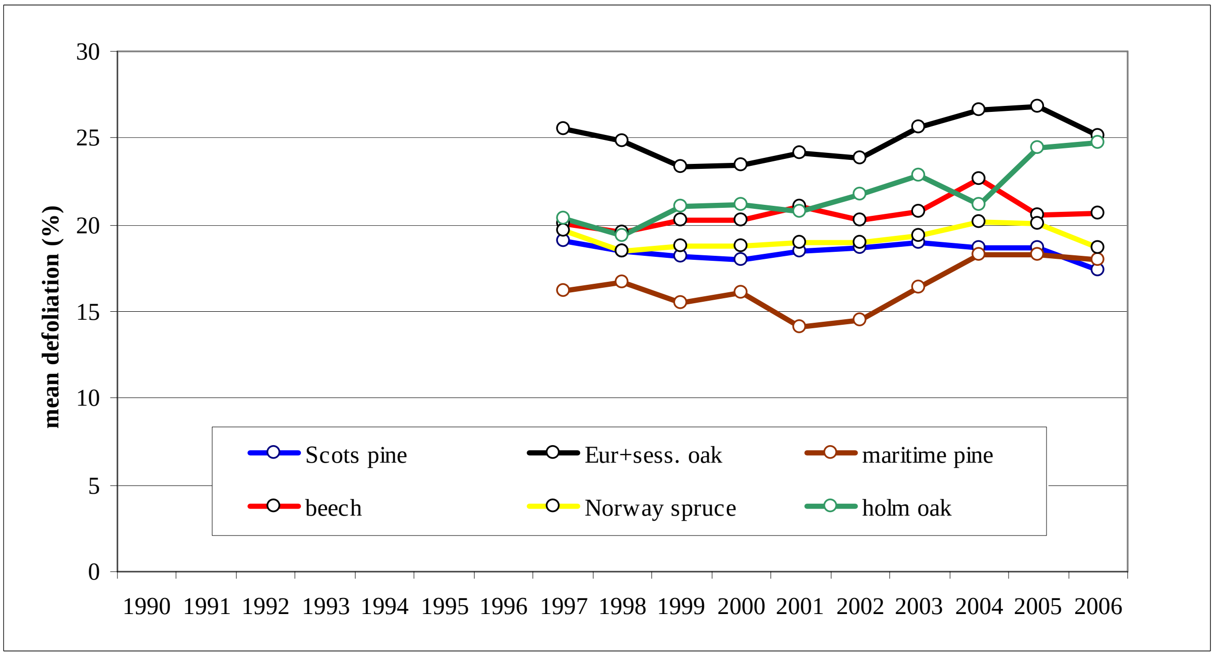


Figure 2.2.2.2-2: Mean defoliation of main species 1997-2006.

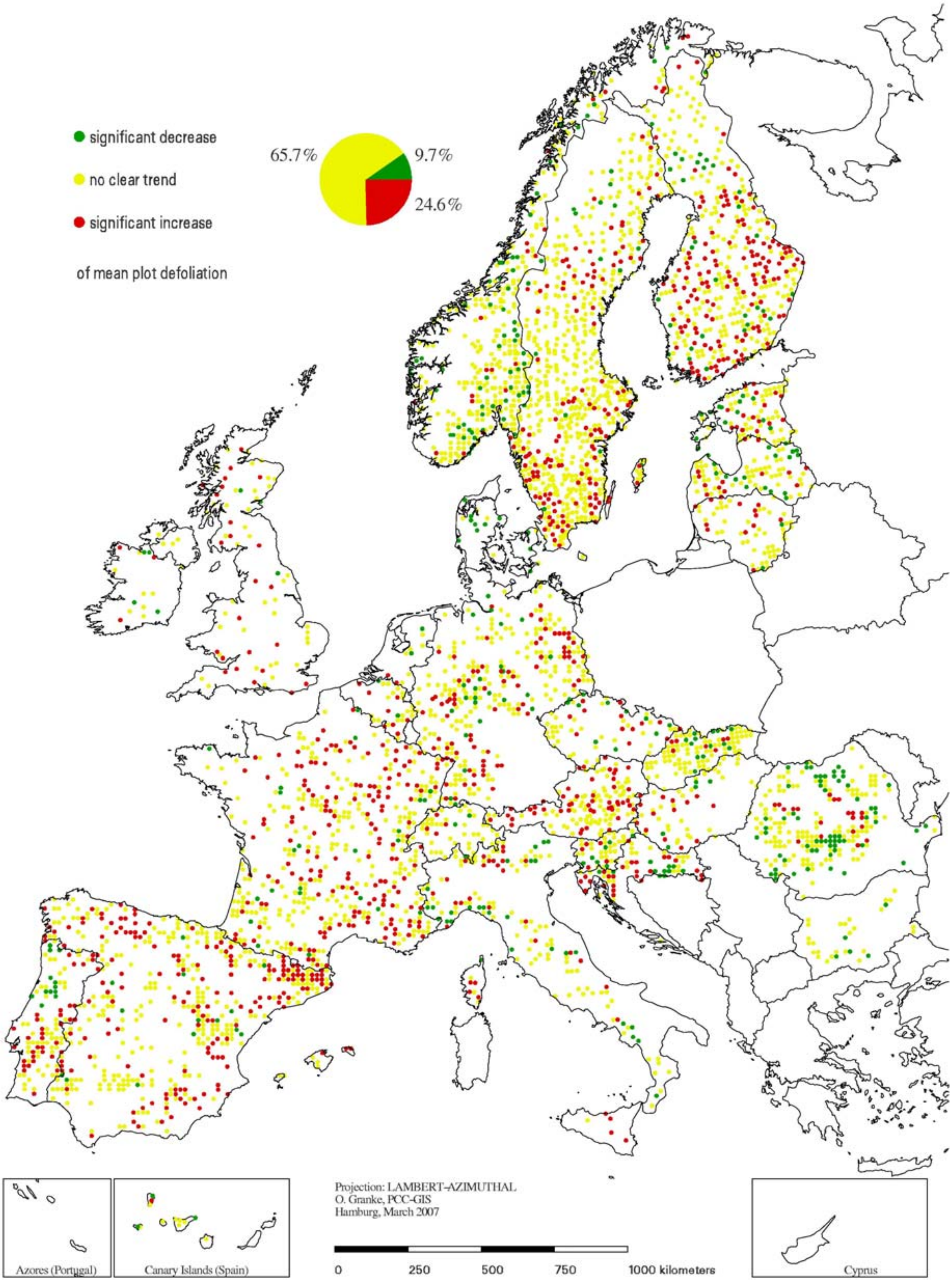


Figure 2.2.2.2-3: Trends of mean plot defoliation of all main species over the years 1997 to 2006.

2.2.2.3 Pinus sylvestris

Pinus sylvestris constitutes the largest share of sample trees in both periods of investigation, 1990-2006 and 1997-2006. It is the only species which is present in all climatic regions. In the total of all regions, the portion of damaged trees shows a pronounced decrease from a peak at 46.2% in 1994 to 19.2% in 2006. This reflects mainly the recuperation in the Sub-Atlantic region which represents by far the largest share of trees. An improvement of the health status in *Pinus sylvestris* since 2001 can also be observed in the Atlantic (North) region (Figure 2.2.2.3-1).

In the Mediterranean (Higher) region the time series show a continued increase in trees damaged observed from 2000 on. It represents only a small portion of the total *Pinus sylvestris* sample trees, but here the share of not defoliated trees decreased from 85.9% in 1990 to 33.0% in 2006 (Figure 2.2.2.3-1).

As regards the spatial distribution of the damage the pie diagram shows that the share of the plots showing deterioration (18.6%) is larger than that of recuperating plots (9.6%) (Figure 2.2.2.3-2). The map shows the high number of deteriorating plots in the Boreal region (mainly Finland). Some plots with continued increase of defoliation can also be observed in Sweden. Small clusters of plots with deteriorated health status since 1997 lie in the eastern part of Germany and in Spain close to the French border. A marked improvement can be seen in the north of Finland and in Norway. Predominantly, namely for 71.8% of all plots no clear trend in forest condition of *Pinus sylvestris* was found.

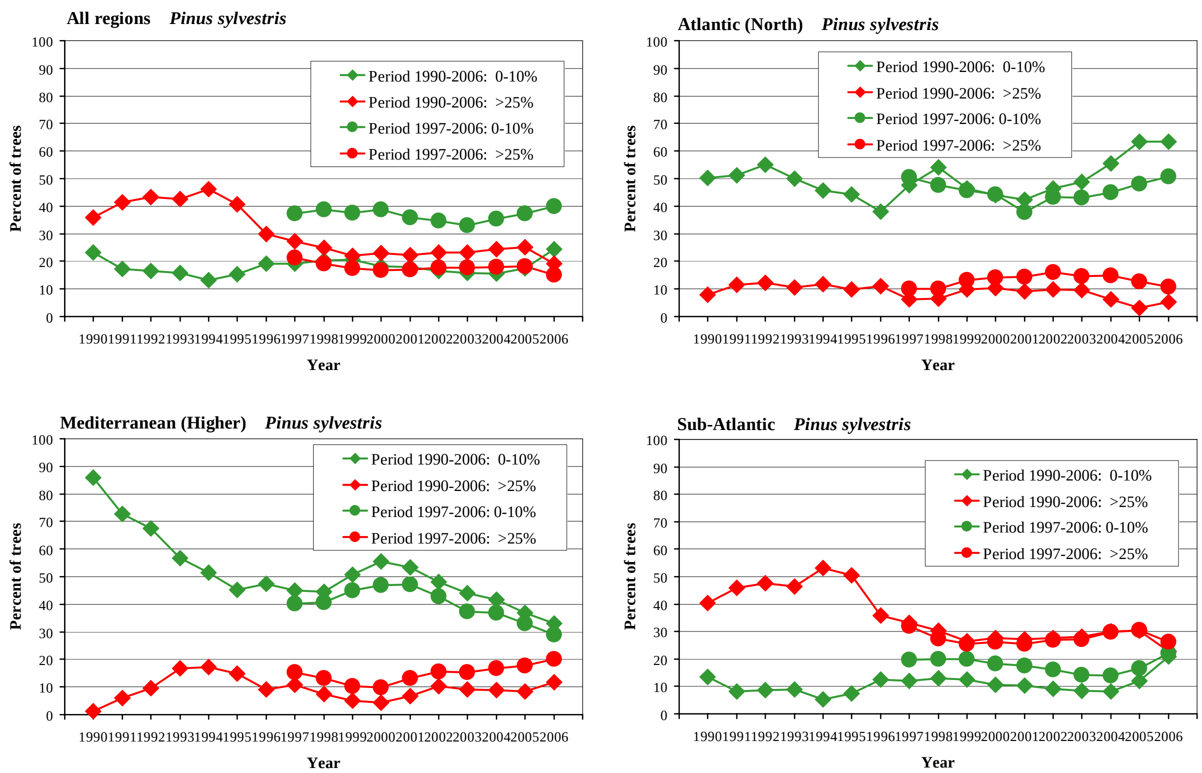


Figure 2.2.2.3-1: Shares of trees of defoliation 0-10% and >25% in two periods (1990-2006 and 1997-2006).

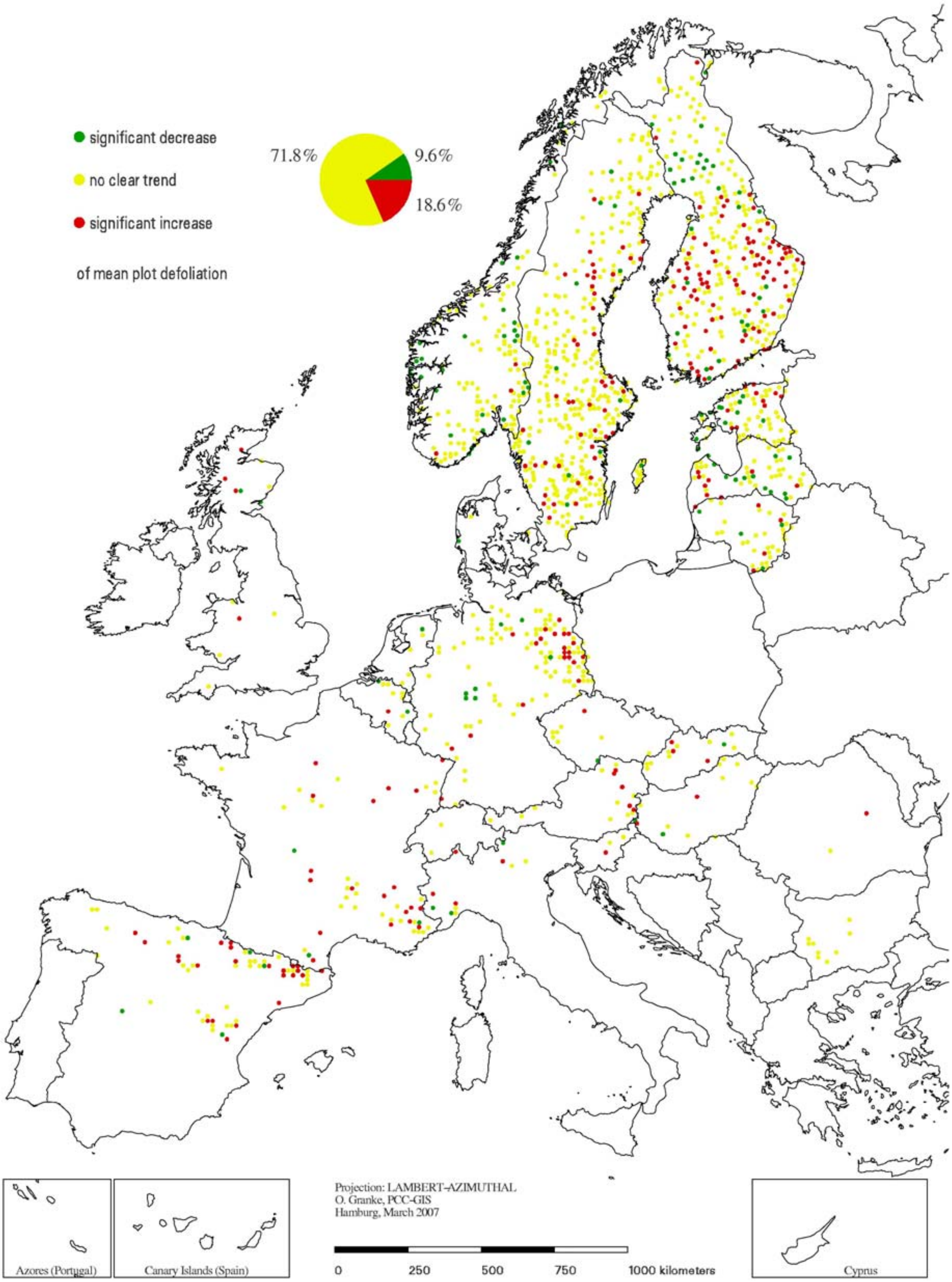


Figure 2.2.2.3-2: Trend of mean plot defoliation (slope of linear regression) of *Pinus sylvestris* over the years 1997 to 2006.

2.2.2.4 Picea abies

In both periods of observation, *Picea abies* constitutes the second largest share of trees behind *Pinus sylvestris*. In the period 1990-2006, the share of damaged trees in the total of all regions decreased from its peak of 38.2% in 1994 to 29.0% in 2006 (Figure 2.2.2.4-1). This development reflects largely the one in the Continental and Sub-Atlantic regions. The latter comprises the largest share of *Picea abies* trees. The Sub-Atlantic and Mountainous (South) regions show a sudden increase in defoliation from 2003 to 2004 with a subsequent decrease in 2005 and 2006. This pattern is interpretable as an effect of the dry and hot summer of 2003 and a recovery from it in 2005. *Picea abies* plots in the Continental region show the most pronounced trend, where the share of damage trees continually decreased from 31.6% in 2003 to 14.8% in 2006. Correspondingly, the percentage of healthy trees rose within these three years from nearly 35% to almost 54%. In the 1990-2006 sample of *Picea abies* in the Mountainous (South) region crown condition deteriorated between 2005 and 2006.

Figure 2.2.2.4-2 shows the spatial distribution and the shares of plots with decreasing and increasing defoliation. Of all plots in the map, 24.3% showed a distinct increase in defoliation, whereas only 10.2% of them showed a distinct decrease. 65.5% of the plots do not show clear temporal development in defoliation since 1997. According to the trend calculations used the health status of *Picea abies* improved in Romania. The regions showing temporal deterioration of defoliation occur in Southern Sweden and Finland.

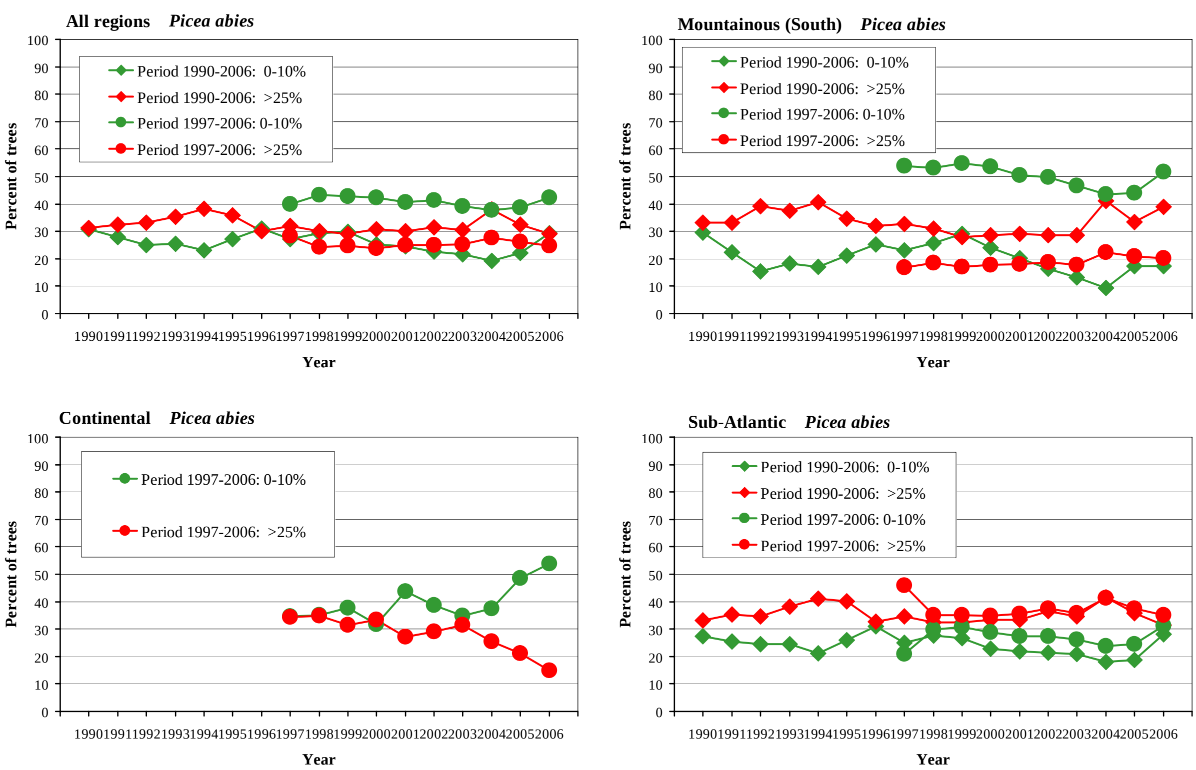


Figure 2.2.2.4-1: Shares of trees of defoliation 0-10% and >25% in two periods (1990-2006 and 1997-2006).

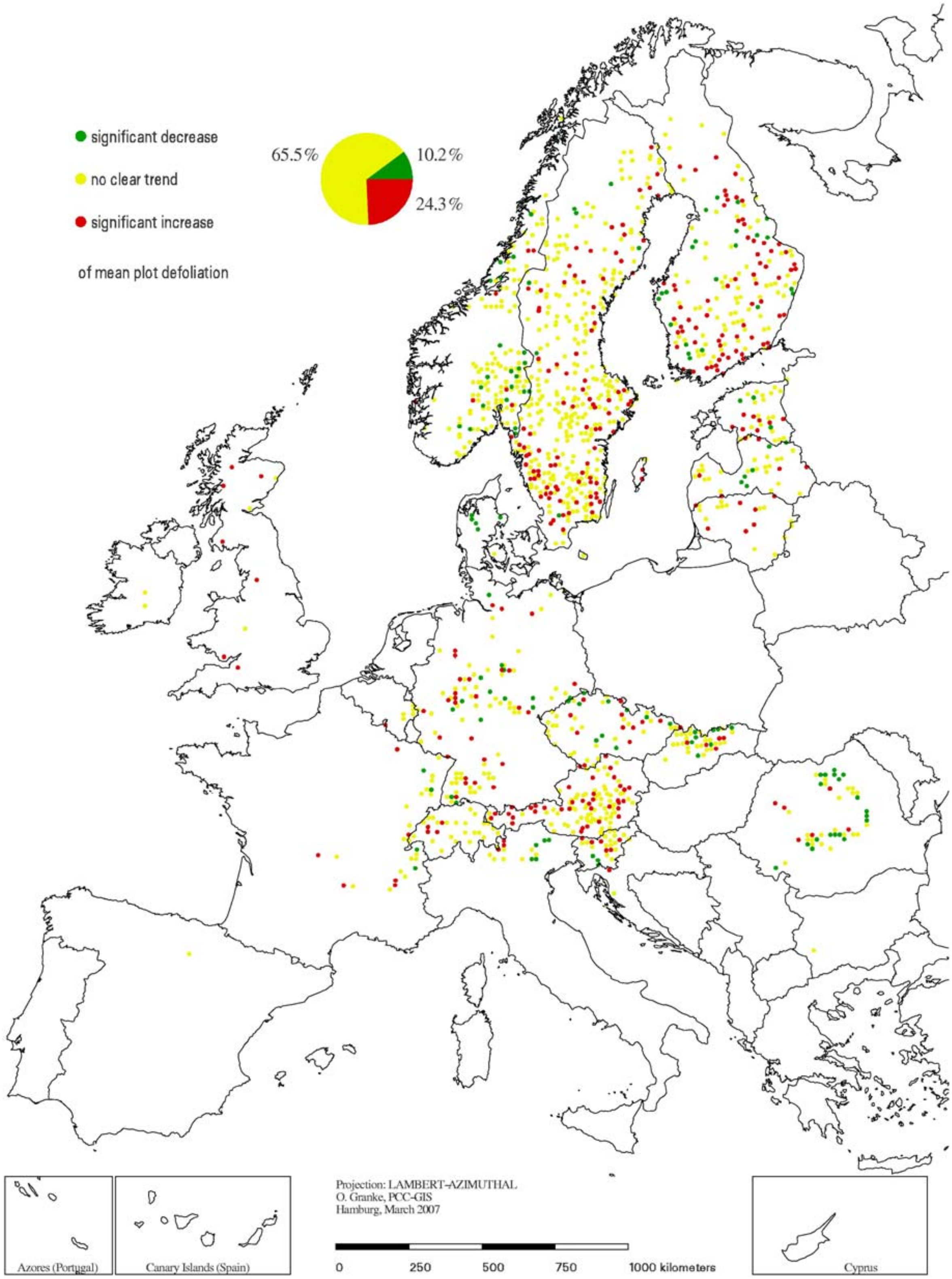


Figure 2.2.2.4-2: Trend of mean plot defoliation (slope of linear regression) of *Picea abies* over the years 1997 to 2006.

2.2.2.5 Fagus sylvatica

Fagus sylvatica constitutes the largest portion of the broadleaved species. In both periods of observation (1990-2006 and 1997-2006) crown condition across all regions deteriorates. This becomes particularly obvious in the decrease in the share of not defoliated trees between 1990 and 2006 (Figure 2.2.2.5-1). The dry and hot summer of 2003 caused an increase in defoliation in 2004 in all regions except for the Mountainous (South) region. The subsequent decrease in defoliation indicates a recuperation of the trees in 2005 followed by an increased share of damaged trees in 2006 across all regions. This reflects in particular the development of crown condition in the Sub-Atlantic region which constitutes the majority of the *Fagus sylvatica* trees. Both the drought damage and the following recuperation are especially pronounced in the Atlantic (North) region, where the share of damaged trees increased by 16.6 percent points from 29.2% in 2003 to 45.8% in 2004, and decreased again to 32.2 % and 32.8% in 2005 and 2006, respectively. Another obvious increase in defoliation occurred in the 1990-2005 sample in the Mountainous (South) region. There, the share of damaged trees almost tripled from 11.8% in 2002 to 32.5% in 2003 which reflects largely the high fructification in the eastern Slovak Republic. The overall deterioration of crown condition of *Fagus sylvatica* over the whole period of 1997-2006 observed particularly in the Sub-Atlantic region is evident in Figure 2.2.2.5-2.

The map shows the spatial distribution of the trends since 1997 across Europe. The share of plots with increasing defoliation is 19.7% against a share of 13.9% of plots showing decreasing defoliation. The highest number of plots with an improved crown condition is in Romania.

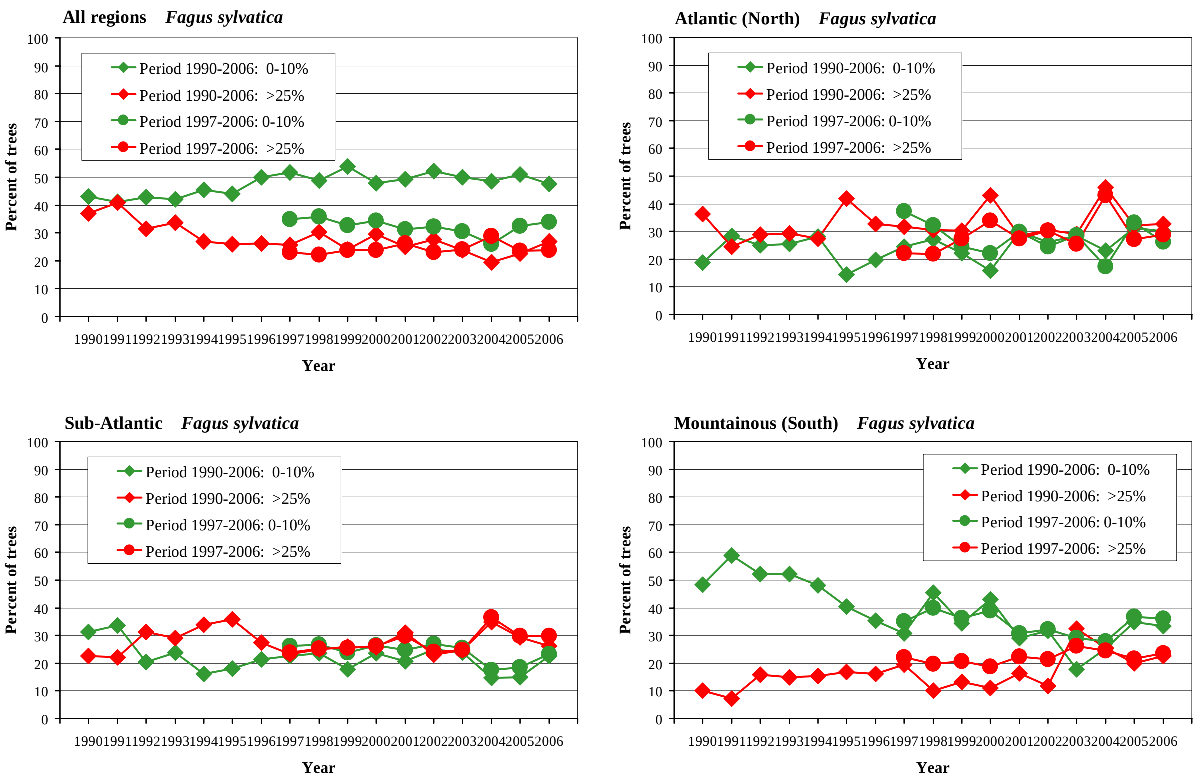


Figure 2.2.2.5-1: Shares of trees of defoliation 0-10% and >25% in two periods (1990-2006 and 1997-2006).

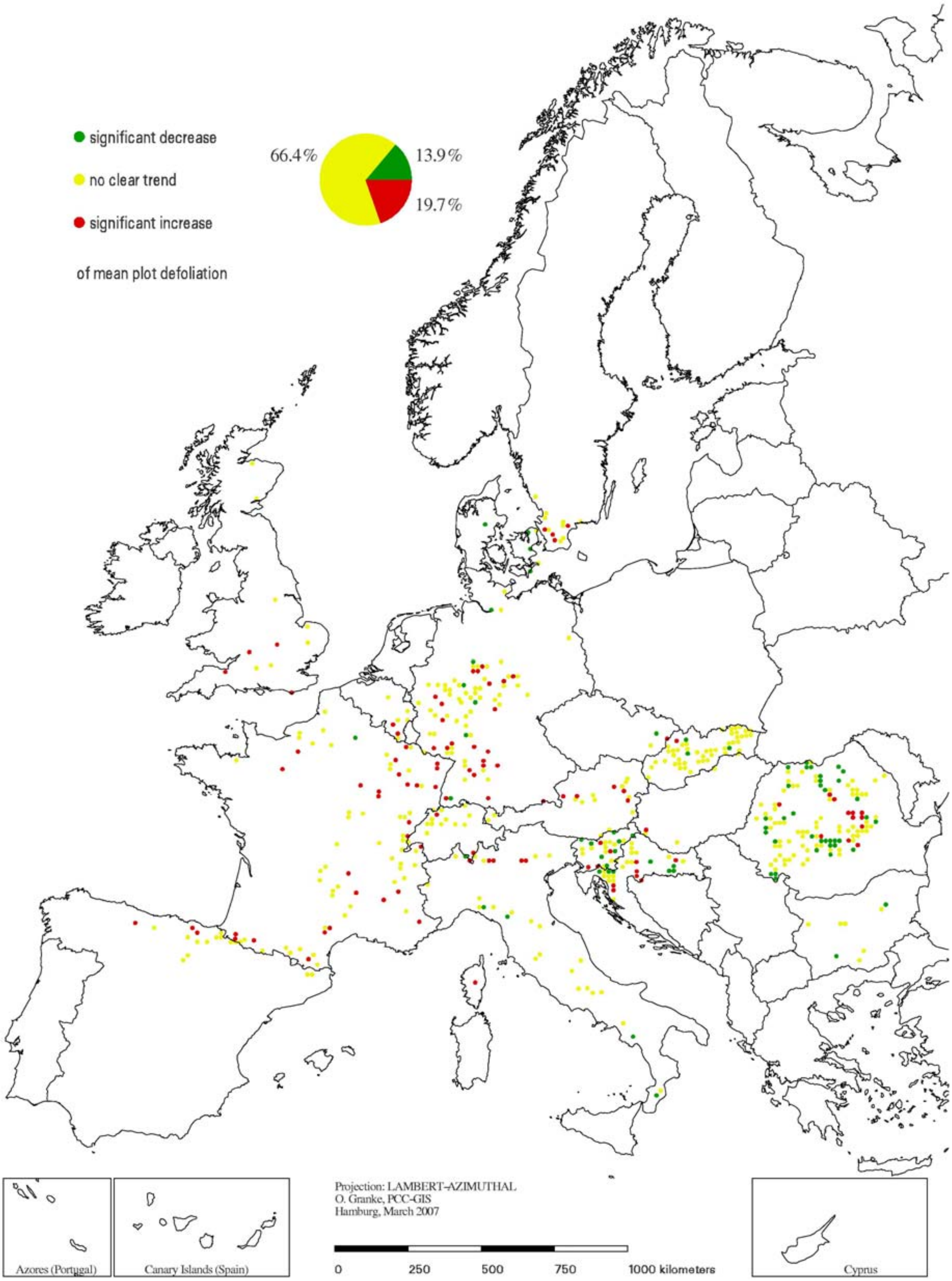


Figure 2.2.2.5-2: Trend of mean plot defoliation (slope of linear regression) of *Fagus sylvatica* over the years 1997 to 2006.

2.2.2.6 Quercus robur and Q. petraea

In the species group *Quercus robur* and *Quercus petraea*, the share of damaged trees across all regions recovered from its peak at 46.5% in 1994. After a steady state from 1999 onwards, it increased markedly in 2003 because of the summer heat and drought. This reflects mainly the development of crown condition in the Sub-Atlantic region which comprises the largest share of the sample trees of this species group. There, the share of damaged trees of the time series 1990-2005 increased by 10.3 percent points from 32.6% in 2002 to 42.9% in 2005, followed by a marked recuperation in 2006. The improved crown condition in this region shows a pronounced decrease in damaged trees to 30.1% in 2006. A recuperation of *Quercus robur* and *Quercus petraea* occurred also in Mountainous (South) region, where the share of damaged trees dropped between 2005 and 2006 by 11.1 percent points. Also in the Continental region the both oak species recovered in the last two years. Considered spatially, defoliation of 65.5% of oak plots has been very variable without a clear trend (Figure 2.2.2.6-2). The highest number of plots with increased defoliation is situated in France.

Of all plots in the map, 25.8% show increasing and 8.7% show decreasing defoliation.

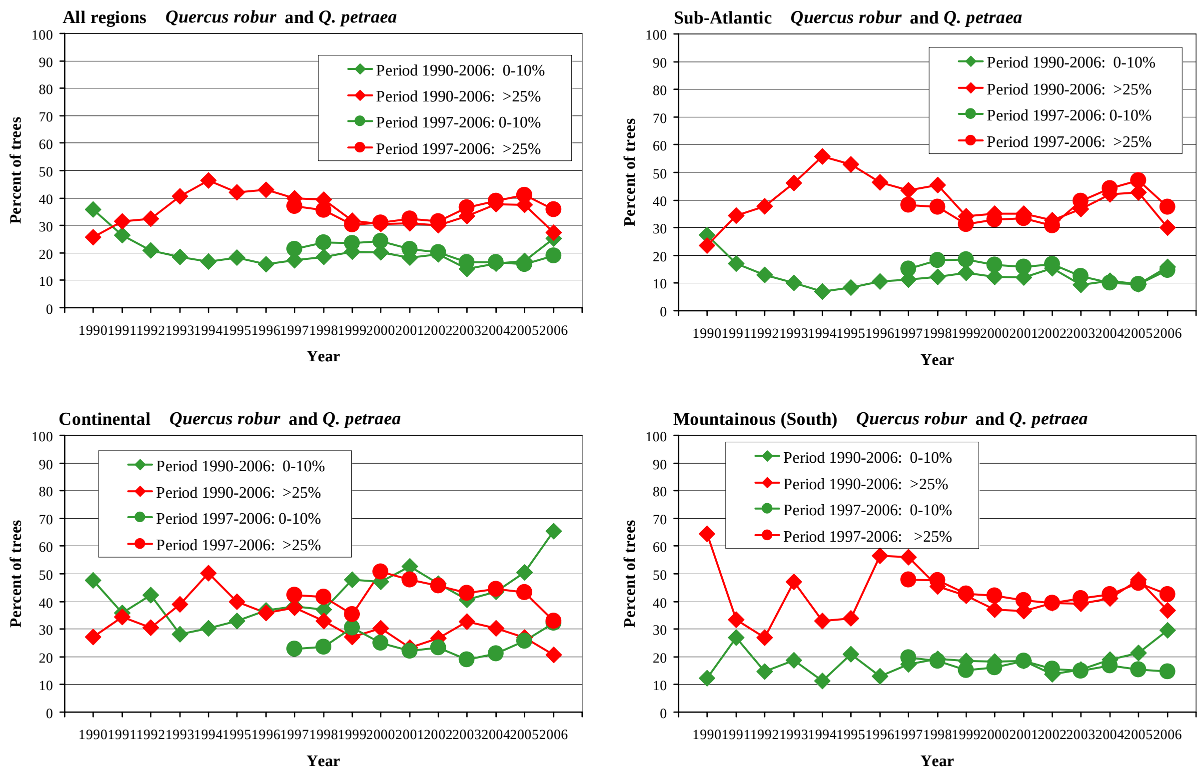


Figure 2.2.2.6-1: Shares of trees of defoliation 0-10% and >25% in two periods (1990-2006 and 1997-2006).

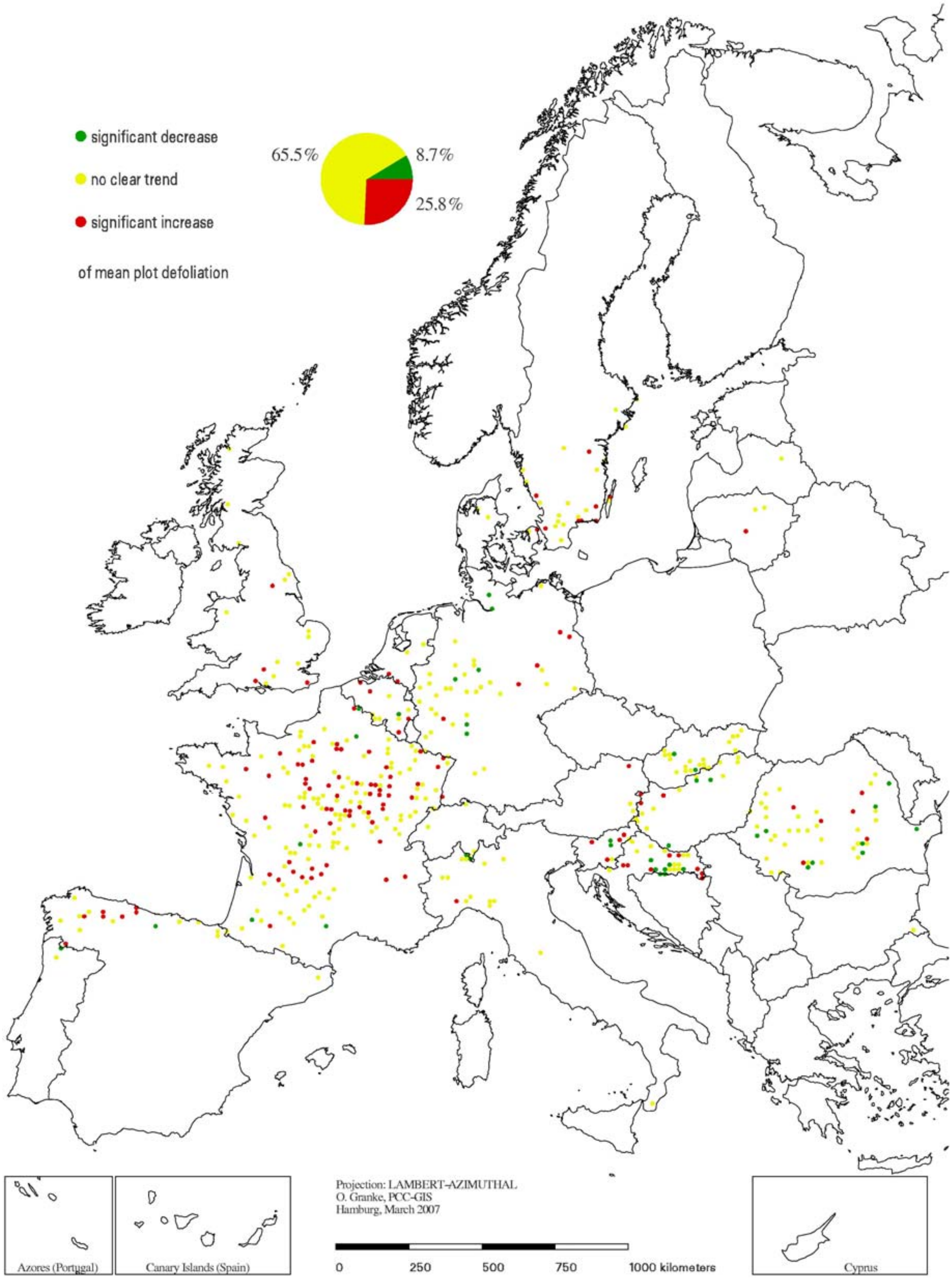


Figure 2.2.2.6-2: Trend of mean plot defoliation (slope of linear regression) of *Quercus robur* and *Quercus petraea* over the years 1997 to 2006.

2.2.2.7 Quercus ilex and Q. rotundifolia

Across all regions, *Quercus ilex* and *Quercus rotundifolia* show an increase in the share of damaged trees to a peak of 28.1% in 1995. This deterioration was followed by a clear recuperation to 13.4% in 1998 (Figure 2.2.2.7-1). Since then the share of damaged trees of both samples (1990-2004 and 1997-2004) undulated around 20% until the year 2004. The subsequent sharp increase in 2005 is explained by exceptional summer drought. It continues in 2006 across all regions. Only in the Mediterranean (Higher) region a slight improvement is observed with a share of damaged trees diminished from 33.5% in 2005 to 29.9% in 2006. In Portugal, after summers already dry in 2003 and 2004, the summer of 2005 was the driest for the last 50 years. Defoliation of *Quercus ilex* and *Q. rotundifolia* was caused by water deficit followed by insects and fungi outbreaks in trees weakened by insufficient water supply. Also France reported unusual summer drought in June and July 2006.

A comparison of the maps in Figures 2.2.2.7-2 and 2.1.2.1-1 confirms that many of the plots with increasing defoliation are situated at higher altitudes. Of all plots on the map, 37.7% show increasing defoliation against only 4.9% with decreasing defoliation.

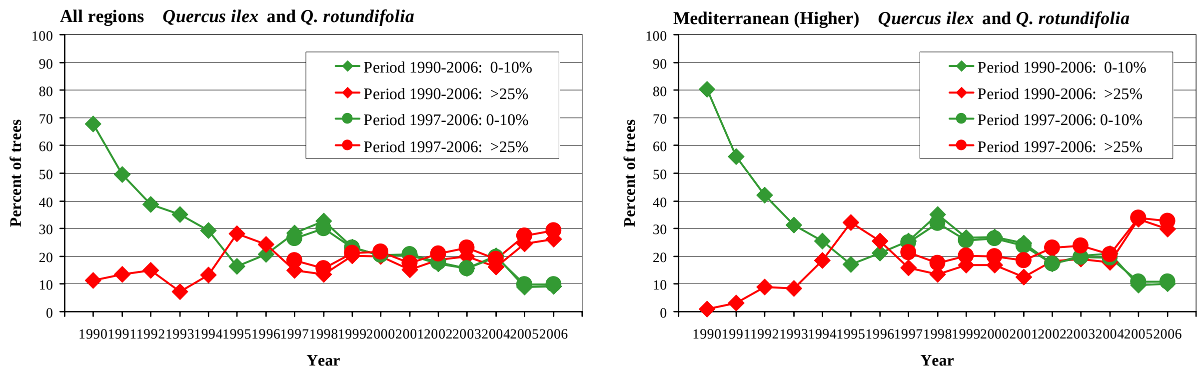


Figure 2.2.2.7-1: Shares of trees of defoliation 0-10% and >25% in two periods (1990-2006 and 1997-2006).

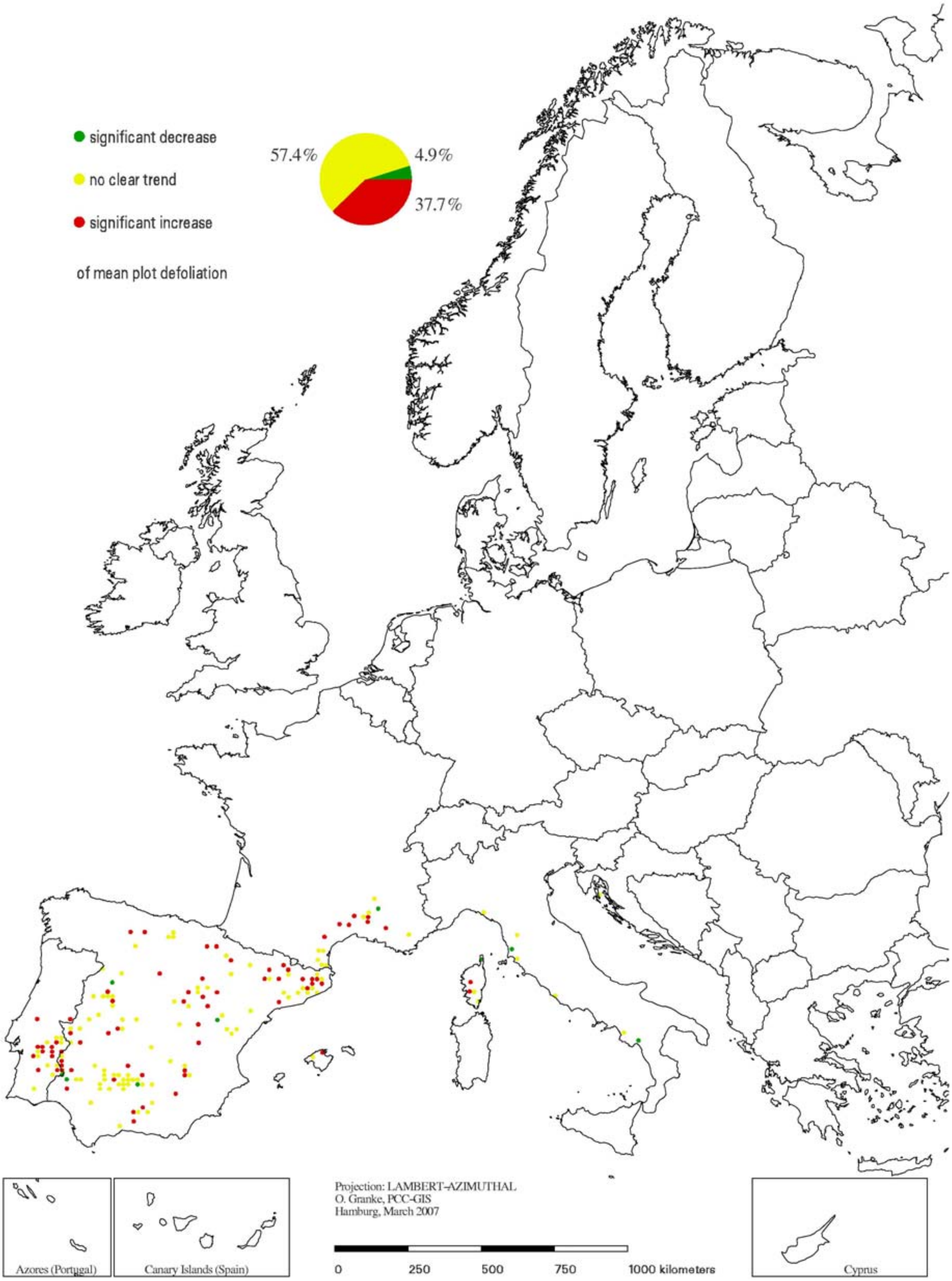


Figure 2.2.2.7-2: Trend of mean plot defoliation (slope of linear regression) of *Quercus ilex* and *Quercus rotundifolia* over the years 1997 to 2006.

2.2.2.8 Pinus pinaster

Over the entire period of observation, the share of damaged trees of *Pinus pinaster* across all regions changed only slightly (Figure 2.2.2.8-1). Despite this, defoliation of this species increased due to a continuous decrease in the share of not defoliated trees. This share fell from 68.9% in 1990 to 37.3% in 2006. This development reflects largely the one in the Mediterranean (Lower) and Mediterranean (Higher) regions, where almost 75% of all *Pinus pinaster* trees occur. In the Mediterranean (Higher) region a striking deterioration of crown condition occurred. There, the share of damaged trees almost doubled in both time series between 2005 and 2006.

The map in Figure 2.2.2.8-2 shows that the plots with increasing mean defoliation are scattered across the whole habitat, while a number of recuperating plots is concentrated in Portugal. The share of deteriorating plots is with 27.3% clearly larger than the share of improving plots with 11.6%.

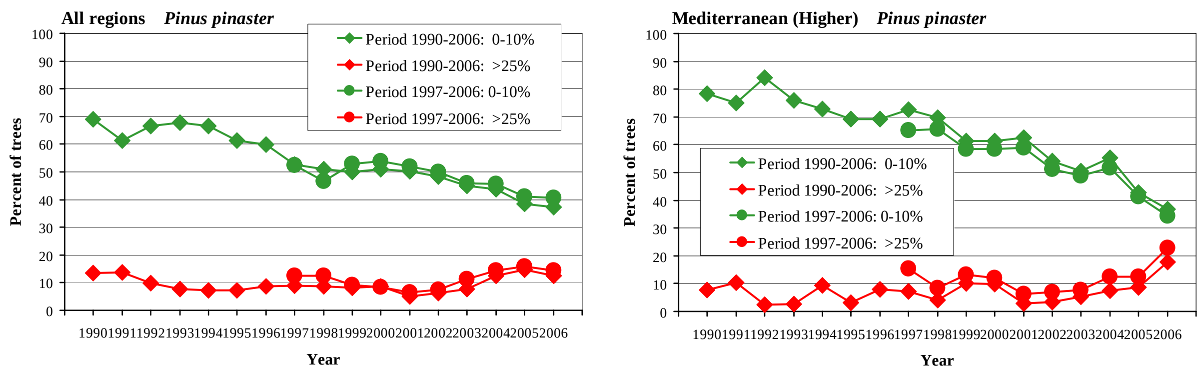


Figure 2.2.2.8-1: Shares of trees of defoliation 0-10% and >25% in two periods (1990-2006 and 1997-2006).

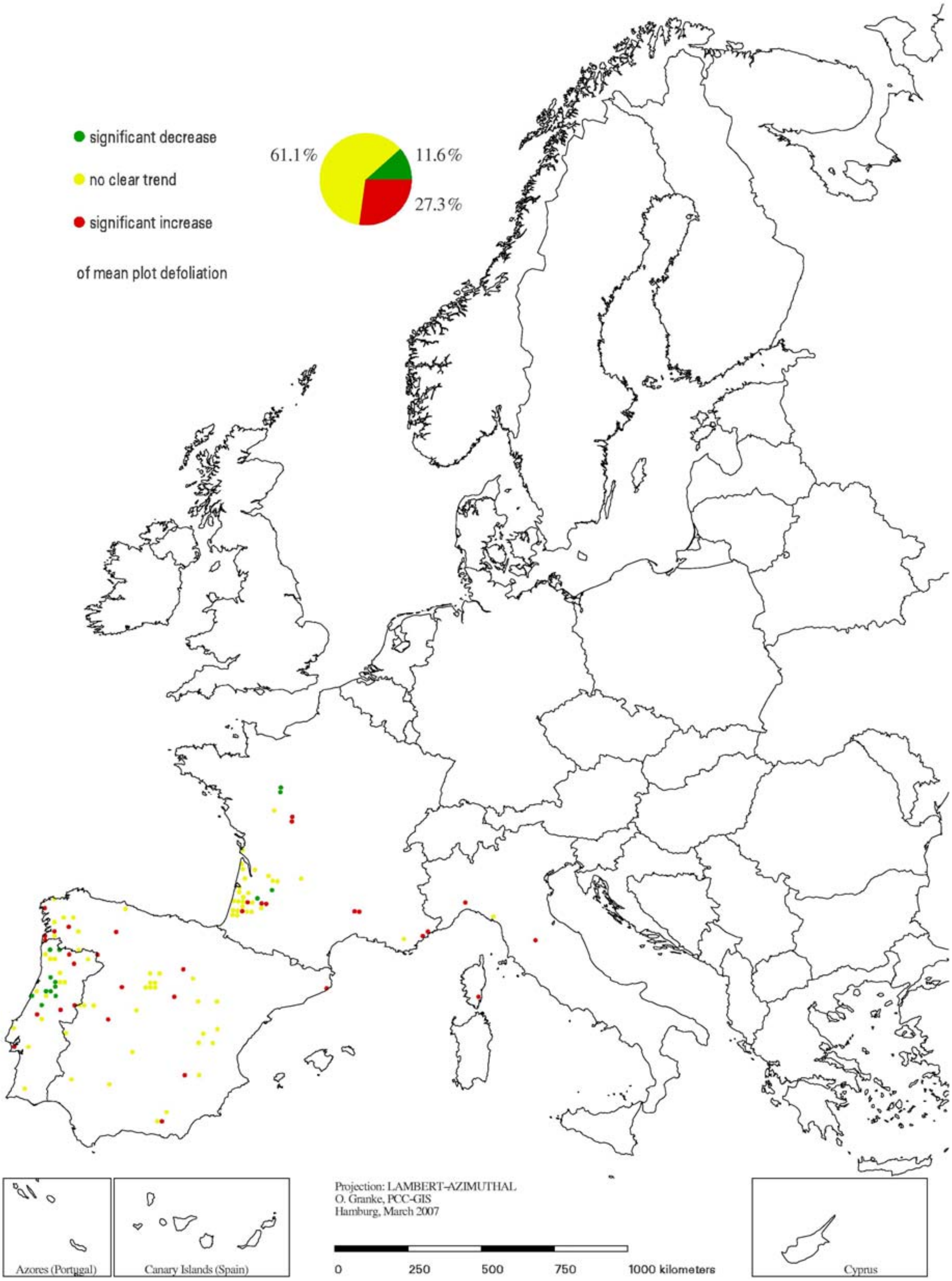


Figure 2.2.2.8-2: Trend of mean plot defoliation (slope of linear regression) of *Pinus pinaster* over the years 1997 to 2006.

2.2.3 Further damage symptoms and their causes

Defoliation is a key indicator for the condition of trees, but trees can show many other symptoms like discolouration of leaves, dead branches or stem wounds. They reflect the impact of both natural and anthropogenic factors like insects, fungi, extreme weather conditions or inappropriate tree harvesting. These factors can seriously affect and even destroy forests. Their information on their occurrence is essential for the study of cause-effect mechanisms.

From the start of ICP Forests information on presence or absence of eight so-called easily identifiable damage causes has been collected on Level I plots. In 2004 a new method for the assessment of damage causes was implemented allowing for more detailed information. Besides defoliation also other types of damage symptoms are recorded, as well as information on their extent and causes.

The main objective of assessing damage causes is to collect information on their impact on crown condition, but in the long-term these observations may also, at least for some of the more common damage factors, provide baseline data on their distribution and occurrence in European forests.

In the following evaluation an overview is presented of the observations of symptoms, mortality and the related causes for the trees assessed according to this new method.

2.2.3.1 Sample

In 2006 the new method for the assessment of damage causes was implemented in the Level I grid by 19 countries: Andorra, Austria, Belarus, Belgium, Czech Republic, Cyprus, Finland, France, Latvia, Lithuania, Luxembourg, Italy, Netherlands, Norway, Poland, Slovak Republic, Spain, Sweden and United Kingdom.

The total sample consisted of 92184 trees on 4541 plots, of which 80093 trees on 4464 plots could be evaluated for symptoms and damage causes. The main tree species are *Pinus sylvestris*, *Picea abies*, *Fagus sylvatica*, *Quercus ilex*, *Betula pubescens*, *B. pendula* and *Quercus robur* (table 2.2.3.1-1).

Table 2.2.3.1-1: Tree species distribution

	Number of trees	%
Pinus sylvestris	22485	28.1
Picea abies	13648	17.0
Fagus sylvatica	5096	6.4
Quercus ilex	3773	4.7
Betula pubescens	3750	4.7
Betula pendula	3161	3.9
Quercus robur	3124	3.9
other species	25056	31.3
Total	80093	100.0

2.2.3.2 Affected tree parts and observed symptoms

Overall 43122 trees showed symptoms on leaves, branches and/or stem (54%). In 29862 trees only one symptom was reported, while 13260 trees showed multiple symptoms like defoliation and discolouration or a combination of symptoms on leaves, branches and/or stem. As a result the number of observations is much higher than the number of trees showing symptoms: overall 60485 records of symptoms were reported (Table 2.2.3.2-1).

Table 2.2.3.2-1: Numbers and percentages of observations of symptoms in leaves, branches and stem.

Affected part	Symptom	Number of observations	%
Leaves / Needles	devoured/missing	15085	24.7
	discolouration	6881	11.3
	deformations	1265	2.1
	abnormal size	1248	2.1
	signs insects	1046	1.7
	other symptom	971	1.6
	signs fungi	565	0.9
	other signs	101	0.2
	Total leaves	27162	44.6
Branches	dead/dying	13503	22.1
	devoured/missing	1851	3.0
	broken	1698	2.8
	deformations	519	0.9
	other signs	459	0.8
	signs insects	270	0.4
	abortion/absciss.	245	0.4
	wounds	158	0.3
	necrosis	157	0.3
	decay/rot	92	0.2
	other sympt.	68	0.1
	signs fungi	32	0.1
	slime flux/resin flow	17	0.0
	Total branches	19069	31.4
Stem	wounds	4964	8.2
	deformations	2059	3.4
	decay/rot	1912	3.1
	slime flux/resin flow	1451	2.4
	signs insects	1312	2.2
	necrosis	774	1.3
	other signs	733	1.2
	signs fungi	484	0.8
	tilted	425	0.7
	broken	299	0.5
	other symptom	201	0.3
	Total stem	14614	24.0
TOTAL		60845	100.0

The majority of these observations concerned symptoms on leaves (44.6%), 31.4% of the observations were made on branches and 24% on the stem. Devoured/missing leaves were observed most frequently (24.8%). This symptom is important in relation to the assessment of defoliation, but in this chapter on symptoms and damage causes it is reported only if additional information on the type or the cause of defoliation could be collected.

Discolouration of leaves represented 11.3% of the reported symptoms, including yellowing (5.1%), red to brown discolouration (5.5%), bronzing and other deviations of the usual colour of the living foliage (0.7%). Deformations, abnormal size and other symptoms on leaves as well as signs indicating the presence of insects or fungi are less common (8.5%). Dead branches (22.2%) and, to a much lesser extent, missing (3%) or broken branches (2.8%) represented the highest share regarding symptoms on branches. Stem wounds represented 8.2% of the observed symptoms, followed by stem deformations (3.4 %) and wood decay or rot (3.1%). In trees showing multiple symptoms the most frequent combinations were devoured or missing leaves and dead branches, yellowing of leaves and dead branches and devoured or missing leaves and yellowing.

For the **main tree species** considerable differences were found in the share of trees showing symptoms: *Pinus sylvestris* (N trees with symptoms = 9444; 42%), *Picea abies* (N = 5541; 41%), *Fagus sylvatica* (N = 4163; 82%), *Quercus ilex* (N = 2802; 74 %), *Betula pubescens* (N = 1547; 41%), *B. pendula* (N = 1204; 38%) and *Quercus robur* (N = 2548; 82%).

For each species the total number of symptom observations and the most frequently reported symptoms are listed below (Table 2.2.3.2-2). Devoured or missing leaves and dead branches represented a high share in the reported symptoms for most species. Stem wounds were reported mainly in *Picea abies, Fagus sylvatica, Betula pubescens and B. pendula*.

However even in widely distributed tree species, some of these symptoms were reported by one or a few countries only, e.g. stem necrosis in *Picea abies* was reported almost exclusively by Sweden. This indicates that this symptom is either of regional or local importance only or that it was overlooked or present but not reported by observers in other countries.

Table 2.2.3.2-2: Numbers and percentages of observations of symptoms for the main tree species.

Pinus sylvestris (Nsympt = 10897)	dead/dying branches (20.6%) devoured/missing needles (17.2%) discolouration of needles (13.4%)
Picea abies (Nsympt = 7128)	stem wounds (22.9% resin flow (15.2%) stem necrosis (9.6%)
Fagus sylvatica (Nsympt = 7136)	devoured/missing leaves (25.2%) dead/dying branches (20.0%) stem wounds (11.3%)
Quercus ilex (Nsympt = 4314)	dead/dying branches (35.7%) devoured/missing leaves (27.8%) leaf deformations (11.0%)
Betula pubescens (Nsympt = 1780)	leaf discol. (24.6%) devoured/missing leaves (24.1%) stem wounds (9.7%)
Betula pendula (Nsympt = 1330)	devoured/missing leaves (32.6%) stem wounds (13.8%) dead/dying branches (9.8 %)
Quercus robur (Nsympt = 4372)	dead/dying branches (30.2%) devoured/missing leaves (28.8%) leaf discol. (18.1%)

2.2.3.3 Causes

The assessment method allows for linking the observed symptoms on leaves, branches or stem to specific causal agents. Causes are grouped into nine different categories and a more detailed level of reporting up to species level is possible.

Overall 62542 records could be evaluated for causal agents (Table 2.2.3.3-1). Insects (26.3%) are the most frequently reported cause, followed by Abiotic factors (14.0%) and Fungi (13.1%). This is in line with the national reports on forest condition, where insects are often quoted as important damage factors. Defoliators account for the majority of the observations in this category.

Drought is the most frequently observed abiotic factor (8.9 %). As regards fungi, species causing canker (4.5%), decay and root rot (3.1%) and needle cast (1.5%) represented the highest share in the observations.

Other important factors include silvicultural operations (3.9%), mainly in connection to stem damage, and competition (4.6%).

Table 2.2.3.3-1: Numbers and percentages of observations of causes.

Cause	Number of observations	%
Game & grazing	**826**	**1.3**
Insects	**16426**	**26.3**
- defoliators	*8836*	*14.1*
- stem & branch borers	*3557*	*5.7*
- other insects	*4033*	*6.4*
Fungi	**8190**	**13.1**
- needle cast & rust	*933*	*1.5*
- decay & root rot	*1947*	*3.1*
- canker	*2818*	*4.5*
- other fungi	*2492*	*4.0*
Abiotic factors	**8762**	**14.0**
- drought	*5542*	*8.9*
- other abiotic factor	*3220*	*5.1*
Direct action of men	**3361**	**5.4**
- silvicult. Operations	*2437*	*3.9*
- other direct action of men	*924*	*1.5*
Fire	**371**	**0.6**
Atmospheric pollutants	**347**	**0.6**
Other known causes	**4309**	**6.9**
- parasitic/climbing plant	*1089*	*1.7*
- competition	*2879*	*4.6*
- other identified cause	*341*	*0.5*
Investigated but unidentified	**19950**	**31.9**
Total	**62542**	**100.0**

Symptoms in relation to specific causes

Devoured or missing leaves and dead branches were the most frequently reported symptoms on the observed trees. For *Pinus sylvestris, Fagus sylvatica, Quercus ilex* and *Q. robur* an overview of the most important causes linked to these symptoms is presented below (Table 2.2.3.3-2).

Table 2.2.3.3-2: Symptoms in relation to specific causal factors.

Symptom	Tree species	Number of observations	Main cause: fungi (%)	drought (%)	insects (%)	other known cause (%)	unidentified (%)	Total (%)
Devoured/missing leaves	*Pinus sylv.*	1887	7	17	32	9	35	100
	Fagus sylvatica	1871	0	0	85	2	13	100
	Quercus ilex	1232	0	32	62	1	5	100
	Quercus robur	1265	0	0	62	1	37	100
Dead/dying branches	*Pinus sylv.*	2338	51	3	9	9	28	100
	Fagus sylvatica	1474	7	4	0	5	84	100
	Quercus ilex	1759	5	53	24	4	14	100
	Quercus robur	1358	1	1	13	8	77	100

Devoured or missing leaves in *Fagus sylvatica, Quercus robur*, *Q. ilex* and to a lesser extent in *Pinus sylvestris* could be mainly attributed to defoliating insects. Frequently reported species include *Rhynchaenus fagi* on beech, winter moth (*Operophtera brumata)* and Oak leaf roller *(Tortix viridana*) on Oak and *Neodiprion sertifer* and Pine Processionary moth (*Thaumetopoea pityocampa*) on Scots pine. In *Quercus ilex* but also in *Pinus sylvestris* drought was found as another factor causing missing leaves.

Fungal infections were reported as the main cause for dead branches in *Pinus sylvestris*. A large proportion of these observations (46%) was linked to *Brunchorstia pinea* in Sweden. In *Quercus ilex* dead branches could be mainly attributed to drought.

2.2.3.4 Dead trees

Of the 80093 sample trees which could be evaluated for symptoms and causes 0.5% (432 trees) was reported to be dead. Because countries treat dead trees in the sample in different ways, not all these trees have died in 2006. Some countries remove dead trees, in other countries they are kept in the database and are repeatedly reported as dead. Therefore this percentage of dead trees is not the same as the mortality rate in 2006.

For more than 60% of these trees at least one causal factor was reported (table 2.2.3.4-1). Fungal infections, including species causing root rot and stem rusts, were the most important factor (16%), followed by abiotic factors including wind (6%), drought (3%) and snow (3%). Other causes include fire (11%), bark feeding insects (8%), defoliators (2 %) and competition (5%).

The observed damage causes are not necessarily the only reason for the death of the trees, but they are assumed to have at least contributed. The bark beetle *Ips sexdentatus* for instance, reported in dead Scots pine, is known to attack especially trees already weakened by other factors. Also *Ips typographus*, reported in dead Spruce, is mainly a weakness parasite, although this species can also act as a primary damaging agent attacking healthy trees when conditions are favourable and population densities high. *Discosporium populeum*, reported in dead Poplar, is a stem and branch pathogen infecting trees already weakened by repeated leaf rust infections or other unfavourable conditions. Other factors like drought can lead directly to mortality of trees or predispose trees to further attack by insects or fungi.

Table 2.2.3.4-1: Reported causes for dead trees

Cause of death	**Number of observations**	**%**
Fungi	72	16
Abiotic factors	66	15
Insects	47	11
Fire	49	11
Other known cause	35	8
Investigated but unidentified	136	31
No data	33	7
Total	438	100

2.2.3.5 Conclusions

In 2006 the new method for the assessment of damage causes was successfully implemented in 19 European countries. Detailed information on different types and causes of damage is available for a subset of the sample trees. Overall 54% of the trees showed symptoms on leaves, branches or stem. Results indicated that only a few symptoms are common and their relative importance varied between tree species. Devoured or missing leaves, dead branches and discolouration were the most frequently observed symptoms. A variety of other symptoms on leaves, branches or stem was observed in lower numbers.

Insects, fungi and abiotic factors were the most important causes linked to the observed symptoms. In particular defoliators, stem borers, drought and fungi causing canker and root rot affected the observed trees. On individual tree species level, only a limited number of identified damaging agents was important.

0.5% of the trees in the observed subsample were reported to be dead. For 60% of these trees causal factors were reported. Fungal infections and abiotic factors, mainly drought and wind, were the most frequently reported causes, but also fire, bark feeding and defoliating insects and competition were mentioned. These factors are not necessarily the only reason for the death of the trees. Some of the reported causal agents are weakness parasites, while other factors like drought or fire can lead directly to mortality or predispose trees to further damage by insects and fungi.

Keeping record of damage types and causal factors over the years will provide an interesting tool for quantifying their impact on tree health as well as their role in stand dynamics. In the second year of implementation of the new methodology for assessment of damage causes it became obvious that format specifications and data submission still needs to be trained in a number of countries. This will be a task of the Expert Panel and data centre in the coming year, in order to improve the data quality and increase the number of plots and trees that can be evaluated. Also implementation of field assessments will need to be completed in those countries that have not yet submitted data in the new formats.

3. INTENSIVE MONITORING

3.1 Introduction

The intensive monitoring aims to assess causal relationships on the forest ecosystem scale. For this purpose, up to 11 surveys are conducted on more than 860 intensive monitoring (Level II) plots selected in the most important forest ecosystems of 28 participating countries. Not all surveys are conducted on all plots. Also, not all surveys are conducted continuously or annually, but need to be conducted only every few years. The data analyses conducted for the present chapter refer to data assessed by the year 2004. For each of the surveys Table 3.1-1 shows the number of installed plots, the number of plots assessed in 2004, 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 installed and assessed in 2004, and assessment frequencies.

Survey	Number of plots installed	Number of plots Assessed in 2004	Assessment frequency
Crown condition	797	676	Annually
Foliar chemistry	767	127	Every two years
Soil condition	738	0	Every ten years
Soil solution chemistry	254	221	Continuously
Tree growth	769	347	Every five years
Deposition	545	434	Continuously
Ambient air quality	61	61	Continuously
Meteorology	212	212	Continuously
Phenology	146	146	Several times per year
Ground vegetation	723	98	Every five years
Litterfall	114	114	Continuously

Results of the intensive monitoring have been presented in annual Technical Reports since 1997 (e.g. DE VRIES et al., 2003). Chapter 3.2 of the present report describes bulk and throughfall deposition as measured by the countries on their Level II plots until the year 2004. In Chapter 3.3, the measured depositions are compared with those depositions calculated with models by the Co-operative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP). Chapter 3.4 describes critical loads for acidity and nitrogen as well as their exceedances, and estimates acidification and eutrophication in future years under deposition scenarios by means of dynamic modelling. Chapter 3.5 presents relationships between deposition, defoliation and growth.

3.2 Deposition and its trends

3.2.1 Method

The spatial variability and temporal development of nitrate (NO_3^-), ammonium (NH_4^+) and sulphate (SO_4^{2-}) deposition on Level II plots from 1999 to 2004 was calculated using the approach described in earlier reports (LORENZ et al. 2005 and 2006). In addition, depositions of calcium (Ca^{2+}), sodium (Na^+), and chlorine (Cl^-) as well as the amount of precipitation were taken into account whenever needed for a sound interpretation of the results. The deposition data were collected and analysed according to the ICP Forests Manual (ANONYMOUS 2004), both in the open field (bulk deposition) and under canopy (throughfall). Bulk deposition is measured in order to reflect the local air pollution situation. Throughfall and in some cases stemflow are measured in order to assess element fluxes into forest ecosystems. Throughfall is mostly larger than in the open field as wet deposition is additionally polluted by dry deposition washed off the foliage. With respect to element fluxes in the forest canopy, two major processes can be observed during the passage of the deposition through the canopy (Figure 3.2.1-1):

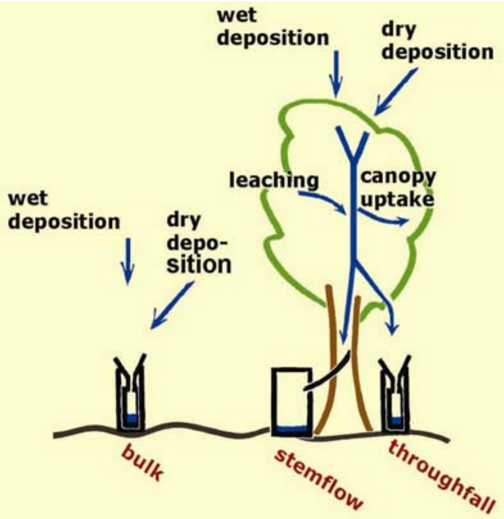


Figure 3.2.1-1: Deposition measurement in forests.

1. Canopy leaching: The solution of an element, mostly of nutrient cations, from the tree crown 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 of an element, mostly nitrogen compounds, from the precipitation water by the leaves which leads to decreased deposition of the particular element in the throughfall deposition compared to bulk deposition.

Both effects are crucial to interpreting deposition below canopy

The time span 1999 to 2004 for trend analyses is a trade-off between the needs for high numbers of plots in order to cover a wide range of deposition situations and for the length of the time span. Given the time span of only six years, the present study must be understood as a mere description of the changes over time rather than a trend analysis which would require a longer period. From the 545 sites on which deposition is measured within ICP Forests, only those sites were selected which have been operational for the whole period 1999-2004, with a maximum of 1 month of missing data per year . Deposition in missing periods was replaced by the respective average daily deposition of the remaining year. 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)

For the interpretation of trends in deposition also the trends in precipitation were taken into account.
The analysis of the spatial variation of deposition was not based on a single year but on the arithmetic mean of the deposition of the years 2002 to 2004. This plotwise mean deposition of a three years' period was chosen in order to compensate for high interannual fluctuations of deposition. By selecting measurements from only 3 years a higher number of plots qualified for the analysis than in case of the trend study based on the longer time span. For the mapping of mean deposition, percentile classes were chosen spanning the whole range of values found. The percentiles were calculated for the total of bulk and throughfall values in order to permit a comparison between bulk and throughfall maps due to uniform threshold values. Table 3.2.1-1 presents the numbers of plots having qualified for the analysis of spatial and temporal variation

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

Variation	Deposition	Na^+	Cl^-	Ca^{2+}	N- NH_4^+	N- NO_3^-	S- SO_4^{2-}
Temporal (1999–2004)	Bulk	206	206	206	205	206	198
	Throughfall	231	231	231	230	231	223
Spatial (2002–2004)	Bulk	219	219	219	219	219	219
	Throughfall	252	252	252	252	252	252

For the interpretation of the results several restrictions have to be watched. In the present study canopy exchange was not taken into account so that throughfall does not reflect total deposition under canopy. 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 1999 to 2004 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 (Chapter 3.3). Bulk and throughfall depositions expressed in kg ha^{-1} a^{-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 (Chapter 3.4).

3.2.2 Results

3.2.2.1 Spatial variation

Both bulk and throughfall deposition of sulphur show rough spatial patterns across Europe (Figures 3.2.2.1-1 and 3.2.2.1-2). Nearly one third (30.2%) of the plots received a bulk deposition higher than 5.7 kg ha^{-1} a^{-1}. Many of these plots are situated close to coastlines. This holds particularly true for Belgium, Greece, Italy, and the United Kingdom. It is partly also the case for some plots in France, Sweden, and Spain. Most of these plots show also sodium depositions ranging from 10.3 to 63.7 kg ha^{-1} a^{-1}. This indicates the input of seaspray which is also a carrier of sulphate. But sulphur depositions of 5.7 kg ha^{-1} a^{-1} and higher were also measured on plots remote from any coastlines, indicating mainly an anthropogenic origin. This holds true for the Czech Republic, central and eastern Germany, for northern Italy and for the Slovak Republic. The throughfall deposition of sulphur is higher than bulk deposition. On nearly half of the plots (49.8%) a throughfall higher than 5.7 kg ha^{-1} a^{-1} was found. These plots are mostly located in central Europe. Plots with lowest sulphur throughfall ranging from 0.7 to 3.3 kg ha^{-1} a^{-1} are mainly situated in the Nordic countries and in the Alps.

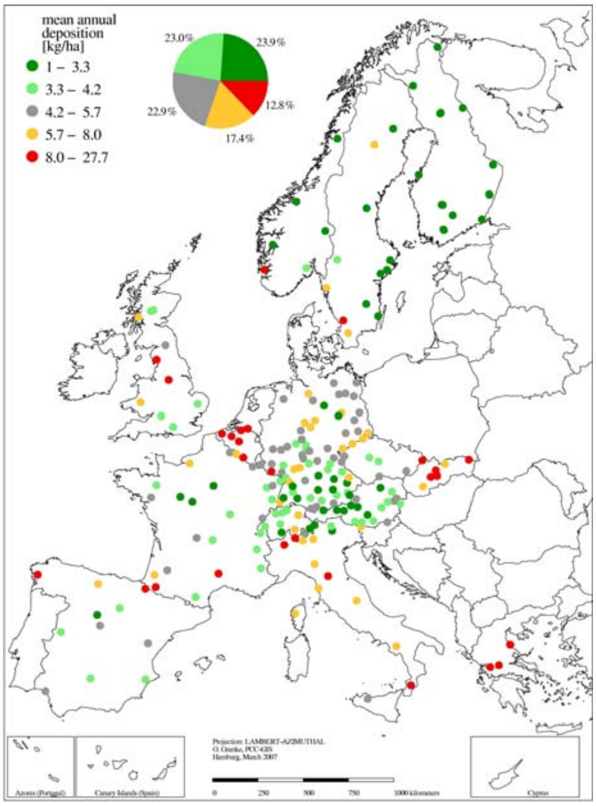


Figure 3.2.2.1-1: Mean annual sulphate sulphur ($S\text{-}SO_4^{2-}$) bulk deposition 2002 to 2004

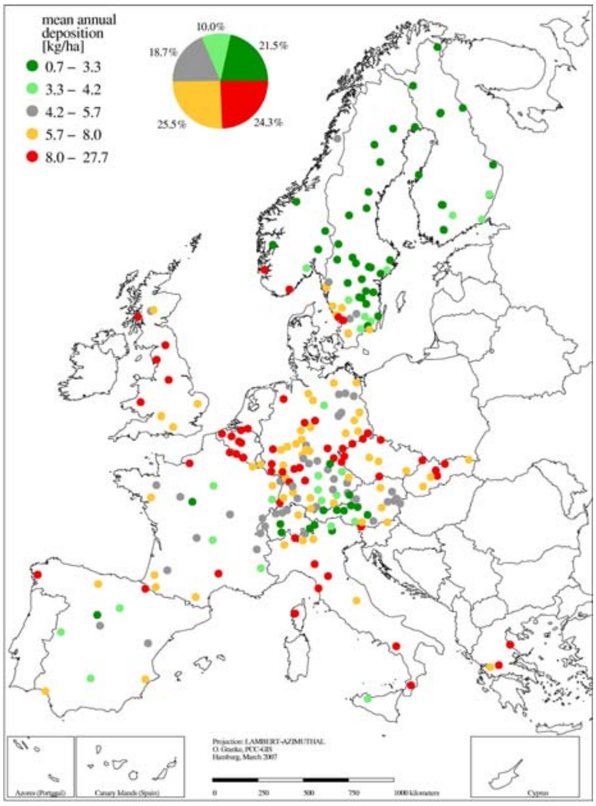


Figure 3.2.2.1-2: Mean annual sulphate sulphur ($S\text{-}SO_4^{2-}$) throughfall deposition 2002 to 2004.

Rough spatial patterns are also discernable for the bulk and throughfall deposition of nitrate (Figures 3.2.2.1-3 and 3.2.2.1-4). Nearly one third (29.4%) of the plots experienced a bulk nitrate nitrogen deposition higher than 4.5 kg ha^{-1} a^{-1}. A throughfall deposition higher than 4.5 kg ha^{-1} a^{-1} was found on more than half (51.4%) of the plots. These plots are mainly situated in central Europe. Plots with lowest nitrate nitrogen throughfall (0.2 – 1.8 kg ha^{-1} a^{-1}) are located in the nordic countries and in the Alps. This spatial pattern reflects partly areas of high vehicle exhaust due to dense traffic.

Bulk deposition of ammonium nitrogen is also highest in central Europe, but those plots showing highest deposition are greatly scattered. About one third (34.8%) of the plots received bulk depositions of 5.1 kg ha^{-1} a^{-1} and higher. The spatial pattern is much more pronounced for throughfall deposition. Throughfall exceeded 5.1 kg ha^{-1} a^{-1} on 45.8% of the plots. Similar as for sulphur and nitrate nitrogen, the plots showing the lowest ammonium nitrogen throughfall ranging from 0.2 to 1.6 kg ha^{-1} a^{-1} are situated mainly in the nordic countries and in the Alps.

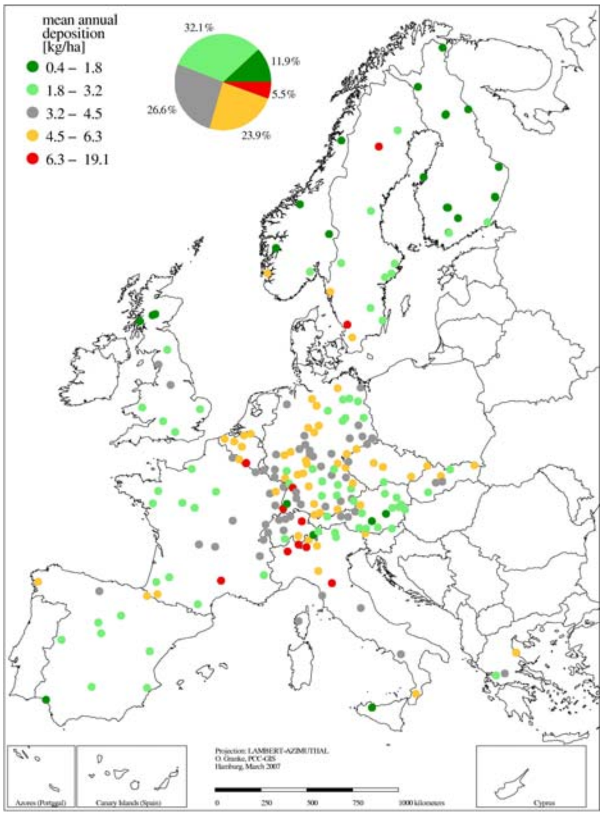


Figure 3.2.2.1-3: Mean annual nitrate nitrogen ($N\text{-} NO_3^-$) bulk deposition 2002 to 2004.

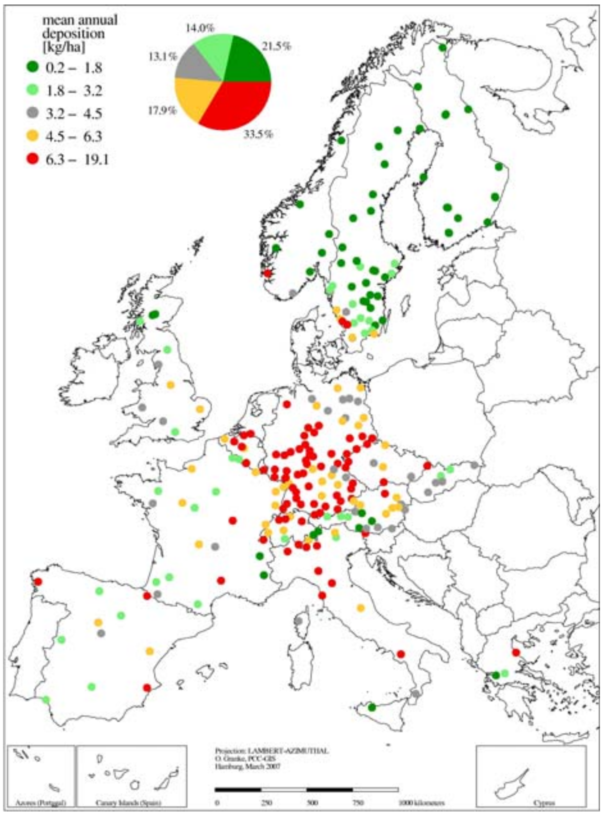


Figure 3.2.2.1-4: Mean annual nitrate nitrogen ($N\text{-} NO_3^-$) throughfall deposition 2002 to 2004.

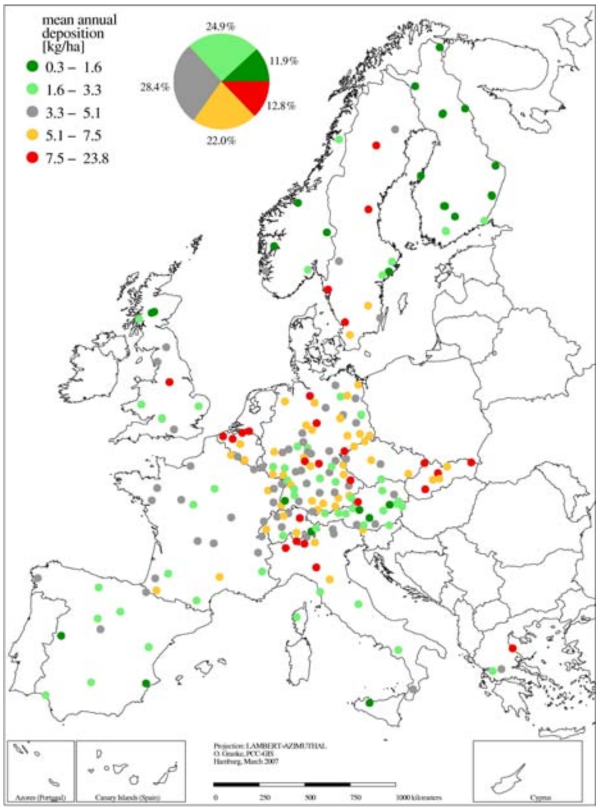


Figure 3.2.2.1-5: Mean annual ammonium nitrogen ($N\text{-} NH_4^+$) bulk deposition 2002 to 2004.

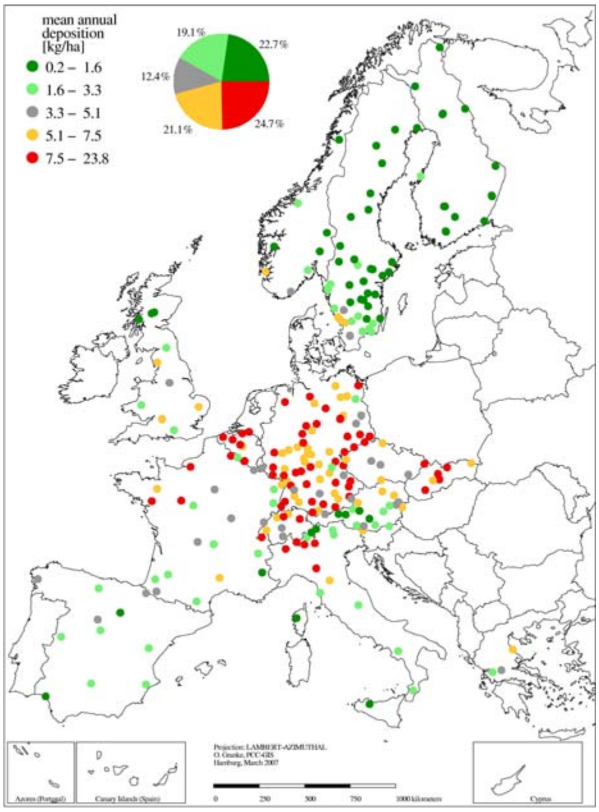


Figure 3.2.2.1-6: Mean annual ammonium nitrogen ($N\text{-} NH_4^+$) throughfall deposition 2002 to 2004.

3.2.2.2 Temporal variation

The distinctness of temporal trends in bulk and throughfall deposition varies greatly among sulphate, nitrate and ammonium within the six years' observation period. Bulk and throughfall deposition of sulphate are highest and show the most pronounced trends among all six time series (Figure 3.2.2.2-1). Sulphur throughfall deposition decreases from 8.8 kg ha^{-1} a^{-1} in 1999 to 6.3 kg ha^{-1} a^{-1} in 2004. Bulk deposition shows a similar decrease at a lower level, namely from 6.7 kg ha^{-1} a^{-1} in 1999 to 4.9 kg ha^{-1} a^{-1} in 2004. The similarity of the bulk and throughfall graphs for sulphur is due to the fact that sulphur hardly interacts with the canopy. The approximately linear slopes of both graphs over six years are interrupted by a marked dip in 2003. Bulk and throughfall deposition decreased by a nearly uniform rate every year, then showed an exceptionally strong decrease in the dry year 2003, and returned to its previous rate of decrease in 2004. This reflects the high dependence of bulk and throughfall deposition from precipitation and dry deposition.

The nitrogen depositions are lower than the depositions of sulphur in most years and show a less pronounced rate of decrease. Moreover, their response to the low precipitation in 2003 is different from that of sulphur. In 2003 bulk deposition of nitrate nitrogen shows an exceptional decrease. In contrast, throughfall of both nitrate and ammonium nitrogen are rather increased in the dry year. This suggests an indication for the notorious impact of canopy exchange on nitrogen throughfall and dry deposition.

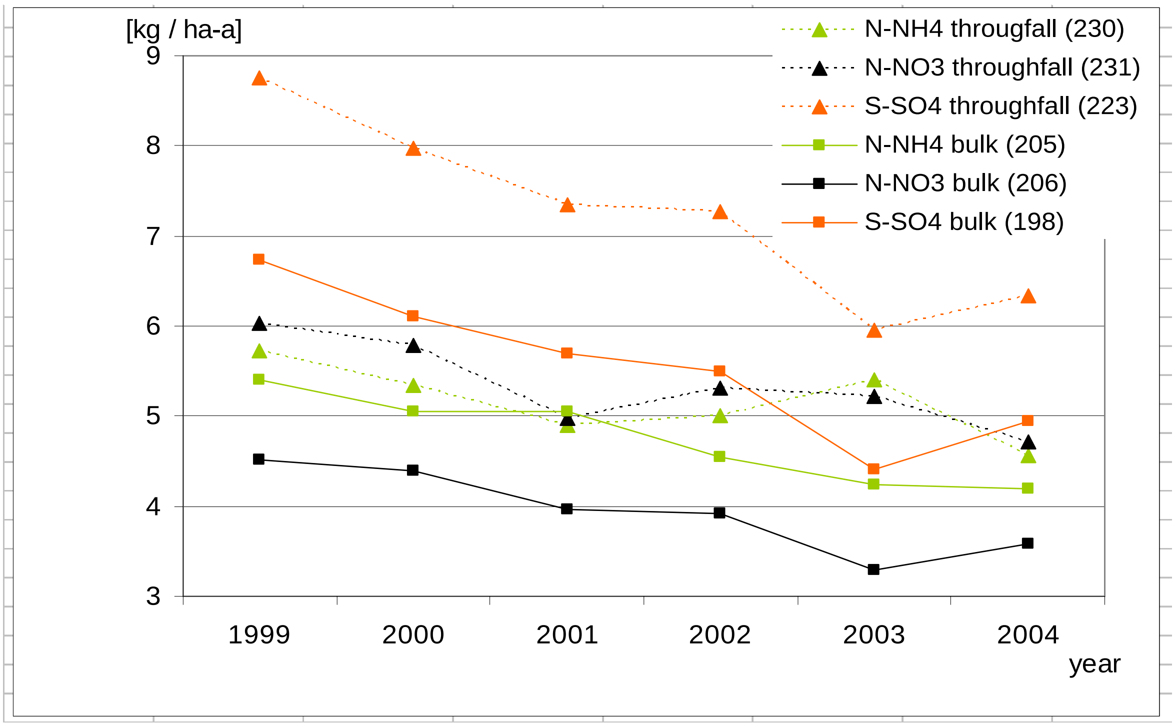


Figure 3.2.2.2-1: Mean annual bulk and throughfall deposition of sulphur, nitrate nitrogen and ammonium nitrogen

For the present study deposition was analysed because the deposition of a pollutant affects the ecosystem no matter to which extent it is related to precipitation. However, the dependence of bulk and throughfall deposition on precipitation raises the question if their six year's decrease reflects decreased precipitation rather than improved air quality. In fact a quantitative evaluation of the rain water amounts in the samplers indicates that precipitation has been decreasing from 1999 to 2004. However, the opposite was observed in the period from 1996 to 2001. In this period, precipitation was found to have clearly increased (LORENZ et al. 2005). The decrease in precipitation observed afterwards occurred mainly in the dry summer of the year 2003. Hence, deposition did not decrease continuously due to continuously decreasing precipitation, but due to reduced air pollutant concentrations. This finding is confirmed by earlier studies indicating decreasing air pollutant concentrations in wet deposition (LORENZ et al. 2004). It is also confirmed if trends in deposition on the individual plots are considered (Figures 3.2.2.2-2 to 3.2.2.2-7). The pie diagrams in these figures show that the shares of plots with significantly decreasing deposition range from 9.1% (ammonium throughfall) to 30.5% (sulphur throughfall). In contrast, those shares of plots with significantly increasing deposition range from only 0.5% (sulphur and ammonium bulk deposition) to 3.0% (ammonium and nitrate throughfall). However, on the individual plots statistically significant decreases in deposition do mostly not coincide with statistically significant decreases in precipitation (Figures 3.2.2.2-8 and 3.2.2.2-9). For sulphur, about one quarter of the plots with significantly decreasing bulk deposition also shows decreasing precipitation. This share is even smaller for sulphur throughfall. Less than one tenth of the plots of significantly decreasing sulphur throughfall deposition also show significantly decreasing precipitation. The respective shares for nitrate and ammonium nitrogen are similarly small.

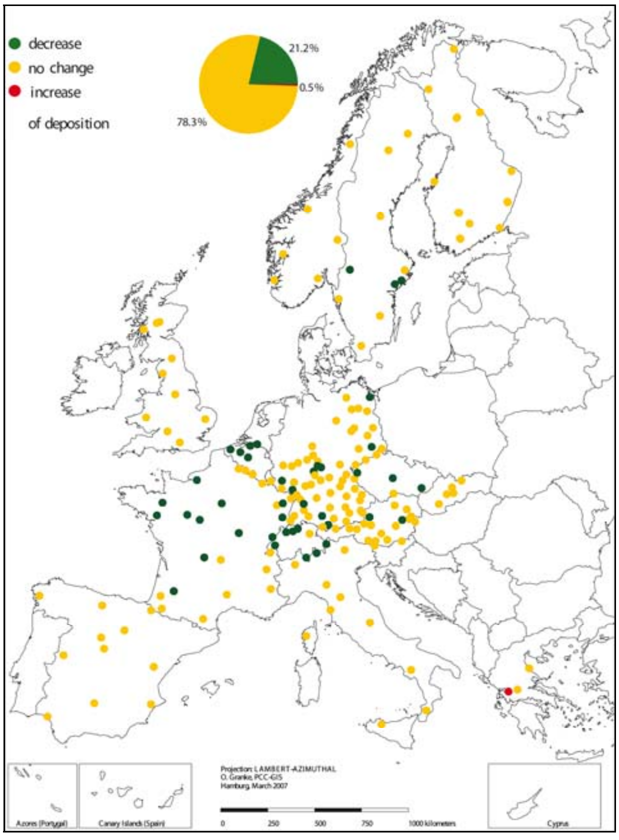


Figure 3.2.2.2-2: Trends in sulphur (S-SO_4^{2-}) in bulk deposition from 1999 to 2004.

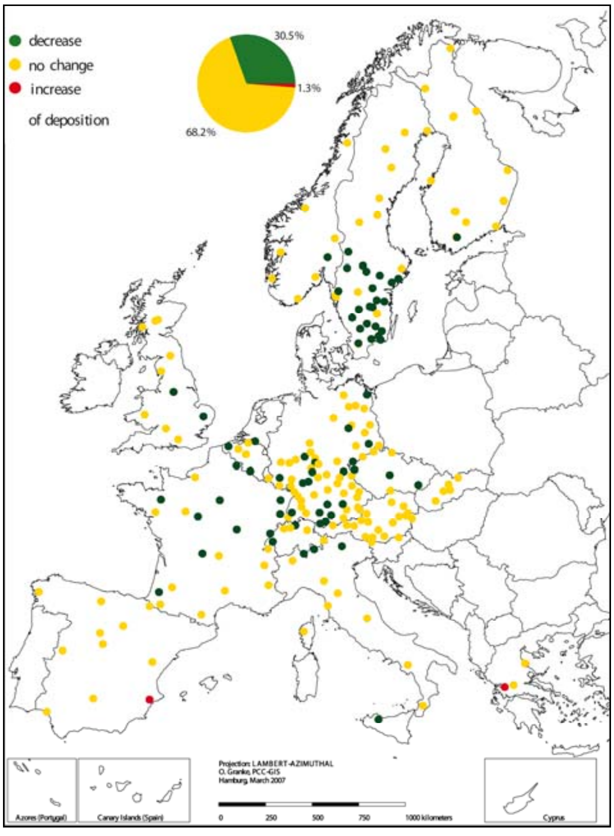


Figure 3.2.2.2-3: Trends in sulphur (S-SO_4^{2-}) in throughfall deposition from 1999 to 2004.

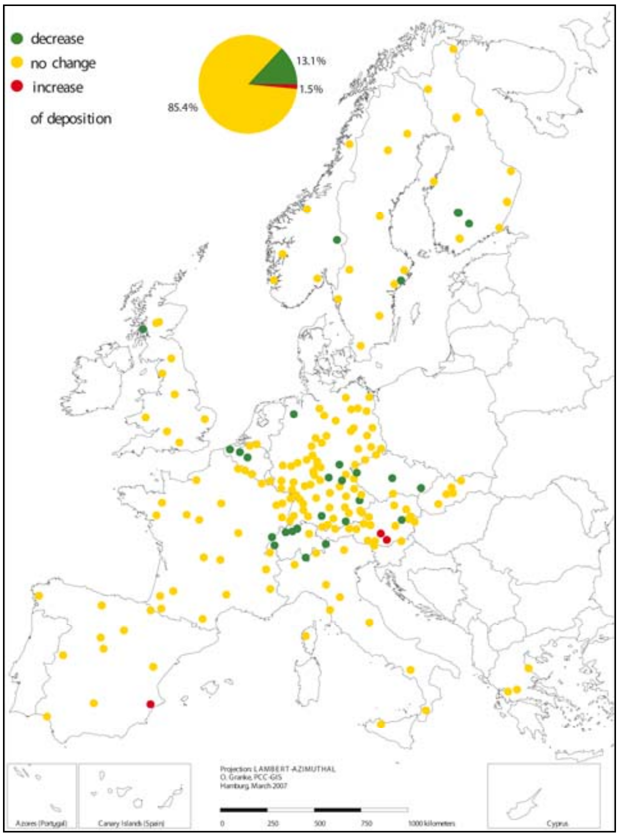


Figure 3.2.2.2-4: Trends in nitrate nitrogen (N-NO_3^-) in bulk deposition from 1999 to 2004.

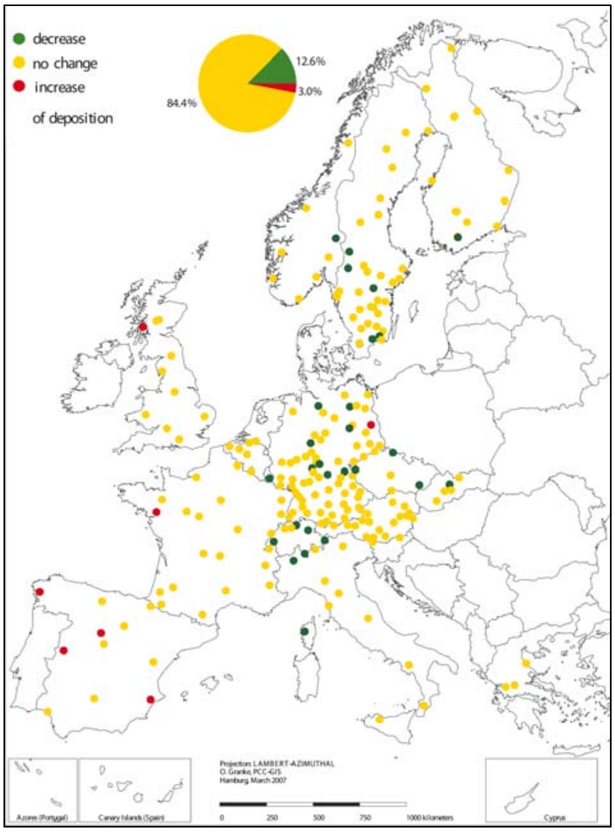


Figure 3.2.2.2-5: Trends in nitrate nitrogen (N-NO_3^-) in throughfall deposition from 1999 to 2004.

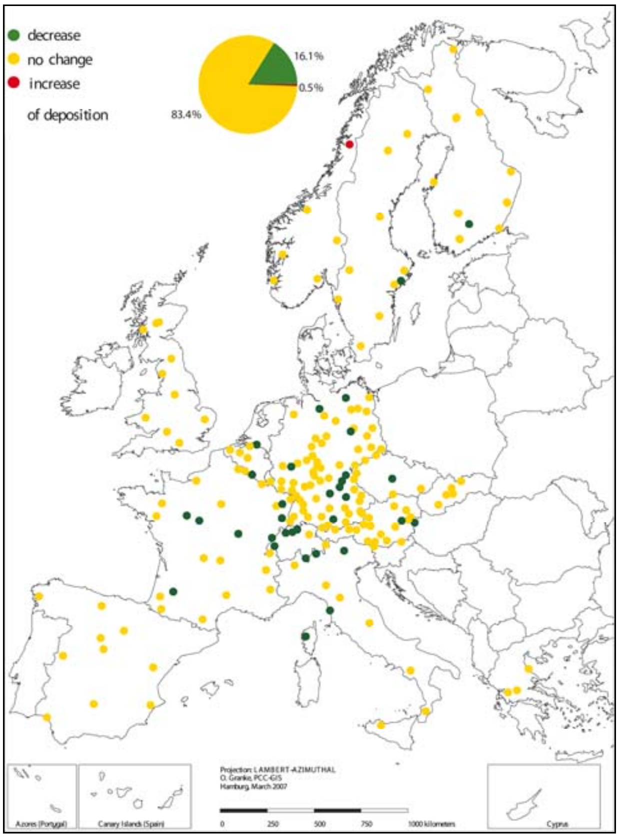


Figure 3.2.2.2-6: Trends in ammonium nitrogen (N-NH_4^+) in bulk deposition from 1999 to 2004.

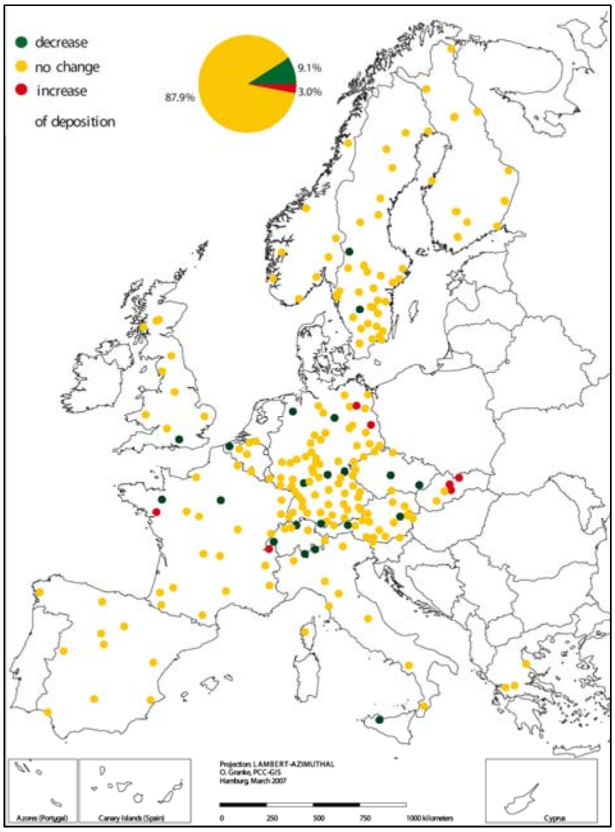


Figure 3.2.2.2-7: Trends in ammonium nitrogen (N-NH_4^+) in throughfall deposition from 1999 to 2004.

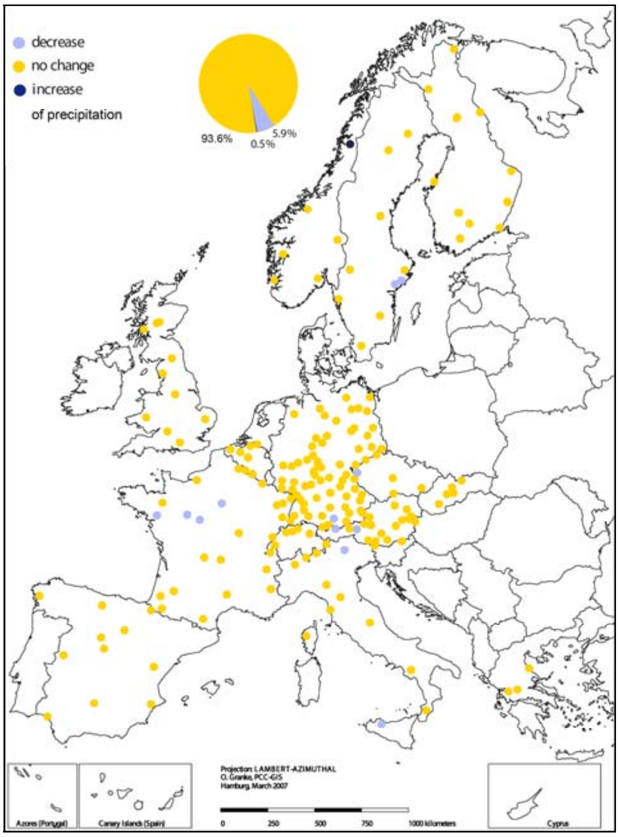


Figure 3.2.2.2-8: Trends in precipitation (bulk deposition water) from 1999 to 2004.

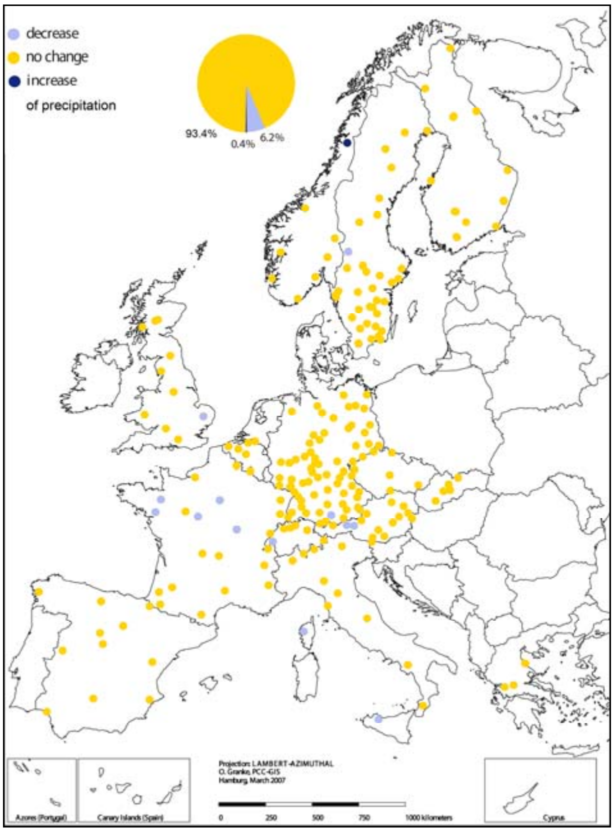


Figure 3.2.2.2-9: Trends in precipitation (throughfall deposition water) from 1999 to 2004.

3.3 Modelling of acidification and eutrophication in forest ecosystems

3.3.1 Introduction

Despite a successful environmental policy, effective abatement strategies and enormous progress in nature protection forest ecosystems are furthermore stressed. Important anthropogenic impacts are geochemical changes, especially of forest soils, due to atmospheric deposition of acidifying and eutrophying pollutants on the one hand and climate change processes on the other hand. Therefore innovative strategies of evaluating forest monitoring data with respect to effects are of unchanged importance and aim at sustainable management and effective environmental policy. The effects on forest vitality and biodiversity reveal a considerable delay after changes in soil conditions which also occur with some delay after the impact of atmospheric pollution. Influences of climate change might become more important in the future. This all requires adaptation of forest management and nature conservation practices, continued observation of forest, monitoring and modelling.

Critical loads of acidity and nutrient nitrogen and their exceedances as well as the application of geochemical dynamic models have proven to be a useful scientific basis for environmental work under CLRTAP and for the EU air pollution prevention policy, especially the NEC directive and the CAFE program. They are together with other results of ICP Forests Level II monitoring a scientific basis for optimised control strategies in the upcoming review of the Gothenburg Protocol and the EU NEC directive. Therefore it is considered worthwhile to undertake an intensive evaluation of the forest monitoring data with respect to the effects criteria used in critical loads computation and mapping as well as in dynamic modelling.

Critical loads refer to a steady state situation at a sustainable status of the regarded ecosystems. In practice the actual status of the ecosystems often differs from the critical loads situation. Therefore, in order to receive a picture of the current risk to ecosystems it is recommended to compare the current status of European forest soils and vegetation with available site specific effects thresholds (critical limits) used in the models. The long-term monitoring data of ICP Forest Level II plots enable the derivation of trends in soil condition. This information can be used to validate predictions of effects or recovery by dynamic models and to adapt the models to observed trends of chemical parameters.

3.3.2 Selected Plots

From the whole domain of Level II plots in Europe only those with deposition measurements and a complete set of the mandatory soil analysis are suitable for Critical Load and / or dynamic modelling. Although around 400 plots fulfil these criteria, only for few plots soil physical data is available, since the submitting of soil texture and bulk density has just recently become part of the official data collection procedure. Table 3.3.2-1 lists the numbers of suitable plots per country. Several Countries, including Austria (AT), Belgium (BE), Czech Republic (CZ), Hungary (HU), The Netherlands (NL), Finland (FI), Spain (ES), and Greece (GR) submitted soil physics data in the last years to FIMCI. As a reaction to a recent call for data, Belgium (Flanders) (BE(FL)), Switzerland (CH), Germany (Rhineland-Palatinate) (DE(RP)), Finland (FI), Italy (IT), Norway (NO), Poland (PL), Slovak Republic (SK), and Sweden (SE) sent soil files to update the Level II database. While the data sent from BE(FL), DE(RP), NO and SK were conform with the actual manual while the others were not (partly outdated manual without texture data, partly free format with varying data). The total of the various data sources (old database, answers to the recent call for data and additional submitted data and the German national Level II database) allowed the calculation of Critical Loads for 186 plots from 12 countries. IT, SE and PL delivered no suitable texture data and there were no data for the absolute yield at the Slovakian sites.

Table 3.3.2-1: Number of plots per country suitable for critical loads (CL) calculation and dynamic modelling (VSD)

Region (Plots CL/Plots VSD)	Country	Plots with CL-calculation	Plots with VSD calculation
Alps (29/29)	AT	19	19
	CH	10	10
Central Europe (113/86)	BE	6	6
	CZ	2	2
	DE	82	66
	HU	13	3
	NL	4	3
	PL	6	6
Northern Europe (21/21)	FI	11	11
	NO	10	10
Southern Europe (14/13)	ES	10	9
	GR	4	4
Western Europe (9/9)	UK	9	9
Total		186	158

At some plots only the critical loads mass balance method was applicable, main reasons for not calculating these plots with VSD also are the following:

9 German and 10 Hungarian plots are not calculated due to missing variables (mostly C-Pool, 3 plots have no measured CEC), 7 German and 1 Dutch plots are not calculated due to the uncommon C/N ratio in the soil (<10). The missing Spanish plot lies outside of the spatial domain of the deposition history (SCHÖPP et al., 2003).

It is crucial for the calculation of Critical Loads to know the climatic conditions, especially precipitation and temperature. While the precipitation rate is measured together with the deposition only very few sites have temperature measurements. For data consistency reasons and to use the climate standard period (1960-1990), the global climate dataset by New et al. (2002) was used to interpolate the climatic parameters for the Level II plots (KRAFT 2007).

3.3.3 Critical Loads

The general definition of a critical load is
"*a quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment do not occur according to present knowledge*" (ANONYMUS, 2004b).

3.3.3.1 Critical Loads of Acidity

$$CL_{max}(S) = Bc^*_{dep} + Na_{dep} - Cl^*_{dep} + Bc_w + Na_w - Bc_u - ANC_{le,crit}$$

The exceedance of the Critical Load is given when the most sensitive Critical Limit of acidity is violated. Possible Critical Limits are given in Table 3.3.3.1-1 (ICP Modelling and Mapping, 2004).

Table 3.3.3.1-1: Critical limits protecting different compartments of forest ecosystems

Critical limit	Description	Protects	Value
[Al]/[Bc]	Concentration ratio of Al to (Ca + Mg + K) in soil solution $ANC_{le,crit} = -Q^{2/3} \cdot \left(1.5 \cdot \frac{Bc_{le}(Al/Bc)_{crit}}{K_{gibb}}\right)^{1/3} - 1.5 \cdot Bc_{le}(Al/Bc)_{crit}$ $Bc_{le} = Bc_{dep} + Bc_{w} - Bc_{upt}$	Tree growth	0.5 – 1.7
$Al_{le,crit}$	Critical leaching of Al $ANC_{le,crit} = -Q^{2/3} \cdot \left(\frac{Al_w}{K_{gibb}}\right)^{1/3} - Al_w$ $Al_w = p \cdot BC_w$	Soil structure	$Al_{le} \leq Al_w$
pH	pH of soil solution $ANC_{le,crit} = -Q \cdot \left([H]_{crit} + K_{gibb} \cdot [H]^3_{crit}\right)$	Ground vege-tation	3.8 - 5
[Bc]/[H]	Concentration ratio (Ca + Mg + K)/H $ANC_{le,crit} = 0.5 \cdot \frac{Bc_{dep} + Bc_w - Bc_u}{(Bc/H)_{crit}}$	Tree growth	0.2 – 0.8

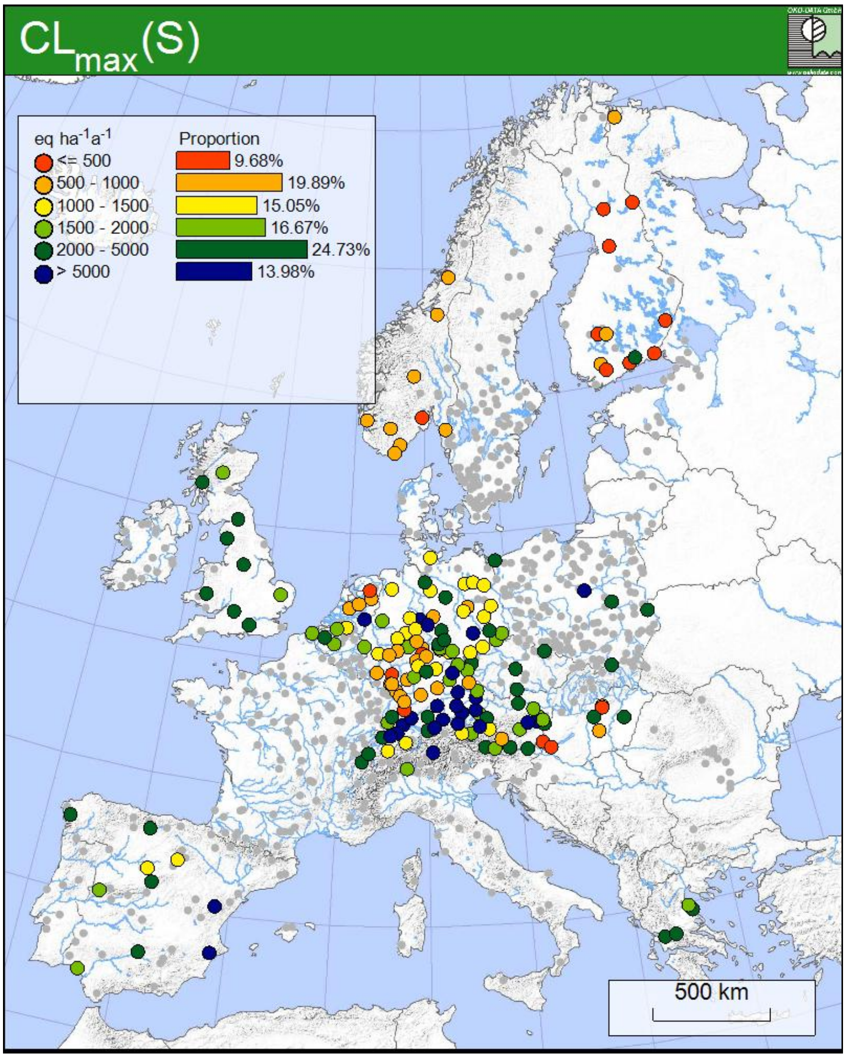


Figure 3.3.3.1-1: Critical loads for sulphur.

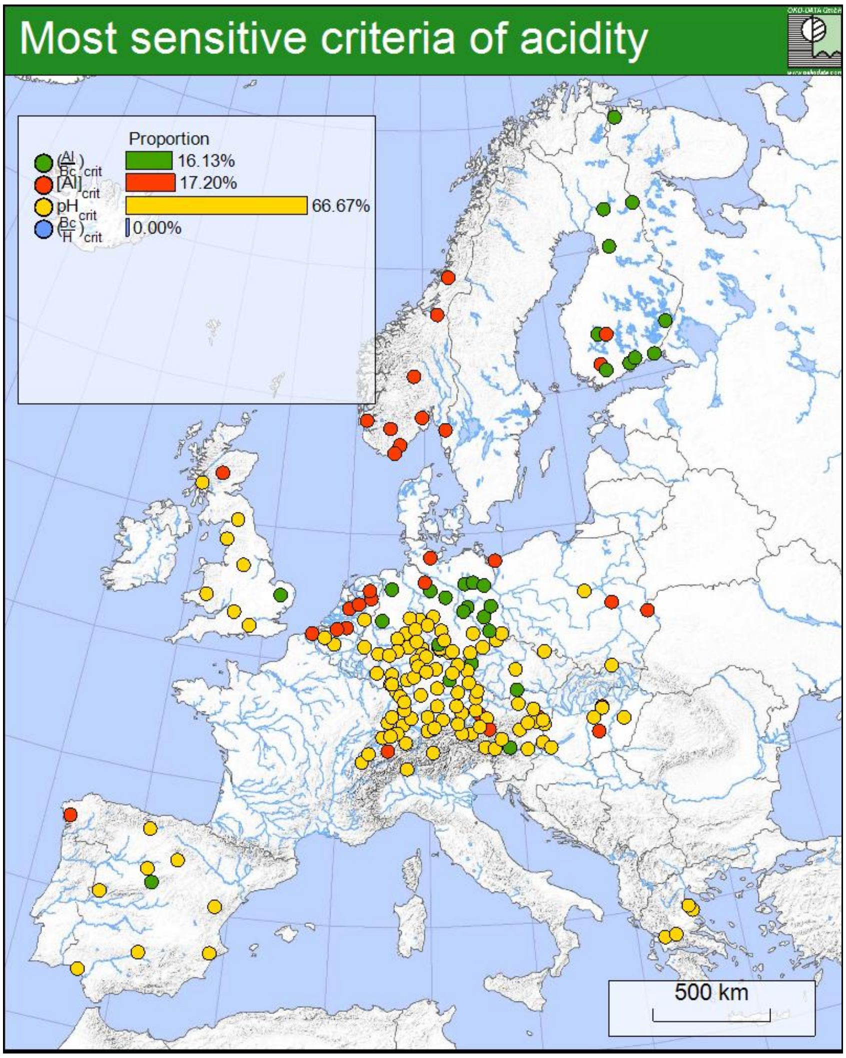


Figure 3.3.3.1-2: Critical loads for most sensitive criteria of acidity.

The pH critical limit is typically the most sensitive criterion in natural basic soils. In regions with low weathering rates and high depositions of base cations the Al/Bc ratio stays, due to the little amount of total Al in a non-critical range, while Al is already released from silicates and the soil structure changed. The Al_{le} Critical Limit applies mainly in regions with higher depositions of base cations, like coastal regions and Poland. The Al/Bc criterion applies at sites with less deposition of base cations on naturally acidic soils (Figure 3.3.3.1-2).

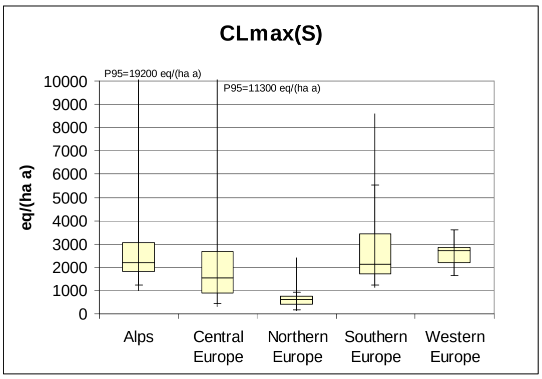


Figure 3.3.3.1-3: Box plot of the Critical Load of acidity in different European regions. Boxes mark the 2nd and 3rd quartile, the horizontal lines mark the $5^{th}/95^{th}$ percentile, and the lengths of the whiskers mark the total range.

In general the calculation of Critical Loads of acidity at Level II plots lead to the following conclusions:

- Geologically highly variable regions like central Europe and the Alps show the greatest variability of Critical Loads. Geologically uniform regions like northern Europe, with their mainly acidic parent material have only slightly varying critical loads
- The main influencing factor for $CL_{max}(S)$ is the weathering rate of base cations → sensitive north / insensitive south.

3.3.3.2 Critical Load of nutrient Nitrogen

$$CL_{nut}(N) = N_i + N_u + \frac{N_{le(acc)}}{1 - f_{de}}$$

For the Critical Load for nutrient nitrogen there is up to now only one Critical Limit, the concentration of nitrogen below the rooting depth. A restrictive use of the proposed values for [N] from the ICP Modelling and Mapping Manual (0.2 – 0.4 mg N/l) causes little influence of the critical limit to the Critical Load. Only in regions with high precipitation (western UK, Norway, high Alps) the acceptable nitrogen leaching rates together with a denitrification rate at Critical Loads conditions become important factors. But some of these regions (high Alps, sub arctic region) are sensitive to N exposure (Achermann et al, 2003), although the Critical Load according to the SMB model suggests these regions to be insensitive (Figures 3.3.3.2-1 and 3.3.3.2-2).

In central Europe, the most important N sink is the removal by harvest (estimated as 70% of the annual yield), while this sink is small in cold (northern Europe) or arid areas. Especially the Spanish sites have very small Critical Loads for their lack of water flux and harvestable yield. In northern Europe becomes the long term net immobilisation of nitrogen into the organic substance a significant factor because of the low mineralisation rate in cold climates (Figure 3.3.3.2-3).

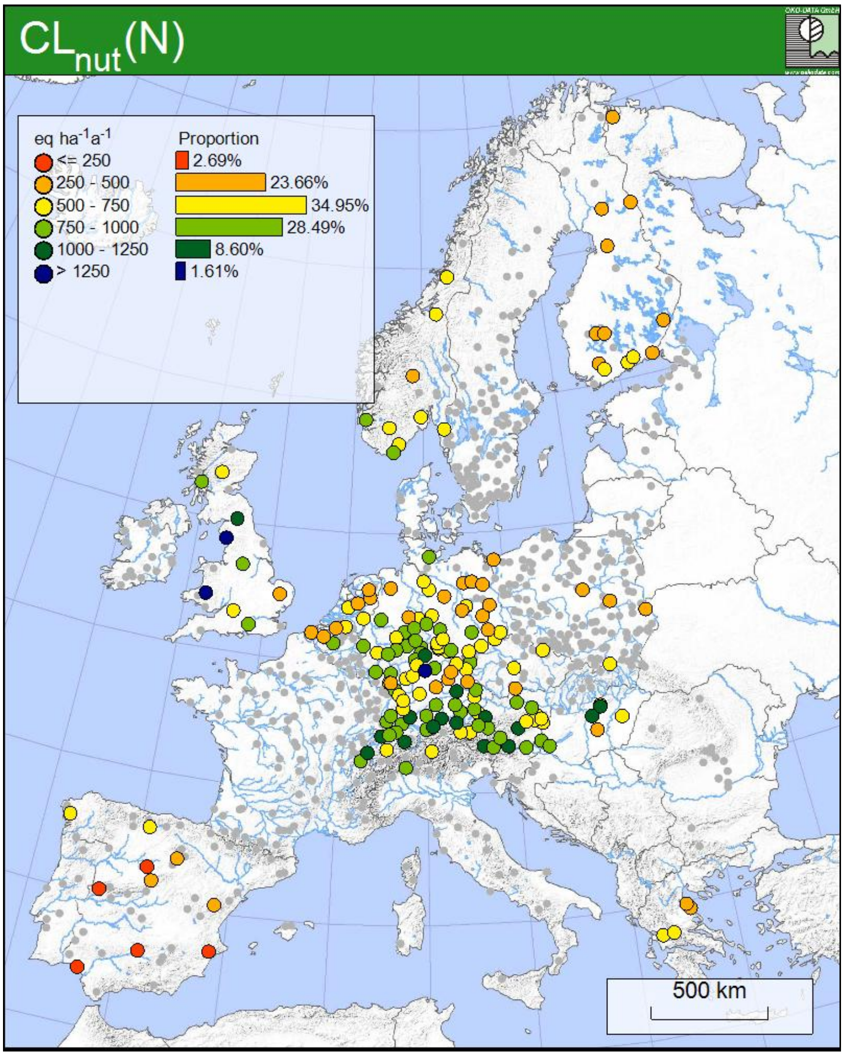


Fig. 3.3.3.2-1: Critical Load of nutrient Nitrogen.

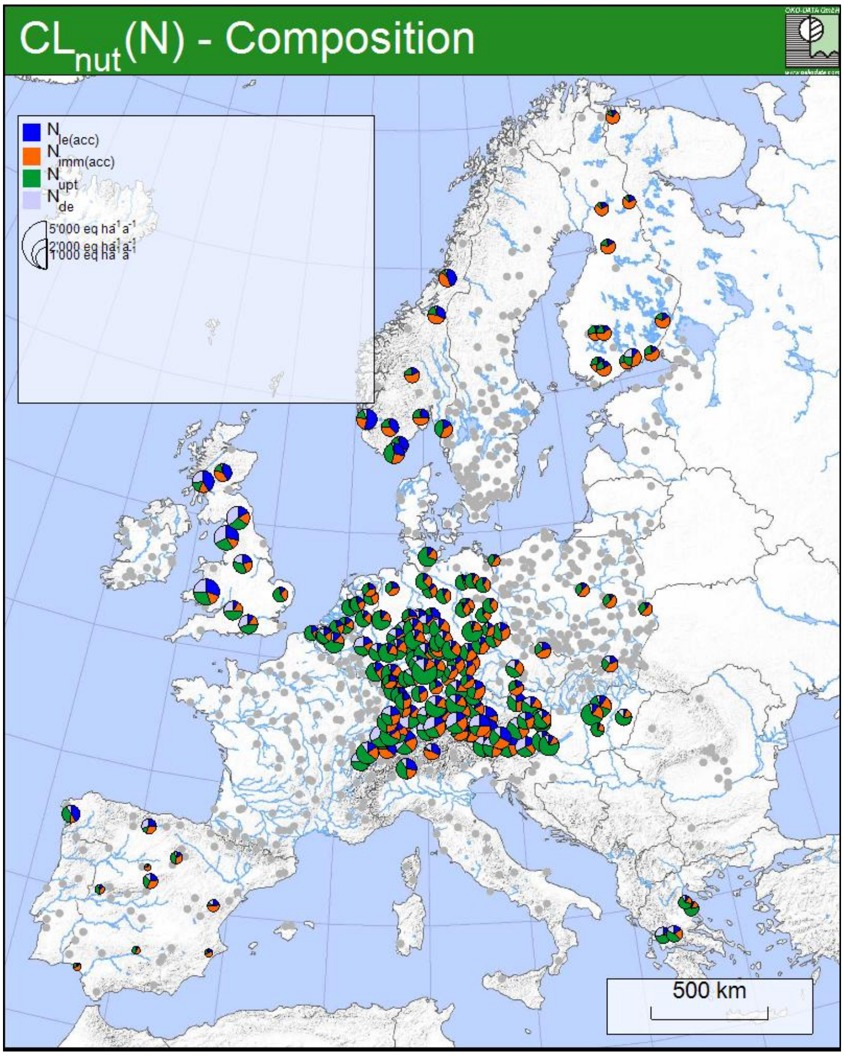
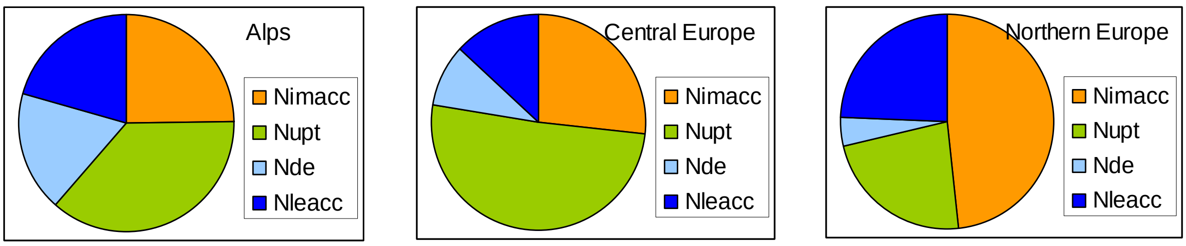
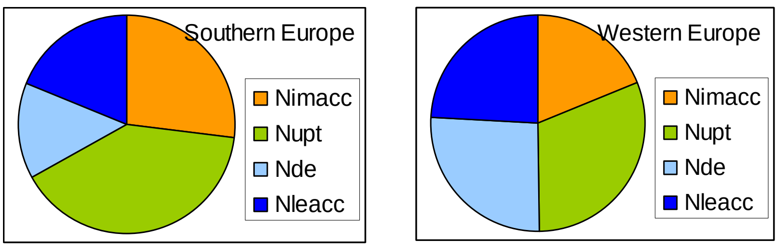


Figure 3.3.3.2-2: Critical Load of nutrient Nitrogen, absolute value and composition of the different sink according to the SMB model.





Nimacc = long term acceptable N immobilisation into the organic substance

Nupt = N uptake into biomass and removal by harvesting

Nde = N denitrification

Nleacc = acceptable concentration of N below the rooting depth

Figure 3.3.3.2-3: Composition of different sinks according to the SMB model in different regions.

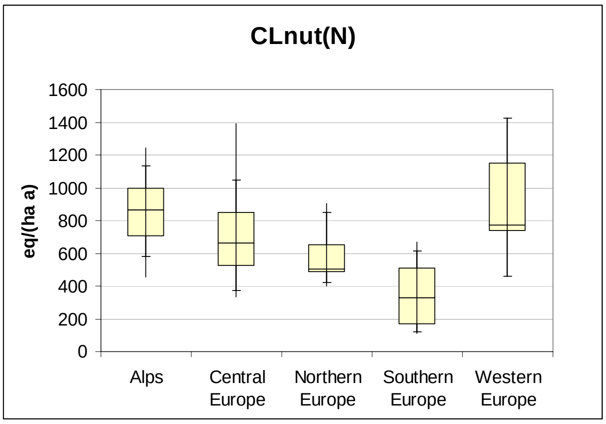


Figure 3.3.3.2-3: Box plot of the Critical Load nutrient Nitrogen in different European regions, the box marks the 2nd and 3rd quartile, the horizontal marks the 5th/95th percentile, the length of the whiskers the total range.

3.3.3.3 Exceedance of Critical Loads

At the Level II plots also the exceedances of Critical Loads by measured throughfall were derived and mapped (at Polish plots measured wet deposition data plus EMEP dry deposition values). The application of the mass balance method for deriving Critical Loads and an observed exceedance of this thresholds helps to find out areas of ecological risks and possible damages. Due to the high influence of precipitation surplus in the SMB equations in areas of high precipitation the Critical Loads are sometimes overestimated (e.g. in the Alps) or the total deposition is sometimes underestimated. Therefore the results of this study reflect trends of nearly 200 plots but not at every single site.

The decrease in sulphur emissions over the past 20 years resulted in a reduced exceedance of critical loads for acid deposition. In the same period the reduction in the emissions of nitrogen oxides and ammonia remained insignificant. Therefore, emissions of nitrogen compounds have become relatively more important and will continue to threaten ecosystem function and stability. This fact, and the acidity already accumulated in the soils, will remain responsible for the continued environmental problems in forest soils and other natural ecosystems in the coming decade. Dynamic model results show that recovery from pollutant stress will often be very slow and may sometimes even require one hundred years. The risk of environmental damage remains at an unacceptable level (Figures 3.3.3.3-1 and 3.3.3.3-2). To reduce deposition values of sulfur and nitrogen to be inside the Critical Load Function - given by CLmax(S), CLmax(N) for effects of acidification and CLnut(N) for eutrophication (details: see the Mapping Manual 2004) and thus avoid further risk to the ecosystems, no reduction is needed at nearly 33 percents of the plots but N reduction is needed at 58 percent and N plus S reduction is needed on 8 percent of the plots (Figure 3.3.3.3-3).

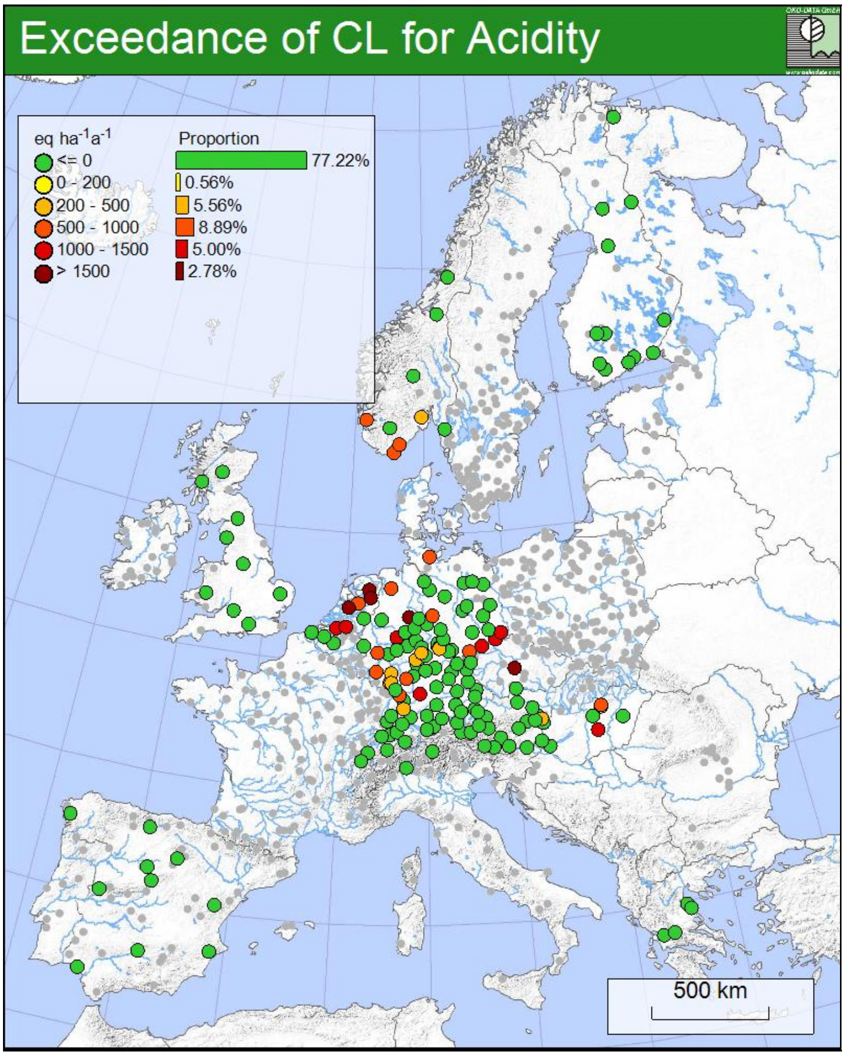


Figure 3.3.3.3-1: Exceedance of Critical Loads for acidity.

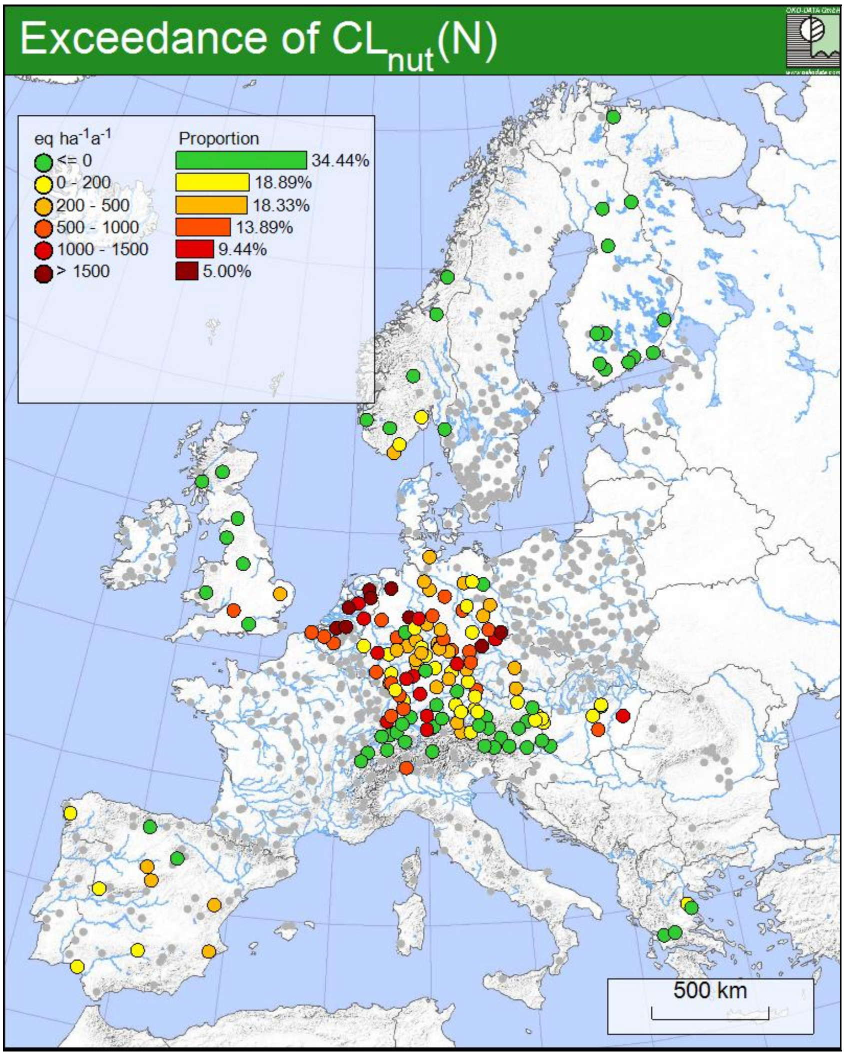


Figure 3.3.3.3-2: Exceedance of Critical Loads for nutrient nitrogen.

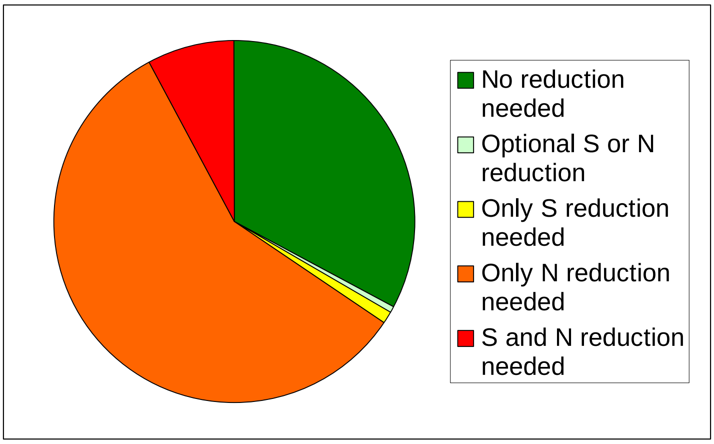


Figure 3.3.3.3-3: Required deposition reduction to reach Critical Load.

3.3.4 Dynamic modelling of acidification with VSD

The VSD dynamic soil chemistry model shows the effects of acid deposition on the soil solution over time. The key processes included in the model are element fluxes in deposition, nutrient uptake by trees, nutrient cycling including mineralization, weathering processes for base cations and aluminium, and leaching of elements to groundwater. Also equilibrium reactions within the soil solution are taken into account. The calculations rely on Level II data and historical deposition rates. Future deposition scenarios based on the UNECE Gothenburg Protocol were applied as calculated by the International Institute for Applied Systems Analysis (IIASA). The depicted plots are not representative for Europe, but were selected for reasons of data availability. The application of dynamic models to all Level II plots is intended in the future. Modelling carried out with steady state boundary conditions (as for SMB) except pollutant deposition, the pollutant deposition history was calculated by SCHÖPP et al. (2003).

Results of the dynamic model VSD are demonstrated in Figures 3.3.4-1 to 3.3.4-6. The pH value is chosen as accepted chemical indicator of acidification. For the years 1950, 1980, 2000, 2030 and 2030 VSD results at the selected Level II plots showing the change of pH, first an effect of acidification and than a recovery.

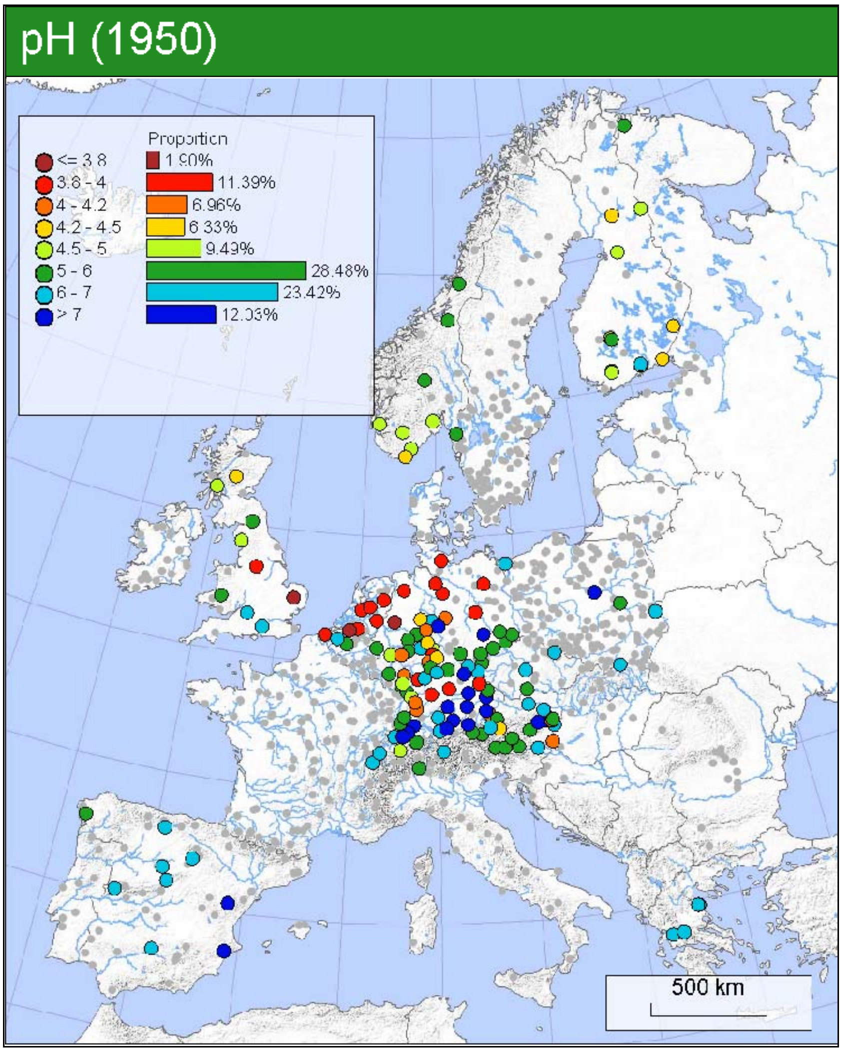


Figure 3.3.4-1: Modelled soil solution pH in 1950.

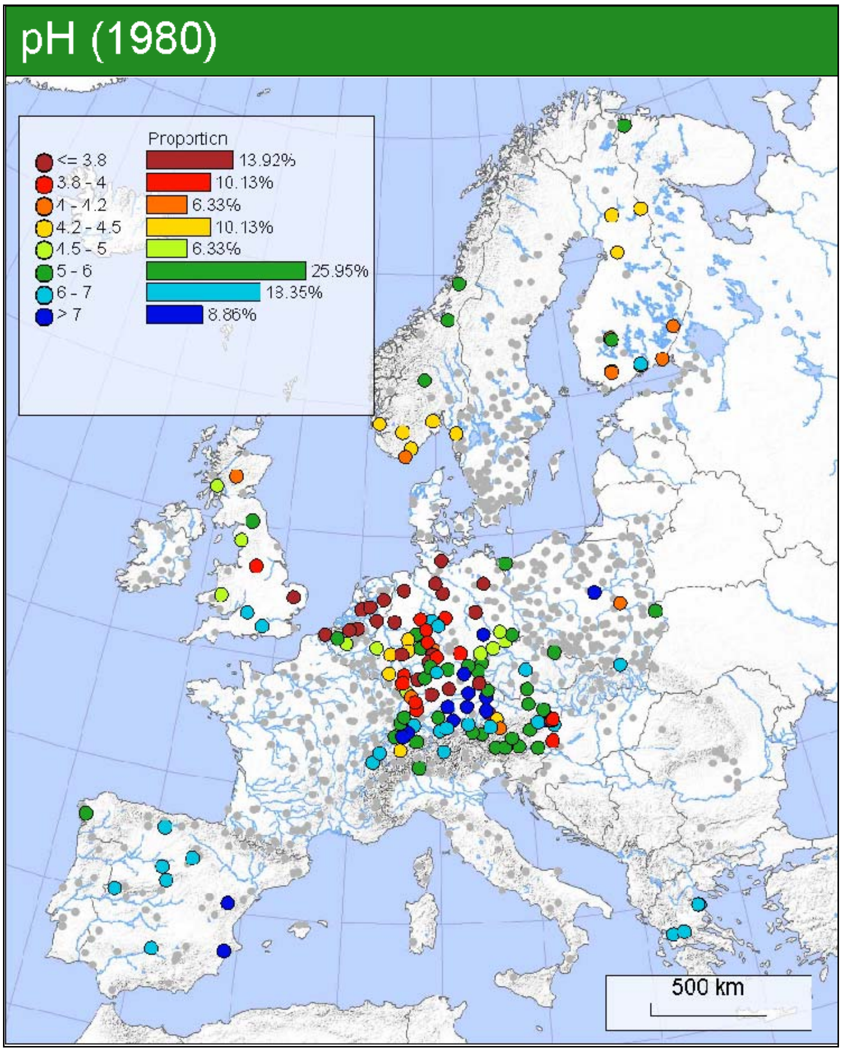


Figure 3.3.4-2: Modelled soil solution pH in 1980.

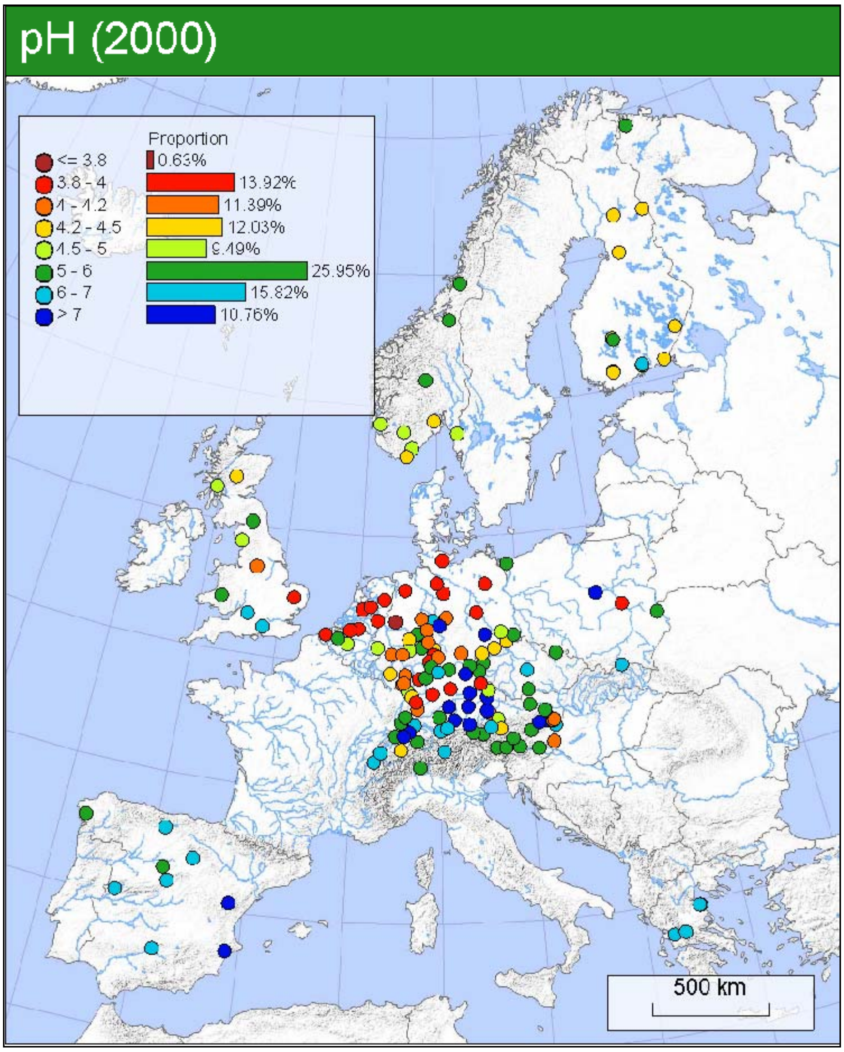


Figure 3.3.4-3: Modelled soil solution pH in 2000.

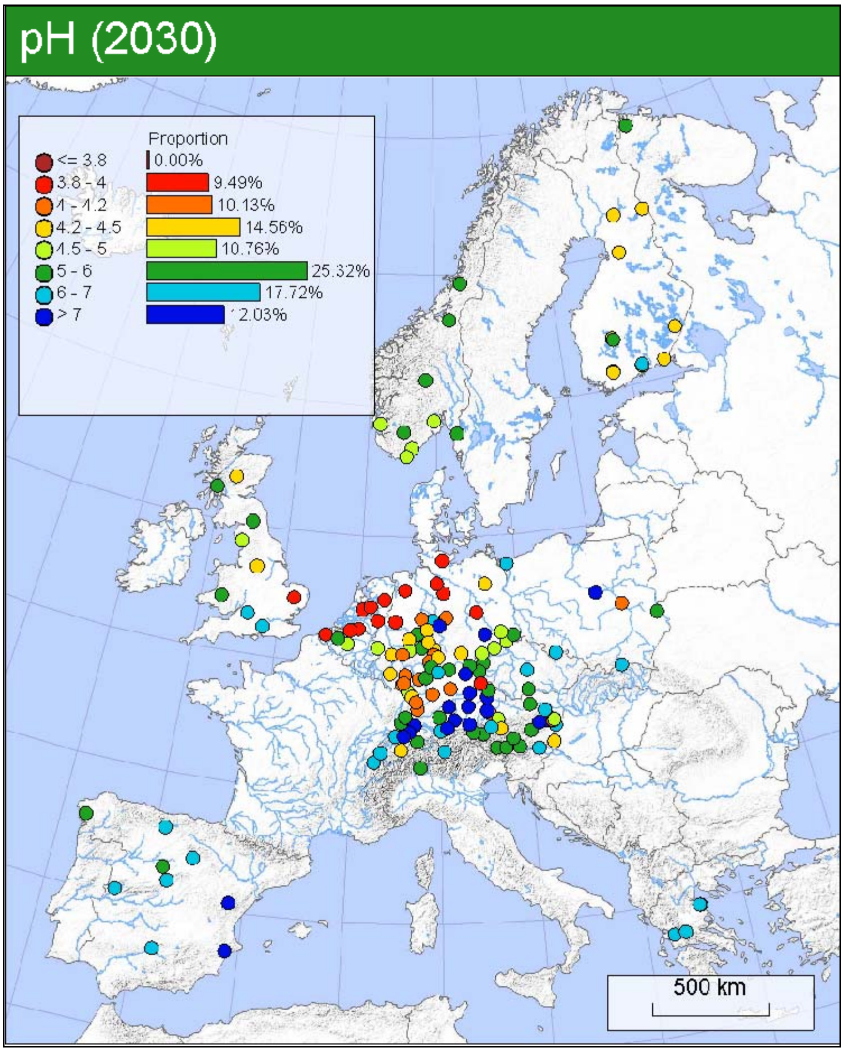


Figure 3.3.4-4: Modelled soil solution pH in 2030.

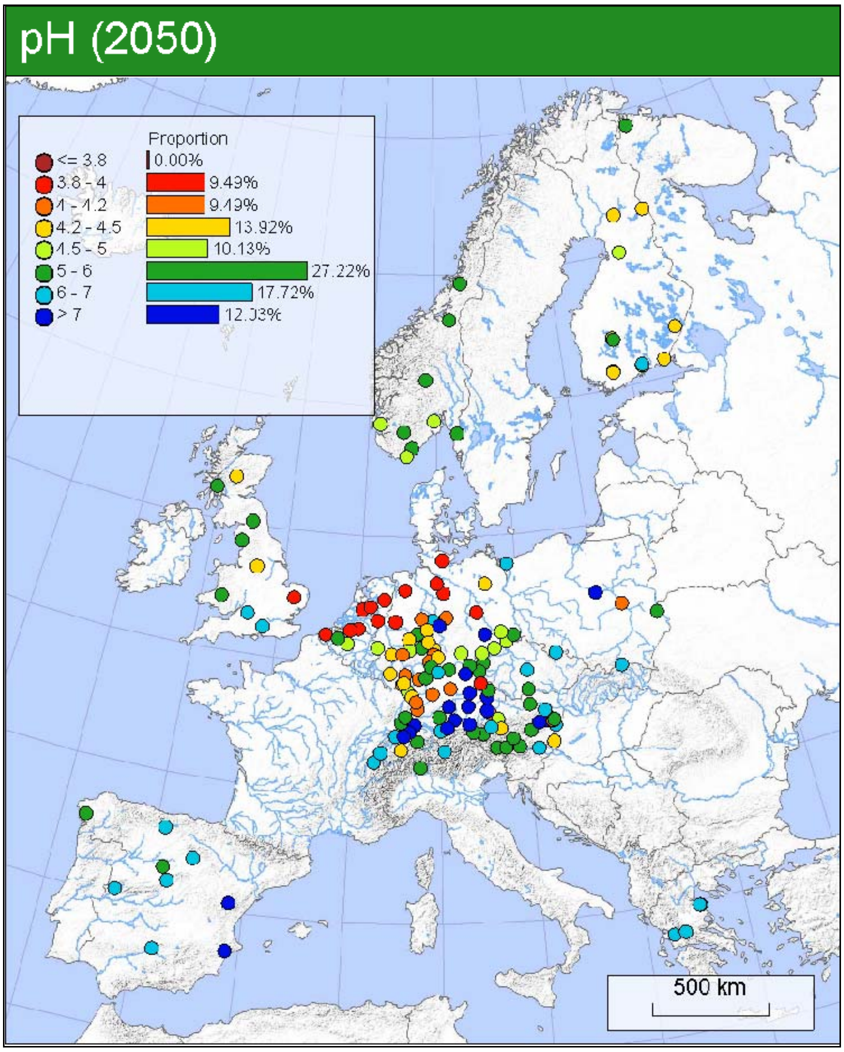


Figure 3.3.4-5: Modelled soil solution pH in 2050.

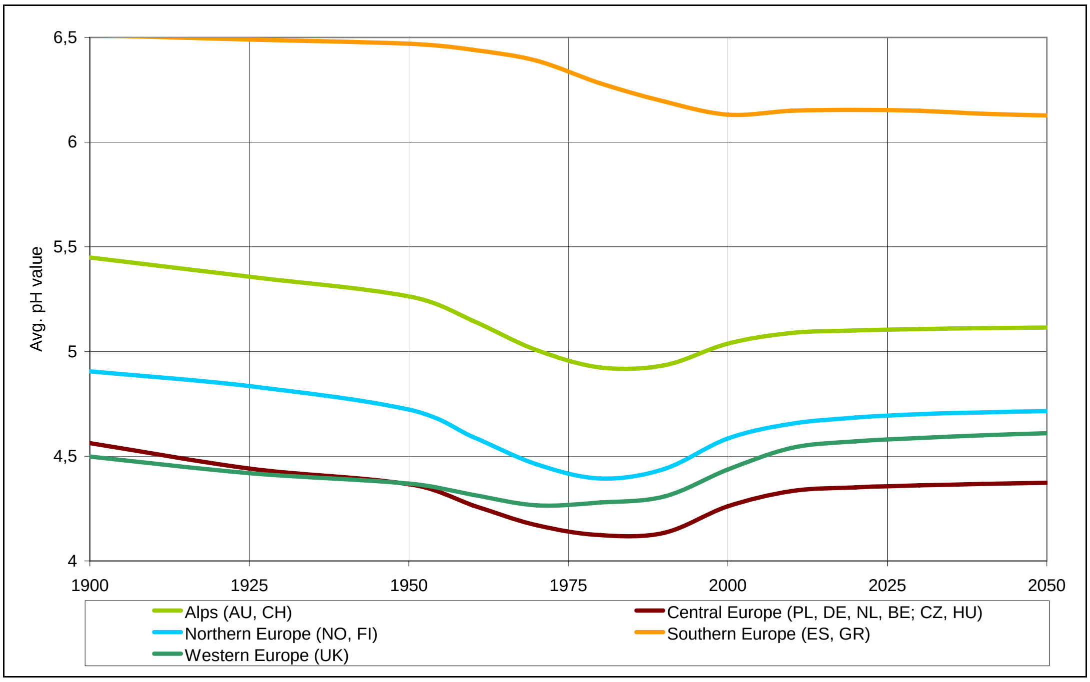


Figure 3.3.4-6: Development of the average pH in the soil solution below rooting depth over time in different regions of Europe for the years 1900 - 2050.

In general the results of VSD application at Level II plots focus in the following conclusions:

- Acidification starts in 1960, maximum in 1990, after 2000 recovery (compare with exceedance of acidification)
- 1-layer models tend to overestimate recovery (compared with SAFE-results, see ICP Forests Technical Report, 2006)
- Late effects and little acidification effects in southern Europe, no recovery
- Short damage delay time and strong effects in the Alps and northern Europe, recovery
- Short damage delay time and little effects with good recovery in UK
- Short damage delay time and heavy effects in central Europe
- The delayed response of southern Europe, due to later industrialization is clearly shown
- Longer average recovery damage delay time, due to higher CEC in the Alps region is shown
- Average level of recovery from acidification for each region is shown.

4. NATIONAL SURVEY REPORTS IN 2006

Reports on the results of the national crown condition surveys at Level I of the year 2006 were received from 27 countries. For these countries, the present chapter presents summaries. Besides that, numerical data on crown condition in 2006 were received from 32 countries. These results are tabulated in Annex II. In Annex II-1 basic information on the forest area and survey design of the participatory 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 broadleaved 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 broadleaved 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 Northern Europe

4.1.1 Estonia

Forest condition in Estonia has been systematically monitored since 1988. In 2006, altogether 2 191 trees were examined on 92 permanent Level I sample plots from July to October. Out of 2 191 trees, 594 *Picea abies*, 1480 *Pinus sylvestris* and 117 broadleaves were assessed.

In Estonia the most defoliated tree species has traditionally been *Pinus sylvestris*. Remarkable improvement of crown condition of this species was observed from 1994 to 2000. Afterwards a certain decline was registered until 2003, and in 2004 a notable improvement started. In 2006, defoliation increased again. In 2006, only 39.6% of Scots pines were not defoliated (defoliation class 0) compared to 49.3 in 2005, 53.9% were slightly (defoliation class 1), 5.6% were moderately (defoliation class 2) and 0.9% were severely defoliated or dead (defoliation classes 3 and 4).

The increase in defoliation of *Picea abies* which started in 1996 stopped in 2002 and remained on the same level until 2005. In 2006, some improvement in crown condition occurred. In 2006, 59.8% of the assessed *Picea abies* trees were not defoliated, 35.4% were slightly, 4.2% were moderately, and only 0.7% were severely defoliated or dead) compared to 2.2% in 2005.

Needles cast (425 damaged trees) and shoot blight (638 damaged trees) were the most significant reasons of biotic damage of trees. The condition of deciduous species was estimated to be better than that of conifers.

4.1.2 Finland

The 2006 the forest condition survey was conducted on 606 sample plots on 16 x 16 km and 24 x 32 km grids. There were no notable changes in the average defoliation level of assessed trees between the years 2005 and 2006. Of the 11 506 trees assessed in 2006, 55%

of the conifers and 56% of the broadleaves were not suffering from defoliation (leaf or needle loss 0-10%). The proportion of slightly defoliated (11- 25%) conifers was 35%, and that of moderately defoliated (over 26%) 9%. For broadleaves, the corresponding proportions were 34% and 10%, respectively. In general, the average tree-specific degree of defoliation was 9.6% (9.2% in 2005) in *Pinus sylvestris*, 17.4% (17.8% in 2005) in *Picea abies* ,and 12.1% (10.9% in 2005) in broadleaves (mainly *Betula* spp.). On mineral soil sites the average defoliation degree was 9.7% (9.5% in 2005) in *Pinus sylvestris*, 17.5% (17.9%) in *Picea abies* and 12.5% (11.4%) in broadleaves, and on peat lands 9.2% (8.2%), 16.0% (16.8%) and 10.7% (9.4%), respectively. A total of 31 trees (0.3%) died during 2005-2006 (0.1% in 2004/2005).

The proportion of discoloured *Picea abies* decreased from 10.2% to 5.1%. Due to the summer drought in 2006, the proportion of discoloured *Pinus sylvestris* clearly increased from less than 1% in 2005 to 6.8% in 2006. However, most of these discoloured *Pinus sylvestris* belonged to discolouration class 10 to 25%, and moderate or severe discolouration was rare. Also leaf discolouration on broadleaves increased from 2.1% to 4.8%. The most frequent discolouration symptoms on *Pinus sylvestris* were needle yellowing and browning, and the symptoms were mainly concentrated on other than current year needles.

Snow caused severe damage during winter 2005/2006 in most parts of Finland, especially in central and Northern Finland. Most of the snow breaks were left unharvested because the broken trunks were so scattered in the forest that it was not economically viable to extract them individually. In autumn 2006, snow again caused heavy damage already in November, especially in south-eastern Finland. Storms caused less damage than in previous years. Summer 2006 was very dry and the number of recordings of fungal diseases was very low. One fifth of the damage reported on *Pinus sylvestris* and broadleaves was related to drought. In contrast, the autumn was mild and very wet and caused floods in many areas. Pine defoliators were abundant and increased numbers of the pine sawfly, *Neodiprion sertifer*, were reported on around 90 000 ha in Eastern Finland. In western Finland the web-spinning sawfly *Acantholyda posticalis* was reported for the first time to have caused severe damage on 30 ha of forest.

No clear correlation was found between the defoliation pattern of conifers or broadleaves and the modelled sulphur or nitrogen deposition (Finnish Meteorological Institute 2002) at the national level in 2006.

4.1.3 Latvia

In 2006, the forest condition survey was carried out on 342 permanent sample plots on the national 8 x 8 km grid, including 93 plots of the transnational 16 x16 km grid. In total 8 116 sample trees were assessed of which 73% were conifers (*Pinus sylvestris* and *Picea abies*) and 27% broadleaves (*Betula* spp., *Populus tremula* etc.).

The distribution of all tree species in defoliation classes shows a situation very similar to that of previous years – 19.4% of all trees were not defoliated, 67.2% were slightly defoliated and 13.4% were moderately defoliated to dead.

The condition of *Pinus sylvestris* has slightly deteriorated compared to 2005, the proportion of trees in defoliation classes 2-4 has increased by 4.1 percent points and the mean defoliation has increased from 20.5% in 2005 to 21.7% in 2006. This was the second year of increase in pine defoliation after a long period of pine crown condition improvement. The increase can be explained by quite extensive European sawfly *Neodiprion sertifer* attacks on pines in the northwest and northern regions of Latvia, observed already for three years.

Health condition of the second most common tree species, *Picea abies,* shows no significant changes since 2001 and the mean defoliation has stabilized at the level of about 20% (19.8% in 2006).
Regardless of the drought during the first part of summer, the crown condition of *Betula* spp. has improved compared to 2005, the share of trees with more than 25% defoliation has decreased by 4.7 percent points, reaching the lowest level over the assessment period (8.7%). Mean defoliation has decreased as well - by 1.3 percent points to 17.6% in 2006.

Signs of visual damage were recorded for 19.4% of the assessed trees (18.3% in 2005). The largest proportion of damaged trees was recorded for *Pinus sylvestris* (22.0%), of which more than a half (14%) is damaged by insects (*Neodiprion sertifer*). For *Picea abies* and *Betula* spp. the proportion of damaged trees was 15.4% and 14.6%, respectively. *Picea abies* was most commonly damaged by deer and harmful abiotic factors. In 2006, a high population density of bark beetles (*Ips typographus*) was observed in Latvia, to a great extent as a result of the severe windstorm in 2005 and favorable weather conditions for the development of bark beetles in 2006. Regardless of the overall situation, no significant increase in the number of infested sample trees was found in the survey. The risk of high bark beetle damage for *Picea abies* continues for the years to come. The most commonly recorded cause of damage for broadleaves were insects, mostly defoliators; however, only 0.5% of the broadleaved trees were affected moderately and severely.

4.1.4 Lithuania

The forest condition survey was carried out on 203 sample plots of the Level I transnational (16 × 16 km) and national (8 × 8 km) grids in 2006. In total 4 872 sample trees representing 16 tree species were assessed. The main tree species were *Pinus sylvestris, Picea abies, Betula pendula, Betula pubescens, Populus tremula, Alnus glutinosa, Alnus incana, Fraxinus excelsior,* and *Quercus robur.*

Mean defoliation of all tree species was 20.5%, and thus rather unchanged as compared to the previous year 2005 (20.3%). 15.3% of all sample trees were not defoliated, 72.7% – slightly defoliated and only 12.0% were assessed as moderately defoliated, severely defoliated and dead (defoliation classes 2 – 4). The mean defoliation level of conifers and broadleaves was about the same as in 2005. Mean defoliation of conifers was 19.7% (19.6% in 2005) and 21.9% for broadleaves (22.0% in 2005).

Pinus sylvestris constitutes 45.9% of all sample trees and its condition significantly influences the mean defoliation of all tree species. Mean defoliation of *Pinus sylvestris* was 19.6% (19.7% in 2005). Starting from 1998 mean defoliation of *Pinus sylvestris* did not exceed 21.0%. Mean defoliation of *Picea abies* was 0.6 percent points higher than in 2005 (19.3%).

As in the previous year, *Fraxinus excelsior* and *Quercus robur* had the highest defoliation. Mean defoliation of *Fraxinus excelsior* was 44.4% (32.4% in 2005). The number of not defoliated trees was 7.0% (13.4% in 2005) and the share of trees in defoliation classes 2-4 was 58.9% (34.4% in 2005). Mean defoliation of *Quercus robur* was 27.7% (31.4% in 2005) and the share of trees in defoliation class 0 was 6.3 (4.7% in 2005), and 32.3%

(34.6% in 2005) in defoliation classes 2-4. The condition of *Fraxinus excelsior* noticeably worsened due to the influence of diseases.

Populus tremula and *Alnus glutinosa* had the lowest mean defoliation and the lowest share of trees in defoliation classes 2-4. Mean defoliation of *Populus tremula* was 16.5% (18.6% in 2005) and the proportion of trees in defoliation classes 2-4 was 7.5% (10.0% in 2005). Mean defoliation of *Alnus glutinosa* was 18.7% (18.5% in 2005) and the share of trees in defoliation classes 2-4 was 7.6% (7.7% in 2005).

11.7% of all sample trees had some kind of identifiable damage symptoms. The most frequent damage were those caused by direct action of man (2.4%), abiotic agents (1.8%), fungi (1.8%) and insects (1.4%). Identifiable amage symptoms were most frequent for *Fraxinus excelsior* (58.9%) and *Quercus robur* (38.5%). *Alnus glutinosa* (4.4%) and *Pinus sylvestris* (7.0%) had the lowest proportion of trees with damage symptoms.

The condition of Lithuanian forests can be defined as relatively stable, because mean defoliation of all tree species has shown only minor variations already since 1996.

4.1.5 Norway

With respect to all assessed tree species the results for 2006 show a general increase in crown defoliation compared to the year before. The defoliation for *Picea abies, Pinus sylvestris* and *Betula* spp. was 16.7%, 16.8% and 22.7%, respectively. After a peak with low defoliation for both *Picea abies* and for *Pinus sylvestris* in 2004, the two last years show a deterioration of defoliation. *Betula* spp. had the lowest defoliation in 2001. Since then, defoliation has increased.

Of all the coniferous trees, 42.3% were rated not defoliated, representing a decrease of 4.7 percent points. Only 31% of the *Pinus sylvestris* trees were rated as not defoliated while 50.8% of all *Picea abies* trees were not defoliated. The decrease was greatest for *Pinus sylvestris* with 8.3 percent points. For *Betula* spp. 31.9% of the trees were observed in the class of not defoliated trees, representing a decrease of 2.9 percent points compared to the year before. The percentage of severely defoliated *Betula* spp. trees was assed with 6.3%, representing an increase compared with the last 5 years. Of all the species *Betula* spp. had the highest rating of trees with severely defoliation in 2006.

Regarding discolouration there was an improvement for *Picea abies*. Only 6.7% of the trees showed signs of discolouration, compared to 15% in 2005. For *Pinus sylvestris*, 4.9% were assessed as discoloured, reflecting the same level as the year before. In *Betula* spp., an increase in discoloured trees was observed and was assessed to 8.5% in 2006. For all the species, the amount of trees with discolouration varied between years.

The mortality rate was 1.2%, representing an increase of 0.9 percent points. The highest mortality rate was recorded for *Betula* spp. with 3.2% No serious attacks by pests or pathogens were recorded.

In general, the observed crown condition results from an interaction between climate, pests, pathogens and general stress. According to The Norwegian Meteorological Institute the growth season (June, July and August) of 2006 is regarded as relatively warm and dry. The middle temperature was 1.8^{O}C above the normal temperature and the precipitation was 90% of the normal for these months.

4.1.6 Sweden

The national forest condition survey based on the transnational Level I grid, was carried out on 790 plots in 2006. In total, 10 331 conifers and broadleaved trees were assessed. The national results are in addition based on 7 399 sample trees (*Picea abies* and *Pinus sylvestris*) on 3 590 sample plots of the National Forest Inventory, and concern as in previous years only forest in thinning age or older. The main tree species are *Picea abies, Pinus sylvestris, Betula pendula, Betula pubescens, Fagus sylvatica*, and *Quercus robur*.

The proportion of trees with more than 25% defoliation was 30.5% for *Picea abies* (27.9% in 2005) and 9.9% for *Pinus sylvestris* (11.4% in 2005). The increased defoliation in *Picea abies* is seen in the northern parts of Sweden, while *Picea abies* in southern Sweden as well as *Pinus sylvestris* all over the country showed a decreased defoliation. In southern Sweden a recovery from previous year, which was strongly affected by the storm in January 2005, was observed. In *Betula* spp. a slightly increased defoliation is noticed and the proportion of trees with more than 25% was 9.8% (8.5% in 2005). The share of discoloured *Picea abies* trees has in 2006 decreased to 5.0%. In *Pinus sylvestris* discolouration is still rare, 2.4 %.

The bark beetle population increased during the summer 2005 due to wind thrown trees left in the forest after the severe storm in January 2005. The long and warm summer of 2006 contributed to an enlarge population of bark beetles. The *Ips typographus* bred with a second generation which is rare in Sweden. Also the populations of *Tomicus* spp. have increased as indicated by larger amounts of dropped gnawed pine shoots. Bark beetles will also have a significant affect on the condition in coming years due to the risk of increasing populations. Among defoliators extensive regional outbreaks were found in south and southwestern Sweden where birch and oak trees were attacked by *Erannis defoliaria* and *Operophtera brumata*. The fruiting in Picea abies was in 2006 extensive, however a large part of the cones were attacked by insects. No major outbreaks of fungal diseases were registered (root rot excluded).

4.2. Central Europe

4.2.1 Austria

Since the year 2003, the crown condition assessment in Austria has been carried out on the transnational grid of 16 x 16 km only. Since that year, no national evaluation of the data has been done and no national forest condition report for Austria has been published. During the assessment period of 2006, in addition to crown condition, the assessment of the BioSoil- Biodiversity project was carried out on all plots from July to September.

The transnational grid in 2006 comprises 135 plots with about 3400 sample trees. The ratio of trees that were removed was 2.4% of the sample trees, and at one plot all trees were cut.

In comparison to the last year, crown condition over all species did not change markedly. The mean defoliation decreased by 0.4 percent-points. About 15% of all sample trees were classified as damaged (defoliation classes 2-4), that is the same value as in the previous year. In comparison to 2005, the mean defoliation of the coniferous species decreased, while the mean defoliation of the broadleaved species increased. Out of the most common conifers, the mean defoliation of *Picea abies* did not change remarkably and the mean defoliation of *Pinus sylvestris* decreased by about 5 percent points. The mean defoliation of the main broadleaved species *Fagus sylvatica* increased while the mean defoliation of

Quercus sp. decreased. However, because of the low number of broadleaved sample trees, the figures are not very reliable.

The mortality rate, calculated as the percentage of trees that died between two surveys, remained with about 0.5% remarkably high. The mortality rate might even be higher, as trees that had died and were removed between two subsequent assessments cannot be taken into account.

During winter 2005/2006 in some parts of Austria heavy damage by snow occurred, comprising an amount of about two Mio m³ of timber. Infestation of bark beetles still was an enormous problem in the Austrian forests in 2006. In some regions, infestation of bark beetles even occurred until up to the timberline what has not been the case up to now.

The results of the Bioindicator grid in 2005 revealed the lowest sulphur impact since the beginning of measurements in 1983. Only on 4% of the plots, the thresholds for sulphur were exceeded. In addition, the maximum values for sulphur in the needle samples during the 23-years observation period decreased distinctly by 50%.

4.2.2 Croatia

88 sample plots on the 16 x 16 km grid were included in the forest condition survey in 2006. The percentage of trees of all species within classes 2-4 in 2006 (24.9%) is slightly lower than in 2005 (27.1%) and comparable to the year 2004 (25.2%). For broadleaves the share of trees in classes 2-4 (18.2%) is similar to 2004 (17.8%) and 2005 (19.2%). For conifers, the percentage of damaged trees in classes 2-4 (71.7%) is lower than recorded in 2005 (79.5%) and almost comparable to the values reported in 2004 (70.6%). Although the percentage of moderately to severely damaged conifers is high, it does not have a stronger impact on the overall percentage of trees of all species for the same damage class, because of the low representation of coniferous trees in the sample (265 coniferous trees vs. 1843 broadleaved trees).

Although *Abies alba* is still the most damaged tree species, the percentage of moderately to severely damaged trees in 2006 was 69.7%, which is 18.8 percent points lower than in the year 2005. 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 2005.

The lowest damage of *Quercus robur* was recorded in 1988 (8.1%), the highest in 1994 (42.5%), and it has been fairly constant later with 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. In 2006 it was slightly lower (20.5%).

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.%), and in subsequent years even lower values were recorded: 5.1% in 2003, 7.5% in 2004 and 7.0% in 2005, and 6.3% in 2006.

Overall, there was a slight improvement in the state of crown defoliation in Croatia and for silver fir it was quite substantial.

4.2.3 Czech Republic

No important changes in the development of defoliation were observed in the year 2006 as compared to 2005; neither for coniferous nor for deciduous species. In 2006, younger coniferous species (up to 59 years) showed lower defoliation within the long-term period than younger deciduous species. The reverse is true for older coniferous stands (60 years old and older) where defoliation was distinctly higher than in the older deciduous species. No important changes occurred for the main species *Picea abies* in both age categories when compared with the last year. Certain changes were observed for some species in the younger stands. Compared with the last year, mild worsening of defoliation appeared in *Pinus sylvestris,* reflected by a larger share of trees in defoliation classes 2 and 3 at the expense of class 1. For *Abies alba* defoliation in younger stands decreased, which is reflected by an increase in the share of trees in defoliation class 1 (from 50% to 60%) and a decrease of trees in the higher class 2 (from 35% to 25%). Compared with the last year, *Betula pendula* in the younger stands shows worsening of defoliation. The share of trees in class 0 fell markedly from 18.9% in 2005 to 2.7% in 2006.

Negligible changes in defoliation or slight improvements occurred in the older age classes of the main deciduous species. The share of *Quercus* sp. trees in class 1 increased from 34.6% to 38.7% at the expense of the share of trees in class 2. For *Fagus sylvatica* the share of trees in class 0 increased (from 16.6% to 19.6%).

During the summer season (June) forest stands in some forest regions, mainly in northern Moravia, were sporadically mechanically damaged by strong wind, sometimes even of tornado type. During the vegetation period a little higher occurrence of kambiophagous insects was observed in the forest areas, mainly in spruce stands, in the southern and north-western Bohemia.

In 2006 no important change was reported for the main pollutants (solid substances, SO_2, NO_x, CO, VOC). During the last years their development has fluctuated.

4.2.4 Germany

The 2006 crown condition survey was carried out on 423 plots of the 16 km x 16 km grid and included a total of 10 327 trees. Only few changes were recorded compared to the previous year:

The proportion of damaged trees (defoliation classes 2 – 4) amounts to 28% (2005: 29%). The percentage of trees with slight defoliation was 40% (2005: 42%) and 32% of the trees were undamaged.

Fagus sylvatica was the tree species which showed the highest percentage of damaged trees (48%), even more than *Quercus* spp. (44%). *Picea abies* had 27% of damaged trees. The lowest share of damaged trees was found for *Pinus sylvestris* (18%).

The trees have recovered only slowly from the after-effects of the dry summer 2003. Furthermore, in June and July 2006 there was again a period of uncommonly hot and dry weather conditions. The mean temperature in July exceeded the long term average (1961 – 1990) for July by 5° C; this was the highest temperature ever measured in July since the beginning of national weather records in 1901. These weather conditions in June and July resulted in high concentrations of ozone in ambient air.

A study on ambient air quality and deposition completed in 2006 shows that

- all different assessment approaches for ozone impacts (AOT40, MPOC and flux-based models for ozone uptake) suggest a risk of ozone damage to forest vegetation.

- Nitrogen inputs are still too high and critical loads for N-compounds continue to be exceeded on most of the sites included in the study.
- SO_2-concentrations and S-depositions exceeding critical levels and loads do not longer occur, but the high S-depositions in the past have accumulated in forest ecosystems and can still have adverse impacts.

4.2.5 Poland

In 2006, the integration of the ICP Forests monitoring network with the national forest inventory started. The first stage of the integration included the establishment of 438 permanent observation plots on a 16 x 16 km grid according the ICP geographical coordinates for Poland, among them 376 in stands above 20 years old subjected evaluation. In the next year plots on a 8 x 8 km grid will be established as the national grid. In contrast to the former grid the new one covers not only the state forest but also all types of forest ownership. Changes in plot localization, the extension of the grid to private forest and the inclusion of stands between 20-40 years resulted difficulties with comparison of 2006 data with earlier years.

27.0% of all sample trees were without any symptoms of defoliation. 20.1% of all trees were classified as severely damaged or dead (classes 2-4).

For 21.1% of the conifers, defoliation of more than 25% (classes 2-4) was observed. With regard to the three main coniferous species, *Abies alba* remained the species with the highest defoliation (26.1% trees, 60 years old and older, in classes 2-4).

For broadleaves the proportion of trees with more than 25% defoliation (classes 2-4) amounted to 18.1%. As in the previous survey, the highest defoliation amongst broadleaved trees was observed in stands of *Quercus* spp. In 2006, a share of 25.0% of *Quercus* trees up to 59 years old and 32.5% of oak trees 60 years old and older were in defoliation classes 2-4.

In 2006, discolouration (classes 1-4) was observed on 1.8% of the conifers and 1.6% of the broadleaves.

4.2.6 Slovak Republic

The 2006 national crown condition survey was carried out on 107 Level I plots on the 16 x 16 km grid net. The assessments covered 4 868 trees, 3 975 of which being assessed as dominant or co-dominant trees according to Kraft classification. Of the 3 975 assessed trees, 28.1% were damaged (defoliation classes 2-4). The respective figures were 42.4% for conifers and 17.0% for broadleaved trees. Compared to the 2005, the share of trees defoliated more than 25% increased by 5.2 percent points. Mean defoliation for all tree species together was 23.1%, with 27.4% for conifers and 19.7% for broadleaved trees. Results show that crown condition in Slovak Republic is worse than on the European average. This is mainly due to the condition of coniferous species.

Compared to the 2005 survey, a pronounced decrease in mean defoliation was observed in *Carpinus betulus* and *Fraxinus excelsior* only. Statistically significant improvements were not observed for any species.

Since 1987, the lowest damage was observed for *Fagus sylvatica* and *Carpinus betulus*, with exception of fructification years. The most severe damage has been observed in *Abies* *alba*, *Picea abies* and *Robinia pseudacacia*.

From the beginning of the forest condition monitoring in 1987 until 1996 results showed 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 crown condition survey, damage types and detailed damage causes were assessed. 42.7% of all sample trees (4 868) had some kind of damage symptoms. The most frequent damage was caused by fungi (19.2 %) and logging activities (17.6 %) at tree stems. Additional damage causes were insects (15.3%), and abiotic agents (5.6%). Epiphytes had the most important influence on defoliation. 67% of trees damaged by epiphytes revealed defoliation above 25%. In addition, abiotic agents had a direct link to defoliation.

4.2.7 Switzerland

In 2006, 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 2006 improved in comparison to 2005. In 2006, 22.6% of the trees had more than 25% unexplained defoliation (i.e. subtracting the known causes such as insect damage, or frost damage; 2005: 28.1%) and 30.3% of the trees had more than 25% total defoliation (2005: 39.2%). Annual mortality rates have fallen to the normal value of 3 out of 1000 trees. On the Swiss Level II plots the decrease in crown defoliation was not as strong and varied by plot and species. No consistent differences between species or regions were found. Mortality rates on most Level II plots were also close to normal following the increase after 2003. Fructification in *Fagus sylvatica* was high in 2006.

4.3 Southern Europe

4.3.1 Andorra

In 2006, the crown condition survey in Andorra was conducted on 3 plots of the 16 x16 transnational grid. The survey included 74 trees, 43 *Pinus sylvestris* and 31 *Pinus uncinata*. The results obtained in 2006 reflect a low level of defoliation and discolouration. Most of the *Pinus sylvestris* (86%) were in defoliation classes 0-1. However, for *Pinus uncinata* 45.16% of the trees were slightly defoliated, 25.81% were moderately defoliated and 19.35% of the trees were not defoliated. Related to discolouration, the largest part of the trees (95.29% of *Pinus sylvestris* and 93.55% of *Pinus uncinata)* was in classes 0-1.

Results obtained in 2006 show an improvement in forest condition comparing these results to those obtained in 2004, (in 2005 the survey was not conducted in Andorra). There seems to be a tendency of increasing shares in classes 0 and 1 and decreasing shares in classes 2 and 3 for both pine species. Defoliation and discolouration follow a similar distribution as registered in 2004.

In 2004 the most important damage cause in Andorran forests was pine processionary caterpillar (*Thaumetopoea pityocampa*), which affected 66.7% of the surveyed trees, mostly *Pinus sylvestris*, of a single plot. In 2006 the pine processionary caterpillar was completely eliminated from the same plot, because of a phytosanitary treatment applied in autumn 2005.

4.3.2 Cyprus

The annual assessment of crown condition was conducted on 15 Level I plots, during the period August - October 2006. The assessment covered the main forest ecosystems of Cyprus and a total of 360 *Pinus brutia, Pinus nigra* and *Cedrus brevifolia* trees. Defoliation, discouloration and the agents causing damage to the trees were recorded.

From the total number of trees assessed (360 trees), 11.7% were not defoliated, 67.5% were slightly defoliated, 20.3% were moderately defoliated, and 0.5% were severely defoliated. A slight discouloration was observed as well. From the total number of trees assessed (360 trees), 96.1% were not discoulored and 3.9% were slightly discoulored. Only *Pinus brutia* trees showed discouloration.

The comparison of the results with those of 2005 shows a deterioration of the defoliation status of trees. A decrease of the number of trees being in class 0 *(not defoliated)* and class 1 *(moderately defoliated)* has been observed. On the other hand, an increase in the number of trees being in class 2 *(slightly defoliated)* has been observed.

From the total number of sample trees, 45.8% showed signs of insect attack, 11.9% showed signs of attack by “other agents” like lichens, dead branches and mice, while a percentage of 11.7% showed a combination of insect attacks and one of other agents.

Specifically, 10% of the trees were attacked by unspecified insect defoliator, 13.1% by a sucking insect (*Leucaspis* spp.), 3.1% by *Thaumetopoea wilkinsoni,* dead branches appeared at 4.4% of the trees and 2.22% were attacked by rats. The results show that sucking and defoliator insects are the major biotic factors causing defoliation during the year 2006. No damage was attributed to any of the known pollutants. However, the poor edaphic conditions and the adverse drought conditions prevailing in Cyprus should be considered as significant factors contributing to the defoliation of trees.

Forest fire is 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 annually burnt area is kept small. During 2006, 93 forest fires damaged 244 ha of state forests. 114 ha were coniferous forests, 69 ha were broadleaved forests and 61 ha were other forest cover types. The main causes of fires were: carelessness of forest visitors and farmers, malicious, unknown and natural causes. Forest fire did not cause any damage to the “Level I” plots in 2006.

4.3.3 Italy

The 2006 Level I survey in Italy considered 6 941 trees on 251 permanent plots. Most of the trees (69.2%) were included in the classes 1 to 4; 30.5% of the trees were included in the classes 2 to 4 (severely damaged to dead).

49.0% of the conifers and 23% of the broadleaves were without any defoliation (class 0). 19.5% of the conifers and 35.2% of the broadleaves were in defoliation classes 2 to 4. Among the old conifers (≥60 years), the highest defoliation was recorded for *Pinus* *sylvestris* (35% of trees in the classes 2 to 4); followed by *Larix decidua* (31.9%) and *Picea abies* (13%). *Abies alba* had 12.9% of trees in classes 2 to 4.

Among the young broadleaves (<60 years), *Castanea sativa* and *Quercus pubescens* had 57.5% and 53.8% of trees respectively in the classes 2 to 4, followed by *Quercus cerris* (21.9%), *Fagus sylvatica* (20.9%) and *Ostrya carpinifolia* (29.9%). Among the old broadleaves (≥60 years), *Castanea sativa* had 59.1% in the classes 2-4, followed by *Quercus petraea* (54.5%), *Quercus cerris* (21.9%), and *Fagus sylvatica* (18.3%). *Quercus ilex* showed the lowest level of defoliation (14% of trees in the classes 2-4).

In 2005, a new methodology for a more detailed assessment of damage factors (biotic and abiotic) was introduced. For conifers, most of the observed symptoms were attributed to insects (13.3% of the whole sample), subdivided in "needle mining" (27.7% of the assessed trees), and defoliators (19.7); abiotic agents were recorded for 2.8% of the sample trees. For broadleaves, 34.5% of the symptoms were attributed to insects especially "defoliators" (77.4%), "stem, branch and twigs borer" (8.1%), and "gall makers" (3.2%). Fungi were recorded on 9.9% of the sample trees and abiotic agents on 4.2% sample trees.

4.3.4 Spain

General results show that in 2006 78.5% of the sample trees were healthy: they were assigned to defoliation classes 0 and 1 (between 0 and 25% of leaf volume loss). 19.5% of the trees were in classes 2 and 3, with defoliation levels higher than 25%. These results show that defoliation remained on average rather unchanged as compared to 2005. The mean values comprise a slight improvement for conifers and a minor decrease in defoliation for broadleaves as compared to 2005.

A decline had been noticed starting from 1991, which, in the beginning was more related to the conifers. Symptoms observed in the broadleaves were not so clear at that time, but from 1993 on, the worsening had become more severe for this group. Defoliation was highest in 1995 specifically for broadleaves. During 1996 and 1997, a recovery in health condition of forest trees was detected. Since then there has been a fluctuation with a constantly better situation for conifers. In 2005 a remarkable worsening for both species groups took place. In 2006 a very light recovery for conifers and a slight worsening for broadleaves were observed. The results for broadleaves have only been exceeded by the bad ones obtained during 1995.

During the year 2006, out of the four species surveyed, *Pinus halepensis* followed by *Quercus ilex* are the ones which had lowest defoliation. *Pinus sylvestris* remained rather unchanged as compared to 2005. *Quercus pyrenaica* was the species most affected by the worsening in 2006, reaching values in the range of the drought year 1995.

When trying to link defoliation and discolouration with the possible causal agents, in principle for classes 2 and 3 (moderate and severe defoliation) among all the codes reported, the main causing agents were the abiotic ones with the prevailing observation of drought, followed by damage caused by insects, mainly defoliators and to a much lesser extent other damage types as lack of light, competition, parasitic and epiphytic plants, some damage caused by fungi (mainly needle cast and decay fungi) were recorded. On 7.5% of the moderately and severely damaged trees there was damage that could not be identified.

Atmospheric pollution 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 contributes to the degradation processes of the forests. The continuous and periodic evaluation of the plots belonging to the European Level I grid net proved to be a useful and easy method to assess the tree condition and the changes and trends in the forest health status.

4.4 Western Europe

4.4.1 Belgium

Flanders

The 2006 survey was conducted on 72 plots on a 4 x 4 km grid. Ten of these plots are part of the transnational 16 x16 km grid. The number of observer teams was reduced and now all sample trees were assessed by 2 teams of the Research Institute for Nature and Forest.

19.1% of the sample trees showed more than 25% defoliation and 0.4% of the trees died. The mean defoliation was 21.7%. The share of damaged broadleaves was 19.7%, while for conifers this was 17.8%. The mean defoliation in broadleaves was 21.6% and 22.0% in conifers.

The level of damaged trees decreased for most of the tree species. *Pinus sylvestris* is the only main species with a small increase in the share of damaged trees and in mean defoliation.

Fagus sylvatica showed the best condition with 11.2% of the trees in defoliation classes 2-4 and a mean defoliation of 16.8%. There was more fruiting in beech than in 2005, but still much less than in the mast year 2004. It is the only species with a significant decrease in defoliation.

41.8% of the *Populus* trees in the survey were damaged. With 30.2% *Populus* showed the highest mean defoliation of all tree species observed. The unfavourable condition is mainly due to fungal diseases. A few trees died due to infection by *Discosporium populeum* following rust disease by *Melampsora larici-populina*.

In *Quercus robur* there were less moderately to severely defoliated trees (20.0%) than in 2005, but mean defoliation was slightly higher. Defoliation in *Quercus rubra* was lower, with 13.2% of the trees being damaged. In the north-eastern part of Flanders, caterpillar damage by *Thaumetopoea processionea* on *Quercus robur* is continuing.

Defoliation is higher in *Pinus nigra subsp. laricio* than in *Pinus sylvestris*. In 2006, infection by *Sphaeropsis sapinea* was common in both tree species. Nevertheless the condition of *Pinus nigra* improved compared to last year, but still 29.2% of the trees were in defoliation classes 2-4. Only 14.8% of the *Pinus sylvestris* showed moderate to severe defoliation.

Flanders participates in the BioSoil project, and soil sampling and biodiversity assessments have been carried out in the transnational Level I plots. In 2005, the new method for damage assessment was only applied in the plots of the 16 x 16 km grid, while in 2006 this method was also applied in the regional 4 x 4 km grid.

Wallonia

The 2006 survey concerned 1 184 trees (356 conifers and 828 broadleaves) on 52 plots, on the regional 8x8 km systematic grid.

The trends for the trees with defoliation ≥25% are different for conifers and broadleaves:

The conifers were two times more defoliated in the beginning of the nineties, but they stay now at a lower rate than broadleaves with 14% of the trees being damaged.

The broadleaves showed an increase in the share of damaged trees from 10% in 1990 to about 20% in 2005. These damages were due to degradation of beech trees caused by *Scolytidae* in 2000-2002 and drought in 2003 and of the European oaks (drought in 2003).

For the first time since many years, an improvement of mean defoliation was observed for the main species in 2006, especially for beech and sessile oak.

Discolouration has continuously decreased both for broadleaves and conifers since the high level of 2003, despite of the high temperature in July 2006. About 10% of the broadleaved trees and 8.4% of the conifers showed more than 25% of discolouration in 2006.

4.4.2 Denmark

The Danish forest condition monitoring in 2006 showed that most tree species had satisfactory health, based on both Level I and Level II plots and NFI plots. A notable exception was *Fraxinus excelsior* which had extensive dieback of shoots. In general, the average defoliation scores of *Picea abies*, *Fagus sylvatica* and *Quercus* (*robur* and *petraea*) were slightly higher than in previous years, but still within the acceptable. Most other tree species also had low defoliation. All tree species except oak had abundant fruiting in 2006. Attacks by the bark beetle *Ips typographus* multiplied in the warm and dry July, and only the high precipitation of late summer and autumn kept the crowns green in affected conifers.

Based on both Level I and Level II plots and NFI plots, the results of the crown condition survey in 2006 showed that 75% of all coniferous trees and 55% of all deciduous trees were undamaged. 20% of all conifers and 35% of all deciduous trees showed warning signs of damage, and 5% of all conifers and 10% of all deciduous trees were damaged. The mean defoliation of *Picea abies* was 8% in 2006, and the share of damaged trees remained at only 5%. The health condition for *Fagus sylvatica* continued to improve in 2006, in spite of a heavy mast production. Mean defoliation was 10%, and only 6% of the beech trees were damaged. In 2006 the mean defoliation of *Quercus* spp. increased to 20% due to local defoliations by caterpillars in spring. The share of damaged trees increased slightly to 17%.

Looking back at almost 20 years of forest health monitoring it may be concluded that in Denmark there were serious problems in the mid-eighties. In the nineties, defoliation remained high, mostly due to dry summers around 1995. Since then defoliation has decreased, and most tree species are in good health, in spite of various problems with insects, fungi and storms.

4.4.3 France

In 2006, the forest damage monitoring in the French part of the systematic European network comprised 9 950 trees on 498 plots. In spite of a drought and a heat wave during the months of June and July 2006, the foliage loss remained stable for most of broad-leaved species, whereas it slightly increased for conifers. Nevertheless, broad-leaved trees still remained at a higher defoliation level than conifers.

Quercus pubescens and evergreen oak species in the South East of France had the worst crown condition of all monitored species in 2006.

Death of sampled trees stayed at a relatively low level (less than 0.4 %). The mortality rate of branches has not really increased in 2006, except for *Castanea sativa*, *Quercus pubescens* and *Pinus sylvestris*.

The number of discoloured trees was low (less than 10 %) except for *Prunus* spp. and *Larix* spp. Damage was reported on a third of the sampled trees, mainly on broad-leaved species. Attacks by defoliating caterpillars amounted to more than a half of the reports of damage. Nevertheless, summer observations showed that their impact on the foliage was quite low, and seldom went beyond 20%. The other most important causes of damage were beech leaf mining weevil (*Rhynchaenus fagi*), mistletoe (*Viscum album*) on *Pinus sylvestris,* and the oak buprestid (*Coraebus florentinus*) on *Quercus* spp. Abnormally small leaves were observed on *Quercus* spp. and *Fagus sylvatica*.

4.4.4 The Netherlands

Over the last four years, most coniferous trees in The Netherlands (over 75% and even 80% in 2006) were not defoliated; they had defoliation below 10%. This high percentage however is mostly due to *Pinus sylvestris*, which over the years showed an increasing percentage of not defoliated trees (from 75% in 2003 to 96% in 2006). The defoliation of *Pseudotsuga menziesii* on the other hand increased over the years 2003 – 2005 and slightly recovered in 2006. The percentages of moderately defoliated *Pseudotsuga menziesii* increased in the period 2003 to 2005 from 12% to 92% and decreased again in 2006 to 76%. A shift took place in the class of slightly defoliated trees, which comprised 16% in 2006 compared to 4% in 2005.

The defoliation of broadleaves (mainly *Quercus* spp.) in The Netherlands was higher as compared to conifers. In 2003, 48% of the trees were slightly defoliated. In 2005, however, 49% were already moderately defoliated. This effect is mainly caused by trees 60 years and older, especially those older than 100 years. In 2006 the vitality of the *Quercus* spp. recovered; a situation which is comparable to that of conifers. The percentage of moderately defoliated trees decreased to 23%, whereas the percentage of not defoliated trees increased to 34% compared to the 11% in 2005.

4.4.5 United Kingdom

Following a winter which was dry, the spring of 2006 was mild and wetter than average across most of the country providing good conditions for tree growth at the start of the growing season. Although the early summer was dry and extreme heat characterised the mid-summer period, few symptoms of water deficit were noted on trees during the course of the survey. Overall, the condition of the surveyed trees was poorer this year than in 2005 with a reduction in the percentage of trees in class 0 (0-10% defoliation) occurring for both conifers and broadleaves. For the conifers, this represented a reversal of the minor improvements in condition which occurred in both 2004 and 2005. The deterioration in the condition of the broadleaved species largely reflected a marked reduction in the crown density of *Fagus sylvatica*, for which the percentage of slightly- to moderately- defoliated trees increased from 61.0% in 2005 to 71.8% in 2006.

As in previous cases where a short-term decline in condition has been recorded, the reduction in the crown density of *Fagus sylvatica* in 2006 was associated with heavy mast production, fruiting being recorded as common or abundant on 63.1% of the assessed trees. However, crown dieback of *Fagus sylvatica* was also more common in 2006 than at any time since 2001 and affected >10% of the crown on 16.3% of trees this year. The condition of *Quercus robur* was largely unchanged since last year but continued to display marked regional variation, with severe defoliation due to attacks by larvae of the moths *Operophtera brumata* and *Erannis defoliaria* being more prevalent in the north of the country.

Picea abies exhibited a slight decrease in crown density in 2006, although foliage retention of the species was generally good with only 7.3% of trees retaining needles for less than 5 years. Shoot death was more severe this year than at any time in the last decade, however, being common or abundant on 31.4% of the assessed trees. Whilst the level of defoliation recorded for *Pinus sylvestris* in 2006 was largely unchanged compared with the previous year, the species displayed an unprecedented degree of foliar discolouration. The proportion of trees with yellowing of older foliage was markedly higher than normal, largely as a result of the premature senescence of 2- and 3- year old needles which was evident by early August in certain parts of the country. Little change in the crown condition of *Picea sitchensis* occurred in 2006 in spite of a reduction in the incidence of insect damage, which affected only 6.8% of surveyed trees in 2006 compared with 18.4% of trees in 2005.

4.5 South-Eastern Europe

4.5.1 Bulgaria

In 2006, the forest condition survey was carried out on 141 plots on a grid net of 16 x16 km, 8 x 8 km and 4 x 4 km. A total of 5 069 sample trees were assessed, 2 630 conifers and 2 439 broadleaves. For all species, there was a sight worsening of crown condition. The share of moderately to severely damaged trees (defoliation classes 2-4) increased compared to the 2005 results. The share of trees without visible defoliation decreased from 22.4% in 2005 to 17.3% in 2006.

For conifers, the percentage of damaged trees slightly increased. As compared to the previous year, trees without visible defoliation remained almost the same. The share of severely defoliated and dead trees increased respectively by 1.1 and 2.2 percent points.

For *Pinus nigra*, some damage was caused by needle-rust and blight shoots fungi including *Dothistroma septospora* and *Sphaeropsis sapinea.*

Defoliation of broadleaves (*Quercus* spp. and *Fagus sylvatica*) was higher in 2006 than in 2005. The share of trees without any defoliation decreased by 10.4 percent points, compared to 2005. The share of dead *Quercus* trees increased by 7.8 percent points. *Quercus* trees were attacked by defoliating insects including *Operophthera brumata*, pathogens such as *Nectria* spp., *Hypoxilon mediterraneum*, *Pezicula cinnamomea* and *Agrobacterium tumefaciens*. Beech stands suffered under mining insects such as *Rhynchaenus fagi* and pathogens 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 the previous years, no specific damage factor was observed for more than half of the trees.

4.5.2 Hungary

In 2006, thanks to the rainy weather, the improvement of the general health condition of Hungarian forests continued similar to the year of 2005. *Fagus sylvatica* was again the most healthy tree species although some older beech stands still have not recovered from the heat and drought in 2003.

Fortunately, the *Lymantria dispar* gradation finally collapsed in 2006 although 10 000 hectares of forests had to be treated with biological pesticides. The consequences of the 3-year-long gradation in forests are weakened immunity, secondary damage and decline of stands. Several stands need to be reforested.

Western Hungarian *Picea abies* and *Pinus sylvestris* forests suffered from bark beetles (mainly *Ips typhographus*). Not least due to the rainy summer, *Picea abies* showed a better resistance against this secondary pest. In the South of Lake Balaton *Pinus sylvestris* and *Quercus robur* were damaged by cockchafer (*Melolontha melolontha*) so heavily that reforestation and afforestation is impossible without protection.

Heterobasidium annosum caused damage in *Pinus sylvestris* and *Pinus nigra* forests stocking on the drier sites of the Great Hungarian Plain.

Cryphonectria parasitica damage was extending in Western and South-Western Hungary *Castanea sativa* and *Quercus petraea* forests. *Dryocosmus kuriphilus Yasumatsu* was not encountered in *Castanea sativa* forests.

Robinia pseudoacacia was affected less by leaf miners (*Parectopa robiniella* and *Phillonoricter robiniella*) as compared to 2005.

4.5.3 Romania

In 2006, 97 626 trees were assessed on 3 879 permanent plots of the national 4 x 4 km monitoring network. From the total number of sample trees, 8.6% were assigned to defoliation classes 2-4 (5.2% for conifers and 9.9% for broadleaves). The health status of the Romanian forests has not changed significantly compared to the previous year (the share of trees in defoliation classes 2-4 increased by 0.5 percent points).

Among the main species, *Picea abies* (4.4%), *Fagus sylvatica* (6.3%), *Abies alba* (7.4%) and *Pinus* spp. (9.2%) had the lowest shares of damaged trees (defoliation classes 2-4), and *Quercus frainetto* (27.6%), *Quercus pedunculiflora* + *Q. pubescens* (24.2%) and *Robinia pseudoacacia* (21.4%), had the highest shares. As compared to the previous year (2005), in 2006 the species with lowest defoliation (*Picea abies*, *Fagus sylvatica*, *Abies alba*), showed a slight increase in the share of damaged trees by 0.5, 0.7 and 1.0 percent points, respectively. *Quercus frainetto*, *Quercus pubescens* + *Quercus pedunculiflora* and *Robinia pseudoaccacia* showed increasing percentages of trees in classes 2-4 with 0.6, 9.7 and 4.2 percent points, respectively.

The situation of *Quercus pubescens* + *Quercus pedunculiflora* and *Robinia pseudoaccacia* may be explained by a remarkable shift (especially for *Quercus pubescens* + *Quercus pedunculiflora*) from class 1 to class 2. For these species, a large number of trees were assessed with 20-25% crown defoliation in 2005 and with 30-35% in 2006. This deterioration can be explained by excess of water in autumn 2005 and spring 2006.

In general, the favourable climatic conditions in 2005 and in spring of 2006 had a positive influence on forest condition in 2006. The overall situation has remained rather unchanged.

4.5.4 Serbia

In the Republic of Serbia, the 16 x 16 km grid consists of 103 sampling plots, 27 new plots were added on a 4 x 4 km grid, resulting in a total number of 130 plots (not including the Kosovo and Metohija). Assessments were based on around 3 000 trees assessed in the years 2004 – 2006.

After 2005, broadleaved and coniferous trees recovered compared to previous years, but nevertheless in 2006, more than 36% of the trees were classified as damaged. *Pinus nigra* had the highest defoliation among conifers. More than 61% of the trees were slightly or moderately defoliated. *Picea abies* had the highest share of not defoliated trees.

Quercus petraea was the broadleaved species with highest defoliation with more than 65% of the trees in the classes slightly and moderately defoliated. *Carpinus betulus* and *Fagus sylvatica* had lowest defoliation.

In 2006 there was the highest share of conifers with no defoliation (64.8% as compared to 46.2% in 2005 and 50.1% in 2004). Related to this development, the share of trees in defoliation classes 1 and 2 decreased over the three years. The assessment of defoliation showed stagnation of severe defoliation and a slightly increasing proportion of dead trees. In 2006 there was as well the highest share of broadleaves with no defoliation (63.8% as compared to 51.3% in 2005 and 59.5% in 2004).

4.6 Eastern Europe

4.6.1 Republic of Moldova

In 2006, the forest condition survey was carried out on a 2 x 2 km grid comprising 12 729 trees. 72.4% of all trees were rated as slightly or not defoliated. 27.6% of the trees were in defoliation classes 2-4. 91.4% of the trees were in discolouration classes 0-1.

The main tree species mostly affected were *Quercus pubescens* and *Quercus pedunculiflora* with 39.6% of the trees in classes 2-4, *Robinia pseudoacacia* and *Quercus robur* with 36.7 and 35.3% of the trees in defoliation classes 2-4, respectively. 42.9% of the pine trees and 23.3% of the ash stands were rated as damaged or dead. As concerns all broadleaves over 60 years and compared to the previous year, there was a minor increase from 26.5% to 27.6% of the assessed trees assigned to defoliation classes 2-4.

The assessment of damage causes showed a higher influence of biotic factors. From the total of 12 729 assessed trees, 9 851 trees were without any damage, corresponding to 77.4% of the total sample. The majority of damages were caused by insects. They caused damage to 2 227 trees, corresponding to 82.7% of all damaged trees. 58.8% of the trees with registered damage were included in defoliation classes 2-4.

4.6.2 Ukraine

The following includes the results of the pilot-project for the development of a national forest monitoring system which is a joint activity of the Ukrainian Research Institute of Forestry and the Ukrainian Forest Inventory Service. Aims of the pilot-project are to improve the forest monitoring system and to optimize the grid of monitoring plots. It is expected that in future the grid density and amount of monitoring plots will be changed in order to derive a representative grid reflecting the different natural zones of the country.

First results allow for the assessment of changes in forest condition between 2005 and 2006. In 2006, 35 896 sample trees were assessed on 1 518 forest monitoring plots in 22 administrative regions of Ukraine (about 85% of the total area of the country). Mean defoliation of conifers was 10.9% and 11.0% for broadleaved trees. In general, some improvement in tree condition was observed for the total sample as compared to the previous year. In 2006, the percentage of undamaged trees increased (68.3% against 62.6%). At the same time, the share of slightly to moderately defoliated trees decreased from 36.3% to 31.1%. These changes may, however, be due to a change of sample trees.

For the sample of common sample trees (CSTs) (30 008 trees) only minor changes with a small improving tendency were observed. Mean defoliation of all species in 2006 (11.3%) was lower than in 2005 (11.6%). Changes are characterised by decreasing shares of trees in defoliation classes 1, 2 and 3 and an increase in classes 0 and 4. There were hardly any changes in classes 1 and 3. Some improvement of tree condition was registered for CST of *Quercus robur*. A statistically significant change was observed in class 2 (decrease by 2.5 percent points) against an increase in classes 0 and 1 by 1.8 percent points. A similar tendency was observed for the CSTs of *Fagus sylvatica* and *Fraxinus excelsior*. For *Pinus sylvestris* the increase in class 0 was related to a decrease in classes 1 and 2. For *Picea excelsa* the decrease in classes 0, 2 and 3 corresponded to an increase in classes 1 and 4. The improvement of tree crown condition may be explained by more favorable weather conditions in 2006 and by a decrease of the impact of defoliating insects.

4.7 Northern America

4.7.1 Canada

While Natural Resources Canada’s Canadian Forest Service (CFS) does not have a national monitoring program for forest health, there are several projects and programs that generate relevant information. Other information is gathered through regionally based surveys or through partner agencies.

Canada’s Forest Inventory
Canada’s Forest Inventory provides tabular summaries of data in order to meet commitments to report to Parliament annually on the State of Canada’s Forests, to provide data to the United Nations Global Forest Resources Assessment, and to report on sustainable development through Criteria and Indicators processes. This inventory is a national compilation of 57 individual source inventories into a common format (see http://www.bookstore.cfs.nrcan.gc.ca/detail_e.php?recid=12586209).

National Forest Inventory
A National Forest Inventory (NFI), with permanent observational units on a national grid, has been proposed. The first report will be compiled in 2007. In addition to providing consistent estimates for traditional forest inventory attributes, the NFI will provide a framework for collecting data on socio-economic indicators, as well as data related to forest health (e.g. insect damage, disease infestation), biodiversity, and productivity. A prototype of the data management system is available on the NFI website www.pfc.forestry.ca/monitoring/inventory/index_e.html. This year a project was undertaken to identify and determine the compatibility of the current NFI framework with other land-based monitoring programs in Canada and to assess the potential for partnerships and synergies. One of the recommendations of the resulting report was for the

NFI to establish a long term partnership with ICP Forests to learn and share the wealth of information that this program has gathered over the past two decades.

Criteria & Indicators of Sustainable Forest Management in Canada

In 2006, the Canadian Council of Forest Ministers (CCFM) released the report Criteria and Indicators (C&I) of Sustainable Forest Management in Canada. The CCFM C&I process is compatible with the Montréal Process and shares the themes identified in the Global Forest Resources Assessment that are also common to the Ministerial Conference for the Protection of Forests in Europe and the other international C&I processes. The report addresses many aspects of forest health including biodiversity, ecosystem conditions and productivity, global ecological cycles, and soil and water. It can be accessed at http://www.ccfm.org/current/ccitf_e.php.

Climate Change Impacts on the Productivity and Health of Aspen (CIPHA)

Because of the significant ecological importance of trembling aspen (*Populus tremuloides*) as the most widely distributed tree species in North America and for its value as a carbon stock and a commercial species for fiber, the CIPHA project was initiated in 2000. The project includes long term research plots in 72 aspen stands along a regional climate gradient. Tree health and mortality are assessed annually, and changes in aboveground biomass are estimated using tree-ring analysis and plot-based measurements. The results to date demonstrate that drought and insects are major agents of disturbance that could cause a sustained, regional-scale decrease in aspen productivity and carbon uptake under the projected climatic changes over coming decades. One of the major challenges is in "scaling up" these patchy, stand-level impacts to the regional scale. Field measurements are being related to satellite remote sensing data in the development of methods for detecting, quantifying, and mapping aspen dieback and mortality. A recent publication provides addition details of the results from this study.1

Acid Rain

The 2006 progress report on the 1991 Canada–United States Air Quality Agreement indicates that over the last two years Canada has continued to reduce its emissions of sulfur dioxide and nitrogen oxides, the major contributors to acid rain, by targeting major sources such as electric generating units, industrial sources, and on-road and non-road transportation. Canada's total sulphur dioxide emissions are almost half of the 1980 level and 28% below the national cap of 3.2 million tonnes. Despite this overall progress, in eastern Canada, acid rain continues to damage sensitive ecosystems, and in 2005 the provinces of Nova Scotia, Quebec, and Ontario developed stricter regulations to reduce emissions from major sources. In western Canada, however, due to a booming energy production sector, acid rain may become more problematic.

Many areas of eastern Canada are continuing to experience levels of acidic deposition that exceed critical loads (the maximum amounts of acidifying deposition ecosystems can tolerate in the long term without being damaged). Acid deposition is especially a concern for eastern forests because the region is a major receptor of long-range transported air pollutants, forest health is poor in some areas, and forest soil fertility is marginal in many areas. Scientists have concluded that the critical loads of many sensitive terrains fall below the current target of 20 kilograms of wet sulfate per hectare per year, and even with full implementation of the commitments made in the 1980s and 1990s, it is anticipated that

[1] E. H. Hogg et al. 2006. Impact of the 2001-2003 drought on productivitity and health of western Canadaian aspen forests. pp 89-94 in Guyon, J.C. (comp.) Proceedings of the 53rd Western Internatioanl Forest Disease Work Conference, 2005 September 26-29, Jackson, WY. USDA Forest Service.

almost 800,000 square kilometres in southeastern Canada will receive harmful levels of acidic deposition.

The New England Governors/Eastern Canadian Secretariat (NEG/ECS) Acid Rain Program initiated a forest mapping project to determine sustainable levels of acidic deposition for forest soils in eastern Canada and found that 52% of eastern Canada receives acid deposition that exceeds critical loads. The highest exceedances occur in eastern Ontario and southern Quebec. Preliminary estimates show that more than 48% of the upland forest area in Ontario and Quebec and over 35% of the upland forest area of Nova Scotia and insular Newfoundland receive acid deposition that exceeds critical loads.

NEG/ECS research in the Lac Clair Watershed in Quebec has also found that atmospheric pollution adds more than twice as much acidity to the ecosystem as it does beneficial mineral nutrients and that water runoff containing atmospherically deposited sulphur and nitrogen leaches away more nutrients than are added to the system from mineral weathering. The research concluded that the present rates of atmospheric deposition of sulphur and nitrogen exceed their long term sustainable rates where nutrient losses would be matched by nutrient supply.

Ozone

Air quality monitoring in Canada between 2001 and 2003 showed that approximately half of Canadians were living in communities with three-year averages above the Canada-wide Standard air quality target for ozone of 65 parts per billion (ppb).

Canada-wide standards for ozone commit jurisdictions (federal and provincial/territorial) to the development of jurisdictional implementation plans, and the provinces of Ontario and Quebec in particular have drafted regulations to protect the quality of the atmosphere and, consequently, the health of ecosystems. Canada is also addressing trans-boundary air pollution through the 1991 Canada-United States Air Quality Agreement and has made considerable progress in meeting the requirements of the Ozone Annex to reduce emissions of nitrogen oxides and sulfur dioxide.

Fire

In Canada, neither the number of fires nor the area burned has exhibited particular trends between 1975 and 2006. The fluctuations in forest fires are primarily due to the variability of weather. In the 2006 fire season, there were 9713 fires covering 2.1 million hectares: both figures only slightly exceed the 10-year averages. The mild winter with below normal snow and moisture levels experienced in many regions as well as the early arrival of spring likely were contributing factors to the incidence of forest fire in Canada in 2006. Due to natural variations and lack of data, the precise influence of humans cannot be determined, but between 1990 and 2004, human-induced fires account for, on average, 51% of annual fires. In the same period, lightning strikes were responsible for 82% of the burnt area.

Insects

Insects are considered the leading cause of disturbances in Canadian forests in terms of total area affected. Overall, the total area damaged by insects in Canada has decreased steadily since 1975. The spruce budworm (*Choristoneura occidentalis*) and the forest tent caterpillar (*Malacosoma disstria*), both species native to Canada, have had the most significant impacts on Canadian forests by removing tree foliage and consequently reducing growth. In 2004, the forest tent caterpillar affected 1.6 million hectares of forests, while the spruce budworm impacted 0.7 million hectares. Invasive alien species also cause damage to Canadian forests. With no natural predators in invaded ecosystems, they can spread over large distances. These species, such as long horned beetles, are difficult to detect and therefore hard to contain.

The mountain pine beetle (*Dendroctonus rufipennis)* is a native insect that kills trees through a combination of larval feeding on tree tissue and the introduction of a fungus. The province of British Columbia has been disproportionately affected and, by the time the infestation has run its course, it is expected to kill as much as 80% of lodgepole pine (*Pinus contorta*) in BC. In 2006, aerial surveys showed roughly 9.2 million hectares of BC forests were in a stage of red-attack by the mountain pine beetle. Though it has mostly affected BC, scientists believe that Alberta's jack pine (*Pinus banksiana*) forests could also be at risk.

4.7.2 USA

Background Information
Since 2002, the USDA Forest Service has been developing a systematic approach to assess critical loads and levels (CL) in a partnership with Canada and Mexico under the auspices of the North American Forestry Commission. Assistance of the ICP Forests and ICP Mapping and Modelling Programmes has helped in implementation of the CL ideas for the US forests and other ecosystems. Although insufficient funding did not allow for a full implementation of the originally planned network of nine ICP-Forest Level II plots, significant progress has been accomplished at four sites (Otter Creek in West Virginia, Glacier Lakes Ecosystem Study (GLEES) in Wyoming, and San Bernardino Mountains and Kings River Projects in California).

Main results
During 2006, field measurements aimed at development of CL for N & S, and acidity continued at the four listed above sites. Additional work aiming at providing scientific basis for the development of new, biologically-based critical levels for ozone is under way at the USDA Forest Service Pacific Southwest and Rocky Mountain Research Stations.

Critical load estimates have been made for N as a nutrient in mixed conifer forest ecosystems at 15 sites across N deposition gradients in the San Bernardino Mountains and southern Sierra Nevada Mountains in California. These results suggest that CL values determined with the simple mass balance (SMB) steady state model are several-fold lower than empirical critical load values determined from edaphic, vegetative and hydrologic indicators of N status. In these studies the effects of periodic forest fires on CL and how the Mediterranean climate in California affects critical load determinations have also been investigated. Current research also includes studies of the CL for N deposition impacts on lichen communities in coniferous forests of California and Oregon, and dynamic modelling estimates of CL for N as a nutrient are also being evaluated. Plans are also underway to establish two Level II plots in the San Bernardino Mountains for determination of CL for acidification using the ICP Forests SMB approach.
At the Kings River Project, the collection of data compatible with the ICP-Forests Level II intensive sites continued in the 2006 season. Soil characterization and vegetation chemistry were completed. The site will be added to the National Atmospheric Deposition Network as CA28 (Kings River) in 2007. Analysis of site condition is planned for 2007.

A database has been organized for input into the simple mass balance CL model. A study plan has been written to begin CL analysis at GLEES and the southern Rocky Mountains (SE Wyoming, Colorado, northern New Mexico), using the SMB and very simple dynamic (VSD) models for terrestrial ecosystems, and the SSWC and MAGIC models for aquatic ecosystems.

Data from these sites is being used to calculate critical loads for nitrogen and sulphur using a simple mass-balance approach (USDA Forest Service Northeastern Research Station).

Outlook

During 2007, the described activities will continue at four demonstration sites. Several research proposals have been submitted to the new multi-agency (EPA, USDA FS, NPS) "Critical Loads Development Project". Cooperation of the USDA Forest Service Research & Development with the USDA Forest Service Forest Inventory Analysis (FIA) and Forest Health Monitoring (FHM) programs will be continued. It will include efforts aimed at a wider application of the critical loads for N & S deposition, acidity and critical levels for ozone effects on the Forest Service lands.

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Annex I-1
Climatic regions

The **Boreal** region comprises Finland, the central and northern parts of Sweden, Estonia except the coastal regions and some plots in northern and central Norway. The climate is mainly cold with a short vegetation period. In the northernmost parts the climate changes to arctic conditions. The Boreal region is dominated by *Picea abies* and *Pinus sylvestris*. In 2006, 19.3% of the plots of the European survey were located in the Boreal region.

The **Boreal (Temperate)** region covers most parts of southern Sweden and Norway, the whole of the Baltic countries Latvia and Lithuania, the coastal regions of Estonia and the whole of Belarus. This region contains a higher proportion of deciduous tree species, compared to the colder Boreal region. 15.5% of the assessed trees were in the Boreal (Temperate) region.

The **Atlantic (North)** region comprises the United Kingdom, Ireland, Denmark, the Netherlands, the southern coasts of Sweden and Norway, north-west Germany, northern Belgium and France. The climate is characterised by mild winters, a relatively uniform distribution of precipitation over the year and long transitional seasons. The forests consist of *Picea abies*, *Pinus sylvestris, Picea sitchensis, Quercus robur* and *Fagus sylvatica*. 5.6% of the plots were situated in this region.

The **Atlantic (South)** region comprises central and south-western France, the atlantic coast of Spain and the northern parts of Portugal. The climate is warm, with high precipitation in winter, but very little frost and snow. There is a higher proportion of oak species, dependent on warmer summers, than in the Atlantic (North) region. Also frequent are *Castanea sativa, Pinus pinaster, Pinus radiata* and *Pinis sylvestris.* 4.5% of the plots were located in this region.

The plots of the **Sub-Atlantic** region are located in Poland, the Czech Republic, the western parts of Slovakia, northern Austria and Switzerland, eastern and southern Germany, southern Belgium, central-eastern France, and the whole of Luxembourg. The climate is typically temperate and characterised by large temperature differences between summer and winter, with a gradient from the western parts to the eastern parts. If the whole region is considered, the forests are very heterogeneous, dominated by *Picea abies, Pinus sylvestris* and *Fagus sylvatica*. In this region 17.4% of all plots were located.

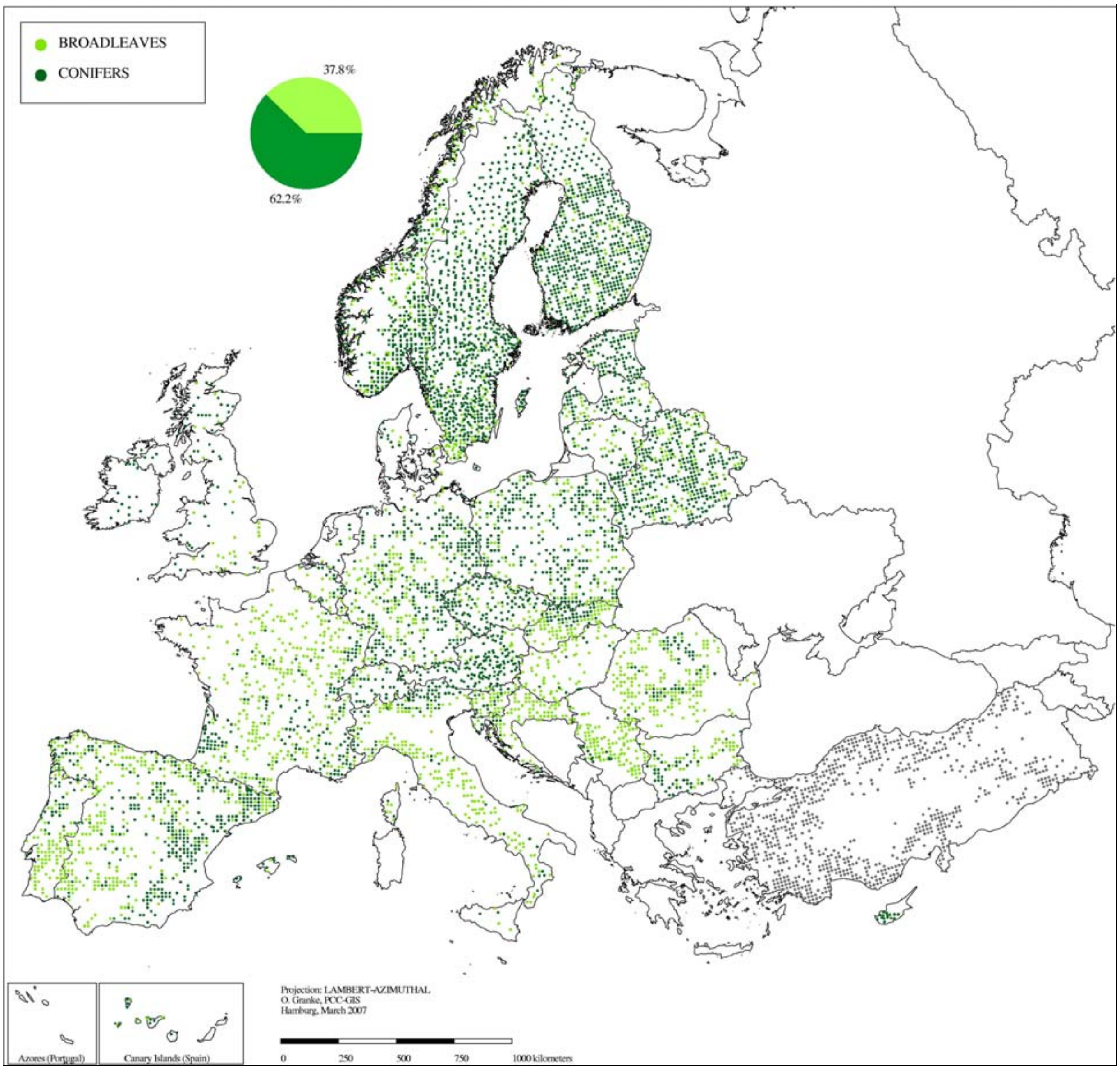
The **Continental** region consists of the Republic of Moldova, large parts of Romania, eastern and northern Bulgaria and nearly all Hungary. The climate is typically continental with warm and dry summers, and low temperatures in winter. The forests are characterised by oak species, *Fagus sylvatica, Robinia pseudoacacia, Carpinus betulus, Picea abies* and *Abies alba.* In 2006, 5.6% of the sample plots were located in this region.

The **Mountainous (South)** region comprises plots on several mountain ridges. They share steep climatic gradients and consequently complex geobotanical structures, depending on altitude and exposition. They comprise the Alpine system (Pyrenees, Alps, Tatras, Carpathians and the Balkan), the Appenin, the Vosges, and in Germany the Black Forest and the Bavarian/Bohemian Forests. The dominant species are *Picea abies, Fagus sylvatica, Larix decidua, Pinus nigra, Pinus sylvestris* and *Abies alba*. This climatic region comprises 11.7% of all sample plots.

The **Mountainous (North)** region was introduced to account for the peculiarities of the mountainous climate in northernmost Europe in comparison to that in the other parts of Europe. This region is located only in Norway. It is characterised by large seasonal variations in climate, but with a generally shorter vegetation period. The plots at lower altitudes on the Atlantic coast are influenced by the Gulf stream and have a more temperate climate. The most frequently occurring species are *Betula pubescens, Picea abies* and *Pinus sylvestris*. 5.1% of the sample plots were located in the Mountainous (North) region.

The Mediterranean region as a whole is divided in the **Mediterranean (Higher)** and **Mediterranean (Lower)** regions. The higher areas (6% of the plots) are situated between 400 m and ca. 1000 m altitude in Portugal, Spain, southern France, Italy, Slovenia, Croatia, Romania and Greece with humid climate. The Mediterranean (Lower) regions (9.3% of the plots) cover Cyprus and lower parts of the countries mentioned above. The climate is characterised by hot and dry summers and frequent drought periods in summer. Both Mediterranean regions are dominated by *Pinus halepensis, Pinus nigra, Pinus pinaster, Quercus ilex, Quercus cerris* and *Quercus pubescens.*

Annex I-2
Braodleaves and conifers (2006)



805 plots in Turkey are selected and partly installed. Tree data have not yet been reported.

Annex I-3
Species assessed (2006)

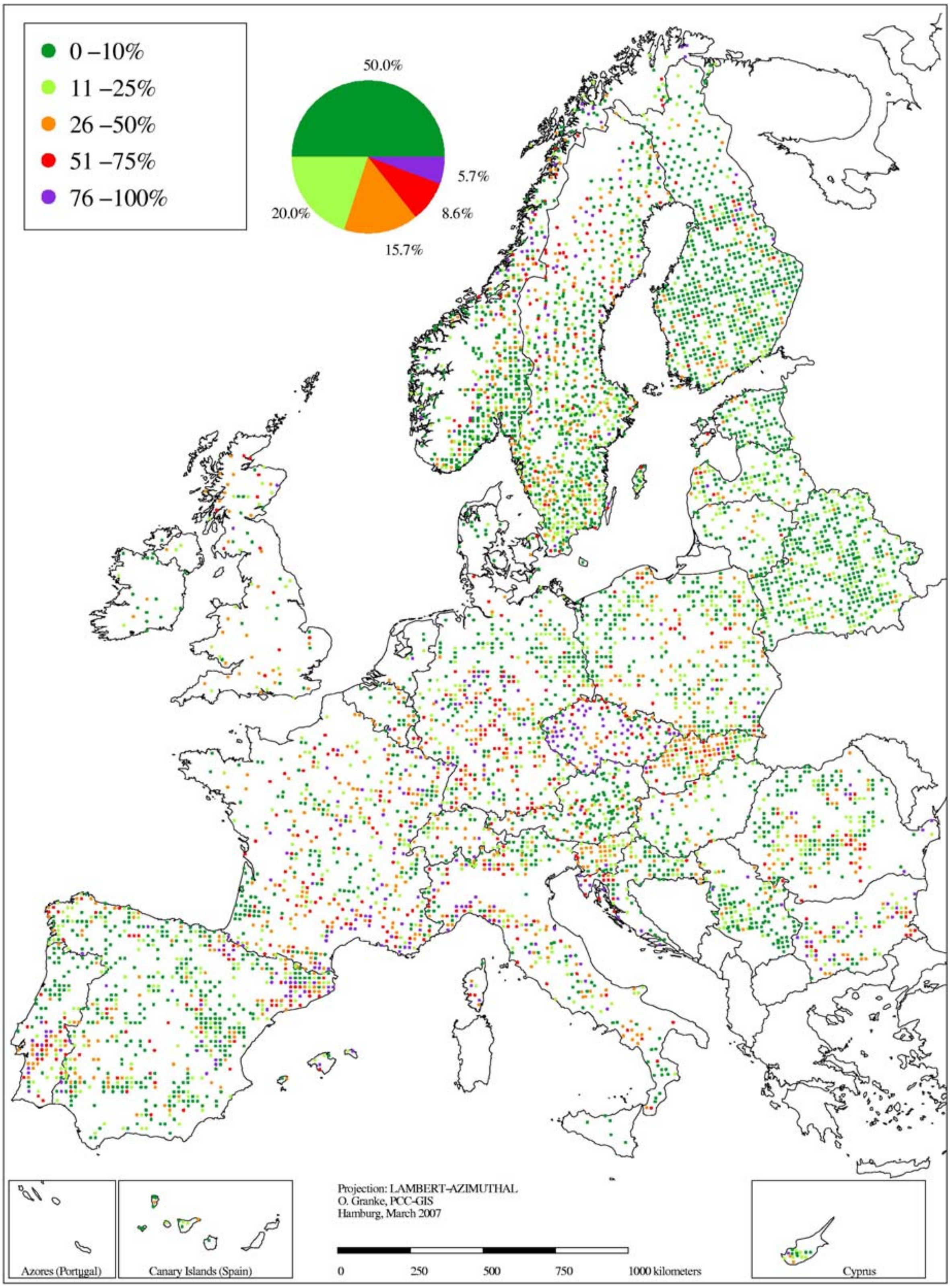
	Observed trees		Observed plots	
Species	**Number**	**%**	**Number**	**%**
Pinus sylvestris	34411	26.49	1943	17.68
Picea abies	24517	18.88	1570	14.29
Fagus sylvatica	11357	8.74	687	6.25
Quercus robur	4742	3.65	495	4.50
Betula pubescens	4455	3.43	735	6.69
Betula pendula	4371	3.37	768	6.99
Quercus ilex	3822	2.94	221	2.01
Quercus petraea	3322	2.56	334	3.04
Pinus pinaster	3164	2.44	172	1.57
Pinus nigra	2562	1.97	151	1.37
Pinus halepensis	2491	1.92	128	1.16
Quercus cerris	2116	1.63	178	1.62
Abies alba	2089	1.61	227	2.07
Quercus pubescens	1966	1.51	162	1.47
Carpinus betulus	1894	1.46	261	2.37
Quercus suber	1591	1.22	89	0.81
Alnus glutinosa	1524	1.17	181	1.65
Eucalyptus spp.	1506	1.16	68	0.62
Larix decidua	1303	1.00	192	1.75
Castanea sativa	1262	0.97	145	1.32
Populus tremula	1174	0.90	286	2.60
Fraxinus excelsior	1141	0.88	219	1.99
Picea sitchensis	965	0.74	48	0.44
Quercus pyrenaica	962	0.74	54	0.49
Quercus frainetto	957	0.74	70	0.64
Fagus moesiaca	901	0.69	52	0.47
Robinia pseudoacacia	790	0.61	76	0.69
Acer pseudoplatanus	701	0.54	189	1.72
Quercus rotundifolia	633	0.49	36	0.33
Pseudotsuga menziesii	552	0.43	49	0.45
Populus hybrides	519	0.40	25	0.23
Pinus pinea	450	0.35	36	0.33
Quercus faginea	394	0.30	49	0.45
Ostrya carpinifolia	390	0.30	60	0.55
Tilia cordata	378	0.29	90	0.82
Pinus radiata	322	0.25	16	0.15
Pinus brutia	300	0.23	14	0.13
Alnus incana	292	0.22	46	0.42
Juniperus thurifera	279	0.21	22	0.20
Prunus avium	235	0.18	111	1.01
Acer campestre	192	0.15	80	0.73
Pinus contorta	192	0.15	16	0.15
Fraxinus angustifolia	182	0.14	20	0.18
Pinus uncinata	178	0.14	16	0.15
Olea europaea	173	0.13	19	0.17
Quercus rubra	163	0.13	23	0.21

	Observed trees		Observed plots	
Species	**Number**	**%**	**Number**	**%**
Tilia platyphyllos	155	0.12	21	0.19
Other broadleaves	152	0.12	37	0.34
Fraxinus ornus	147	0.11	53	0.48
Acer platanoides	132	0.10	53	0.48
Populus nigra	109	0.08	11	0.10
Pinus cembra	98	0.08	11	0.10
Alnus cordata	85	0.07	3	0.03
Larix kaempferi	82	0.06	11	0.10
Sorbus aucuparia	71	0.05	32	0.29
Pinus strobus	70	0.05	11	0.10
Sorbus aria	53	0.04	33	0.30
Ulmus glabra	51	0.04	26	0.24
Salix caprea	48	0.04	30	0.27
Juniperus oxycedrus	48	0.04	17	0.15
Populus alba	46	0.04	12	0.11
Acer opalus	44	0.03	17	0.15
Populus canescens	44	0.03	4	0.04
Salix spp.	42	0.03	14	0.13
Juniperus communis	39	0.03	7	0.06
Salix alba	37	0.03	8	0.07
Cupressus sempervirens	35	0.03	5	0.05
Acer monspessulanum	33	0.03	12	0.11
Cedrus atlantica	32	0.02	4	0.04
Ulmus minor	30	0.02	13	0.12
Sorbus torminalis	28	0.02	23	0.21
Cedrus brevifolia	24	0.02	1	0.01
Platanus orientalis	22	0.02	2	0.02
Juniperus phoenicea	22	0.02	9	0.08
Buxus sempervirens	21	0.02	3	0.03
Corylus avellana	19	0.01	10	0.09
Quercus fruticosa	19	0.01	1	0.01
Quercus trojana	19	0.01	1	0.01
Juglans regia	16	0.01	6	0.05
Arbutus unedo	15	0.01	6	0.05
Ilex aquifolium	10	0.01	6	0.05
Pyrus communis	9	0.01	6	0.05
Sorbus domestica	9	0.01	8	0.07
Ulmus laevis	9	0.01	6	0.05
Tsuga spp.	9	0.01	1	0.01
Cupressus lusitanica	8	0.01	1	0.01
Carpinus orientalis	7	0.01	2	0.02
Ceratonia siliqua	7	0.01	2	0.02
Phillyrea latifolia	7	0.01	2	0.02
Malus domestica	4	0.00	2	0.02
Cedrus deodara	4	0.00	1	0.01
Other conifers	4	0.00	1	0.01
Prunus serotina	3	0.00	1	0.01
Quercus coccifera	3	0.00	3	0.03
Abies grandis	3	0.00	1	0.01

	Observed trees		Observed plots	
Species	**Number**	**%**	**Number**	**%**
Pinus mugo	3	0.00	1	0.01
Thuya spp.	3	0.00	1	0.01
Prunus padus	2	0.00	2	0.02
Salix fragilis	2	0.00	2	0.02
Chamaecyparis lawsonia	2	0.00	1	0.01
Salix cinerea	1	0.00	1	0.01
Salix eleagnos	1	0.00	1	0.01
Pistacia terebinthus	1	0.00	1	0.01
Picea omorika	1	0.00	1	0.01
All species	129880	100.00	10990	100.00

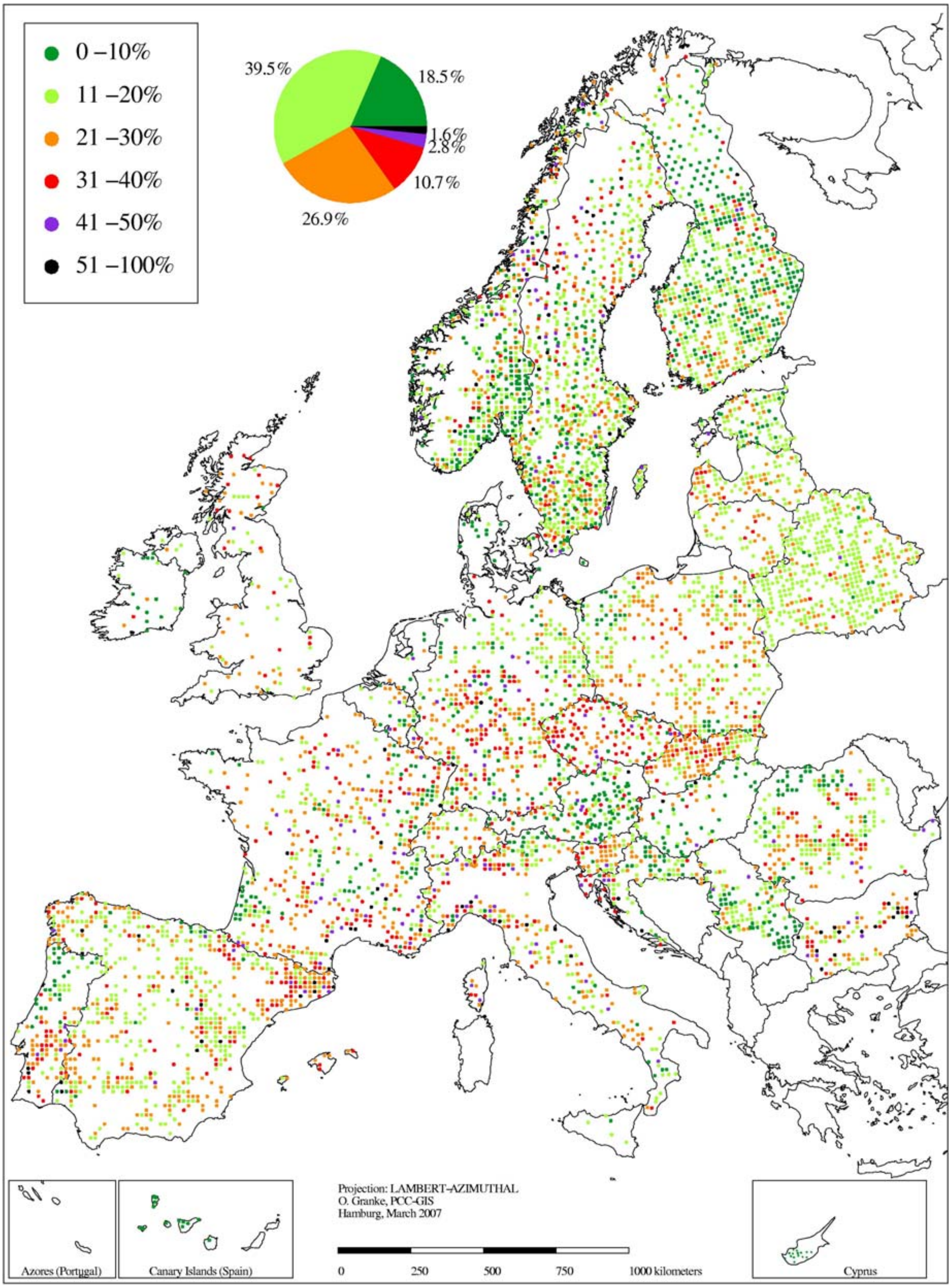
Annex I-4
Percentage of trees damaged (2006)

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.



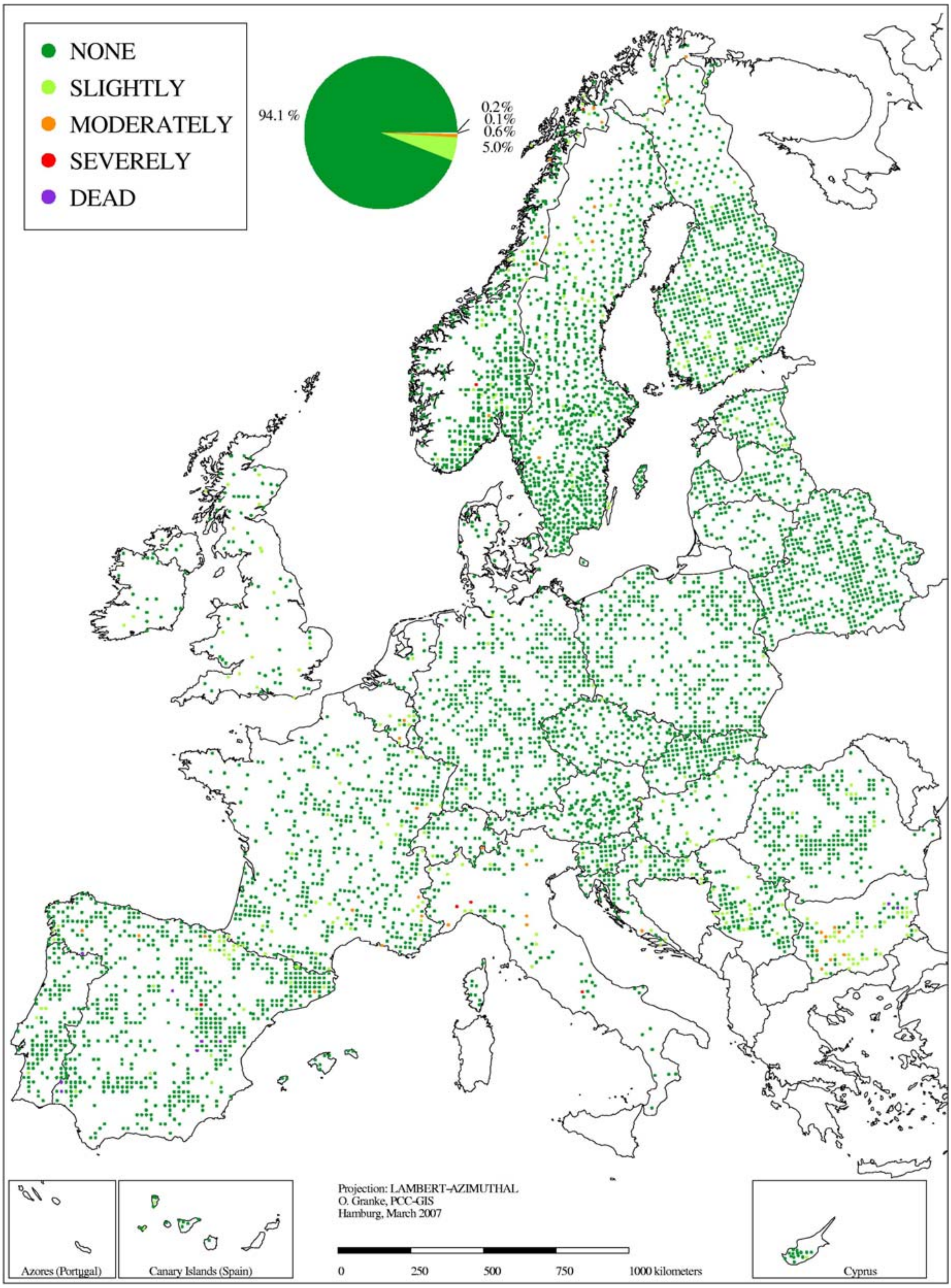
Annex I-5
Mean plot defoliation of all species (2006)

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.

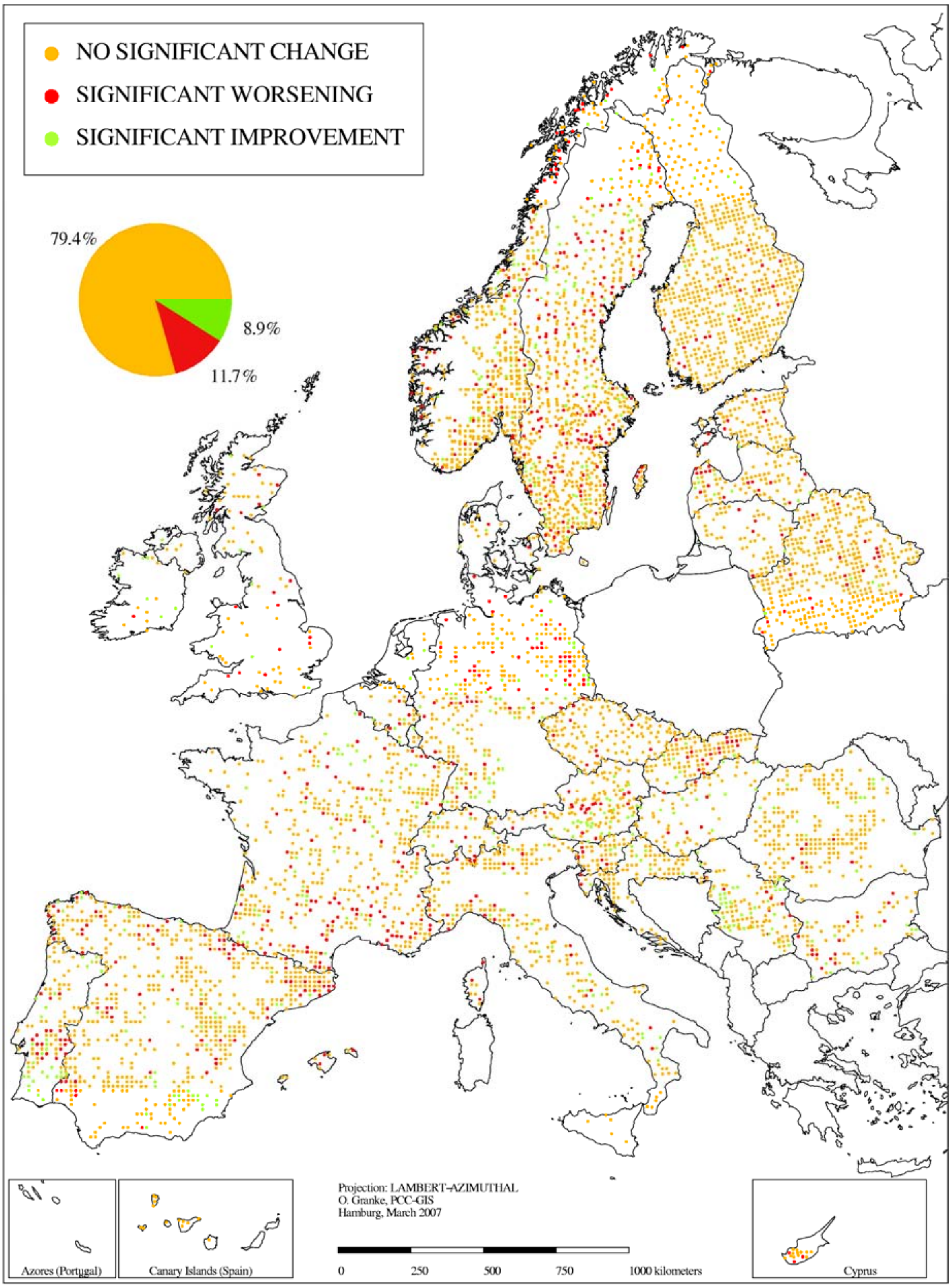


Annex I-6
Plot discolouration (2006)

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 (2005-2006)



Annex I-8
Development of defoliation of most common species (1990-2006).

Picea abies

ATLANTIC (NORTH)	Number of trees	0-10%	>10-25%	>25%	SUB-ATLANTIC	Number of trees	0-10%	>10-25%	>25%
1990	526	52.3	28.3	19.4	1990	3822	27.4	39.5	33.1
1991	524	54.8	22.7	22.5	1991	3767	25.5	39.1	35.4
1992	525	49.5	30.7	19.8	1992	3826	24.6	40.7	34.7
1993	521	47.8	21.7	30.5	1993	3781	24.6	37.2	38.2
1994	522	39.7	26.2	34.1	1994	3778	21.1	37.8	41.1
1995	503	42.6	28.6	28.8	1995	3833	25.9	34.0	40.1
1996	495	49.5	30.1	20.4	1996	3835	31.0	36.4	32.6
1997	475	51.6	26.3	22.1	1997	3855	25.1	40.4	34.5
1998	497	52.3	27.6	20.1	1998	4674	27.6	39.9	32.5
1999	507	56.0	24.7	19.3	1999	4651	26.7	40.9	32.4
2000	489	53.1	26.0	20.9	2000	4651	22.9	43.6	33.5
2001	490	61.9	21.6	16.5	2001	4444	21.9	44.8	33.3
2002	466	64.0	22.3	13.7	2002	4509	21.3	42.1	36.6
2003	466	61.8	21.9	16.3	2003	4563	21.0	44.5	34.5
2004	465	62.4	21.7	15.9	2004	4540	18.0	40.4	41.6
2005	444	61.5	24.1	14.4	2005	4471	18.8	45.4	35.8
2006	447	62.6	25.1	12.3	2006	2414	28.1	40.5	31.4
BOREAL (TEMP.)	Number of trees	0-10%	>10-25%	>25%	MOUNTAIN-OUS (SOUTH)	Number of trees	0-10%	>10-25%	>25%
1990	405	35.6	41.2	23.2	1990	1715	29.6	37.3	33.1
1991	599	32.4	46.6	21.0	1991	1727	22.4	44.5	33.1
1992	595	30.1	50.9	19.0	1992	1697	15.4	45.5	39.1
1993	594	29.0	54.0	17.0	1993	1674	18.2	44.2	37.6
1994	531	37.1	47.5	15.4	1994	1708	17.1	42.3	40.6
1995	547	39.5	45.5	15.0	1995	1803	21.1	44.3	34.6
1996	585	30.4	52.0	17.6	1996	1778	25.2	42.9	31.9
1997	545	32.5	48.1	19.4	1997	1726	23.0	44.2	32.8
1998	551	36.5	47.5	16.0	1998	2151	25.8	43.2	31.0
1999	552	32.8	49.6	17.6	1999	2131	29.1	43.1	27.8
2000	549	24.8	51.3	23.9	2000	2077	24.0	47.3	28.7
2001	540	25.7	53.2	21.1	2001	2017	20.2	50.6	29.2
2002	540	23.1	60.8	16.1	2002	1995	16.3	55.0	28.7
2003	522	24.3	58.8	16.9	2003	2012	13.2	58.1	28.7
2004	518	27.8	56.2	16.0	2004	1956	9.4	49.5	41.1
2005	518	33.8	51.9	14.3	2005	1938	17.2	49.4	33.4
2006	480	29.4	59.1	11.5	2006	999	17.2	43.8	39.0
ALL REGIONS	Number of trees	0-10%	>10-25%	>25%					
1990	6485	30.7	38.0	31.3					
1991	6634	27.8	39.8	32.4					
1992	6660	24.9	41.9	33.2					
1993	6584	25.4	39.2	35.4					
1994	6553	23.0	38.8	38.2					
1995	6700	27.1	37.2	35.7					
1996	6707	30.9	39.0	30.1					
1997	6615	27.2	40.9	31.9					
1998	7887	29.4	40.5	30.1					
1999	7855	29.8	41.0	29.2					
2000	7780	25.3	44.0	30.7					
2001	7505	24.4	45.5	30.1					
2002	7524	22.7	45.7	31.6					
2003	7569	21.7	47.7	30.6					
2004	7485	19.2	42.8	38.0					
2005	7377	22.0	45.6	32.4					
2006	4346	29.3	41.7	29.0					

Pinus sylvestris

ATLANTIC (NORTH)	Number of trees	0-10%	>10-25%	>25%	MEDITERR. (HIGHER)	Number of trees	0-10%	>10-25%	>25%
1990	588	50.2	41.8	8.0	1990	541	85.9	12.8	1.3
1991	591	51.3	37.2	11.5	1991	541	72.8	21.3	5.9
1992	581	55.1	32.7	12.2	1992	564	67.4	23.0	9.6
1993	592	50.0	39.4	10.6	1993	564	56.6	26.6	16.8
1994	591	45.7	42.5	11.8	1994	540	51.5	31.3	17.2
1995	576	44.3	45.8	9.9	1995	549	45.2	39.9	14.9
1996	577	38.1	51.0	10.9	1996	541	47.4	43.4	9.2
1997	573	47.5	46.2	6.3	1997	540	45.0	44.3	10.7
1998	573	54.1	39.4	6.5	1998	540	44.4	48.2	7.4
1999	647	46.4	43.7	9.9	1999	603	50.6	44.3	5.1
2000	643	44.0	45.6	10.4	2000	602	55.5	40.2	4.3
2001	648	42.4	48.5	9.1	2001	604	53.3	40.1	6.6
2002	648	46.5	43.8	9.7	2002	603	48.0	41.6	10.4
2003	647	48.8	41.6	9.6	2003	601	44.1	46.9	9.0
2004	639	55.5	38.2	6.3	2004	601	41.6	49.6	8.8
2005	519	63.4	33.5	3.1	2005	599	36.9	54.8	8.3
2006	518	63.3	31.5	5.2	2006	600	33.0	55.2	11.8
MOUNTAIN-OUS (SOUTH)	Number of trees	0-10%	>10-25%	>25%	BOREAL (TEMP.)	Number of trees	0-10%	>10-25%	>25%
1990	739	66.9	21.2	11.9	1990	960	10.4	34.4	55.2
1991	742	51.1	32.3	16.6	1991	1154	4.9	32.8	62.3
1992	758	39.4	40.7	19.9	1992	1130	3.1	26.3	70.6
1993	743	36.9	41.2	21.9	1993	1156	4.0	34.2	61.8
1994	731	29.5	40.7	29.8	1994	1099	9.9	43.8	46.3
1995	747	31.7	54.9	13.4	1995	1079	15.9	56.6	27.5
1996	754	35.5	49.5	15.0	1996	1117	20.0	57.8	22.2
1997	763	34.3	55.7	10.0	1997	1096	18.0	61.7	20.3
1998	829	39.6	50.0	10.4	1998	1115	19.5	60.7	19.8
1999	918	48.4	41.7	9.9	1999	1134	14.2	67.0	18.8
2000	904	35.6	51.7	12.7	2000	1068	15.0	67.8	17.2
2001	895	37.5	49.5	13.0	2001	1121	12.3	74.9	12.8
2002	896	26.2	54.7	19.1	2002	1133	15.5	72.0	12.5
2003	896	23.1	59.0	17.9	2003	1131	19.6	71.0	9.4
2004	899	20.7	61.7	17.6	2004	1134	17.5	72.7	9.8
2005	895	22.0	60.1	17.9	2005	1123	12.3	74.8	12.9
2006	673	29.3	55.7	15.0	2006	1133	8.3	73.8	17.9
SUB-ATLANTIC	Number of trees	0-10%	>10-25%	>25%	CONTINENTAL	Number of trees	0-10%	>10-25%	>25%
1990	8491	13.5	46.2	40.3	1990	149	46.3	18.1	35.6
1991	8534	8.2	45.8	46.0	1991	157	56.0	25.5	18.5
1992	8538	8.6	43.9	47.5	1992	158	62.6	20.3	17.1
1993	8549	8.9	44.6	46.5	1993	162	63.0	16.0	21.0
1994	8011	5.4	41.5	53.1	1994	162	59.9	17.3	22.8
1995	7838	7.5	42.1	50.4	1995	166	69.3	12.0	18.7
1996	7838	12.4	51.7	35.9	1996	168	66.7	14.3	19.0
1997	7815	12.1	54.8	33.1	1997	168	64.9	14.9	20.2
1998	8210	12.9	56.8	30.3	1998	181	62.4	21.0	16.6
1999	8205	12.5	61.0	26.5	1999	180	68.4	17.2	14.4
2000	8216	10.5	61.9	27.6	2000	170	65.9	14.7	19.4
2001	8195	10.4	62.4	27.2	2001	170	68.8	15.9	15.3
2002	8059	9.1	63.2	27.7	2002	170	61.2	18.2	20.6
2003	8103	8.5	63.4	28.1	2003	169	53.3	26.0	20.7
2004	8139	8.1	61.9	30.0	2004	168	57.8	20.2	22.0
2005	8100	12.1	57.5	30.4	2005	166	56.6	18.1	25.3
2006	5141	20.8	56.3	22.9	2006	160	68.7	17.5	13.8

Pinus sylvestris

ALL REGIONS	Number of trees	0-10%	>10-25%	>25%
1990	11630	23.1	41.1	35.8
1991	11877	17.2	41.5	41.3
1992	11887	16.6	40.0	43.4
1993	11924	15.9	41.6	42.5
1994	11292	13.2	40.6	46.2
1995	11113	15.3	44.0	40.7
1996	11154	19.1	51.0	29.9
1997	11115	19.2	53.6	27.2
1998	11608	20.4	54.6	25.0
1999	11847	20.6	57.3	22.1
2000	11764	18.3	58.7	23.0
2001	11794	17.9	59.8	22.3
2002	11670	16.4	60.3	23.3
2003	11708	15.9	60.9	23.2
2004	11741	15.5	60.2	24.3
2005	11564	17.5	57.4	25.1
2006	8387	24.5	56.3	19.2

Fagus sylvatica

ATLANTIC (NORTH)	Number of trees	0-10%	>10-25%	>25%	ATLANTIC (SOUTH)	Number of trees	0-10%	>10-25%	>25%
1990	420	18.8	45.0	36.2	1990	123	65.9	21.1	13.0
1991	420	28.3	47.2	24.5	1991	95	57.9	28.4	13.7
1992	420	25.0	46.2	28.8	1992	119	59.7	31.1	9.2
1993	420	25.5	45.2	29.3	1993	119	62.2	31.1	6.7
1994	425	28.2	44.3	27.5	1994	80	33.8	54.9	11.3
1995	423	14.4	43.8	41.8	1995	120	59.2	35.0	5.8
1996	404	19.8	47.5	32.7	1996	96	33.3	52.1	14.6
1997	420	24.5	43.8	31.7	1997	120	29.2	54.1	16.7
1998	420	27.1	42.4	30.5	1998	120	27.5	60.8	11.7
1999	431	22.0	47.8	30.2	1999	121	35.5	55.4	9.1
2000	436	15.8	41.1	43.1	2000	126	42.9	47.6	9.5
2001	461	29.7	41.9	28.4	2001	127	48.8	46.5	4.7
2002	459	26.1	43.4	30.5	2002	128	28.9	57.8	13.3
2003	463	28.3	42.5	29.2	2003	128	27.3	60.2	12.5
2004	472	23.1	31.1	45.8	2004	128	15.6	71.1	13.3
2005	494	31.2	36.6	32.2	2005	130	16.2	69.2	14.6
2006	488	30.1	37.1	32.8	2006	130	13.8	67.7	18.5
SUB-ATLANTIC	Number of trees	0-10%	>10-25%	>25%	MOUNTAIN-OUS (SOUTH)	Number of trees	0-10%	>10-25%	>25%
1990	2372	31.2	46.2	22.6	1990	976	48.3	41.7	10.0
1991	2430	33.6	44.3	22.1	1991	994	59.0	33.8	7.2
1992	2447	20.4	48.4	31.2	1992	1001	52.2	31.9	15.9
1993	2425	23.8	47.1	29.1	1993	1014	52.2	32.9	14.9
1994	2386	16.2	49.8	34.0	1994	950	48.0	36.7	15.3
1995	2421	18.0	46.1	35.9	1995	1010	40.4	42.7	16.9
1996	2435	21.4	51.2	27.4	1996	1004	35.4	48.5	16.1
1997	2477	22.5	54.2	23.3	1997	1011	30.7	49.9	19.4
1998	2685	23.5	51.5	25.0	1998	1053	45.4	44.5	10.1
1999	2719	17.8	56.3	25.9	1999	1158	34.4	52.3	13.3
2000	2732	23.6	50.6	25.8	2000	1204	43.1	45.9	11.0
2001	2722	20.6	48.4	31.0	2001	1193	29.0	54.7	16.3
2002	2725	24.9	52.0	23.1	2002	1200	31.8	56.4	11.8
2003	2743	23.8	51.4	24.8	2003	1202	17.8	49.7	32.5
2004	2757	14.6	50.5	34.9	2004	1195	25.2	49.4	25.4
2005	2698	15.0	55.7	29.3	2005	1188	34.9	45.2	19.9
2006	1987	22.6	51.3	26.1	2006	1034	33.4	44.0	22.6

Fagus sylvatica

ALL REGIONS	Number of trees	0-10%	>10-25%	>25%
1990	37.0	43.0	20.0	37.0
1991	40.9	41.2	17.9	40.9
1992	31.4	42.8	25.8	31.4
1993	33.6	42.0	24.4	33.6
1994	27.0	45.4	27.6	27.0
1995	25.9	44.0	30.1	25.9
1996	26.2	49.9	23.9	26.2
1997	25.8	51.6	22.6	25.8
1998	30.2	48.7	21.1	30.2
1999	24.1	53.9	22.0	24.1
2000	29.6	47.9	22.5	29.6
2001	25.0	49.2	25.8	25.0
2002	27.6	52.2	20.2	27.6
2003	23.9	50.0	26.1	23.9
2004	19.4	48.5	32.1	19.4
2005	22.7	51.0	26.3	22.7
2006	27.0	47.7	25.3	27.0

Quercus ilex and *Q. rotundifolia*

MEDITERR. (HIGHER)	Number of trees	0-10%	>10-25%	>25%	MEDITERR. (LOWER)	Number of trees	0-10%	>10-25%	>25%
1990	652	80.4	18.7	0.9	1990	2326	65.0	21.5	13.5
1991	652	56.1	40.8	3.1	1991	2308	47.2	36.3	16.5
1992	653	42.0	49.1	8.9	1992	2323	38.2	45.7	16.1
1993	653	31.2	60.4	8.4	1993	2298	36.4	56.9	6.7
1994	653	25.4	56.1	18.5	1994	2294	31.4	57.4	11.2
1995	671	17.1	50.7	32.2	1995	2277	16.6	56.4	27.0
1996	665	21.1	53.5	25.4	1996	2278	20.5	54.7	24.8
1997	665	25.6	58.5	15.9	1997	2278	29.0	56.2	14.8
1998	657	35.0	51.6	13.4	1998	2278	31.9	54.4	13.7
1999	770	26.6	56.5	16.9	1999	2896	21.8	56.2	22.0
2000	764	27.0	56.2	16.8	2000	2914	17.6	60.8	21.6
2001	765	24.7	62.8	12.5	2001	2914	19.4	65.2	15.4
2002	765	17.3	64.4	18.3	2002	2918	17.6	64.4	18.0
2003	766	20.2	60.7	19.1	2003	2919	14.1	66.1	19.8
2004	766	20.9	61.3	17.8	2004	2916	20.3	64.4	15.3
2005	770	9.5	57.0	33.5	2005	2888	8.8	69.1	22.1
2006	770	10.0	60.1	29.9	2006	2893	9.1	66.3	24.6

ALL REGIONS	Number of trees	0-10%	>10-25%	>25%
1990	3074	67.8	20.9	11.3
1991	3064	49.4	37.2	13.4
1992	3080	38.6	46.6	14.8
1993	3055	35.1	57.8	7.1
1994	3027	29.3	57.4	13.3
1995	3052	16.3	55.6	28.1
1996	3034	20.6	55.1	24.3
1997	3034	28.3	56.9	14.8
1998	3026	32.8	53.8	13.4
1999	3820	23.4	56.4	20.2
2000	3852	20.2	59.8	20.0
2001	3853	20.4	64.5	15.1
2002	3857	17.4	63.8	18.8
2003	3859	15.6	64.4	20.0
2004	3855	20.2	63.7	16.1
2005	3832	8.9	66.5	24.6
2006	3838	9.1	64.7	26.2

Pinus pinaster

ATLANTIC (SOUTH)	Number of trees	0-10%	>10-25%	>25%	MEDITERR. (HIGHER)	Number of trees	0-10%	>10-25%	>25%
1990	438	47.3	18.5	34.2	1990	421	78.4	14.0	7.6
1991	432	41.0	28.7	30.3	1991	380	75.0	14.7	10.3
1992	453	56.5	27.4	16.1	1992	370	84.1	13.5	2.4
1993	422	59.5	32.2	8.3	1993	370	75.9	21.4	2.7
1994	423	60.3	31.0	8.7	1994	432	72.9	17.8	9.3
1995	420	57.1	36.2	6.7	1995	432	69.3	27.5	3.2
1996	420	54.5	34.3	11.2	1996	432	69.2	22.9	7.9
1997	410	60.3	32.9	6.8	1997	427	72.6	20.1	7.3
1998	410	52.7	39.3	8.0	1998	432	69.6	26.2	4.2
1999	598	52.9	43.1	4.0	1999	511	61.2	28.8	10.0
2000	600	49.0	40.2	10.8	2000	482	61.2	29.0	9.8
2001	592	41.7	53.2	5.1	2001	481	62.4	34.7	2.9
2002	593	41.3	48.8	9.9	2002	482	54.2	42.5	3.3
2003	565	37.0	57.0	6.0	2003	482	50.6	44.0	5.4
2004	563	32.9	52.9	14.2	2004	472	55.3	37.3	7.4
2005	504	35.3	54.8	9.9	2005	473	42.9	48.4	8.7
2006	499	38.3	52.1	9.6	2006	435	36.8	45.3	17.9
MEDITERR. (LOWER)	Number of trees	0-10%	>10-25%	>25%	ALL REGIONS	Number of trees	0-10%	>10-25%	>25%
1990	1680	71.5	18.6	9.9	1990	2588	68.9	17.6	13.5
1991	1665	62.7	26.8	10.5	1991	2526	61.4	25.0	13.6
1992	1667	64.9	25.0	10.1	1992	2539	66.6	23.5	9.9
1993	1560	67.6	23.6	8.8	1993	2401	67.7	24.6	7.7
1994	1617	66.5	27.1	6.4	1994	2521	66.5	26.3	7.2
1995	1459	60.0	31.5	8.5	1995	2360	61.4	31.5	7.1
1996	1429	57.8	33.9	8.3	1996	2330	59.8	31.5	8.7
1997	1413	43.1	46.5	10.4	1997	2313	52.7	38.3	9.0
1998	1407	43.7	46.3	10.0	1998	2312	50.9	40.5	8.6
1999	1641	42.5	47.9	9.6	1999	2866	49.9	42.0	8.1
2000	1641	46.4	45.6	8.0	2000	2839	51.0	40.4	8.6
2001	1633	47.6	46.3	6.1	2001	2822	50.2	44.7	5.1
2002	1629	48.1	45.9	6.0	2002	2820	48.4	45.4	6.2
2003	1439	45.5	44.8	9.7	2003	2602	44.9	47.3	7.8
2004	1404	43.3	42.1	14.6	2004	2556	43.8	43.8	12.5
2005	1281	36.2	44.0	19.8	2005	2375	38.4	46.9	14.7
2006	1208	35.3	52.9	11.8	2006	2260	37.3	50.3	12.4

Quercus suber

MEDITERR. (LOWER)	Number of trees	0-10%	>10-25%	>25%	ALL REGIONS	Number of trees	0-10%	>10-25%	>25%
1990	1402	39.1	19.2	41.7	1990	1441	38.9	18.9	42.2
1991	1381	26.5	29.7	43.8	1991	1418	26.7	29.3	44.0
1992	1449	29.6	37.7	32.7	1992	1487	29.6	37.2	33.2
1993	1401	46.1	44.5	9.4	1993	1438	47.6	43.3	9.1
1994	1397	39.2	47.0	13.8	1994	1434	40.7	45.8	13.5
1995	1398	19.4	54.3	26.3	1995	1435	21.3	53.1	25.6
1996	1400	32.9	52.1	15.0	1996	1437	33.9	51.5	14.6
1997	1403	34.3	53.2	12.5	1997	1440	35.8	52.0	12.2
1998	1403	26.8	58.2	15.0	1998	1440	28.1	57.2	14.7
1999	1511	23.4	56.9	19.7	1999	1548	24.5	56.3	19.2
2000	1533	21.2	62.0	16.8	2000	1570	22.4	61.2	16.4
2001	1534	22.0	59.6	18.4	2001	1571	22.5	59.4	18.1
2002	1557	22.1	60.4	17.5	2002	1594	22.5	60.2	17.3
2003	1541	19.4	54.4	26.2	2003	1578	19.8	54.5	25.7
2004	1557	20.9	52.4	26.7	2004	1594	21.6	52.2	26.2
2005	1501	3.9	60.0	36.1	2005	1535	4.2	60.3	35.5
2006	1496	11.0	44.2	44.8	2006	1532	12.6	43.5	43.9

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

ATLANTIC (NORTH)	Number of trees	0-10%	>10-25%	>25%	ATLANTIC (SOUTH)	Number of trees	0-10%	>10-25%	>25%
1990	322	57.2	30.4	12.4	1990	279	64.5	8.6	26.9
1991	323	39.9	43.7	16.4	1991	267	53.5	13.5	33.0
1992	323	25.1	56.3	18.6	1992	247	47.8	27.5	24.7
1993	326	25.2	41.4	33.4	1993	248	51.2	35.1	13.7
1994	316	35.8	33.2	31.0	1994	197	55.3	33.5	11.2
1995	331	37.2	41.0	21.8	1995	239	40.2	48.1	11.7
1996	328	15.9	39.0	45.1	1996	237	32.9	49.4	17.7
1997	335	17.9	43.0	39.1	1997	238	34.5	52.1	13.4
1998	335	25.7	47.7	26.6	1998	240	33.8	44.5	21.7
1999	335	23.6	39.4	37.0	1999	280	35.4	53.5	11.1
2000	337	27.3	47.2	25.5	2000	278	30.6	57.9	11.5
2001	341	20.8	52.8	26.4	2001	281	20.3	60.8	18.9
2002	342	24.9	46.4	28.7	2002	282	20.6	62.7	16.7
2003	338	15.1	51.5	33.4	2003	298	22.1	62.5	15.4
2004	340	12.9	47.1	40.0	2004	299	20.4	58.9	20.7
2005	309	20.1	45.3	34.6	2005	302	21.9	60.9	17.2
2006	307	18.6	51.1	30.3	2006	314	29.3	55.7	15.0

SUB-ATLANTIC	Number of trees	0-10%	>10-25%	>25%	MOUNTAIN-OUS (SOUTH)	Number of trees	0-10%	>10-25%	>25%
1990	1634	27.3	49.2	23.5	1990	205	12.2	23.4	64.4
1991	1635	17.0	48.6	34.4	1991	212	26.9	39.6	33.5
1992	1624	13.1	49.1	37.8	1992	212	14.6	58.5	26.9
1993	1624	10.2	43.6	46.2	1993	214	18.7	34.1	47.2
1994	1630	6.9	37.3	55.8	1994	197	11.2	55.8	33.0
1995	1631	8.5	38.6	52.9	1995	210	21.0	45.2	33.8
1996	1608	10.6	43.0	46.4	1996	209	12.9	30.6	56.5
1997	1627	11.2	45.4	43.4	1997	209	17.2	26.8	56.0
1998	1693	12.2	42.4	45.4	1998	238	19.3	35.3	45.4
1999	1723	13.8	52.1	34.1	1999	243	18.5	39.5	42.0
2000	1725	12.3	52.7	35.0	2000	241	18.3	44.8	36.9
2001	1729	12.1	52.7	35.2	2001	244	18.4	45.1	36.5
2002	1735	15.4	52.0	32.6	2002	246	13.8	46.8	39.4
2003	1737	9.4	53.8	36.8	2003	247	15.4	45.3	39.3
2004	1744	10.7	47.3	42.0	2004	267	19.1	39.7	41.2
2005	1736	9.5	47.6	42.9	2005	266	21.4	30.8	47.8
2006	1194	15.9	54.0	30.1	2006	210	29.5	33.8	36.7

CONTINENTAL	Number of trees	0-10%	>10-25%	>25%	ALL REGIONS	Number of trees	0-10%	>10-25%	>25%
1990	166	47.6	25.3	27.1	1990	2649	35.8	38.5	25.7
1991	178	35.9	29.8	34.3	1991	2655	26.5	42.0	31.5
1992	177	42.4	27.1	30.5	1992	2624	20.8	46.8	32.4
1993	177	28.2	32.8	39.0	1993	2630	18.5	40.9	40.6
1994	185	30.3	19.5	50.2	1994	2564	16.9	36.6	46.5
1995	185	33.0	27.0	40.0	1995	2648	18.3	39.7	42.0
1996	190	36.8	27.4	35.8	1996	2624	15.9	41.0	43.1
1997	191	38.2	24.1	37.7	1997	2656	17.2	42.9	39.9
1998	207	37.1	30.0	32.9	1998	2769	18.6	42.0	39.4
1999	207	47.8	25.1	27.1	1999	2844	20.4	47.9	31.7
2000	208	47.1	22.6	30.3	2000	2873	20.1	49.4	30.5
2001	205	52.7	23.9	23.4	2001	2884	18.2	51.0	30.8
2002	205	46.4	26.8	26.8	2002	2894	19.5	50.4	30.1
2003	204	40.7	26.5	32.8	2003	2907	14.1	52.4	33.5
2004	264	43.6	26.1	30.3	2004	2998	16.0	46.3	37.7
2005	264	50.4	22.7	26.9	2005	2965	17.1	45.5	37.4
2006	262	65.3	14.1	20.6	2006	2382	25.2	47.4	27.4

Abies alba

SUB-ATLANTIC	Number of trees	0-10%	>10-25%	>25%
1990	385	11.2	27.5	61.3
1991	385	10.1	23.9	66.0
1992	386	9.8	23.1	67.1
1993	382	8.1	26.7	65.2
1994	385	7.8	22.9	69.3
1995	402	8.0	30.8	61.2
1996	401	9.7	35.4	54.9
1997	392	11.5	35.7	52.8
1998	432	11.6	34.5	53.9
1999	429	10.5	37.5	52.0
2000	430	9.3	36.0	54.7
2001	419	10.3	29.6	60.1
2002	459	15.9	32.2	51.9
2003	459	13.7	38.3	48.0
2004	459	14.2	37.9	47.9
2005	458	19.0	42.8	38.2
2006	362	32.3	42.6	25.1

MOUNTAIN-OUS (SOUTH)	Number of trees	0-10%	>10-25%	>25%
1990	335	21.5	30.1	48.4
1991	348	22.7	34.2	43.1
1992	347	14.7	43.5	41.8
1993	347	11.2	30.8	58.0
1994	343	15.5	39.7	44.8
1995	359	14.8	37.6	47.6
1996	366	13.7	32.8	53.5
1997	360	10.3	40.8	48.9
1998	342	16.4	38.9	44.7
1999	347	13.8	42.1	44.1
2000	383	17.5	43.1	39.4
2001	374	16.0	46.3	37.7
2002	425	13.4	49.7	36.9
2003	439	10.0	44.6	45.4
2004	440	11.1	47.1	41.8
2005	449	16.0	51.9	32.1
2006	397	18.1	40.6	41.3

ALL REGIONS	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	817	13.1	39.4	47.5
2001	793	13.0	37.5	49.5
2002	884	14.7	40.6	44.7
2003	898	11.9	41.4	46.7
2004	903	12.6	42.5	44.9
2005	911	17.7	47.2	35.1
2006	763	24.8	41.4	33.8

Picea sitchensis

ATLANTIC (NORTH)	Number of trees	0-10%	>10-25%	>25%
1990	311	61.1	29.3	9.6
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

ALL REGIONS	Number of trees	0-10%	>10-25%	>25%
1990	311	61.1	29.3	9.6
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

All species

ATLANTIC (NORTH)	Number of trees	0-10%	>10-25%	>25%	ATLANTIC (SOUTH)	Number of trees	0-10%	>10-25%	>25%
1990	2729	47.8	34.3	17.9	1990	1668	66.6	14.0	19.4
1991	2729	44.8	34.8	20.4	1991	1555	56.6	21.7	21.7
1992	2718	41.4	37.8	20.8	1992	1799	64.3	23.2	12.5
1993	2710	38.8	35.6	25.6	1993	1782	61.3	27.3	11.4
1994	2693	38.5	36.8	24.7	1994	1608	59.2	28.7	12.1
1995	2642	36.2	37.6	26.2	1995	1704	58.8	33.0	8.2
1996	2624	37.0	39.9	23.1	1996	1560	51.4	37.9	10.7
1997	2605	42.0	38.0	20.0	1997	1680	56.1	35.2	8.7
1998	2628	45.8	36.2	18.0	1998	1704	49.3	38.3	12.4
1999	2754	45.9	35.4	18.7	1999	2376	55.2	37.1	7.7
2000	2726	43.6	36.2	20.2	2000	2376	48.6	37.2	14.2
2001	2765	45.7	36.4	17.9	2001	2376	42.8	48.5	8.7
2002	2746	43.6	37.9	18.5	2002	2376	36.6	50.1	13.3
2003	2724	43.7	37.2	19.1	2003	2376	34.8	51.9	13.3
2004	2746	43.4	33.9	22.7	2004	2376	35.6	48.9	15.5
2005	2536	48.0	34.2	17.8	2005	2316	31.8	51.5	16.7
2006	2596	50.9	32.3	16.8	2006	2346	33.7	48.4	17.9
SUB-ATLANTIC	Number of trees	0-10%	>10-25%	>25%	MEDITERR. (HIGHER)	Number of trees	0-10%	>10-25%	>25%
1990	18600	21.3	43.3	35.4	1990	3636	78.4	16.9	4.7
1991	18638	17.8	43.2	39.0	1991	3586	60.3	30.8	8.9
1992	18707	15.2	43.0	41.8	1992	3600	50.9	36.0	13.1
1993	18654	15.6	42.1	42.3	1993	3600	46.8	40.8	12.4
1994	18016	11.6	40.5	47.9	1994	3612	43.0	39.6	17.4
1995	18056	14.8	39.6	45.6	1995	3684	34.0	44.9	21.1
1996	18005	19.0	46.1	34.9	1996	3660	36.1	46.1	17.8
1997	18052	18.3	49.2	32.5	1997	3636	40.2	46.3	13.5
1998	19727	19.5	48.8	31.7	1998	3636	42.9	45.9	11.2
1999	19765	18.6	52.6	28.8	1999	4356	40.0	48.3	11.7
2000	19847	17.8	52.6	29.6	2000	4326	39.2	49.7	11.1
2001	19547	17.1	52.5	30.4	2001	4326	33.6	53.1	13.3
2002	19570	16.9	53.2	29.9	2002	4326	30.4	53.7	15.9
2003	19577	15.6	54.0	30.4	2003	4326	28.7	56.6	14.7
2004	19591	13.0	51.9	35.1	2004	4326	28.5	56.6	14.9
2005	19380	15.1	52.4	32.5	2005	4326	20.6	57.6	21.8
2006	13913	24.5	50.4	25.1	2006	4296	20.7	55.9	23.4
MEDITERR. (LOWER)	Number of trees	0-10%	>10-25%	>25%	MOUNTAIN-OUS (SOUTH)	Number of trees	0-10%	>10-25%	>25%
1990	8715	67.4	18.5	14.1	1990	5271	45.5	31.8	22.7
1991	8634	57.5	26.5	16.0	1991	5336	42.3	35.7	22.0
1992	8853	50.8	32.7	16.5	1992	5347	32.4	40.7	26.9
1993	8622	51.6	38.6	9.8	1993	5320	31.6	40.6	27.8
1994	8578	46.8	39.4	13.8	1994	5232	28.0	42.2	29.8
1995	8394	32.6	46.2	21.2	1995	5506	27.2	47.0	25.8
1996	8424	36.3	47.1	16.6	1996	5498	29.2	45.4	25.4
1997	8435	37.0	50.9	12.1	1997	5458	28.9	46.1	25.0
1998	8454	38.1	48.9	13.0	1998	6074	35.2	42.5	22.3
1999	10038	33.7	51.5	14.8	1999	6633	36.7	43.8	19.5
2000	10188	31.5	54.1	14.4	2000	6763	33.3	47.0	19.7
2001	10218	30.5	56.6	12.9	2001	6647	28.2	50.6	21.2
2002	10248	28.5	57.2	14.3	2002	6745	24.3	53.4	22.3
2003	9978	25.7	57.4	16.9	2003	6794	19.8	53.7	26.5
2004	9888	27.9	56.6	15.5	2004	6734	19.9	51.3	28.8
2005	9527	15.3	59.9	24.8	2005	6736	25.1	50.4	24.5
2006	9497	17.3	57.0	25.7	2006	5208	26.8	47.7	25.5

All species

BOREAL (TEMP.)	Number of trees	0-10%	>10-25%	>25%	CONTINENTAL		0-10%	>10-25%	>25%	0-10%
1990	1920	28.9	34.1	37.0	1990		1133	60.9	19.2	19.9
1991	2424	22.6	37.7	39.7	1991		1151	64.0	19.1	16.9
1992	2396	18.7	37.5	43.8	1992		1151	62.3	18.2	19.5
1993	2420	20.1	41.9	38.0	1993		1162	56.9	18.5	24.6
1994	2257	27.1	43.7	29.2	1994		1140	53.9	17.9	28.2
1995	2262	34.4	46.2	19.4	1995		1160	61.5	15.9	22.6
1996	2368	31.8	50.1	18.1	1996		1117	65.3	15.0	19.7
1997	2297	30.0	53.5	16.5	1997		1073	66.9	14.9	18.2
1998	2326	30.4	53.6	16.0	1998		1155	66.5	16.0	17.5
1999	2348	25.2	57.9	16.9	1999		1230	71.9	13.7	14.4
2000	2256	18.8	61.1	20.1	2000		1230	67.7	13.6	18.7
2001	2325	18.0	65.9	16.1	2001		1211	64.1	18.9	17.0
2002	2340	19.7	66.7	13.6	2002		1182	63.5	17.3	19.2
2003	2293	21.4	65.9	12.7	2003		1182	58.0	18.3	23.7
2004	2290	21.3	65.8	12.9	2004		1422	62.1	16.5	21.4
2005	2263	21.5	65.2	13.3	2005		1375	66.0	15.4	18.6
2006	2242	18.9	66.6	14.5	2006		1386	73.6	11.9	14.5

ALL REGIONS	Number of trees	0-10%	>10-25%	>25%
1990	43672	42.9	32.1	25.0
1991	44053	36.5	35.8	27.7
1992	44571	32.2	38.1	29.7
1993	44270	31.6	39.5	28.9
1994	43136	28.6	39.3	32.1
1995	43408	26.7	41.6	31.7
1996	43256	29.3	44.9	25.8
1997	43236	29.8	47.1	23.1
1998	45704	31.2	46.1	22.7
1999	49500	30.9	48.4	20.7
2000	49712	28.7	49.7	21.6
2001	49415	26.8	51.9	21.3
2002	49533	25.2	52.8	22.0
2003	49250	23.1	53.6	23.3
2004	49373	22.9	51.6	25.5
2005	48459	21.3	52.6	26.1
2006	41484	26.3	50.5	23.2

Annex I-9
Development of defoliation of most common species (1997-2006).

Picea abies

ATLANTIC (NORTH)	Number of trees	0-10%	>10-25%	>25%
1997	1387	64.3	24.4	11.3
1998	1411	57.8	30.9	11.3
1999	1411	56.3	31.3	12.4
2000	1393	56.6	28.0	15.4
2001	1270	61.4	26.9	11.7
2002	1258	60.0	25.7	14.3
2003	1234	56.6	27.7	15.7
2004	1216	53.9	29.6	16.5
2005	1171	54.4	26.0	19.6
2006	1147	52.4	29.6	18.0

SUB-ATLANTIC	Number of trees	0-10%	>10-25%	>25%
1997	9056	20.8	33.3	45.9
1998	7265	29.8	35.1	35.1
1999	7567	30.8	34.2	35.0
2000	7560	28.9	36.2	34.9
2001	7553	27.3	37.2	35.5
2002	7585	27.3	35.3	37.4
2003	7571	26.3	37.8	35.9
2004	7658	23.7	35.0	41.3
2005	7579	24.6	38.0	37.4
2006	6131	31.3	33.7	35.0

MEDITERR. (HIGHER)	Number of trees	0-10%	>10-25%	>25%
1997	115	36.5	41.8	21.7
1998	115	21.7	41.8	36.5
1999	127	26.0	41.7	32.3
2000	127	27.6	46.4	26.0
2001	115	33.0	40.0	27.0
2002	102	37.3	42.1	20.6
2003	115	46.1	32.2	21.7
2004	115	49.6	33.9	16.5
2005	122	54.1	27.9	18.0
2006	122	51.6	29.5	18.9

MEDITERR. (LOWER)	Number of trees	0-10%	>10-25%	>25%
1997	79	67.1	21.5	11.4
1998	73	31.5	48.0	20.5
1999	82	47.5	35.4	17.1
2000	80	61.2	30.0	8.8
2001	81	63.0	25.9	11.1
2002	109	44.1	33.9	22.0
2004	109	33.9	40.4	25.7
2004	109	31.2	36.7	32.1
2005	109	27.5	43.1	29.4
2006	109	26.6	45.0	28.4

MOUNTAIN-OUS (NORTH)	Number of trees	0-10%	>10-25%	>25%
1997	864	47.3	20.4	32.3
1998	854	48.2	19.9	31.9
1999	847	49.8	23.3	26.9
2000	847	48.1	28.6	23.3
2001	1002	55.8	20.4	23.8
2002	1010	50.0	24.9	25.1
2003	1030	55.0	20.9	24.1
2004	1058	60.8	21.6	17.6
2005	1133	59.1	21.0	19.9
2006	1137	58.9	22.7	18.4

MOUNTAIN-OUS (SOUTH)	Number of trees	0-10%	>10-25%	>25%
1997	5795	53.9	29.2	16.9
1998	5816	53.2	28.4	18.4
1999	5988	54.8	28.2	17.0
2000	6233	53.5	28.8	17.7
2001	6176	50.6	31.4	18.0
2002	6169	49.7	31.6	18.7
2003	6120	46.6	35.6	17.8
2004	6132	43.5	34.1	22.4
2005	5783	43.9	35.2	20.9
2006	5224	51.6	28.1	20.3

BOREAL	Number of trees	0-10%	>10-25%	>25%
1997	6074	43.5	31.1	25.4
1998	6129	41.9	33.5	24.6
1999	6100	41.4	32.6	26.0
2000	6016	39.2	36.2	24.6
2001	5975	36.6	35.3	28.1
2002	5914	38.9	35.3	25.8
2003	5884	37.4	34.9	27.7
2004	6423	39.3	35.7	25.0
2005	6440	39.9	36.0	24.1
2006	6408	38.7	36.4	24.9

BOREAL (TEMPERATE)	Number of trees	0-10%	>10-25%	>25%
1997	3798	47.5	38.6	13.9
1998	3781	50.4	35.9	13.7
1999	3765	43.7	38.1	18.2
2000	3778	50.3	35.6	14.1
2001	3809	45.4	39.8	14.8
2002	3819	50.9	36.0	13.1
2003	3799	46.3	38.7	15.0
2004	3791	42.1	38.1	19.8
2005	3802	44.2	34.5	21.3
2006	3754	44.0	37.0	19.0

CONTINENTAL	Number of trees	0-10%	>10-25%	>25%
1997	556	34.7	30.9	34.4
1998	508	35.1	30.1	34.8
1999	500	37.8	30.6	31.6
2000	460	31.7	35.0	33.3
2001	459	43.8	29.0	27.2
2002	453	38.7	32.2	29.1
2003	446	34.8	33.6	31.6
2004	398	37.5	36.9	25.6
2005	432	48.6	30.3	21.1
2006	432	53.9	31.3	14.8

ALL REGIONS	Number of trees	0-10%	>10-25%	>25%
1997	27772	40.0	31.7	28.3
1998	26001	43.2	32.5	24.3
1999	26436	42.8	32.4	24.8
2000	26543	42.4	33.7	23.9
2001	26489	40.6	34.5	24.9
2002	26468	41.4	33.6	25.0
2003	26357	39.3	35.5	25.2
2004	26949	37.7	34.7	27.6
2005	26619	38.8	34.9	26.3
2006	24494	42.3	33.0	24.7

Pinus sylvestris

ATLANTIC (NORTH)	Number of trees	0-10%	>10-25%	>25%
1997	1181	50.5	39.5	10.0
1998	1251	47.6	42.4	10.0
1999	1321	45.7	41.2	13.1
2000	1369	44.3	41.6	14.1
2001	1372	37.7	47.9	14.4
2002	1372	43.3	40.7	16.0
2003	1392	43.0	42.5	14.5
2004	1392	44.9	40.2	14.9
2005	1310	48.1	39.2	12.7
2006	1286	50.7	38.6	10.7

ATLANTIC (SOUTH)	Number of trees	0-10%	>10-25%	>25%
1997	212	59.0	25.0	16.0
1998	212	53.8	34.9	11.3
1999	212	47.2	39.6	13.2
2000	212	58.9	32.1	9.0
2001	212	52.3	35.4	12.3
2002	212	42.0	44.3	13.7
2003	211	47.9	36.0	16.1
2004	211	49.3	37.4	13.3
2005	211	57.8	27.0	15.2
2006	210	50.0	39.0	11.0

SUB-ATLANTIC	Number of trees	0-10%	>10-25%	>25%
1997	10829	19.7	48.4	31.9
1998	10717	20.0	52.7	27.3
1999	10785	20.0	54.5	25.5
2000	10772	18.3	55.4	26.3
2001	10799	17.6	57.0	25.4
2002	10663	16.0	57.0	27.0
2003	10707	14.1	58.7	27.2
2004	10732	13.9	56.3	29.8
2005	10696	16.7	52.7	30.6
2006	8061	22.0	51.7	26.3

MEDITERR. (HIHGER)	Number of trees	0-10%	>10-25%	>25%
1997	781	40.1	44.5	15.4
1998	781	40.7	46.1	13.2
1999	872	45.0	44.6	10.4
2000	872	46.9	43.2	9.9
2001	872	47.1	39.7	13.2
2002	872	42.8	41.7	15.5
2003	872	37.3	47.3	15.4
2004	872	36.9	46.4	16.7
2005	872	33.0	49.3	17.7
2006	872	28.9	51.1	20.0

MEDITERR. (LOWER)	Number of trees	0-10%	>10-25%	>25%
1997	140	47.1	37.9	15.0
1998	140	50.0	34.3	15.7
1999	158	47.5	34.8	17.7
2000	158	40.5	43.7	15.8
2001	158	37.3	44.3	18.4
2002	158	36.1	44.3	19.6
2003	158	31.0	50.6	18.4
2004	158	28.5	51.9	19.6
2005	158	35.4	45.0	19.6
2006	158	31.0	47.5	21.5

MOUNTAIN-OUS (NORTH)	Number of trees	0-10%	>10-25%	>25%
1997	929	44.8	37.2	18.0
1998	929	42.7	40.5	16.8
1999	929	46.4	39.4	14.2
2000	930	49.9	38.8	11.3
2001	937	49.4	39.3	11.3
2002	937	45.8	41.7	12.5
2003	937	51.0	38.6	10.4
2004	937	61.6	29.6	8.8
2005	943	58.1	31.8	10.1
2006	946	54.2	35.9	9.9

MOUNTAIN-OUS (SOUTH)	Number of trees	0-10%	>10-25%	>25%
1997	2616	23.6	38.6	37.8
1998	2610	26.2	31.9	41.9
1999	2553	31.5	34.0	34.5
2000	2189	27.8	41.3	30.9
2001	2141	35.6	38.6	25.8
2002	2128	26.9	45.3	27.8
2003	2394	19.4	50.9	29.7
2004	2292	20.2	46.0	33.8
2005	2171	17.7	47.3	35.0
2006	1954	23.0	43.3	33.7

BOREAL	Number of trees	0-10%	>10-25%	>25%
1997	8038	63.9	28.4	7.7
1998	8038	64.5	29.0	6.5
1999	8072	64.8	28.6	6.6
2000	8105	64.6	29.6	5.8
2001	8185	59.2	32.0	8.8
2002	8290	58.3	35.2	6.5
2003	8254	55.6	37.1	7.3
2004	9880	59.6	34.7	5.7
2005	10143	61.9	33.0	5.1
2006	10225	59.0	36.3	4.7

BOREAL (TEMP.)	Number of trees	0-10%	>10-25%	>25%
1997	4775	32.8	52.5	14.7
1998	4789	39.2	48.5	12.3
1999	4810	27.0	60.9	12.1
2000	4737	38.4	51.3	10.3
2001	4858	30.1	58.3	11.6
2002	4840	31.1	55.8	13.1
2003	4815	34.4	54.6	11.0
2004	4804	31.8	56.2	12.0
2005	4812	33.9	53.2	12.9
2006	4790	32.1	56.7	11.2

CONTINENTAL	Number of trees	0-10%	>10-25%	>25%
1997	427	45.4	16.9	37.7
1998	427	51.1	11.0	37.9
1999	350	60.9	21.7	17.4
2000	495	56.1	26.5	17.4
2001	536	44.2	38.1	17.7
2002	491	43.8	32.6	23.6
2003	475	38.7	37.7	23.6
2004	445	36.2	42.2	21.6
2005	474	37.0	35.4	27.6
2006	449	42.6	35.4	22.0

ALL REGIONS	Number of trees	0-10%	>10-25%	>25%
1997	29928	37.3	41.4	21.3
1998	29894	38.8	42.1	19.1
1999	30062	37.6	44.9	17.5
2000	29839	38.8	44.5	16.7
2001	30070	35.8	47.1	17.1
2002	29963	34.6	47.7	17.7
2003	30215	33.0	49.3	17.7
2004	31723	35.3	46.7	18.0
2005	31790	37.4	44.4	18.2
2006	28951	39.9	45.1	15.0

Fagus sylvatica

ATLANTIC (NORTH)	Number of trees	0-10%	>10-25%	>25%	ATLANTIC (SOUTH)	Number of trees	0-10%	>10-25%	>25%
1997	997	37.3	40.5	22.2	1997	262	29.8	48.4	21.8
1998	997	32.1	46.0	21.9	1998	244	41.0	49.2	9.8
1999	1017	24.5	48.0	27.5	1999	244	36.1	54.5	9.4
2000	1021	22.0	44.0	34.0	2000	244	48.8	43.4	7.8
2001	1034	29.8	42.8	27.4	2001	244	56.1	39.8	4.1
2002	1058	24.6	45.2	30.2	2002	244	34.8	52.9	12.3
2003	1058	28.5	45.9	25.6	2003	243	31.3	50.6	18.1
2004	1058	17.4	39.6	43.0	2004	243	17.3	63.8	18.9
2005	1079	33.2	39.7	27.1	2005	243	30.9	49.8	19.3
2006	1079	26.1	45.0	28.9	2006	243	24.7	51.4	23.9

SUB-ATLANTIC	Number of trees	0-10%	>10-25%	>25%	MEDITERR. (HIGHER)	Number of trees	0-10%	>10-25%	>25%
1997	3539	26.2	50.1	23.7	1997	805	36.7	33.9	29.4
1998	3504	26.6	48.2	25.2	1998	813	34.4	35.6	30.0
1999	3647	23.7	50.7	25.6	1999	919	33.8	38.9	27.3
2000	3563	26.5	47.3	26.2	2000	919	32.5	41.9	25.6
2001	3595	24.7	45.5	29.8	2001	932	28.1	41.3	30.6
2002	3620	27.0	49.0	24.0	2002	903	30.5	43.0	26.5
2003	3641	25.4	49.8	24.8	2003	878	28.8	49.3	21.9
2004	3640	17.6	45.8	36.6	2004	879	25.6	48.7	25.7
2005	3578	18.4	51.7	29.9	2005	944	30.3	46.3	23.4
2006	3073	23.2	47.0	29.8	2006	969	33.5	46.2	20.3

MEDITERR. (LOWER)	Number of trees	0-10%	>10-25%	>25%	MOUNTAIN-OUS (SOUTH)	Number of trees	0-10%	>10-25%	>25%
1997	669	42.9	30.5	26.6	1997	3523	35.2	42.6	22.2
1998	666	43.0	34.2	22.8	1998	3583	39.8	40.5	19.7
1999	863	34.1	38.3	27.6	1999	3698	36.3	43.0	20.7
2000	873	33.4	39.0	27.6	2000	3927	39.0	42.3	18.7
2001	873	27.4	40.0	32.6	2001	3694	30.7	47.0	22.3
2002	857	29.5	45.9	24.6	2002	3742	32.1	46.4	21.5
2003	812	29.9	46.6	23.5	2003	3786	29.0	44.8	26.2
2004	880	26.3	48.0	25.7	2004	3681	28.0	47.6	24.4
2005	863	38.6	41.5	19.9	2005	3736	36.7	41.6	21.7
2006	863	44.0	40.9	15.1	2006	3700	36.1	40.4	23.5

CONTINENTAL	Number of trees	0-10%	>10-25%	>25%	ALL REGIONS	Number of trees	0-10%	>10-25%	>25%
1997	1645	47.4	33.0	19.6	1997	11447	34.8	42.2	23.0
1998	1759	46.2	34.5	19.3	1998	11573	35.9	41.9	22.2
1999	1455	50.1	27.6	22.3	1999	11850	32.7	43.5	23.8
2000	1447	48.3	28.7	23.0	2000	12001	34.3	42.0	23.7
2001	1588	47.9	28.9	23.2	2001	11967	31.2	42.7	26.1
2002	1638	51.3	30.0	18.7	2002	12069	32.3	44.7	23.0
2003	1561	49.1	32.5	18.4	2003	11986	30.6	45.4	24.0
2004	1512	48.3	35.6	16.1	2004	11900	25.9	45.3	28.8
2005	1543	52.6	33.2	14.2	2005	11993	32.5	43.9	23.6
2006	1602	51.9	32.7	15.4	2006	11536	34.0	42.3	23.7

Quercus ilex and *Q. rotundifolia*

MEDITERR. (HIGHER)	Number of trees	0-10%	>10-25%	>25%	MEDITERR. (LOWER)	Number of trees	0-10%	>10-25%	>25%
1997	860	25.0	53.6	21.4	1997	2553	27.0	55.9	17.1
1998	817	31.9	50.5	17.6	1998	2553	29.8	54.6	15.6
1999	938	25.8	54.1	20.1	1999	3196	21.6	56.3	22.1
2000	938	26.5	53.6	19.9	2000	3220	17.3	59.9	22.8
2001	938	23.8	57.6	18.6	2001	3233	19.2	64.2	16.6
2002	938	17.3	59.6	23.1	2002	3220	17.6	63.3	19.1
2003	938	19.6	56.6	23.8	2003	3193	13.9	64.8	21.3
2004	962	19.5	59.8	20.7	2004	3197	19.5	63.0	17.5
2005	962	10.8	55.2	34.0	2005	3163	9.1	66.2	24.7
2006	962	10.8	56.6	32.6	2006	3163	9.3	63.8	26.9

Quercus ilex and Q. rotundifolia

MOUNTAIN-OUS (SOUTH)	Number of trees	0-10%	>10-25%	>25%	ALL REGIONS	Number of trees	0-10%	>10-25%	>25%
1997	155	22.6	43.2	34.2	1997	3660	26.4	55.0	18.6
1998	155	24.5	65.2	10.3	1998	3617	30.1	54.2	15.7
1999	241	29.5	54.7	15.8	1999	4467	23.1	55.8	21.1
2000	285	30.9	57.2	11.9	2000	4535	20.4	58.0	21.6
2001	285	23.5	55.1	21.4	2001	4548	20.6	61.8	17.6
2002	285	21.4	44.2	34.4	2002	4535	17.8	61.2	21.0
2003	240	15.8	42.1	42.1	2003	4463	15.7	61.2	23.1
2004	282	19.5	48.9	31.6	2004	4533	19.7	61.2	19.1
2005	240	12.5	52.5	35.0	2005	4457	9.9	62.7	27.4
2006	240	12.5	50.0	37.5	2006	4457	9.8	60.9	29.3

Pinus pinaster

ATLANTIC (SOUTH)	Number of trees	0-10%	>10-25%	>25%	MEDITERR. (HIGHER)	Number of trees	0-10%	>10-25%	>25%
1997	1223	59.2	27.3	13.5	1997	472	65.2	19.3	15.5
1998	1227	42.0	40.8	17.2	1998	459	65.6	25.9	8.5
1999	1392	60.0	32.3	7.7	1999	537	58.3	28.5	13.2
2000	1347	59.4	31.8	8.8	2000	503	58.5	29.4	12.1
2001	1367	54.4	38.7	6.9	2001	503	59.0	34.8	6.2
2002	1347	52.4	39.9	7.7	2002	503	51.3	41.7	7.0
2003	1347	47.9	40.9	11.2	2003	503	48.9	43.3	7.8
2004	1348	46.9	38.6	14.5	2004	507	51.7	35.9	12.4
2005	1287	45.5	43.1	11.4	2005	507	41.4	46.0	12.6
2006	1268	49.6	39.2	11.2	2006	469	34.3	42.9	22.8
MEDITERR. (LOWER)	Number of trees	0-10%	>10-25%	>25%	MOUNTAIN. (SOUTH)	Number of trees	0-10%	>10-25%	>25%
1997	1485	41.4	47.2	11.4	1997	69	76.9	21.7	1.4
1998	1465	43.8	46.5	9.7	1998	69	65.3	21.7	13.0
1999	1692	43.0	47.6	9.4	1999	130	80.8	14.6	4.6
2000	1692	46.4	46.6	7.0	2000	127	77.2	17.3	5.5
2001	1692	46.2	47.4	6.4	2001	127	71.6	20.5	7.9
2002	1692	46.7	46.1	7.2	2002	127	60.6	30.7	8.7
2003	1508	43.0	44.7	12.3	2003	127	45.7	42.5	11.8
2004	1452	41.9	42.4	15.7	2004	127	51.2	41.7	7.1
2005	1331	35.3	42.9	21.8	2005	127	53.6	35.4	11.0
2006	1302	33.1	52.4	14.5	2006	127	51.2	32.3	16.5
ALL REGIONS	Number of trees	0-10%	>10-25%	>25%					
1997	3249	52.3	35.1	12.6					
1998	3220	46.6	40.9	12.5					
1999	3751	52.9	38.0	9.1					
2000	3669	53.9	37.8	8.3					
2001	3689	51.9	41.5	6.6					
2002	3669	49.9	42.7	7.4					
2003	3485	45.9	42.9	11.2					
2004	3434	45.7	39.9	14.4					
2005	3252	41.0	43.2	15.8					
2006	3166	40.6	44.9	14.5					

Quercus suber

MEDITERR. (LOWER)	Number of trees	0-10%	>10-25%	>25%	ALL REGIONS	Number of trees	0-10%	>10-25%	>25%
1997	1474	34.5	51.9	13.6	1997	1543	37.1	49.9	13.0
1998	1474	26.9	56.9	16.2	1998	1542	29.6	54.9	15.5
1999	1575	23.1	56.2	20.7	1999	1667	25.3	54.5	20.2
2000	1575	21.3	61.9	16.8	2000	1667	22.7	61.2	16.1
2001	1575	22.7	57.9	19.4	2001	1667	23.4	58.1	18.5
2002	1598	23.3	58.6	18.1	2002	1690	23.6	58.8	17.6
2003	1572	19.1	54.3	26.6	2003	1640	19.8	54.6	25.6
2004	1572	20.9	53.3	25.8	2004	1641	22.1	52.9	25.0
2005	1526	3.9	60.5	35.6	2005	1591	5.6	60.1	34.3
2006	1525	10.8	44.4	44.8	2006	1591	13.6	43.3	43.1

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

ATLANTIC (NORTH)	Number of trees	0-10%	>10-25%	>25%	ATLANTIC (SOUTH)	Number of trees	0-10%	>10-25%	>25%
1997	1286	28.6	44.5	26.9	1997	1554	24.6	38.5	36.9
1998	1339	27.6	45.1	27.3	1998	1534	29.6	38.2	32.2
1999	1340	24.7	48.6	26.7	1999	1560	30.2	45.1	24.7
2000	1318	29.7	50.8	19.5	2000	1554	32.6	43.2	24.2
2001	1322	20.4	49.9	29.7	2001	1531	28.2	45.4	26.4
2002	1322	18.8	48.7	32.5	2002	1531	22.7	50.0	27.3
2003	1311	18.2	49.2	32.6	2003	1530	18.6	46.5	34.9
2004	1311	16.8	46.7	36.5	2004	1527	20.2	44.8	35.0
2005	1281	16.1	46.6	37.3	2005	1499	15.3	48.3	36.4
2006	1281	14.6	46.6	38.8	2006	1480	16.9	49.4	33.7
SUB-ATLANTIC	Number of trees	0-10%	>10-25%	>25%	MEDITERR. (HIGHER)	Number of trees	0-10%	>10-25%	>25%
1997	2754	15.2	46.5	38.3	1997	219	20.5	46.2	33.3
1998	2757	18.2	44.3	37.5	1998	219	22.8	40.7	36.5
1999	2805	18.4	50.3	31.3	1999	221	28.5	47.1	24.4
2000	2790	16.5	50.5	33.0	2000	221	26.2	48.9	24.9
2001	2790	15.8	50.9	33.3	2001	222	21.2	48.6	30.2
2002	2810	16.9	52.4	30.7	2002	220	14.5	52.3	33.2
2003	2810	12.5	47.8	39.7	2003	220	11.8	53.2	35.0
2004	2812	10.2	45.6	44.2	2004	220	11.8	50.9	37.3
2005	2802	9.5	43.5	47.0	2005	220	10.5	47.2	42.3
2006	2384	14.6	48.0	37.4	2006	221	10.9	46.6	42.5
MEDITERR. (LOWER)	Number of trees	0-10%	>10-25%	>25%	MOUNTAIN-OUS (SOUTH)	Number of trees	0-10%	>10-25%	>25%
1997	527	23.3	40.8	35.9	1997	771	19.6	32.6	47.8
1998	620	28.4	36.1	35.5	1998	772	18.4	34.1	47.5
1999	639	27.9	44.2	27.9	1999	757	15.1	42.1	42.8
2000	634	29.3	42.0	28.7	2000	828	16.2	41.7	42.1
2001	634	30.0	46.0	24.0	2001	719	18.6	41.1	40.3
2002	639	28.3	49.8	21.9	2002	708	15.7	44.8	39.5
2003	639	25.4	49.4	25.2	2003	716	14.8	44.0	41.2
2004	648	28.2	46.5	25.3	2004	773	16.9	40.6	42.5
2005	689	28.6	42.1	29.3	2005	706	15.3	38.1	46.6
2006	694	38.9	36.2	24.9	2006	666	14.6	42.8	42.6
BOREAL (TEMPERATE)	Number of trees	0-10%	>10-25%	>25%	CONTINENTAL	Number of trees	0-10%	>10-25%	>25%
1997	128	39.8	43.8	16.4	1997	869	22.9	34.8	42.3
1998	128	43.0	44.5	12.5	1998	862	23.5	35.0	41.5
1999	128	23.4	48.5	28.1	1999	786	30.5	34.1	35.4
2000	128	53.9	34.4	11.7	2000	821	25.0	24.2	50.8
2001	128	41.4	43.0	15.6	2001	824	22.0	30.2	47.8
2002	128	46.9	37.5	15.6	2002	668	23.2	31.1	45.7
2003	130	26.9	47.7	25.4	2003	656	18.9	38.1	43.0
2004	135	28.9	44.4	26.7	2004	689	21.2	34.4	44.4
2005	135	37.0	44.5	18.5	2005	775	25.7	31.0	43.3
2006	135	26.7	47.4	25.9	2006	757	32.1	35.0	32.9

ALL REGIONS	Number of trees	0-10%	>10-25%	>25%
1997	8117	21.4	41.7	36.9
1998	8240	23.7	40.7	35.6
1999	8245	23.6	46.2	30.2
2000	8303	24.2	44.8	31.0
2001	8179	21.4	46.2	32.4
2002	8035	20.1	48.4	31.5
2003	8021	16.5	47.0	36.5
2004	8124	16.6	44.4	39.0
2005	8116	15.8	43.2	41.0
2006	7627	19.1	45.2	35.7

Abies alba

SUB-ATLANTIC	Number of trees	0-10%	>10-25%	>25%
1997	673	30.2	31.9	37.9
1998	647	30.9	32.1	37.0
1999	689	31.8	32.7	35.5
2000	649	30.4	34.2	35.4
2001	649	31.3	29.6	39.1
2002	689	33.8	28.9	37.3
2003	689	30.5	34.7	34.8
2004	689	29.6	33.1	37.3
2005	689	32.8	35.4	31.8
2006	620	39.4	37.4	23.2

MEDITERR. (HIGHER)	Number of trees	0-10%	>10-25%	>25%
1997	125	39.2	17.6	43.2
1998	125	42.4	15.2	42.4
1999	141	36.9	23.4	39.7
2000	141	31.9	23.4	44.7
2001	129	28.7	20.2	51.1
2002	129	27.9	24.8	47.3
2003	129	24.8	23.3	51.9
2004	129	20.9	20.2	58.9
2005	130	23.1	17.7	59.2
2006	130	21.5	27.7	50.8

MOUNTAIN-OUS (SOUTH)	Number of trees	0-10%	>10-25%	>25%
1997	1155	34.8	33.6	31.6
1998	1099	33.8	36.9	29.3
1999	1118	32.6	39.7	27.7
2000	1152	33.9	38.1	28.0
2001	1111	35.4	40.5	24.1
2002	1121	34.2	38.9	26.9
2003	1162	30.8	37.7	31.5
2004	1160	35.3	34.8	29.9
2005	1135	35.5	40.2	24.3
2006	1076	35.5	34.0	30.5

CONTINENTAL	Number of trees	0-10%	>10-25%	>25%
1997	183	16.4	29.0	54.6
1998	183	15.8	28.4	55.8
1999	172	19.2	27.3	53.5
2000	165	14.5	33.9	51.6
2001	165	27.9	32.1	40.0
2002	168	25.6	36.9	37.5
2003	167	19.8	45.5	34.7
2004	167	27.5	32.9	39.6
2005	181	27.6	29.8	42.6
2006	180	45.0	26.1	28.9

ALL REGIONS	Number of trees	0-10%	>10-25%	>25%
1997	2201	32.1	32.2	35.7
1998	2119	32.2	33.6	34.2
1999	2185	31.9	35.1	33.0
2000	2148	31.6	35.4	33.0
2001	2091	33.2	34.9	31.9
2002	2144	33.2	34.5	32.3
2003	2184	29.9	36.4	33.7
2004	2186	32.3	33.3	34.4
2005	2176	33.6	36.3	30.1
2006	2047	36.9	33.8	29.3

Picea sitchensis

ATLANTIC (NORTH)	Number of trees	0-10%	>10-25%	>25%
1997	991	42.3	39.5	18.2
1998	1021	35.5	38.3	26.2
1999	928	45.2	34.8	20.0
2000	975	41.4	35.7	22.9
2001	944	37.8	38.9	23.3
2002	920	29.5	41.5	29.0
2003	899	28.4	41.8	29.8
2004	882	32.9	39.0	28.1
2005	882	36.2	38.3	25.5
2006	945	40.2	35.8	24.0

ALL REGIONS	Number of trees	0-10%	>10-25%	>25%
1997	1012	43.6	38.6	17.8
1998	1042	36.8	37.6	25.6
1999	949	46.4	34.0	19.6
2000	996	42.7	34.9	22.4
2001	965	38.9	38.3	22.8
2002	941	30.2	41.4	28.4
2003	920	29.2	41.7	29.1
2004	903	33.8	38.7	27.5
2005	903	37.7	37.4	24.9
2006	966	39.6	36.2	24.2

All species

ATLANTIC (NORTH)	Number of trees	0-10%	>10-25%	>25%
1997	7144	46.4	37.2	16.4
1998	7337	43.2	39.2	17.6
1999	7386	42.6	39.4	18.0
2000	7418	43.3	37.9	18.8
2001	7297	40.9	39.4	19.7
2002	7317	39.3	38.7	22.0
2003	7263	38.2	40.1	21.7
2004	7264	35.3	39.4	25.3
2005	7076	39.3	37.8	22.9
2006	7071	38.4	38.4	23.2

ATLANTIC (SOUTH)	Number of trees	0-10%	>10-25%	>25%
1997	5720	45.0	31.6	23.4
1998	5724	42.9	35.2	21.9
1999	6336	49.3	35.8	14.9
2000	6216	48.7	34.7	16.6
2001	6216	45.7	39.9	14.4
2002	6196	39.6	42.5	17.9
2003	6136	35.6	41.2	23.2
2004	6096	34.5	41.6	23.9
2005	5976	32.0	43.9	24.1
2006	5926	32.4	43.2	24.4

All species

SUB-ATLANTIC	Number of trees	0-10%	>10-25%	>25%
1997	30279	22.5	42.6	34.9
1998	28309	25.8	44.3	29.9
1999	29092	25.8	46.0	28.2
2000	28850	24.8	46.5	28.7
2001	28876	23.6	47.1	29.3
2002	28914	23.0	47.7	29.3
2003	28886	20.9	48.7	30.4
2004	29026	18.5	46.3	35.2
2005	28854	20.2	46.4	33.4
2006	24938	26.1	44.7	29.2

MEDITERR. (HIGHER)	Number of trees	0-10%	>10-25%	>25%
1997	7540	33.2	39.4	27.4
1998	7480	36.1	41.2	22.7
1999	8491	34.3	43.6	22.1
2000	8446	32.8	45.6	21.6
2001	8478	28.6	46.2	25.2
2002	8310	27.4	47.2	25.4
2003	8329	25.1	49.6	25.3
2004	8500	25.3	49.8	24.9
2005	8476	23.1	48.3	28.6
2006	8503	23.2	46.4	30.4

MEDITERR. (LOWER)	Number of trees	0-10%	>10-25%	>25%
1997	12230	35.0	46.6	18.4
1998	12231	34.9	46.3	18.8
1999	14526	31.2	49.2	19.6
2000	14647	29.4	50.8	19.8
2001	14712	28.0	52.3	19.7
2002	14801	26.6	53.2	20.2
2003	14358	24.1	53.6	22.3
2004	14427	26.0	52.7	21.3
2005	14005	19.5	52.9	27.6
2006	14019	21.9	50.4	27.7

MOUNTAIN-OUS (NORTH)	Number of trees	0-10%	>10-25%	>25%
1997	3151	43.4	33.6	23.0
1998	3142	44.1	33.8	22.1
1999	3131	45.5	33.9	20.6
2000	3132	47.3	36.1	16.6
2001	3380	50.0	32.2	17.8
2002	3400	44.7	35.7	19.6
2003	3423	47.2	33.5	19.3
2004	3644	51.1	29.5	19.4
2005	3784	52.8	29.2	18.0
2006	3826	48.8	32.3	18.9

MOUNTAIN-OUS (SOUTH)	Number of trees	0-10%	>10-25%	>25%
1997	18618	37.8	35.5	26.7
1998	18767	39.2	33.6	27.2
1999	20030	39.6	35.5	24.9
2000	20353	38.7	36.9	24.4
2001	20085	36.4	38.6	25.0
2002	19652	35.6	39.6	24.8
2003	19782	32.4	41.7	25.9
2004	19962	31.0	41.3	27.7
2005	19280	32.6	42.3	25.1
2006	18222	35.6	38.5	25.9

BOREAL	0-10%	>10-25%	>25%	0-10%
1997	16511	56.3	29.2	14.5
1998	16556	55.5	30.6	13.9
1999	16524	55.4	29.9	14.7
2000	16465	54.1	32.6	13.3
2001	16494	50.2	33.5	16.3
2002	16548	50.7	35.5	13.8
2003	16514	48.8	36.1	15.1
2004	19364	52.3	34.9	12.8
2005	19712	54.4	33.6	12.0
2006	19791	51.3	36.5	12.2

BOREAL (TEMP.)	Number of trees	0-10%	>10-25%	>25%
1997	10798	40.9	45.4	13.7
1998	10818	44.6	42.7	12.7
1999	10812	35.2	50.5	14.3
2000	10763	43.1	44.5	12.4
2001	10999	37.3	49.6	13.1
2002	10989	39.9	47.1	13.0
2003	10931	39.5	47.3	13.2
2004	10882	36.5	48.1	15.4
2005	10847	39.6	45.0	15.4
2006	10829	37.7	48.0	14.3

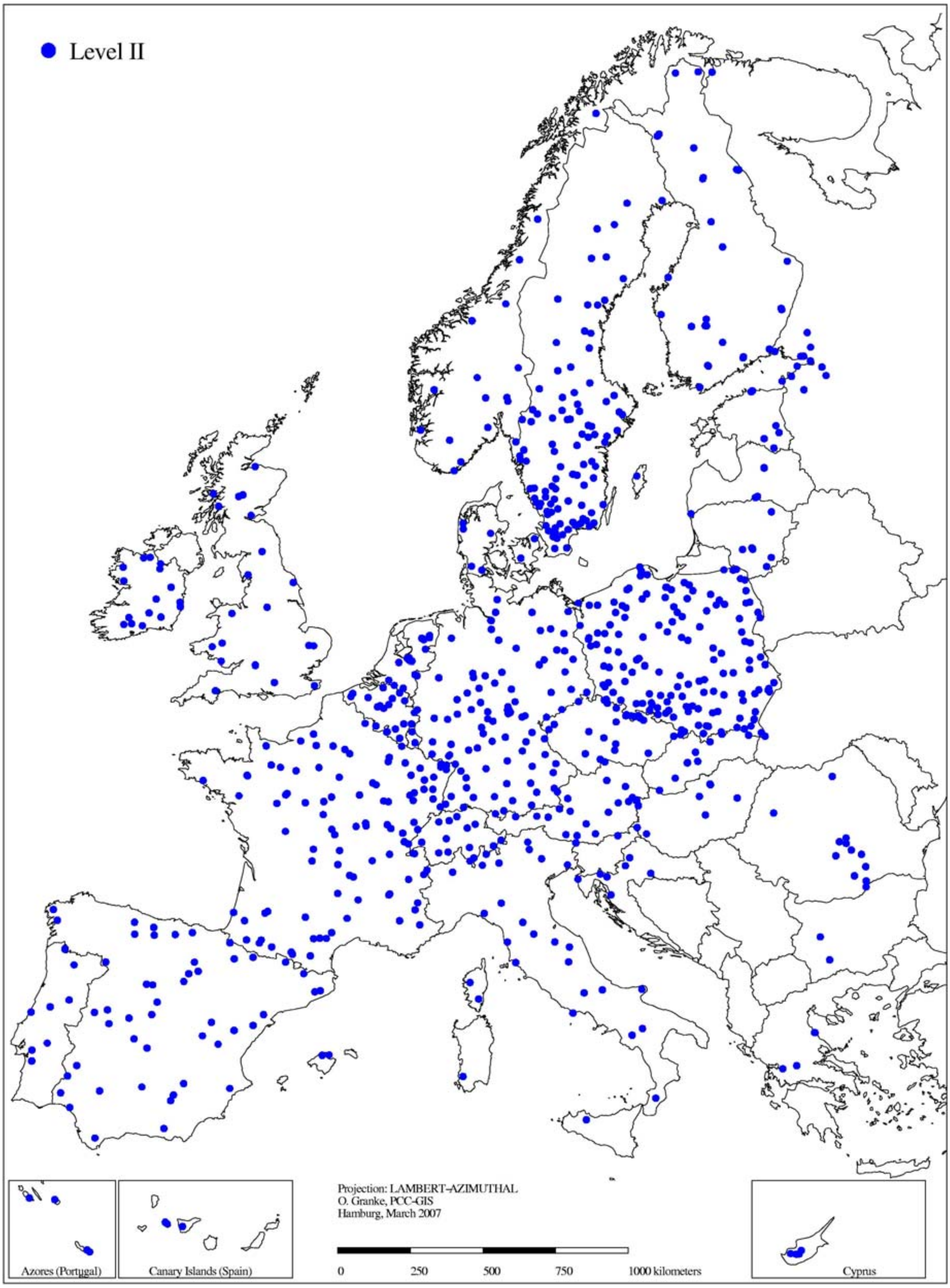
CONTINENTAL	Number of trees	0-10%	>10-25%	>25%
1997	6515	36.0	31.9	32.1
1998	6940	33.7	31.8	34.5
1999	6179	41.8	29.9	28.3
2000	6335	38.7	27.9	33.4
2001	6569	39.5	31.3	29.2
2002	6454	38.0	34.7	27.3
2003	6210	34.4	36.2	29.4
2004	6049	36.4	35.9	27.7
2005	6366	41.9	32.7	25.4
2006	6520	43.1	33.1	23.8

ALL REGIONS	Number of trees	0-10%	>10-25%	>25%
1997	118506	37.1	38.4	24.5
1998	117304	38.4	38.7	22.9
1999	122507	37.7	40.6	21.7
2000	122625	37.4	40.9	21.7
2001	123106	35.1	42.6	22.3
2002	122581	34.2	43.5	22.3
2003	121832	32.1	44.4	23.5
2004	125214	32.2	43.2	24.6
2005	124376	33.1	42.7	24.2
2006	119645	34.8	42.0	23.2

	Period 1990 - 2006			Period 1997 - 2006		
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	11630	24.3	0.15			
1991	11877	26.2	0.14			
1992	11887	26.9	0.14			
1993	11924	26.6	0.14			
1994	11292	27.7	0.14			
1995	11113	26.0	0.14			
1996	11154	23.3	0.13			
1997	11115	22.5	0.12	29928	19.1	0.09
1998	11608	21.9	0.12	29894	18.5	0.08
1999	11847	21.3	0.11	30062	18.2	0.08
2000	11764	21.9	0.12	29839	18.0	0.08
2001	11794	21.8	0.11	30070	18.5	0.08
2002	11670	22.4	0.12	29963	18.7	0.08
2003	11708	22.5	0.12	30215	19.0	0.08
2004	11741	22.7	0.12	31723	18.7	0.08
2005	11564	22.7	0.13	31790	18.7	0.08
2006	8387	20.1	0.14	28951	17.4	0.08
Picea abies						
1990	6485	22.4	0.22			
1991	6634	22.5	0.21			
1992	6660	23.3	0.20			
1993	6584	24.3	0.22			
1994	6553	25.7	0.23			
1995	6700	24.6	0.23			
1996	6707	22.3	0.21			
1997	6615	22.9	0.20	27772	19.7	0.10
1998	7887	22.0	0.18	26001	18.5	0.10
1999	7855	21.8	0.18	26436	18.8	0.10
2000	7780	22.9	0.18	26543	18.8	0.10
2001	7505	22.7	0.17	26489	19.0	0.10
2002	7524	23.3	0.18	26468	19.0	0.10
2003	7569	23.2	0.18	26357	19.4	0.10
2004	7485	25.3	0.19	26949	20.2	0.10
2005	7377	23.2	0.18	26619	20.1	0.11
2006	4346	21.6	0.24	24494	18.7	0.11
Quercus robur and ***Q. petraea***						
1990	2649	21.0	0.34			
1991	2655	23.4	0.33			
1992	2624	24.1	0.32			
1993	2630	26.1	0.32			
1994	2564	27.6	0.34			
1995	2648	26.9	0.34			
1996	2624	27.8	0.36			
1997	2656	26.3	0.32	8117	25.5	0.20
1998	2769	25.9	0.31	8240	24.8	0.19
1999	2844	23.8	0.28	8245	23.3	0.17
2000	2873	23.5	0.28	8303	23.4	0.18
2001	2884	23.7	0.27	8179	24.1	0.18
2002	2894	23.3	0.27	8035	23.8	0.17
2003	2907	24.6	0.26	8021	25.6	0.18
2004	2998	26.6	0.30	8124	26.6	0.18
2005	2965	25.7	0.30	8116	26.8	0.18
2006	2382	21.8	0.31	7627	25.1	0.19

	Period 1990 - 2006			Period 1997 - 2006		
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** $s_{\bar{x}} = s/\sqrt{N}$
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	11447	20.1	0.15
1998	4417	19.5	0.20	11573	19.6	0.15
1999	4568	20.6	0.19	11850	20.3	0.14
2000	4637	20.5	0.21	12001	20.3	0.15
2001	4640	21.5	0.21	11967	21.1	0.14
2002	4649	20.0	0.19	12069	20.3	0.14
2003	4678	21.7	0.20	11986	20.8	0.14
2004	4693	24.2	0.22	11900	22.6	0.15
2005	4651	21.9	0.20	11993	20.6	0.14
2006	3780	21.2	0.23	11536	20.7	0.15
Pinus pinaster						
1990	2588	12.9	0.30			
1991	2526	15.4	0.37			
1992	2539	13.7	0.34			
1993	2401	12.0	0.34			
1994	2521	12.3	0.31			
1995	2360	12.7	0.28			
1996	2330	14.5	0.36			
1997	2313	15.5	0.33	3249	16.2	0.31
1998	2312	15.8	0.32	3220	16.7	0.28
1999	2866	16.5	0.32	3751	15.5	0.27
2000	2839	17.8	0.39	3669	16.1	0.31
2001	2822	14.7	0.23	3689	14.1	0.20
2002	2820	15.5	0.24	3669	14.5	0.18
2003	2602	16.2	0.28	3485	16.4	0.25
2004	2556	18.7	0.38	3434	18.3	0.32
2005	2375	18.9	0.36	3252	18.3	0.30
2006	2260	18.4	0.37	3166	18.0	0.30
Quercus ilex and ***Q. rotundifolia***						
1990	3074	13.8	0.25			
1991	3064	16.0	0.22			
1992	3080	17.4	0.24			
1993	3055	16.0	0.17			
1994	3027	19.6	0.29			
1995	3052	24.0	0.28			
1996	3034	22.6	0.27			
1997	3034	19.4	0.25	3660	20.4	0.23
1998	3026	18.5	0.23	3617	19.4	0.21
1999	3820	21.1	0.23	4467	21.1	0.20
2000	3852	20.9	0.19	4535	21.2	0.18
2001	3853	20.2	0.19	4548	20.8	0.18
2002	3857	21.2	0.18	4535	21.8	0.18
2003	3859	22.3	0.22	4463	22.8	0.20
2004	3855	20.3	0.17	4533	21.2	0.18
2005	3832	23.8	0.18	4457	24.4	0.19
2006	3838	24.0	0.21	4457	24.7	0.21

Annex I-10
Level II plots



Annex II-1
Forests and surveys in European countries (2006)

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	1063	10x10	299	8970
Andorra	47	17	15	2	17	16 x 16	3	74
Austria	8385	3878	2683	798	3481	16 x 16	135	3425
Belarus	20760	7812	4685	3127	7812	16 x 16	398	9373
Belgium	3035	691	281	324	691	4^2 / 8^2	121	2841
Bulgaria	11100	4064	1289	2775	4064	$4^2/8^2/16^2$	141	5069
Croatia	5654	2061	321	1740	2061	16 x 16	88	2108
Cyprus	925	298	172	0	138	16x16	15	360
Czech Republic	7886	2630	2057	573	2630	$8^2/16^2$	135	5661
Denmark	4300	468	294	174	468	$7^2/16^2$	22	528
Estonia	4510	2264	1139	1125	2264	16 x 16	92	2191
Finland	30447	20338	18148	1926	20074	16^2 / 24x32	606	11506
France	54926	14591	4058	9228	13100	16 x 16	498	9950
Germany	35562	11076	6084	4236	10890	16^2 / 4^2	423	10327
Greece	12890	2512	954	1080	no survey in 2006			
Hungary	9300	1853	234	1619	1853	4 x 4	1220	28386
Ireland	7028	680	399	37	399	16 x 16	37	455
Italy	30128	8675	1735	6940	8675	16 x 16	251	6941
Latvia	6459	2950	1554	1247	2950	8 x 8	342	8116
Liechtenstein	16	8	6	2	no survey in 2006			
Lithuania	6520	2121	1155	859	2014	8x8/16x16	203	4872
Luxembourg	259	89	30	54	no survey in 2006			
Rep. of Moldova	3376	318	6	312	318	2x2/2x4	528	12729
The Netherlands	3482	334	158	52	210	16 x 16	11	230
Norway	32376	12000	6800	5200	12000	$3^2/9^2$	1669	9004
Poland	31268	9200	6955	2245	9200	16 x 16	376	7520
Portugal	8893	3234	1081	2153	3234	16 x 16		
Romania	23750	6244	1929	4315	6244	4 x 4	3879	97626
Russian Fed.	11100	8125			no survey in 2006			
Serbia	8836	2360	179	2181	1868	16 x 16/4 x 4	130	2935
Slovak Republic	4901	1961	815	1069	1961	16 x 16	107	3975
Slovenia	2027	1099	410	688	1099	16 x 16	45	1080
Spain	50471	11588	5910	4056	11588	16 x 16	620	14880
Sweden	41000	23400	19600	900	20600	varying		
Switzerland	4129	1186	818	368	1186	16 x 16	48	1025
Turkey	77945	20199	9426	10773	no survey in 2006			
Ukraine	60350	9400	3969	5347	5875	16 x 16	1518	35900
United Kingdom	24291	2825	1647	1178	2825	random	341	8184
TOTAL	651207	203612	107167	79303	165364	varying	14301	316241

Annex II-2

Percent of trees of all species by defoliation classes and class aggregates (2006)

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	1063	8970	44.0	45.0	10.0	1.0	11.0
Andorra	17	74	18.9	58.1	16.2	6.8	23.0
Austria	3481	3425	57.8	27.2	10.7	4.3	15.0
Belarus	7812	9373	37.4	54.7	6.5	1.4	7.9
Belgium	691	2841	33.1	49.0	16.3	1.6	17.9
Bulgaria	4064	5069	17.3	45.3	24.5	12.9	37.4
Croatia		2108	41.6	33.6	22.0	2.8	24.8
Cyprus	138	360	11.7	67.5	20.3	0.5	20.8
Czech Republic	2630	5661	12.3	31.5	54.5	1.7	56.2
Denmark	468	528	64.2	28.2	6.6	1.0	7.6
Estonia	2264	2191	46.6	47.2	5.4	0.8	6.2
Finland	20074	11506	55.3	35.1	8.6	1.0	9.6
France	13100	9950	28.5	35.9	31.9	3.7	35.6
Germany	10890	10327	31.8	40.6	26.0	1.6	27.6
Greece			no survey in 2006				
Hungary	1853	28386	41.3	39.5	13.9	5.3	19.2
Ireland	399	455	73.7	18.9	6.1	1.3	7.4
Italy	436	6941	30.8	38.7	25.9	4.6	30.5
Latvia	2950	8116	19.4	67.2	11.4	2.0	13.4
Liechtenstein			no survey in 2006				
Lithuania	2014	4872	15.3	72.7	9.7	2.3	12.0
Luxembourg			no survey in 2006				
Rep. of Moldova	318	12729	44.3	28.1	22.4	5.2	27.6
The Netherlands	210	230	64.0	17.0	16.5	2.5	19.0
Norway	12000	9004	39.8	36.9	18.2	5.1	23.3
Poland	9200	7520	27.0	52.9	19.6	0.5	20.1
Portugal							
Romania	6244	97626	69.8	21.6	7.6	1.0	8.6
Russian Fed.			no survey in 2006				
Serbia	1868	2935	63.9	24.8	10.7	0.6	11.3
Slovak Republic	1961	3975	13.9	58.0	27.0	1.1	28.1
Slovenia	1099	1080	31.0	39.7	23.7	5.6	29.3
Spain	11588	14880	17.2	61.2	18.2	3.4	21.6
Sweden							
Switzerland	1186	1025	29.2	48.3	13.8	8.7	22.5
Turkey			no survey in 2006				
Ukraine	5875	35900	68.3	25.1	5.6	1.0	6.6
United Kingdom	2825	8184	26.1	48.0	23.9	2.0	25.9

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 (2006)

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	171		28.8	57.6	12.4	1.2	13.6
Andorra	15	74	18.9	58.1	16.2	6.8	23.0
Austria	2683	3047	58.5	27.0	10.7	3.8	14.5
Belarus	4685	6859	36.7	55.8	6.2	1.3	7.5
Belgium	281	897	31.9	52.3	14.6	1.2	15.8
Bulgaria	1289	2630	7.4	45.0	35.6	12.0	47.6
Croatia	321	265	7.6	20.7	62.6	9.1	71.7
Cyprus	172	360	11.7	67.5	20.3	0.5	20.8
Czech Republic	2057	4553	10.5	27.2	60.6	1.7	62.3
Denmark	294	291	80.4	17.9	1.4	0.3	1.7
Estonia	1139	2074	45.3	48.7	5.2	0.8	6.0
Finland	18148	9539	55.2	35.2	8.6	1.0	9.6
France	4058	3461	48.9	27.5	20.9	2.7	23.6
Germany	6084	6519	35.4	42.0	21.2	1.4	22.6
Greece	954		no survey in 2006				
Hungary	234	3917	39.7	39.5	15.3	5.5	20.8
Ireland	399	445	73.7	18.9	6.1	1.3	7.4
Italy	1735	2076	49.0	31.5	17.1	2.4	19.5
Latvia	1554	5922	14.6	70.2	13.1	2.1	15.2
Liechtenstein	6		no survey in 2006				
Lithuania	1155	3169	14.8	75.7	7.8	1.7	9.5
Luxembourg	30		no survey in 2006				
Rep. of Moldova	6	70	44.3	17.1	35.7	2.9	38.6
The Netherlands	158	150	80.0	4.7	13.4	1.9	15.3
Norway	6800	6837	42.3	37.5	16.5	3.7	20.2
Poland	6955	5139	24.1	54.8	20.6	0.5	21.1
Portugal	1081						
Romania	1929	24862	77.5	17.3	4.4	0.8	5.2
Russian Fed.	5800		no survey in 2006				
Serbia	179	338	64.8	21.6	11.8	1.8	13.6
Slovak Republic	815	1726	5.0	52.6	40.7	1.7	42.4
Slovenia	410	410	29.8	38.1	25.9	6.2	32.1
Spain	5910	7511	21.3	60.0	15.5	3.2	18.7
Sweden	19600						
Switzerland	818	723	28.3	49.2	15.5	7.0	22.5
Turkey	9426		no survey in 2006				
Ukraine	3969	15789	68.2	24.9	6.1	0.8	6.9
United Kingdom	1647	4560	30.1	46.6	21.7	1.6	23.3

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 (2006)

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	600		59.2	32.3	7.6	0.9	8.5
Andorra			only conifers assessed				
Austria	798	378	51.3	28.6	11.4	8.7	20.1
Belarus	3108	2514	39.2	51.9	7.4	1.5	8.9
Belgium	324	1944	33.7	47.5	17.0	1.8	18.8
Bulgaria	2775	2439	28.0	45.6	12.7	13.7	26.4
Croatia	1740	1843	46.3	35.5	16.2	2.0	18.2
Cyprus			only conifers assessed				
Czech Republic	573	1108	19.9	48.9	30.0	1.2	31.2
Denmark	174	237	44.3	40.9	13.1	1.7	14.8
Estonia	1125	117	68.3	23.1	8.6	0.0	8.6
Finland	1926	1967	55.6	34.1	8.9	1.4	10.3
France	9228	6489	17.7	40.3	37.8	4.2	42.0
Germany	4236	3808	25.5	38.1	34.3	2.1	36.4
Greece	1080		no survey in 2006				
Hungary	1619	24469	41.4	39.6	13.8	5.2	19.0
Ireland	37		only conifers assessed				
Italy	6940	4838	23.0	41.8	29.7	5.5	35.2
Latvia	1247	2194	32.4	59.1	6.7	1.8	8.5
Liechtenstein	2		no survey in 2006				
Lithuania	859	1703	16.3	67.1	13.0	3.6	16.6
Luxembourg	54		no survey in 2006				
Rep. of Moldova	312	12659	44.3	28.1	22.3	5.3	27.6
The Netherlands	52	80	33.8	40.0	22.5	3.7	26.2
Norway	5200	2167	31.9	34.9	23.6	9.6	33.2
Poland	2245	2381	33.3	48.7	17.5	0.5	18.0
Portugal	2153						
Romania	4315	72764	67.0	23.1	8.7	1.2	9.9
Russian Fed.	510		no survey in 2006				
Serbia	2181	2597	63.8	25.2	10.6	0.4	11.0
Slovak Republic	1069	2249	20.8	62.2	16.5	0.5	17.0
Slovenia	688	670	31.8	40.6	22.4	5.2	27.6
Spain	4056	7369	13.1	62.5	20.9	3.5	24.4
Sweden	900						
Switzerland	368	302	31.1	46.3	10.3	12.3	22.6
Turkey	10773		no survey in 2006				
Ukraine	5347	20111	68.5	25.3	5.3	0.9	6.2
United Kingdom	1178	3624	21.1	49.7	26.6	2.6	29.2

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 (1995-2006)

Participating countries	All species Defoliation classes 2-4												change % points
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2005/ 2006
Albania				9.8	9.9	10.1	10.2	13.1		12.2		11.1	
Andorra										36.1		23.0	
Austria	6.6	7.9	7.1	6.7	6.8	8.9	9.7	10.2	11.1	13.1	14.8	15.0	0.2
Belarus	38.3	39.7	36.3	30.5	26.0	24.0	20.7	9.5	11.3	10.0	9.0	7.9	-1.1
Belgium	24.5	21.2	17.4	17.0	17.7	19.0	17.9	17.8	17.3	19.4	19.9	17.9	-2.0
Bulgaria	38.0	39.2	49.6	60.2	44.2	46.3	33.8	37.1	33.7	39.7	35.0	37.4	2.4
Croatia	39.8	30.1	33.1	25.6	23.1	23.4	25.0	20.6	22.0	25.2	27.1	24.9	-2.2
Cyprus							8.9	2.8	18.4	12.2	10.8	20.8	10.0
Czech Rep.	58.5	71.9	68.6	48.8	50.4	51.7	52.1	53.4	54.4	57.3	57.1	56.2	-0.9
Denmark	36.6	28.0	20.7	22.0	13.2	11.0	7.4	8.7	10.2	11.8	9.4	7.6	-1.8
Estonia	13.6	14.2	11.2	8.7	8.7	7.4	8.5	7.6	7.6	5.3	5.4	6.2	0.8
Finland	13.3	13.2	12.2	11.8	11.4	11.6	11.0	11.5	10.7	9.8	8.8	9.7	0.9
France	12.5	17.8	25.2	23.3	19.7	18.3	20.3	21.9	28.4	31.7	34.2	35.6	1.4
Germany	22.1	20.3	19.8	21.0	21.7	23.0	21.9	21.4	22.5	31.4	28.5	27.6	-0.9
Greece	25.1	23.9	23.7	21.7	16.6	18.2	21.7	20.9			16.3		
Hungary	20.0	19.2	19.4	19.0	18.2	20.8	21.2	21.2	22.5	21.5	21.0	19.2	-1.8
Ireland	26.3	13.0	13.6	16.1	13.0	14.6	17.4	20.7	13.9	17.4	16.2	7.4	-8.8
Italy	18.9	29.9	35.8	35.9	35.3	34.4	38.4	37.3	37.6	35.9	32.9	30.5	-2.4
Latvia	20.0	21.2	19.2	16.6	18.9	20.7	15.6	13.8	12.5	12.5	13.1	13.4	0.3
Liechtenstein													
Lithuania	24.9	12.6	14.5	15.7	11.6	13.9	11.7	12.8	14.7	13.9	11.0	12.0	1.0
Luxembourg	38.3	37.5	29.9	25.3	19.2	23.4							
Rep. of Moldova	40.4	41.2				29.1	36.9	42.5	42.4	34.0	26.5	27.6	1.1
The Netherlands	32.0	34.1	34.6	31.0	12.9	21.8	19.9	21.7	18.0	27.5	30.2	19.5	-10.7
Norway	28.8	29.4	30.7	30.6	28.6	24.3	27.2	25.5	22.9	20.7	21.6	23.3	1.7
Poland	52.6	39.7	36.6	34.6	30.6	32.0	30.6	32.7	34.7	34.6	30.7	20.1	-10.6
Portugal	9.1	7.3	8.3	10.2	11.1	10.3	10.1	9.6	13.0	16.6	24.3		
Romania	21.2	16.9	15.6	12.3	12.7	14.3	13.3	13.5	12.6	11.7	8.1	8.6	0.5
Russian Fed.	12.5						9.8	10.9					
Serbia		3.6	7.7	8.4	11.2	8.4	14.0	3.9	22.8	14.3	16.4	11.3	-5.1
Slovak Rep.	42.6	34.0	31.0	32.5	27.8	23.5	31.7	24.8	31.4	26.7	22.9	28.1	5.2
Slovenia	24.7	19.0	25.7	27.6	29.1	24.8	28.9	28.1	27.5	29.3	30.6	29.4	-1.2
Spain	23.5	19.4	13.7	13.6	12.9	13.8	13.0	16.4	16.6	15.0	21.3	21.5	0.2
Sweden	14.2	17.4	14.9	14.2	13.2	13.7	17.5	16.8	19.2	16.5	18.4		
Switzerland	24.6	20.8	16.9	19.1	19.0	29.4	18.2	18.6	14.9	29.1	28.1	22.6	-5.5
Turkey													
Ukraine	29.6	46.0	31.4	51.5	56.2	60.7	39.6	27.7	27.0	29.9	8.7	6.6	-2.1
United Kingdom	13.6	14.3	19.0	21.1	21.4	21.6	21.1	27.3	24.7	26.5	24.8	25.9	1.1

Austria: From 2003 on, results are based on the 16x16 km transnational gridnet and must not be compared with previous years.
Czech Republic: Only trees older than 60 years assessed until 1997. *France*: Due to methodological changes, only the time series 1997-2006 are consistent. *Italy*: Due to methodological changes, only the time series 1993-96 and 1997-2006 are consistent, but not comparable to each other.
Russian Federation: North-western and Central European parts only. *Ukraine*: Due to a denser gridnet since 2005, results must not be compared with previous years.

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 (1995-2006)

Paticipating countries	Conifers Defoliation classes 2-4												change% points
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2005/ 2006
Albania				12.0	12.1	12.3	12.4	15.5		14.0		13.6	
Andorra										36.1		23.0	
Austria	6.6	7.3	6.3	6.3	6.4	9.1	9.6	10.1	11.2	13.1	15.1	14.5	-0.6
Belarus	43.9	43.1	41.2	33.9	28.9	26.1	23.4	9.7	9.5	8.9	8.4	7.5	-0.9
Belgium	21.0	25.8	19.2	13.5	15.5	19.5	17.5	19.7	18.6	15.6	16.8	15.8	-1.0
Bulgaria	41.4	46.5	53.5	69.8	48.9	46.4	39.1	44.0	38.4	47.1	45.4	47.6	2.2
Croatia	57.5	57.0	68.7	45.8	53.2	53.3	65.1	63.5	77.4	70.6	79.5	71.7	-7.8
Cyprus							8.9	2.8	18.4	12.2	10.8	20.8	10.0
Czech Rep.	60.7	74.9	71.9	54.6	57.4	58.3	58.1	60.1	60.7	62.6	62.7	62.3	-0.4
Denmark	34.8	23.2	15.9	17.0	9.9	8.8	6.7	4.5	6.1	5.8	5.5	1.7	-3.8
Estonia	14.2	14.6	11.4	9.0	9.1	7.5	8.8	7.9	7.7	5.3	5.6	6.0	0.4
Finland	13.7	13.7	12.8	12.2	11.9	12.0	11.4	11.9	11.1	10.1	9.2	9.6	0.4
France	9.2	13.5	16.2	16.8	14.1	12.0	14.0	15.2	18.9	18.6	20.8	23.6	2.8
Germany	18.3	16.7	15.4	19.0	19.2	19.6	20.0	19.8	20.1	26.3	24.9	22.6	-2.3
Greece	13.6	14.4	13.8	12.9	13.5	16.5	17.2	16.1			15.0		
Hungary	18.7	17.8	17.4	18.7	17.6	21.5	19.5	22.8	27.6	24.2	22.0	20.8	-1.2
Ireland	26.3	13.0	13.6	16.1	13.0	14.6	17.4	20.7	13.9	17.4	16.2	7.4	-8.8
Italy	19.4	25.1	28.1	25.5	23.1	19.2	19.1	20.5	20.4	21.7	22.8	19.5	-3.3
Latvia	23.0	24.8	21.9	18.9	20.6	20.1	15.8	14.3	12.2	11.9	13.2	15.2	2.0
Liechtenstein													
Lithuania	26.6	12.9	13.9	13.6	11.5	12.0	9.8	9.3	10.7	10.2	9.3	9.5	0.2
Luxembourg	12.9	12.7	8.0	10.5	8.7	7.0							
Rep. of Moldova	33.3	48.4							55.4	35.5	38.0	38.6	0.6
The Netherlands	45.4	43.5	45.3	43.2	14.5	23.5	20.7	17.5	9.4	17.2	17.9	15.3	-2.6
Norway	24.0	25.1	28.5	27.5	24.3	21.8	25.1	24.1	21.2	16.7	19.7	20.2	0.5
Poland	54.5	40.5	36.8	34.6	30.6	32.1	30.3	32.5	33.2	33.4	29.6	21.1	-8.5
Portugal	6.6	5.6	7.8	6.6	6.0	4.3	4.3	3.6	5.3	10.8	17.1		
Romania	15.2	10.4	10.3	9.0	9.1	9.8	9.6	9.9	9.8	7.6	4.7	5.2	0.5
Russian Fed.	10.1	9.4	0.0				9.8	10.0					
Serbia		4.4	7.9	6.0	9.2	10.0	21.3	7.3	39.6	19.8	21.3	12.6	-8.7
Slovak Rep.	52.0	41.0	42.2	40.3	40.2	37.9	38.7	40.4	39.7	36.2	35.3	42.4	7.1
Slovenia	33.6	26.0	32.5	36.7	38.0	34.5	32.2	31.4	35.3	37.4	33.8	32.1	-1.7
Spain	18.1	18.1	11.5	12.9	9.8	12.0	11.6	15.6	14.1	14.0	19.4	18.7	-0.7
Sweden	14.5	16.9	15.9	15.0	13.6	13.5	18.4	17.7	20.4	16.0	19.6		
Switzerland	23.2	21.4	19.9	19.7	18.3	33.0	19.1	19.9	13.3	27.4	28.2	22.5	-5.7
Turkey													
Ukraine	25.7	45.8	32.7	64.9	50.0	47.3	16.8	14.6	15.4	11.4	8.1	6.9	-1.2
United Kingdom	13.0	13.9	17.0	19.8	20.1	20.2	20.6	25.1	25.8	23.2	22.2	23.3	1.1

Austria: From 2003 on, results are based on the 16x16 km transnational gridnet and must not be compared with previous years.
Czech Republic: Only trees older than 60 years assessed until 1997. *France*: Due to methodological changes, only the time series 1997-2006 are consistent. *Italy*: Due to methodological changes, only the time series 1993-96 and 1997-2006 are consistent, but not comparable to each other. *Russian Federation:* North-western and Central European parts only. *Ukraine*: Due to a denser gridnet since 2005, results must not be compared with previous years.

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 (1995-2006)

Paticipating countries	Broadleaves Defoliation classes 2-4												change % points
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2005/ 2006
Albania				8.0	8.1	8.4	8.4	10.7		10.3		8.5	
Andorra									only conifers assessed				
Austria	6.5	11.6	12.2	9.6	9.4	7.6	10.4	11.3	10.2	13.6	12.9	20.1	7.2
Belarus	22.9	29.2	23.0	19.3	17.0	16.9	13.3	9.0	15.8	12.9	10.6	8.9	-1.7
Belgium	26.6	18.5	16.1	19.2	19.1	18.8	18.3	17.0	16.6	21.3	21.4	18.8	-2.6
Bulgaria	32.7	33.0	43.9	48.4	35.9	45.8	26.0	29.0	27.2	30.1	23.1	36.4	13.3
Croatia	35.2	26.0	27.8	21.9	16.8	18.3	18.7	14.4	14.3	17.2	19.2	18.2	-1.0
Cyprus									only conifers assessed				
Czech Rep.	30.6	34.0	26.5	13.5	17.1	21.4	21.7	19.9	24.4	31.8	32.0	31.2	-0.8
Denmark	39.7	36.1	28.4	30.1	18.8	13.9	8.5	15.4	16.6	19.1	14.4	14.8	0.4
Estonia	1.1	5.3	7.4	1.0	1.1	9.5	2.1	2.7	6.7	5.3	3.4	8.6	5.2
Finland	11.0	10.3	8.4	9.4	8.6	9.9	8.8	8.8	8.3	8.4	7.2	10.3	3.1
France	14.3	20.1	29.9	26.9	22.9	21.6	23.6	25.5	33.5	38.7	41.3	42.0	0.7
Germany	29.9	30.8	28.6	25.2	26.9	29.9	25.4	24.7	27.3	41.5	35.8	36.4	0.6
Greece	38.2	34.6	34.9	31.7	20.2	20.2	26.6	26.5			17.9		
Hungary	20.2	19.5	19.7	19.0	18.2	20.8	21.5	20.8	22.0	21.0	20.9	19.0	-1.9
Ireland									only conifers assessed				
Italy	18.5	31.2	38.0	38.9	39.3	40.5	46.3	44.6	45.0	42.0	36.5	35.2	-1.3
Latvia	10.0	11.4	11.3	13.6	14.2	22.2	14.8	12.8	13.5	14.3	12.9	8.5	-4.4
Liechtenstein													
Lithuania	20.8	12.2	15.9	19.7	11.8	17.7	16.3	19.0	24.6	21.8	15.4	16.6	1.2
Luxembourg	51.4	49.8	41.8	33.3	25.8	33.5							
Rep. of Moldova	40.5	41.1	30.0		41.4	29.2	36.9	42.5	42.3	33.9	26.4	27.6	1.2
The Netherlands	10.8	19.2	17.8	14.0	10.0	18.8	18.5	29.6	33.7	46.9	53.1	26.2	-26.9
Norway	47.4	45.0	38.9	42.2	44.8	34.0	33.7	30.4	29.0	33.2	27.6	33.2	5.6
Poland	46.7	37.4	35.8	34.8	31.1	32.0	31.4	33.1	39.6	38.7	34.1	18.0	-16.1
Portugal	10.4	8.3	8.6	12.0	13.7	13.2	12.8	12.6	16.2	19.0	27.0		
Romania	23.1	18.7	16.9	13.3	14.0	15.8	14.7	14.8	13.3	13.0	9.3	9.9	0.6
Russian Fed.	34.4							16.0					
Serbia		3.5	7.4	10.1	13.0	6.7	6.7	0.6	21.5	13.5	15.7	11.0	-4.7
Slovak Rep.	35.8	28.0	23.3	27.0	19.3	13.9	26.9	14.5	25.6	19.9	13.6	17.0	3.4
Slovenia	19.3	15.0	21.4	21.7	23.2	18.4	26.7	25.9	22.6	24.2	28.5	27.6	-0.9
Spain	28.7	20.7	15.8	14.4	16.1	15.7	14.4	17.3	19.1	16.1	23.3	24.4	1.1
Sweden	7.9	20.7	6.1	7.4	8.7	7.5	14.1	9.6	11.1	8.3	9.2		
Switzerland	27.0	19.8	12.5	18.1	20.4	22.1	16.3	16.0	18.1	32.8	27.9	22.6	-5.3
Turkey													
Ukraine	33.0	46.2	30.7	43.2	59.7	69.6	53.3	36.7	35.3	43.2	9.2	6.2	-3.0
United Kingd.	14.5	15.0	22.0	22.9	23.2	23.8	21.9	30.3	23.2	30.6	28.2	29.2	1.0

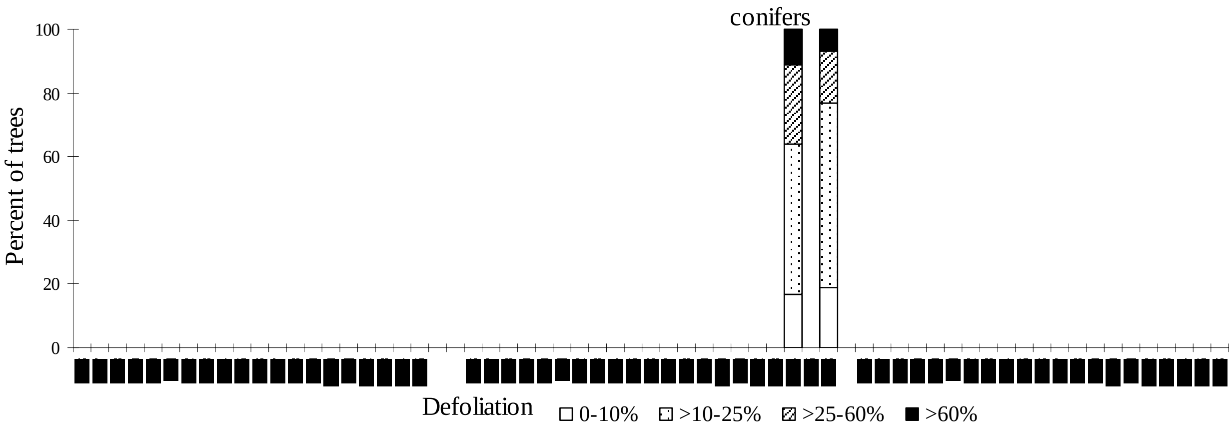
Austria: From 2003 on, results are based on the 16x16 km transnational gridnet and must not be compared with previous years.
Czech Republic: Only trees older than 60 years assessed until 1997. *France*: Due to methodological changes, only the time series 1997-2006 are consistent. *Italy*: Due to methodological changes, only the time series 1993-96 and 1997-2006 are consistent, but not comparable to each other.
Russian Federation: North-western and Central European parts only. *Ukraine*: Due to a denser gridnet since 2005, results must not be compared with previous years.

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.

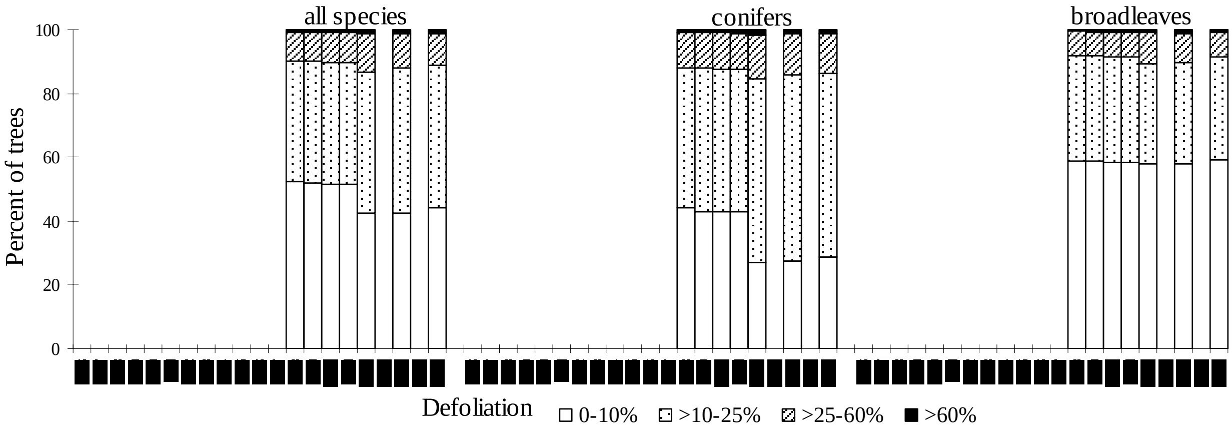
Annex II-8

Changes in defoliation (1986-2006)

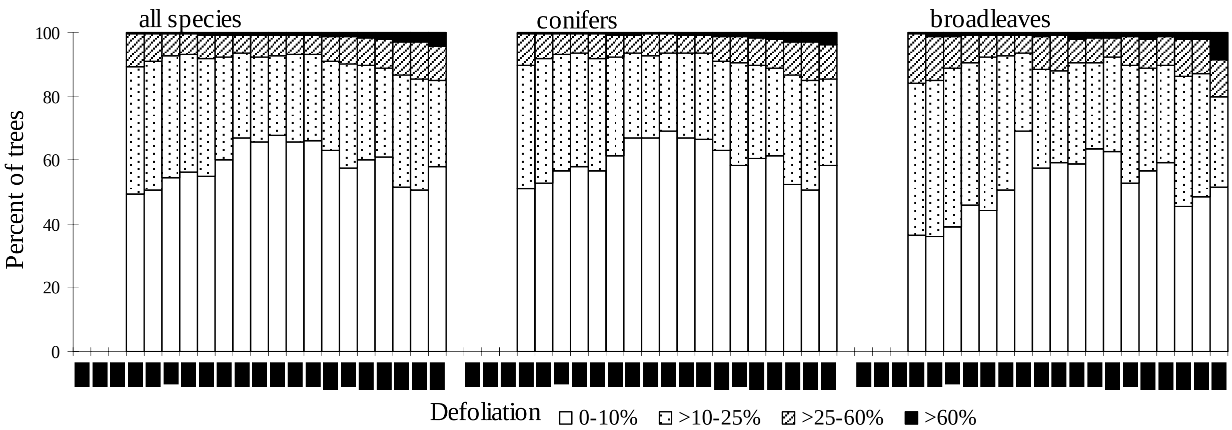
Andorra



Albania

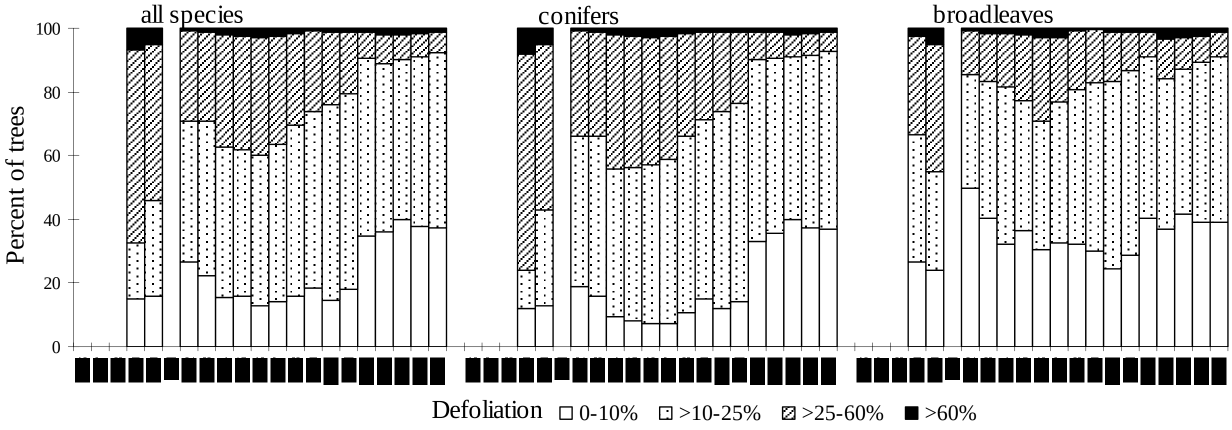


Austria *

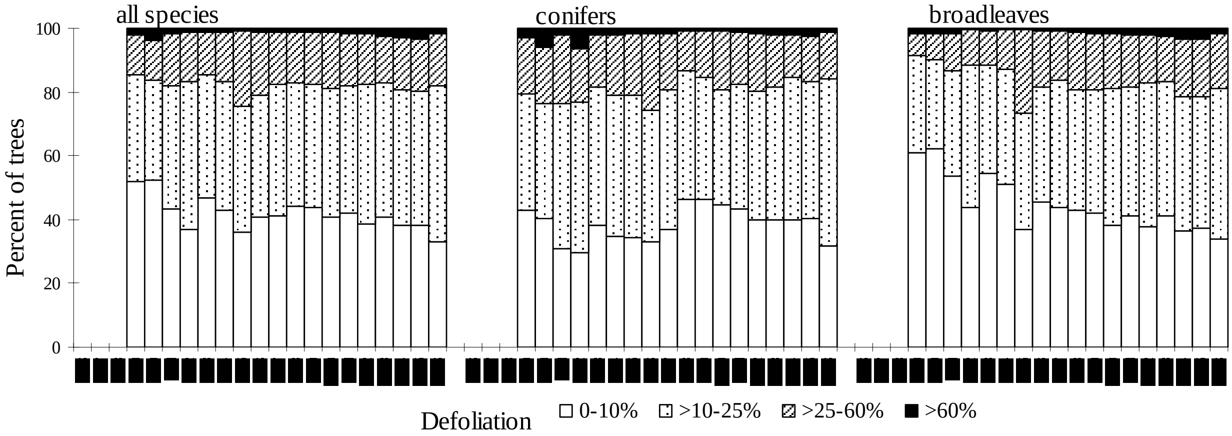


* from 2003 on, results are based on the 16x16 km transnational gridnet and must not be compared with previous years.

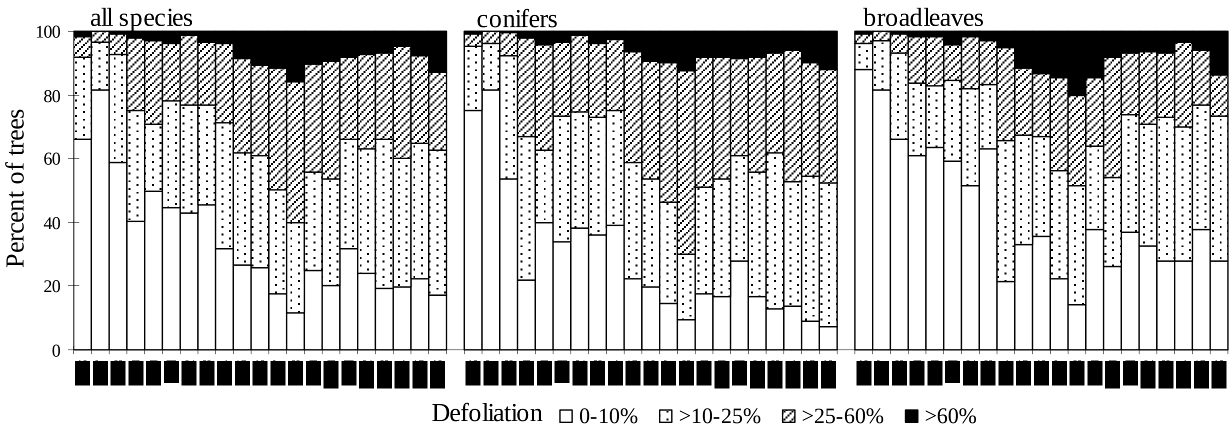
Belarus



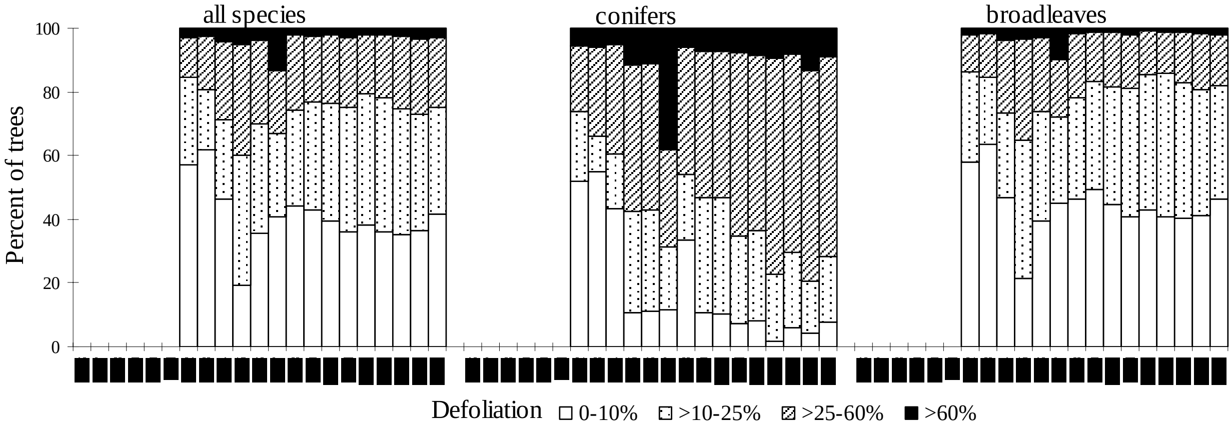
Belgium



Bulgaria



Croatia



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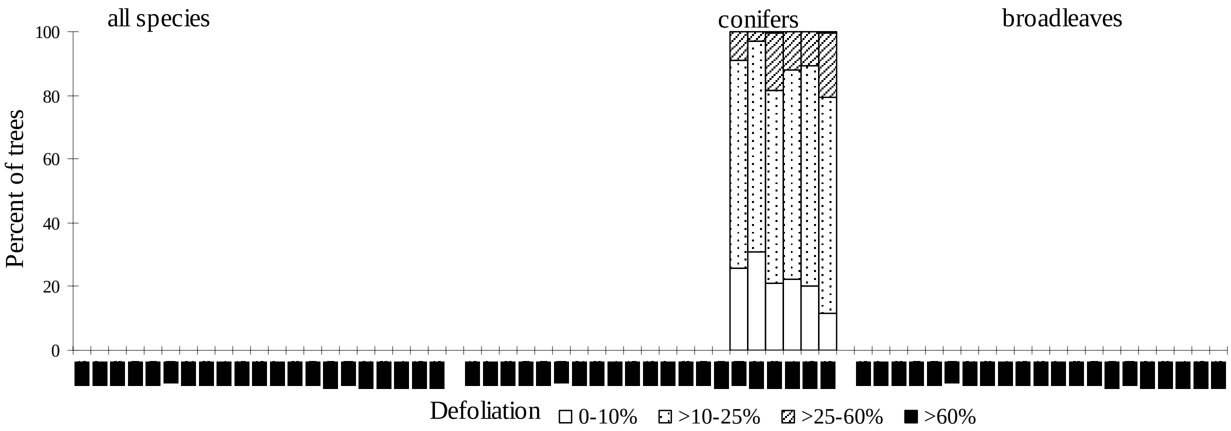
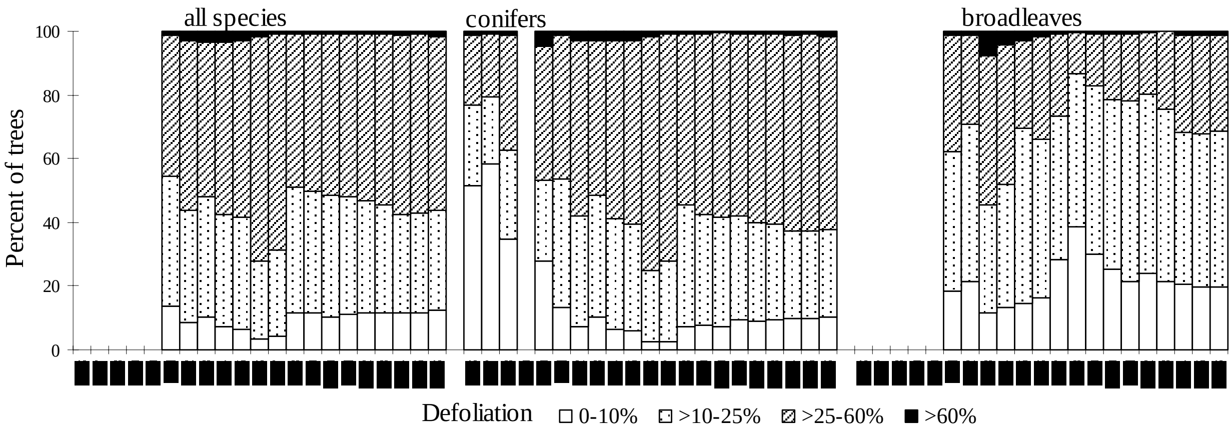
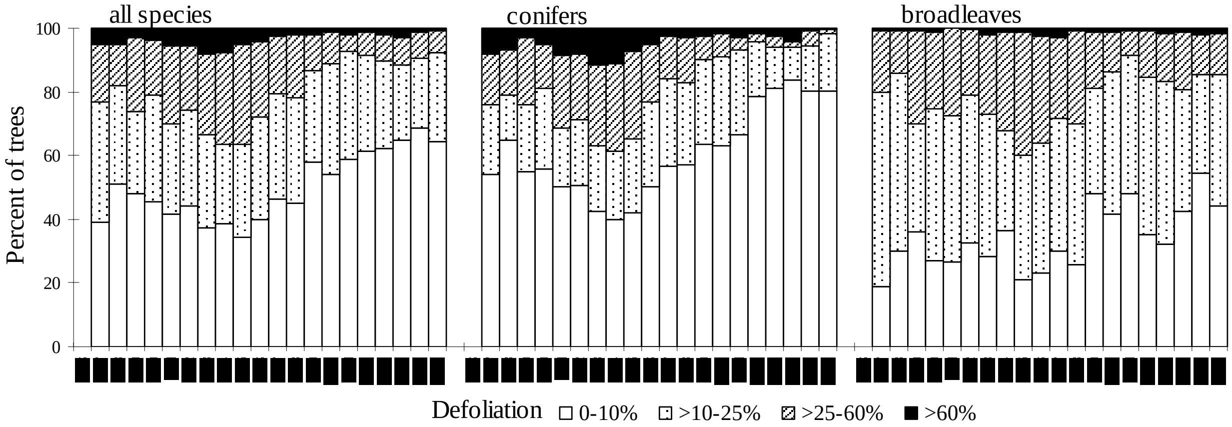


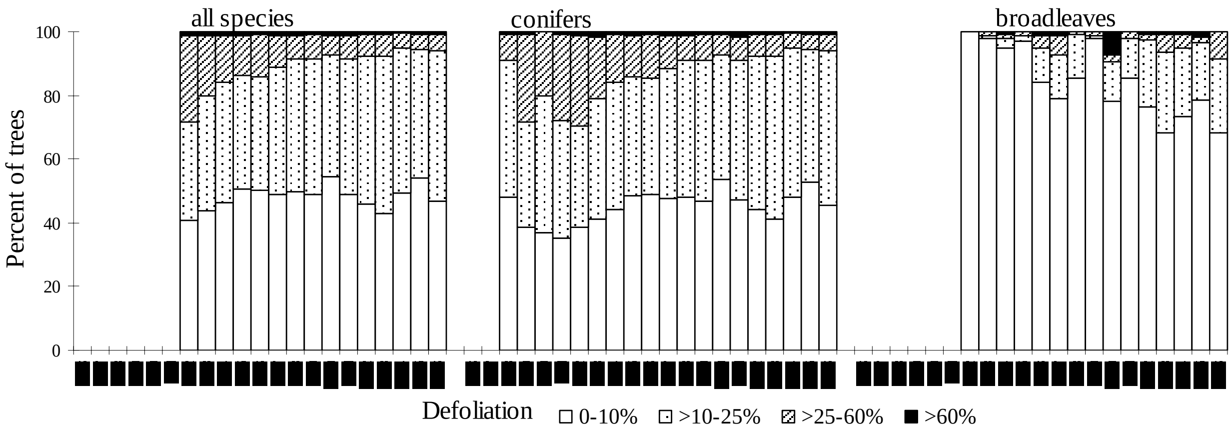
Czech Republic



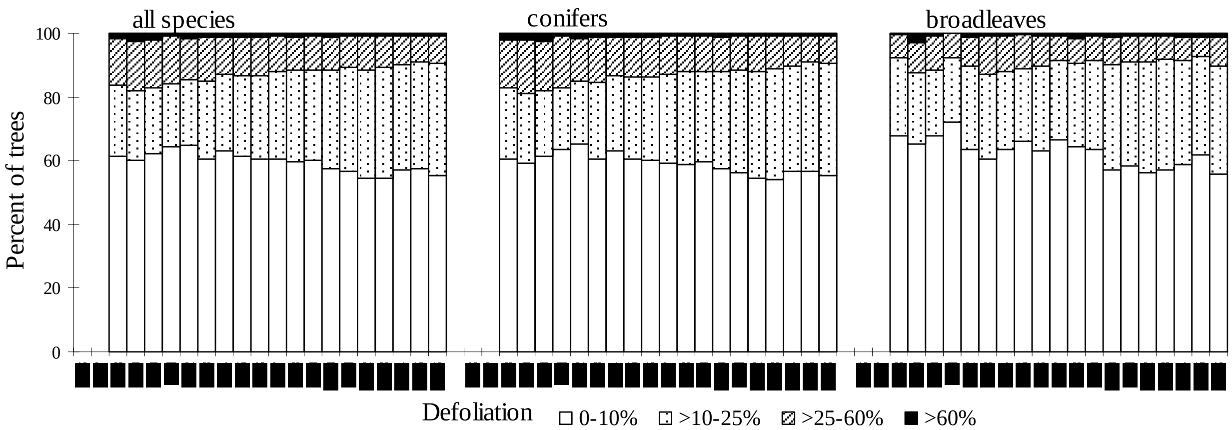
Denmark



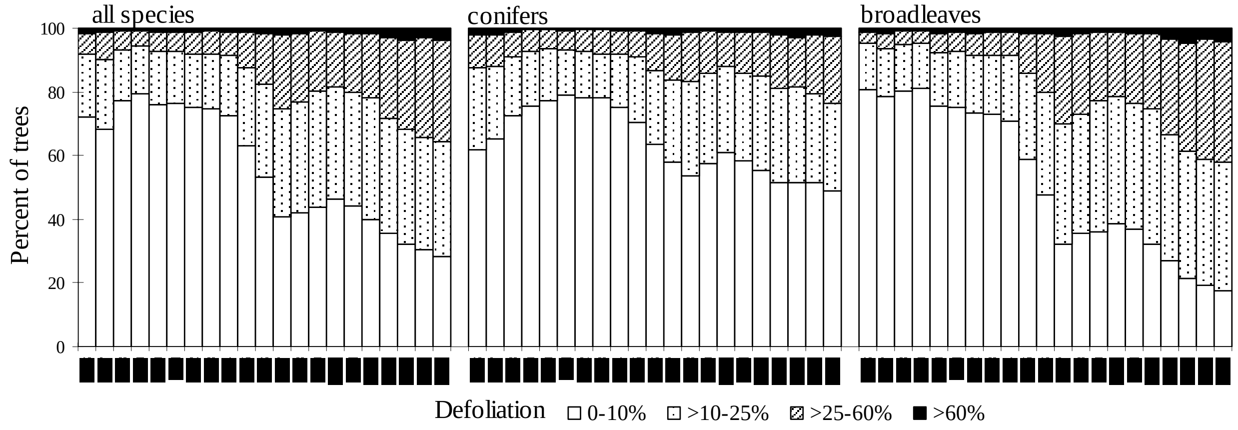
Estonia



Finland

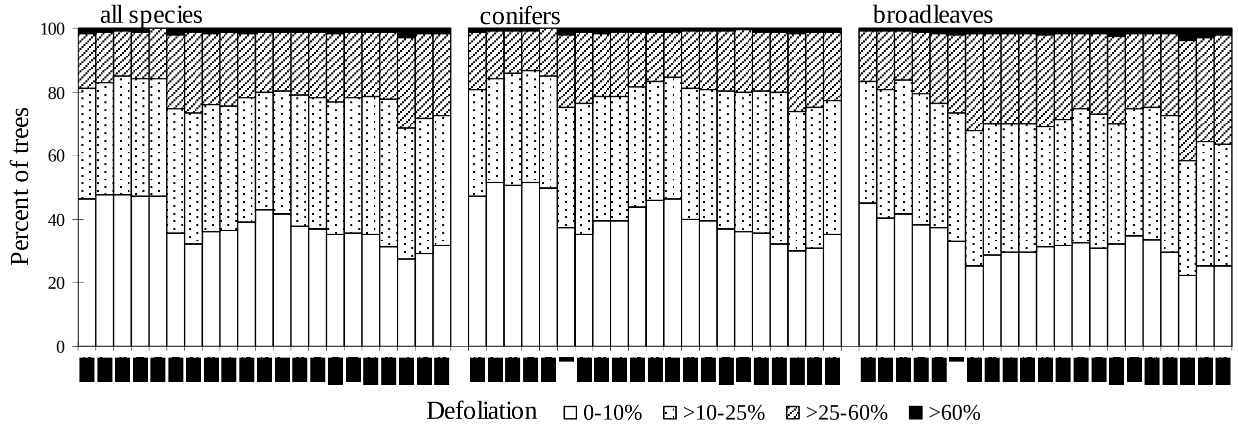


France *



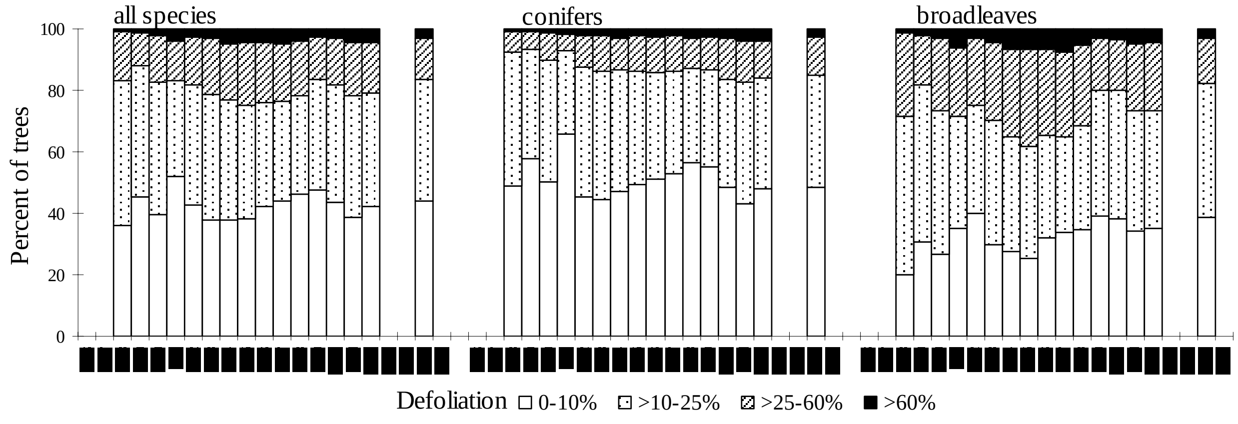
* due to methodological changes, only the time series 1988-94 and 1997-99 are consistent, but not comparable to each other.

Germany

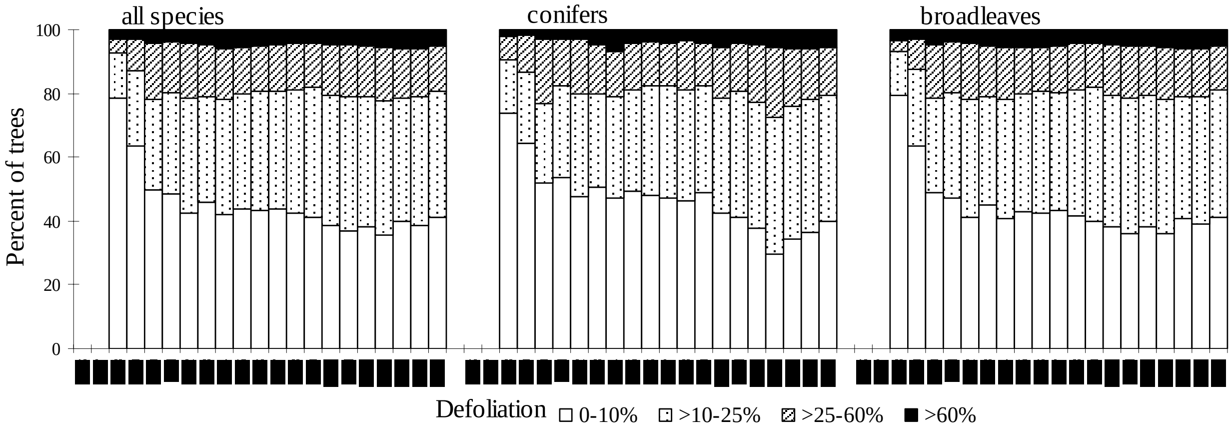


* since 1991 with former GDR

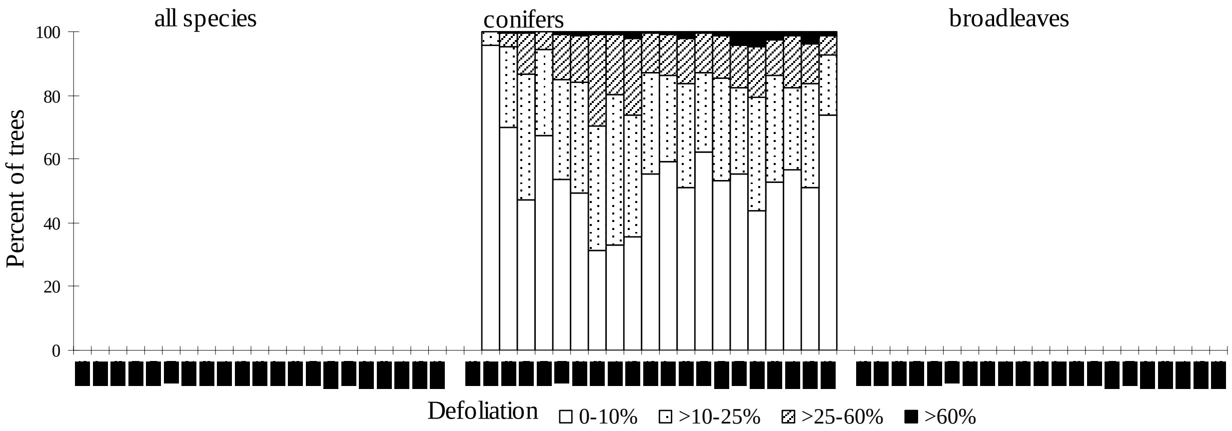
Greece



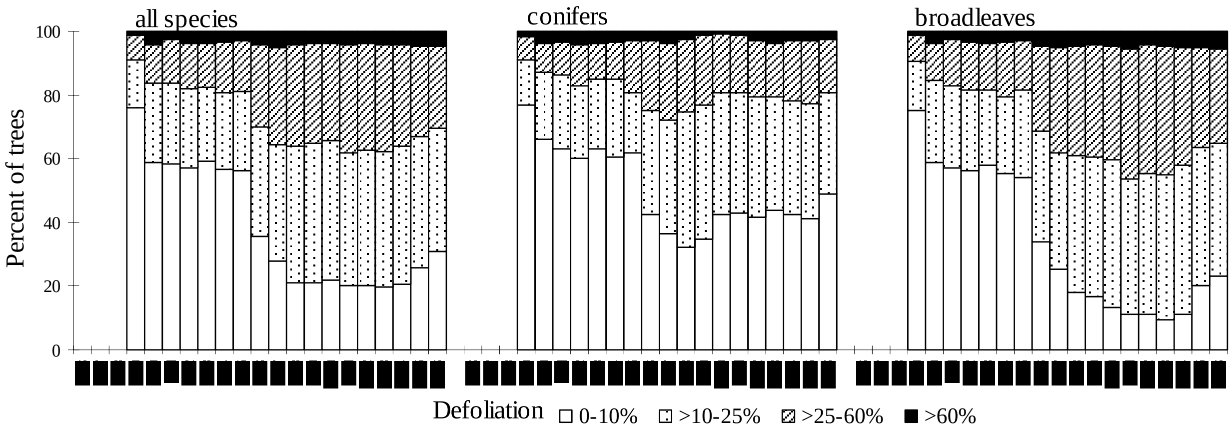
Hungary



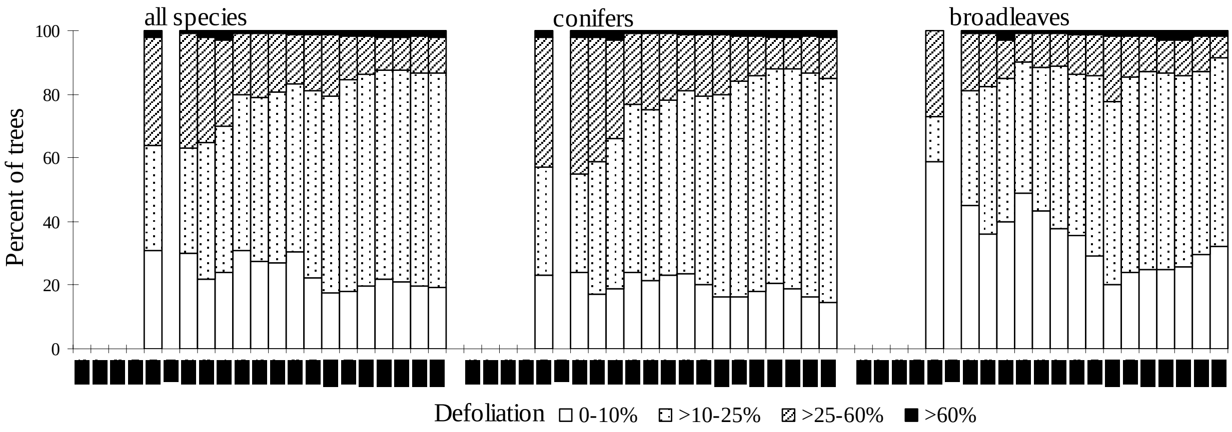
Ireland



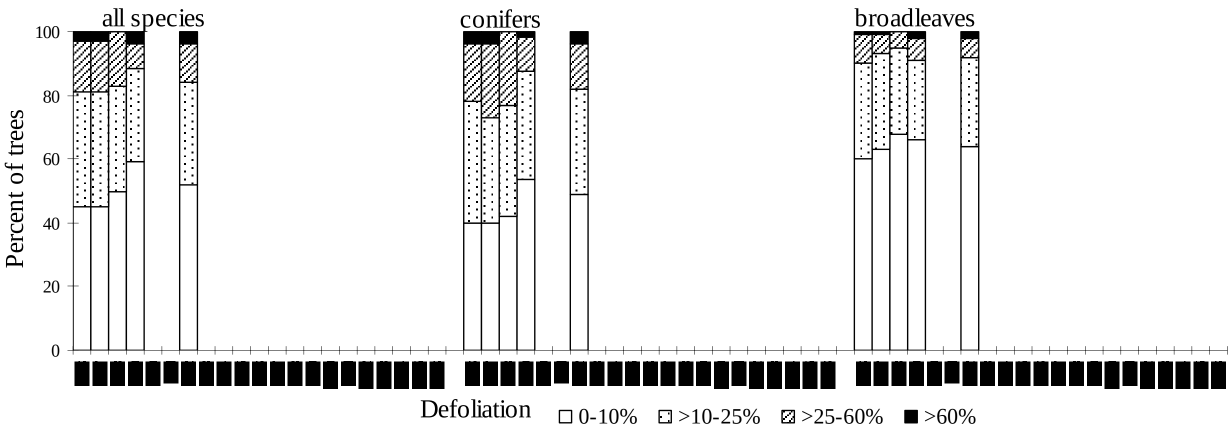
Italy



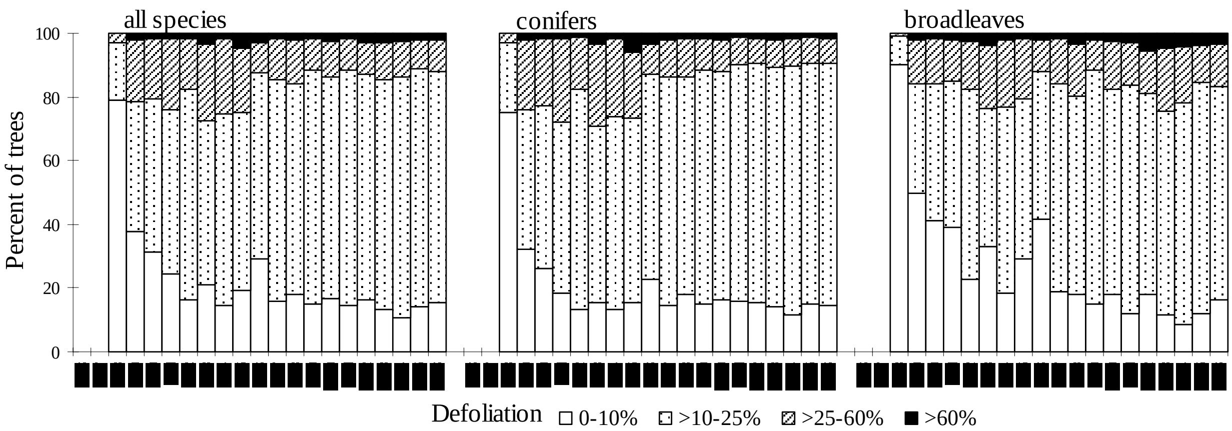
Latvia



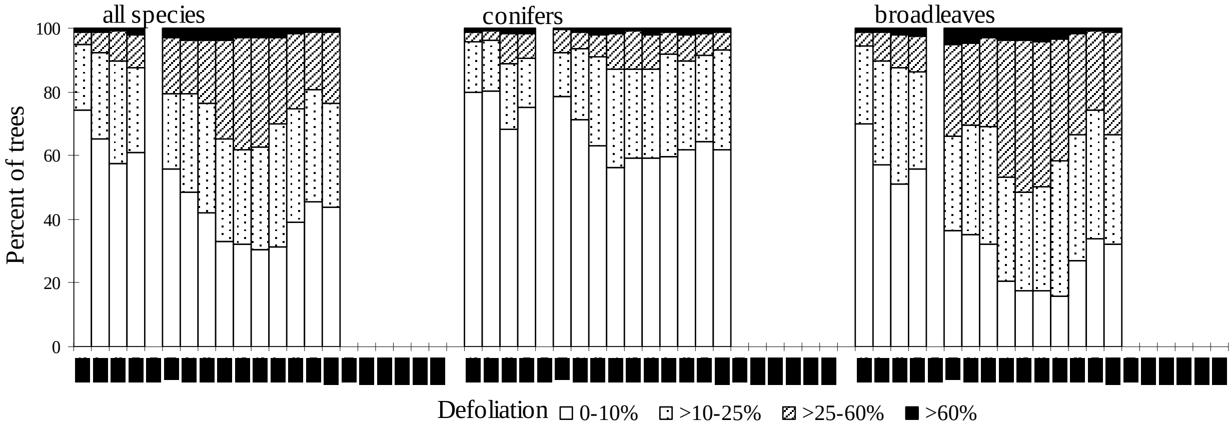
Liechtenstein



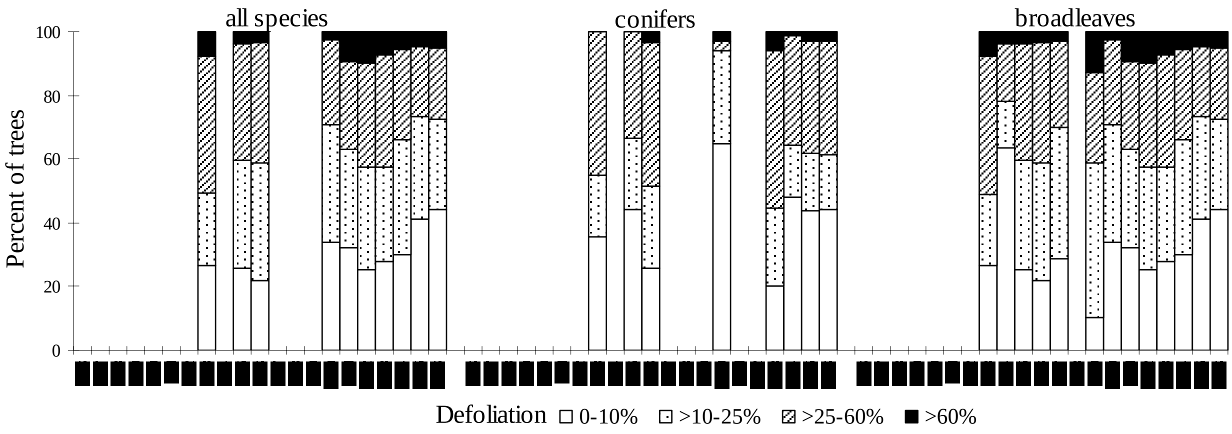
Lithuania



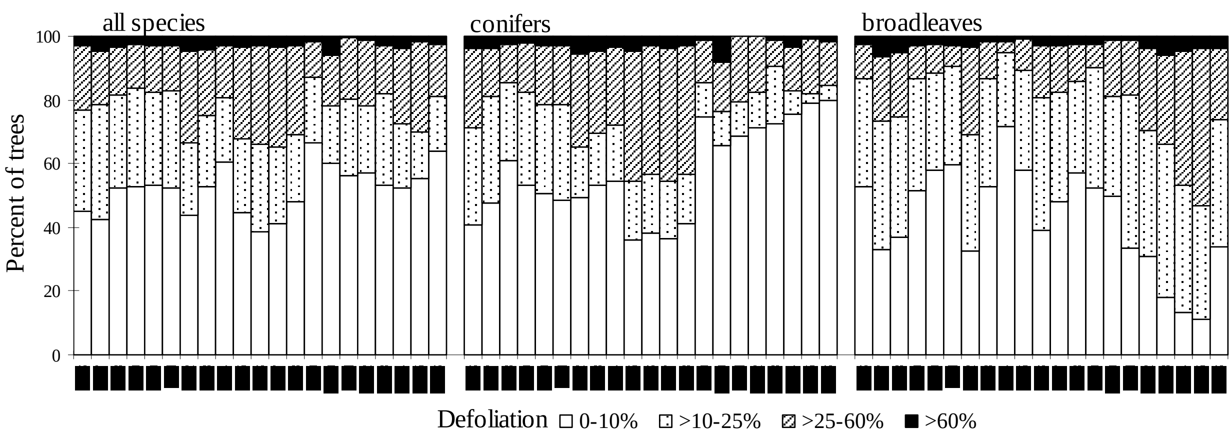
Luxembourg



Republic of Moldova

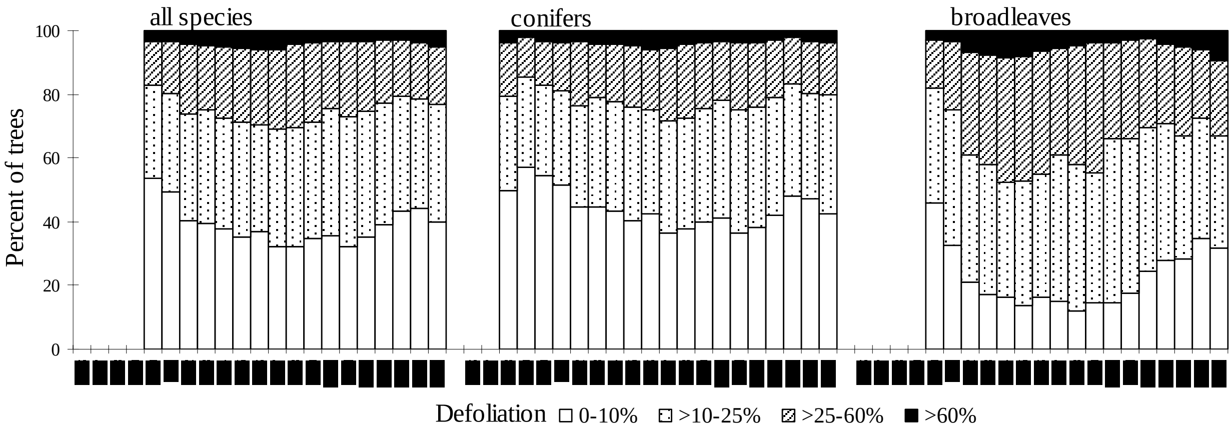


The Netherlands

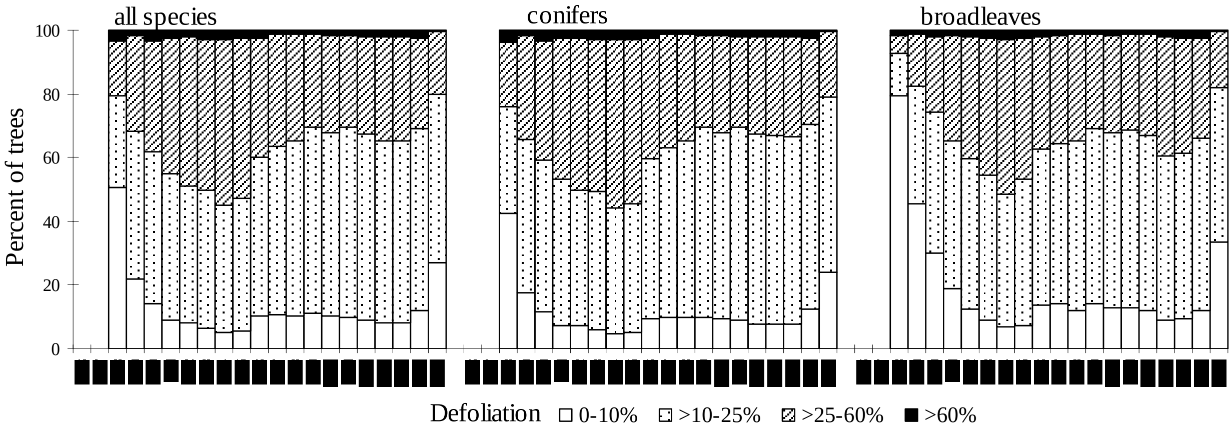


1989-1994: 1500 plots, 1995-1998: 200 plots, since 1999: 11 plots

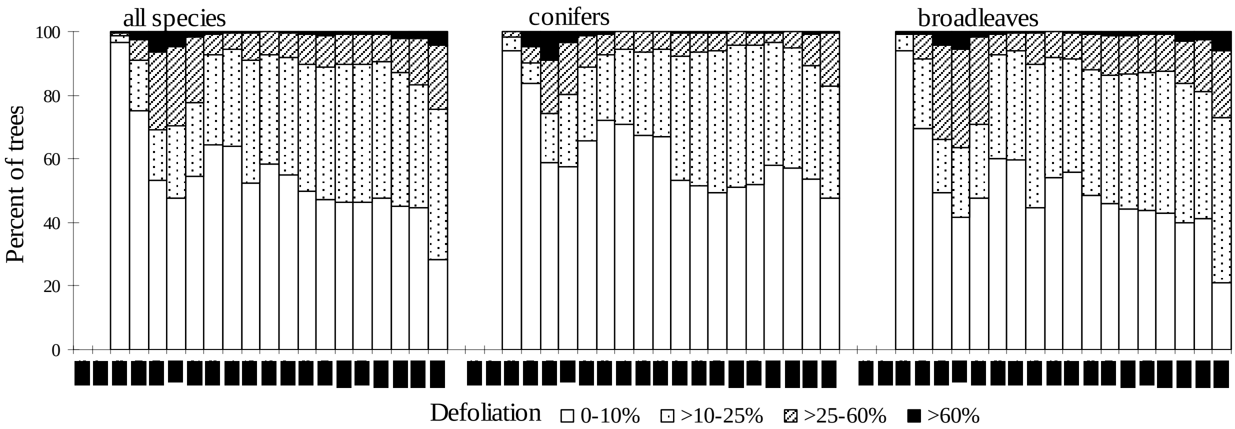
Norway



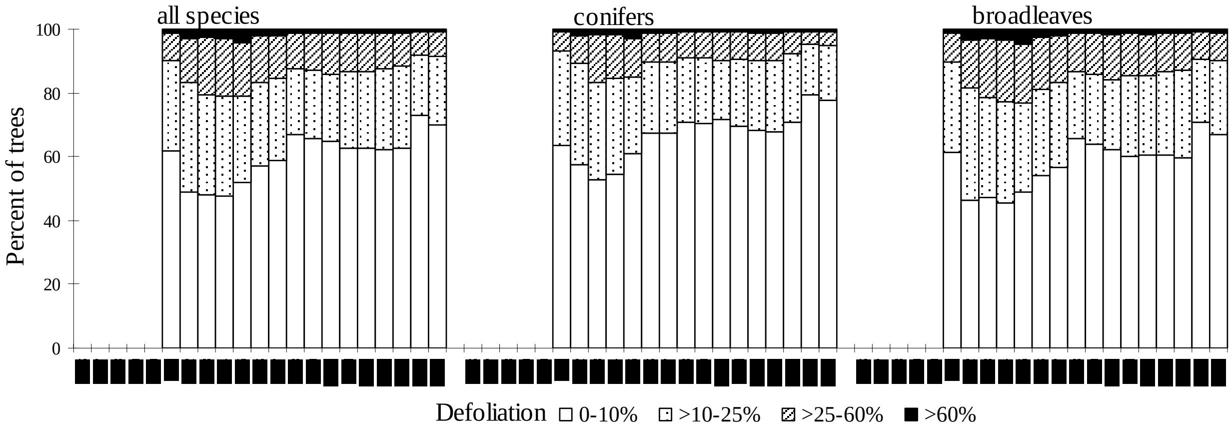
Poland



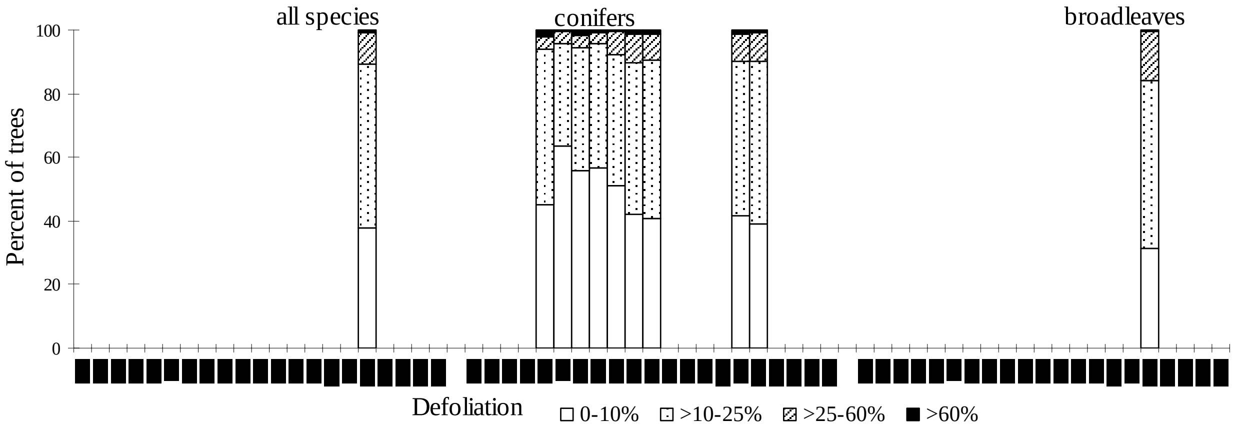
Portugal



Romania

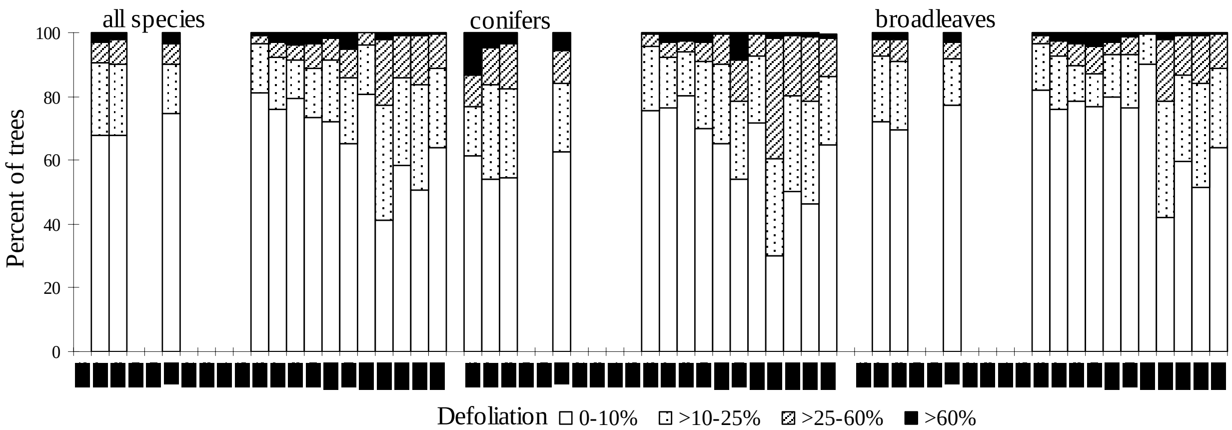


Russian Federation *

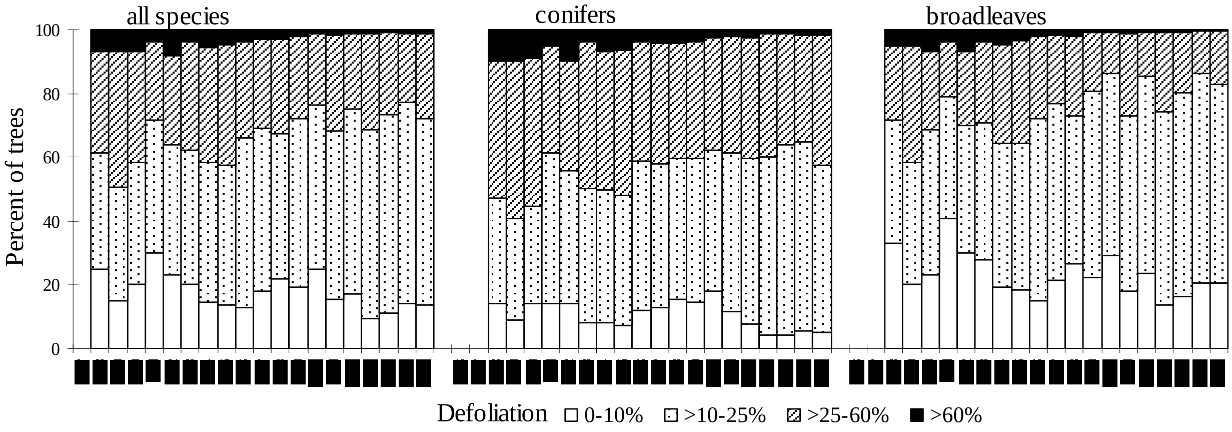


* Only regional surveys in north-western and Central European parts of Russia.

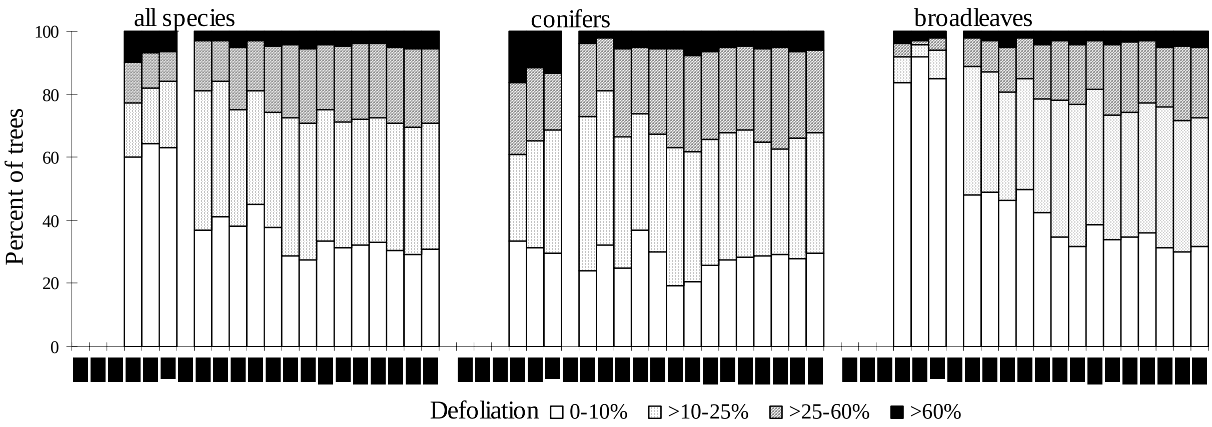
Serbia



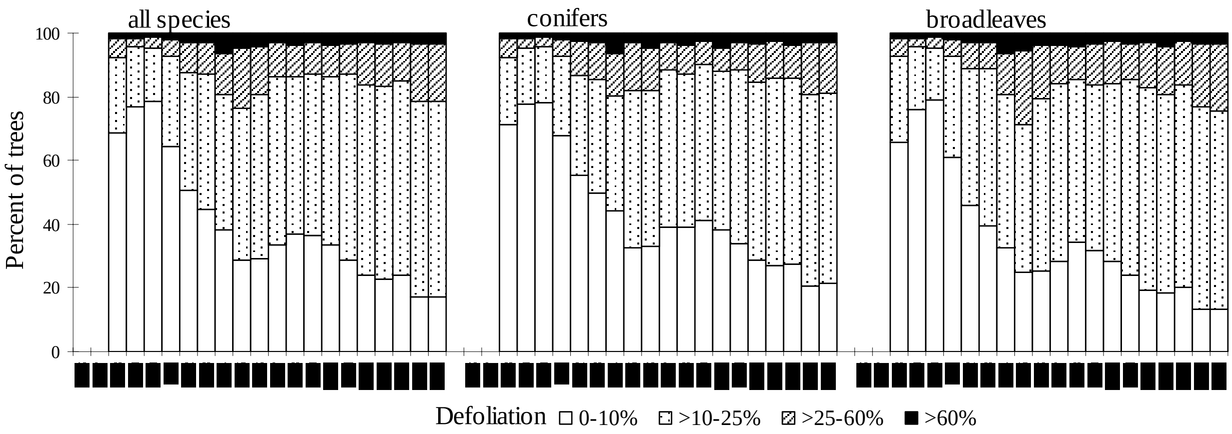
Slovak Republic



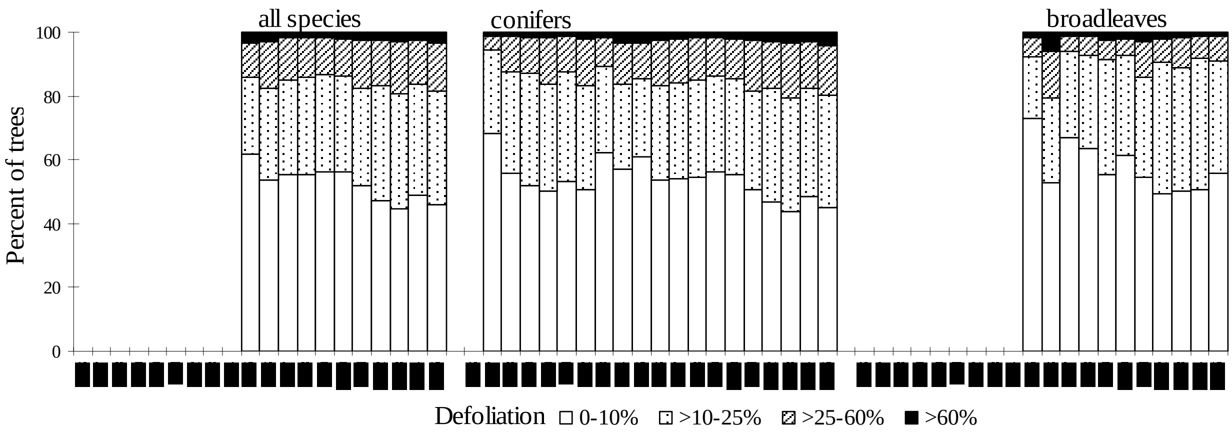
Slovenia



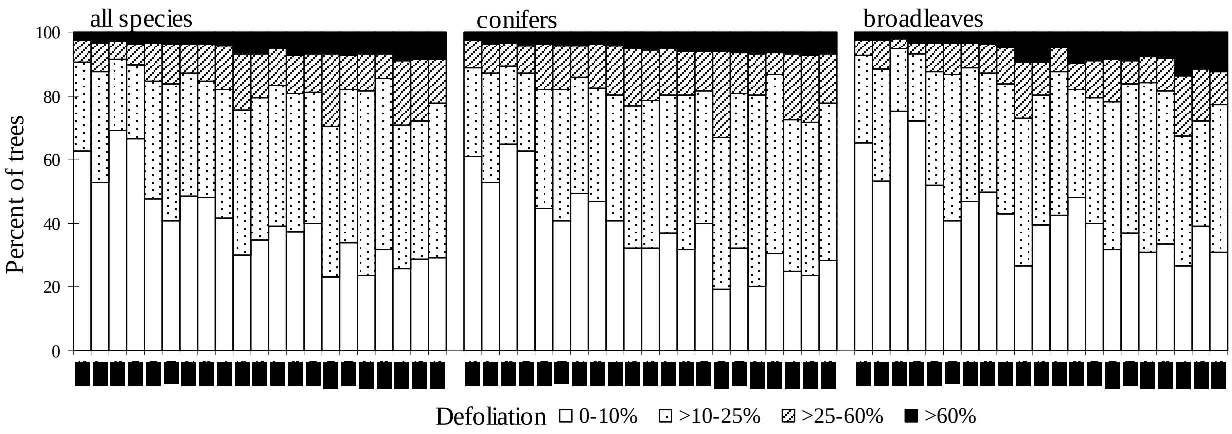
Spain



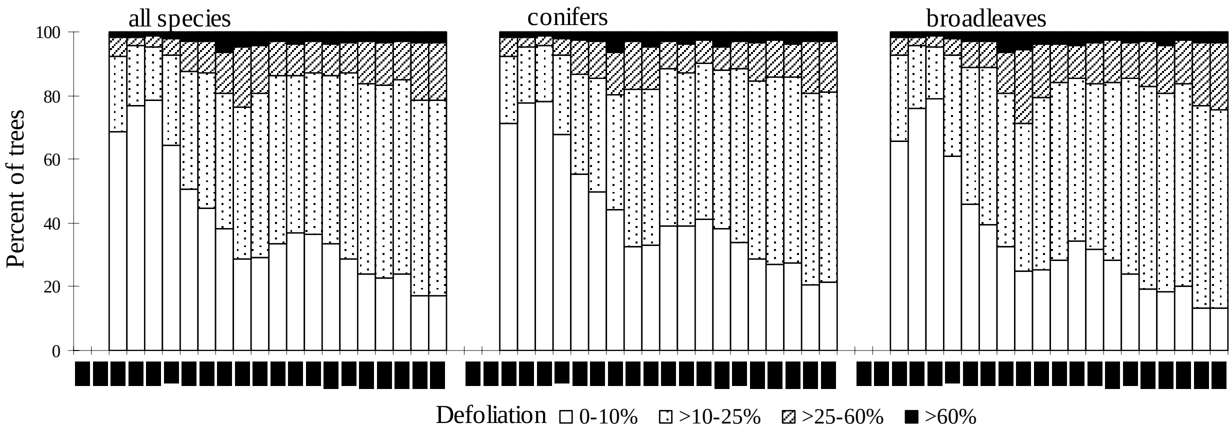
Sweden



Switzerland

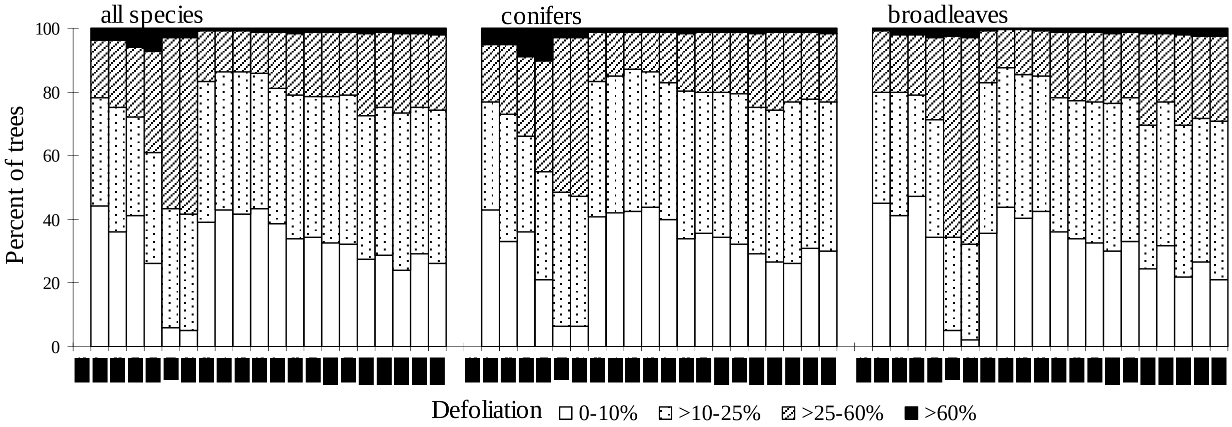


Ukraine



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:

$$t = \frac{\left|\bar{x}_{2006} - \bar{x}_{2005}\right|}{\sqrt{\frac{s^2}{n_{2006}} + \frac{s^2}{n_{2005}}}}$$

where $\bar{x}_{2006} - \bar{x}_{2005}$ is the difference in mean plot defoliation between the assessments in 2005 and 2006,

s - the standard deviation of these differences,

n_{2006}, n_{2005} - number of sample trees on plots being tested.

The standard deviation *s* is calculated as follows

$$s = \sqrt{\frac{(n_{2006} - 1)s_{2006}^2 + (n_{2005} - 1)s_{2005}^2}{n_{2006} + n_{2005} - 2}}$$

with standard deviations s_{2006}, s_{2005} derived from the defoliation scores for the years 2006 and 2005 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 90 70 107 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 Bundesforschungsanstalt für Forst- und Holzwirtschaft Leuschnerstr. 91 21031 HAMBURG GERMANY Phone: +49 40 739 62 100/Fax: +49 40 739 62 299 e-mail: m.koehl@holz.uni-hamburg.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: +49 228 529-4130/Fax: +49 228 529-4318 e-mail: sigrid.strich@bmelv.bund.de Ms Sigrid Strich
PCC of ICP Forests	Programme Coordinating Centre of ICP Forests Bundesforschungsanstalt für Forst- und Holzwirtschaft Leuschnerstr. 91 21031 HAMBURG GERMANY Phone: +49 40 739 62 140/Fax: +49 40 739 62 480 e-mail: lorenz@holz.uni-hamburg.de Internet: http://www.icp-forests.org Mr Martin Lorenz
EC	European Commission Directorate-General Environment Dir. B – Protecting the Natural Environment ENV.B.1 – Agriculture, Forests & Soil Herrn Ernst Schulte B-1049 BRUSSEL Internet: http://www.europa.eu.int/comm/environment Mr Ernst Schulte

European Commission - DG Joint Research Centre	Institute for Environment and Sustainability, LMU - INFOREST (TP 261) Via E. Fermi 1 21020 ISPRA (VA) ITALY http://inforest.jrc.it/ Phone: +39 0332 786138, Fax: +39 0332 785500 e-mail: jesus.san-miguel@jrc.it, Mr Jesus San Miguel Phone: +39 0332 786362 | Fax: +39 0332 789803 e-mail: annemarie.bastrup-birk@jrc.it Ms Annemarie Bastrup-Birk

2. Expert Panels, WG and other Coordinating Institutions

Expert Panel on Soil and Soil Solution	Laboratorium Bodemkunde Universiteit Gent Geologisch Instituut Krijgslaan 281 9000 GENT BELGIUM Phone: +32 9 264 46 37/Fax: +32 9 264 49 97 e-mail: eric.vanranst@ugent.be Mr Eric van Ranst, Chairman
	Research Institute for Forest and Nature Gaverstraat 4 9500 GERAARDSBERGEN BELGIUM Phone: +32 54 43 7111/Fax: +32 54 43 6160 e-mail: bruno.devos@inbo.be Mr Bruno De Vos, Co-Chairman
Working Group on Soil Solution	Finnish Forest Research Institute (METLA) Rovaniemi Research Station Eteläranta 55 96300 ROVANIEMI FINLAND Phone: +358 10 211 4552 / Fax: +358 10 211 4552 e-mail: john.derome@metla.fi Mr John Derome
Expert Panel on Foliar Analysis and Litterfall	Finnish Forest Research Institute Kaironiementie 54 39700 PARKANO FINLAND Phone: +358 10 2111/Fax: +358 10 211 4001 e-mail: pasi.rautio@metla.fi Mr Pasi Rautio, Chairman

Expert Panel on Forest Growth	Eidgenössische Forschungsanstalt für Wald, Schnee und Landschaft WSL Zürcherstr. 111 8903 BIRMENSDORF SWITZERLAND Phone: +41 44 739 25 94/Fax: +41 44 739 22 15 e-mail: dobbertin@wsl.ch Mr Matthias Dobbertin, Chairman
	Bundesforschungs- und Ausbildungszentrum für Wald, Naturgefahren und Landschaft (BFW) Seckendorff-Gudentweg 8 1131 WIEN AUSTRIA Phone: +43 1 878 38 1327/Fax: +43 1 878 38 1250 e-mail: markus.neumann@bfw.gv.at Mr Markus Neumann, Co-Chairman
	Forest Research Station Alice Holt Lodge Wrecclesham, Farnham Surrey GU10 4LH United Kingdom e-mail: Sam.Evans@forestry.gsi.gov.uk Mr Sam Evans, Co-Chairman
Expert Panel on Deposition Measurements	Norwegian Forest and Landscape Institute Raveien 9 1432 AS NORWAY Phone: +47 64 94 8892/Fax: +47 64 94 2980 e-mail: Nicholas.Clarke@skogoglandskap.no Mr Nicholas Clarke, Chairman
Working Group on Ambient Air Quality	CEAM c/Charles Darvin, 14 46980 PATERNA SPAIN e-mail: MJose@ceam.es Ms M. Sanz, Chairwoman
	Eidgenössische Forschungsanstalt für Wald, Schnee und Landschaft (WSL) Zürcherstr. 111 8903 BIRMENSDORF SWITZERLAND Phone: +41 44 7392 564/Fax: +41 44 7392 215 e-mail: marcus.schaub@wsl.ch Mr Marcus Schaub, Vice-Chairman

Expert Panel on Crown Condition Assessment	Nordwestdeutsche Forstliche Versuchsanstalt Grätzelstr. 2 37079 Göttingen GERMANY Phone: +49 551 69401 222/Fax: +49 551 -69401-160 e-mail: johannes.eichhorn@nw-fva.de Mr Johannes Eichhorn, Chairman Mr Marco Ferretti, Vice-chairman e-mail: marcoferretti_004@fastwebnet.it Mr Andras Szepesi, Vice-chairman e-mail: szepesi.andras@aesz.hu
ad hoc Group on Assessment of Biotic Damage Causes	Institute for Forestry and Game Management Gaverstraat 4 9500 GERAARDSBERGEN BELGIUM Tel. +32 54 43 71 15/Fax: +32 54 43 61 60 e-mail: peter.roskams@inbo.be Mr Peter Roskams, Chairman
ad hoc Group on Quality Assurance within Crown Condition Assessments	Forest Research Station Alice Holt Lodge, Wrecclesham FARNHAM SURREY GU10 4LH UNITED KINGDOM Phone: +44 1 420 526202/Fax: +44 1 420 23653 e-mail: d.durrant@forestry.gov.uk Mr. Dave Durrant
Expert Panel on Biodiversity and Ground Vegetation Assessment	Coillte Teoranta Research and Development Newtownmountkennedy CO. WICKLOW IRELAND Phone: +353 120 11 162/Fax: +3531 20 111 99 e-mail: Pat.Neville@coillte.ie Mr Pat Neville, Chairman Ministry for Agriculture and Forestry Policy VI Div. - National Forest Service CONECOFOR Office via Carducci 5 00187 ROMA ITALY Phone: +39 06 46656084/184/284/Fax: +39 06 42815632 e-mail: conecofor@corpoforestale.it Mr Bruno Petriccione, Co-Chairman
WG on Quality Assurance and Quality Control in Laboratories	C.N.R. Institute Ecosystem Study Largo Tonolli 50 28922 Pallanza (VB) ITALIA Phone: +0323 518300/Fax: +0323 556513 e-mail: r.mosello@ise.cnr.it Mr Rosario Mosello, Chairman

Expert Panel on Meteorology and Phenology	Bavarian State Institute of Forestry Am Hochanger 13 85354 FREISING GERMANY Phone: +49 (8161) 71 – 4921Fax: e-mail: ras@lwf.uni-muenchen.de Mr Stephan Raspe, Chairman
	Finnish Forest Research Institute Punkaharju Research Station Finlandtie 18 58450 PUNKAHARJU FINLAND Phone: +358 211 4010/Fax: +358 211 4001 e-mail: egbert.beuker@metla.fi Mr Egbert Beuker, Co-chairman Phenology
FFCC	Bundesamt und Forschungszentrum für Wald Seckendorff-Gudent-Weg 8 1131 WIEN AUSTRIA Phone: +43-1-87838-1114/ Fax:+43-1-87838-1250 e-mail: alfred.fuerst@bfw.gv.at Mr Alfred Fürst
FSCC	Research Institute for Forest and Nature - INBO Gaverstraat 4 9500 GERAARDSBERGEN BELGIUM Phone: + 32 (0) 54 43 61 75/Fax: + 32 (0) 54 436160 e-mail: FSCC@inbo.be Ms Nathalie Cools

3. Ministries (Min) and National Focal Centres (NFC)

Albania (Min)	Ministry of the Environment Dep. of Biodiversity and Natural Resources Management Rruga e Durresit Nr. 27 TIRANA ALBANIA Phone: +355 4 270 630 7 624 Fax: +355 4 270 627 e-mail: cep@cep.tirana.al
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