International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests

United Nations
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for Europe

European Commission

Forest Condition in Europe

Results of the 1993 Survey

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PREFACE

With the present report the United Nations Economic Commission for Europe (UN/ECE) and the European Union (EU) continue their series of common Forest Condition Reports. The first of this kind was published in 1992. The report describes the results of both the national and the transnational crown condition surveys, which are conducted annually within the International Cooperative Programme on the Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) of UN/ECE and under EU-Council Regulation (EEC) 3528/86 on the Protection of the Community's Forests against Atmospheric Pollution. These two programmes have the objective to continuously monitor and document the extent and development of recent forest damage in Europe, as well as to contribute to cause-effect studies.

ICP Forests was launched under the Convention on Long-range Transboundary Air Pollution in 1985, which in the meantime has been signed by 37 Parties. Of these Parties, 32 states and the European Union are participating in ICP Forests. Also participating are Estonia, Latvia and Moldavia, which are expected to sign the Convention in the near future.

Every year the participating countries submit reports on the results of their national forest damage surveys to the Programme Coordinating Centre West (PCC West) of ICP Forests. Canada and the United States of America also report annually on their research and forest health monitoring programmes in North America.

In 1987, 11 EU-Member States started surveying forest damage annually on the plots of a uniform (16x16 km) large-scale transnational grid, along with a number of site parameters. Since 1988 all 12 EU-Member States have been participating in this survey. Since 1990 this network has been gradually extended, as 15 non-EU countries have joined this survey. These countries are Austria, Croatia, Czech Republic, Estonia, Finland, Hungary, Lithuania, Moldavia, Norway, Poland, Romania, the Slovak Republic, Slovenia, Sweden and Switzerland. Altogether there are now 27 European countries participating in the transnational survey. These countries submit their transnational data either to the European Commission or directly to PCC West of ICP Forests. At PCC West the data are evaluated for the preparation of the annual report.

The preparation of the present report was made possible thanks to

- the submission of forest condition data by the participating countries,
- financial support granted by the European Union,
- voluntary financial contributions granted by UN/ECE member states,
- the calculation of geographical coordinates of the inventory grid intersection points by the European Commission, Corine project, DG XI.

SUMMARY

The main objective of the present report is a condensed description of the condition of forests in Europe, as it has been assessed by transnational and national surveys of the United Nations Economic Commission for Europe (UN/ECE) and the European Union (EU). The report presents survey results from 35 European countries, referring to about 26 000 sample plots with about 558 000 sample trees. Of 222 million hectares of forests in Europe as reported by the participating countries, around 181 million hectares have been covered by the surveys (3 million less than in 1992). The results of the 1993 survey indicate that forest damage continues to be a problem in Europe, as a significant proportion of the forests shows signs of defoliation and/or discolouration.

The transnational survey results for 1993 revealed that 22.6% of the total sample of around 102 800 trees had been defoliated by more than 25% and are thus classified as damaged. The respective value in 1992 was 23.5%, which was 0.9 percent points higher than this year.

In 1993 the share of trees with a discolouration of more than 10% was 10.0% of the total tree sample. This change is insignificant (0.1 percent points lower) as compared with the previous year (10.1%).

As regards the two main species groups, 20.4% of the total broadleaves were damaged in 1993. This indicates that the broadleaves are now in a slightly better condition than the conifers, of which 23.9% were damaged. Among the most common species, the most severely affected broadleaved species was *Quercus* spp. (deciduous) with 27.1% damaged trees, followed by Other broadleaves with 22.7% trees damaged. Among the conifers, *Abies* spp. and *Picea* spp. showed the highest percentages of trees classified as damaged (36.7% and 26.5%, respectively).

In the subsample of common trees, the proportion damaged increased between 1988 and 1993 in all of the 12 species analyzed. Among the conifers, *Picea sitchensis* showed the greatest increase, from 4.6% in 1988 to 33.8% in 1993. This was probably due to *Elatobium.* Amongst broadleaved species, there was a dramatic increase in damage in *Quercus suber,* from 0.7% in 1988 to 44.0% in 1991, but the share of damaged trees decreased rapidly from 36.2% in 1992 to 9.5% in 1993. Damage in *Quercus robur* increased remarkably from 12.9% in 1988 to 26.8% in 1993.

In both the national and the transnational survey the most important probable causes for the observed defoliation and discolouration were reported to be adverse weather conditions, insects, fungi, air pollution and forest fires. Very little direct impact from known pollution sources was reported, but this does not exclude the possibility of more widespread effects of air pollution. Particularly in the main damage areas of some countries, but also in several other regions, air pollution is considered as of major concern, because the atmospheric concentrations and the depositions of several air pollutants are thought to exceed the critical levels and loads for forest ecosystems. These countries regard air pollution as the most important factor causing forest damage. The majority of the remaining countries consider air pollution as a predisposing factor leading to the weakening of forest ecosystems.

The great spatial and temporal variation in the survey results emphasizes the importance of continued monitoring of defoliation and discolouration and additional assessments of various ecological data which may contribute to a better understanding of cause-effect relationships. Therefore, within the cooperation between UN/ECE and EU, in addition to the

large scale crown condition assessment, an integrated monitoring system is being established. This intensive monitoring aims at the recognition of factors and processes with special regard to the impact of air pollutants on the more common forest ecosystems. This is accomplished by means of a number of subjectively selected permanent monitoring plots, on which a soil inventory, foliar analyses, deposition measurements and increment studies will be conducted.

1. INTRODUCTION

Eight years of continuous monitoring of forest condition and more than a decade of cause-effect research have changed the understanding of forest decline in Europe considerably. In the early 1980s forest decline as diagnosed by means of defoliation and discolouration of trees was mainly tried to be explained by means of several hypotheses involving the effects of air pollution. The reasons for this were the rapid dynamics of forest damage at many locations, the absence of obvious classical damaging agents, an increasing awareness of the impact of air pollution on the environment and the results of cause-effect research on several forest sites. Cause-effect research revealed a multitude of factors and mechanisms, with air pollution being involved to differing extent in certain regions. In the europewide monitoring of forest condition established in the mid 1980s, defoliation and discolouration became the key parameters, because they constituted the most obvious symptoms and were relatively easy to assess. The continuous large-scale monitoring could not contribute to cause-effect research because of the low specificity of these parameters, but reached its objective to document the large scale development of forest condition in Europe. The previous reports on the forest condition assessments in Europe have shown us that air pollution has caused less dramatic damage than feared in the early 1980s at the large scale, but that a general worsening of forest condition is to be observed in many regions. In certain regions the damage is severe and locally catastrophical, particularly at locations where air pollution is high.

The present report documents forest condition in Europe, as it has been assessed in the surveys of UN/ECE and EU in 1993, and the development of forest condition since the beginning of the monitoring. The content of the present report has been structured as follows:

Chapter 2 describes the principles of the survey methods. The knowledge of the methodical background is indispensable for the interpretation of the results. Chapter 2.6 focusses on the problem of interpretation, as numerous misinterpretations of the results have occurred in the past.

Chapter 3 presents the results of the 1993 surveys. The transnational results (Chapter 3.1) reflect forest condition in Europe as a whole. These results refer to correlations between the symptoms assessed and the site parameters. The national reports (Chapter 3.2) reflect forest condition in particular countries and focus on its interpretation in connection with various damaging factors. Corresponding to the mandate of the Programme, this interpretation pays particular attention to the effects of air pollution. The interpretation given for the respective participating country under Chapter 3.2 represents the official opinions of the responsible authorities.

Both the transnational and the national survey results are interpreted together in Chapter 4, also with special regard to the effects of air pollution. These interpretations represent the view of the members of the two Programmes of UN/ECE and EU.

Chapter 5 presents the conclusions drawn from the survey results and their interpretation.

In Chapter 6 the references used for the survey methods and the former Reports are cited. Annexes I and II provide maps, graphics and tables relevant to the transnational and national results, respectively. Annex III provides a list of species names in Latin and 11 other languages. Annex IV contains a list of the Focal Centres and Ministries of the participating countries.

2. METHODS OF THE 1993 SURVEYS

2.1 Overview

The following chapters describe the basic methods of both the transnational and the national surveys. This description refers to the selection of sample plots and sample trees, the assessment of defoliation, discolouration and additional parameters as well as to the evaluation and presentation of the survey results. For methodical details the ICP Forests Manual (UN/ECE, 1994), the Commission Regulations (EEC) 1696/87 and 926/93of EU and the EU-Council Regulation (EEC) 3528/86 should be consulted. Chapter 2.6 discusses the interpretation of the survey results, for which the basic knowledge of the survey methods is essential.

2.2 Selection of sample plots

2.2.1 Transnational survey

The **transnational survey** aims at the documentation of the development of forest condition on the European level. This is achieved by means of a large scale monitoring of tree vitality using uniform survey methods in a systematic way and by assessing a number of site parameters on a 16x16 km transnational grid of sample plots. In several countries the plots of this transnational grid are a subsample of a denser national grid (Chapter 2.2.2).

The transnational grid was created in Gauss-Kriiger projection. The latitude and longitude of the sampling points were then obtained by means of a reprojection of the grid points to geographical coordinates. These coordinates were calculated and provided to the participating countries by the Corine project of the EU. If a country outside the EU had already established plots with coordinates deviating from the calculated ones, the existing plots were accepted, provided that the mean point density resembled that of a 16x16 km grid, and that the assessment methods corresponded to those of the ICP Forests Manual and the relevant Commission Regulations. The fact that the grid is currently less dense in parts of the boreal forests can be shown to be of negligibly small influence due to the homogeneity of these forests and their current forest condition.

2.2.2 National surveys

The **national surveys** aim at the development of forest condition in the respective country and are therefore conducted on national grids. The densities of these national grids vary between lxl km and 32x32 km due to differences in the size of forest area, in the structure of forests and in forest policies. Because of differences in species composition and site conditions and use of different reference trees, comparisons between the two surveys and between different countries should be made with great care.

2.3 Selection of sample trees

Within both the national and transnational surveys, at each sampling point positioned on forest land, 20-30 sample trees are systematically selected according to a statistically sound procedure. The tree sample includes all tree species, provided the trees have a minimum height of 60 cm. Only predominant, dominant, and co-dominant trees (according to the system of KRAFT) without significant mechanical damage qualify as sample trees. Trees removed within management operations or blown over by wind must be replaced by newly selected trees. A special evaluation of the replaced trees has shown that, due to the small percentage of removed trees, this replacement does not distort the assessment results.

2.4 Assessment parameters

2.4.1 Defoliation and discolouration

On each plot the defoliation and discolouration of the sample trees are assessed in comparison to a reference tree of full foliage. If no reference tree can be found in the vicinity of the sample trees, photo guides suitable for the region under investigation may be used.

In the transnational survey defoliation is reported in general in 5% steps, and discolouration in discoluration classes. The national survey results for defoliation are reported by most countries in 10% steps. This assessment down to the nearest 5 or 10% permits studies of the annual variation of foliage with far greater accuracy than the traditional system of only 5 classes of uneven width. Nevertheless, some countries still report their national results by means of the traditional classification. Discolouration in the national surveys is reported by all countries using the traditional classification. The traditional classification for defoliation and discolouration is shown in Table 2.4.1-1.

The assessment does not permit separating changes in crown density or discolouration attributable to air pollution from those caused by other factors. As a consequence, defoliation due to any other causes is included, although known causes should be recorded during the assessment.

Field assessment methods and damage symptomatology are subject to continuous discussion and periodic revision.

Table 2.4.1-1: Defoliation and discolouration classes according to UN/ECE 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%	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	100%	dead

2.4.2 Additional parameters

On the plots of the transnational survey, additional parameters have to be assessed as laid down in Commission Regulation (ECE) 926/93. The following information has to be submitted for each plot:

country, plot number, plot coordinates, altitude, aspect, water availability, humus type, soil type (optional), mean age of dominant storey, tree numbers, tree species, observations of easily indentifiable damage, date of observation.

2.5 Evaluation and presentation of the survey results

The parameters assessed in the transnational survey are submitted treewise and plotwise to the EU before being screened and evaluated at PCC-West of ICP Forests. The national survey results are submitted to PCC-West as country related mean values, however, classified according to species and age groups. The data sets are accompanied by national reports providing explanations and interpretations.

The survey results are expressed mainly in terms of the percentages of the tree sample falling into the traditional 5 defoliation or discolouration classes. This traditional classification reflects to a certain extent the experience gathered in central Europe between 1980 and 1983. At that time, any loss of foliage exceeding 10% was considered as abnormal, indicating an incipient stage of impaired forest health. Furthermore, assumptions based on physiological observations of the vitality of differently defoliated trees led to the establishment of the uneven class widths. Because of these reasons and in order to ensure comparability with previous presentations of survey results the traditional classification of both defoliation and discolouration has been retained for comparative purposes, although it is considered arbitrary by some countries.

In many cases only a distinction has 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. The reason for this is that trees of a defoliation up to 25% are looked upon as "undamaged" (Chapter 2.6), with a defoliation of >10-25% indicating a "waming-stage". Classes 2, 3 and 4 represent considerable defoliation and are thus referred to as "damaged". Similar to the sample trees, the sample points are referred to as "damaged" if the mean defoliation of its trees (expressed as percentages) falls into class 2 or higher. Otherwise the sample point will be considered as "undamaged".

In order to allow certain comparisons to be made between results of subsequent years, subsamples have been defined which consist of those sample trees that have been observed over two or more consecutive years.

The most important results have been tabulated separately for all countries having participated (called "total Europe") and for the EU-Member States. For those countries, from which suitable data sets of their national survey have been received, the basic results of the national surveys are presented in 10% defoliation classes in order to enhance resolution and thus to be able to study changes in defoliation. All tree species are referred to by their proper botanical names, i.e. in Latin. Annex III-1 provides a list of species names in Latin and 11 other languages.

2.6 Interpretation of the survey results

The survey results show especially the spatial distribution and the temporal development of forest condition in Europe, if interpreted carefully. This is in well agreement with the objectives of the common large-scale survey of ICP Forests and EU. Care must be taken in the interpretation in order to avoid wrong conclusions. This holds true particularly for the explanation of any potential causes of forest damage and for all regional and temporal comparisons of the survey results. The following paragraphs pay particular attention to limitations of the interpretability, which in the past have frequently led to misinterpretations. Typical misinterpretations are the explanation of the normal variability of defoliation in forest stands as damage, the explanation of abnormal defoliation and discolouration as mainly an effect of air pollution, and the comparison of forest condition between countries and regions without regard to the problem of intercalibration.

Crown density even of a healthy tree strongly depends on a variety of factors, such as genotype, age and site conditions. Forest condition assessment tries to eliminate these factors by comparing the crown density of the sample trees with that of the local reference trees or photo guides, which are assumed to represent the typical crown density of a healthy tree. The selection of proper sample trees, though within the responsibility of trained personnel familiar with the local habitus of the trees, is principally subject to bias. This means that no perfect intercalibration can be reached. Besides the insufficient intercalibration, the estimation of defoliation percentages by itself is biased. For these reasons any interpretation of defoliation assessments from different regions must account for the limited comparability of the assesement results.

The defoliation assessed on the sample trees constitutes the loss of needles or leaves in comparison to that of the reference tree. As a consequence e.g. a high altitude spruce tree of a certain defoliation percentage will have a lower absolute crown density than a spruce tree at low altitude, to which the same defoliation percentage was assigned. This means that the assessment results as documented by means of tables, graphics and maps, are relative quantities to be interpreted as deviations from the local standard, and not as absolute crown density values.

Defoliation is an indicator of the general physiological condition of a tree, and subject to a large variety of influencing factors. A certain variability of defoliation in a forest stand is quite natural and not necessarily to be interpreted as a sign of deteriorating health. For instance, conifers regulate their amount of foliage according to the availability of moisture and nutrients or as a response to weather conditions. Broadleaves which have lost foliage due to late frost or insect attack may replace part of the loss with new leaves or may compensate for the loss without showing any growth reductions. A defoliation of up to approximately 25% (defoliation classes 0 and 1) is thought to often constitute natural variation only. Forest condition assessment therefore attempts to account for the natural variation by considering trees of defoliation classes 0 and 1 as undamaged.

A defoliation larger than 25% (defoliation classes 2, 3 and 4) is considered as damaged, but must be interpreted carefully because its causes are in the most cases unknown. The identification of obvious damaging agents must be reported, but does not necessarily explain the entire defoliation assessed. Many of the possible causes responsible for the defoliation assessed have been known ever since as classical forest diseases, such as insects and fungi, and do not necessarily imply a long term decline. This means that any damage observed must only be interpreted as recent forest damage, if it is really recent, enduring and not explainable by classical damaging agents. Also, due to the lacking specifity of defoliation as a stress symptom, any forest damage documented in the tables, graphics and maps of the present report hardly permits interpretations with respect to air pollution.

It has been claimed that the severity of forest damage is underestimated as a result of the replacement of dead trees by living trees. Detailed statistical analyses of the results of 8 monitoring years, however, clearly indicate that the number of dead trees has remained so small that their replacement has not significantly influenced the results. A statistical distortion of this kind could occur on sites of severe forest dieback at certain locations. Large-scale monitoring of forest condition, however, does not reflect forest condition at the scale of small areas.

The fact that local forest dieback does not necessarily reveal itself in large-scale monitoring results is a good example for the difficulties arising from regional comparisons. In the present Report, the maps documenting the transnational results must be interpreted bearing in mind that they do not necessarily reflect the particular forest condition in individual small areas or in countries. Therefore the figures in the maps are not suitable for comparisons between small areas or countries. Although forest condition in particular countries is reflected in the national results, even comparisons between these must be made with extreme care because of the already mentioned differences in intercalibration and in the application of the methods.

As recent forest damage is understood as a long term process, the interpretation of forest condition data should focus on trends rather than on statical information. For the interpretation of trends the limited comparability of data between countries is of only little relevance.

As regards the interpretation with respect to air pollution, the results of the large-scale assessment (Level I) must be supported by the results from permanent plots with higher monitoring intensity. Such interpretations have already partly been provided by a number of countries based on their existing permanent sample plots. Considerable additional information will become available from the higher intensity monitoring on permanent plots (Level II) of ICP Forests and EU.

3. RESULTS OF THE 1993 SURVEY

3.1 Transnational survey

3.1.1 The sample trees and plots in 1993

In 1993 the extension of the transnational grid continued. With 102 800 sample trees assessed on 4 791 sample plots in 27 countries, the 1993 transnational sample was the most comprehensive ever. Compared to a tree sample of 94 699 in 1992, there was an increase by 8 101 trees, or 8.6%. This increase was partly caused by the inclusion of the newly participating countries Croatia, Moldavia and Slovenia, and partly by the resumption of the transnational survey in the Czech Republic. Compared to the 26 389 trees of the first transnational survey in 1987, the total tree sample is now nearly four times as large. The considerable extension of the grid since 1987 is partly due to the completion of the grid within EU-Member States, but mainly the consequence of the participation of non-EU-Member States since 1990. The non-EU-Member States now hold more than half of the total tree sample. In addition, Spain and Denmark provided completely new datasets ranging back to 1987 and 1989, respectively. Tables 3.1.1-1 and 3.1.1-2 list the plot and tree samples of the actual database, and are thus not comparable with respective lists in previous reports.

Table 3.1.1-1: Numbers of sample plots from 1987 to 1993 according to the actual database

Country	Number of sample plots						
	1987	1988	1989	1990	1991	1992	1993
Belgium	11	33	33	29	29	29	29
Denmark			25	25	25	25	25
France	75	228	509	514	513	505	506
Germany	300	299	298	412	411	414	412
Greece		84	104	101	101	98	96
Ireland	22	22	22	22	22	22	22
Italy	189	208	206	206	208	204	215
Luxemburg	4	4	4	4	4	4	4
Netherlands	14	14	14	14	14	14	13
Portugal	108	154	152	152	151	149	143
Spain	322	388	457	447	436	462	460
United Kingdom	75	75	76	72	74	72	69
EU	1120	1509	1900	1998	1988	1998	1994
Austria				72	79	77	76
Croatia							84
Czech Republic		79		87		146	175
Estonia							90
Finland					358	412	404
Hungary				67	66	65	65
Lithuania						73	74
Moldavia							12
Norway						387	390
Poland				475	476	476	476
Romania						215	167
Slovak Republic						111	111
Slovenia							34
Sweden					622	603	594
Switzerland				45	45	45	45
Total Europe	1120	1588	1900	2744	3634	4608	4791

Table 3.1.1-2: Numbers of sample trees from 1987 to 1993 according to the actual database

Country	Number of sample trees						
	1987	1988	1989	1990	1991	1992	1993
Belgium	264	792	791	684	686	673	689
Denmark			600	600	600	600	600
France	1806	4465	10192	10280	10255	10093	10118
Germany	8062	7919	7883	10616	10664	10799	10729
Greece		1979	2463	2392	2392	2320	2272
Ireland	535	461	462	458	458	460	462
Italy	5059	5536	5695	5759	5799	5728	5942
Luxemburg	96	96	96	96	96	96	95
Netherlands	280	280	278	279	280	280	260
Portugal	2274	4621	4569	4563	4587	4513	4308
Spain	5905	9313	11074	10794	10557	11088	11040
United Kingdom	1803	1791	1811	1726	1770	1728	1656
EU	26389	37607	45572	48402	48014	48233	48171
Austria				2132	2244	2167	2121
Croatia							2016
Czech Republic		1975		2175		3635	4352
Estonia							2160
Finland					3899	4545	4427
Hungary				1351	1371	1348	1361
Lithuania						1768	1843
Moldavia							288
Norway						4001	4016
Poland				9496	9520	9520	9520
Romania						5155	4004
Slovak Republic						5251	5144
Slovenia							816
Sweden					12166	12223	12036
Switzerland				479	495	488	525
Total Europe	26389	39582	45572	64035	77709	98334	102800

In contrast to previous years, the UK data this year are based on an assessment of crown density made with reference to a tree with full foliage growing under the same local conditions as the assessed trees, rather than with reference to photographs of fully-foliated trees growing under ideal conditions. This explains the apparently large change in defoliation since 1992. The change makes possible a better comparison of results with those of other countries.

In 1993, a share of 60.9% of all sample trees accounted for **coniferous species** and a share of 39.1% for **broadleaved species.** The respective shares in the 1992 survey were 60.1%, and 39.9%, indicating that the proportions have changed slightly in favour of the coniferous trees. This can be explained by the participation of Estonia and particularly of the Czech Republic, in which the overwhelming part of the sample trees is coniferous. Annex I-1 documents the spatial distribution of the conifers, the broadleaves and the maquis over the area surveyed. Each plot was assigned to the species group which comprised the majority of trees on the plot.

The number of **species** assessed in 1993 was 111, so that the relative occurrence of the most species was generally low (Annex 1-2). As in previous years, *Pinus sylvestris* representing 24.9% and *Picea abies* with 23.3% of all trees accounted for nearly half of the total tree sample. Their share has slightly increased in 1993, also mainly because of the participation of Estonia and the Czech Republic. The six most frequent species accounted for more than two thirds of all trees assessed. Besides *Pinus sylvestris* and *Picea abies,* these species were *Fagus sylvatica* (8.8%), *Quercus robur* (4.2%), *Pinus pinaster* (3.4%) and *Quercus ilex* (2.9%).

Mean age was reported for 83.6% of all plots assessed. This percentage was slightly smaller than in 1992 (86.4%), as this parameter was not reported by the Czech Republic.

Water availability was reported for 55.6% of all plots. This share increased slightly since 1992 (52.4%), because water availability was reported for nearly all plots of the newly participating countries.

As in the previous years, **soil unit** was reported only for a very small share of the plot sample. However, whilst until 1992 soil unit had only been reported from Austria and Germany, in 1993 it was also reported for nearly all plots of Estonia and Greece. As a consequence, the share for which soil unit was reported increased from 2.5% in 1992 to 6.2% in 1993. This share is expected to increase far more in the future years, as many countries will conduct soil analyses on their plots.

Altitude was reported for 79.5%, **aspect** for 74.3% and **humus type** for 65.4% of the total plot sample. Defoliation and discolouration were also evaluated with respect to these parameters, however, results are not presented. As in recent years, the analysis of these parameters has not led to conclusive results, partly because these parameters were assessed on a smaller number of plots. This does not mean, however, that these parameters should not be assessed any more in the future. On the contrary, these parameters may become of importance for future extended evaluations of trends in particular regions or for particular species.

Easily identifiable damage types including game and grazing, insects, fungi, abiotic agents, action of man, fire, known pollution and other were reported for 29.8% of the total tree sample.

In order to calculate the changes in defoliation and discolouration between two successive years without any bias due to changing numbers of trees, a subsample of so called **Common Sample Trees (CSTs)** has been defined every year. This subsample comprises only those sample trees which have been observed both in the particular survey and in the year preceeding it. For the period of 1992-1993 this subsample contained 84 969 trees or 82.7% of the grand total of trees. This is an increase by 12.9 percent points as compared to the previous period, when the CSTs comprised only 66 141 or 69.8% of the grand total. The reason for this increase is the inclusion of a great number of sample trees in 1992 due to the participation of several new countries. The CSTs of the period of 1992-1993 do not comprise trees of the United Kingdom because of the above mentioned methodical adjustment.

A similar evaluation was made for the period from 1988-1993 on 12 of the most common tree species in the total tree sample. The respective subsample comprised 19 528 trees or 19.0% of the grand total.

3.1.2 Defoliation and discolouration

Of the 102 800 sample trees of 1993, 22.6% of the trees had a **defoliation** of more than 25%, i.e. were in defoliation classes 2-4 and thus considered as damaged. The respective percentage for the EU-Member States was 16.0%. The conifers had a higher proportion of damaged trees (23.9%) than the broadleaves (20.4%). This difference was slightly less pronounced in the EU-Member States (17.0% and 15.1%, respectively, see Table 3.1.2-1). As several non-EU-Member States did not assess discolouration on all of their sample trees, **discolouration** was reported for only 92 943 trees in 1993. 10.0% of this tree sample had a **discolouration** of more than 10%. In contrast to defoliation, discolouration was higher in the broadleaves than in the conifers. The difference in discolouration between broadleaves and conifers was clearly less pronounced in the EU-Member States (Table 3.1.2-2).

Table 3.1.2-1: Percentages of defoliation for broadleaves, conifers and all species

	Spccics type	Defoliation							No. trees
		0-10%	>10-25%	0-25%	>25-60%	>60%	dead	>25%	
EU	Broadleaves	51.9	33.0	84.9	12.8	1.5	0.8	15.1	25258
	Conifers	50.1	32.9	83.0	14.8	1.1	1.1	17.0	22913
	All species	51.0	33.0	84.0	13.8	1.3	0.9	16.0	48171
Total Europe	Broadleaves	46.7	32.9	79.6	17.4	2.2	0.8	20.4	40149
	Conifers	41.5	34.6	76.1	21.5	1.7	0.7	23.9	62651
	All species	43.5	33.9	77.4	19.9	1.9	0.8	22.6	102800

Table 3.1.2-2: Percentages of discolouration for broadleaves, conifers and all species

	Species type	Discolouration						No. trees
		0-10%	>10-25%	>25-60%	>60%	dead	>10%	
EU	Broadleaves	87.2	9.3	2.2	0.5	0.8	12.8	25257
	Conifers	88.3	8.7	1.7	0.2	1.1	11.7	22913
	All species	87.7	9.0	2.0	0.4	0.9	12.3	48170
Total Europe	Broadleaves	87.1	9.2	2.3	0.5	0.8	12.9	39584
	Conifers	92.0	5.7	1.2	0.2	0.9	8.0	53359
	All species	90.0	7.2	1.7	0.3	0.8	10.0	92943

Of the total tree sample, **defoliation** among the **broadleaved species groups** was highest for *Quercus* spp. (27.1% damaged). The lowest percentage of damaged trees was found for *Quercus ilex* and *Eucalyptus* spp. (both of them 7.1%). Of all **coniferous species groups,** *Abies* spp. had the highest percentage of damaged trees (36.7%). The share of damaged trees was lowest for *Larix* spp. (17.0%) (Annex 1-3).

Discolouration among the **broadleaved species groups** of the sample was most prevalent for *Castanea sativa.* (24.3% of the trees discoloured, i.e. showing discolouration greater than 10%). *Quercus ilex* showed the lowest percentage of discoloured trees (5.5%) (Annex 1-4). For **coniferous species groups** the variation among the species was smaller. In total Europe *Abies* spp. was the species group with the highest percentage of discoloured trees (17.6%). The least discolouration was found in *Picea* spp. and *Pinus* spp. with 6.2% and 8.3% of the trees being discoloured, respectively (Annex 1-4).

Figure 3.1.2-1 shows the spatial distribution of the percentages of damaged trees per plot over the entire survey area. The pie diagram in Figure 3.1.2-1 reveals that on 50% of the plots the share of damaged trees is 10% or lower. These plots are mainly located in Scandinavia, in southwestern Europe and in the eastern part of the Alps. On the other hand, the share of damaged trees ranges from 51 %-75% on 9% of the plots, and from 76%-100% on 7% of the plots. This means that on 16% of all plots more than half of the trees are damaged. As in previous years, the areas with the highest proportion of damaged trees are located in central Europe.

Maps of the distribution of the mean plot defoliation and plot discolouration over the entire area are shown in Annexes 1-5 and 1-6. The mean plot defoliation (Annex 1-5) is classified according to the five defoliation classes. On 26% of the plots the mean defoliation is larger than 25% (classes 2-4 with 25%, 1% and 0%, respectively). These plots are mainly located in central Europe.

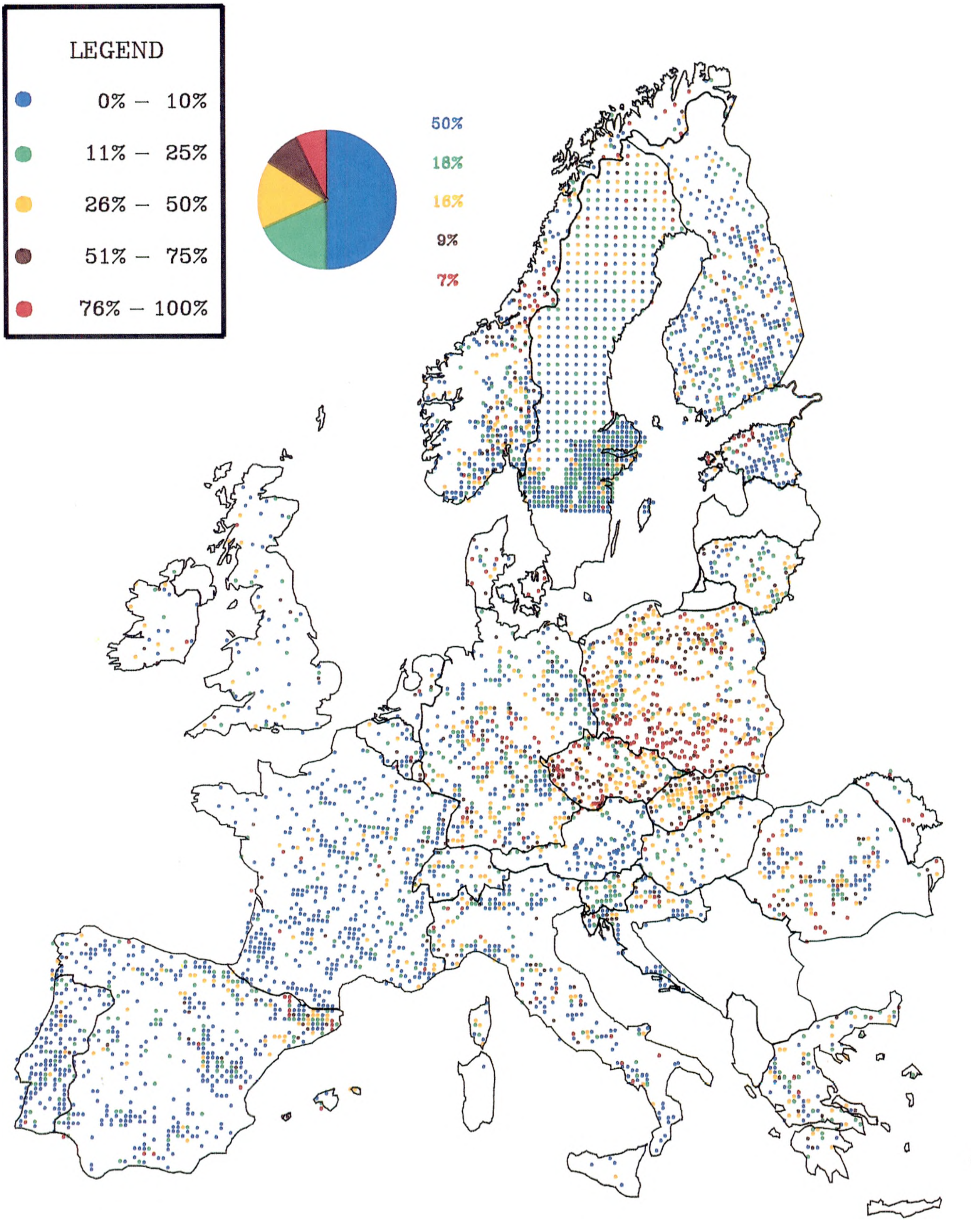


Figure 3.1.2-1: Percentage of trees damaged in 1993. For proper interpretation of the map see Chapter 2.6.

3.1.3 Defoliation and discolouration by climatic region

3.1.3.1 Classification

The total sample of 1993 was stratified according to the same climatic classification introduced with last year's report on the 1992 survey. This classification had been derived from the one by the Commission of the European Communities (1985) and the one by WALTER-HARNICKELL-MULLËR-DOMBOIS, (1975). Of these two classifications, several smaller regions had been combined into larger ones, because excessive splitting of the data set had to be avoided in order to keep the numbers of sample trees per region sufficiently large. The resulting 9 climatic regions specified to match the most important forest vegetation types, and the percentages of the plots they comprised in 1993 are shown in Table 3.1.3.1-1. Figure 3.1.3.1-1 shows the distribution of all installed plots over the climatic regions.

Table 3.1.3.1-1: Distribution of the 1993 plot sample over the climatic regions

Climatic regions	Number of plots	Percent of plots
Boreal	817	17.1%
Boreal (temperate)	453	9.5%
Atlantic (north)	258	5.4%
Atlantic (south)	263	5.5%
Sub-atlantic	1173	24.4%
Continental	152	3.2%
Mountainous	811	16.9%
Mediterranean (higher)	364	7.6%
Mediterranean (lower)	500	10.4%
All regions	4791	100%

The **Boreal** region comprises Finland, the northern two thirds of Sweden and the northernmost part of Norway. The climate is mainly cold temperate with low winter temperatures, however, milder than at equal latitudes outside Europe because of the Gulf Stream influence. The Boreal region is dominated by *Picea abies* and *Pinus sylvestris.* The northernmost part of the Boreal region merges into arctic climate. The Boreal region represented 17.1% of the total sample plots in 1993.

The **Boreal (temperate)** region represents southern Sweden, parts of southernmost Norway and all of Estonia and Lithuania. It constitutes a transition between the Boreal climate and the temperate climate of the Atlantic and Sub-atlantic regions, and contains a higher proportion of deciduous species than the Boreal region. It comprised 9.5% of the total plot sample in 1993.

The **Atlantic (north)** region comprises all of the United Kingdom, Ireland, Denmark and the Netherlands. Moreover, it includes the coast of southern Sweden, a small part of the coast of southernmost Norway, as well as the northwestern parts of Germany, Belgium and France. The climate in this region is generally moist and windy with moderate temperatures in summer and winter, and with long transitional seasons. This region is dominated by *Fagus sylvatica, Pinus sylvestris* and *Picea abies.* In 1993, 5.4% of all sample plots were located within the Atlantic (north) region.

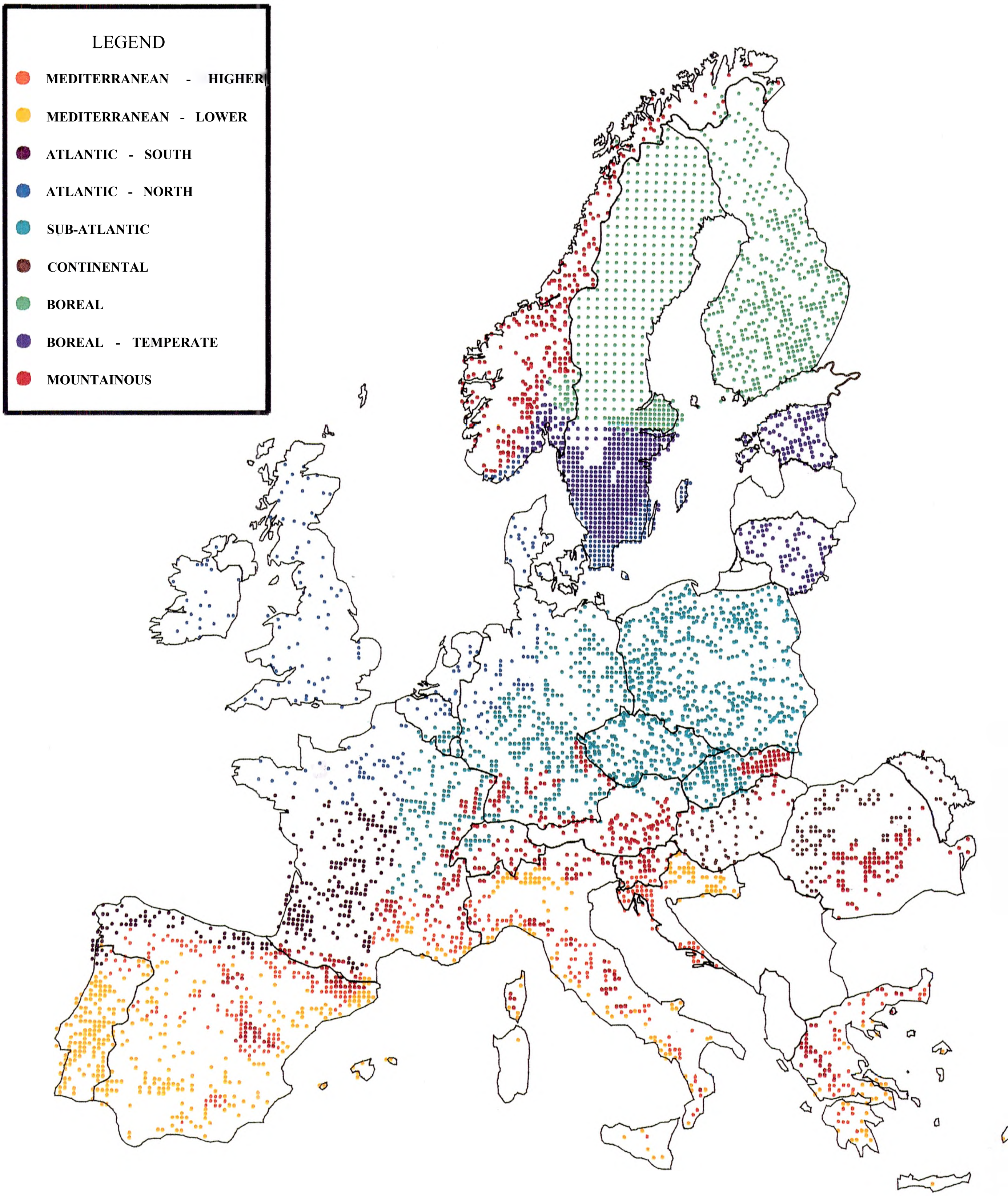


Figure 3.1.3.1-1: Climatic regions

The **Atlantic (south)** region comprises central and southwestern France and the Biscaya coast of Spain. As compared with the Atlantic (north) region, the climate is rather warm temperate 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. The Atlantic (south) region contained 5.5% of all sample plots in 1993.

The **Sub-atlantic** region covers total Poland, the largest part of Germany, the Czech Republic, the Slovak Republic, northern Switzerland, northern Austria, southeastern Belgium, northeastern France and total Luxembourg. The climate in this region is typically temperate. It shows larger differences between summer and winter temperatures, and has less wind as compared to the Atlantic region. There is a gradient from higher winter temperatures in the west to lower winter temperatures in the east. Forest vegetation is heterogeneous, consisting mainly of *Picea abies, Pinus sylvestris* and *Fagus sylvatica.* The Sub-atlantic region is the largest one in the classification and contained 24.4% of all sample plots in 1993.

The **Continental** region includes nearly all of Hungary, total Moldavia and western Romania. As compared with the sub-Continental region, the climate merges from typically temperate to semiarid and is characterized by higher temperatures and dry periods in summer, and lower temperatures in winter. The forest areas are characterized by oak species. With only 3.2% of the total sample plots in 1993, this region is the smallest one.

The **Mountainous** regions include several mountain ridges spread all over Europe. These mountain ridges are represented by one region only, because they all share steep climatic gradients. As a consequence, the geobotanical structures are very complex, depending on altitude and exposition. The Mountainous regions comprise the Alpine system (Pyrenees, Alps, Tatras, Carpathians and Balkan chains), several ridges in the Mediterranean countries, the mountains of Norway and several highland areas. The dominant species are *Picea abies, Pinus sylvestris, Abies alba* and *Larix decidua.* 16.9% of all plots were part of the Mountainous regions in 1993.

The **Mediterranean (higher)** region is to be found in northernmost Portugal as well as in parts of Spain, southern France, Italy, Slovenia, Croatia and Greece. This region lies between 400 and 1 000 m altitude. As compared with the Mediterranean (lower) region, the climate is partly more humid and the forest sites are more favourable for deciduous *Quercus* species and for *Acer* species. Forest vegetation includes a large variety of *Quercus* species. This region comprised 7.6% of all plots in 1993.

The **Mediterranean (lower)** region comprises nearly all of Portugal, the largest part of Spain, the Mediterranean coast of southern France with Corsica, the lower parts of Italy including Sardinia and Sicily, a large part of Croatia as well as parts of Greece. The climate is characterized by dry summers and periods of extensive drought. Rainfall is mainly confined to the winter season. Forest vegetation includes *Pinus halepensis, Pinus pinaster, Quercus ilex, Quercus suber* and *Castanea sativa.* In 1993, 10.4% of all plots were situated in the Mediterranean (lower) region.

3.1.3.2 Results

For each climatic region the percentages of the trees in the five **defoliation** classes are presented in Table 3.1.3.2-1, for all species as well as separately for the broadleaved and coniferous species. The percentages in the five defoliation classes for all species are also shown graphically for each climatic region in Figure 3.1.3.2-2.

As regards all species, Table 3.1.3.2-1 shows that the share of damaged tree26
s ranged from 8.6% in the Atlantic (south) region to 39.5% in the Sub-atlantic region. In all regions the proportion of trees with a defoliation greater than 60%, including dead trees, was almost negligible and reached its highest amount with 3.9% in the Continental region.

In 3 out of the 9 regions, the coniferous species had a higher defoliation than the broad-leaved species. Theses are the Atlantic (north), the Sub-atlantic and the Mediterranean (lower) region. The assessment results of each region, as presented in Table 3.1.3.2-1, are referred to in the following paragraphs, paying attention to the differences between **species groups** (see Annex 1-3 for details). Also mentioned are the deviations from last year's results. It must be noted, however, that these deviations do not necessarily reflect actual changes in forest condition, as the results may be biased by changes in the survey method and in the tree sample. Such bias due to methodical changes is explained in the text. The unbiased changes in forest condition from 1992 to 1993 are dealt with in Chapter 3.1.9. A complete interpretation of the causes of the deviations observed between the results of the two survey years, against the background of information provided by the countries, is given in Chapter 4.

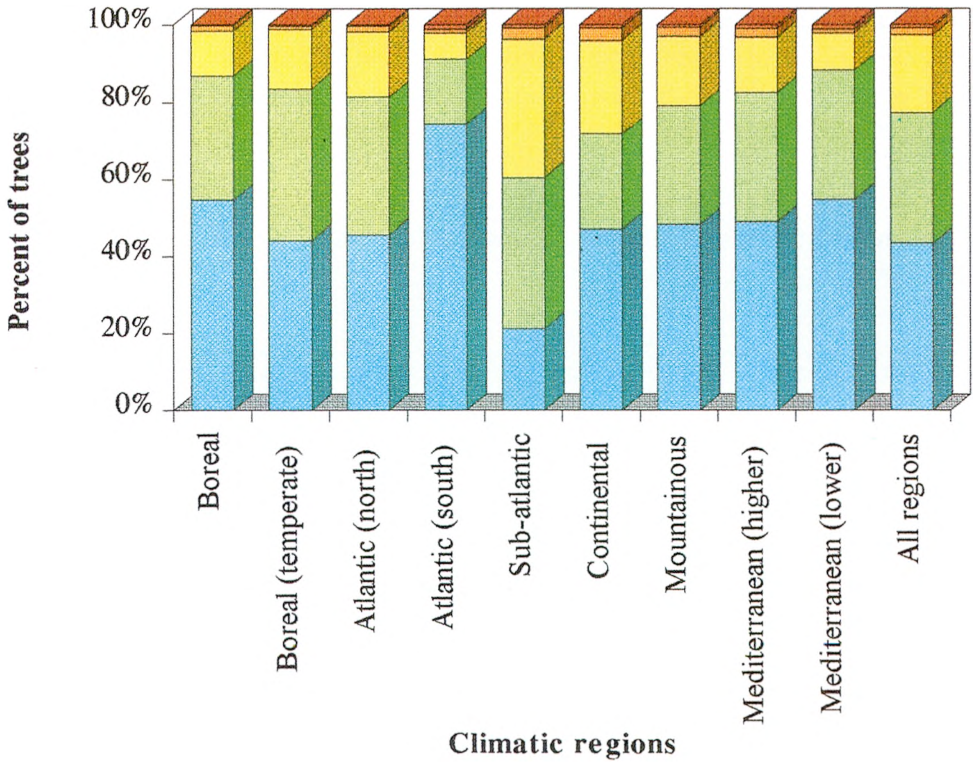
In the **Boreal** region the proportion of damaged sample trees of all species was 13.0%. This is far lower than the respective value in 1992 (21.1%), which is attributable to this year's relatively low percentage of damaged trees in the *Picea* spp. sample (21.2% against 34.6% in 1992). The *Picea* spp. sample comprised 42.3% of the tree sample of the Boreal region, and thus had considerable impact on the proportion of damaged trees of all species. As a result, in contrast to last year, the defoliation of coniferous trees was slightly lower than that of the broadleaved trees (12.8% and 14.6%, respectively).

The share of damaged trees in the **Boreal (temperate)** region was 16.3%. This figure differs only slightly from that of last year (14.2%), although the tree sample for this region has greatly changed due to the inclusion of Estonia and the changing of plots in Sweden. The percentage of damaged broadleaves (17.1%) was slightly higher than that of the conifers (16.2%). This result was dominated by *Picea* spp., which with 48.7% had the largest proportion of the tree sample of this region, followed by *Pinus* spp. with 43.5%. The percentages of damaged trees of these two species groups were similar, with 16.3% for *Pinus* spp. and 16.0% for *Picea* spp.

In the **Atlantic (north)** region 18.5% of the trees of all species were considered as damaged. This is a significantly lower percentage than last year (26.1%), mainly due to the adjustment of the assessment method in the United Kingdom (Chapter 3.1.1). This adjustment affects the results of the 4 most abundant species groups of this region, i.e. *Picea* spp. comprising 29.2% of the trees of all species, *Pinus* spp. (22.5%), *Quercus* spp. (19.7), *Fagus* spp. (14.2). In contrast to last year, the broadleaves were less defoliated than the conifers (14.3% and 22.0%, respectively). As regards the broadleaves, the percentage of damaged trees was 17.1 for *Quercus* spp. and 18.7% for *Fagus* spp.. Of the conifers, *Picea* spp. had a percentage of 25.2% and *Pinus* spp. a percentage of 15.8% damaged sample trees.

Table 3.13.2-1: Percentages of defoliation for broadleaves, conifers and all species as well as total tree numbers by climatic region

Climatic region	Defoliation							No. trees	
	0-10%	>10-25%	0-25%	>25-60%	>60%	dead	>25%	Total Europe	EU
Boreal									
Broadleaves	54.1	31.3	85.4	11.6	2.9	0.1	14.6	834	
Conifers	54.9	32.3	87.2	11.3	1.4	0.1	12.8	11480	
All species	54.8	32.2	87.0	11.4	1.5	0.1	13.0	12314	
Boreal (temperate)									
Broadleaves	39.4	43.5	82.9	15.5	0.8	0.8	17.1	734	
Conifers	44.7	39.1	83.8	15.0	0.8	0.4	16.2	8628	
All species	44.2	39.5	83.7	15.1	0.8	0.4	16.3	9362	
Atlantic (north)									
Broadleaves	50.1	35.6	85.7	13.2	0.9	0.2	14.3	2539	2501
Conifers	42.0	36.0	78.0	19.4	2.0	0.6	22.0	3053	2828
All species	45.7	35.8	81.5	16.6	1.5	0.4	18.5	5592	5329
Atlantic (south)									
Broadleaves	71.1	19.2	90.3	6.7	1.6	1.4	9.7	3578	3578
Conifers	80.4	12.8	93.2	5.9	0.4	0.5	6.8	2020	2020
All species	74.5	16.9	91.4	6.4	1.1	1.1	8.6	5598	5598
Sub-atlantic									
Broadleaves	26.4	38.2	64.6	31.1	3.6	0.7	35.4	8305	3967
Conifers	19.3	39.4	58.7	37.9	2.5	0.9	41.3	19850	6541
All species	21.4	39.1	60.5	35.9	2.8	0.8	39.5	28155	10508
Continental									
Broadleaves	45.0	25.4	70.4	25.5	3.2	0.9	29.6	2856	
Conifers	56.9	20.9	77.8	19.1	2.1	1.0	22.2	627	
All species	47.2	24.6	81.8	24.3	3.0	0.9	28.2	3483	
Mountainous									
Broadleaves	47.9	31.1	79.0	17.9	2.5	0.6	21.0	7284	2980
Conifers	48.8	30.8	79.6	17.6	2.1	0.7	20.4	9145	4193
All species	48.4	30.9	79.3	17.7	2.3	0.7	20.7	16429	7173
Mediterranean (higher)									
Broadleaves	48.0	33.8	81.8	14.1	2.7	1.4	18.2	5330	4454
Conifers	50.9	33.1	84.0	14.0	1.5	0.5	16.0	3538	3022
All species	49.2	33.5	82.7	14.1	2.2	1.0	17.3	8868	7476
Mediterranean (lower)									
Broadleaves	53.4	35.5	88.9	9.6	0.9	0.6	11.1	8689	7778
Conifers	57.7	29.7	87.4	9.2	0.9	2.5	12.6	4310	4309
All species	54.9	33.6	88.5	9.4	0.9	1.2	11.5	12999	12087



Defoliation E 0-10% |J >10-25% □ >25-60% >60% gg dead

Figure 3.1.3.2-1: Defoliation by climatic region.

With 8.6% of the trees of all species damaged, the **Atlantic (south)** region was the one with the lowest defoliation, as it was already last year with 8.2%. However, in the broadleaves the percentage of damaged trees had increased slightly from 8.4% in 1992 to 9.7% in 1993, whereas it had decreased from 8.1% to 6.8% in the conifers.

As in 1992, the defoliaton was highest in the **Sub-atlantic region.** In 1993 the percentage of damaged trees of all species (39.5%) was even higher than it had been in 1992 (37.8%). This also holds true for both the broadleaves with 35.4% of damaged trees (33.2% in 1992) and the conifers with 41.3% (40.1% in 1992), of which the conifers were again clearly more damaged. With 38.9% of all sample trees in this region, *Pinus* spp. had the greatest impact on this result. 41.9% of all *Pinus* spp. trees were damaged.

In the **Continental region,** the percentage of damaged trees of all species was 28.2% (22.6% in 1992). The higher percentage of damaged trees in 1993 is partly caused by the inclusion of Moldavia as a newly participating country with a relatively high share of damaged trees. However, also of influence is the exclusion of 48 plots in Romania, which led to the exclusion of a great number of *Picea* spp. trees of low defoliation. As a result, the 1993 sample is dominated by *Quercus* spp., which comprised 26.1% of the sample trees of all species, and which had 38.6% of damaged trees. Consequently, in 1993 the broadleaves had a higher percentage of damaged trees than the conifers (29.6% and 22.2%, respectively).

The percentage of damaged trees of all species of the **Mountainous regions** was 20.7% (21.3% in 1992). The proportion of damaged coniferous trees (20.4%) was slightly smaller than the respective proportion of the broadleaved trees (21.0%). This region is dominated by conifers, which represent 55.7% of all trees, and at the same time have generally lower percentages of damaged trees than the broadleaves.

In the **Mediterranean (higher)** region 17.3% of the trees of all species were damaged (17.7% in 1992). The broadleaves represented 60.1% of the total sample trees in this region and at the same time had with 18.2% a higher share of damaged trees than the broadleaves (16.0%). This result is particularly influenced by *Quercus* spp., which comprised 23.4% of all sample trees, 22.0% of its trees being damaged. As regards the conifers, 32.1% of the tree sample consisted of *Pinus* spp., with 14.1% of its trees being damaged.

The percentage of damaged trees in the **Mediterranean (lower)** region (11.5%) was clearly lower than in 1992 (16.0%). This deviation from last year's result is mainly due to the lower percentage of damaged trees in the broadleaves (11.1% in contrast to 17.7% in 1992). This is not to be explained by the inclusion of Croatia, with 15.6% of the Croatian broadleaved sample being damaged. Of greater influence, however, was the *Quercus suber* sample with 10.8% damaged trees against 31.2% in 1992, and the species summarized under the item "other broadleaves" with 12.8% damaged trees against 17.7% in 1992.

Table 3.1.3.2-2 and Figure 3.1.3.2-3 show the **discolouration** of the sample trees by climatic region. Detailed data for species groups are given in Annex 1-4.

Discolouration was highest in the Mediterranean (higher) region and in the Continental region, with 16.3% and 16.2% of the trees of all species, respectively, having a discolouration greater than 10%. The lowest proportion of trees more than 10% discoloured occurred in the Boreal (temperate) region (1.9%). The discolouration of the broadleaves was greater than that of the conifers in all regions but the Boreal, the Boreal (temperate) and the Mediterranean (lower) ones.

Table 3.1.3.2-2: Percentages of discolouration for broadleaves, conifers and all species as well as total tree numbers by climatic region

Climatic region	Discolouration							No. trees	
	0-10%	>10-25%	0-25%	>25-60%	>60%	dead	>10%	Total Europe	EU
Boreal									
Broadleaves	98.4	1.0	99.4	0.1	0.4	0.1	1.6	831	
Conifers	96.4	2.7	99.1	0.7	0.1	0.1	3.6	7657	
All species	96.7	2.5	99.2	0.6	0.1	0.1	3.3	8488	
Boreal (temperate)									
Broadleaves	98.8	0.3	99.1	0.1	0.0	0.8	1.2	734	
Conifers	98.0	1.0	99.0	0.4	0.1	0.5	2.0	6899	
All species	98.1	0.9	99.0	0.4	0.1	0.5	1.9	7633	
Atlantic (north)									
Broadleaves	84.4	11.5	95.9	3.7	0.2	0.2	15.6	2538	2500
Conifers	85.9	10.2	96.1	3.2	0.1	0.6	14.1	3025	2828
All species	85.3	10.8	96.1	3.4	0.1	0.4	14.7	5563	5328
Atlantic (south)									
Broadleaves	84.4	11.7	96.1	2.0	0.4	1.5	15.6	3578	3578
Conifers	86.1	12.4	98.5	1.0	0.0	0.5	13.9	2020	2020
All species	84.9	12.0	96.9	1.7	0.3	1.1	15.1	5598	5598
Sub-atlantic									
Broadleaves	86.6	8.9	95.5	3.0	0.6	0.9	13.4	7744	3967
Conifers	94.0	4.0	98.0	0.7	0.2	1.1	6.0	16138	6541
All species	91.6	5.6	97.2	1.5	0.3	1.0	8.4	23882	10508
Continental									
Broadleaves	82.6	11.9	94.5	4.2	0.4	0.9	17.4	2856	
Conifers	89.0	8.8	97.8	1.0	0.2	1.0	11.0	627	
All species	83.8	11.3	95.1	3.6	0.4	0.9	16.2	3483	
Mountainous									
Broadleaves	89.6	8.0	97.6	1.4	0.4	0.6	10.4	7284	2980
Conifers	90.2	7.0	97.2	1.8	0.3	0.7	9.8	9145	4193
All species	90.0	7.4	97.4	1.6	0.3	0.7	10.0	16429	7173
Mediterranean (higher)									
Broadleaves	82.8	11.8	94.6	2.6	1.4	1.4	17.2	5330	4454
Conifers	85.0	11.4	96.4	2.5	0.6	0.5	15.0	3538	3022
All species	83.7	11.6	95.3	2.6	1.1	1.0	16.3	8868	7476
Mediterranean (lower)									
Broadleaves	89.5	7.7	97.2	1.9	0.3	0.6	10.5	8689	7778
Conifers	84.8	10.8	95.6	1.8	0.1	2.5	15.2	4310	4309
All species	88.0	8.7	96.7	1.9	0.2	1.2	12.0	12999	12087

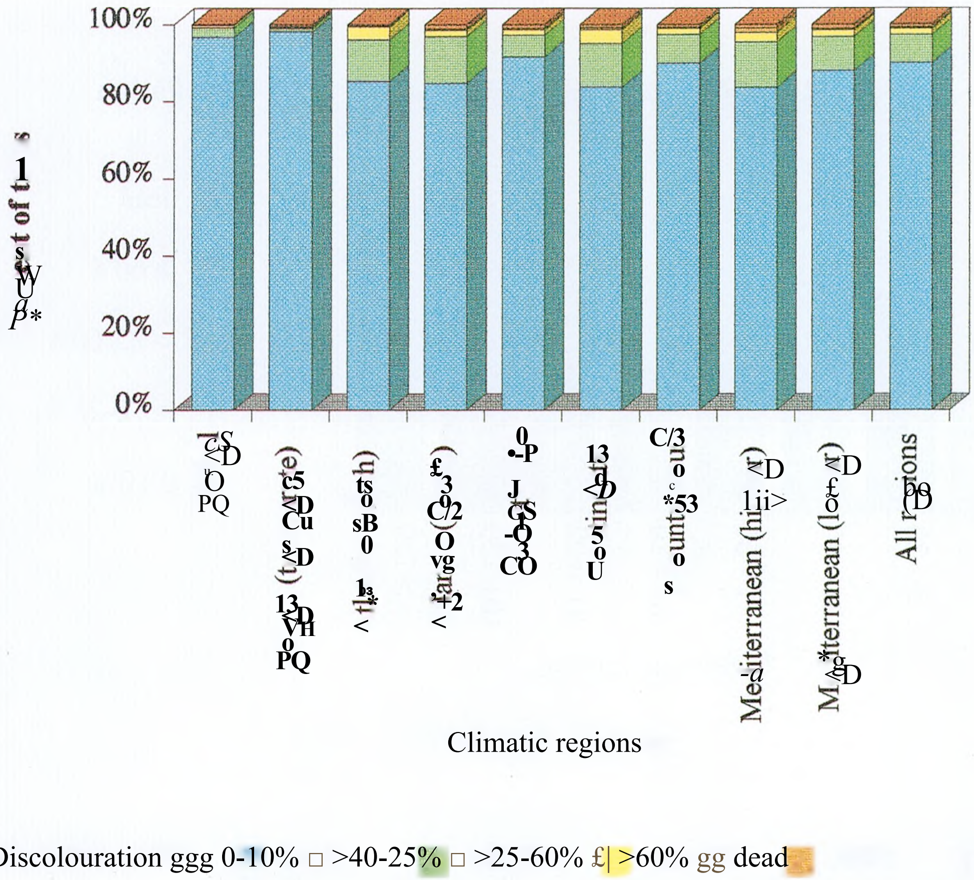


Figure 3.1.3.2-3: Discolouration by climatic region

3.1.4 Defoliation and discolouration by mean age

The database of the 1993 survey confirms the strong positive correlation between age and **defoliation** which has been found for slightly smaller data sets already in the previous surveys. For both the EU-Member States and total Europe, Table 3.1.4-1 shows the percentages of trees in each defoliation class for 7 classes of different mean stand age and for a class of irregular age composition. The results for total Europe are presented graphically in Figure 3.1.4-1.

As in the previous years, the percentage of damaged trees (defoliation >25%) shows a gradual increase with increasing mean age between ages 0-80. With higher ages, however, the percentage of damaged trees remains at approximately the same level. The share of dead and severely defoliated trees is very small compared to the total number of sample trees, but this is partly a result of the conventional classification with only 5 damage classes. A higher resolution, such as the 10%-defoliation classes of the national surveys (Annex II-8) provides a more realistic view of the defoliation distribution.

The results of the evaluation of **discolouration** by mean age are not presented in this report because of their low conclusiveness.

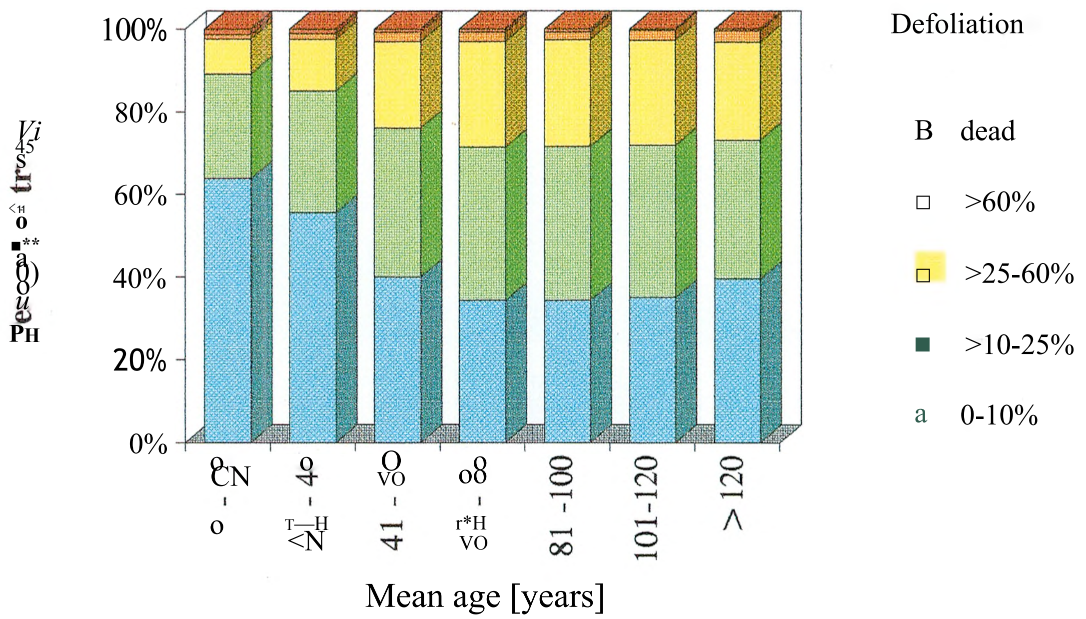


Figure 3.1.4-1: Percentages of trees of different defoliation classes per age class

Table 3.1.4-1: Percentages of defoliation of all species by mean age

	Mean age [years]	Defoliation							No. of trees
		0-10%	>10-25%	0-25%	>25-60%	>60%	dead	>25%	
EU	0-20	65.0	25.0	90.0	7.7	0.9	1.4	10.0	7502
	21 -40	56.8	29.6	86.4	11.2	1.3	1.1	13.6	12528
	41 -60	49.7	35.8	85.5	12.9	1.1	0.5	14.5	8516
	61 - 80	46.3	37.8	84.1	14.3	1.0	0.6	15.9	5375
	81 -100	39.7	39.7	79.4	18.3	0.9	1.4	20.6	4557
	101-120	34.0	39.9	73.9	23.5	2.3	0.3	26.1	2358
	>120	31.8	35.5	67.3	30.1	2.4	0.2	32.7	2639
	Irregular	51.6	32.6	84.2	12.7	1.9	1.2	15.8	4696
	Total	51.0	33.0	84.0	13.8	1.3	0.9	16.0	48171
Total Europe	0-20	63.8	25.3	89.1	8.5	1.1	1.3	10.9	8652
	21-40	55.6	29.5	85.1	12.5	1.4	1.0	14.9	16648
	41-60	40.1	35.9	76.0	21.0	2.3	0.7	24.0	17945
	61 -80	34.4	37.0	71.4	25.6	2.3	0.7	28.6	15644
	81-100	34.4	37.1	71.5	26.0	1.8	0.7	28.5	11540
	101-120	35.2	36.6	71.8	25.5	2.4	0.3	28.2	5326
	>120	39.6	33.4	73.0	23.9	2.7	0.4	27.0	5380
	Irregular	51.2	31.7	82.9	14.0	2.0	1.1	17.1	5056
	Total	43.9	33.6	77.5	19.7	2.0	0.8	22.5	86191

3.1.5 Defoliation and discolouration by water availability

Water availability refers to the relative availability of water to the principal species in a plot, and is determined at the date of observation. In 1993 water availability has been reported for 64 696 trees or 62.9% of the total tree sample by means of a simple classification. Table 3.3.5-1 shows the percentages of trees of different defoliation and discolouration classified according to sites with insufficient, sufficient and excessive water availability. The overwhelming majority (82.3%) of the trees assessed for water availability was stocking on sites with sufficient water availability.

The results show that the trees on sites of sufficient water availability had a slightly lower proportion of damaged trees (18.9%) than those for which water availability was insufficient or excessive (20.5% and 23.0%, respectively).

The highest discolouration was found on sites with insufficient water availability. On these sites 17.9% of the trees were discoloured. On sites with sufficient water availability, the percentage of discoloured trees was 11.6% and on sites with excessive water availability 5.0%.

Table 3.1.5-1: Percentages of trees of different defoliation and discolouration by water availability

Water availability	Defoliation		Discolouration		Sample trees	
	0-25%	>25%	0-10%	>10%	Number	%
Insufficient	79.5	20.5	82.1	17.9	8792	13.6
Sufficient	81.1	18.9	88.4	11.6	53264	82.3
Excessive	77.0	23.0	95.0	5.0	2640	4.1
Total	80.7	19.3	87.7	12.3	64696	100.0

3.1.6 Defoliation and discolouration by FAO soil unit

In 1993 Estonia and Greece for the first time provided the soil units of their plots. This raised the number of countries submitting soil units from 2 to 4. Since 1990, when the reporting of soil units had been adopted on a voluntary basis, only Austria and Germany had been submitting the respective information. As a result of the participation of Estonia and Greece, the share of those plots for which soil units is available has risen from 2.5% in 1992 to 6.2% in 1993. In 1993 soil unit was reported for 299 plots representing 7 447 trees. The number of soil units reported increased from 15 to 35. These units were determined by means of the FAO soil classification system (2nd edition 1976). The percentages of trees in the defoliation and discolouration classes in these soil units are shown in Annex I-10.

The highest proportion of damaged trees (80% in defoliation classes 2-4) was found on Calcaric Lithosols. This is an extremely high increase compared to last year's result on this soil unit, which was nearly three times lower (27.2% in defoliation classes 2-4) and representing the second highest share of damaged trees in 1992. The second to the fifth highest shares of damaged trees in 1993 were found on Luvic Calcisols (56.5%), Haplic Phaeozems (54.2%), Humic Cambisols (47.7%) and Ferric Podzols (37.5%). These soil units were investigated for the first time in 1993, and showed clearly higher shares of damaged trees than the soil units studied until 1992. In the 1992 sample, the Cambie Arenosols had the highest proportion of damaged trees (29.8%).

As compared to the 1992 results, the proportion of damaged trees is remarkably higher in the following soil units:

Luvic Arenosols	(1992: 9.2%; 1993: 21.7%),
Eutric Cambisols	(1992: 3.4%; 1993: 9.2%),
Chromic Luvisols	(1992: 1.0%; 1993: 20.5%),
Gleyic Luvisols	(1992: 0.0%; 1993: 8.4%),
Orthic Podzols	(1992: 2.7%; 1993: 17.8%),
Humic Podzols	(1992: 3.3%; 1993: 11.1%),
and Orthic Rendzinas	(1992: 2.3% ; 1993: 23.5%).

In contrast, the proportion of damaged trees decreased significantly on Eutric Planosols from 16.7% in 1992 to 0% in 1993. These soil unit showed the third highest share of damaged trees in 1992. No defoliation was found on Calcic Cambisols and Eutric Planosols.

Discolouration was highest on Cambic Arenosols (33.9% of all trees discoloured) and on Eutric Planosols (29.2% of all trees discoloured). This is remarkable, because on this soil unit no defoliated trees were found. The third highest share of discoloured trees occurred on Luvic Arenosols (22.5%). This soil unit showed the highest rate in 1992 (31.7%). In all the other soil units, discolouration was far lower, the proportions of discoloured trees ranging below 7%. No discoloured trees were found on Calcaric Gleysols, Calcic Cambisols, Eutric Gleysols, Eutric Regosols, Dystric Regosols, Mollic Leptosols, Humic Cambisols, Luvic Calcisols, Haplic Phaeozems, Humic Alisols and Cumulic Anthrosols.

Any interpretation of the above mentioned results (Chapter 4) and any comparisons with last year's results should be made with great care, as the number of trees representing the individual soil units are partly very small. This holds true in particular for the Calcaric Lithosols, Calcic Cambisols, Mollic Leptosols, Humic Cambisols, Luvic Calcisols, Haplic Phaeozems, Eutric Planosols, Ferric Podzols, Humic Alisols and Cumulic Anthrosols (all below 50 trees). Moreover, the bias induced by the changes in the numbers of trees induced by the inclusion of more plots must be taken into account. For instance, the steep increase in the share of damaged trees on the Calcaric Lithosols can be shown to be solely caused by the inclusion of 24 trees in Estonia. Given the differences in defoliation between the various soil units, it is strongly recommended that the observation of soil unit will be extended in future surveys.

3.1.7 Easily identifiable damage

The eight types of damages that can be easily identified on the sample trees are:

- **game and grazing (damage to trunk, bark etc.)**
- **presence or traces of an excessive number of insects**
- **fungi**
- **abiotic agents (wind, drought, snow etc.)**
- **direct action of man (poor silvicultural practices, logging etc.)**
- **fire**
- **known local or regional pollution (classical smoke damage)**
- **other types of damage**

For these categories, only the **presence** of such damages is indicated. It is presented in Table 3.1.7-1 in terms of the percentage of the total tree or plot sample that is affected. No indication is given of the **intensity** of the damage. It is possible that more than one type of identifiable damage occurs on a single tree. Such trees will therefore be represented more than once in the table. Of the 102 800 trees of the total tree sample, 30 655 trees (29.8%) showed any identifiable damage of one or more causes. These trees were observed on 2 891 plots (60.3%) of the total plot sample. The trees outnumber the plots, as several trees with identifiable damage may occur on the same plot. On the other trees identifiable damage was either not present or not assessed. In the Czech Republic and in Finland (8 779 trees together) easily identifiable damage was not assessed at all.

In total Europe, as in the previous years, the most commonly observed type of damage was caused by **insects** (11.7% of the trees and 25.1% of the plots). The second most commonly observed type was **other damage.** After a significant increase in the frequency of this damage type since 1990, other damage represented also the second largest group in 1992 with 10.5% of all trees. In 1993, however, a slight decrease of its frequency was observed (9.7% of all trees and 26.3% of all plots).

Table 3.1.7-1: Percentages of trees with defoliation >25% and discolouration >10% by identified damage types, based on a total of 4 791 plots with 102 800 trees

Damage type	Defoliation % in classes 2, 3,4		Discolouration % in classes 1, 2, 3,4		Observations (% of total)			
					Total Europe		EU	
	Total Europe	EU	Total Europe	EU	Trees	Plots	Trees	Plots
Game/Grazing	20.4	19.5	16.2	19.2	1.8	5.5	2.7	6.0
Insects	28.3	20.8	14.7	12.4	11.7	25.1	18.0	40.1
Fungi	27.1	19.5	19.0	18.8	6.0	18.9	8.3	25.0
Abiotic agents	31.5	31.4	30.8	35.8	5.2	22.3	5.4	19.6
Action of man	23.2	17.2	15.1	17.2	4.8	20.8	4.9	14.6
Fire	28.4	29.0	28.9	30.9	0.7	1.4	1.3	2.9
Known pollution	29.3	3.0	44.4	56.0	0.3	0.4	0.1	0.2
Other	13.6	11.2	10.6	10.8	9.7	26.3	16.5	27.8
Any ident. damage	24.5	19.3	16.6	16.6	29.8	60.3	39.9	65.8
No ident. damage	21.6	13.7	6.9	9.4	70.2	39.7	60.1	34.2
Total	22.6	16.0	10.0	12.3	102800	4791	48171	1994

The presence of **abiotic agents, fungi** and **action of man** was observed less frequently, representing respectively 5.2%, 6.0% and 4.8% of the total tree sample. In comparison to 1992, only the frequency of fungi showed a little increase from 5.5% to 6.0%. The frequency of the two other groups decreased: abiotic agents from 8.9% to 5.2%, and action of man from 5.3% to 4.8%.

Game/grazing, fire and damage by **known pollution** (i.e. classical smoke damage caused by air pollution of nearby emittents) was recorded to a far smaller amount, namely on 1.8%, 0.7% and 0.3% of the trees. Of the total sample, 7.9% of the trees suffered damage from more than one damage type.

Among the trees showing any identifiable damage, the proportions of trees in defoliation classes 2-4 ranged between 13.6% (1349 trees) **(other types of damage)** and 31.5% (1682 trees) **(abiotic agents)** in total Europe. For the damage types **game/grazing, fungi** and **fire,** the respective proportions increased in comparison with the 1992 survey results. The most obvious increase occurred in the group of damage caused by **fire,** from 22.9% (158 trees) in 1992 to 28.4% (200 trees) in 1993. In the respective percentages of trees affected by the other damaging agents there was a decrease in 1993. The largest decrease was reported for the share of trees affected by **known pollution,** namely from 42.9% (97 trees) in 1992 to 29.3% (97 trees) in 1993. These changes should be regarded very carefully because the number of sample trees was too small.

When regarding all trees with **any identifiable damage** together, the percentage of trees in defoliation classes 2-4 (24.5%) is 2.9 percent points higher as compared to trees with **no identifiable damage** (21.6%). In the EU-Member States, 5.6 percent points more trees appear to be damaged (defoliation more than 25%) in the presence of any identifiable damage (19.3%) than when no damage has been identified (13.7%).

As regards discolouration, in total Europe the share of trees of discolouration greater 10% showing any identifiable damage (16.6%) was 9.7 percent points larger than the one without identifiable damage (6.9%). In the EU-Member States, the respective shares of discolouration were 16.6% and 9.4%, yielding a 7.2 percent point difference between the subsamples with any and no identifiable damage types.

The most pronounced negative effect in terms of discolouration was observed for trees affected by **known pollution** with 44.4% of the trees 147 trees) in discolouration classes 1-4 in total Europe. The respective figure for the EU-Member States is 56.0% (37 trees). In comparison to 1992, this represents an increase by 6.8 percent points regarding total Europe and a decrease by 1.8 percent points regarding the EU-Member States. Similar to the defoliation results, these changes in discolouration should be regarded with care because of the small number of sample trees.

Interpretation of the data related to identifiable damage is difficult. The main problem is that some of the damaging agents are more easily identified, or identified with more certainty than others. Moreover, it is not always clear from the data reported if no obvious damage could be identified or if no assessment has been made. Damage types were observed on a low proportion of sample trees (0.3 to 11.7%) only. Therefore, the data presented here only give a general indication of the effect of several damage types.

3.1.8 Changes in defoliation and discolouration from 1992-1993

3.1.8.1 Comparison of the total tree samples and the Common Sample Trees

Any comparison of the **total tree samples** of 1992 and 1993 will produce biased results since only a part of both samples consists of exactly the same trees. For the reasons mentioned in Chapter 3.1.1, the 1993 survey includes an increased number of observations.

In order to be able to compare the results of 1992 and 1993, a subsample is defined containing all trees that are common to both surveys: the **Common Sample Trees (CSTs).** This common sample consists of 84 969 trees, representing 89.4% of the total tree sample of 1992 and 82.7% of the total tree sample of 1993. This is 18 828 or 28.5% more CSTs than in the 1992 survey. The reasons for this year's particularly large number of CSTs are the inclusion of Lithuania, Norway and Romania in 1992. Moreover, part of the Swedish tree samples, representative for identical areas in 1992 and 1993, have been treated as CSTs. In addition, in 1993 the Czech Republic submitted both the 1992 and the 1993 data. The increasing number of CSTs is not only valuable for a more objective calculation of changes in defoliation and discolouration, but also indicates a growing consistency of the datasets in the participating countries. Because of the reasons mentioned in Chapter 3.1.1, the sample trees of the United Kingdom were not included in the CSTs this year.

Table 3.1.8.1-1 shows the percentages of trees in the different defoliation and discolouration classes for the total tree samples in 1992 and 1993, and the percentages for the trees common to the 1992 and 1993 surveys.

According to Table 3.1.8.1-1, the share of trees in **defoliation** classes 2, 3 and 4 was lower in 1993 (22.6%) than in 1992 (23.5%). From this result, however, no improvement of the forest condition must be derived because of the numerous sources of bias mentioned above. The evaluation of the CSTs provides a more reliable view of the actual development of defoliation. The share of damaged CSTs was 23.3% in 1992 and 23.1% in 1993, rather indicating a negligibly small change in forest condition since 1992. The changes were also small in all the individual defoliation classes but class 2, the share of which decreased from 21.1% to 20.3%. The share of dead trees increased from 0.3% to 0.8%, indicating a mortality of 0.5%. This low mortality is in well agreement with the findings of the previous surveys.

The nearly steady state in forest condition at a large scale between 1992 and 1993 is also documented by the maps in Annexes 1-7 and 1-8. These maps were prepared on the basis of the mean defoliation of the CSTs on each plot. The pie diagram in Annex 1-7 shows that the percentage of plots changing from undamaged to damaged and from damaged to undamaged is relatively low (9% and 7%, respectively). 84% of the plots did not change their defoliation class. In Annex 1-8, the pie diagram reveals that 15% of the plots showed a significant decrease of mean defoliation, whereas 14% of the plots showed a significant worsening. 71% of the plots did not show significant changes in defoliation.

The map on changes in plot defoliation (Annex 1-8) was prepared on the basis of statistical significance tests for the first time. Principally, the significance of a change in plot defoliation depends on the size of the change in the defoliation of each tree and on the number of trees on the plot. The map in Annex 1-8 only shows changes in plot defoliation which are greater than 5% and statistically significant at the 95% probability level. The mathematical background for the calculation has been provided in the Forest Condition Report 1993.

Whilst Annexes 1-7 and 1-8 revealed small changes at the large scale, large changes are to be found at the regional scale. For central Europe and for Scandinavia in certain of their main damage areas a general worsening occurred. An improvement is evident in northern Scandinavia and in the southwestern part of the Iberian peninsula. Chapter 3.1.8.2 provides statistical tests of the changes in plot defoliation in the various climatic regions.

The proportion of trees showing **discolouration** hardly changed from 1992 to 1993 in both the total tree sample and the CSTs. The slight decrease of discoloured trees in the total tree sample was lower than in the Common Sample, indicating that the extension of the grid caused a relative increase of the proportion of discoloured trees.

Table 3.1.8.1-1: Percentages of the total tree sample and the Common Sample Trees **in** different defoliation and discolouration classes in 1992 and 1993

	Total tree sample		Common Sample Trees	
	1992	1993	1992	1993
Defoliation				
0-10%	43.0	43.5	43.2	43.0
>10-25%	33.5	33.9	33.5	33.9
0-25%	76.5	77.4	76.7	76.9
>25-60%	20.8	19.9	21.1	20.3
>60%	2.1	1.9	1.9	2.0
dead	0.6	0.8	0.3	0.8
>25%	23.5	22.6	23.3	23.1
Discolouration				
0-10%	89.9	90.0	90.3	90.6
>10-25%	7.5	7.2	7.7	6.9
>25-60%	1.6	1.7	1.6	1.4
>60%	0.3	0.3	0.3	0.3
dead	0.7	0.8	0.1	0.8
>10%	10.1	10.0	9.7	9.4
No. of trees	94 699	102 800	84 969	84 969

3.1.8.2 Changes in defoliation and discolouration by climatic region

The changes in defoliation of the CSTs from 1992 to 1993 in each climatic region were statistically tested both for the percentage of trees in defoliation classes and for mean plot defoliation. The changes in both figures are presented in Table 3.1.8.2-1. The asterisks in the table mark differences of statistical significance at the 95% probability level. Figure 3.1.8.2-1 visualizes the changes in the percentage of trees in defoliation classes. The following descriptions refer to the changes in the percentage of trees damaged, which can be derived both from Table 3.1.8.2-1 and Figure 3.1.8.2-1.

No significant change in the percentage of trees damaged (from 23.3% to 23.1%) was found for the total CSTs of all regions. However, significant increases and significant decreases in the percentage of trees damaged did occur in most of the individual climatic regions.

The most obvious changes occurred in the Boreal (temperate) and the Continental regions, where the percentages of CSTs damaged increased significantly by 4.8 and 4.3 percent points, respectively. Further significant, but less obvious increases were found in the Atlantic (north) region (2.4 percent points), in the Mediterranean (higher) region (1.6 percent points) and in the Atlantic (south) region (1.3 percent points).

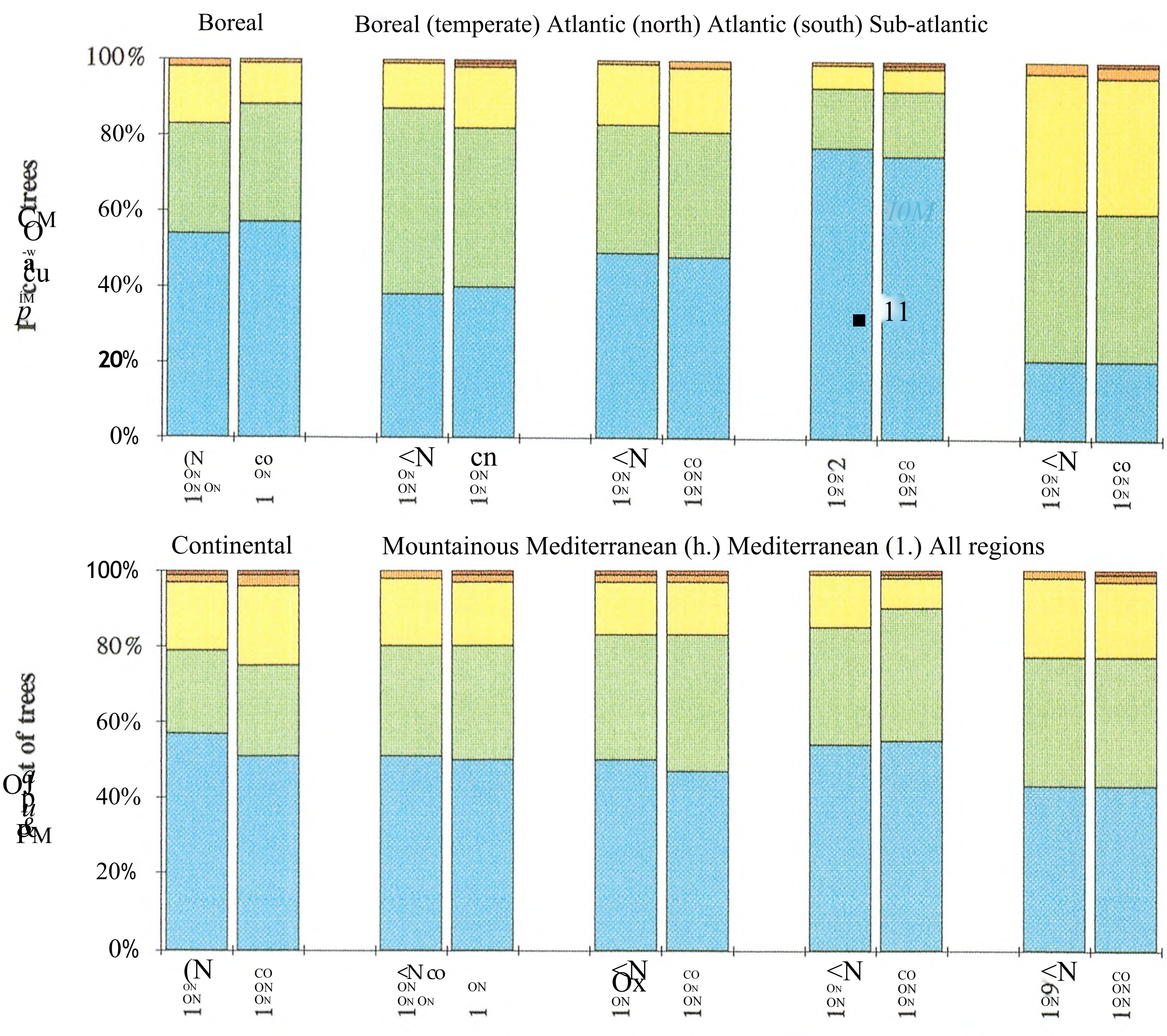
Significant decreases of the percentages of trees damaged occurred in the Boreal and Mediterranean (lower) regions with 4.2 percent points and 3.8 percent points, respectively. A significant but very low decrease by 0.2 percent points was found in the Sub-atlantic region.

For the first time, also the changes in the percentages of discoloured trees in each climatic region were statistically tested. These changes are presented in Table 3.1.8.2-2. As with defoliation, the asterisks in the table mark differences of statistical significance at the 95% probability level. Figure 3.1.8.2-2 visualizes these changes. It is striking that the change in the share of discoloured trees in all regions (-0.3 percent points) is nearly as small as the respective change in defoliation (-0.2 percent points), but significant. This is because, in contrast to defoliation, discolouration has significantly changed in climatic regions with relatively high numbers of CSTs, such as the Sub-atlantic, Mountainous and Mediterranean (lower) regions. The highest significant increase in discolouration was found in the Atlantic (south) region (6.1 percent points), the highest significant decrease in the Continental region (5.3 percent points).

Table 3.1.8.2-1: Changes in the percentages of damaged trees *(A p)* and mean defoliation *(A d)* of the CSTs from 1992 to 1993

Climatic region	No. of CSTs *n*	Percentage of damaged trees *P92*	*P93*	*Ap*	Mean defoliation d_{92}	d_{93}	*Ad*
Boreal	7992	16.5	12.3	-4.2 *	15.7	14.5	- 1.2 *
Boreal (temperate)	4546	12.7	17.5	4.8 *	16.7	17.9	1.2 *
Atlantic (north)	3774	17.3	19.7	2.4 *	16.3	17.2	0.9 *
Atlantic (south)	5346	7.2	8.5	1.3 *	8.9	9.9	0.9 *
Sub-atlantic	26114	39.5	39.3	-0.2	25.3	25.3	0.0
Continental	2976	20.5	24.8	4.3 *	15.4	18.0	2.5 *
Mountainous	15103	20.3	20.3	0.0	16.6	17.1	0.5 *
Mediterr. (lower)	11753	14.4	10.6	-3.8 *	14.2	14.0	-0.2
Mediterr. (higher)	7365	16.0	17.6	1.6 *	16.2	17.5	1.3 *
All regions	84969	23.3	23.1	-0.2	18.3	18.6	0.3 *

* significant at the 95% probability level



Defoliation 0-10% >10-25% >25-60% >60% dead

Figure 3.1.8.2-1: Percentages of defoliation of the Common Sample Trees in 1992 and 1993 for each of 9 climatic regions and for the total sample of CSTs

Table 3.1.8.2-2: Changes in the percentages of discoloured trees (A *p*) of the CSTs from 1992 to 1993

Climatic region	No. of CSTs *n*	Percentage of discoloured trees *P92*	*P93*	A *p*
Boreal	7992	5.0	3.7	- 1.3 *
Boreal (temperate)	4546	2.3	2.4	0.1
Atlantic (north)	3774	13.1	14.0	0.9
Atlantic (south)	5346	8.6	14.7	6.1 *
Sub-atlantic	26114	10.0	8.3	- 1.7 *
Continental	2976	16.7	11.4	-5.3 *
Mountainous	15103	8.7	9.6	0.9 *
Mediterr. (lower)	11753	12.8	10.5	-2.3 *
Mediterr. (higher)	7365	10.2	13.0	2.8 *
All regions	84969	9.7	9.4	[illegible] *

* significant at the 95% probability level

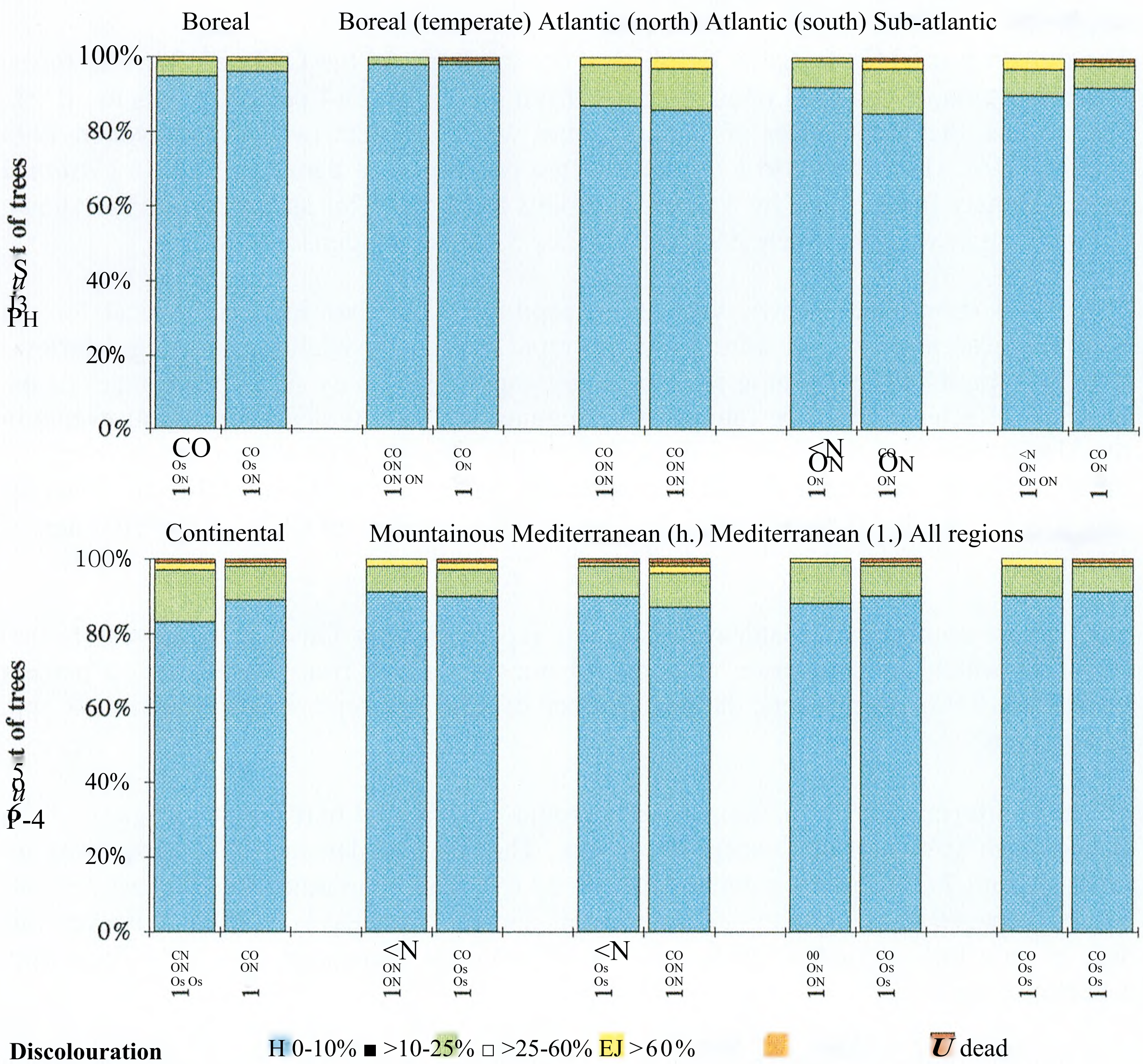


Figure 3.1.8.2-2: Percentages of discolouration of the Common Sample Trees in 1992 and 1993 for each of 9 climatic regions and for the total sample of CSTs

3.1.8.3 Changes in defoliation and discolouration by species group

The differences in defoliation and discolouration between the CSTs in 1992 and 1993 are specified according to species groups in Table 3.1.8.3-1.

As described in the previous chapter, the CSTs as a whole showed no significant change in **defoliation.** The share of damaged CSTs decreased slightly from 23.3% in 1992 to 23.1% in 1993. In the broadleaved CSTs the proportion of trees showing a defoliation greater than 25% diminished by 0.6 percent points from 20.5% to 19.9%. In the coniferous CSTs the respective proportion remained at its level of 25.2%.

Among the **broadleaved CSTs,** the most conspicuous deterioration, as expressed by the shares of damaged trees, occurred in *Quercus* spp.. The vitality of this species had already decreased in the CSTs of 1991 and 1992. Between 1992 and 1993 the proportion of damaged trees increased from 21.5% by 4.2 percent points to 25.7%. Among *Quercus ilex,* which had shown an obvious increase in defoliation in 1992, the share of damaged trees decreased slightly by 0.2 percent points.

The most remarkable change in defoliation occurred among the CSTs of *Quercus suber.* The proportion of damaged trees decreased from 33.7% by 23.4 percent points to 10.3%. This means, that the number of damaged trees was more than two thirds lower in 1993 than in 1992. There was also a decrease in the proportion of damaged trees in *Castanea sativa,* namely from 20.3% by 3.8 percent points to 16.5%. This species group had shown a prominent increase between 1991 and 1992 by 5.7 percent points.

The above mentioned species, with the exception of *Quercus* spp., are typical for the Mediterranean regions, and were subject to rapid changes in vitality, including deteriorations and improvements. These rapid changes, especially if only small percentages of the trees are affected, should be interpreted in connection with typical detrimental events in the Mediterranean region, such as drought and fire. Though large, these changes have less influence on the result for the total broadleaves than the changes in vitality of *Quercus* spp, *Fagus* spp., and Other broadleaves, because the numbers of CSTs of the latter are far larger.

The largest number of broadleaved CSTs is represented by Other broadleaves (11 060 trees), in which the proportion of damaged trees decreased from 20.5% by 1.5 percent points to 19.9%. The second largest number of CSTs is represented by *Quercus* spp. (9 707 trees).

Of the **coniferous CSTs,** the most species groups experienced only slight changes in defoliation from 1992 to 1993, except *Abies* spp.. The share of damaged *Abies* spp. trees increased from 29.2% by 4.4 percent points to 33.6%. This represented the highest percentage of damaged trees, both among the conifers and the broadleaves in 1993. However, this was of only little influence on the total result, which is dominated mainly by *Pinus* spp. and *Picea* spp..

The largest number of coniferous CSTs (27 378) was comprised by *Pinus* spp., showing a slight decrease in the proportion of damaged trees from 24.1% by 0.3 percent points to 23.8%. *Picea* spp., with 18 747 trees the second largest group of coniferous CSTs, showed a slight increase in the share of damaged trees by 0.3 percent points from 27.4% to 27.7%. As a result, the proportion of damaged coniferous CSTs remained at its level of 25.2%.

As to **discolouration,** some species groups improved over the period 1992-1993, whereas other species groups deteriorated. However, there was an overall higher discolouration in 1993 than in 1992 in the conifers, whereas an improvement occurred on the average in the boadleaves.

Among the **broadleaved CSTs,** the considerable decrease of discolouration observed in *Quercus suber* already last year continued. The proportion of discoloured trees (discolouration classes 1-4) decreased remarkably from 23.9% to 5.6%. Obvious increases in discolouration occurred in *Eucalyptus* spp. (from 3.3% to 6.8% of the trees in classes 1-4), in *Castanea sativa* (from 21.7% to 24.0%) and in *Quercus* spp. (from 11.0% to 12.9%). As regards *Eucalyptus* spp., rapid changes have occurred in recent years. This result may be biased by the comparatively low number (1 033) of CSTs of the latter species group.

In the **coniferous CSTs** a small increase in the proportion of discoloured trees was to be found in all species groups. The most prominent change in discolouration occurred in Other conifers, namely an increase in discoloured trees from 10.1% to 13.8%. This result, however, may also be affected by the small number (900) of CSTs in this species group.

Table 3.1.83-1: Percentages of the Common Sample Trees in different defoliation and discolouration classes in 1992 and 1993 by species group

Species Group	Defoliation						Discolouration		No. of trees
	0-10%		>10-25%		>25%		>10%		
	1992	1993	1992	1993	1992	1993	1992	1993	
Castanea sativa	61.5	65.4	18.4	18.1	20.3	16.5	21.7	24.0	1253
Eucalyptus spp.	83.7	77.6	11.7	17.5	4.6	4.9	3.3	6.8	1033
Fagus spp.	48.4	49.5	32.5	32.5	19.2	18.1	10.6	8.3	7661
Quercus (dec.) spp.	44.6	40.9	34.0	33.3	21.5	25.7	11.0	12.9	9707
Quercus ilex	46.7	40.6	46.0	52.3	7.3	7.1	5.1	4.7	2935
Quercus suber	30.8	48.1	35.6	41.6	33.7	10.3	23.9	5.6	1495
Other broadleaves	46.9	46.4	29.1	31.0	24.0	22.5	16.6	12.7	11060
Total broadleaves	47.5	46.7	32.0	33.4	20.5	19.9	12.7	11.0	35144
Abies spp.	42.3	40.3	28.0	26.2	29.2	33.6	11.7	14.0	1873
Larix spp.	59.8	60.8	24.6	25.2	15.6	13.9	9.7	9.8	927
Picea spp.	37.9	39.4	34.7	32.9	27.4	27.7	5.6	6.8	18747
Pinus spp.	40.5	40.0	35.4	36.2	24.1	23.8	8.0	8.3	27378
Other conifers	61.3	53.1	24.8	32.4	13.9	14.4	10.1	13.8	900
Total conifers	40.3	40.4	34.5	34.3	25.2	25.2	7.4	8.2	49825
Total	43.3	43.0	33.5	33.9	23.3	23.1	9.7	9.4	84969

3.1.9 Changes in defoliation since 1988

Similar to the Common Sample Trees (CSTs) of 1992 and 1993 (Chapter 3.1.8) a separate sample of trees common to the years 1988-1993 was defined in order to study the trends in vitality over a longer period. Commencing this time series in 1987 would have resulted into a far lower number of common trees. Of the total tree sample, 28 656 trees were found with information available for each year between 1988 and 1993. This sample excludes the trees of the United Kingdom, because of the reasons mentioned in Chapter 3.1.8.

The evaluation was confined to the ten most common species, each of which comprised more than 850 common trees. Also evaluated were ***Abies alba*** and ***Picea sitchensis.*** These two species had lower tree numbers and were not to be included according to their ranking, but they are of importance in particular regions, especially in the Mountainous and in the Atlantic (north) region. The evaluation was carried out specieswise both for the total number of common trees and for the individual regions. As in the 1992 survey, no evaluation was made for those regions, in which the number of trees of a certain species was lower than 100. No common trees existed in the Boreal, the Boreal (temperate) and the Continental region.

The selection described above resulted in a total sample of 19 528 trees common to the surveys from 1988 to 1993. The twelve species, their tree numbers in each of the remaining six climatic regions and their tree numbers for the six regions as a whole are listed in Table 3.1.9-1. The defoliation for each of the twelve species is tabulated for each region in Annex 1-9.

Table 3.1.9-1: Numbers of trees common to the surveys from 1988 to 1993, by species and climatic region, Tree numbers in brackets are lower than 100 and represent samples too small for regional evaluations.

Species	Atlantic (north)	Atlantic (south)	Sub-atlantic	Moun-tainous	Mediterr. (lower)	Mediterr. (higher)	No. of trees	m
Picea abies	179	(29)	1736	1278	(83)	(1)	3306	16.9
Pinus sylvestris	523	108	1049	724	117	634	3155	16.3
Fagus sylvatica	292	161	945	491	357	389	2635	13.4
Quercus ilex	(0)	(24)	(0)	107	1238	605	1974	10.1
Pinus pinaster	(0)	309	(0)	(71)	1308	284	1972	10.1
Pinus halepensis	(0)	(0)	(0)	(8)	1005	388	1401	7.2
Quercus suber	(0)	(3)	(0)	(0)	1215	(32)	1250	6.4
Pinus nigra	(20)	(6)	(54)	233	267	619	1199	6.1
Quercus robur	252	214	303	(93)	(29)	(62)	953	4.9
Quercus petraea	(39)	(78)	421	137	(97)	(79)	851	4.4
Abies alba	(4)	(9)	239	301	(13)	(26)	592	3.0
Picea sitchensis	237	(0)	(3)	(0)	(0)	(0)	240	1.2
							19528	100.0

The following chapters 3.1.9.1 - 3.1.9.12 describe the development of the defoliation for 12 selected tree species in detail. Special emphasis is laid on the proportions of trees in defoliation classes 2-4, the trees of which have been called "damaged". The development of defoliation over time is displayed graphically for all trees and those regions with at least 100 trees of the respective species.

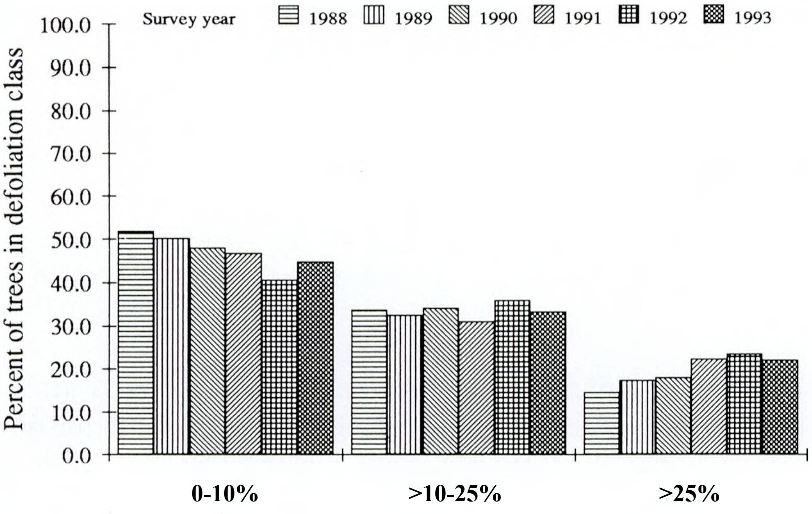
3.1.9.1 Picea abies

Picea abies represented the largest share of all common trees since 1988. Besides that, ***Picea abies*** is the species with the most common trees in the Sub-atlantic and the Mountainous region. In addition to these regions, a smaller amount of trees was evaluated in the Atlantic (north) region.

In the total sample of common ***Picea abies*** trees, the share of damaged trees has increased gradually from 1988 to 1992. In 1993, a slight improvement from 23.5% in 1992 to 21.9% occurred. This result is similar to those for the Sub-atlantic and the Mountainous region, which represented the largest shares of common ***Picea abies*** trees.

The proportion of damaged trees in the Atlantic (north) region showed a slight increase from 15.1% in 1988 to 17.1% in 1989, remained at this level until 1990 and increased slightly to 20.4% in 1991. In contrast to the other regions evaluated, there was a remarkable increase in the proportion of damaged trees from 18.4% in 1992 to 29.4% in 1993. This was the highest percentage of damaged ***Picea abies*** trees in 1993 of the 3 regions evaluated. Accordingly, the share of undamaged and slightly defoliated trees decreased. This obvious deterioration in the Atlantic (north) region, however, influenced the result for the total ***Picea abies*** sample only little, because its largest shares in the Sub-atlantic and Mountainous regions showed a decrease in the proportion of damaged trees in 1993.

ALL TREES



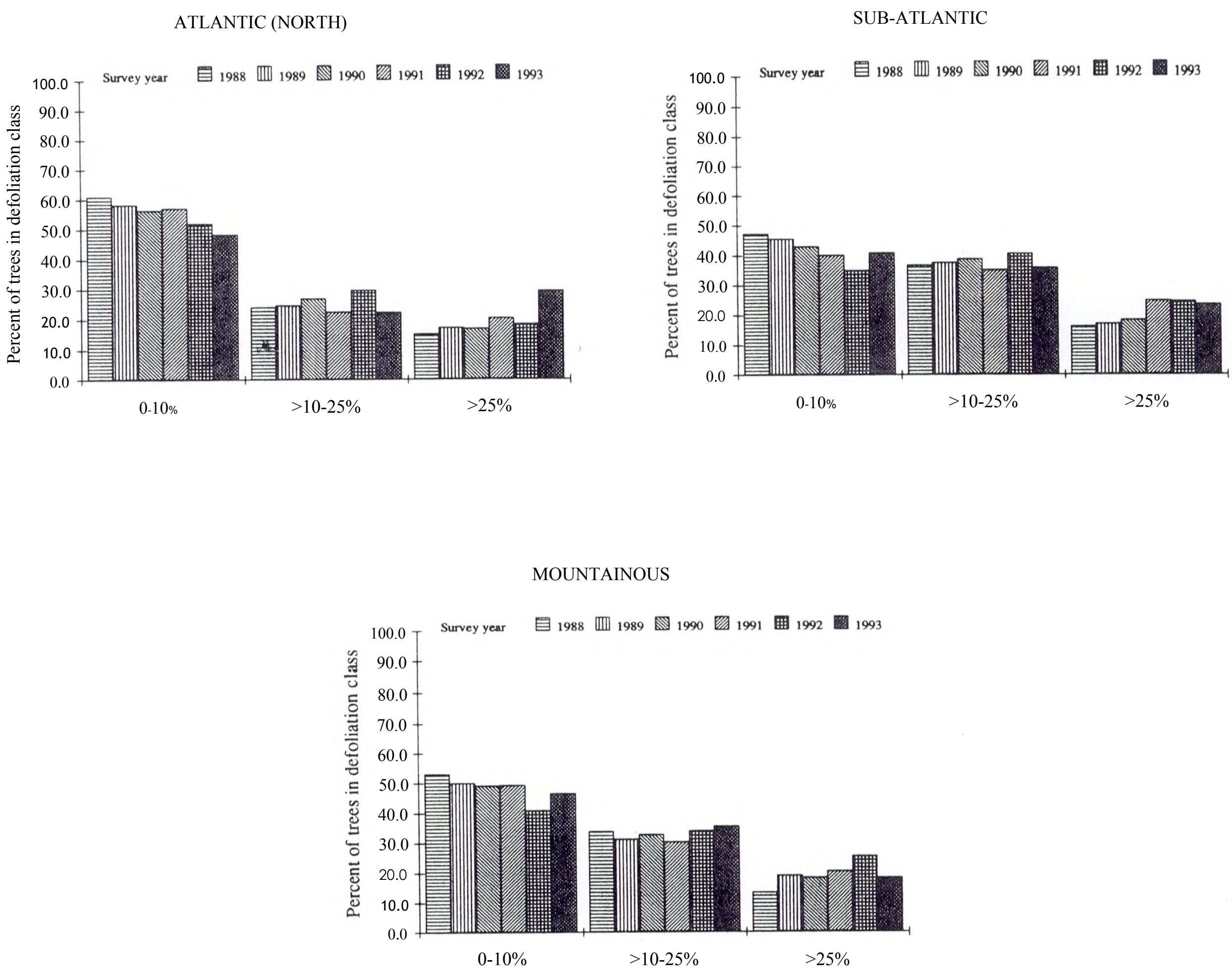


Figure 3.1.9.1-lb: Defoliation of ***Picea abies*** from 1988-1993

3.**1.9.2** **Pinus sylvestris**

Pinus sylvestris represented the second largest share of the common sample since 1988. This species was evaluated in all climatic regions, having its largest proportion in the Sub-atlantic region.

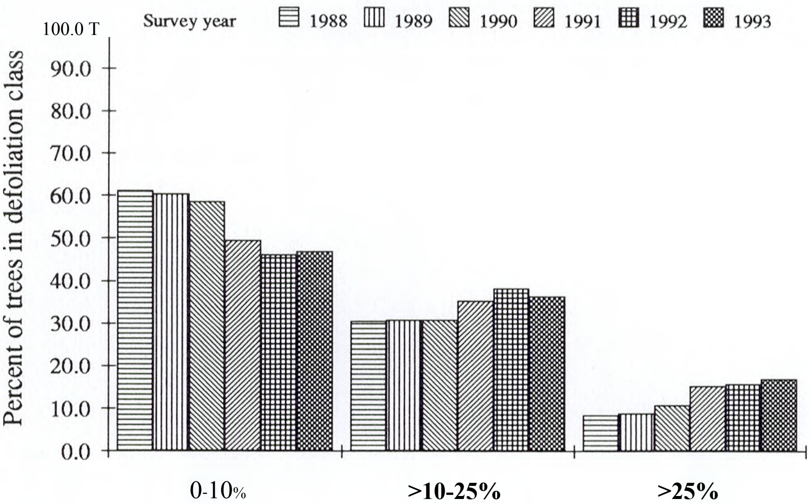
Since 1988, the proportion of damaged ***Pinus sylvestris*** trees increased gradually from 8.4% to 16.9% in the total sample of common trees. Great differences in the development of defoliation were found among the various climatic regions, however, in all regions the share of damaged trees increased.

The increase in the share of damaged trees was most obvious in the Mountainous, Mediterranean (higher) and Mediterranean (lower) regions. In the Mountainous region, the respective share increased gradually from 4.6% in 1989 to 18.5% in 1993. In the Mediterranean (higher) region the share of damaged trees rose clearly from 6.5% in 1991 to 13.4% in 1992 and reached its maximum with 17.5% in 1993. In the Mediterranean (lower) region, a continuous increase started in 1989 from 0.9% to the maximum of 10.3% in 1993.

The percentage of damaged trees was highest during the total period of observation in the Sub-atlantic region. After its continuous increase from 13.0% in 1988 to its maximum of 25.6% in 1991, it decreased to 20.2% in 1992. The percentage of damaged trees remained at this level with 20.3% in 1993.

As compared to the other regions, the share of damaged trees remained at a relatively low level in the Atlantic (north) and Atlantic (south) regions. Nevertheless, it increased from 5.9% to 10.8%, and from 2.8 to 8.3%, respectively.

ALL TREES



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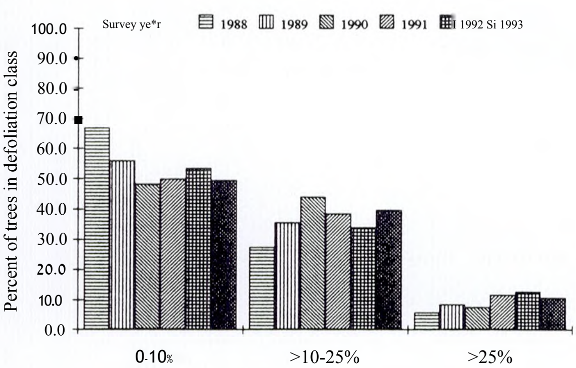

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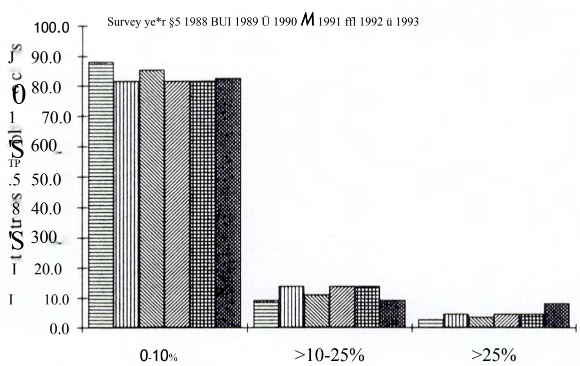


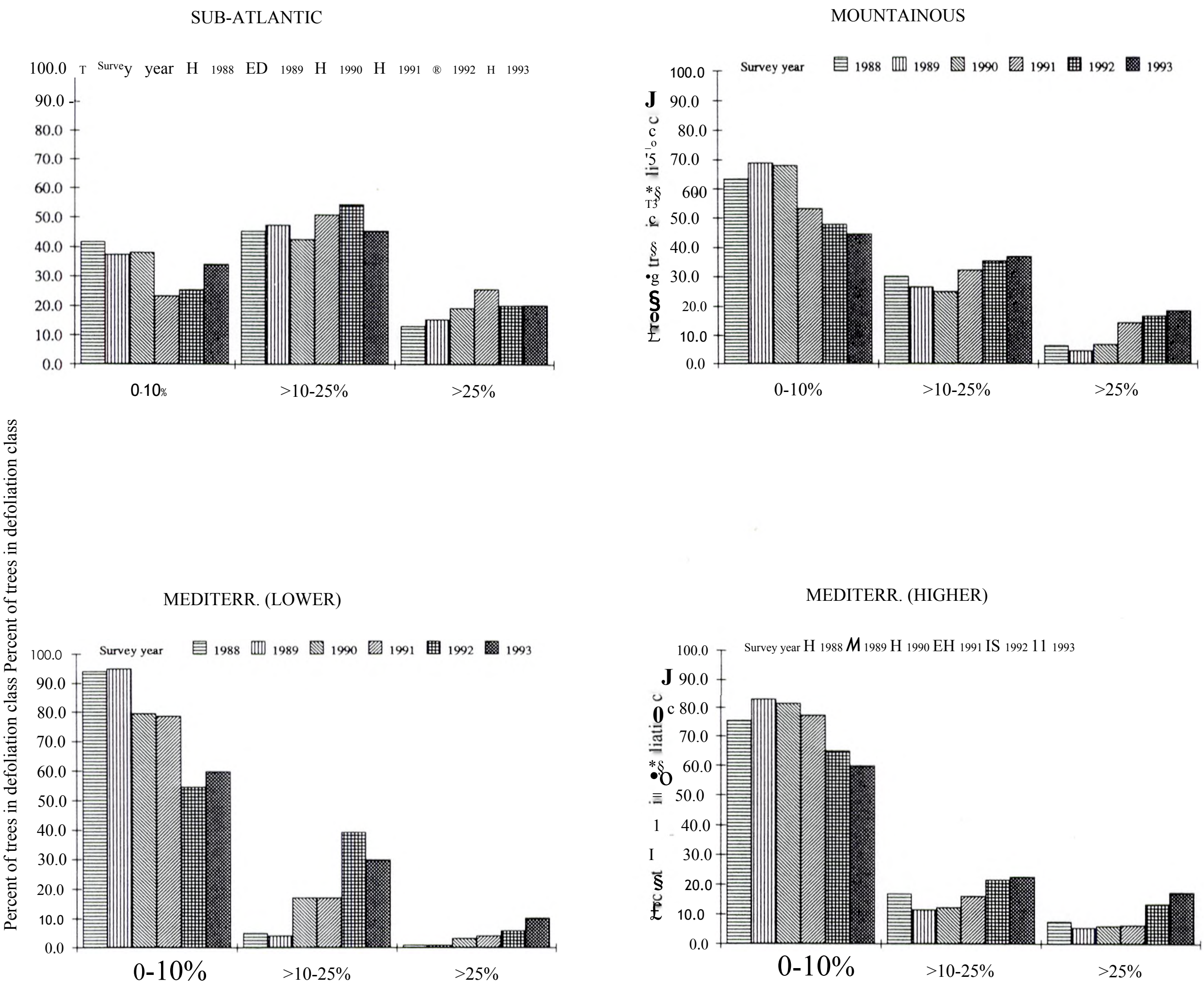


Figure 3.1.9.2-lb: Defoliation of ***Pinus sylvestris*** from 1988-1993

3.1.9.3 Fagus sylvatica

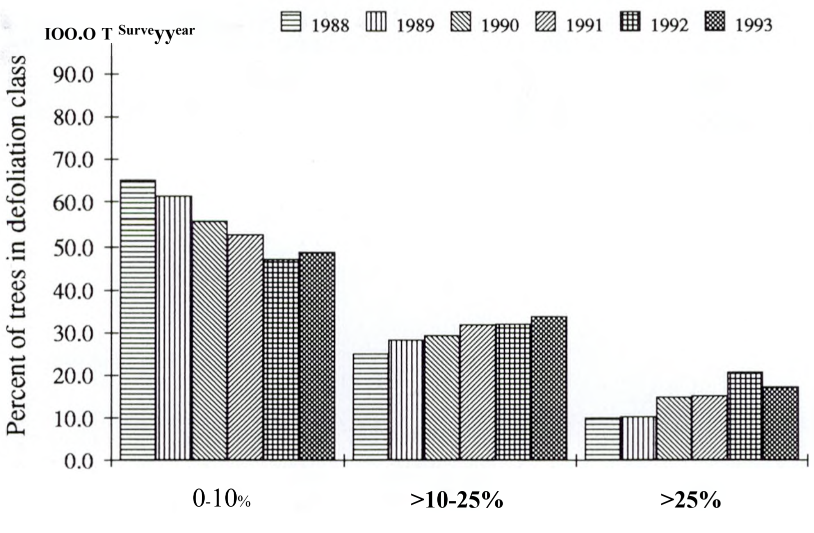
Fagus sylvatica represented the third largest sample within the common trees and was evaluated in all climatic regions. The largest share of this species was found in the Sub-atlantic region.

As regards the total common ***Fagus sylvatica*** trees, the proportion of damaged trees increased from 10.0% in 1988 to 17.3% in 1993. A maximum was reached with 20.8% in 1992. The increase in the damaged share was to be observed in all regions, though to a differing extent.

The development of the whole sample was mainly influenced by the dominating share of trees in the Sub-atlantic region, where the maximum and subsequent decrease of defoliation were even more pronounced. In this region, the share of damaged trees increased continuously from 12.4% in 1989 to 31.9% in 1992 and decreased to 24.1% in 1993. The Sub-atlantic and the Atlantic (north) region had far higher shares of damaged trees during the period of observation than the others. The defoliation in the Atlantic (north) region showed a sharp increase from 14.4% in 1988 to the maximum of 36.0% in 1990. After a decrease to 24.9% in 1991, the share of damaged trees remained at a high level of 28.5% since 1992. This represented the highest percentage of damaged ***Fagus sylvatica*** trees in 1993.

In the Atlantic (south) and the Mediterranean (lower) regions, nearly no damaged trees were present in 1988 and 1989. Since 1990, between 6.2 and 6.8% of the trees in the Atlantic (south) region, and between 7.8% and 9.0% in the Mediterranean (lower) region were damaged. In the Mediterranean (higher) region the percentage of damaged trees increased from 5.9% in 1988 to 11.3% in 1993, with a maximum of 13.4% in 1992. The smallest increase since 1988 and a relatively low percentage of damaged trees, ranging between 5.7% in 1991 and 12.6% in 1992, was observed in the Mountainous region.

ALL TREES



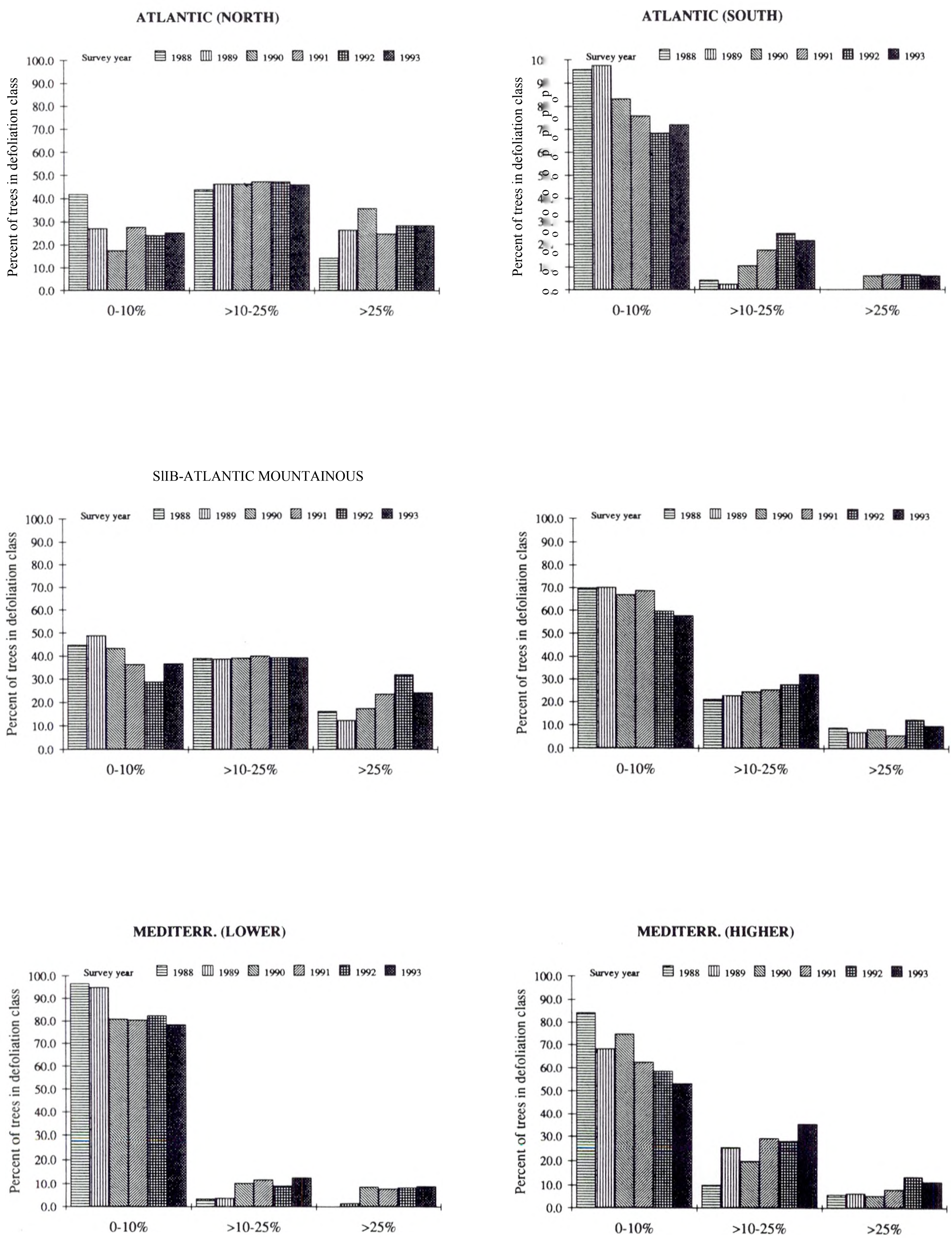


Figure 3.1.9.3-lb: Defoliation of ***Fagus sylvatica*** from 1988-1993

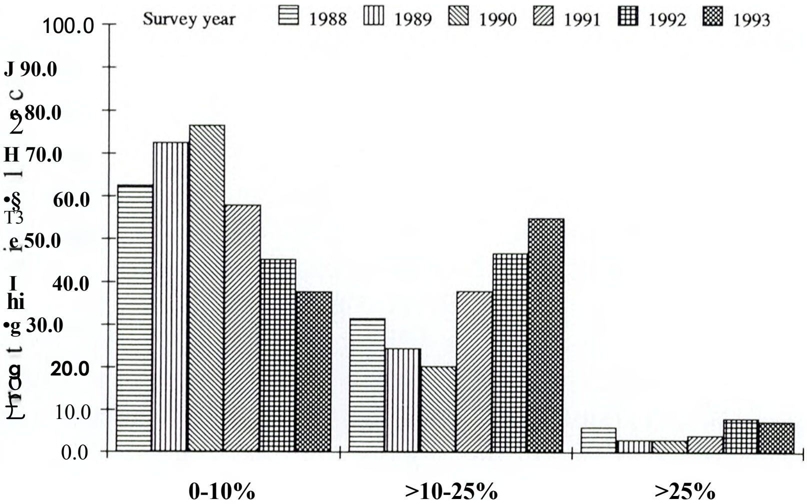
3.1.9.4 Quercus ilex

The most of the common ***Quercus ilex*** trees were evaluated in the Mediterranean (lower) region. Also investigated was the share in the Mediterranean (higher) and a smaller amount in the Mountainous region (see Table 3.1.9-1).

The development of the defoliation of the total common ***Quercus ilex*** sample was characterized by a migration of trees between defoliation classes 0 and 1. From 1988 to 1990 the proportion of trees in defoliation class 0 increased from 62.5% to 76.6%. Accordingly, at the same time the share of class 1 decreased from 31.5% to 20.3%. After 1990, this improvement in forest condition was reversed and turned into a deterioration. The share of defoliation class 0 dropped to 58.0% in 1991 and continued its decrease to 37.7% in 1993. Simultaneously the share of class 1 jumped to 37.9% in 1991 and increased to 55.0% in 1993. As a result, the share of damaged trees remained at a low level during the total period of observation, ranging between 3.0% in 1990 and 8.1% in 1992. This development was strongly determined by the overwhelming proportion of sample trees in the Mediterranean (lower) region and the proportion in the Mediterranean (higher) region. The total common sample and the two Mediterranean samples were very similar in their development.

Compared with the Mediterranean regions the defoliation of ***Quercus ilex*** in the Mountainous climatic zone developed rather irregularly. The proportion of damaged ***Quercus ilex*** trees in the Mountainous region showed a very sharp increase from 2.8% in 1988 and 1989 to 24.3% in 1990. After a remarkable decrease to 9.3% in 1991 the damaged sample jumped to its maximum share of 30.8% in 1992. In 1993, the share of damaged trees decreased again to 17.8%, which represented the highest proportion of damaged ***Quercus ilex*** trees of the three regions in 1993.

ALL TREES



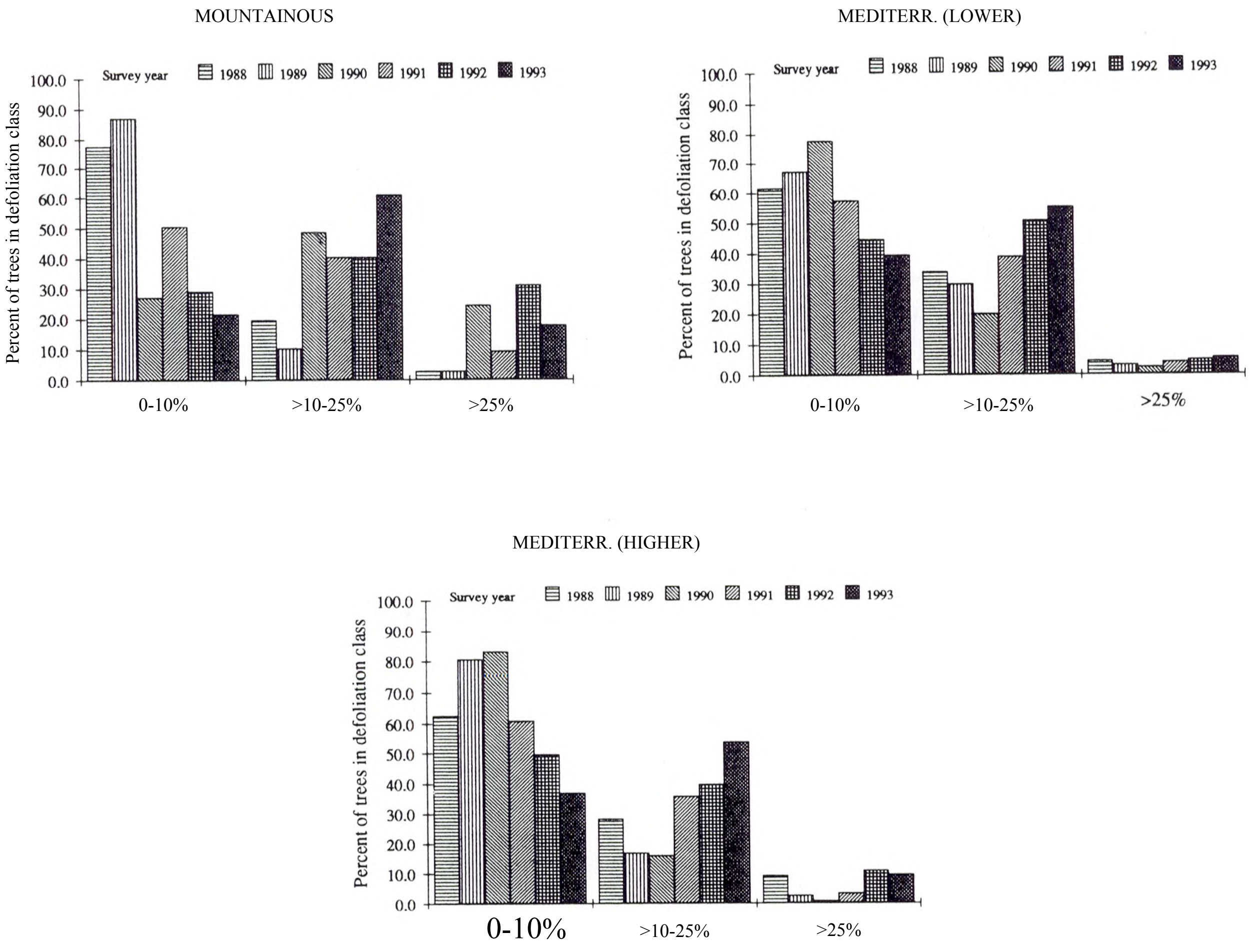


Figure 3.1.9.4-lb: Defoliation of ***Quercus ilex*** from 1988-1993

3.1.9.5 Pinus pinaster

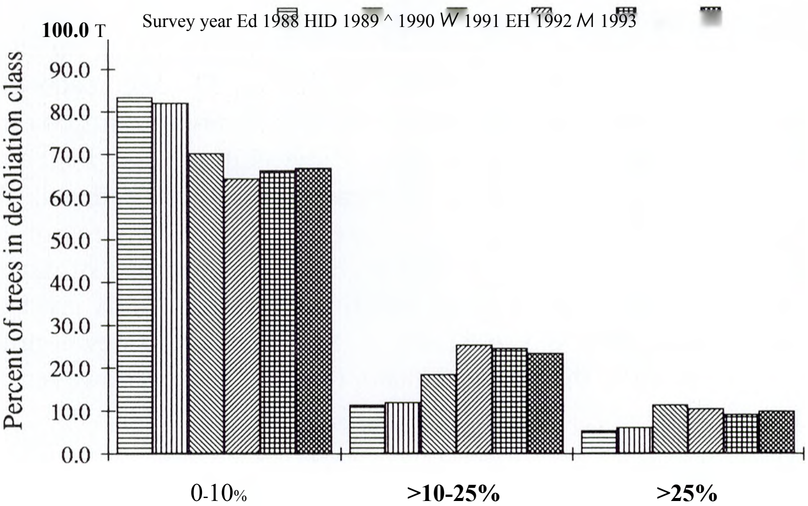
The overwhelming share of common ***Pinus pinaster*** trees is situated in the Mediterranean (lower) region. As in the previous year, ***Pinus pinaster*** represented the highest amount of common trees in this climatic region. Further evaluations were made in the Mediterranean (higher) and the Atlantic (south) region.

After an obvious jump of the share of damaged individuals in the total sample of common ***Pinus pinaster*** trees from 6.1% in 1989 to 11.3% in 1990, the respective percentage decreased to 9.2% in 1992. In 1993, a little increase to 9.8% occurred again. This development was greatly influenced by that in the Mediterranean (lower), and resembled strongly to that in the Mediterranean (higher) region. In the Mediterranean (lower) region, a slight and continuous increase occurred from 5.8% in 1989 to 9.5% in 1993. This development is similar to that in the Mediterranean (higher) region, where the continuous increase started already in 1988 with 2.8% and continued to 6.7% in 1993. A little decrease from 4.9% in 1990 to 3.9% was observed in 1991. In this region, the lowest share of damaged ***Pinus pinaster*** trees was found in 1993.

The development of the proportion of damaged trees in the Atlantic (south) region was quite different. Here, a very sharp increase from 1.9% in 1988 to the maximum of 33.7% in 1990 occurred. After this, the share of damaged trees decreased remarkably to 12.9% in

1992 and to 11.7% in 1993. Among the regions evaluated, this was the largest percentage of damaged ***Pinus pinaster*** trees found in 1993.

ALL TREES



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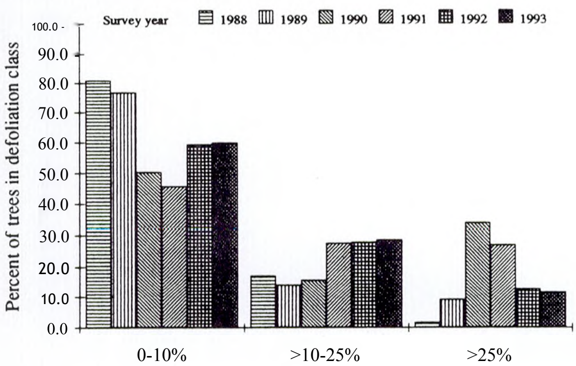

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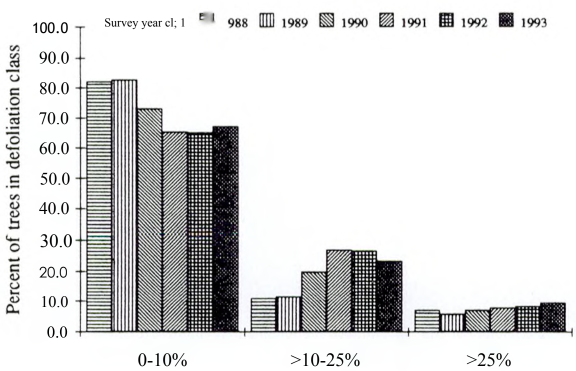

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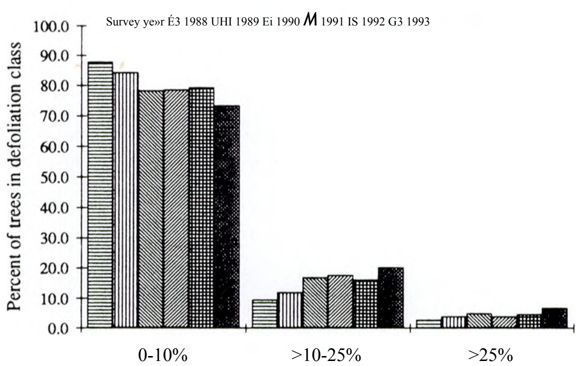
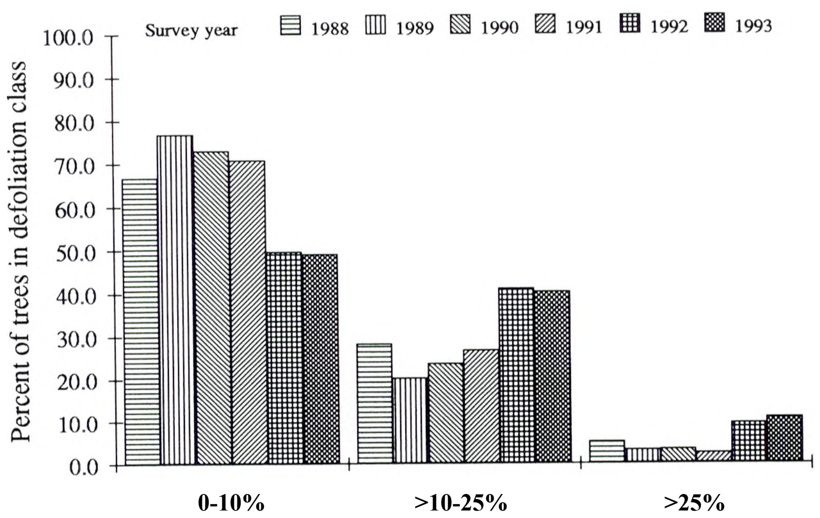


3.1.9.6 Pinus halepensis

Pinus halepensis had the overwhelming part of its common trees in the Mediterranean (lower) region. A smaller amount of trees were also investigated in the Mediterranean (higher) region.

Concerning the total common sample, the proportion of damaged ***Pinus halepensis*** trees remained at a low level until 1991, then jumped to 9.4% in 1992 and reached 10.7% in 1993. This sharp increase was also found in defoliation class 1: after an improvement from 28.2% in 1988 to 20.1% in 1989, the share of trees in defoliation class 1 increased to its maximum of 41.0% in 1992. In 1993, a slight decrease to 40.3% occurred. This corresponds to the development in the Mediterranean (lower) region, as this region comprised by far the largest number of common trees. In this region, the proportion of damaged trees decreased from 5.8% in 1988 to 3.0% in 1989, remained roughly at this level until 1991 and then increased to 9.7% in 1992 and to 11.6% in 1993. A similar development of the share of damaged trees occurred in the Mediterranean (higher) region, however, at an even lower level.

ALL TREES



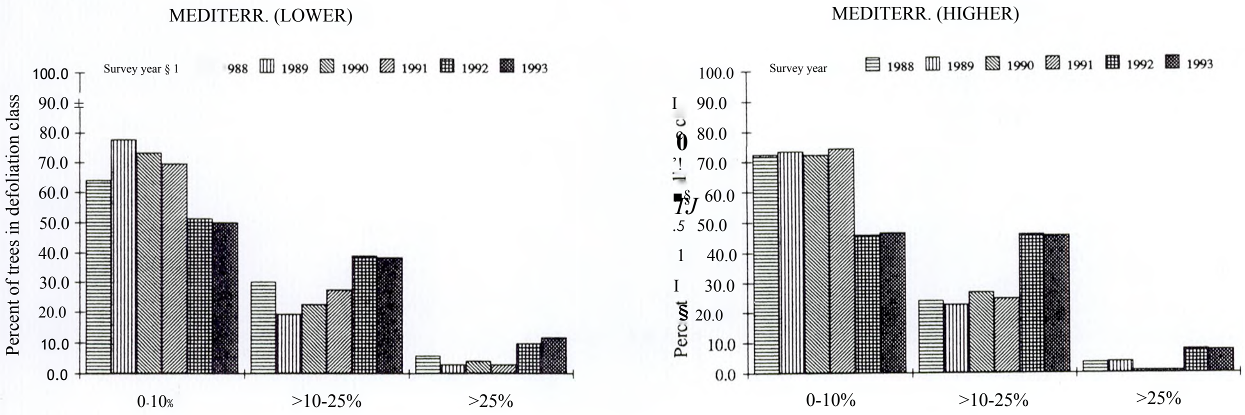


Figure 3.1.9.6-lb: Defoliation of ***Pinus halepensis*** from 1988-1993

3.1.9.7 Quercus suber

Nearly all common ***Quercus suber*** trees are in the Mediterranean (lower) region. Evaluations were only performed in this region.

The share of damaged trees in the total ***Quercus suber*** sample showed a dramatic increase from 0.7% in 1988 to 9.6% in 1989, and then to 43.4% in 1990. The maximum was reached in 1991 with 44.0%. However, a remarkable improvement occurred in 1993. The share of damaged trees diminished from the maximum of 44.0% to 36.2% in 1992 and to 9.5% in 1993.

The rapid increase in the share of damaged trees from 1988 to 1991 was accompanied by an increase in the share of trees in defoliation class 1. In contrast to defoliation classes 2-4, however, the increase in the share of trees in defoliation class 1 continued after 1991 and reached its highest level in 1993 with 42.0%. At the same time, the proportion of not defoliated trees dropped from 92.1% in 1988 to 25.9% in 1992. This remarkable decrease was followed by a sharp increase to 48.5% in 1993.

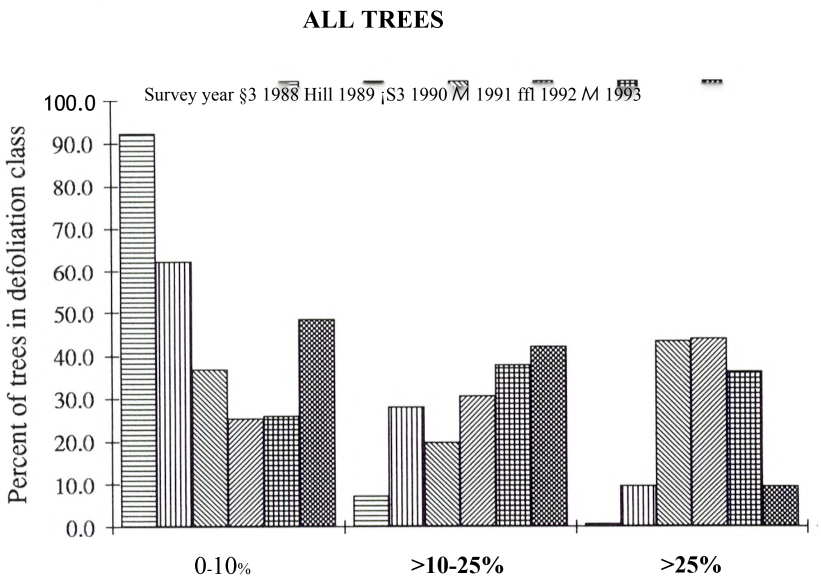


Figure 3.1.9.7-1: Defoliation of ***Quercus suber*** from 1988-1993

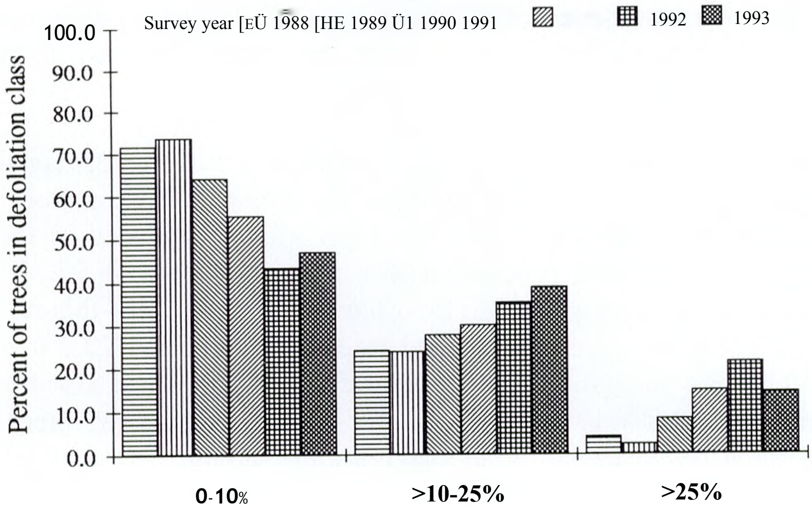
3.1.9.8 Pinus nigra

The largest amount of common ***Pinus nigra*** trees was found in the Mediterranean (higher) region. Further common trees were evaluated in the Mediterranean (lower) and the Mountainous region.

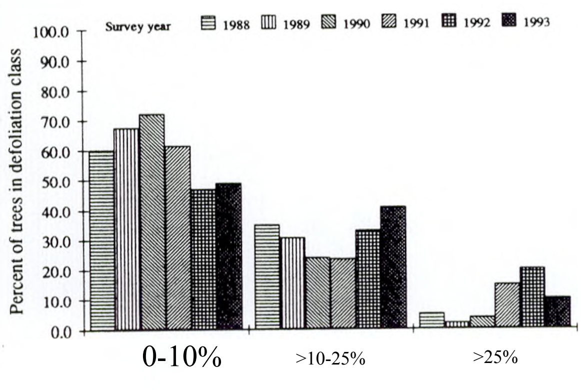
The development of the share of damaged ***Pinus nigra*** trees was very similar in the regions evaluated. Its main characteristics were an overall increase reaching its maximum in 1992, followed by an obvious recuperation in 1993. In the total common sample, after an increase in the proportion of damaged trees from 4.2% in 1988 to 21.4% in 1992, a decrease to 14.3% occurred in 1993. In contrast, the share of trees in defoliation class 1 increased continuously from 24.2% in 1988 to 38.8% in 1993. Correspondingly, the share of not defoliated trees decreased rather gradually except for 1992 from 71.6% in 1988 to 46.9% in 1993.

The development of the total common ***Pinus nigra*** sample was correlated very closely with that in the Mediterranean (higher) region, where the largest amount of damaged ***Pinus nigra*** trees was found in 1993. In this region, the share of damaged trees increased from 3.2% in 1988 to its maximum of 23.3% in 1992 and decreased to 17.0% in 1993. The proportion of trees in the warning stage increased apart from 1989 continuously from 24.7% in 1988 to 42.1% in 1993. In the Mediterranean (lower) region, the percentage of damaged trees decreased from 5.6% in 1988 to 3.0% in 1989, increased to 15.7% in 1991 and reached its maximum of 22.8% in 1992. A decrease to 14.6% occurred in 1993. In the Mountainous region, where the smallest amount of damaged ***Pinus nigra*** trees was found in 1993, the respective proportion decreased from 5.2% in 1988 to 2.1% in 1989, increased again to 3.9% in 1990 and then jumped to 15.0% in 1991 before the maximum was reached in 1992 with 20.2%. In 1993, a decrease to 10.3% occurred.

ALL TREES



MOUNTAINOUS



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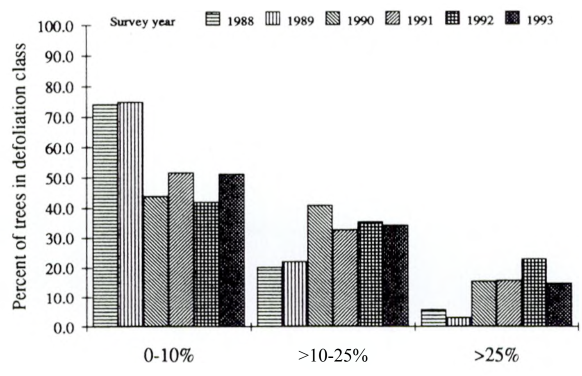

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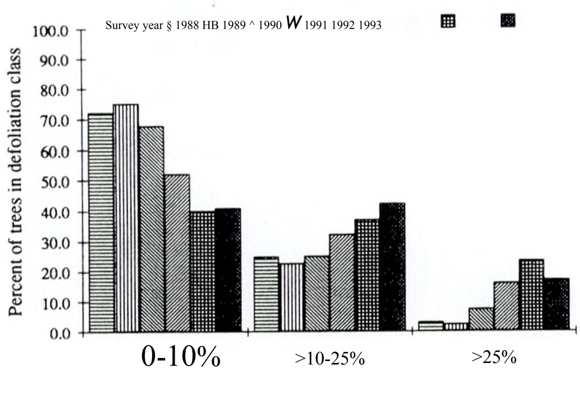


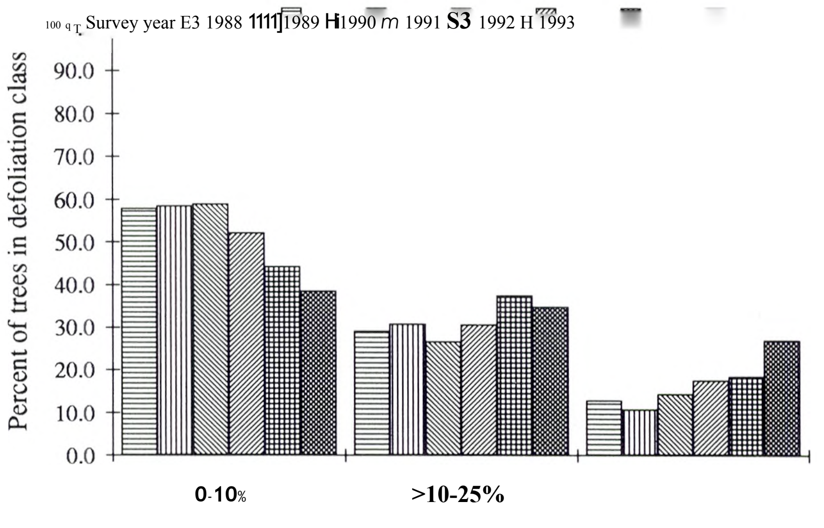
3.1.9.9 Quercus robur

Quercus robur had its largest proportion of common trees in the Sub-atlantic region. Further comprehensive shares of common ***Quercus robur*** trees were evaluated in the Atlantic (north) and the Atlantic (south) region.

Regarding the ***Quercus robur*** trees in all assessed regions, the share of damaged trees increased continuously from 10.7% in 1989, but showed a remarkable jump from 18.4% in 1992 to 26.8% in 1993. This sharp increase was especially pronounced in the Atlantic (north) region, where the respective proportion rose from 20.4% to 35.5%. This represented the highest amount of damaged ***Quercus robur*** trees in 1993. In this region, a remarkable decrease in the percentage of damaged trees occurred from 22.2% in 1988 to 10.1% in 1989. An obvious increase in the share of damaged trees was also found in the Sub-atlantic region from 18.8% in 1992 to 28.4% in 1993. This was preceded by a continuous increase since 1989, similar to the total common sample.

In contrast, in the Atlantic (south) region, where the smallest amount of damaged ***Quercus robur*** trees was found, a slight decrease of the share of damaged trees occurred from 12.6% in 1992 to 11.2% in 1993. This share was relatively low as compared to the other two regions, ranging between 8.4% in 1988 and 15.9% in 1991.

ALL TREES



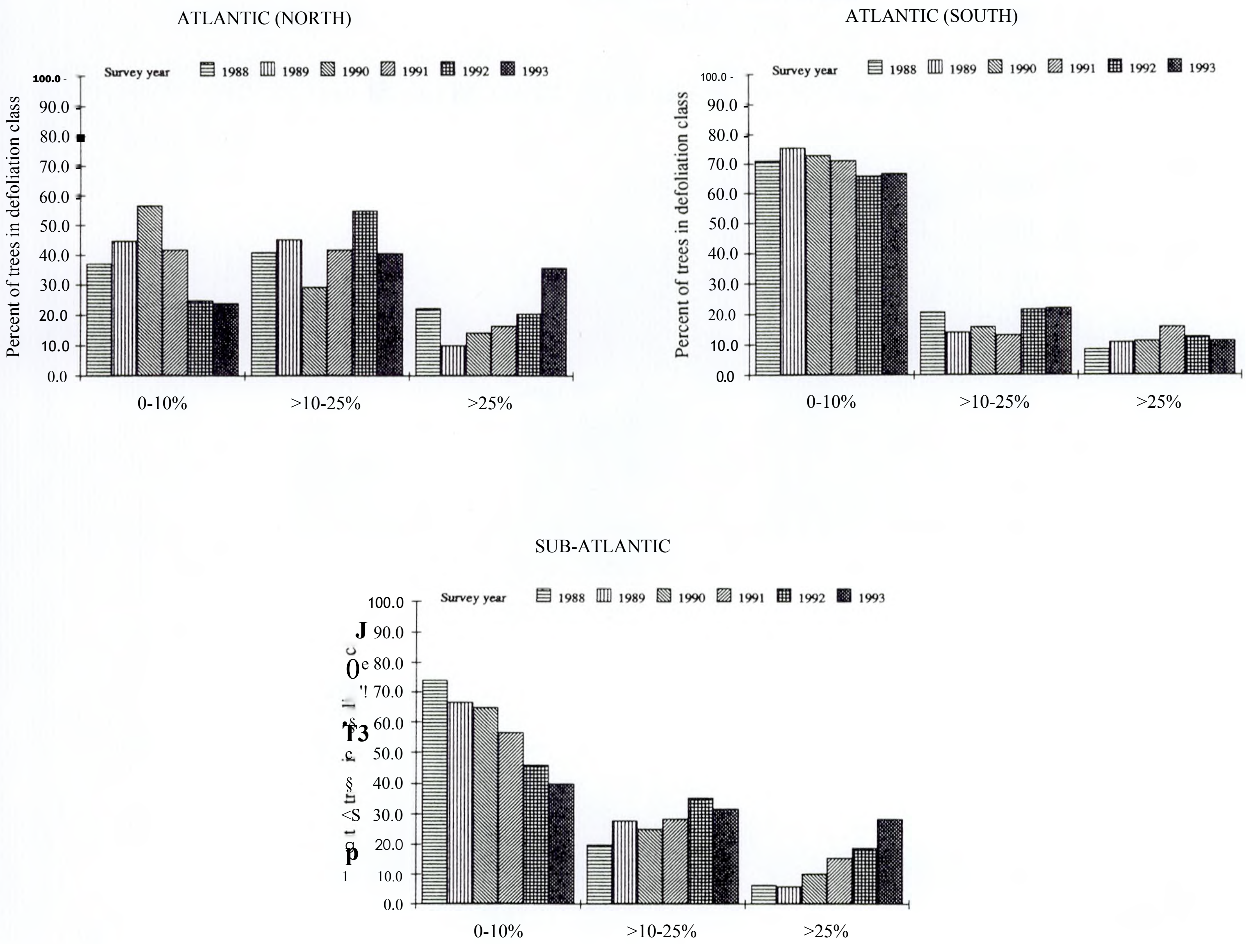


Figure 3.1.9.9-lb: Defoliation of ***Quercus robur*** from 1988-1993

3.1.9.10 Quercus petraea

Most of the common ***Quercus petraea*** trees appeared in the Sub-atlantic region. A smaller amount of trees was also investigated in the Mountainous region.

The total sample of common ***Quercus petraea*** trees showed a slight decrease from 13.2% in 1988 to 9.5% in 1990. After a subsequent rise to a steady level of 17.5% and 17.4% in 1991 and 1992, respectively, in 1993 there was an obvious increase in the share of damaged trees to 24.4%. This development of the total ***Quercus petraea*** sample was mainly influenced by the changes of defoliation in the Sub-atlantic region, where the proportion of damaged trees decreased from 14.0% in 1988 to 10.7% in 1990. After a jump to 19.2% in 1991, the respective proportion of trees increased to 24.7% in 1993.

Especially in the Mountainous region, the development in the defoliation of ***Quercus petraea*** was irregular. In this region, the share of damaged trees decreased from 24.8% in 1989 to 15.3% in 1990, increased again to 24.1% in 1991 and dropped to 19.7% in 1992. In 1993, a remarkable increase to 38.7% was found. Also the share of trees in the warning stage has been showing a remarkable variation since 1988 in the Mountainous region.

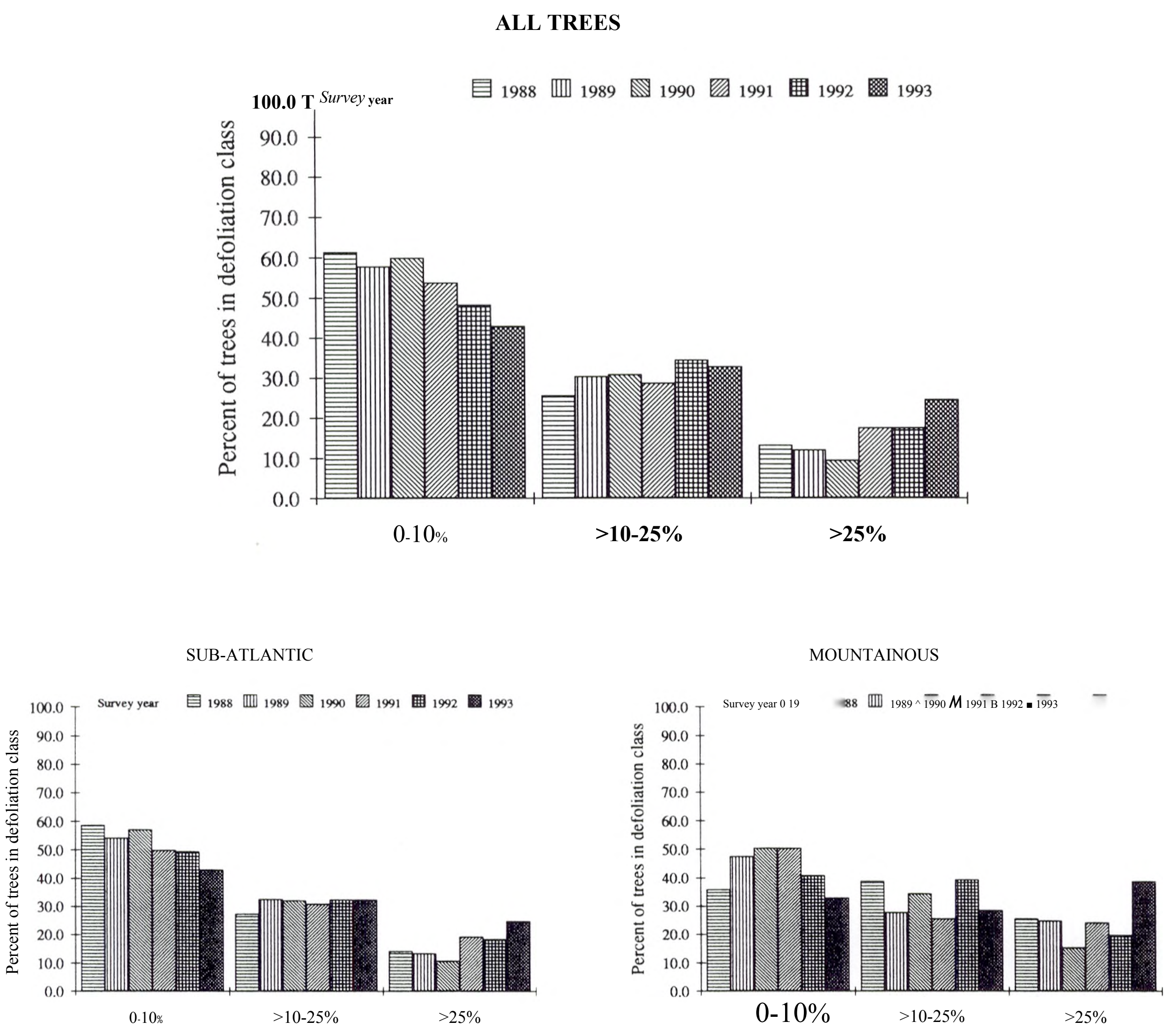


Figure 3.1.9.10-1 : Defoliation of ***Quercus petraea*** from 1988-1993

3.1.9.11 Abies alba

Common trees of ***Abies alba*** appeared in the Mountainous and the Sub-atlantic region with the Mountainous region having a little larger proportion.

The result of the 1993 assessment showed an increase in the total proportion of damaged common ***Abies alba*** trees from 22.5% in 1992 to 30.5% in 1993, after a steadily high level ranging between 23.2% and 25.6% since 1988. This increase is due to an obvious deterioration in the Mountainous region, where a remarkable jump from 24.3% in 1992 to 34.9% in 1993 was found after an oscillation around a high level of 21.6% and 26.9% since 1988. In the Sub-atlantic region, at the same time there was a much smaller increase from 24.3% to 27.2%. In this region, the share of damaged trees oscillated around a steadily high level, too. The share of damaged trees decreased from 27.6% in 1988 to 22.2% in 1990, reached its maximum of 29.7% in 1991 and decreased again to 24.3% in 1992. In both regions, a decrease in the percentage of trees in the warning stage was found from 1992 to 1993.

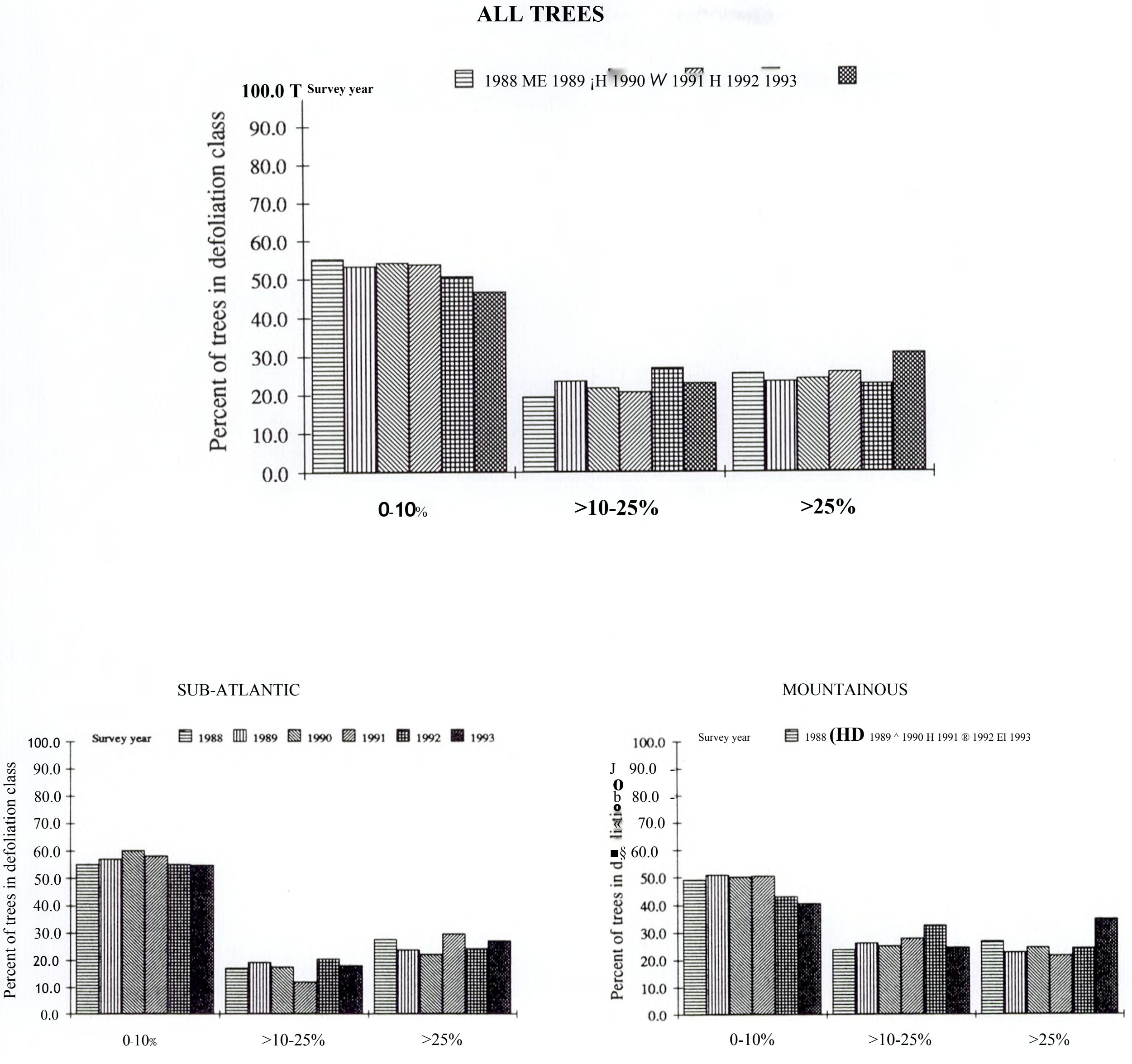


Figure 3.1.9.11-1: Defoliation of ***Abies alba*** from 1988-1993

3.1.9.12 Picea sitchensis

Common ***Picea sitchensis*** trees were only evaluated in the Atlantic (north) region. As a consequence, the development of defoliation of the total common Picea sitchensis sample nearly coincided with the development in this region.

Concerning the total sample of common ***Picea sitchensis*** trees, a sharp increase was found in the proportion of damaged trees from 4.6% in 1988 to 20.9% in 1989, followed by a decrease to 4.9% in 1990. In 1991, there was another increase to 19.8%. After a steady level from 1991 to 1992, another sharp increase to 33.8% occurred in 1993. The increase in defoliation since 1988 is thought to be mainly due to ***Elatobium.***

The share of trees in the warning stage increased from 26.7% in 1988 to 37.6% in 1989. Since 1990 it has been remaining at a level ranging between 28.5% in 1990 and 30.8% in 1993.

ALL TREES

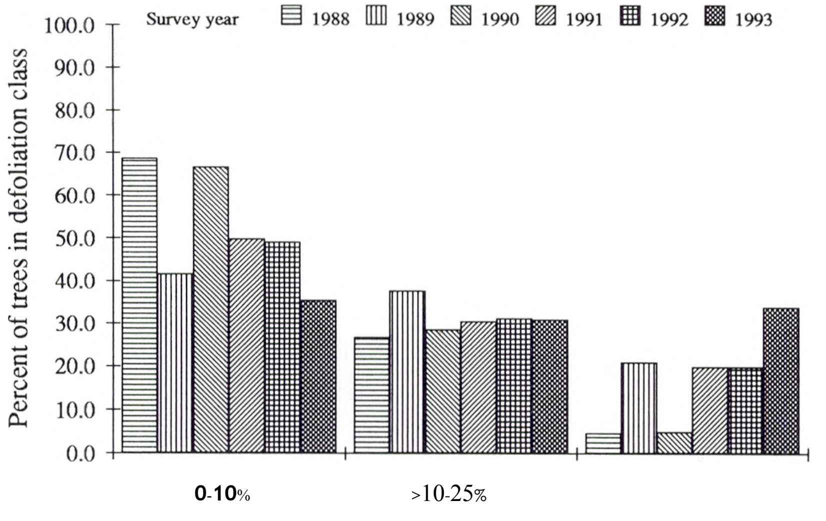


Figure 3.1.9.12-1: Defoliation of ***Picea sitchensis*** from 1988-1993

3.1.10 Extended evaluation

3.1.10.1 Defoliation of trees prior to their exclusion

The impact of the exclusion of trees on the survey results can be evaluated by scrutinizing the defoliation in the year before their exclusion. The reasons for the exclusion ranges from thinning, sanitary fellings and harvesting to mortality. These reasons, however, remain unknown in the most cases. A similar study has been performed already in the 1992 survey in order to test the frequently stated hypothesis that the replacement of excluded trees by new ones produces lower forest damage figures. The results in this report showed that between 1988 and 1992 very similar shares of trees were excluded in defoliation classes 0, 1 and 2. Of the trees of defoliation class 3 only a slightly larger share of the trees was excluded. Of the dead trees, by far the highest share of trees was excluded from the survey. However, the number of excluded trees of defoliation class 3 and of the dead trees was very low. This indicated that the survey results were unaffected by the exclusion of trees.

To elucidate this problem further, the distribution of the excluded trees was again scrutinized, however, this time for the updated data set of the years 1988 to 1993 and with respect to stand age. Moreover, it was tested if the respective relationships are different for all regions (i.e. the total tree sample), for regions showing low defoliation and for regions showing high defoliation. For this purpose, two regions of high defoliation and low defoliation had to be defined. For the region of low defoliation, large parts of Scandinavia, western Europe and the Alps were selected. The region of high defoliation was represented by the main damage areas of central Europe.

In Table 3.1.10.1-1 the 12 233 trees excluded between 1988 and 1993 are classified according to defoliation in the year before their exclusion.

Table 3.1.10.1-1: Distribution of the defoliation of all trees excluded between 1988 and 1993

Defoliation	Percentages of trees in defoliation classes prior to exclusion		
	all regions	region of low defoliation	region of high defoliation
0-10%	47.2	51.5	3.6
>10-25%	26.4	27.9	12.7
>25-60%	16.6	14.1	37.9
>60%	2.8	2.5	16.3
dead	7.0	4.0	29.5

Table 3.1.10.1-1 shows that the majority of trees in all regions (47.2%) and regions of low defoliation (51.5%) were undamaged before disappearing from the inventory. However, there is a striking difference between the distribution of trees excluded over the defoliation classes in these two regions on the one hand and in the region of high defoliation on the other hand. In the region of high defoliation this distribution is almost reversed.

It was assumed that the high share of excluded trees in defoliation class 0 found in all regions and in the region of low defoliation was mainly a consequence of thinning, harvesting and natural selection due to competition and calamities in young stands. For these two regions, the distribution of excluded trees over the defoliation classes was tested for different age classes. In contrast, in the region of high defoliation, mainly trees of high defoliation and dead trees were excluded. Because of the small sample size in region of high defoliation, the analysis according to age classes could not be performed here.

Table 3.1.10.1-2 shows that the largest share of excluded trees of all ages, namely 47.2%, had a defoliation of 0-10% prior to their exclusion. The shares of excluded trees in the classes of defoliation >10-25% and >25% were far smaller and nearly at the same level, namely 26.7% and 26.3%, respectively.

Table 3.1.10.1-2: Defoliation of trees prior to their exclusion (all regions)

Age [years]	Defoliation prior to exclusion			No. of trees
	0 -10%	>10 - 25%	>25%	
0- 20	48.6	24.2	27.2	1662
21 - 40	47.3	26.2	26.5	2873
41 - 60	47.4	28.1	24.5	2541
61 - 80	45.9	26.9	27.2	1975
81 - 100	49.7	26.8	23.5	1526
101 - 120	44.8	26.3	28.9	781
>120	42.4	27.8	29.8	875
All ages	47.2	26.4	26.4	12233

The share of trees not defoliated before their exclusion show a slight decrease from 48.6% to 45.9% with increasing age until 80 years. After that the respective proportion rises to its maximum of 49.7% in the age class 81-100, followed by a decrease to 42.4% in the highest age class >120. The share of slightly defoliated trees shows no great changes by age class. The respective percentages range from 24.2% in age class 0-20 to 28.1% in age class 41-60. As regards the proportion of trees defoliated more than 25% before their exclusion, a slight decrease appears with rising age until 60 years. The minimum is found in age class 81-100. With increasing age, the respective percentage rises to its maximum of 29.8% in age class >120.

Interpretations of the results in table 3.1.10.1-2 have to be made with care, particularly because of the far lower numbers of trees aged over 100 years, compared to the younger age classes. Nevertheless, the results indicate, that a great proportion, partly nearly one half, of trees excluded from the assessment showed no defoliation in the year before the exclusion, and that no obvious differences appeared in the percentages of trees between defoliation classes 1 and 2-4.

In the region of low defoliation the number of excluded trees (2 519) is large enough for evaluation. The results of this evaluation are presented in Table 3.1.10.1-3.

Table 3.1.10.1-3: Defoliation of trees prior to their exclusion (region of low defoliation)

Age [years]	Defoliation prior to exclusion			No. of trees
	0 - 10%	>10-25%	>25%	
0- 20	56.3	22.1	21.6	213
21 - 40	54.5	23.5	22.0	472
41 - 60	47.0	32.3	20.7	508
61 - 80	44.2	31.9	23.9	511
81 - 100	52.7	29.1	18.2	461
101 - 120	54.1	24.4	21.5	172
>120	42.3	38.5	19.2	182
All ages	51.5	27.9	20.6	2519

The share of trees being not defoliated prior to their exclusion decreases from its maximum of 56.3% in age class 0-20 to 44.2% in age class 61-80. After that the respective proportion increases to 52.7% in age class 81-100 and to 54.1% in age class 101-120. In age class >120 the share shrinks remarkably to 42.3%.The respective share of slight defoliated trees shows a moderate increase from 22.1% in age class 0-20 to 32.3% in age class 41-60, followed by a shrinkage to 24.4% in age group 101-120. In age group >120 the respective percentage rises remarkably to 38.5%. Concerning the proportion of trees in defoliation classes 2-4 before exclusion no significant trends are apparent. The percentages range between 18.2% in age class 81-100 and 23.9% in age class 61-80, which is at the same time the highest deviation in this defoliation group.

3.1.10.2 Defoliation of trees prior to their death

In Chapter 3.1.10.1 as well as in last year's report the exclusion of trees from the survey was scrutinized with only little regard to the reasons of their exclusion. In these studies trees may have disappeared e.g. due to thinning, sanitary fellings, windthrow or mortality. With respect to recent forest damage, however, it is of particular importance if tree death is extensive and predictable by defoliation.

In last year's report it was already found that severely defoliated trees were not more likely to be removed from the sample than less defoliated trees. This finding was emphasized as an argument against the assertion that the survey results are biased by the continuous removal of damaged trees. Of course, dead trees had been removed, but mortality was shown to range around only 0.5% per year.

In Table 3.1.10.2-1, all trees having died between 1988 and 1993 (1 637 trees) are classified according to their defoliation in the year prior to their death, and according to their age. Age was included as a factor in consideration of the results of the transnational surveys, which have revealed a general increase in the defoliation with higher tree ages. Severely damaged and dead trees, however, were found to be more frequent in younger stands.

Table 3.1.10.2-1 shows that the largest share of all the 1 637 dead trees (36.7%) had a defoliation greater than 60% in the year before their death. The second largest share (33.3%) had died despite a defoliation of only 0-10% prior to the death. This remarkably bipolar distribution changes considerably, if the trees are classified according to their age. Figure 3.1.10.2-1 visualizes the results:

The trees of age classes 0-20 and 21-40 years account for more than half of the dead trees, which is in good agreement of the findings of last year's report, and can be explained by competition in young stands. In these low age classes the distribution is bipolar, having its highest share in defoliation class 0 and the second highest share in defoliation class 3. However, as the share of trees dying after more than 60% defoliation increases with age, and the share of trees dying after a defoliation of 0-10% decreases, the situation is reversed from age 41 on. Still bipolar, the distribution now has its peak (42.9%) in defoliation class 3. From age 41 on, the distribution is clearly shifted towards the severely defoliated trees, having only one peak until age 120. At age 120 and older, 75.3% of the trees have died after showing severe defoliation. Now the distribution is bipolar again.

Care has to be taken in the interpretation of the above figures, as the number of old and severely defoliated trees is extremely low. Nevertheless, the results indicate that in young stands tree death may happen unexpectedly, whereas in old stands trees die often after a stage of severe defoliation.

This raises the question, if similar relationships hold true for regions of particularly high damage. The problem in answering these questions lies in the fact that the number of dead trees shrinks rapidly if the sample is split into different regions. The present study was also applied to the main damage area in central Europe. In this region, no tree died in age class 0-20, 1 tree died in age class 21-40, and 7 and 4 trees died in age classes 101-120 and >120 years, respectively. In age classes 41-60, 61-80 and 81-100, the numbers of dead trees were 50, 44 and 21, respectively.

Table 3.1.10.2-1: Defoliation of dead trees prior to their death

Age [years]	Defoliation prior to death				No. of trees
	0 - 10%	>10-25%	>25-60%	>60%	
0- 20	50.9	18.7	11.5	18.9	390
21 - 40	42.6	14.0	13.8	29.6	534
41 - 60	29.5	16.5	11.1	42.9	261
61 - 80	17.0	11.9	22.6	48.5	177
81 - 100	8.4	18.2	33.8	39.6	154
101 - 120	9.1	9.1	20.4	61.4	44
>120	14.3	7.8	2.6	75.3	77
All ages	33.3	15.1	14.9	36.7	1637

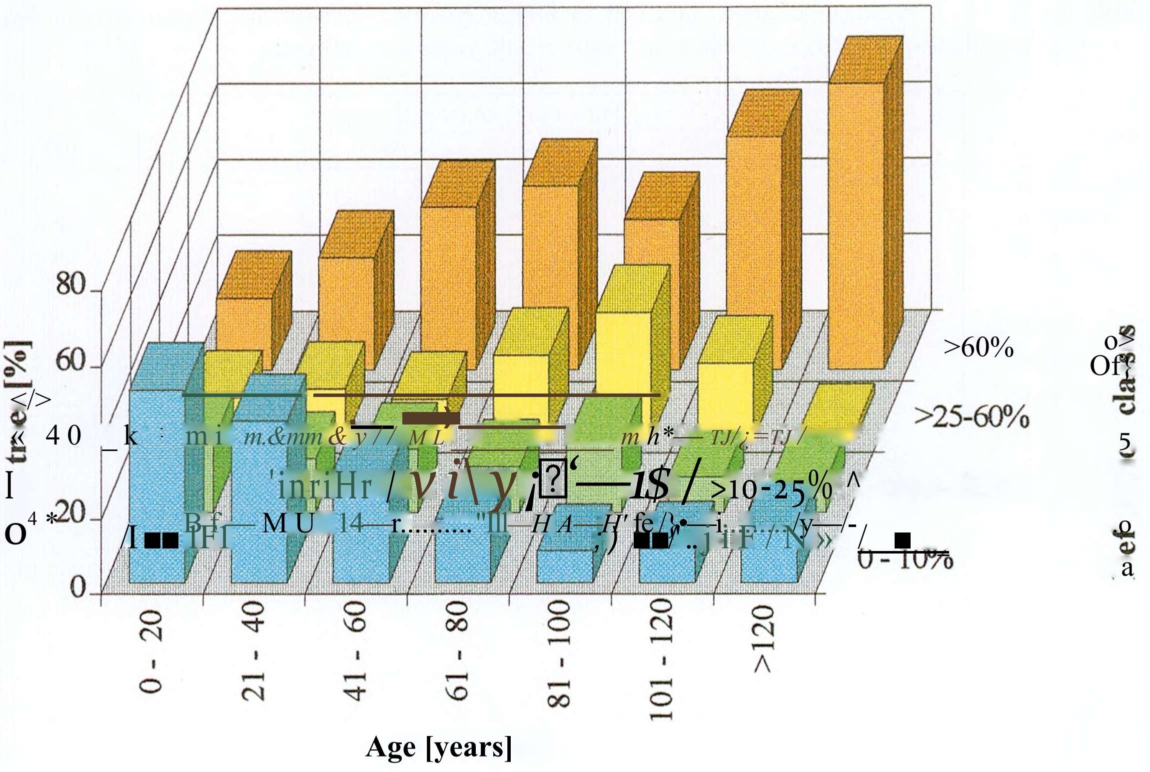


Figure 3.1.10.2-1: Defoliation of dead trees prior to their death

3.1.10.3 Change in defoliation of trees of different age

Among all parameters assessed in the transnational survey, age has been shown to have the highest correlation with defoliation. The transnational survey results reveal a clear decrease of the percentage of trees in defoliation class 0 in favour of an increase in defoliation class 2 between age classes 0-20 and 61-80. At higher ages, the shares of trees in defoliation classes remain approximately constant (Chapter 3.1.4). This is not surprising, as defoliation has long been known to increase with age even under the absence of damage, particularly in coniferous trees. The correlation revealed in the transnational evaluation may reflect a phase of natural differentiation and a subsequent phase of steady state typical for most stands, rather than a damaging agent affecting selectively older stands. Nevertheless, the existence of such a selectively damaging factor cannot be excluded.

The assumption was made that any potential factor causing defoliation preferably to old trees would reveal itself in a comparison of the development of defoliation of subsamples of the same tree species in the same climatic region, but of different age. Under this assumption the annual changes in the percentage of damaged trees between 1988 and 1993 were studied for ***Fagus sylvatica*** in the Sub-atlantic region and ***Pinus sylvestris*** in the Mountainous region. These subsamples, consisting of 815 ***Fagus sylvatica*** and 601 ***Pinus sylvestris*** trees, were selected because each of the two species is relatively frequent in the respective region, and at the same time shows an increase in defoliation over the last years. The results of this analysis are documented in Table 3.1.10.3-1 and in Figures 3.1.10.3-1 and 3.1.10.3-2.

Table 3.1.10.3-1: Percentage of trees damaged in *Fagus sylvatica*, Sub-atlantic region, and in *Pinus sylvestris,* Mountainous region, according to age classes 0-60 years and >60 years.

	Percentage of trees damaged					
	1988	1989	1990	1991	1992	1993
Fagus sylvatica						
0-60 years	15.5	6.8	7.9	20.1	29.3	16.8
> 60 years	14.8	13.4	19.2	22.1	33.1	26.4
Pinus sylvestris						
0-60 years	7.3	3.0	4.9	13.7	16.2	16.4
>60 years	6.6	4.7	5.7	13.2	12.3	22.6

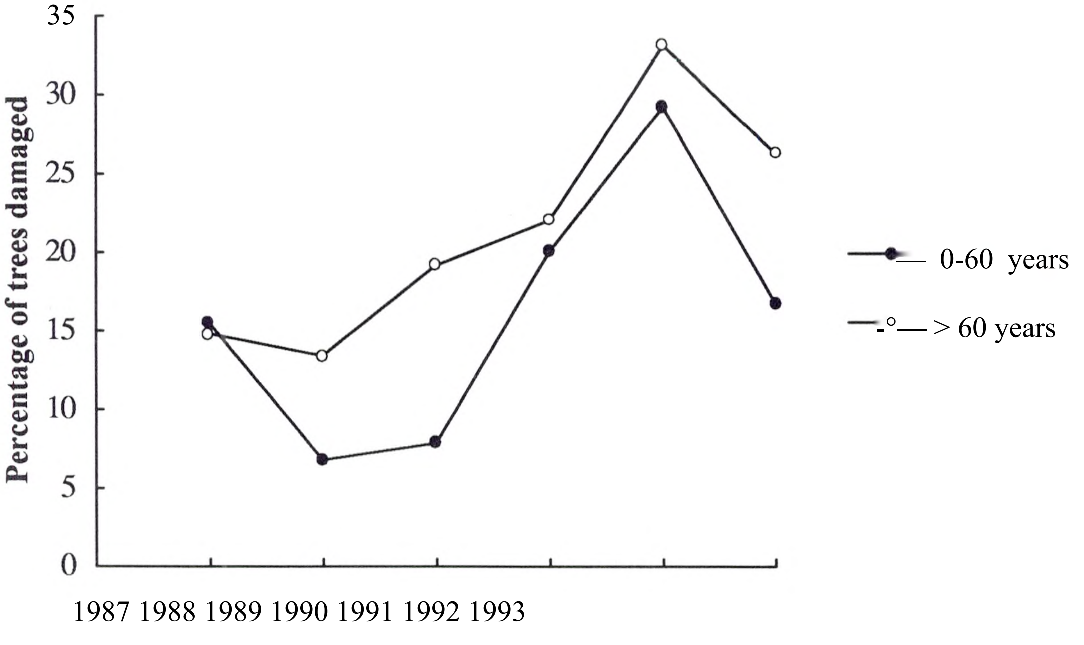


Figure 3.1.10.3-1: Percentage of trees damaged in *Fagus sylvatica,* Sub-atlantic region, in age classes 0-60 years and >60 years.

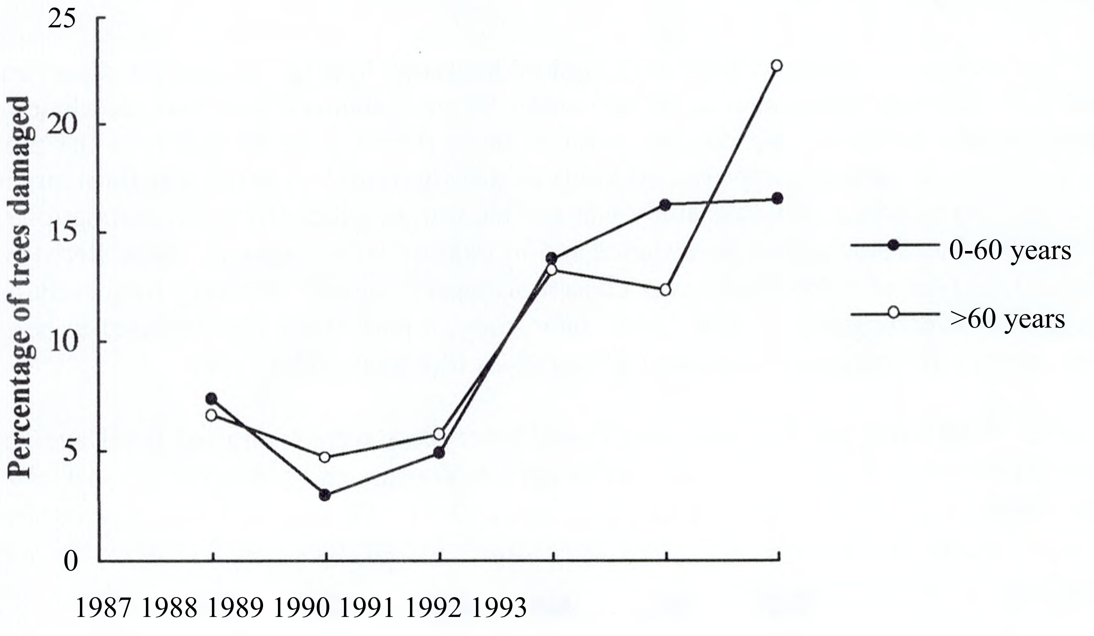


Figure 3.1.10.3-2: Percentage of trees damaged in *Pinus sylvestris,* **Mountainous region, in age classes 0-60 years and >60 years.**

As regards ***Fagus sylvatica,*** there is an obvious difference in the levels of the two curves of the development of the percentage of damaged trees of different age groups. The older trees permanently have a higher percentage of damaged trees than the younger ones, except in 1988. This difference of levels may be merely a result of tree ageing. There is, however, also a difference in the slope of the two curves: the percentage of damaged trees in the older age group increases within 5 years, whereas that of the younger age group arrives after 5 years at nearly the same level.

For ***Pinus sylvestris*** the result is different. The trees of both age groups develop very similar between 1988 and 1991. In 1992 the older trees show a slight recovery, but in 1993 increase rapidly to a clearly higher level than the younger trees.

No general conclusions may be drawn from these results, as they are valid only for the two samples investigated.

3.1.10.4 Defoliation of Picea abies and Fagus sylvatica in mixed stands

In order to investigate the influence of species composition in stands on defoliation, the diversity index was calculated in the last year's report. The diversity index was derived by dividing the number of different species occuring on plot by the total number of trees per plot. According to this definition the diversity index takes the value 1.0, if the number of species equals the number of trees and approximates to zero, if the number of tree species per plot decreases. This diversity index quantifies therefore the heterogeneity of species composition of individual plots. In the 1992 survey, the diversity index lay between 0.04

and 0.3. Higher indices were seldom and not representative for the most common forest types in Europe.

The proportion of damaged trees was highest in stands having diversity indices smaller than 0.1. This was interpreted as an indication for pure stands being more defoliated than mixed stands. However, the interpretation of these results is problematic, as the plots of higher diversity indices comprised all kinds of tree mixtures. To avoid this shortcoming of last year's approach, a new case study was carried out, in which the mean defoliation of all ***Picea abies*** trees stocking in pure stands and in mixture with ***Fagus sylvatica*** were investigated. This type of mixed stand was chosen because it occurs relatively frequently and is thought to be ecologically stable. In the new study, a pure stand was assumed to be given if all trees on the respective plot were ***Picea abies*** (diversity index 0.04).

In total, 7 480 trees stocking on pure ***Picea abies*** plots were identified if all age classes were considered. Of the plots with a mean age of 60 years and older, the number of ***Picea abies*** trees on pure ***Picea abies*** plots amounted to 2 931. Of the plots with ***Picea abies*** and ***Fagus sylvatica*** in mixture, 452 trees were found for all ages and 237 trees for a mean stand age of 60 years and older.

The results of the case study shows that on the plots investigated ***Picea abies*** trees did not show obvious differences in defoliation between pure stands and mixed stands. For all ages, the mean defoliation of ***Picea abies*** trees was 22.9% in pure stands and 21.7% in mixed stands. For age 60 and older, the respective percentages were 24.6% and 23.1%. This results did not change in general if plots of particular shares of ***Picea abies*** in the mixed stands were considered.

3.2 National surveys

3.2.1 General view

As in previous years, the results of the national surveys are presented by means of national reports (Chapters 3.2.2 and 3.2.3) and in tabulated form (Annex II). Annex II-1 provides basic information on the forest area and survey design of each participating country. The distribution of the trees over the defoliation classes is tabulated in for all species, the conifers and the broadleaves in Annexes II-2, II-3 and II-4, respectively. The annual changes in the results are presented for all species, for conifers and for broadleaves in Annexes II-5, II-6 and II-7. Annex II-8 contains tables and diagrams on the distribution of the trees of all species, conifers and broadleaves over 10%-defoliation classes. The changes in defoliation as tabulated in Annexes II-5 to II-7 are also displayed graphically in Annex II-9. It has to be noted, however, that no direct comparison between the annual results is possible due to differences in the samples. For several countries no data have been presented for certain years neither in the tables nor in the graphics, if large differences in the samples were given due to e.g. changes in the grid network, missing data for certain years or the foundation of new member states.

The national survey results of all species assessed can be summarized as follows:

Although it is not possible to make direct comparisons between different countries because of the way in which the common methodology is applied and because of general differences in climatic and site factors, the data show that countries fall into three groups.

In 1993, 31 countries submitted survey reports, including three countries, namely Ireland, the Russian Federation and Sweden, in which only conifers were assessed. In four of these countries the percentage of sample trees classified as damaged (defoliation classes 2-4) was lower than 10%. These countries are Austria, France, Portugal and the Russian Federation.

In eight of the countries the percentage of sample trees classified as damaged ranged between greater 10% and 20%. These countries are Belgium (including Flanders and Wallonia), Croatia, Finland, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

In another 19 countries, i.e. in more than a half of the member states from which survey results were reported, the percentage of sample trees classified as damaged was greater than 20%, with a maximum of 53.0%. These countries are Belarus, Bulgaria, the Czech Republic, Denmark, Estonia, Germany, Greece, Hungary, Ireland, Latvia, Lithuania, Luxembourg, the Republic of Moldova, the Netherlands, Norway, Poland, Romania, the Slovak Republic and Ukraine. In most of these countries the defoliation was particularly high in coniferous stands. The broadleaved stands were particularly affected in the Czech Republic, Germany, Greece, Luxembourg, the Republic of Moldova , Norway and Poland.

In 16 countries from which survey results were reported, a deterioration has occurred. The following Table 3.2.1-1 describes the changes of defoliation observed between 1992 and 1993 in classes 2-4. Changes are rated as unimportant if equal to or less than 5.0 percent points, as slight between 5.1 and 10.0 percent points, as moderate between 10.1 and 20.0 percent points and as substantial if exceeding 20.0 percent points from one year to the next.

The figures in Table 3.2.1-1 refer to only 28 countries by which survey results were submitted. In Slovenia no survey was performed in 1992, and the Republic of Moldova reported survey data for the first time this year. Therefore, no data from both countries were available for the comparison of changes in defoliation from 1992 to 1993.

Table 3.2.1-1: Changes in defoliation observed between 1992 and 1993 in classes 2-4

	Number of countries						
	No or unimportant change	Increase of defoliation			Decrease of defoliation		
		Slight	Moderate	Substantial	Slight	Moderate	Substantial
All species	17	3	1	-	2	1	1
Conifers	17	5	2	-	3	-	1
Broadleaves	18	2	-	1	-	1	2

As regards all species, a slight increase in defoliation occurred in three countries, whereas a slight decrease was observed in two countries. Changes in defoliation are particularly obvious in the conifers. Concerning this species group, an increase occurred in seven countries, whereas a decrease was observed only in four. In two countries the increases in the conifers were moderate, but no substantial increase was found. In comparison to 1992, the increase in defoliation in the broadleaves is less obvious. However, in one country there was a substantial increase in the broadleaves.

3.2.2 Europe

3.2.2.1 Austria

The results of the 1993 survey represent the highest level of mortality since the beginning of the Austrian "Waldschaden-Beobachtungssystem" (WBS) in 1988. The crown condition of ***Picea abies, Pinus sylvestris*** and ***Fagus sylvatica*** deteriorated. In contrast, the crown condition of ***Larix decidua*** and ***Abies alba*** improved. Concerning ***Quercus*** spp., the share of not defoliated and severely defoliated trees increased.

The dry and hot summer of 1992 and the dry May of 1993 are to be considered as the main reason for deterioration. Especially on shallow limestone sites and in the pannonian climatic region, the crown condition deteriorated.

Oaks and other broadleaves on more than 4000 ha in Lower Austria and Burgenland were defoliated by ***Lepidoptera*** spp. between May and June 1993. The most widespread species were ***Lymantria dispar*** and ***Thaumetopoea processionea.*** More than 1 Mio m^3 timber were attacked by bark beetles in 1992. The calamity of bark beetles continued especially in regions of 1000-1200 m above sea level during May and June 1993.

Picea abies was the first investigated tree species investigated in a pilot increment study. On O.lha-sized plots the total assessment includes stem analysis and core sampling. The real increment surpassed the expected values. On the two plots at lower sea level, the about 100 years old trees have a current total increment of 17 m^3 above bark. On the alpine plot at 1690 m above sea level, the current total increment was about 10 m^3. In contrast to the yield tables, the actual increment did not decrease at high ages. The plots at lower altitude show an increase in yield class (five steps between 30 and 100 years). Relations between increment and needle loss have been tested by simple regressions. In cases of less severe needle loss, no significant relations were found.

On 218 plots a remeasurement of diameter breast height (dbh) was carried out in 1993, however, increment calculations have not yet been finished.

Needle and leaf samples were taken from about 850 trees on 284 sample plots for foliar analysis in 1992. The threshold value for sulphur content of 0.11% S was exceeded on 13.0% of the sample plots (1991: 19.0%).

NO_x and ozone were measured on 92 plots in all federal countries by an integrated air quality measurement, but no results are available until now.

Remote sensing investigations using CIR-film mb 7500 have been carried out for aerial inventory in four areas covering about 1100 km^2. Using grids of 250 x 250 m respectively 350 x 350 m, 6-9 trees were identified on each sample plot. Of each sample plot and of each selected tree, the coordinates and some individual parameters were recorded. Seven areas covering 675 km^2 were surveyed by 1000 CIR-aerial photos. As in the previous year, the interpretation will be elaborated only for four areas. The remaining photos are for documentation.

3.2.2.2 Belarus

No data were received from Belarus at the time of the completion of this report.

3.2.2.3 Belgium

Like in the previous years, Flanders and Wallonia submitted independent surveys.

Flanders

The weather conditions in 1993 were more favourable for most tree species than in the previous years. This may have contributed to the slight decrease in the proportion of damaged trees compared to 1992. However, severe discolouration and needle loss have been observed in ***Pinus sylvestris*** and ***Pinus nigra*** spp. ***calabrica*** on dry sandy soils in the north and northeastern parts of Flanders, probably in connection with drought and magnesium deficiency. Symptoms of magnesium deficiency have also been observed in ***Fagus sylvatica.*** In general, trees older than 60 years showed higher defoliation levels than **younger trees.**

In May 1993, ***Thaumetopoea processioned, Euproctis chrysorrhea, Tortrix viridana*** and other defoliators caused severe defoliation in stands of ***Quercus*** spp., but the influence of these insect attacks on tree vitality is difficult to evaluate. Nevertheless, the proportion of trees damaged by insects has decreased in comparison to 1992. With regard to fungi attack, there was an increase in the number of ***Pinus sylvestris*** trees damaged by ***Sphaeropsis sapinea.***

The interactions of unfavourable weather conditions, natural stress and air pollution might be the cause of the weakening of trees and forests. At present no symptoms of direct pollution damage have been observed in the investigated plots. However, deposition measurements on Level II-plots have indicated that the loads of sulphur and nitrogen can be considerable. The influence of pollution on forest soils and the relationship with forest vitality are major parts of the research programme on acidification in the Flemish Region.

The field work of the soil condition inventory on the Level I-plots was completed in 1993. Investigations on the Level II-plots continue and a second report on the results of the period 1991-1992 will be published soon. In 1994 a programme for detailed air pollution measurements by means of analysers will be started on one Level II plot.

Wallonia

In contrast to previous years, the share of undamaged trees has undoubtedly increased in 1993. Moreover, it is to consider, that the assessed percentage rates of defoliation classes do not refer systematically to identical trees.

Conifers have a lower share in damage class 0, but in comparison to broadleaves they presented a better progress in recreation. Nevertheless, in severe damaged trees no recreation has been observed. The percentage of trees with defoliation over 50% is similar to 1992 or shows a slight increase.

Only for 61 of 447 trees the cause of damage could be pointed out. 27 trees are damaged by insects, 13 trees by game, even 13 trees by abiotic causes, 5 trees by fungi and 3 trees are damaged by human influence. Even trees of defoliation respectively discolouration class 0 are affected by game, fungi and human influences.

The decrease in discolouration from 1992 to 1993 is less obvious than in defoliation. The highest improvement was observed in younger broadleaves stands. However, the share of trees over 60 years with severe discolouration has increased.

The improvement of health condition which has been observed in low damaged tree stands was an effect of favourable weather condition in 1993. In addition, insect calamities have not caused severe problems in 1993. However, severe discolouration which has been partly detected depends on the shortage of nutrient elements and is not caused by adverse weather condition.

For the investigation on the damage development of the main tree species, 253 ***Fagus sylvatica,*** 282 ***Quercus*** spp. (146 ***Quercus sessiliflora*** and 136 ***Quercus pedunculata)*** and 350 ***Picea abies*** have been compared since 1990. The results show that a general improvement of health condition of ***Fagus sylvatica*** has occurred due to the favourable weather condition in 1993. ***Quercus sessiliflora*** showed quite a better condition compared to previous years. But the share of trees in defoliation class 2 has slightly increased. In comparison to ***Quercus sessiliflora,*** the improvement of health condition of ***Quercus pendunculata*** is much more obvious. The health condition of other broadleaves are characterized as well, but because of the small quantities, no trends can be pointed out.

Different trends in stands of ***Picea abies*** are explained by different site condition. The overwhelming ***Picea abies*** plots present older stands with quite severe damages, which are overrepresented compared to their real surface area. Other species of conifers, except ***Pinus sylvestris,*** are less represented. Their condition is relatively weak.

The native oak species are objects of thorough research, which will be started soon. It seems that complex climatic and biotic causal connections lead to the deterioration of condition in stands of ***Quercus*** spp..

A remarkable high number of dead trees in stands of ***Pseudotsuga menziesii*** has been observed within the last 30 years. Research concerning this problem in 1992 revealed that the infection of ***Phaeocryptopus gaeumannii*** is an important danger to ***Pseudotsuga menziesii*** in the Ardennes. Additionally, the installation of pheromone traps against mass increase of ***Ips typographus*** has been directed.

Currently, in Wallonia the instructions of fertilizing forest soils with magnesium containing lime are scrutinized.

3.2.2.4 Bulgaria

For all species, the percentage of severely defoliated and dead trees has increased slightly, compared to the 1992 results. A considerable worsening was detected in ***Pinus sylvestris.*** In contrast, ***Pinus nigra*** as well as ***Picea abies*** and ***Abies alba*** showed a recovery in health condition. A slight improvement was also observed in stands of ***Fagus sylvatica,*** on the other hand, discolouration of ***Fagus sylvatica*** as well as ***Quercus petraea*** presented an increase.

188 soil profiles were described according to the Manual. The results show higher concentrations of some heavy metals, especially Zn and Pb, both in the litter and the mineral soil. Higher concentrations of Zn were registered in soil samples from the middle, western and southeastern parts of Bulgaria. Additional, the aerosol origin of Pb has been proved.

Higher heavy metal contents were found in some indicator plants:
208.5 mg/kg Cu in roots of ***Calamagrostis arundinacea,*** 332.0 mg/kg Zn in roots of ***Luzula silvatica,*** 4380.0 and 2925.0 mg/kg Mn in roots of ***Festuca heterophylla*** and leaves of ***Vaccinium myrtillus,*** respectively, and 4.7 mg/kg Cd in stems of ***Galium odoratum.***

The microelement content of K, Ca and Mg in leaves and needles of the assessed tree species varied within the optimum ranges.

The unusually high temperatures in 1992 and 1993 with high deficits of precipitation as well as the environmental pollution and pest attacks were considered as the main causes for forest decline.

An investigation on the health condition of ***Pinus sylvestris*** and ***Pinus nigra*** cultures has been conducted in 1993. The results will be discussed and commented in 1994.

3.2.2.5 Croatia

In 1993, 16 x 16 km plots have been established instead of the 4 x 4 km plots used in 1992.

The share of trees with more than 25% defoliation has increased again. The extremely dry summer in 1993 is supposed to be the main reason for this deterioration.

Recent researches have shown that environmental pollution influences Croatian forests. ***Abies*** spp. and ***Quercus*** spp., the main species groups in Croatia, are thus particularly imperilled, especially in the western parts of Croatia. Unfortunately, no equipment for the desulphurization of SC^-sources and other filtration plants against pollution are available in Croatia.

Lowland forests are stressed by great quantities of heavy metals and other pollutants by flood waters. Due to the environmental pollution, the water regimes of these forests are disbalanced by hydromeliorations in agriculture, construction of hydrotechnical facilities for flood control and hydro power plants.

3.2.2.6 Czech Republic

The evaluation concerning the development of defoliation and relations between defoliation, growth and dendrometric parameters as well as the analysis of soil and leaf samples have not been finished yet. The first complete report will be released in 1994.

No significant changes are expected in the frequency of defoliation classes between 1993 and the previous years. However, it is to be noticed that changes occurred in the share of selected plots in 1993. Probably ***Picea abies, Abies alba*** and ***Larix decidua*** are slightly less defoliated in 1993 than in the previous years, but the health condition of ***Pinus sylvestris*** showed the opposite trend.

Some deviations may be caused by climatic condition. Compared to previous years, the precipitation was sometimes higher during the vegetation season in 1993. So ***Larix decidua*** and ***Betula pendula*** are less defoliated than in previous years.

A great part of the forests in the Czech Republic are influenced by extremely high concentrations of air pollutants. However, this is not the only reason of forest damages.

Health condition in forests of ***Quercus*** spp. is unfavourable because of widespread trachaeomycotic diseases. Most trees are moderately defoliated. The worst condition was found in stands of ***Quercus petraea,*** especially in lower altitudes. It is supposed that this is caused by recent changes in the water regime. Pure stands of ***Quercus robur*** appear only in small highland areas. This may be the reason for the lower defoliation rates of ***Quercus robur.***

3.2.2J Denmark

In order to be able to use existing soil data from the national 7x7 km grid, the Danish part of the international 16x16 km grid was adjusted and now holds a part of the national network. Therefore Denmark has provided a new dataset ranging back to 1989. This adjustment has been carried out in accordance with guidelines from the EU. Comparisons between the old and the new set of data showed no shift in the damage levels in the respective years.

Picea abies showed a constant decline in health status. This is strongly influenced by the generally bad condition of ***Picea abies*** in the western part of Denmark, especially on poor and dry soils. In spite of several thinnings in damaged stands, a continued deterioration was observed. Secondary damaging factors, such as insects and windbreaks might have occurred in these forest stands. On the better soils in other parts of Denmark ***Picea abies*** seems to be recovering.

The "Read Picea-phenomenon" in stands of ***Picea abies*** has forced forest owners to make sanitary fellings to prevent secondary damaging agents such as insect attacks. Those fellings, often made in unfavourable times of the vegetation period, represent an additional weakening of some Danish forests.

In ***Quercus*** spp. a widespread bud dieback or a irregular development of buds was observed as a countrywide phenomenon in spring of 1993. The condition of other tree species is considered stable.

During the last years extreme weather events have occurred in Denmark, e.g. dry summers and warm winters. This can be a predisposing factor for changes in forest condition. High deposition levels of sea salt, nitrogen as well as other air pollution elements in connection with warm winters can act as causing agents for forest damage, especially for the decline of ***Picea abies.*** Climatic condition in connection with insect attacks are assumed to be the reason for the bud dieback of ***Quercus*** spp..

3.2.2.8 Estonia

In Estonia, the survey design has partly been changed in order to obtain more detailed information about forest condition, abiotic stresses, fungal diseases and insect attacks. 91 sample plots by using a 16 x 16 km grid were surveyed in 1993.

Compared to the results from 1988 to 1992, a remarkable improvement of crown condition was reported, especially in stands of ***Pinus sylvestris.*** The crown condition of ***Picea abies*** showed no significant change. But there are considerable regional differences. The most severe defoliation in stands of ***Picea abies*** occurred in the western, northwestern and northeastern parts of Estonia.

In addition to atmospheric pollution, biotic and abiotic factors had some unfavourable influence on the health condition of Estonian forests.

As specific biotic stresses, root rot was found on 28 sample trees, ***Ascocalix abietina*** on 118 sample trees and ***Tomicus*** spp. was on 18 sample trees. Attacks by ***Ips typographus***

and other bark beetles occurred on 13 and elk injury on 28 sample trees. The most frequent abiotic stress factor was mechanical injury on 32 sample trees. One sample tree has been eliminated by windbreak.
The occurrence of pathogens was investigated on all sample plots. The bad crown condition could be attributed to biotic factors on 62 plots. Monitoring of epiphytic lichens were used for bioindication of atmospheric pollution on 12 sample trees of all 91 plots. From 1989 to 1993 also chemical soil indices were investigated on all sample plots, but no data were submitted for this report.

3.2.2.9 Finland

The 1993 results show a close correlation between defoliation and discolouration levels in ***Picea abies***, but no significant change concerning the defoliation of ***Picea abies*** was found. A slight increase in defoliation was observed in stands of ***Pinus sylvestris.*** Since 1986, defoliation has increased by 3.5 percent points in total conifers. No defoliation change between different years could be pointed out in broadleaves.
Site and climatic condition are quite variable in the different parts of Finland. Especially in the north, the harsh climate seriously affects the forest development.

Only two large-scale insect attacks occurred in the last decades. In the 1980s a fungal epidemic of ***Gremmeniella abietina*** endangered some forests in western Finland.

Forest defoliation increases towards the north. High stand ages and rough climatic condition are main causes of defoliation in the interior of Finland. No correlation was found between defoliation patterns and air pollution gradients at the national level, but atmospheric deposition is assumed to be a predisposing factor for forest decline. However, in the local scale and in southern Finland some evidence of covariation of air pollution and defoliation degree in conifers is obviously existing. The most defoliated young tree stands are situated in southern Finland. Bioindicators (epiphytic lichens and algal growth on needles) also indicate pollutant effects in this region.

3.2.2.10 France

Compared to previous years, a very slight increase in defoliation was identified, which is more obvious in conifers than in broadleaves. In this regard, the condition of conifers is still slightly better than that of broadleaves. Likewise a slight increase of discolouration was detected mostly in conifers.

The defoliation of ***Quercus petraea*** and ***Quercus robur*** is still rising, even with increasing speed in stands of ***Quercus petraea.*** This unexplained serious development observed in the northern part of France is alarming. Perhaps it was partly caused in 1993 by strong attacks of defoliators, ***Lymantria dispar*** especially, and ***Microsphaera alphitoides.*** Also in ***Quercus ilex*** and ***Quercus pubescens*** an obvious deterioration of health condition was observed. Instead of oaks, the condition of ***Fagus sylvatica*** improved remarkably in 1993. The defoliation of ***Castanea sativa*** has decreased, too, but the discolouration is still on a high level.

The condition of ***Picea abies*** remained very stable, but for ***Abies alba*** needle loss is still serious. After a spectacular decrease in discolouration in stands of ***Pinus pinaster*** in 1992, a new increase was indicated again in 1993. The same development appeared in stands of ***Pinus sylvestris***, but discolouration also seems to remain on a quite high level in this species, for which the mortality increased slightly again in 1993.

Because of some gaps in knowledge, the causal connections between crown condition on the one hand, and climatic condition, acid and nitrogenous deposition and ozone on the other hand can not be proved. The attacks of defoliators and ***Microsphaera alphitoides*** during some parts of the vegetation period could partly explain the deterioration of ***Quercus*** spp.. Also the abundant precipitation in spring and the climatic extremes in 1993 are assumed to be potential reasons for the increase in discolouration, especially in coniferous stands. For defoliation, high age is without doubt a general weakening factor.

The precipitation during 1993 was quite normal. However, some excessive dry years, which have appeared in France since 1989, are assumed to be possible causes for the observed damage. These events have weakened the forest condition and have favoured the mortality.

For improving the condition of coniferous forests, 251 ha forest soils were fertilized with lime which contents magnesium in 1990 and 1991. Inspite of some remarkable results and a possibility of subvention by 75%, the interest of forest managers in fertilizing remains low.

3.2.2.11 Germany

Compared to the previous year, in 1993 an overall decrease in visible damage by 3.0% has been indicated. In the northwest German Laender there was an increase by 2.0%, whereas in the eastern German and southern German Laender a decrease by 5.0% respectively 2.0% has been recorded.

The level of damage varies widely depending on the specific region. In the northwestern German Federal Laender the percentage of clearly visible damage is comparatively small at 16.0% on average. In the southern German Laender this figure is high at 25.0%. Most severely affected are the forests in the eastern German Laender, the share of visible damage runs up to 29.0% on average. The percentage of visible damage is particularly low in Bremen, Hamburg and Rhineland-Palatinate with 13.0% respectively 14.0%, but particularly serious in Thuringia with 50.0%.

In 1993, the current time series has revealed, that in the northwestern German Laender the percentage of visible damaged trees reached its highest level of 16.0% since the beginning of the time series in 1984. This share amounts to 29.0% in the eastern German Laender. In the southern German Laender, 25.0% showed visible damages. This is a slight decrease compared to previous years.

Picea spp., ***Pinus*** spp. and ***Fagus sylvatica*** showed a decreased defoliation. However, the share of visibly damaged ***Quercus*** spp. has risen up, partly as a result of insect attacks. In this regard, significant regional differences were found.

In 1993 21.0% of conifers showed visible damages. The level has decreased since 1985. However, visible damage among deciduous trees is still increasing. The average was 30.0% in 1993. These opposite trends still have been remaining since several years.

In general, the share of damaged trees is three times higher in the age class over 60 years than in the lower age class. However, visible damage is developing in both age classes.

Forest damage is due to various causes. Air pollutants play a decisive role, but they cannot explain the differences between the levels and development of damage. It is supposed that they are a result of different factors, such as site, stand and management system. Nevertheless, the reduction of pollutant emissions, even from trans-boundary sources, has to be continued consistently.

3.2.2.12 Greece

The number of trees and shrubs observed in 1993 was smaller than in 1992, because one high forest plot has been destroyed by fire and one maquis plot has been clear-felled.

For all species, a decrease by 5.0 percent points in defoliation class 0 with a correspondending increase by 2.0 percent points in defoliation class 2 and 3.0 percent points in defoliation class 3 was observed. This development occurred mainly in broadleaves and similarly in the maquis.

25.8% of the assessed trees showed signs of insect attacks. In 0.7% of the trees, fungal desease was indicated. Abiotic effects occurred in 1.8%, adverse anthropogenic effects in 2.2% and other influence in 9.8% of the trees. 36.0% of the maquis plots showed signs of intense grazing, and 23.0% presented signs of insect attacks.

Some known causes for forest damage are shortly described in the following:

- Forest fires during the hot, dry and windy summer of 1993 destroyed 46.596 ha of maquis and high forest, both in coniferous and broadleaved stands

- Forest grazing, especially overgrazing during the regeneration period has taken unfavourable influence on young fir and deciduous oak stands

- Lack of proper forest management for a long period as well as "negative cuttings" of forest trees by nearby villagers

- The severe lack of precipitation during the summer of 1993 affected the forests, especially the broadleaves

- ***Quercus conferta*** has not yet recovered completely from an attack by ***Phylloxera*** spp. in the previous year, in ***Abies cephalonica*** stands, an infestation by ***Viscum album*** has been observed, and in some regions ***Pinus halepensis*** were defoliated by ***Thaumetopoea pityocampa.***

With exceptions of some local injuries no large-scale adverse effects of air pollution on the health of remote forests has been observed in Greece until yet. This is derived from the low degree of industrialization which is located mostly in unforested areas on low altitude.

3.2.2.13 Hungary

1993 is the first year in which the defoliation has decreased since the start of observations in 1987. The improvement is evident in stands of ***Quercus robur.*** Unfortunately, ***Quercus petraea*** and ***Robinia pseudoacacia*** showed a slight increase in defoliation. In contrast, an extremely high worsening has been indicated in ***Picea*** spp.. Other tree species showed an improvement or a stagnation.

Probably the lower general rate of defoliation is partly caused by some new plots which were established mainly in younger and healthier stands. Another improving factor was the higher precipitation in winter compared to previous years. So there was no serious lack of water in the rainless and hot July and August. After rainfall in September the vegetation period of broadleaves finished in November normally.

The increased number of dead trees is contributed to the transition of forestry. The intensity of sanitary cuts was not sufficient. No significant changes concerning biotic damages were reported. However, unusually large areas were damaged by forest fires.

No sufficient data are available for interpretation about other factors like air and soil pollution, radiation, site deterioration etc.. New soil sampling will be carried out on the 16 x 16 km plots in 1994 according to the soil manual.

3.2.2.14 Ireland

For all surveyed species, the 1993 results showed a significant increase in the share of trees in defoliation classes 2-4. This increased damage in 1993 is mainly caused by widespread attacks of ***Elatobium abietinum*** in case of ***Picea sitchensis*** and Pine Shoot Dieback, produced by the fungus ***Ramiehloridium pini,*** in case of ***Picea contorta.*** Both kinds of disease are also assumed as reasons for the deterioration in ***Picea abies.*** Exposure to wind was recorded more frequently in 1993 than in 1992 for ***Picea sitchensis*** as well as for ***Pinus contorta.*** Abiotic damage decreased in ***Picea abies*** in 1993, compared to 1992. Like in previous surveys, no evidence of pollution damage has been found.

The majority of the assessed trees are located on external or internal forest edges. It became apparent that the damage level in the so-called edge trees was higher than in internal or non-edge locations. A Pilot-Demonstration Study was initiated in 1990 in order to quantify the difference in damage levels between the various tree locations. As a result, the level of defoliation was worst in the external edge trees, intermediate in the internal edge trees, and least in the non-edge trees. Since 1990 there was a 12.0 percent points difference in defoliation between the external edge and non-edge trees, and a 10.9 percent points difference between the external and internal edge trees. Because of the broad similarity of defoliation between the internal edge and non-edge positions, it is suggested that results from future surveys should be adjusted so that non-edge trees be assigned defoliation levels at least no greater than those obtained in internal edge positions.

3.2.2.15 Italy

Air pollution in connection with some other factors are assumed to be the main causes for forest decline in Italy. The climatic condition of the previous years, which have forced the devastations by parasites, are further factors for the forest health status.

Because of gaps in knowledge of the causal connections of forest damage, no activities for forest recreation have been committed yet. The investigation of socio-economical influences on forest decline cannot be reliably evaluated on national level.

3.2.2.16 Latvia

For all species, the total defoliation has increased by 1.8 percent points in 1993. Defoliation of conifers has risen by 0.8 percent points in comparison to 1992, whereas discolouration has diminished by 1.3 percent points.

It has been found that forest stands in Latvia are attacked by insects and fungal diseases. Some of the widespread parasites are ***Bupaleus piniarius, Pamolia flammea, Blastophagus piniperda*** and ***Heterobasidion annosum.*** A menace to ***Picea abies*** is ***Ips typographic.***

The parasites and diseases mentioned are most apparent in the region of the largest quantities of conifers, especially ***Pinus sylvestris.*** Also the highest values in defoliation of conifers have been found in coniferous forest areas. These regions are situated in the western part of Latvia, on sands around Riga and in the Middle Gauja Valley.

A significant correlation between SO2 emissions and the defoliation of ***Pinus sylvestris*** in stands aged over 60 years has been found in various regions of Latvia.

3.2.2.17 Liechtenstein

In 1993, the assessment was only made on permanent sample plots. No data are available concerning the sample plots of the ECE-grid.

Forest damage in Liechtenstein is remaining at a high level. On permanent plots, spread over the whole country, nearly 50.0% of ***Picea*** spp. were classified as healthy.

More dramatical is the condition of ***Abies*** spp., only 26.0% of which were indicated as healthy. More than 5.0% have died until 1993. The share of ***Abies*** spp. in defoliation classes 3 and 4 is 13.0%. Probably they will die in the following years.

The causes for the forest decline have not yet been discovered by scientific investigations. Obviously, some injuring factors act synergistically with different intensities. In common, forest decline is an indicator of the health condition of the environment. Therefore it is necessary to diminish air pollution which is known to be a damaging factor on forests as soon and effectively as possible.

3.2.2.18 Lithuania

The average defoliation of all species in 1993 was 23.4%. 51.4% were slightly and 27.5% were moderately to severely defoliated. Particularly high defoliation levels have been found in conifers aged over 60 years. Only 15.5% of these trees remained undamaged. On the other hand, discolouration has been rarely observed. Only 0.1% of both conifers and broadleaves showed symptoms of discolouration.

In comparison to previous years, the health status of all species has slightly deteriorated. The average defoliation of conifers as well as broadleaves is increasing approximately 1.0% per year. During the monitoring period since 1989, defoliation has increased by 5.0 percent points.

On 74 plots, needle samples have been collected for assessment of chemical contents according to the Manual and for prolyne analysis. On the same sample plots, integrated air quality measurement has been performed. Increment cores for indications of changes in radial tree growth as well as samples for assessment of radionucleids and heavy metals in soil were also collected. 940 soil samples from 235 plots were taken for the monitoring of forest soil according to the Manual.

Health status of forests in Lithuania varies between different geographical regions. Less defoliated forests are mainly presented in the northeastern part, the most defoliated in the southeastern and in the middle part of Lithuania. It has been proved that in regions with high levels of air pollutants, e.g. SO2 and NO_x depositions as well as sulphuric aerosols, defoliation rates are also more serious. Therefore, air pollution is probably a contributing factor to forest decline.

3.2.2.19 Luxembourg

After devastation of some sample plots by thunderstorms in 1990 and because of a lack of staff, the 2x2 km grid was transformed into a 4 x 4 km grid with 1150 trees, which have been assessed in 1993. Two independent "ecosystem-plots" were set up for intensive investigations on forest condition concerning forest population development, climatic effects and atmospheric facts.

It has to be noticed, that the results for conifers aged over 60 years are not representative for the whole country because their number is insufficient.

The assessments of 1991, 1992 and 1993 showed a continuing decrease in undamaged trees. Especially the share of trees in defoliation classes 1 and 2 has highly increased.

A considerable increase in defoliation of ***Fagus sylvatica*** and ***Quercus*** spp. occurred in 1993. The health status of ***Fagus sylvatica*** is now more alarming than that of ***Quercus*** spp.. However, due to the wide variation in the development of oak trees, no definite trend can be pointed out.

As to underwood a growing deterioration has been indicated. This is caused by attacks of ***Tortrix viridana*** and drought, especially on shallow and sun-exposed sites.

Because of the increasing percentage of defoliated trees, a steady deterioration of forest health condition is supposed.

Droughts in previous years effected health status of forests in Luxembourg unfavourably. The average temperature during the vegetation period was high at 16.1° C in 1991 and 17° C in 1992, while in this time the forests had suffered from a deficit in precipitation by -31.0%, compared to the average level of 1951-1980. In June and August 1993 this deficit rose to -63.0%. Probably the deterioration of health status has resulted from these unusual disadvantageous climatic condition.

Because of currently insufficient knowledge, it cannot be explained clearly, how far the observed damage can be explained by acid and nitrogenous deposition, photooxidantic pollution and abiotic influences. Health condition of forests is also affected by windbreaks and the subsequent calamities of bark beetle in 1990.

3.2.2.20 Republic of Moldova

For assessment of defoliation and discolouration, predominant, dominant and codominant trees without any mechanical damages have been investigated from each permanent sample plot.

Concerning all species, 26.7% has been classified in defoliation class 0, 22.5% in class 1, 43.2% in class 2 and 3.5% in defoliation class 3. 1.7% of all trees have died. 36.5% of the conifers were in defoliation class 0 , 19.2% in class 1 and 45.2% in defoliation class 2. No trees have been registered in defoliation classes 3 and 4. But it is to consider, that conifers are unsufficiently represented. 26.6% of the broadleaves were not defoliated, 22.5% were classified in defoliation class 1, 43.2% in class 2 and 5.9% in defoliation class 3. 1.8% of all broadleaves have died.

The unfavourable condition of Moldovan forests is explained by a lack of proper forest management during the last 50 years and negative influences of biotic and abiotic stress factors as well as air pollution. Detailed analysis will be performed in the next years. The intensive permanent monitoring on Level II will start in 1994, according to ICP-Forest methodology.

3.2.2.21 Netherlands

Regarding combined defoliation and discolouration of all tree species, an improvement was found compared to the 1992 results. 25.0% of all trees were notably damaged, this means a decrease by 9.6 percent points.

As to the conifers, the health condition of ***Pinus sylvestris, Pinus nigra, Pinus*** spp. and ***Larix kaempferi*** has improved. ***Pseudotsuga menziesii*** showed little deterioration. The condition of ***Picea abies*** has deteriorated clearly this year again. After 10 years of surveying, there seems to be a statistically significant negative trend regarding ***Pseudotsuga menziesii*** and ***Picea abies.*** In contrast to the conifers, the health condition of all deciduous tree species, especially ***Quercus*** spp., has improved in 1993.

The deterioration of forest health condition is considered as a consequence of interactions between air pollution, desiccation and biotic respectively abiotic factors, such as drought, insect attacks, frost etc.. The general improvement in 1993 is mainly caused by the cold and wet June, July and August. The fact that ***Pseudotsuga menziesii*** did not improve is probably caused by an imbalanced N/P-ratio which possibly leads to root damage.

3.2.2.22 Norway

The results of the 1993 assessment confirmed the continuous slight deterioration of forest health condition. Concerning all investigated species, 39.4% of all sample trees showed no symptoms of defoliation. 35.7% were slightly, 20.1% moderately and 4.6% were severely defoliated. 0.2% of all trees have died. Conifers presented rather low crown densities, particularly ***Picea abies.***

For additional investigation, 755 plots with 42 400 sample trees were established. On these, comparison of the 1992 and 1993 data revealed a slight deterioration for ***Picea abies*** and ***Pinus sylvestris.*** Regardless of site condition, the changes were similar, but variation increased with stand age.

Causes for the continued worsening might be an interaction of adverse climate, general stress and air pollution. Air pollution is thought to be a predisposing factor which forces the sensitivity to other biotic or abiotic stress factors. Long-range transported pollutants are brought by south-westerly winds. Inciting factors are the marginal condition for tree growth, e.g. harsh climatic components as they occur in large areas of Norway. Contributing factors to forest decline are biotic agents like pathogens and pests.

Studies are in progress on 19 permanent plots intended for special forest ecosystem analysis concerning cause-effect relationships between forest damage and air pollution. Results are presented in annual reports from the Norwegian Forest Research Institute.

3.2.2.23 Poland

Forest damage in Poland remains on a very high level. More than 90.0% of the assessed trees showed a defoliation above 10%, which means an increase by 1.7 percent points compared to the 1992 results. The share of trees with more than 25% defoliation increased by 1.2 percent points. The rate of deterioration in broadleaves is higher than in conifers. The percentage of broadleaves in defoliation classes 1-4 increased by 3.5 percent points and the respective proportion of conifers by 1.4 percent points. The highest defoliation among the conifers was found in stands of ***Abies*** spp.. The most affected deciduous species was ***Quercus*** spp.. Discolouration of different intensity was observed in 0.7% of the conifers and 1.0% of the broadleaves.

Extreme weather conditions, particularly dry summers, and insect attacks, especially by ***Lymantria monacha, Panolis flammea, Dendrolimus pini*** and ***Acantholyda nemoralis,*** are the main influencing factors for forest condition.

In the last years, a decrease in air pollution level, especially SO2 and NO_x, was observed. However, forest condition is still getting worse, although the rate of deterioration is slower than some years ago. The highest level of forest damage was found in the Silesian region, due to severe anthropogenic stress factors.

Besides defoliation and discolouration, some other variables giving evidence of forest condition, such as needle length, secondary shoots, fruiting, type of crown transparency and stem injuries caused by insects and fungi have been investigated in Poland.

3.2.2.24 Portugal

In general, the results of the 1993 survey show a remarkable decrease in defoliation. For both conifers and broadleaves the share of trees without any defoliation has risen. Compared to 1992, the percentage of trees classified as slightly defoliated increased by 5.1 percent points to 28.2%, while correspondingly the share of trees in defoliation classes 2 and 3 decreased, particularly in the broadleaves. As for the conifers, a fluctuation has been detected from defoliation class 1 to class 0.

The percentage of conifers in defoliation classes 3 and 4 decreased by 0.4 percent points to 0.9% and for broadleaves by 0.9 percent points to 0.8%.

This remarkable improvement of forest condition is mainly caused by the favourable climatic condition in 1993, particularly the end of the dry period, which had been enduring for several years. For example, 40.7% of ***Quercus suber*** showed more than 25% defoliation in 1992, probably caused by drought. In 1993, this share decreased to 10.2%. The area which has been destroyed by forest fires was far smaller than in 1991 and 1992, too.

As regards the importance of air pollution for forest condition, no conclusions about the correlation between defoliation, discolouration and air pollution effects can be drawn.

3.2.2.25 Romania

The 1993 results show an increased defoliation for all species, compared to 1992. The share of notably defoliated trees has risen from 13.5% to 17.9% and the share with more than 25% of defoliation from 16.8% to 20.5%. ***Abies alba*** was the most seriously affected coniferous species. The most defoliated species among broadleaves was ***Quercus*** spp..

The negative trend in forest condition can probably be explained by excessive drought phenomena from 1992, especially in the southern regions of Romania. The decline is stimulated by local, regional and transboundary air pollution, too. Acid rain and air pollutants (NO2, SC>2, NH3) as well as marginal soil condition are the main causes in the mountainous regions.

Special investigations on the influence of different factors on forest condition were carried out on 15 permanent sample plots placed in the main forest ecosystems. The first preliminary results show a direct correlation between climatic and soil parameters and forest health status. Also, a correlation was found between increment and health status. The change in forest vegetation in connection with the distance from pollution sources and increasing altitude is also a subject of investigation. Forest soil samples, gathered in 1992 and 1993, will be analysed by the National Soil Laboratory.

3.2.2.26 Russian Federation (St. Petersburg Region)

In the total area of the St. Petersburg Region continuous forest condition monitoring has been carried out on a 32 x 32 km network of permanent sample plots. In 1993, the establishment of a 16 x 16 km grid began in the western part of the region (25 plots). Defoliation, discolouration, crown density, needle longevity and dieback of conifers as well as species composition and cover by pine epiphyte lichens were assessed for the purpose of air pollution bioindication. On a denser network of temporary and permanent sample plots, the atmospheric deposition of heavy metals has been surveyed by chemical analysis of mosses for Cd, Cr, Cu, Ni, V, Fe, Zn, Pb. This study was preceeded by the intercalibration of collection and analysis methods.

Around 43% of the trees examined showed defoliation >10%, and a more significant needle loss was observed in 25% of the trees examined. The mean defoliation of coniferous stands was 12.2% (14.2% in 1992).

In 1993 on over half of the total area trees showed needle discolouration. The highest needle discolouration was found in the forests of the Karelian Isthmus and in the extreme southwestern part of the region. On the average, needle discolouration on the sample plots was 7.4% (7.8% in 1992). Discolouration was mainly caused by emissions of powerstations and insect attacks.

Pine needle longevity was on average in the total St. Petersburg Region 2.9 ± 0.3 years (in 1992 3.0 ± 0.4 years).

On about half of the surveyed area a high concentration of $S0_2$ in the air was assessed. The level of sulphur concentration in pine needles was often more than 1230 mg/kg (for dry needles). Kingisepp and Slantzy are the areas with highest air pollution due to the high emission of Estonian powerstations (Narva).

3.2.2.27 Slovak Republic

In 1993, a deterioration of forest health has been observed. The share of trees in defoliation class 0 decreased from 24.0% in 1992 to 20.0%. No change appeared in defoliation class 1, but a significant increase of moderately defoliated trees from 27.0% to 33.0% has been recorded. The sum of trees in defoliation classes 1 and 2 has increased from 76.0% to 80.0%. Changes in conifers were substantially greater than in broadleaves.

This unfavourable development is suggested to be a result of the dry summer of 1993. Air pollution is not considered to be the only factor. ***Quercus*** spp. and the coniferous species ***Picea*** spp., ***Pinus*** spp. and ***Abies*** spp. are very sensitive to unfavourable factors. Moreover, ***Fraxinus*** spp., ***Acer*** spp., ***Acacia*** spp. and ***Populus*** spp. were severely damaged. For ***Acacia*** spp. and ***Populus*** spp. the bad health status is caused by improper forest management, while ***Fraxinus*** spp. and ***Acer*** spp. suffer from rivalry, because they occur mainly dispersed in stands of other tree species. The best condition was found in ***Fagus*** spp. and ***Carpinus betulus.*** Probably they are more resistant than other species.

The monitoring results since 1987 show that the long term deterioration of health status in Slovak forests is quite progressive.

According to the principles of the forest policy in Slovakia, projects on elaboration of corrective measurement should be realized in several regions endangered by anthropogenic activities, especially emission influence.

3.2.2.28 Slovenia

The degree of visible crown damage has slightly increased in the period from 1991 to 1993. The condition of broadleaves is continuing, but conifers have deteriorated slightly, especially ***Picea abies,*** the most assessed tree species. 19.0% of all trees were moderately to severely defoliated. The share of not defoliated trees decreased by 8.0 percent points and the share of severely defoliated and dead trees by 1.0 percent points.

The Slovenian assessment of forest condition features some differences from the UN/ECE manual. Besides defoliation and discolouration, 9 other characteristics and 13 known (but not mentioned) damage types have been observed. The assessed trees, not only dominant or codominant, were not divided into two age classes. Bioindication by epiphytic lichens and mycorrhizal investigations have been performed. Case studies in the Alpine and Dinaric region have been comprising remote sensing, dendrochronology and increment studies. The results show that younger forests react more sensitively on harmful factors than older stands in an observed region. An unexpectedly long increment decrease has appeared long before external damage.

Obviously there is a general influence of dry summers on forest condition. Moreover, a significant fructification of ***Picea abies*** and a spreading of bark beetles have occurred. Some known sources of local pollution have an obvious impact on forest decline, but this impact can not be made responsible for the damages throughout the whole investigated area. However, air pollution is assumed to be one of the most important causes of forest decline besides climatic stresses and activity of man. This is derived from an analyses of total sulphur content in needles of ***Picea abies,*** based on the 16x16 km grid. The sulphur content showed a slight decrease, but nevertheless, 94.0% of the surveyed trees had increased sulphur contents. A coincidence with the spatial distribution of forest damages has been found. The highest values of both sulphur content and forest damage revealed themselves in plainly, densely populated and industrial developed parts of Slovenia.

3.2.2.29 Spain

As the major innovation of the 1993 survey, samples for soil analysis have been collected on 160 sample plots of the national grid.

Concerning defoliation and discolouration, a slight increase has been observed. The increase of conifers in defoliation classes 2-4 has been continuing since 1991. But quite a lot of trees in defoliation class 4 were cut. Unfortunately it is mostly unknown, if they were felled because they died or were harvested.

In general, for the most Spanish regions a lack of precipitation was recorded. Exceptions were the areas of Valencia, Cataluña, Baleares, Comisa Cantábrica and Galicia. However, compared to previous years, the number of forest fires has decreased.

Attacks of ***Thaumetopoea pityocampa*** caused a severe defoliation in stands of ***Pinus*** spp., being forced by the dry weather. Broadleaves were attacked by lots of insects, e.g. ***Lymantria dispar*** and ***Altica quercetorum.*** Severe damages in northern oak forests (Comisa Cantabrica) were caused by ***Microsphaera alphitoides.*** Infestations of ***Viscum album*** and ***Thyriopsis halepensis*** increase constantly. Stands of ***Pinus*** spp. with a previous weakness by drought of forest fires were attacked by populations of bark beetles.

Afforestation and forest improvement, mostly concerning fire prevention ordered at the regional level. Integrated programs on proper forest management, pest control and abiotic agents were performed in several Spanish regions. Studies on the deterioration of forest vegetation are conducted in particularly sensitive areas. Arrangements of afforestation (decree 378/1993) were published according to ECE-order 2080/92.

3.2.2.30 Sweden

The 1993 results of the forest condition survey (Level I) show a general decrease in defoliation of conifers, compared with the previous three years. Especially ***Pinus sylvestris*** has recovered considerably. The only exception is an increased defoliation in ***Picea abies*** in the south of Sweden. Nevertheless, defoliation remains on a higher level, compared with the period 1985-1988, especially in Southern Sweden. The highest defoliation level was found in Northern Sweden.

The forest damage level as well as the between-year variation is interpreted as an effect of natural stress factors combined with direct and indirect effects of anthropogenic air pollutants. The high defoliation level in Northern Sweden is explained as an effect of high aged stands in combination with a harsher climate. Defoliation is almost restricted to trees older than 60 years.

In 1993, a special survey on the damage of ***Be tula*** spp. stands has been carried out in Götaland in Southern Sweden. The results show high defoliation and an increase since the previous survey within the same region in 1990. About 40.0% of the assessed trees had more than 25% defoliation, which is a higher defoliation level than in the northerly regions Svealand and Norrland surveyed in 1991 and 1992. A great variability from year to year has also been detected. Estimations of crown density decrease due to flowering show, that flowering frequency is a crucial factor for defoliation scores. Intense flowering in 1993 and also attacks of insects are likely contributing factors to the severe defoliation.

A survey of ***Fagus sylvatica*** and ***Quercus*** spp. has been performed in 1993 in the south-western part of Sweden. Besides defoliation, some other tree condition parameters have been assessed, such as accumulated shoot growth, branching structure etc. The results show a considerable deterioration of tree condition in both species, compared to the previous survey in 1988. A contributing factor might be the early summer drought in 1992 which have caused reduced shoot growth and high flowering frequency in 1993.

Defoliation observations were reported from 280 intensive permanent plots (9599 ***Picea abies*** and 3342 ***Pinus sylvestris***) in 1993 (Level II). The changes in defoliation during the **last three years are minor. However,** both species had shown a continuing increase in defoliation from 1984 to 1990 in Southern Sweden. Such a trend has not been recognized in

Northern Sweden. Direct and indirect effects of air pollution, e.g. soil acidification, are likely contributing to the observed decline.

3.2.2.31 Switzerland

In general, tree crown condition in Switzerland did not change significantly between 1992 and 1993. The slight increase in the percentage of trees with >25% was within the range of the measurement error. Within individual species, a significant increase in defoliation occurred in ***Picea abies*** and ***Abies alba.*** The condition of ***Fagus sylvatica*** did not change significantly.

Since 1985, an increase in the proportion of trees with more than 25% defoliation has been reported. The causes for this are unknown, but methodological changes are probably involved. Conifers generally show higher levels of defoliation than broadleaves.

During 1993, the national forest health monitoring network was changed from 4x4 km into 8x8 km, but this had no effect on the consistency of the results throughout Switzerland. On this 8x8 km network, both soil and vegetation were assessed in 1993. The soil investigation was based on the UN/ECE Manual. For the vegetation survey, methods developed in Switzerland were used. Data from both investigations are currently being analysed.

An intensive survey on forest ecosystem plots (Level II) was initiated in 1993. Four monitoring plots have been established; more plots will follow in 1994 and 1995. The plots will be located in the most important forest types of Switzerland with emphasis given to those forest types known to be sensitive to environmental change. On each plot, a variety of ecosystem measurements will be taken, as far as practicable according to the Manuals of ICP Forests and ICP Integrated Monitoring.

The level of defoliation is considered as an inadequate indicator of forest condition. Therefore, other crown parameters have been included. A number of new indices have been developed and are currently being tested.

Important objectives of the Forest Investigation Programme are the monitoring of forest health status and the evaluation of relationships between forests, soils, climate and air pollution. The results should enable the identification of some of the factors affecting forest health. A quick application of the results to forest and environmental policy will be necessary if particular problems are detected.

No direct indication that forest condition is adversely affected by air pollution has been found in Switzerland. This, however, may reflect inadequacies in the inventory methods rather than the absence of air pollution effects. As a result of experimental research, ozone is considered to be the pollutant representing the greatest risk to tree condition at present. In future, nitrogen deposition may cause increasing problems, but little evidence of such effects has been recorded until now. In general, the influence of air pollution on forest condition and its role as a predisposing factor for other damaging agents is still unclear, due to a lack of knowledge about forest ecosystem processes and how these processes are influenced by air pollutants.

3.2.2.32 Turkey

No data were received from Turkey at the time of the completion of this report.

3.2.2.33 Ukraine

No report was received from Ukraine at the time of the completion of this report.

3.2.2.34 United Kingdom

In contrast to previous years, the 1993 results are based on an assessment of defoliation made with reference to a tree with full foliage growing under the same conditions as the assessed trees, rather than with reference to photographs of fully-foliated trees growing under ideal conditions. This explains the apparently large change in defoliation since 1992, but it improves the comparison of results with those of other countries, in which a method based on local reference trees is used. However, in order to maintain the existing time series of defoliation figures, trees were also assessed using the old method. These results indicate a decrease in the proportion of trees of all species in defoliation classes 2-4 by 4.3 percent points, compared to 1992.

Climatic conditions were favourable for tree growth in 1993, mainly due to a wet summer, and the condition of ***Picea abies, Pinus sylvestris*** and ***Fagus sylvatica*** improved. A marked 2-year decline in ***Pinus sylvestris*** was reversed and a similar decline in ***Quercus robur*** was arrested. The recovery of ***Fagus sylvatica*** continued in 1993 after a decline which began in 1991. It is probable that the condition of ***Picea sitchensis,*** which was unchanged during 1993, primarily reflects the incidence of ***Elatobium abietinum.***

The quantities of air pollutants reaching forests and woodlands vary substantially depending on the location and nature of emission sources, the topography and the principal deposition mechanism (rain, mist, gas). The sensitivity of tree species and soils also vary greatly. Application of the critical loads and levels approaches is therefore essential in considering the role of pollution in influencing forest condition. Current models indicate some exceedences of critical loads and levels, implying some damage. The interception of sulphur and nitrogen appears to be of greatest importance in the uplands, while ozone, and perhaps ammonia, may be of importance in the lowlands. Observations suggest that in the short-term such effects are not as great as the impacts of biotic and abiotic agents. In the United Kingdom there is no evidence for long-term pollutant damage of the type identified for some forests in central Europe.

3.2.2.35 Yugoslavia (successor states)

No data were received from the successor states of Yugoslavia at the time of the completion of this report.

3.2.3 North America

3.2.3.1 Canada

Forest health in Canada has been monitored systematically since 1984 when the Acid Rain National Early Warning System (ARNEWS) was established. The term 'acid rain' encompasses all forms of air pollution - wet and dry deposition of sulfates (SO„), nitrates (NO,), ozone (0_3), gaseous pollutants and airborne particles. The ARNEWS assesses the health of the forest using a common set of measurements taken on permanent sample plots established by the Forest Insect and Disease Survey (FIDS) of Forestry Canada.

The strategy of the ARNEWS is to detect early signs of damage to forest trees and soils that may have been caused by acid rain by separating damage attributable to insects, diseases and other natural causes, from those caused by pollution, and to monitor the long term changes in vegetation and soils attributable to acid deposition and other pollutants.

In addition to the ARNEWS network of plots, a system of plots to sample the condition of sugar maple ***(Acer saccharum)*** was established in 1988. This is a joint project between Canada and the United States, which measures the crown condition of maples in managed (sugarbush) and unmanaged stands. Results to date show that most of the trees sampled (>90%) were healthy. A high proportion of trees which did exhibit crown dieback also had major damage to roots or boles. The condition of sugar maples in sugarbushes managed for sap production was essentially not different from the condition of stands classified as unmanaged.

An analysis of the data collected from the ARNEWS plots in 1993 indicates that there is still no large scale decline in the health of Canadian forests which can be directly attributed to atmospheric pollution. This is a similar conclusion to that reached from the results analyzed in previous years. It is, of course, possible that trees have been weakened or stressed by other factors, and that this stress is not apparent.

Tree mortality was in the range of 1 to 2% annually, and was caused largely by competition within stands. This is the most common cause of tree mortality in these typically densely spaced natural stands. Over the whole country the effects of insects, diseases, drought and storms were observed frequently. This caused stress and mortality on a variety of species throughout the whole country.

In eastern Canada, needle flecking was reported on species of ***Picea*** and ***Pinus*** in 1993. These symptoms have been observed for several years and can be caused by several factors such as weather events, insects, diseases or by pollution, particularly ozone. Research is currently underway to determine the causes of this damage.

3.2.3.2 United States of America

Forest Land extends over 298 million hectares or 33% of the total land area. Of the forest land, coniferous forests cover 158 million hectares (53%) and broadleaved forests cover 140 million hectares (47%). Forest ownership is diverse with about 8 million owners of 0.4 ha or more forest land.

The Forest Health Monitoring (FHM) program is jointly managed and largely funded by the USDA Forest Service and the U.S. Environmental Protection Agency in cooperation with other program partners. Essential partners include the National Association of State Foresters, participating States, and other Federal Agencies.

Initiated in 1990, Detection Monitoring (Level I) now includes all four FHM Regions and fourteen States: Alabama, California, Colorado, Connecticut, Delaware, Georgia, Massachusetts, Maine, Maryland, New Hampshire, New Jersey, Rhode Island, Virginia, and Vermont. A total of 809 permanent monitoring plots (about 20% of the total for the contiguous U.S.) have been established in the four FHM Regions. Data were taken on stand structure, growth, mortality, crown condition, biotic and abiotic damage, and regeneneration measures of stand dynamics and diversity. These data are currently being analyzed, and more complete 1993 monitoring results will be reported later this year. Plans are being made to expand Detection Monitoring to two additional States in 1994, as well as to expand the list of environmental indicators to include measures of photosynthetically reactive radiation (PAR), lichen communities, air pollution (ozone) effects on bioindicator plants (eastwide), and plant diversity.

Preliminary results follow for two indicators of Crown Condition and for Ozone Bioindicator Plants in the eastern and northeastern U.S.

Crown Condition: Tree crown defoliation was examined for more than 21 tree species in the eastern U.S. This analysis was done for individual species recorded on 45 or more plots within specific analysis regions. Two of the crown variables examined were Dieback and Transparency.

Except for loblolly pine ***(Pinus taeda***) and white ash ***(Fraxinus americana),*** initial analyses of dieback and transparency show that for both variables, less than 10% of any tree species fell in the Undesirable category, and less than 3% of any tree species fell in the Poor category.

Loblolly pine had the highest Dieback percentage (11%) falling in the Undesirable category. White ash had the highest Dieback percentage (5%) falling in the Poor category.

Ozone Bioindicator Plants: Field teams established biomonitoring sites for determining the presence or absence of ozone symptoms at 107 of the 254 forested plots in the northeastern U.S. Based on data from the 107 biomonitoring sites, an estimated 11% of the forested area sampled had symptoms of ozone injury on bioindicator plants. All of the plots that rated positive for ozone symptoms were located in areas which were categorized as having elevated ozone levels. As in previous years, blackberry and milkweed were the species most often reported with ozone symptoms.

4. INTERPRETATION

With 102 800 trees assessed, the total tree sample of the transnational survey of 1993 was the largest since the beginning of the surveys in 1987. Of these sample trees, 22.6% were considered as damaged. Both the transnational and the national surveys show that losses of needles and leaves exist to different extent in all participating countries. As in the previous years, the areas of highest defoliation are located in central Europe, but defoliation is also high in certain areas of northern and southeastern Europe.

The survey results give evidence of trends of defoliation and discolouration as well as of their correlations with other parameters assessed. However, the extent, spatial distribution and development of defoliation and discolouration must be interpreted very carefully. The reason is that defoliation and discolouration, though in the centre of the discussion since the beginning of forest damage research and assessments, are by themselves neither specific for recent forest damage in general nor for air pollution damage in particular. As a consequence, the results of comparisons of the two symptoms with other parameters do not permit definite conclusions on cause-effect-relationships, even if statistically significant.

Among all other parameters assessed, **stand age** was found to have the highest correlation with the intensity of defoliation. The proportion of damaged trees increased from 10.9% in age class 0-20 years to 27.0% in age class >120 years, as derived from the transnational survey results. The higher defoliation in old stands is confirmed by the national survey results. The strong correlation found, however, largely reflects the well known natural loss of foliage due to ageing, particularly in coniferous trees. The explanation of the correlation between defoliation and age was confirmed in a study focusing on severely defoliated and dead trees. Among the severely defoliated and dead trees there is a relatively high proportion of younger trees. The reason for this could be the high degree of competition in younger stands even within canopy classes 1-3, which leads to high natural mortality.

Although the defoliation assessment in its present shape can give no definite answers as to which degree the loss of needles due to ageing masks a defoliation caused by damaging agents, the development of defoliation of a coniferous species (***Pinus sylvestris*** in the Mountainous region) and a broadleaved species (***Fagus sylvatica*** in the Sub-atlantic region) was tested for differences in the age groups 0-60 years and older than 60 years. In contrast to ***Pinus sylvestris, Fagus sylvatica*** showed a clear different development in both age groups. This indicates that factors other than age are affecting old ***Fagus sylvatica*** trees with a higher intensity than young trees.

Although in 1993 two more countries submitted information on **soil unit,** the interpretation of defoliation in connection with this parameter is still impeded by too low a number of sample plots. Soil unit was only assessed by Austria, Estonia, Germany and Greece. As a result, the tree numbers per soil unit are often far too low to yield conclusive results. Moreover, care must be taken in the interpretation, as soil unit comprises a wide range of different sites formed by specific geological ground material, climatic conditions, and vegetation etc., and defoliation is influenced by further site conditions not assessed on the plots. However, as in previous surveys, certain correlations between defoliation and soil unit were found. This shows that it is important that in the future soil unit is assessed by all countries. A more complete data set will become available from next year on, when soil sampling will be carried out on Level I plots by many countries.

The highest percentages of damaged trees were found on Calcaric Lithosols (80.0%), Luvic Calcisols (56.6%), and Haplic Phaeozems (56.6%). Faced with their small sample sizes (Annex I-10), no definite conclusions about relationships between these soils and defoliation can be drawn. However, Calcaric Lithosols and Luvic Calcisols have certain characteristics which might have fostered defoliation:

High defoliation on Calcaric Lithosols may be linked to their shallowness, dryness and their association with bare rock. These are typical characteristics of Mountainous regions, where high defoliation has been known ever since due to soil properties and harsher climate.

All of the Luvic Calcisols were situated in the Mediterranean region. This soil unit is characterized by high lime contents and a subsurface horizon enriched with clay, which may lead to limited water availability, particularly under the arid conditions of the Mediterranean region, may have contributed to high defoliation.

Those soil units represented by far higher numbers of plots show generally smaller percentages of damaged trees. These are the Chromic Luvisols (649 trees, 20.5% of them damaged), the Orthic Podzols (594 trees, 17.8% of them damaged), the Dystric Cambisols (584 trees, 9.1% of them damaged) and the Leptic Podzols (524 trees, 5.0% of them damaged). These results do not reveal any correlations between defoliation and particular soil characteristics.

As regards defoliation by **water availability,** the share of damaged trees was 20.5% on plots of insufficient water availability, 18.9% on plots of sufficient water availability and 23.0% on plots of excessive water availability. The conclusion that sufficient water availability has led to the lowest defoliation seems fairly vague when the small differences between the respective shares of damaged trees are taken into account. This does not confirm the results of last year's survey, which revealed very similar defoliation on plots of sufficient and excessive water availability (18.8% and 18.6%, respectively) and a clearly higher defoliation on plots of insufficient water availability (24.0%). This may be explained by changes in the influences of factors other than water availability and by changes in the sample. All in all, the rough water availability classes do not seem to be strongly correlated with defoliation.

Based on the national survey results, the **weather** is thought to have strong influence on defoliation by many countries. In the national reports, the changes in forest condition observed are ascribed to weather phenomena by more than half of the participating countries. More than one third of the countries mention drought and high temperatures during the vegetation period of 1993 or of several previous years as predisposing or triggering factors for the damage observed. Pests are often looked upon as secondary agents, which were fostered by warm and dry weather conditions. Other weather phenomena ranging among the most important stressors are frost, snow, hail and storm. Whilst drought, heat and subsequent pests are considered as major problems mainly in central, eastern and southern Europe, harsh winter climate is mentioned as a cause for forest damage in northern Europe. In western Europe and parts of central and southeastern Europe, higher precipitation during the vegetation period of 1993 is reported to have caused an improvement of forest condition.

As regards the spatial distribution of the defoliation, differences in its intensity were found between various **climatic regions.** In the transnational survey, the proportion of damaged trees was highest in the Sub-atlantic region (39.5%) and lowest in the Atlantic (south) region (8.6%).

Though the climate and particularly the weather have been found also in the previous surveys to greatly influence crown condition, the differences in defoliation observed between the various climatic regions can not be readily explained as of climatic origin for the following reasons:

Firstly, the use of local reference trees should compensate for the climatic influence to a certain degree. Secondly, as the climatic impact on defoliation has been partly eliminated, those differences in defoliation between individual regions which can not be explained by climatic influences become particularly evident, feigning defoliation of climatic origin. For instance, as in previous years, defoliation was particularly high in the Sub-atlantic region, where defoliation is particularly high due to local air pollution effects in some of the main damage areas. Because of these reasons, the direct comparison of the defoliation between different climatic regions is unlikely to reveal climatic effects. Nevertheless, the stratification of the total tree sample according to climatic regions remains indispensable, because the classification into climatic regions provides an additional variable for future multivariate analyses and evaluations.

The importance of synergistic effects of unfavourable weather conditions with **easily identifiable damage,** particularly insects and fungi, become obvious in both the transnational and the national survey results. As part of the transnational survey, tree-related data on easily identifiable damage are reported. These data, however, are difficult to interpret, since they only represent trees for which the type of damage has been established conclusively. Trees that are affected as well, but do not show any kind of symptom that can be related to a known damage type are not included. Consequently the data presented here only give a general indication of the effect of the several damage types.

Easily identifiable damage was reported for 29.8% of all trees of the transnational survey. On these trees the defoliation was higher than on those for which no damage types had been reported. As in recent years, the most frequently observed type of damage was insect attack with 11.7% of the trees for which easily identifiable damage had been reported. Second on the frequency scale (9.7%) were "other types of damage", giving evidence of the multitude of factors responsible for the defoliation assessed. Classical smoke damage was reported for a very small number of trees (0.3%). As a consequence, the results for classical smoke damage were not further interpreted. For 70.2% of the trees no evident source of damage was reported. These trees, however, comprise an unknown proportion of trees on which damage was present, but the causes not reported.

The percentage of trees considered as damaged in 1993 (22.6%) is slightly smaller than that of the 1992 survey (23.5%). However, as regards the **development of damage** over time, a direct comparison of the proportion of damaged trees in the total tree sample of the 1993 transnational survey with that of 1992 would be biased due to differing annual sample sizes.

The differences between the samples of 1992 and 1993 were particularly comprehensive as compared to former surveys. The number of sample plots and trees was greatly enlarged because of the inclusion of the newly participating countries Croatia, Moldavia and Slovenia, as well as by the resumption of the transnational survey in the Czech Republic. Some changes in the plot sample in several countries, though less relevant for the sample size, also rendered the 1993 survey results incomparable to those of the year 1992. In order to be able to use existing soil data, Denmark has made an adjustment of the Level I grid. Therefore Denmark has provided a new dataset ranging back to 1989. Comparison between the old and the new set of data showed no shift in the damage levels in the respective years. Spain also provided a revised data set. In addition, the United Kingdom adjusted its assessment method to the international standards.

As a consequence of these changes, differences between the 1993 results and the results of previous years observed within the total sample or the subsamples of individual climatic regions do not give evidence of the actual development of forest condition. The actual development of forest condition in Europe is better reflected by the Common Sample Trees (CSTs) evaluated for the periods 1992-1993, and by the common trees of the surveys from 1988 to 1993. With 84 969 CSTs of 1992 and 1993, this common sample was the largest ever, which indicates an increasing consistency of the total data base.

The statistical evaluation shows that out of the 84 969 CSTs the share of damaged trees did not change significantly between 1992 and 1993 (23.3% and 23.1%, respectively). But there were both significant increases and significant decreases in the shares of damaged CSTs in 7 out of 9 climatic regions. These, however, compensated for each other within the total CSTs.

The largest change occurred in the Boreal (temperate) region, where the share of damaged CSTs increased significantly from 12.7% by 4.8 percent points to 17.5%. This is largely due to the increase in defoliation to be observed in Lithuania. From Lithuania an increase in defoliation has been reported particularly in the coniferous species.

The second largest change was an increase in the share of damaged CSTs from 20.5% by 4.3 percent points to 24.8% in the Continental region. This increase reflects the deterioration of forest condition in Romania, where excessive drought and local air pollution caused an increase in defoliation in many species, particularly in ***Abies alba*** and ***Quercus spp.***. The decline of ***Abies alba*** in Romania also reveals itself in the change in the share of damaged CSTs of ***Abies alba*** from 29.2% in 1992 to 33.6% in 1993. The ***Abies alba*** decline in Romania also explains the sharp increase in defoliation of ***Abies alba*** trees of the sample common to the years 1988 to 1993 in the Mountainous region. In the Mountainous region, the share of damaged Abies alba trees of this common sample increased from 24.3% in 1992 to 34.9% in 1993.

The largest decrease of the share of damaged CSTs between 1992 and 1993 occurred in the Boreal region, from 16.5% by 4.2 percent points to 12.3%. This is a consequence of the considerable recovery of ***Pinus sylvestris*** on many plots in central and northern Sweden.

The second largest decrease of the share of damaged CSTs, namely from 14.4% by 3.8 percent points to 10.6%, is mainly due to a clear recovery of ***Quercus suber*** in Portugal. This has been explained by the cease of a long drought period. This recovery becomes particularly obvious if the share of all damaged CSTs of ***Quercus suber*** is considered (33.7% in 1992 and 10.3% in 1993). This recovery is even more obvious in the common

Quercus suber sample of 1988 and 1993 of the Mediterranean (lower) region. Here the share of damaged trees decreased from 35.6% in 1992 to 9.7% in 1993.

The above changes in defoliation derived from the CSTs reveal themselves clearly in the maps presented in Annexes 1-7 and 1-8. According to these maps the worsening of forest condition reveals itself particularly in such areas where defoliation was already high, namely in central Europe. Moreover, the maps show the differences in the results obtained when comparing percentages of trees damaged and mean plot defoliation. For example, statistically significant changes in mean plot defoliation occurs frequently in Norway (Annex 1-8). This deterioration, however, is less recognizable in the map of changes in the percentages of trees damaged (Annex 1-7).

A deterioration of forest vitality can also be inferred for a longer period of time from the evaluation of the trees common to the 1988 to 1993 surveys. Within the 5 year period, all of the 12 species analyzed show an increase in the proportion of damaged trees. This trend is obvious even in individual climatic regions. Both gradual and irregular changes can be found. Irregular changes are frequent in the Mediterranean species. This may indicate that the causes of the changes in defoliation observed in the Mediterranean region are different from those in the other parts of Europe. The sudden changes in defoliation of the Mediterranean species may be largely explained by stressors typical for the Mediterranean region, namely drought, heat and fire. This explanation is in good agreement with the national reports from the Mediterranean countries. In contrast to that, the long term gradual decline of forest condition in the other parts of Europe must be explained by stressors affecting forest condition continuously over a longer period.

In order to gain deeper insight into the causes of **removals and death** of trees, the defoliation of all trees having been removed or having died since 1988 was studied with respect to differences in age and regions. As in last year it could be shown that the overwhelming majority of trees removed showed no or slight defoliation, and that the trees having died mostly had high defoliation, but comprised only 7.0% of all trees excluded and a negligibly small share of the total tree sample. This indicates that the removal and death of trees does not whitewash the survey results.

Moreover, it was shown that in young stands a higher share of trees was removed than in old stands. The younger the stands were, the smaller was the share of damaged trees among the removals. It was also shown that the trees having died in younger stands had low defoliation prior to their death, whereas in older stands the defoliation of the trees dying was high. This indicates that most of the removed trees stem from thinnings in the younger, less defoliated stands. Whilst tree death in the younger stands is mainly due to competition and sudden calamities, it occurs after a phase of high defoliation either due to ageing or due to damage in older stands. All in all, the results give rise to the assumption that the majority of trees is removed in the course of normal thinning rather than in the course of sanitary cuttings.

Moreover it was tested if the above findings, which refer to the total data set, also hold true for the region of high defoliation in central Europe. The results show that in this area among the removed trees the share of moderately and severely defoliated trees is clearly higher than in the remaining parts of Europe. The share of dead trees is 29.5% of all trees removed. This indicates that in the area of high defoliation in central Europe sanitary cuttings and tree death are frequent reasons for the exclusion of trees from the survey.

On the one hand, **pure stands** have been postulated to be more susceptible against environmental changes than **mixed stands** because of a lower ecological stability. On the other hand, mixed stands have been claimed to be subject to higher air pollution risks because of their higher canopy roughness. None of these two hypotheses could be confirmed in a study of ***Picea abies*** in pure stands and in different degrees of mixture with ***Fagus sylvatica.*** The defoliation of Picea abies showed nearly no differences in pure stands and in mixed stands.

The results of the transnational and national surveys reveal that there is a large number of stresses and site conditions influencing the extent of defoliation and discolouration. The most important probable causes for the observed defoliation and discolouration have been reported to be adverse weather conditions, insects, fungi, forest fires and air pollution. In accordance with the objectives of the surveys particular attention is being paid to the effects of air pollution as one of the many factors causing the symptoms observed.

More than half of the countries participating in the surveys report air pollution to be a predisposing, accompanying or triggering factor. Air pollution is considered as of concern particularly in northern, central and eastern Europe. The degree to which air pollution has contributed to defoliation and discolouration, however, cannot be quantified as a consequence of the lacking specificity of the symptoms assessed. It must be stated that the trend towards the deterioration of forest condition observed in the common trees from 1988 to 1993 already in earlier years continues. It is this trend which cannot be readily explained by site conditions and natural damaging agents. Although there is no direct evidence of this being an effect of air pollution, this phenomenon deserves special attention because a continuous and large scale weakening of forest health by long-range transboundary air pollution is likely to manifest itself in effects like the ones observed.

5. CONCLUSIONS AND RECOMMENDATIONS

The development of forest condition as assessed in the transnational and national surveys of UN/ECE and EU (Level I) reveals that forest damage in terms of defoliation and discolouration continues to be a problem in Europe. Though at the large scale forest decline has developed less dramatically than feared in the early 1980s, a general worsening of forest condition is to be observed in many parts of Europe. In certain regions the damage is severe and locally catastrophical. There is a concentration of main damage areas in some countries of Central Europe, in which many thousand hectares of forest have died.

According to the opinion of the countries participating in the surveys, the most frequent causes of the symptoms observed are adverse weather conditions, insects, fungi, air pollution and forest fires. Particularly in some of the main damage areas, but also in several other regions, air pollution is considered as of major concern, because the atmospheric concentrations and the depositions of several air pollutants is thought to exceed the critical levels and loads for forest ecosystems. The forest condition monitoring of UN/ECE and EU pays particular attention to the effects of air pollution stress.

Additional information is to be expected from a more complete and correct collection of annual data on the plots of the transnational survey. For example, given the differences in defoliation on the soils currently assessed by only four countries, the soil sampling foreseen in many countries next year will be of particular value. In this context it must be mentioned that despite the intensive monitoring on permanent plots the large-scale assessment must be continued. Time series of many consecutive years are expected to give evidence of the potential impact of transboundary air pollution and other factors. Moreover, the large spatial and temporal variation can only be scrutinized by means of time series of observations detached from the constraints of national borders. From the political point of view, evidence of transnational effects is the precondition for common abatement strategies.

Without the large-scale monitoring of forest condition in recent years, today's understanding of recent forest damage can not be imagined. The main benefits received from the monitoring until today are:

- a more accurate knowledge of the extent, dynamics and spatial distribution of the symptoms of forest damage in Europe
- a database for future time series analyses of defoliation and complex studies in combination with ecological parameters
- impetus to environmental policies and forest damage research.

As the large-scale monitoring does not aim at cause-effect relationships, its results can not be interpreted directly with respect to the impact of air pollution. Instead, the interpretation of the results has often to rely on explanations given in country reports, which in turn are based on studies on permanent sample plots.

In order to contribute also to a better understanding of the impact of air pollution on forest ecosystems, UN/ECE and EU have implemented a system of permanent plots for a more intensive and continuous monitoring (Level II). This approach is consistent with the stipulations of the European Ministers of the Ministerial Conference on the Protection of Forests in Europe, in Strasbourg, December 1990. On Level II soil analyses, foliar analyses, increment studies and deposition measurements will be carried out, for which four Expert Panels of ICP Forests have developed harmonized methods. These methods are described in the 3rd edition of the ICP-Forests Manual. Further efforts in harmonization are under preparation in the fields of meteorological measurements. Vegetation assessments and crown condition assessments are planned to be developed further. The application of such methods will provide additional important information for a more thorough interpretation of the data.

The synoptical interpretation of the growing database will require access by a range of potential users and data exchange with other ICPs under the Convention on Long-range Transboundary Air Pollution. For this reason a common data bank and regulations regarding data ownership, data security and data exchange are being planned by ICP Forests and EU.

In the national reports of many countries the importance of dry conditions in recent years, both in terms of drought stress to trees and increased frequency of forest fires, has been emphasized. Any atmospheric changes that increased the frequency of dry conditions in Europe would have serious consequences for many forests, particularly in the south. ICP Forests and EU therefore support any moves that might help to reduce the rate of global warming and other effects of global climatic change. Due regard should be paid to these impacts within in the future monitoring activities.

As regards abatement strategies, a reduction of the air pollution load should improve the condition of endangered forests and postpone further disruption to ecosystems. Sulphur dioxide, ammonia, nitrogen oxides (as precursors of ozone and acid deposition) and others may all be important in particular areas.

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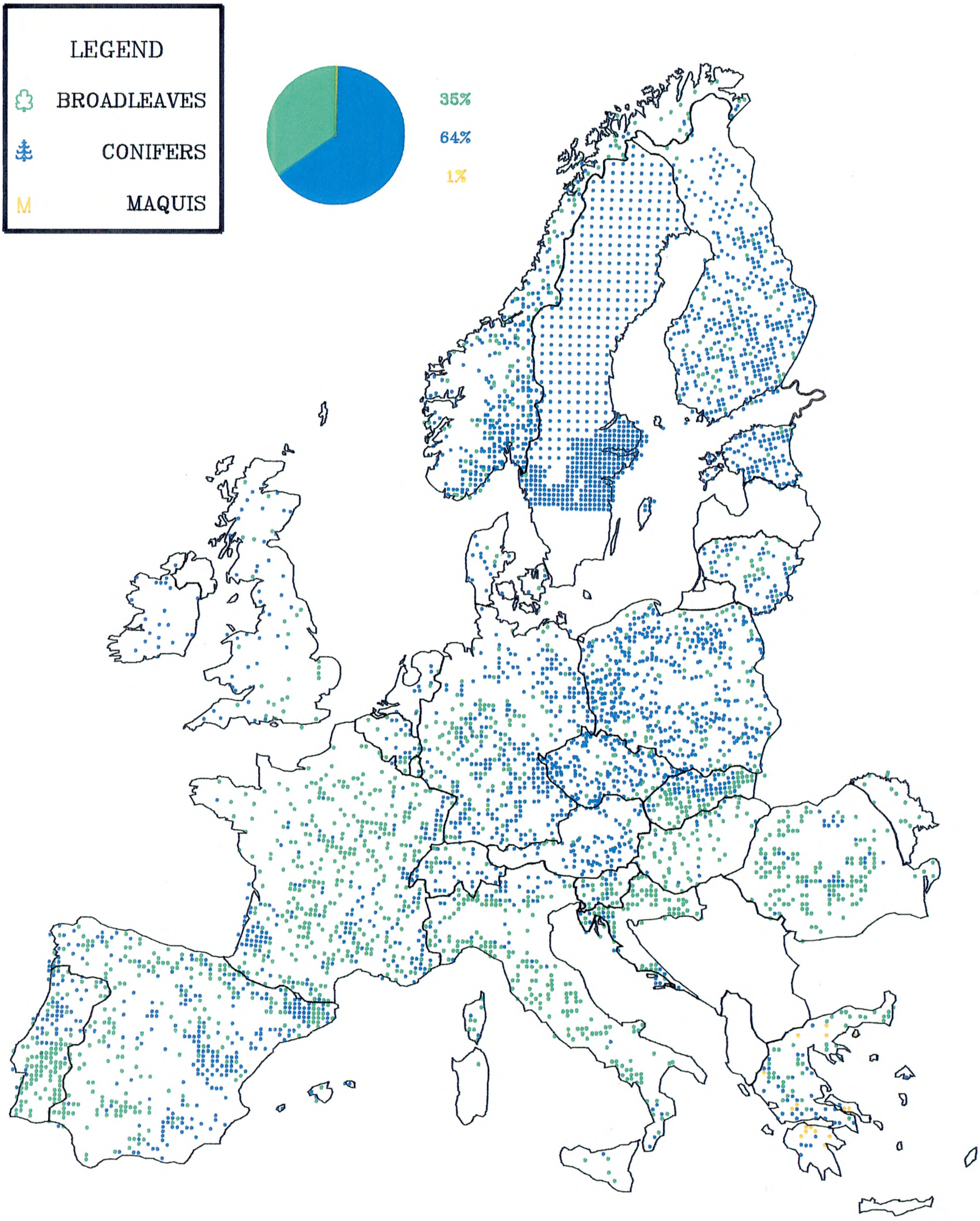
Annex I

Transnational survey

Annex 1-1

Broadleaves and conifers (1993)



Annex 1-2

Species assessed (1993)

EUROPEAN UNION & ICP	OBSERVED TREES		OBSERVED PLOTS	
	NUMBER	%	NUMBER	%
SPECIES				
Pinus sylvestris	25637	24.94	1575	19.48
Picea abies	23981	23.33	1355	16.76
Fagus sylvatica	9084	8.84	517	6.40
Quercus robur	4288	4.17	353	4.37
Pinus pinaster	3470	3.38	182	2.25
Quercus petraea	2918	2.84	302	3.74
Quercus ilex	2989	2.91	188	2.33
Betula pubescens	2257	2.20	346	4.28
Pinus halepensis	2017	1.96	111	1.37
Quercus pubescens	1799	1.75	166	2.05
Pinus nigra	1805	1.76	119	1.47
Abies alba	1687	1.64	166	2.05
Carpinus betulus	1624	1.58	214	2.65
Quercus suber	1544	1.50	92	1.14
Castanea sativa	1390	1.35	147	1.82
Betula pendula	1034	1.01	235	2.91
Quercus cerris	1092	1.06	106	1.31
Eucalyptus sp.	1128	1.10	58	0.72
Larix decidua	924	0.90	138	1.71
Robinia pseudacacia	861	0.84	77	0.95
Quercus pyrenaica	888	0.86	50	0.62
Fraxinus excelsior	756	0.74	150	1.86
Quercus rotundifolia	657	0.64	33	0.41
Picea sitchensis	609	0.59	34	0.42
Ainus glutinosa	516	0.50	67	0.83
Acer pseudoplatanus	442	0.43	120	1.48

EUROPEAN UNION & ICP	OBSERVED TREES		OBSERVED PLOTS	
	NUMBER	%	NUMBER	%
SPECIES				
Pseudotsuga menziesii	468	0 .46	42	0. 52
Populus hybrides	452	0 . 44	25	0.31
Quercus faginea	369	0.36	46	0. 57
Quercus frainetto	377	0 . 37	26	0.32
Populus tremula	295	0.29	102	1.26
Pinus pinea	337	0.33	32	0.40
Other broadleaves	282	0.27	69	0.85
Ostrya carpinifolia	283	0.28	45	0.56
Prunus avium	234	0.23	88	1. 09
Tilia cordata	259	0 .25	53	0. 66
Abies cephalonica	269	0.26	13	0 . 16
Juniperus thurifera	241	0.23	20	0.25
Acer campestre	192	0 . 19	64	0 .79
Quercus coccifera	228	0.22	17	0.21
Pinus radiata	204	0.20	11	0. 14
Pinus contorta	190	0 . 18	12	0 . 15
Abies borisii-regis	179	0. 17	10	0. 12
Ainus incana	141	0. 14	27	0.33
Fraxinus ornus	127	0. 12	39	0.48
Olea europaea	125	0. 12	19	0.24
Populus nigra	118	0. 11	13	0. 16
Quercus rubra	107	0. 10	20	0.25
Fagus moesiaca	121	0 . 12	6	0 . 07
Pinus uncinata	118	0. 11	9	0. 11
Populus alba	118	0.11	8	0. 10
Ainus cordata	90	0. 09	7	0. 09

EUROPEAN UNION & ICP	OBSERVED TREES		OBSERVED PLOTS	
	NUMBER	%	NUMBER	%
SPECIES				
Larix kaempferi	85	0. 08	8	0. 10
Pinus brutia	76	0. 07	5	0. 06
Platanus orientalis	76	0. 07	5	0. 06
Carpinus orientalis	68	0. 07	8	0. 10
Acer platanoides	47	0. 05	25	0.31
Sorbus aria	44	0. 04	26	0.32
Juniperus oxycedrus	51	0 . 05	18	0.22
Pinus cembra	56	0 . 05	7	0. 09
Pinus strobus	54	0. 05	6	0. 07
Salix caprea	41	0. 04	17	0.21
Acer monspessulanum	44	0 . 04	14	0. 17
Ulmus glabra	37	0. 04	20	0 .25
Juniperus phoenicea	46	0. 04	10	0. 12
Arbutus unedo	48	0 . 05	7	0 . 09
Juniperus communis	45	0. 04	9	0.11
Sorbus torminalis	29	0.03	23	0.28
Cupressus sempervirens	42	0. 04	7	0 . 09
Populus canescens	43	0. 04	3	0. 04
Sorbus aucuparia	32	0.03	13	0. 16
Tilia platyphyllos	33	0 . 03	9	0 . 11
Salix sp.	30	0 . 03	10	0. 12
Fraxinus angustifolia	35	0. 03	5	0. 06
Quercus trojana	35	0 . 03	4	0. 05
Phillyrea latifolia	32	0.03	7	0. 09
Salix alba	28	0.03	6	0 . 07
Corylus avellana	21	0. 02	9	0.11

EUROPEAN UNION & ICP	OBSERVED TREES		OBSERVED PLOTS	
	NUMBER	%	NUMBER	%
SPECIES				
Buxus sempervirens	23	0. 02	4	0. 05
Ulmus minor	19	0 . 02	7	0 . 09
Arbutus andrachne	22	0. 02	2	0. 02
Acer opalus	15	0.01	9	0.11
Sorbus domestica	14	0.01	9	0 . 11
Other conifers	18	0 . 02	4	0 . 05
Quercus macrolepsis	21	0 . 02	1	0.01
Pyrus communis	13	0.01	6	0 . 07
Quercus fruticosa	18	0 . 02	1	0 . 01
Phillyrea angustifolia	17	0 . 02	1	0 . 01
Fagus orientalis	11	0.01	1	0.01
Pinus leucodermis	11	0 . 01	1	0.01
Tsuga sp.	11	0 . 01	1	0 . 01
Pistacia terebinthus	10	0.01	1	0.01
Cercis siliquastrum	8	0 . 01	1	0 . 01
Ilex aquifolium	6	0 . 01	3	0 . 04
Prunus padus	6	0.01	3	0. 04
Prunus dulcis	8	0 . 01	1	0 . 01
Ainus viridis	7	0 . 01	1	0 . 01
Juglans regia	5	0 . 00	3	0 . 04
Thuya sp.	5	0 . 00	2	0. 02
Ulmus laevis	5	0 . 00	2	0 . 02
Salix eleagnos	5	0 . 00	1	0 . 01
Cedrus deodara	3	0 . 00	2	0 . 02
Cedrus atlantica	3	0 . 00	2	0. 02
Juniperus sabina	4	0 . 00	1	0 . 01

EUROPEAN UNION & ICP	OBSERVED TREES		OBSERVED PLOTS	
	NUMBER	%	NUMBER	%
SPECIES				
Juglans nigra	2	0.00	2	0. 02
Abies grandis	3	0. 00	1	0.01
Prunus serótina	2	0 . 00	1	0.01
Pistacia lentiscus	2	0. 00	1	0.01
Abies pinsapo	1	0.00	1	0.01
Malus domestica	1	0.00	1	0.01
Ceratonia siligua	1	0.00	1	0.01
Taxus baccata	1	0. 00	1	0 . 01
TOTAL SPECIES	102800	100.00	8084	100.00

Annex 1-3

Defoliation by species group and climatic region (1993)

TOTAL CLIMATIC REGIONS	DEFOLIATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	65.3	18.6	12.4	2.9	0.9
Eucalyptus sp.	76.6	16.3	3.4	0.4	3.3
Fagus sp.	49.6	33.0	16.2	1.1	0.2
Quercus (deciduous) sp.	40.5	32.5	23.6	2.6	0.9
Quercus ilex	40.5	52.4	6.5	0.4	0.2
Quercus suber	47.5	41.8	9.7	0.6	0.4
Other broadleaves	46.7	30.6	18.0	3.5	1.2
TOTAL BROADLEAVES	46.7	32.9	17.4	2.2	0.8
Abies sp.	37.8	25.5	31.9	3.4	1.4
Larix sp.	57.6	25.5	15.2	1.1	0.7
Picea sp.	39.9	33.5	23.4	2.3	0.8
Pinus sp.	42.1	36.2	19.8	1.2	0.6
Other conifers	54.1	31.8	12.2	2.0	-
TOTAL CONIFERS	41.5	34.6	21.5	1.7	0.7
EU & ICP	43.5	33.9	19.9	1.9	0.8

BOREAL	DEFOLIATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Other broadleaves	54.1	31.3	11.6	2.9	0.1
TOTAL BROADLEAVES	54.1	31.3	11.6	2.9	0.1
Picea sp.	44.7	34.0	18.5	2.6	0.1
Pinus sp.	63.4	30.8	5.4	0.3	0.0
TOTAL CONIFERS	54.9	32.3	11.3	1.4	0.1
EU & ICP	54.9	32.2	11.4	1.5	0.1

BOREAL (TEMPERATE)	DEFOLIATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Quercus (deciduous) sp.	5.3	84.2	10.5	-	-
Other broadleaves	40.3	42.4	15.7	0.8	0.8
TOTAL BROADLEAVES	39.4	43.5	15.5	0.8	0.8
Picea sp.	49.4	34.6	14.6	0.8	0.6
Pinus sp.	39.4	44.3	15.5	0.7	0.1
TOTAL CONIFERS	44.7	39.1	15.0	0.8	0.4
EU & ICP	44.3	39.5	15.1	0.8	0.4

ATLANTIC (NORTH)	DEFOLIATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	92.9	5.1	1.0	1.0	-
Fagus sp.	40.2	41.1	17.4	1.3	-
Quercus (deciduous) sp.	42.4	40.5	16.2	0.8	0.1
Other broadleaves	72.7	23.1	3.1	0.4	0.7
TOTAL BROADLEAVES	50.2	35.6	13.2	0.9	0.2
Abies sp.	12.9	41.9	41.9	3.2	-
Larix sp.	61.7	29.8	8.5	-	-
Picea sp.	41.2	33.6	21.9	2.6	0.7
Pinus sp.	44.6	39.6	14.2	1.1	0.5
Other conifers	21.8	28.7	46.0	3.4	-
TOTAL CONIFERS	42.1	36.0	19.4	2.0	0.6
EU & ICP	45.8	35.8	16.6	1.5	0.4

ATLANTIC (SOUTH)	DEFOLIATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	83.8	8.3	5.8	1.8	0.3
Eucalyptus sp.	56.8	22.2	5.1	0.6	15.3
Fagus sp.	78.1	18.0	3.2	0.7	-
Quercus (deciduous) sp.	67.6	24.4	6.9	1.1	0.1
Quercus ilex	72.3	26.2	1.5	-	-
Quercus suber	100.0	-	-	-	-
Other broadleaves	73.8	11.3	8.9	3.3	2.8
TOTAL BROADLEAVES	71.1	19.2	6.7	1.6	1.4
Abies sp.	100.0	-	-	-	-
Larix sp.	89.3	10.7	-	-	-
Picea sp.	98.3	1.7	-	-	-
Pinus sp.	78.5	13.8	6.6	0.4	0.6
Other conifers	96.5	3.5	-	-	-
TOTAL CONIFERS	80.3	12.8	5.9	0.4	0.5
EU & ICP	74.5	16.9	6.4	1.1	1.1

SUB-ATLANTIC	DEFOLIATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	86.4	9.1	4.5	–	–
Fagus sp.	28.0	43.7	26.4	1.6	0.3
Quercus (deciduous) sp.	20.2	36.3	38.3	4.2	1.0
Other broadleaves	30.7	34.1	29.0	5.2	1.0
TOTAL BROADLEAVES	26.4	38.2	31.1	3.6	0.7
Abies sp.	28.2	21.4	44.5	5.0	0.9
Larix sp.	24.8	39.8	32.0	2.8	0.6
Picea sp.	23.3	35.8	36.7	2.7	1.6
Pinus sp.	14.8	43.3	39.2	2.2	0.5
Other conifers	69.5	27.0	3.0	0.4	-
TOTAL CONIFERS	19.3	39.4	37.9	2.5	0.9
EU & ICP	21.4	39.1	35.9	2.8	0.8

CONTINENTAL	DEFOLIATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Fagus sp.	57.4	27 . 5	13.8	1.3	
Quercus (deciduous) sp.	35.8	25.6	34.3	3 . 3	1.0
Quercus suber	-	68 . 2	31.8	-	-
Other broadleaves	45.0	23 . 0	26.1	4 . 3	1.5
TOTAL BROADLEAVES	45.0	25.4	25.5	3 . 2	0.9
Abies sp.	20.8	18 . 9	54.7	5.7	-
Picea sp.	57 . 4	25.1	16.0	1.4	-
Pinus sp.	64 . 5	14 . 5	15.9	2 . 3	2.7
Other conifers	75.0	25.0	-	-	-
TOTAL CONIFERS	56. 9	20.9	19. 1	2 . 1	1.0
EU & ICP	47 . 2	24 . 6	24 . 3	3 . 0	0.9

MOUNTAIN	DEFOLIATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	54.0	26.5	12.2	3.7	3.7
Fagus sp.	59.4	27 . 7	12 . 1	0.7	0.1
Quercus (deciduous) sp.	33.0	34 . 8	28.3	3 . 1	0.8
Quercus ilex	33.8	49.0	16.6	0.7	-
Other broadleaves	44 . 7	31.8	18 . 6	4 . 1	0 . 8
TOTAL BROADLEAVES	47.9	31.1	17.9	2.5	0.6
Abies sp.	46.6	24 . 8	25.3	2 . 1	1.2
Larix sp.	70.0	19 . 7	9.5	-	0.8
Picea sp.	49.0	29 . 7	17 . 9	2 . 8	0.7
Pinus sp.	46.7	35. 3	16. 1	1.1	0.8
Other conifers	43 . 3	42 . 1	11.7	2.9	-
TOTAL CONIFERS	48 . 8	30.8	17 . 6	2 . 1	0.7
EU & ICP	48 . 4	30.9	17 . 7	2 . 3	0.7

MEDITERRANEAN (HIGHER)	DEFOLIATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	43.9	23.9	26.6	4.5	1.1
Fagus sp.	64.3	28.4	6.2	0.5	0.6
Quercus (deciduous) sp.	46.0	32.0	17.9	2.7	1.4
Quercus ilex	37.7	54.0	7.8	0.2	0.2
Quercus suber	98.4	-	-	1.6	-
Other broadleaves	45.5	29.2	15.5	6.3	3.5
TOTAL BROADLEAVES	48.1	33.8	14.1	2.7	1.4
Abies sp.	34.1	29.7	30.0	5.5	0.7
Larix sp.	69.0	26.0	5.0		-
Picea sp.	40.7	42.6	13.0	-	3.7
Pinus sp.	53.2	32.7	12.6	1.1	0.4
Other conifers	36.7	41.5	18.4	3.4	-
TOTAL CONIFERS	50.8	33.1	14.0	1.5	0.5
EU & ICP	49.2	33.5	14.1	2.2	1.0

MEDITERRANEAN (LOWER)	DEFOLIATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	64.1	25.3	7.9	2.6	-
Eucalyptus sp.	80.3	15.2	3.0	0.4	1.1
Fagus sp.	74.2	16.9	8.5	0.4	-
Quercus (deciduous) sp.	45.8	31.8	19.2	1.6	1.6
Quercus ilex	41.3	52.8	5.2	0.5	0.2
Quercus suber	45.9	43.3	9.8	0.6	0.4
Other broadleaves	53.0	34.2	11.0	1.2	0.6
TOTAL BROADLEAVES	53.4	35.5	9.6	0.9	0.6
Abies sp.	41.1	37.9	14.7	0.5	5.8
Larix sp.	84.8	8.3	3.8	1.5	1.5
Picea sp.	67.6	18.5	13.0	0.9	
Pinus sp.	57.2	30.3	9.1	0.9	2.5
Other conifers	63.0	33.3	1.9	1.9	-
TOTAL CONIFERS	57.7	29.7	9.2	0.9	2.5
EU & ICP	54.8	33.6	9.4	0.9	1.2

Annex 1-4
Discolouration by species group and climatic region (1993)

TOTAL CLIMATIC REGIONS	DISCOLOURATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	75.7	18 . 7	3 . 5	1.2	0.9
Eucalyptus sp.	91.2	5.5		-	3 . 3
Fagus sp.	89 . 9	7.5	2.2	0.2	0.2
Quercus (deciduous) sp.	83.7	11.4	3 . 2	0.8	0.9
Quercus ilex	94 . 5	4 . 6	0.3	0.4	0.2
Quercus suber	93 . 1	4 . 9	1.6	-	0 . 4
Other broadleaves	86.6	9.3	2 . 3	0.6	1.2
TOTAL BROADLEAVES	87 .1	9.2	2 . 3	0.5	0.8
Abies sp.	82.4	13 . 1	2.9	0.1	1.5
Larix sp.	90.3	6.7	1.9	0.2	0.9
Picea sp.	93 . 8	3 . 8	1.2	0.2	1.0
Pinus sp.	91.7	6.3	1. 1	0.1	0.8
Other conifers	86.6	11.3	2 . 1	-	-
TOTAL CONIFERS	92.0	5.7	1.2	0.2	0.9
EU & ICP	90 . 0	7.2	1.7	0.3	0.8

BOREAL	DISCOLOURATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Other broadleaves	98.4	1.0	0.1	0.4	0.1
TOTAL BROADLEAVES	98.4	1.0	0.1	0.4	0.1
Picea sp.	95. 6	3.3	0.9	0.2	0.1
Pinus sp.	98.2	1.3	0.4	-	0.0
TOTAL CONIFERS	96. 4	2.7	0.7	0.1	0.1
EU & ICP	96.6	2 . 5	0.6	0.1	0.1

BOREAL (TEMPERATE)	DISCOLOURATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Quercus (deciduous) sp.	100.0	-	-	-	-
Other broadleaves	98.7	0.3	0.1	-	0.8
TOTAL BROADLEAVES	98 . 8	0.3	0.1	-	0 . 8
Picea sp.	97 . 6	1.3	0.4	0.1	0.6
Pinus sp.	98.8	0 . 6	0.4	0.0	0.3
TOTAL CONIFERS	98 . 0	1.0	0.4	0.1	0.5
EU & ICP	98.1	0.9	0.4	0.1	0.5

ATLANTIC (NORTH)	DISCOLOURATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	75.8	21.2	1.0	2 . 0	—
Fagus sp.	79.3	12.1	8.3	0.3	-
Quercus (deciduous) sp.	86.4	11.8	1.7	-	0.1
Other broadleaves	89.7	8.3	1.3	-	0.7
TOTAL BROADLEAVES	84.5	11.5	3.7	0 . 2	0.2
Abies sp.	96.8	3 . 2	-	-	-
Larix sp.	87.2	6.4	6.4	-	-
Picea sp.	86.0	9 . 6	3 . 5	0.2	0.7
Pinus sp.	84 . 7	11.8	2 . 9	0.1	0.5
Other conifers	97.7	2 . 3	-	-	-
TOTAL CONIFERS	86.0	10. 2	3 . 2	0.1	0 . 6
EU & ICP	85.3	10.8	3.4	0.1	0.4

ATLANTIC (SOUTH)	DISCOLOURATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	71.2	24.2	4.0	–	0.5
Eucalyptus sp.	84.7	-	-	-	15.3
Fagus sp.	96.8	2.2	1.1	-	-
Quercus (deciduous) sp.	85.7	11.8	2.0	0.4	0.1
Quercus ilex	100.0	-	-	-	-
Quercus suber	100.0	-	-	-	-
Other broadleaves	81.9	12.5	2.1	0.8	2.8
TOTAL BROADLEAVES	84.4	11.7	2.0	0.4	1.5
Abies sp.	100.0	-	-	-	-
Larix sp.	89.3	10.7	-	-	-
Picea sp.	100.0	-	-	-	-
Pinus sp.	86.0	12.3	1.1	-	0.6
Other conifers	77.0	22.1	0.9	-	-
TOTAL CONIFERS	86.0	12.4	1.0	-	0.5
EU & ICP	85.0	12.0	1.7	0.3	1.1

SUB-ATLANTIC	DISCOLOURATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	95.5	4.5	-	–	–
Fagus sp.	89.7	6.9	2.7	0.3	0.3
Quercus (deciduous) sp.	88.8	6.7	2.7	0.5	1.3
Other broadleaves	80.5	13.6	3.9	0.9	1.1
TOTAL BROADLEAVES	86.6	8.9	3.0	0.6	0.9
Abies sp.	82.1	14.9	1.8	-	1.1
Larix sp.	87.7	8.5	2.4	-	1.4
Picea sp.	91.9	4.2	0.8	0.5	2.7
Pinus sp.	95.7	3.1	0.6	0.1	0.5
Other conifers	91.8	6.0	2.1	-	-
TOTAL CONIFERS	94.0	4.0	0.7	0.2	1.1
EU & ICP	91.6	5.6	1.5	0.3	1.0

CONTINENTAL	DISCOLOURATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Fagus sp.	92.1	6.9	0.7	0.4	–
Quercus (deciduous) sp.	80.5	13.7	4.2	0.5	1.0
Quercus suber	-	4.5	95.5	-	-
Other broadleaves	79.5	13.9	4.8	0.3	1.5
TOTAL BROADLEAVES	82.5	11.9	4.2	0.4	0.9
Abies sp.	66.0	26.4	7.5	-	-
Picea sp.	96.3	3.1	0.6	-	-
Pinus sp.	83.2	13.6	-	0.5	2.7
Other conifers	100.0	-	-	-	-
TOTAL CONIFERS	89.2	8.8	1.0	0.2	1.0
EU & ICP	83.7	11.3	3.6	0.4	0.9

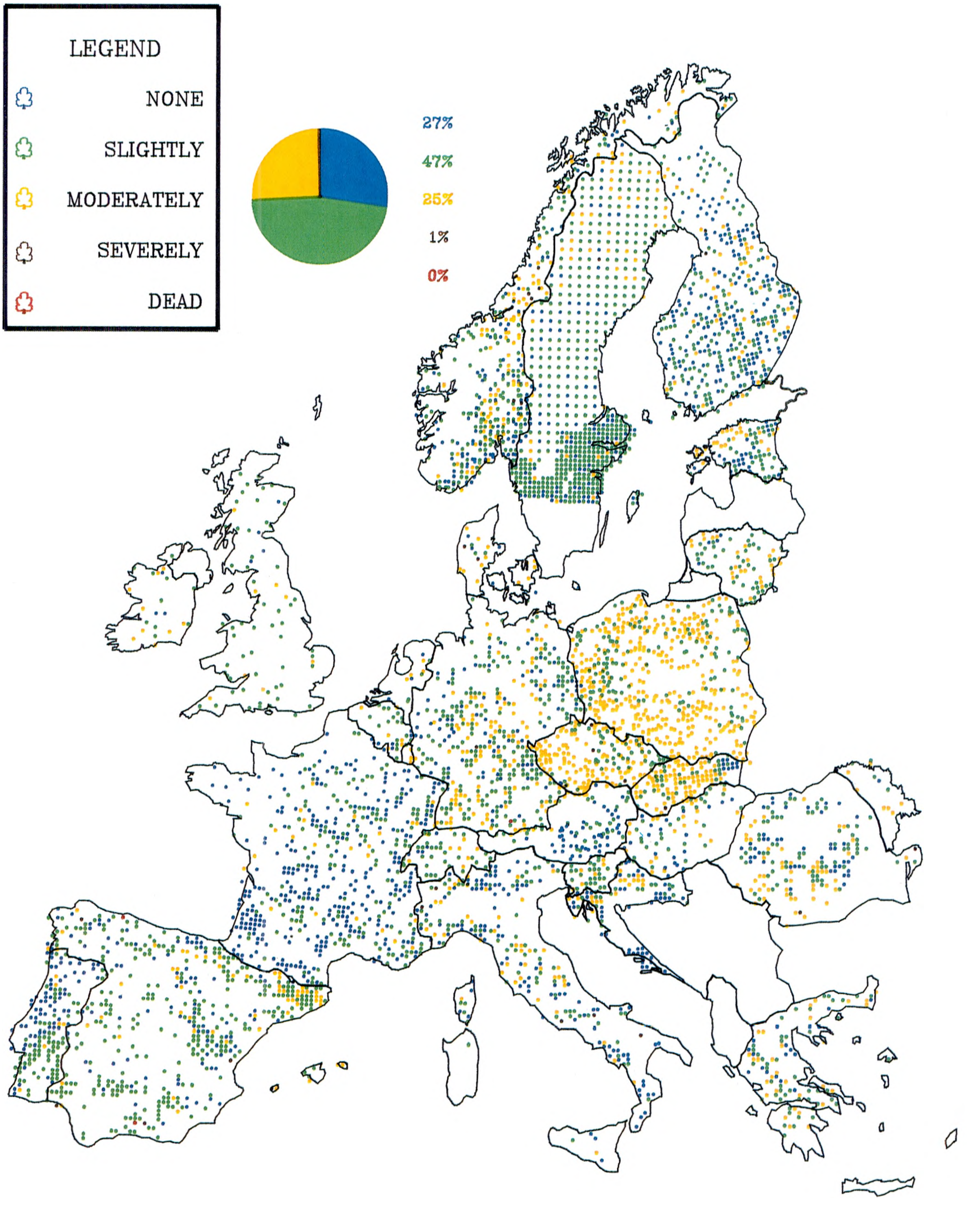
MOUNTAIN	DISCOLOURATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	67.2	21.2	5.3	2.6	3.7
Fagus sp.	93.0	6.3	0.5	0.1	0.1
Quercus (deciduous) sp.	88.3	8.9	1.7	0.3	0.8
Quercus ilex	80.1	17.9	2.0	-	-
Other broadleaves	89.1	7.7	1.9	0.5	0.8
TOTAL BROADLEAVES	89.6	8.0	1.4	0.4	0.6
Abies sp.	89.0	7.9	1.7	0.2	1.2
Larix sp.	89.5	8.2	1.6	-	0.8
Picea sp.	92.9	4.5	1.7	0.3	0.7
Pinus sp.	86.4	10.8	1.8	0.3	0.8
Other conifers	83.3	11.7	5.0	-	-
TOTAL CONIFERS	90.2	7.0	1.8	0.3	0.7
EU & ICP	89.9	7.4	1.6	0.3	0.7

MEDITERRANEAN (HIGHER)	DISCOLOURATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	71.8	20.3	5.0	1.8	1.1
Fagus sp.	88 . 8	9 . 3	1.2	0 . 1	0.6
Quercus (deciduous) sp.	80 . 5	12 . 8	3.8	1.6	1.4
Quercus ilex	91.6	6.6	0.3	1. 2	0.2
Quercus suber	67.2	31.1	1.6	-	-
Other broadleaves	79 . 0	12.5	2.7	2 . 3	3.5
TOTAL BROADLEAVES	82 . 8	11.8	2.6	1.4	1.4
Abies sp.	64 . 1	25 . 6	9.2	0.4	0.7
Larix sp.	99 . 0	-	-	1.0	-
Picea sp.	91.7	4 . 6	-	-	3.7
Pinus sp.	86.5	10. 2	2 . 2	0 . 6	0.4
Other conifers	81.6	17.4	1.0	-	-
TOTAL CONIFERS	85.0	11.4	2 . 5	0.6	0.5
EU & ICP	83.7	11. 6	2.6	1.1	1.0

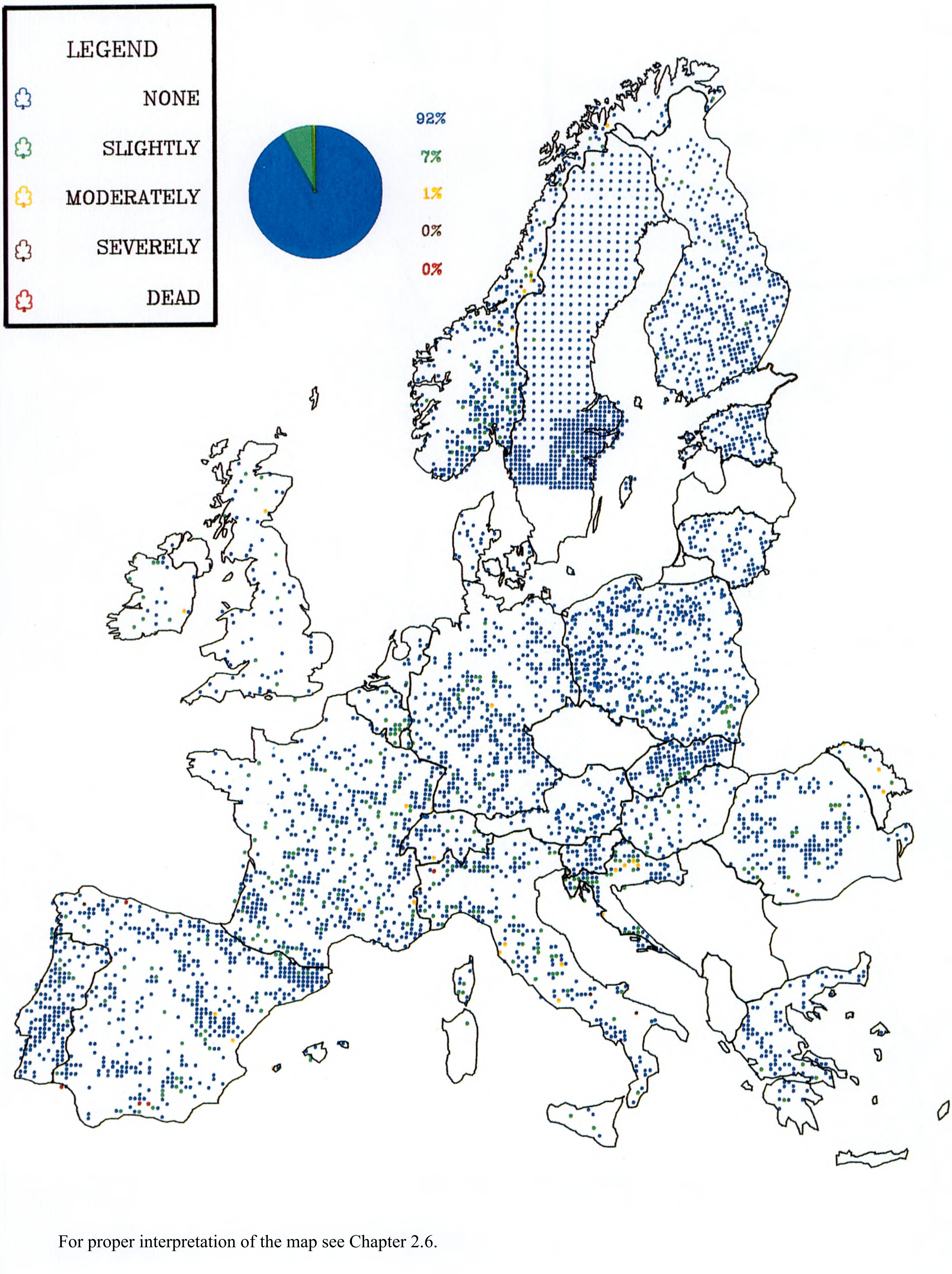
MEDITERRANEAN (LOWER)	DISCOLOURATION				
	NONE	SLIGHT	MODERATE	SEVERE	DEAD
	%	%	%	%	%
SPECIES					
Castanea sativa	90.1	8.2	1.0	0.7	-
Eucalyptus sp.	92 . 4	6.5	-	-	1.1
Fagus sp.	87.2	9 . 2	3.4	0.1	0.1
Quercus (deciduous) sp.	70.2	18 . 8	7 . 8	1.7	1.6
Quercus ilex	96.9	2 . 6	0.2	0.1	0.2
Quercus suber	95.6	3.8	0.2	-	0 . 4
Other broadleaves	90.0	8.1	1.3	0 . 1	0.6
TOTAL BROADLEAVES	89.5	7.7	1.9	0.3	0.6
Abies sp.	78 . 9	12 . 6	2 . 6	-	5.8
Larix sp.	91.7	3 . 8	2 . 3	0.8	1.5
Picea sp.	76.9	11.1	12 . 0	-	-
Pinus sp.	84 .8	11. 1	1.5	0.1	2 . 5
Other conifers	98 . 1	1.9	-	-	-
TOTAL CONIFERS	84 . 7	10. 8	1.8	0. 1	2 . 5
EU & ICP	87.9	8.7	1.9	0.2	1.2

Annex 1-5

Plot defoliation (1993)

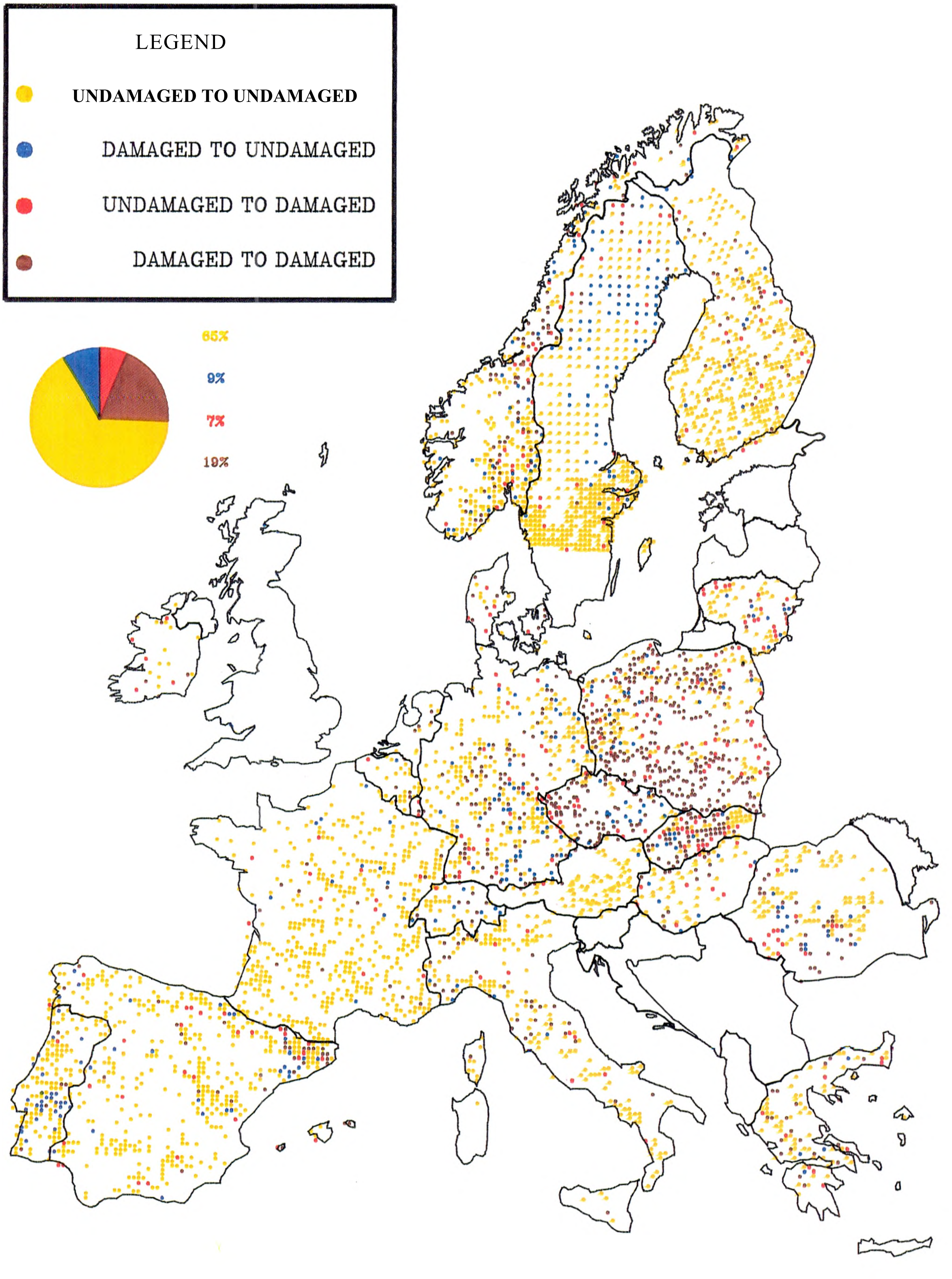


Annex 1-6
Plot discolouration (1993)



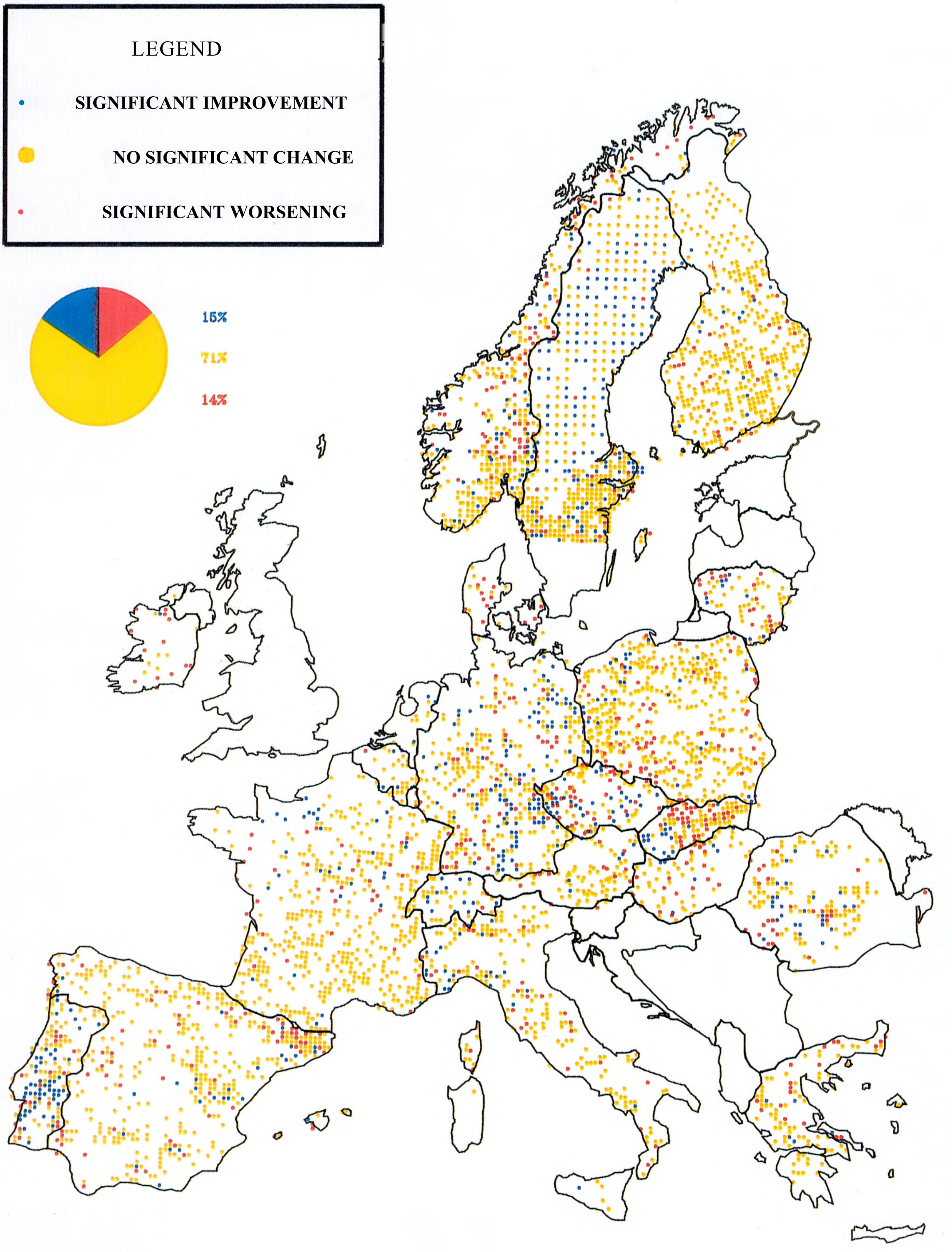
For proper interpretation of the map see Chapter 2.6.

Annex 1-7
Changes in plot defoliation classes (1992-1993)



Annex 1-8

Changes in plot defoliation (1992-1993)



Annex 1-9

Defoliation of most common species (1988-1993)

Survey year / Climatic region

ATLANTIC (NORTH)

Species/class	'88	'89	'90	'91	'92	'93
Picea abies						
0-10%	60.9	58.3	56.3	57.0	52.0	48.2
11-25%	24.0	24.6	26.8	22.6	29.6	22.4
> 25%	15.1	17.1	16.9	20.4	18.4	29.4
Pinus sylvestris						
0-10%	66.8	55.9	48.3	49.9	53 .4	49.5
11-25%	27.3	35.5	44.0	38.4	33.9	39.7
> 25%	5.9	8.6	7.7	11.7	12.7	10.8
Fagus sylvatica						
0-10%	41.8	27.2	17.7	27.8	24.2	25.4
11-25%	43.8	46.3	46.3	47.3	47.3	46.1
> 25%	14.4	26.5	36.0	24.9	28.5	28.5
Pinus pinaster						
0-10%						
11-25%						
> 25%						
Quercus ilex						
0-10%						
11-25%						
> 25%						
Pinus halepensis						
0-10%						
11-25%						
> 25%						
Quercus robur						
0-10%	36.9	44.7	56.6	41.8	24.8	23.9
11-25%	40.9	45.2	29.2	41.8	54.8	40.6
> 25%	22.2	10.1	14.2	16.4	20.4	35.5
Quercus suber						
0-10%						
11-25%						
> 25%						
Pinus nigra						
0-10%						
11-25%						
> 25%						
Quercus petraea						
0-10%						
11-25%						
> 25%						
Picea sitchensis						
0-10%	68.8	41.1	66.2	49.2	48.5	34.6
11-25%	26.6	37.7	28.8	30.8	31.5	31.2
> 25%	4.6	21.2	5.0	20.0	20.0	34.2
Abies alba						
0-10%						
11-25%						
> 25%						

ATLANTIC (SOUTH)

Species/class	'88	'89	'90	'91	'92	'93
Picea abies						
0-10%						
11-25%						
> 25%						
Pinus sylvestris						
0-10%	87.9	81.5	85.2	81 .5	81.5	82.4
11-25%	9.3	13.9	11.1	13.9	13.9	9.3
> 25%	2.8	4.6	3.7	4.6	4.6	8.3
Fagus sylvatica						
0-10%	95.7	97.5	83.2	75.8	68.4	72.1
11-25%	4.3	2.5	10.6	17.4	24.8	21.7
> 25%	0.0	0.0	6.2	6.8	6.8	6.2
Pinus pinaster						
0-10%	80.9	76.7	50.4	45.6	59.3	59.9
11-25%	17.2	14.2	15.9	27.5	27.8	28.5
> 25%	1.9	9.1	33.7	26.9	12.9	11.7
Quercus ilex						
0-10%						
11-25%						
> 25%						
Pinus halepensis						
0-10%						
11-25%						
> 25%						
Quercus robur						
0-10%	71.0	75.3	72.9	71.0	65.9	66.8
11-25%	20.6	14.0	15.9	13.1	21.5	22.0
> 25%	8.4	10.7	11.2	15.9	12.6	11.2
Quercus suber						
0-10%						
11-25%						
> 25%						
Pinus nigra						
0-10%						
11-25%						
> 25%						
Quercus petraea						
0-10%						
11-25%						
> 25%						
Picea sitchensis						
0-10%						
11-25%						
> 25%						
Abies alba						
0-10%						
11-25%						
> 25%						

SUB-ATLANTIC

Species/class	'88	'89	'90	'91	'92	'93
Picea abies						
0-10%	47.2	45.4	42.9	40.1	34.9	40.8
11-25%	36.6	37.6	38.7	35.1	40.6	35.7
> 25%	16.2	17.0	18.4	24.8	24.5	23.5
Pinus sylvestris						
0-10%	41.7	37.4	38.1	23.4	25.4	34.2
11-25%	45.3	47.4	42.6	51.0	54.4	45.5
> 25%	13.0	15.2	19.3	25.6	20.2	20.3
Fagus sylvatica						
0-10%	44.7	48.9	43.4	36.3	28.8	36.6
11-25%	39.0	38.7	39.2	40.1	39.3	39.3
> 25%	16.3	12.4	17.4	23.6	31.9	24.1
Pinus pinaster						
0-10%						
11-25%						
> 25%						
Quercus ilex						
0-10%						
11-25%						
> 25%						
Pinus halepensis						
0-10%						
11-25%						
> 25%						
Quercus robur						
0-10%	73.9	66.4	64.7	56.4	45.9	39.9
11-25%	19.8	27.7	25.1	28.4	35.3	31.7
> 25%	6.3	5.9	10.2	15.2	18.8	28.4
Quercus suber						
0-10%						
11-25%						
> 25%						
Pinus nigra						
0-10%						
11-25%						
> 25%						
Quercus petraea						
0-10%	58.7	54.2	57.2	49.9	49.4	43.0
11-25%	27.3	32.5	32.1	30.9	32.3	32.3
> 25%	14.0	13.3	10.7	19.2	18.3	24.7
Picea sitchensis						
0-10%						
11-25%						
> 25%						
Abies alba						
0-10%	55.2	57.0	60.2	58.2	55.2	54.8
11-25%	17.2	19.2	17.6	12.1	20.5	18.0
> 25%	27.6	23.8	22.2	29.7	24.3	27.2

MOUNTAINOUS

Species/class	'88	'89	'90	'91	'92	'93
Picea abies						
0-10%	53.1	50.0	49.2	49.3	40.9	46.5
11-25%	33.7	31.1	32.6	30.3	33.8	35.3
> 25%	13.2	18.9	18.2	20.4	25.3	18.2
Pinus sylvestris						
0-10%	63.4	68.9	68.1	53.3	47.9	44.5
11-25%	30.2	26.5	25.0	32.3	35.5	37.0
> 25%	6.4	4.6	6.9	14.4	16.6	18.5
Fagus sylvatica						
0-10%	69.8	70.1	67.0	68.8	59.7	57.8
11-25%	21.2	22.8	24.6	25.5	27.7	32.4
> 25%	9.0	7.1	8.4	5.7	12.6	9.8
Pinus pinaster						
0-10%						
11-25%						
> 25%						
Quercus ilex						
0-10%	77.6	86.9	27.1	50.5	29.0	21.5
11-25%	19.6	10.3	48.6	40.2	40.2	60.7
> 25%	2.8	2.8	24.3	9.3	30.8	17.8
Pinus halepensis						
0-10%						
11-25%						
> 25%						
Quercus robur						
0-10%						
11-25%						
> 25%						
Quercus suber						
0-10%						
11-25%						
> 25%						
Pinus nigra						
0-10%	60.0	67.4	72.1	61.4	46 8	48.9
11-25%	34.8	30.5	24.0	23.6	33.0	40.8
> 25%	5.2	2.1	3.9	15.0	20.2	10.3
Quercus petraea						
0-10%	35.8	47.5	50.4	50.4	40.9	32.8
11-25%	38.7	27.7	34.3	25.5	39.4	28.5
> 25%	25.5	24.8	15.3	24.1	19.7	38.7
Picea sitchensis						
0-10%						
11-25%						
> 25%						
Abies alba						
0-10%	49.2	50.9	50.2	50.5	43 .1	40.5
11-25%	23.9	26.2	25.2	27.9	32.6	246
> 25%	26.9	22.9	24.6	21.6	24.3	34.9

Species/class	Survey year / Climatic region																	
	'88	'89	'90	'91	'92	'93	'88	'89	'90	'91	'92	'93	'88	'89	'90	'91	'92	'93
Picea abies	MEDITERR. (LOWER)						MEDITERR. (HIGHER)						ALL TREES					
0-10%													51.8	50.2	48.0	46.8	40.6	44.9
11-25%													33.7	32.5	34.1	31.0	35.9	33.2
> 25%													14.5	17.3	17.9	22.2	23.5	21.9
Pinus sylvestris	MEDITERR. (LOWER)						MEDITERR. (HIGHER)						ALL TREES					
0-10%	94.0	94.8	79.5	78.6	54.7	59.8	75.4	83.0	81.5	77.3	65.0	59.8	61.1	60.4	58.5	49.5	46.2	46.9
11-25%	5.1	4.3	17.1	17.1	39.3	29.9	16.9	11.5	12.3	16.2	21.6	22.7	30.5	30.8	30.8	35.2	38.1	36.2
> 25%	0.9	0.9	3.4	4.3	6.0	10.3	7.7	5.5	6.2	6.5	13.4	17.5	8.4	8.8	10.7	15.3	15.7	16.9
Fagus sylvatica	MEDITERR. (LOWER)						MEDITERR. (HIGHER)						ALL TREES					
0-10%	96.6	95.0	80.9	80.4	82.4	78.4	84.1	68.2	74.8	62.5	58.6	53.2	65.0	61.3	55.7	52.8	47.2	48.8
11-25%	3.4	3.6	10.4	11.8	9.2	12.6	10.0	25.4	19.8	29.3	28.0	35.5	25.0	28.3	29.4	31.9	32.0	33.9
> 25%	0.0	1.4	8.7	7.8	8.4	9.0	5.9	6.4	5.4	8.2	13.4	11.3	10.0	10.4	14.9	15.3	20.8	17.3
Pinus pinaster	MEDITERR. (LOWER)						MEDITERR. (HIGHER)						ALL TREES					
0-10%	82.0	82.7	73.1	65.4	65.1	67.2	87.7	84.1	78.2	78.5	79.2	73.2	83.2	81.9	70.2	64.2	66.2	66.7
11-25%	10.9	11.5	19.8	26.8	26.6	23.3	9.5	12.0	16.9	17.6	16.2	20.1	11.4	12.0	18.5	25.3	24.6	23.5
> 25%	7.1	5.8	7.1	7.8	8.3	9.5	2.8	3.9	4.9	3.9	4.6	6.7	5.4	6.1	11.3	10.5	9.2	9.8
Quercus ilex	MEDITERR. (LOWER)						MEDITERR. (HIGHER)						ALL TREES					
0-10%	61.6	67.1	77.7	57.3	44.5	39.4	62.6	80.5	83.2	61.0	49.6	37.0	62.5	72.5	76.6	58.0	45.2	37.7
11-25%	33.9	29.7	19.9	38.7	50.7	55.1	28.3	16.9	16.0	35.7	39.7	53.6	31.5	24.5	20.3	37.9	46.7	55.0
> 25%	4.5	3.2	2.4	4.0	4.8	5.5	9.1	2.6	0.8	3.3	10.7	9.4	6.0	3.0	3.1	4.1	8.1	7.3
Pinus halepensis	MEDITERR. (LOWER)						MEDITERR. (HIGHER)						ALL TREES					
0-10%	64.2	77.8	73.2	69.6	51.4	50.1	72.4	73.4	72.2	74.3	45.9	46.7	66.7	76.7	73.0	70.8	49.6	49.0
11-25%	30.0	19.2	22.6	27.4	38.9	38.3	24.0	22.7	26.8	24.7	46.1	45.6	28.2	20.1	23.6	26.7	41.0	40.3
> 25%	5.8	3.0	4.2	3.0	9.7	11.6	3.6	3.9	1.0	1.0	8.0	7.7	5.1	3.2	3.4	2.5	9.4	10.7
Quercus robur	MEDITERR. (LOWER)						MEDITERR. (HIGHER)						ALL TREES					
0-10%													58.0	58.6	59.0	52.1	44.2	38.5
11-25%													29.1	30.7	26.6	30.5	37.4	34.7
> 25%													12.9	10.7	14.4	17.4	18.4	26.8
Quercus suber	MEDITERR. (LOWER)						MEDITERR. (HIGHER)						ALL TREES					
0-10%	91.9	63.7	37.2	25.3	26.0	47.1							92.1	62.3	36.8	25.4	25.9	48.5
11-25%	7.4	28.8	20.2	31.0	38.4	43.2							7.2	28.1	19.8	30.6	37.9	42.0
> 25%	0.7	7.5	42.6	43.7	35.6	9.7							0.7	9.6	43.4	44.0	36.2	9.5
Pinus nigra	MEDITERR. (LOWER)						MEDITERR. (HIGHER)						ALL TREES					
0-10%	74.2	74.9	43.8	51.7	41.8	51.3	72.1	75.0	67.8	52.0	39.9	40.9	71.6	73.6	64.1	55.3	43.4	46.9
11-25%	20.2	22.1	40.8	32.6	35.2	34.1	24.7	22.6	24.9	32.0	36.8	42.1	24.2	23.9	27.7	29.9	35.2	38.8
> 25%	5.6	3.0	15.4	15.7	22.8	14.6	3.2	2.4	7.3	16.0	23.3	17.0	4.2	2.5	8.2	14.8	214	14.3
Quercus petraea	MEDITERR. (LOWER)						MEDITERR. (HIGHER)						ALL TREES					
0-10%													61.3	57.8	59.8	53.8	48.2	42.9
11-25%													25.5	30.3	30.7	28.7	34.4	32.7
> 25%													13.2	11.9	9.5	17.5	17.4	24.4
Picea sitchensis	MEDITERR. (LOWER)						MEDITERR. (HIGHER)						ALL TREES					
0-10%													68.7	41.5	66.6	49.8	49.0	35.4
11-25%													26.7	37.6	28.5	30.4	31.2	30.8
> 25%													4.6	20.9	4.9	19.8	19.8	33.8
Abies alba	MEDITERR. (LOWER)						MEDITERR.(HIGHER)						ALL TREES					
0-10%													55.3	53.3	54.3	53.8	50.6	46.7
11-25%													19.4	23.5	21.7	20.6	26.9	22.8
> 25%													25.3	23.2	24.0	25.6	22.5	30.5

Annex 1-10

Percentages of defoliation and discolouration by soil unit

Soil unit	Defoliation			Discolouration		Number of trees
	0-10%	>10-25%	>25%	0-10%	>10%	
Eutric Gleysols	60.8	28.8	10.4	100.0	0.0	240
Calcaric Gleysols	66.7	19.4	13.9	100.0	0.0	72
Eutric Regosols	49.0	27.1	23.9	100.0	0.0	96
Dystric Regosols	26.2	51.2	22.6	100.0	0.0	168
Eutric Leptosols	30.0	44.2	25.8	95.0	5.0	260
Dystric Leptosols	60.9	28.3	10.8	94.2	5.8	120
Mollic Leptosols	29.2	62.5	8.3	100.0	0.0	24
Cambic Arenosols	30.4	39.3	30.3	66.1	33.9	168
Luvic Arenosols	40.0	38.3	21.7	77.5	22.5	120
Eutric Cambisols	61.9	28.9	9.2	94.3	5.7	470
Dystric Cambisols	67.1	23.8	9.1	93,7	6,3	584
Humic Cambisols	9.1	43.2	47.7	100.0	0.0	44
Gleyic Cambisols	81.6	16.8	1.6	98.9	1.1	190
Calcic Cambisols	96.7	3.3	0.0	100.0	0.0	30
Haplic Calcisols	36.5	40.1	23.4	97.4	2.6	192
Luvic Calcisols	8.7	34.8	56.5	100.0	0.0	46
Haplic Phaeozcms	8.3	37.5	54.2	100.0	0.0	24
Luvic Phaeozems	59.7	32.0	8.3	98.6	1.4	72
Haplic Luvisols	47.8	38.8	13.4	96.2	3.8	312
Chromic Luvisols	38.8	40.7	20.5	93.2	6.8	649
Gleyic Luvisols	73.3	18.3	8.4	99.6	0.4	251
Eutric Planosols	79.2	20.8	0.0	70.8	29.2	24
Dystric Pod/oluvisols	48.3	50.9	0.8	99.2	0.8	120
Ferrie Podzols	45.8	16.7	37.5	95.8	4.2	24
Gleyic Podzols	34.4	40.4	25.2	99.0	1.0	480
Orthic Podzols	43.0	39.2	17.8	97.0	3.0	594
Leptic Podzols	72.9	22.1	5.0	96.6	3.4	524
Humic Podzols	55.3	33.6	11.1	96.7	3.3	360
Haplic Alisols	21.4	53.1	25.5	97.9	2.1	192
Humic Alisols	12.5	58.3	29.2	100.0	0.0	48
Cumulic Anthrosols	58.3	29.2	12.5	100.0	0.0	24
Calcaric Lithosols	5.7	14.3	80.0	94.3	5.7	35
Orthic Rendzinas	57.1	19.4	23.5	97.4	2.6	506
Eutric Histosols	59.4	25.0	15.6	96.9	3.1	96
Dystric Histosols	68.4	29.2	2.4	97.9	2.1	288
Total	51.2	32.7	16.1	95.7	4.3	7447

Annex II

National surveys

Annex II-1
Forests and surveys in European countries (1993)

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
Austria	8385	3857	2922	935	3857	8.7 x 8.7	218	6551
Belarus	20760	7028	4757	2271	6001	16 x 16	407	9766
Belgium	3057	602	302	300	602	8x8/16x16	104	2453
Bulgaria	11100	3314	1172	2142	3314	16x16/8x8	188	6968
Croatia	5654	2061	321	1740	1175	16 x 16	84	2016
Czech Republic	7886	2630	2051	579	2630	8x8/16x16	184	12659
Denmark	4300	466	308	158	411	7x7/16x16	67	1542
Estonia	4510	1815	1135	680	1135	16 x 16	91	2160
Finland	30464	20059	18484	1575	20059	varying	405	4382
France	54919	14002	5040	8962	13100	16x16/16x1	506	10120
Germany	35562	10189	6946	3243	10189	4x4	3611	85159
Greece a)	13204	2034	954	1080	2034	16 x 16	80	1888
Hungary	9300	1707	267	1440	1684	4x4	1063	22200
Ireland	6889	380	334	46	285	16 x 16	22	462
Italy	30126	8675	1735	6940	7154	16 x 16		
Latvia	6450	2797	1633	1164	2797	8x8	389	9325
Liechtenstein	16	8	6	2	no survey in 1993			
Lithuania	6520	1823	1073	750	1823	8x8	235	5658
Luxembourg	259	84	30	54	88	16x16/4x4	48	1150
Rep. of Moldova	3050	271	6	265	271	2x2	550	18280
Netherlands	4147	311	208	103	250	1 x 1	1251	31275
Norway	30686	13700	7000	6700	13700	9x9/18x18	1003	8527
Poland	31270	8654	6895	1759	8654	16 x 16	1493	29860
Portugal	8800	3372	1340	2032	3060	16 x 16	143	4309
Romania	23750	6244	1929	4315	6244	2x2/2x4	8296	235179
Russian Fed. b)	80330	31592	25518	6074	31592	varying	69	1656
Slovak Republic	4901	1885	816	1069	1185	16 x 16	111	4353
Slovenia	2008	1071	500	571	1071	16 x 16	34	816
Spain	50471	11792	5637	6155	11792	16 x 16	460	11040
Sweden	40800	23500	19729	3771	19900	varying	4420	15657
Switzerland	4129	1186	818	368	1186	8x8	164	1933
Turkey	77945	20199	9426	10773	no survey in 1993			
Ukraine	60370	6151	2931	3220	2021	16 x 16		1968
United Kingdom	24100	2200	1550	650	2200	random	361	8664
Yugoslavia c)	25600	6100	900	5200	no survey in 1993			
TOTAL	731718	221759	134673	87086	181464	varying	26057	557976

Annex II-2

Defoliation of all species by classes and class aggregates (1993)

Participating countries	Area surveyed (1000 ha)	No. of sample trees	0 none	1 slight	2 moderate	3+4 severe and dead	2+3+4
Austria	3857	6551	54.9	36.9	7.5	0.7	8.2
Belarus	6001	9766	22.3	48.4	27.8	1.5	29.3
Belgium	602	2453	46.6	38.6	13.4	1.4	14.8
Bulgaria	3314	6968	45.7	31.1	19.7	3.5	23.2
Croatia	1175	2016	62.0	18.8	16.6	2.6	19.2
Czech Republic	2630	12659	13.0	34.0	47.2	5.8	53.0
Denmark	411	1542	37.3	29.3	25.4	8.0	33.4
Estonia	1135	2160	43.8	35.9	18.8	1.5	20.3
Finland	20059	4382	60.7	24.1	13.9	1.3	15.2
France	13100	10120	74.8	16.9	7.3	1.0	8.3
Germany	10189	85159	35.9	39.9	22.6	1.6	24.2
Greece a)	2034	1888	37.7	41.1	18.0	3.2	21.2
Hungary	1684	22200	45.8	33.2	16.1	4.9	21.0
Ireland	285	462	only conifers assessed				
Italy	7154						
Latvia	2797	9325	22.0	43.0	33.0	2.0	35.0
Liechtenstein			no survey in 1993				
Lithuania	1823	5658	21.2	51.4	23.8	3.6	27.4
Luxembourg	88	1150	42.2	34.0	20.0	3.8	23.8
Rep. of Moldova	271	18280	26.7	22.5	43.2	7.6	50.8
Netherlands	250	31275	52.6	22.4	20.8	4.2	25.0
Norway	13700	8527	39.4	35.7	20.1	4.8	24.9
Poland	8654	29860	6.3	43.7	47.2	2.8	50.0
Portugal	3060	4309	64.5	28.2	6.5	0.8	7.3
Romania	6244	235179	48.2	31.3	17.9	2.6	20.5
Russian Fed. b)	31592	1656	only conifers assessed				
Slovak Republic	1185	4353	19.8	42.6	33.5	4.1	37.6
Slovenia	1071	816	37.0	44.0	2.0	17.0	19.0
Spain	11792	11040	44.8	42.2	10.0	3.0	13.0
Sweden	19900	15657	only conifers assessed				
Switzerland c)	1186	1933	31.3	50.7	16.0	2.0	18.0
Turkey			no survey in 1993				
Ukraine	2021	1968	27.7	50.8	20.6	0.9	21.5
United Kingdom	2200	8664	38.9	44.2	15.9	1.0	16.9
Yugoslavia d)			no survey in 1993				

a) Excluding maquis. b) Only St. Petersburg Region.
c) Weighted according to diameter breast height (dbh).
d) Former Yugoslavia excluding Croatia and Slovenia.

Annex II-3

Defoliation of conifers by classes and class aggregates (1993)

Participating countries	Coniferous forest (1000 ha)	No. of sample trees	0 none	1 slight	2 moderate	3+4 severe and dead	2+3+4
Austria a)	2922	5723	56.5	35.3	7.6	0.6	8.2
Belarus	4757	7185	15.9	50.3	32.4	1.4	33.8
Belgium	302	1205	38.0	43.7	16.2	2.1	18.3
Bulgaria	1172	4492	36.2	36.9	23.1	3.8	26.9
Croatia	321	395	55.0	11.1	28.1	5.8	33.9
Czech Republic	2051	11545	13.1	34.1	47.6	5.2	52.8
Denmark	308	975	42.6	20.4	25.6	11.4	37.0
Estonia	1135	2065	41.3	37.5	19.6	1.6	21.2
Finland	18484	3754	60.7	23.7	14.2	1.4	15.6
France	5040	3488	77.9	13.9	7.6	0.6	8.2
Germany	6946	55950	39.4	39.2	19.8	1.6	21.4
Greece b)	954	1015	44.3	41.8	11.6	2.3	13.9
Hungary	267	3591	50.5	29.4	15.4	4.7	20.1
Ireland	334	462	31.4	39	28.6	1.0	29.6
Italy	1735						
Latvia	1633	6854	17.0	42.0	39.0	2.0	41.0
Liechtenstein	6		no survey in 1993				
Lithuania	1073	3787	15.5	55.3	25.7	3.5	29.2
Luxembourg	30	386	63.0	28.0	7.0	2.0	9.0
Rep. of Moldova	6	104	35.6	19.2	45.2	0.0	45.2
Netherlands	165	20675	53.1	16.3	25.8	4.8	30.6
Norway	7000	6904	44.6	34.5	16.8	4.1	20.9
Poland	6895	25260	5.8	43.4	47.9	2.9	50.8
Portugal	1340	1545	71.9	21.0	6.2	0.9	7.1
Romania	1929	47288	53.0	30.4	15.0	1.6	16.6
Russian Fed. c)	25518	1656	56.6	38.9	3.6	0.9	4.5
Slovak Republic	816	1822	7.8	42.3	46.3	3.6	49.9
Slovenia	500	380	24.0	49.0	23.0	4.0	27.0
Spain	5637	5510	50.0	35.4	11.6	3.0	14.6
Sweden	19729	15657	62.4	27.0	8.9	1.7	10.6
Switzerland d)	818	1212	27.6	51.7	18.4	2.3	20.7
Turkey	9426		no survey in 1993				
Ukraine	2931	1348	25.4	53.3	20.9	0.4	21.3
United Kingdom	1550	5376	40.9	42.3	15.7	1.1	16.8
Yugoslavia e)	900		no survey in 1993				

Annex II-4
Defoliation of broadleaves by classes and class aggregates (1993)

Participating countries	Broadleav. forest (1000 ha)	No. of sample trees	0 none	1 slight	2 moderate	3+4 severe and dead	2+3+4
Austria a)	935	828	44.3	48.0	6.9	0.8	7.7
Belarus	2271	2581	40.2	43.2	14.9	1.7	16.6
Belgium	300	1248	54.7	33.6	10.9	0.8	11.7
Bulgaria	2142	2476	63.0	20.4	13.5	3.1	16.6
Croatia	1740	1621	63.7	20.7	13.8	1.8	15.6
Czech Republic	579	1114	11.5	33.4	43.6	11.5	55.1
Denmark	158	567	28.4	44.6	24.9	2.1	27.0
Estonia	680	95	97.8	1.1	1.1	0.0	1.1
Finland	1575	627	60.6	26.6	11.8	1.0	12.8
France	8962	6632	73.1	18.5	7.2	1.2	8.4
Germany	3243	29209	28.7	41.4	28.1	1.8	29.9
Greece b)	1080	873	30.0	40.2	25.4	4.4	29.8
Hungary	1440	18609	44.9	33.9	16.2	5.0	21.2
Ireland	46		only conifers assessed				
Italy	6940						
Latvia	1164	2471	36.2	46.0	16.8	1.0	17.8
Liechtenstein	2		no survey in 1993				
Lithuania	750	1871	32.9	43.3	20.0	3.8	23.8
Luxembourg	54	764	32.0	37.0	28.0	3.0	31.0
Rep. of Moldova	265	18176	26.6	22.5	43.2	7.7	50.9
Netherlands	85	10600	52.6	34.3	11.2	1.9	13.1
Norway c)	6700	1623	17.1	40.8	34.4	7.7	42.1
Poland	1759	4600	8.8	45.6	43.0	2.6	45.6
Portugal	2032	2764	60.3	32.2	6.7	0.8	7.5
Romania	4315	187891	47.0	31.6	18.6	2.8	21.4
Russian Fed. d)	6074		only conifers assessed				
Slovak Republic	1069	2531	27.7	43.2	24.7	4.4	29.1
Slovenia	571	436	48.0	41.0	9.0	2.0	11.0
Spain	6155	5530	39.7	48.9	8.3	3.1	11.4
Sweden c)	3771		only conifers assessed				
Switzerland e)	368	721	38.5	48.5	11.4	1.6	13.0
Turkey	10773		no survey in 1993				
Ukraine	3220	620	32.8	45.6	19.6	2.0	21.6
United Kingdom	650	3288	35.6	47.3	16.3	0.8	17.1
Yugoslavia f)	5200		no survey in 1993				

Annex II-5

Defoliation of all species (1986-1993)

Participating countries	All species								% change
	Defoliation classes 2-4								
	1986	1987	1988	1989	1990	1991	1992	1993	1992/1993
Austria				10.8	9.1	7.5	6.9	8.2	1.3
Belarus				67.2	54.0		19.2	29.3	10.1
Belgium				14.6	16.2	17.9	16.9	14.8	-2.1
Bulgaria	8.1	3.6	7.4	24.9	29.1	21.8	23.1	23.2	0.1
Croatia							15.6	19.2	3.6
Czech Republic							56.4	53.0	-3.4
Denmark		23.0	18.0	26.0	21.2	29.9	25.9	33.4	7.5
Estonia			only conifers assessed				28.5	20.3	-8.2
Finland		12.1	16.1	18.0	17.3	16.0	14.5	15.2	0.7
France a)	8.3	9.7	6.9	5.6	7.3	7.1	8.0	8.3	0.3
Germany b)	18.9	17.3	14.9	15.9	15.9	25.2	26.0	24.2	-1.8
Greece c)			17.0	12.0	17.5	16.9	18.1	21.2	3.1
Hungary			7.5	12.7	21.7	19.6	21.5	21.0	-0.5
Ireland			only conifers assessed						
Italy						16.4	18.2		
Latvia					36.0		37.0	35.0	-2.0
Liechtenstein	19.0	19.0	17.0	11.8			16.0		
Lithuania			3.0	21.5	20.4	23.9	17.5	27.4	9.9
Luxembourg	5.1	7.9	10.3	12.3		20.8	20.4	23.8	3.4
Rep. of Moldova								50.8	
Netherlands	23.3	21.4	18.3	16.1	17.8	17.2	33.4	25.0	-8.4
Norway	only conifers assessed				18.2	19.7	26.2	24.9	-1.3
Poland			20.4	31.9	38.4	45.0	48.8	50.0	1.2
Portugal			1.3	9.1	30.7	29.6	22.5	7.3	-15.2
Romania						9.7	16.7	20.5	3.8
Russian Fed.			only conifers assessed						
Slovak Republic			38.8	49.2	41.5	28.5	36.0	37.6	1.6
Slovenia				22.6	18.2	15.9		19.0	
Spain			4.5	4.2	4.8	7.4	12.3	13.0	0.7
Sweden			only conifers assessed						
Switzerland	12.0	15.0	12.0	14.0	17.0	21.0	16.0	18.0	2.0
Turkey									
Ukraine						6.4	16.3	21.5	5.2
United Kingdom d)		22.0	25.0	28.0	39.0	56.7	58.3	16.9	-41.4
Yugoslavia e)						9.8			

a) 16x16 km network after 1988. b) For 1986-1990, only data for former Federal Republic of Germany.
c) Excluding maquis.
d) The difference between 1992 and 1993 is mainly due to a change of assessment method in line with that used in other States. Based on the previous standard the change was - 4,3%.
e) Former Yugoslavia; Croatia and Slovenia excluded from 1991 results.

Annex II-6
Defoliation of conifers (1986-1993)

Participating countries	Conifers								
	Defoliation classes 2-4								% change
	1986	1987	1988	1989	1990	1991	1992	1993	1992/1993
Austria				10.1	8.3	7.0	6.6	8.2	1.6
Belarus				76.0	57.0		33.7	33.8	0.1
Belgium				20.4	23.6	23.4	23.0	18.3	-4.7
Bulgaria	4.7	3.8	7.6	32.9	37.4	26.5	25.5	26.9	1.4
Croatia							26.3	33.9	7.6
Czech Republic							58.4	52.7	-5.7
Denmark		24.0	21.0	24.0	18.8	31.4	28.6	37.0	8.4
Estonia			9.0	28.5	20.0	28.0	29.5	21.2	-8.3
Finland		13.5	17.0	18.7	18.0	17.2	15.2	15.6	0.4
France a)	12.5	12.0	9.1	7.2	6.6	6.7	7.1	8.2	1.1
Germany b)	19.5	15.9	14.0	13.2	15.0	24.8	23.8	21.4	-2.4
Greece			7.7	6.7	10.0	7.2	12.3	13.9	1.6
Hungary			9.4	13.3	23.3	17.8	20.1	20.1	0.0
Ireland		0.0	4.8	13.2	5.4	15.0	15.7	29.6	13.9
Italy						13.8	17.2		
Latvia					43.0		45.0	41.0	-4.0
Liechtenstein	22.0	27.0	23.0	12.4			18.0		
Lithuania			3.0	24.0	22.9	27.8	17.5	29.2	11.7
Luxembourg	4.2	3.8	11.1	9.5			6.3	9.0	2.7
Rep. of Moldova								45.2	
Netherlands	28.9	18.7	14.5	17.7	21.4	21.4	34.7	30.6	-4.1
Norway			20.8	14.8	17.1	19.0	23.4	20.9	-2.5
Poland			24.2	34.5	40.7	46.9	50.3	50.8	0.5
Portugal			1.7	9.8	25.7	19.8	11.3	7.1	-4.2
Romania						6.9	10.9	16.6	5.7
Russian Fed. c)						4.2	5.2	4.5	-0.7
Slovak Republic			52.7	59.1	55.5	38.5	44.0	49.9	5.9
Slovenia					34.6	31.3		27.0	
Spain			7.7	4.7	4.4	7.3	13.5	14.6	1.1
Sweden		5.6	12.3	12.9	16.1	12.3	16.9	10.6	-6.3
Switzerland	14.0	16.0	14.0	18.0	20.0	24.0	19.0	20.0	1.0
Turkey									
Ukraine				1.4	3.0	6.4	13.8	21.3	7.5
United Kingdom d)		23.0	27.0	34.0	45.0	51.5	52.7	16.8	-35.9
Yugoslavia e)	23.0	16.1	17.5	39.1	34.6	15.9			

a) 16x16 km network after 1988. b) For 1986-1990, only data for former Federal Republic of Germany.
c) For 1993, only data for St. Petersburg Region.
d) The difference between 1992 and 1993 is mainly due to a change of assessment method in line with that used in other States. e) Former Yugoslavia; Croatia and Slovenia excluded from 1991 results.

Annex II-7
Defoliation of broadleaves (1986-1993)

Participating countries	Broadleaves								% change
	Defoliation classes 2-4								
	1986	1987	1988	1989	1990	1991	1992	1993	1992/1993
Austria				15.7	14.9	11.1	9.3	7.7	-1.6
Belarus				33.4	45.0		14.8	16.6	1.8
Belgium				8.7	10.0	13.5	11.8	11.7	-0.1
Bulgaria	4.0	3.1	8.8	16.2	17.3	15.3	18.0	16.6	-1.4
Croatia							13.6	15.6	2.0
Czech Republic							31.9	55.1	23.2
Denmark		20.0	14.0	30.0	25.4	27.3	21.2	27.0	5.8
Estonia				only conifers assessed				1.1	
Finland		4.7	7.9	12.6	11.6	7.7	10.1	12.8	2.7
France a)	4.8	6.5	5.3	4.8	7.7	7.4	8.5	8.4	-0.1
Germany b)	16.8	19.2	16.5	20.4	23.8	26.5	32.0	29.9	-2.1
Greece			28.5	18.4	26.5	28.5	25.0	29.8	4.8
Hungary			7.0	12.5	21.5	19.9	21.8	21.2	-0.6
Ireland				only conifers assessed					
Italy		3.6	2.9	9.5	16.7	17.1	18.5		
Latvia					27.0		19.0	17.8	-1.2
Liechtenstein	10.0	7.0	5.0	9.0			8.0		
Lithuania			1.0	16.0	15.8	14.9	17.6	23.8	6.2
Luxembourg	5.6	10.1	12.3	13.9		33.9	30.5	31.0	0.5
Rep. of Moldova								50.9	
Netherlands	13.2	26.5	25.4	13.1	11.5	9.4	31.1	13.1	-18.0
Norway					18.2	25.1	38.9	42.1	3.2
Poland			7.1	17.7	25.6	34.8	40.4	45.6	5.2
Portugal			0.8	8.6	34.1	36.6	29.1	7.5	-21.6
Romania						10.4	18.4	21.4	3.0
Russian Fed. c)				only conifers assessed					
Slovak Republic			28.5	41.8	31.3	21.1	30.0	29.1	-0.9
Slovenia					4.4	5.8		11.0	
Spain			7.4	4.2	4.8	7.4	11.2	11.4	0.2
Sweden				only conifers assessed					
Switzerland	8.0	13.0	6.0	5.0	13.0	15.0	11.0	13.0	2.0
Turkey									
Ukraine				1.4	2.7	6.5	20.2	21.6	1.4
United Kingdom d)		20.0	20.0	21.0	28.8	65.6	67.8	17.1	-50.7
Yugoslavia e)		7.3	9.0	8.2	4.4	8.2			

a) 16x16 km network after 1988. b) For 1986-1990, only data for former Federal Republic of Germany.
c) For 1993, only data for St. Petersburg Region.
d) The difference between 1992 and 1993 is mainly due to a change of assessment method in line with that used in other States. e) Former Yugoslavia; Croatia and Slovenia excluded from 1991 results.

Annex II-8
10%-defoliation classes

Austria 1993

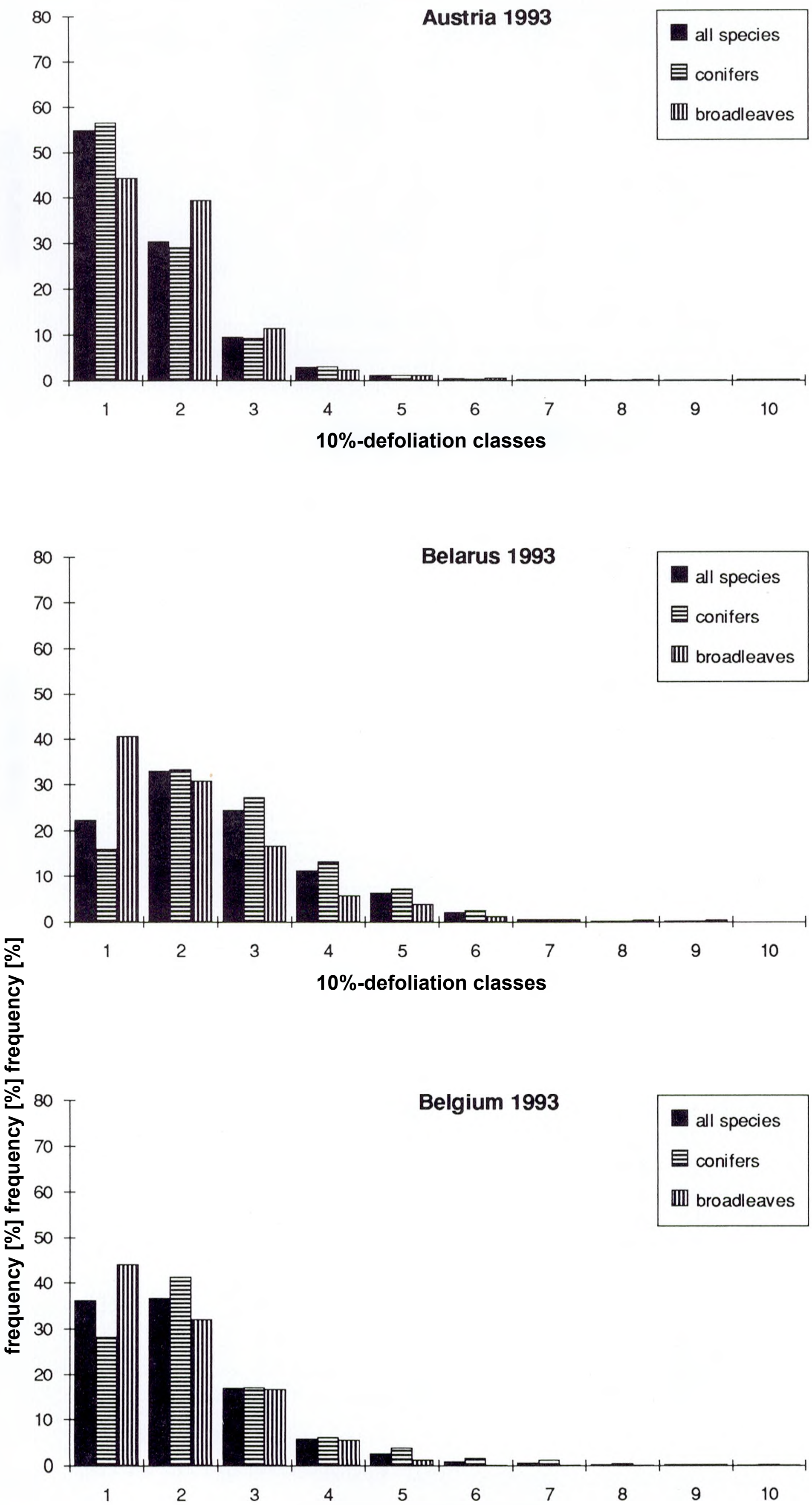
10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0- 10%	54.9	56.5	44.4
>10- 20%	30.4	29.1	39.5
>20- 30%	9.5	9.3	11.4
>30- 40%	3.0	3.1	2.4
>40- 50%	1.1	1.1	1.1
>50- 60%	0.4	0.3	0.5
>60- 70%	0.2	0.2	0.2
>70- 80%	0.2	0.1	0.2
>80- 90%	0.1	0.1	0.1
>90 -100%	0.2	0.2	0.2
total :	100.0	100.0	100.0
mean défoliation	12.0	11.7	13.2

Belarus 1993

10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0- 10%	22.3	15.9	40.6
>10- 20%	32.9	33.3	30.8
>20- 30%	24.4	27.2	16.7
>30- 40%	11.2	13.2	5.6
>40- 50%	6.2	7.1	3.7
>50- 60%	2.0	2.3	1.2
>60- 70%	0.6	0.6	0.6
>70- 80%	0.2	0.2	0.4
>80- 90%	0.2	0.2	0.4
>90 -100%	0.0	0.0	0.0
total :	100.0	100.0	100.0
mean defoliation	20.7	22.4	16.1

Belgium 1993

10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0- 10%	36.2	28.2	44.1
>10- 20%	36.7	41.4	32.0
>20- 30%	17.0	17.2	16.8
>30- 40%	5.7	6.0	5.4
>40- 50%	2.5	3.8	1.1
>50- 60%	0.8	1.5	0.1
>60- 70%	0.6	1.1	0.1
>70- 80%	0.2	0.4	0.1
>80- 90%	0.2	0.2	0.2
>90 -100%	0.1	0.2	0.1
total :	100.0	100.0	100.0
mean defoliation	15.9	17.9	14.1


Austria 1993
all species
conifers
broadleaves
10%-defoliation classes
Belarus 1993
all species
conifers
broadleaves
10%-defoliation classes
Belgium 1993
all species
conifers
broadleaves
frequency [%] frequency [%] frequency [%]
0
10
20
30
40
50
60
70
80
1
2
3
4
5
6
7
8
9
10

Bulgaria 1993

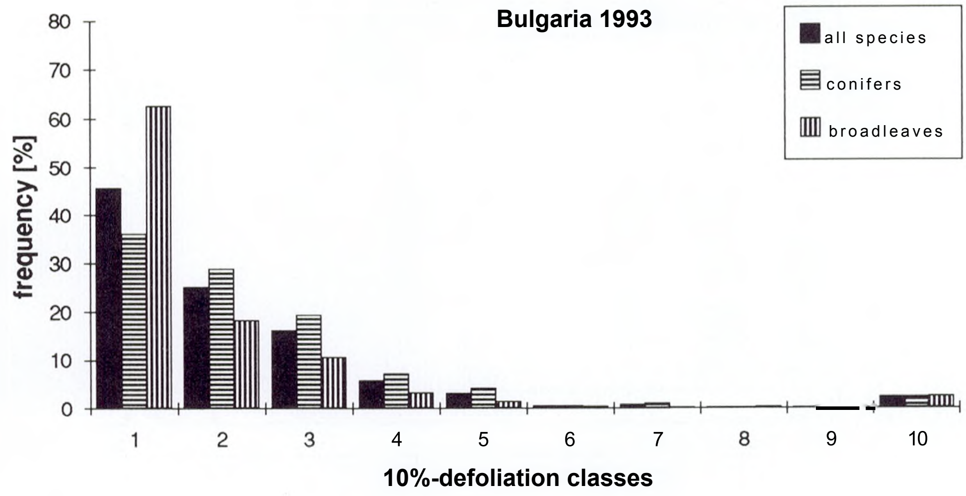
10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0- 10%	45.7	36.2	62.6
>10- 20%	25.1	28.8	18.3
>20- 30%	16.2	19.3	10.6
>30- 40%	5.8	7.2	3.3
>40- 50%	3.2	4.2	1.5
>50- 60%	0.5	0.6	0.4
>60- 70%	0.8	1.1	0.2
>70- 80%	0.2	0.1	0.3
>80- 90%	0.1	0.1	0.3
>90 -100%	2.4	2.4	2.5
total :	100.0	100.0	100.0
mean defoliation	16.9	18.9	13.6

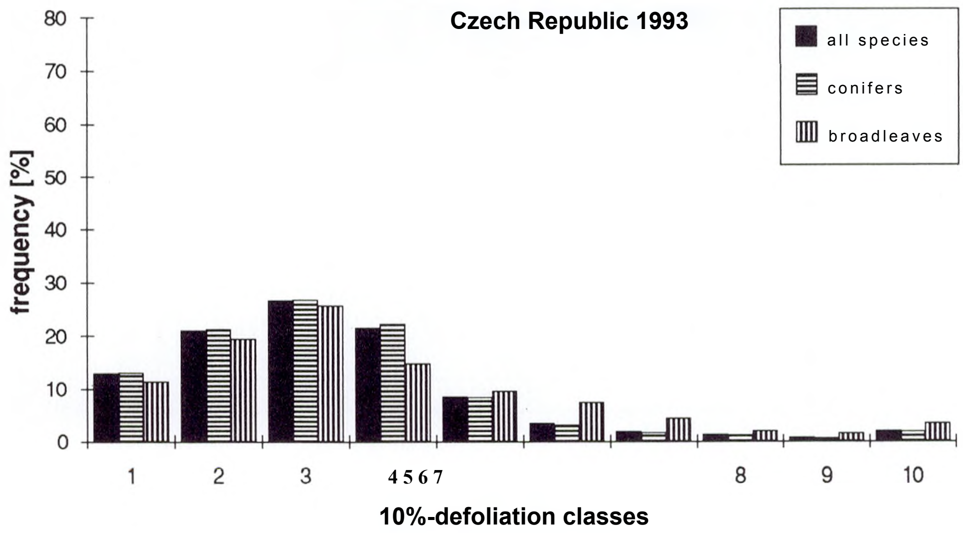
Czech Republic 1993

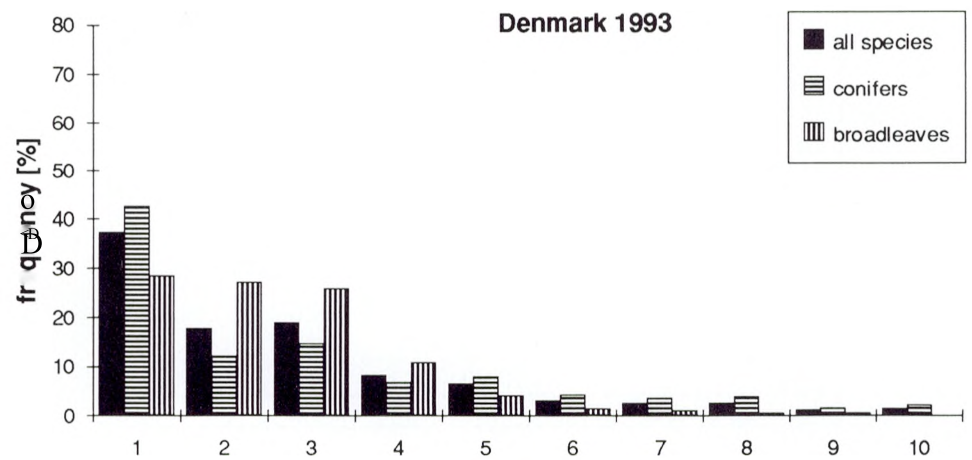
10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0- 10%	13.0	13.1	11.5
>10- 20%	21.0	21.2	19.5
>20- 30%	26.6	26.7	25.7
>30- 40%	21.5	22.2	14.7
>40- 50%	8.5	8.4	9.7
>50- 60%	3.5	3.1	7.5
>60- 70%	1.9	1.6	4.5
>70- 80%	1.3	1.2	2.0
>80- 90%	0.7	0.6	1.5
>90 -100%	2.0	1.9	3.5
total :	100.0	100.0	100.0
mean defoliation	28.4	28.0	32.5

Denmark 1993

10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0- 10%	37.3	42.5	28.4
>10- 20%	17.8	12.2	27.2
>20- 30%	18.9	14.8	25.8
>30- 40%	8.3	6.8	10.9
>40- 50%	6.6	8	4.2
>50 - 60%	3.2	4.3	1.4
>60 - 70%	2.7	3.7	1.1
>70 - 80%	2.6	3.9	0.5
>80- 90%	1.2	1.6	0.5
>90 -100%	1.4	2.2	0.0
total:	100.0	100.0	100.0
mean defoliation	23.0	24.8	19.9


Bulgaria 1993
all species
conifers
broadleaves
frequency [%]
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
10%-defoliation classes


Czech Republic 1993
all species
conifers
broadleaves
frequency [%]
80
70
60
50
40
30
20
10
0
1
2
3
4 5 6 7
8
9
10
10%-defoliation classes


Denmark 1993
all species
conifers
broadleaves
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10

Estonia 1993

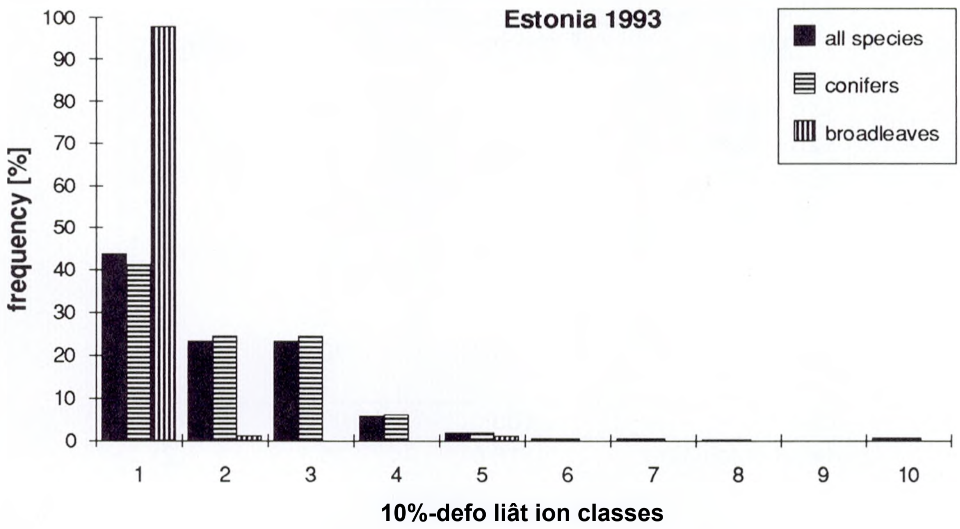
10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0- 10%	43.7	41.2	97.8
>10- 20%	23.3	24.4	1.1
>20- 30%	23.3	24.4	0.0
>30- 40%	5.8	6.1	0.0
>40- 50%	1.9	1.9	1.1
>50- 60%	0.5	0.5	0.0
>60- 70%	0.6	0.6	0.0
>70- 80%	0.2	0.2	0.0
>80- 90%	0.0	0.0	0.0
>90 -100%	0.7	0.7	0.0
total :	100.0	100.0	100.0
mean defoliation	15.9	16.3	5.6

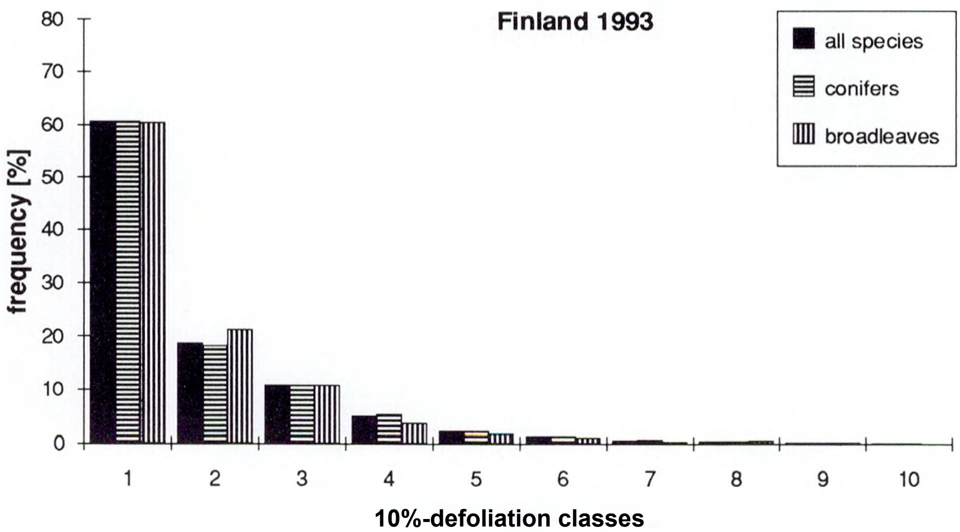
Finland 1993

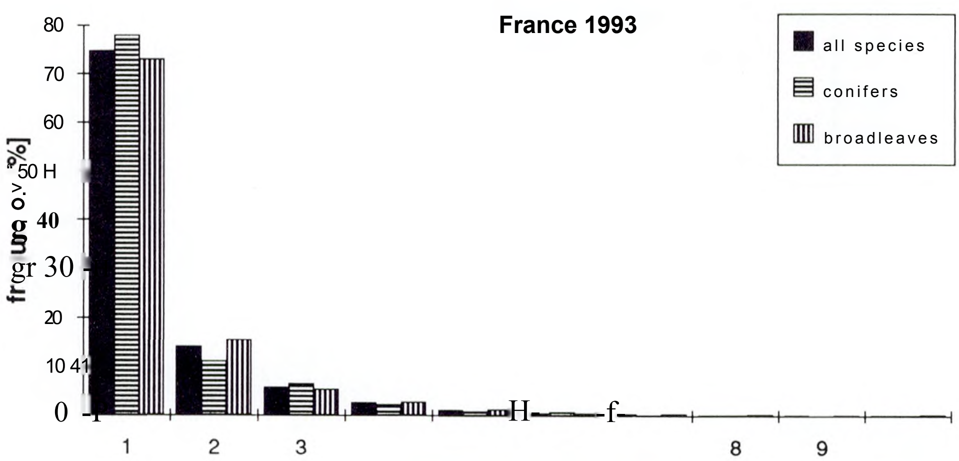
10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0- 10%	60.7	60.7	60.5
>10- 20%	18.7	18.2	21.3
>20- 30%	10.8	10.9	10.8
>30- 40%	5.0	5.3	3.7
>40- 50%	2.2	2.2	1.7
>50- 60%	1.3	1.3	1.0
>60- 70%	0.6	0.7	0.3
>70- 80%	0.4	0.4	0.5
>80- 90%	0.2	0.2	0.2
>90 -100%	0.1	0.1	0.0
total:	100.0	100.0	100.0
mean defoliation	13.0	13.1	12.3

France 1993

10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0- 10%	74.8	77.9	73.1
>10- 20%	14.1	11.1	15.6
>20- 30%	5.8	6.5	5.4
>30- 40%	2.6	2.3	2.8
>40- 50%	1.2	0.9	1.3
>50- 60%	0.6	0.8	0.6
>60- 70%	0.4	0.2	0.4
>70- 80%	0.2	0.1	0.3
>80- 90%	0.1	0.0	0.2
>90 -100%	0.2	0.2	0.3
total :	100.0	100.0	100.0
mean defoliation	9.8	9.2	10.2


Estonia 1993
all species
conifers
broadleaves
frequency [%]
10%-defo liât ion classes


Finland 1993
all species
conifers
broadleaves
frequency [%]
10%-defoliation classes


France 1993
all species
conifers
broadleaves

Greece 1993

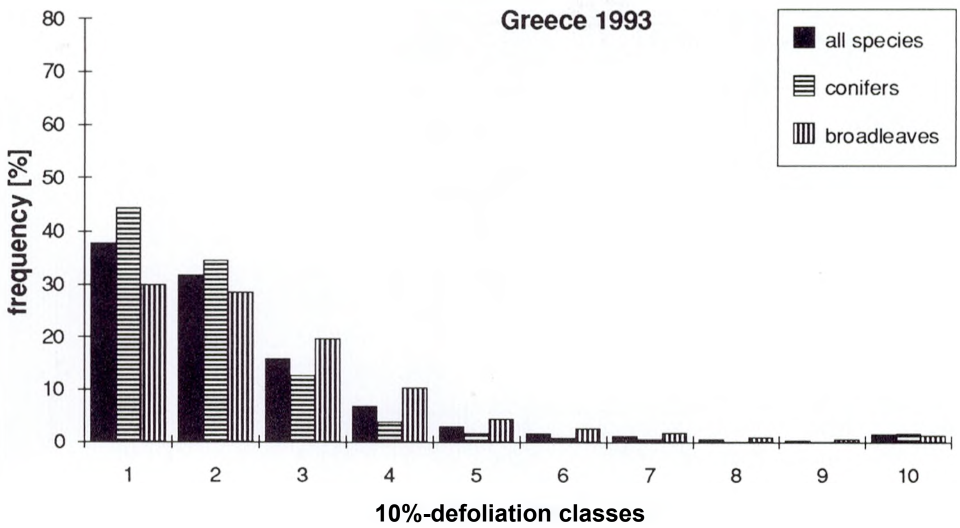
10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0- 10%	37.7	44.3	30.0
>10- 20%	31.7	34.5	28.5
>20- 30%	15.9	12.7	19.7
>30- 40%	6.8	3.8	10.4
>40- 50%	2.9	1.6	4.4
>50- 60%	1.6	0.8	2.6
>60- 70%	1.1	0.5	1.7
>70- 80%	0.5	0.1	0.9
>80- 90%	0.3	0.1	0.5
>90 -100%	1.5	1.6	1.3
total:	100.0	100.0	100.0
mean defoliation :	18.0	15.1	21.2

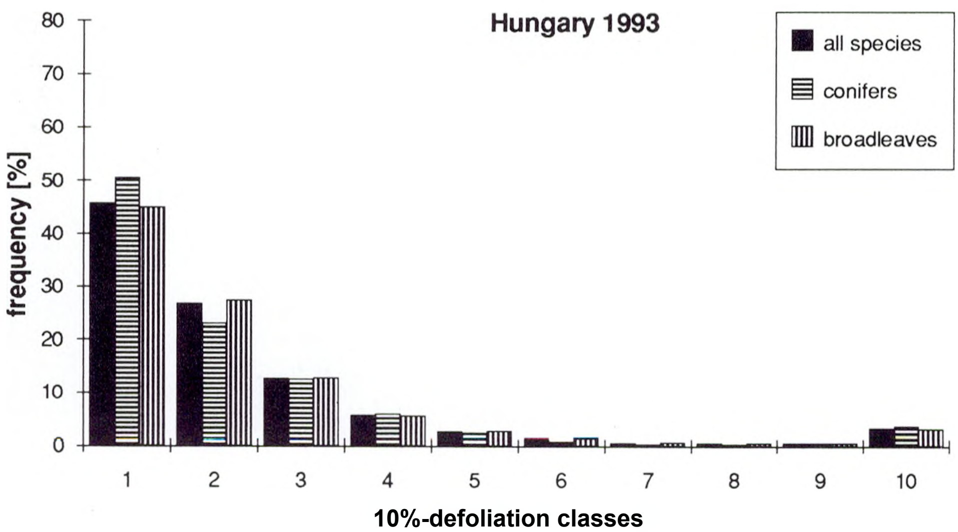
Hungary 1993

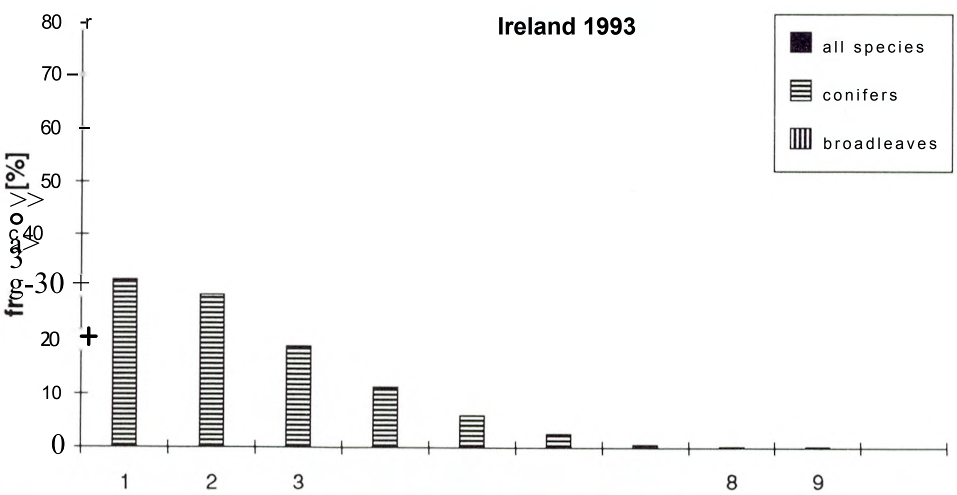
10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0- 10%	45.8	50.5	45.0
>10- 20%	26.8	23.0	27.4
>20- 30%	12.8	12.7	12.9
>30- 40%	5.7	5.9	5.6
>40- 50%	2.6	2.4	2.7
>50- 60%	1.3	0.8	1.4
>60- 70%	0.6	0.3	0.7
>70- 80%	0.6	0.3	0.6
>80- 90%	0.6	0.5	0.6
>90 -100%	3.2	3.6	3.1
total:	100.0	100.0	100.0
mean defoliation :	17.8	17.0	17.9

Ireland 1993

10%-defoliation classes	defoliation-%
	all species conifers broadleaves
0- 10%	31.4
>10- 20%	28.6
>20 - 30%	19.0
>30 - 40%	11.3
>40- 50%	6.1
>50- 60%	2.6
>60- 70%	0.6
>70- 80%	0.2
>80- 90%	0.2
>90 -100%	0.0
total:	100.0
mean defoliation :	19.5


Greece 1993
all species
conifers
broadleaves
frequency [%]
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
10%-defoliation classes


Hungary 1993
all species
conifers
broadleaves
frequency [%]
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
10%-defoliation classes


Ireland 1993
all species
conifers
broadleaves
[%]
80
70
60
50
40
30
20
10
0
1
2
3
8
9

Latvia 1993

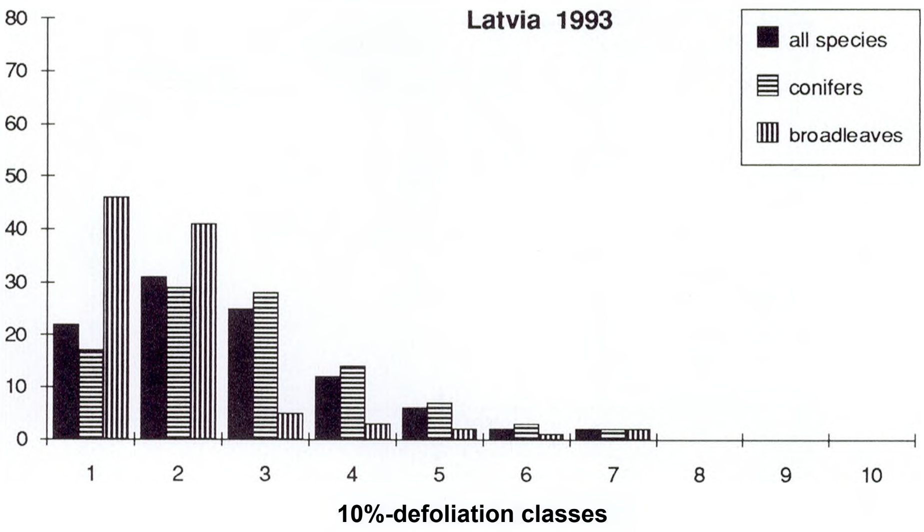
10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0- 10%	22.0	17.0	46.0
>10- 20%	31.0	29.0	41.0
>20 - 30%	25.0	28.0	5.0
>30- 40%	12.0	14.0	3.0
>40- 50%	6.0	7.0	2.0
>50- 60%	2.0	3.0	1.0
>60- 70%	2.0	2.0	2.0
>70- 80%	0.0	0.0	0.0
>80- 90%	0.0	0.0	0.0
>90 -100%	0.0	0.0	0.0
total:	100.0	100.0	100.0
mean defoliation	21.3	23.2	13.5

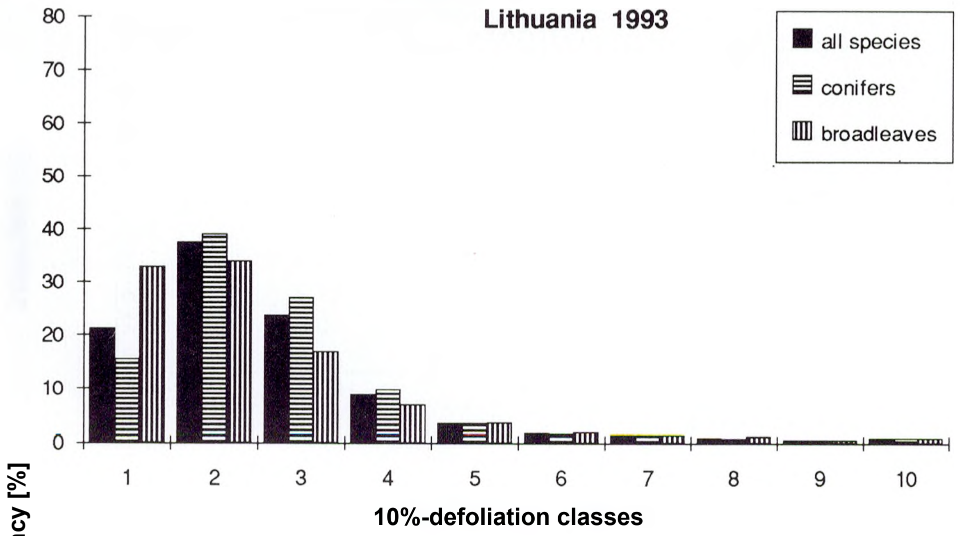
Lithuania 1993

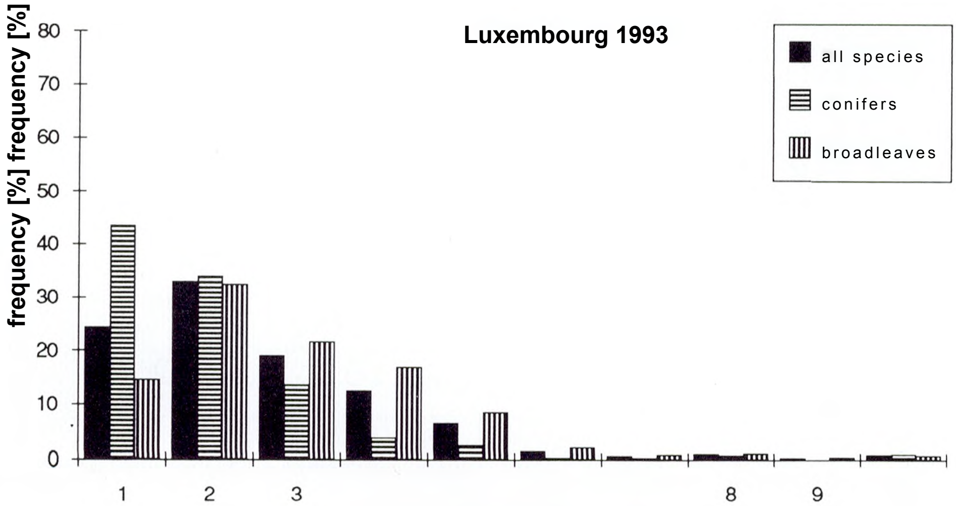
10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0- 10%	21.2	15.5	32.9
>10- 20%	37.5	39.1	34.0
>20- 30%	23.7	27.0	16.9
>30 - 40%	8.8	9.8	6.9
>40- 50%	3.4	3.4	3.5
>50- 60%	1.7	1.6	1.9
>60- 70%	1.4	1.4	1.4
>70- 80%	0.9	0.8	1.1
>80- 90%	0.5	0.5	0.5
>90 -100%	0.9	0.9	0.9
total:	100.0	100.0	100.0
mean defoliation	21.0	22.0	19.0

Luxembourg 1993

10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0- 10%	24.4	43.5	14.7
>10- 20%	33.0	33.9	32.5
>20 - 30%	19.0	13.7	21.7
>30- 40%	12.6	3.9	17.0
>40- 50%	6.6	2.6	8.6
>50- 60%	1.6	0.3	2.2
>60- 70%	0.7	0.3	0.9
>70- 80%	1.0	0.8	1.2
>80 - 90%	0.3	0.0	0.4
>90 -100%	0.9	1.0	0.8
total:	100.0	100.0	100.0
mean defoliation	21.5	15.1	24.7


Latvia 1993
all species
conifers
broadleaves
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
10%-defoliation classes


Lithuania 1993
all species
conifers
broadleaves
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
10%-defoliation classes
frequency [%] frequency [%] frequency [%]


Luxembourg 1993
all species
conifers
broadleaves
80
70
60
50
40
30
20
10
0
1
2
3
8
9

Netherlands 1993

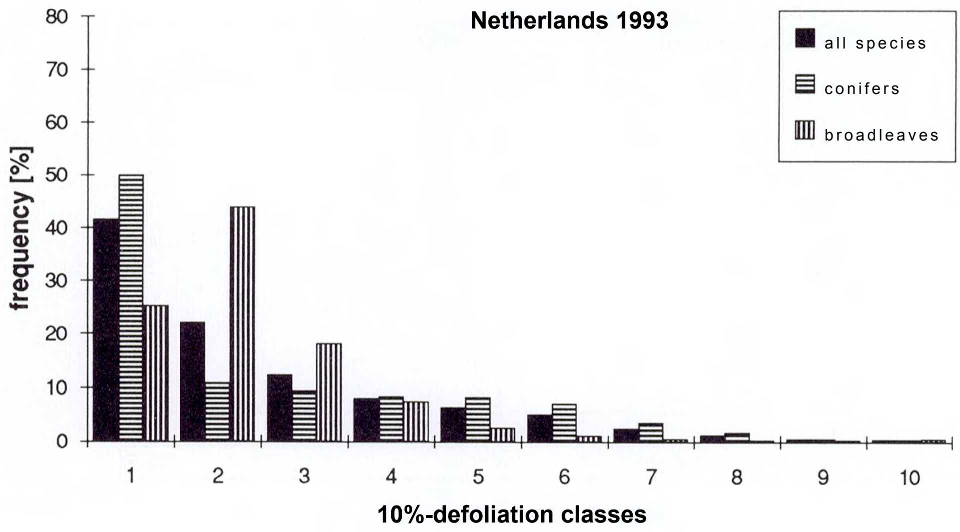
10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0- 10%	41.6	50.0	25.3
>10- 20%	22.1	10.8	43.9
>20- 30%	12.3	9.4	18.1
>30- 40%	8.0	8.3	7.3
>40- 50%	6.3	8.2	2.6
>50- 60%	5.0	7.0	1.2
>60- 70%	2.5	3.5	0.5
>70 - 80%	1.3	1.8	0.3
>80- 90%	0.5	0.6	0.3
>90 -100%	0.4	0.4	0.5
total :	100.0	100.0	100.0
mean defoliation	20.3	21.4	18.0

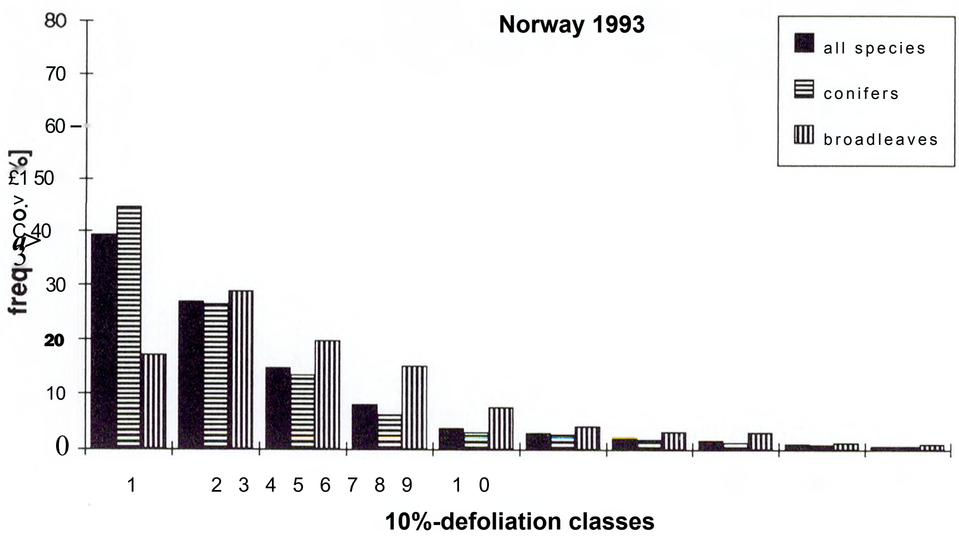
Norway 1993

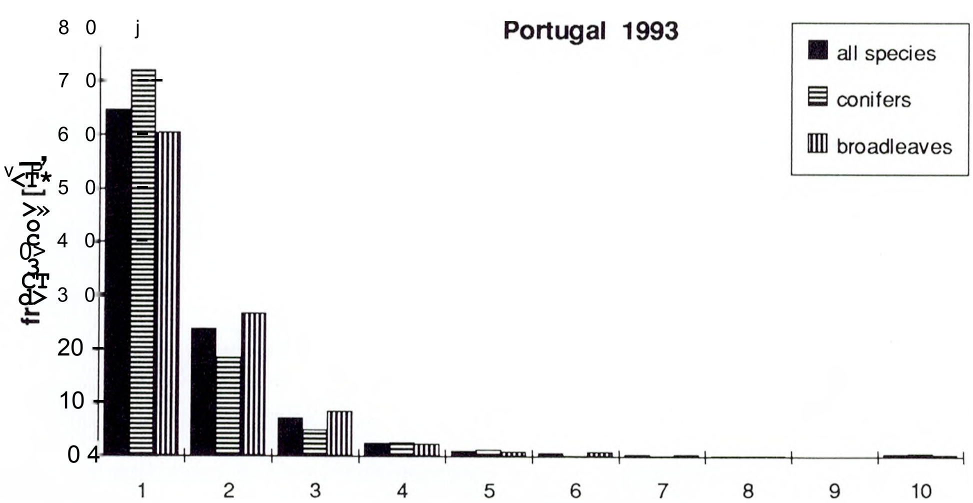
10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0- 10%	39.4	44.6	17.1
>10- 20%	26.9	26.4	28.9
>20- 30%	14.7	13.5	19.8
>30- 40%	7.8	6.1	15.1
>40 - 50%	3.6	2.8	7.3
>50- 60%	2.7	2.5	3.9
>60- 70%	1.9	1.6	3
>70- 80%	1.5	1.2	2.8
>80 - 90%	0.9	0.8	1.2
>90 -100%	0.6	0.5	0.9
total:	100.0	100.0	100.0
mean defoliation	19.2	17.4	26.8

Portugal 1993

10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0- 10%	64.6	72.0	60.4
>10- 20%	23.8	18.5	26.7
>20- 30%	7.1	4.9	8.4
>30 - 40%	2.3	2.5	2.2
>40 - 50%	0.9	1.2	0.8
>50- 60%	0.5	0.1	0.8
>60- 70%	0.3	0.1	0.3
>70- 80%	0.1	0.1	0.1
>80- 90%	0.0	0.0	0.0
>90 -100%	0.4	0.6	0.3
total :	100.0	100.0	100.0
mean defoliation	10.7	9.8	11.3


Netherlands 1993
all species
conifers
broadleaves
frequency [%]
0
10
20
30
40
50
60
70
80
1 2 3 4 5 6 7 8 9 10
10%-defoliation classes


Norway 1993
all species
conifers
broadleaves
0
10
20
30
40
60
70
80
1
10%-defoliation classes


Portugal 1993
all species
conifers
broadleaves
10
20
1 2 3 4 5 6 7 8 9 10

Romania 1993

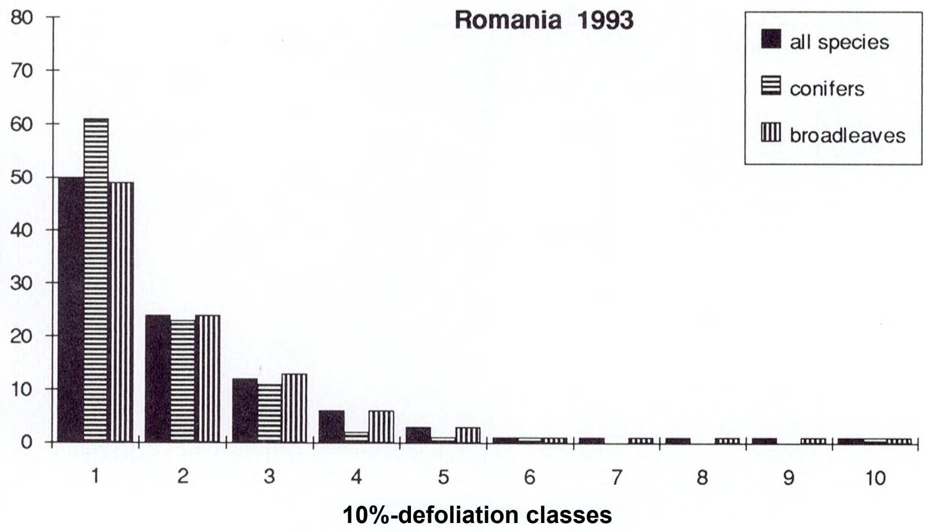
10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0- 10%	50.0	61.0	49.0
>10- 20%	24.0	23.0	24.0
>20 - 30%	12.0	11.0	13.0
>30- 40%	6.0	2.0	6.0
>40- 50%	3.0	1.0	3.0
>50- 60%	1.0	1.0	1.0
>60- 70%	1.0	0.0	1.0
>70- 80%	1.0	0.0	1.0
>80- 90%	1.0	0.0	1.0
>90 -100%	1.0	1.0	1.0
total :	100.0	100.0	100.0
mean defoliation	16.3	11.9	16.5

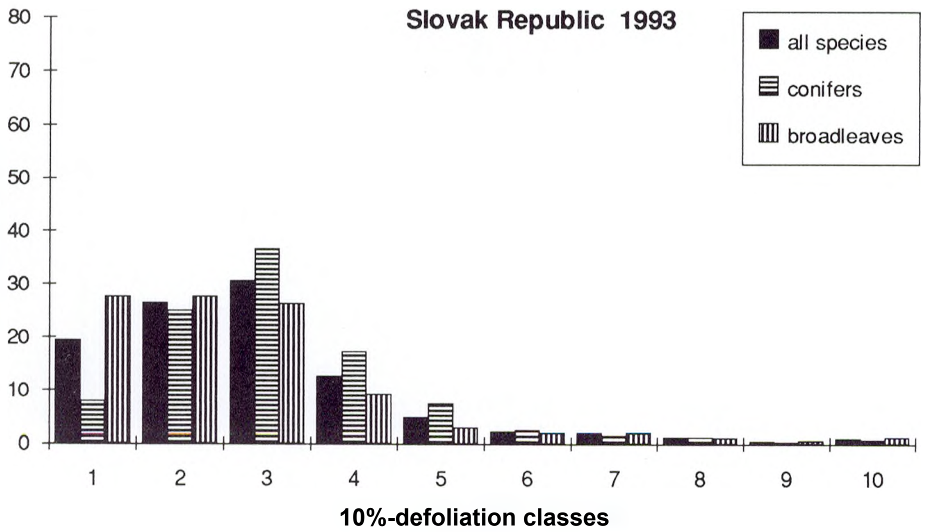
Slovak Republic 1993

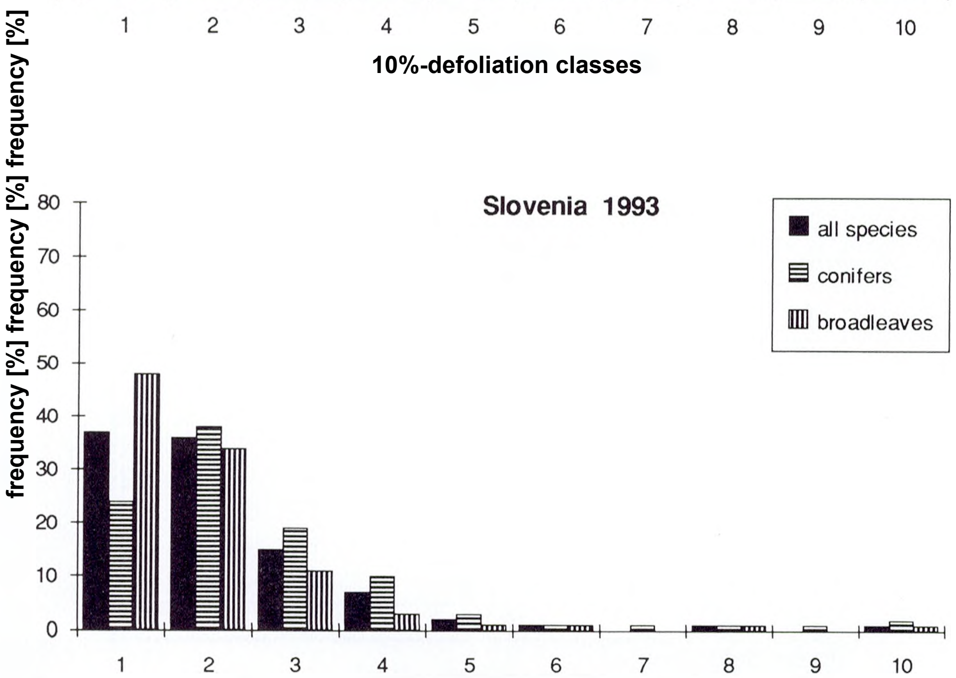
10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0- 10%	19.4	7.8	27.7
>10- 20%	26.5	25	27.6
>20- 30%	30.6	36.7	26.3
>30 - 40%	12.6	17.3	9.2
>40- 50%	4.7	7.3	2.8
>50- 60%	2.1	2.3	1.9
>60 - 70%	1.7	1.4	1.9
>70- 80%	1.1	1.2	1
>80- 90%	0.4	0.3	0.5
>90 -100%	0.9	0.7	1.1
total :	100.0	100.0	100.0
mean defoliation	23.4	26.7	21.1

Slovenia 1993

10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0- 10%	37.0	24.0	48.0
>10- 20%	36.0	38.0	34.0
>20 - 30%	15.0	19.0	11.0
>30- 40%	7.0	10.0	3.0
>40- 50%	2.0	3.0	1.0
>50- 60%	1.0	1.0	1.0
>60- 70%	0.0	1.0	0.0
>70- 80%	1.0	1.0	1.0
>80 - 90%	0.0	1.0	0.0
>90 -100%	1.0	2.0	1.0
total:	100.0	100.0	100.0
mean defoliation	16.6	21.2	14.0


Romania 1993
all species
conifers
broadleaves
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
10%-defoliation classes


Slovak Republic 1993
all species
conifers
broadleaves
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
10%-defoliation classes


frequency [%] frequency [%] frequency [%]
Slovenia 1993
all species
conifers
broadleaves
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10

Spain 1993

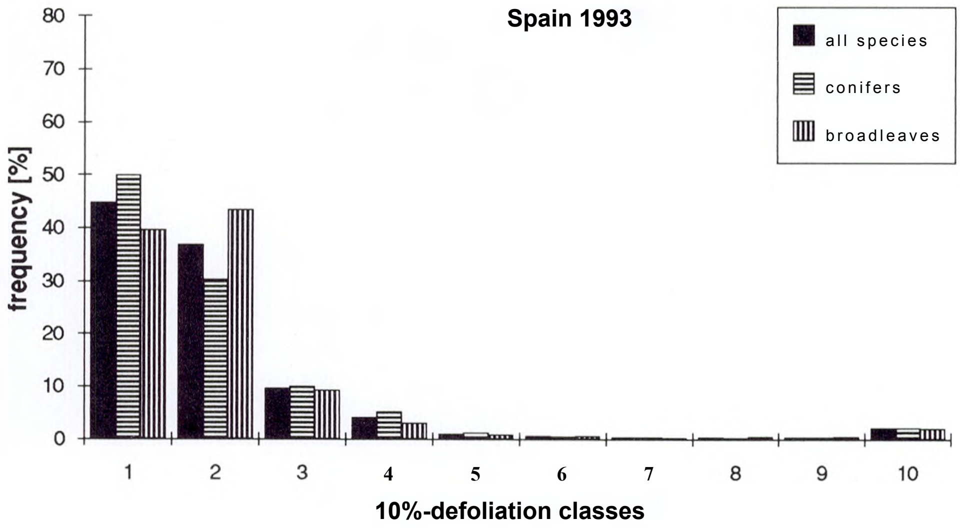
10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0- 10%	44.8	50.0	39.7
>10- 20%	36.9	30.3	43.5
>20- 30%	9.6	10.0	9.3
>30- 40%	4.1	5.3	3.0
>40- 50%	0.9	1.1	0.8
>50- 60%	0.5	0.4	0.6
>60- 70%	0.3	0.4	0.2
>70- 80%	0.3	0.3	0.4
>80 - 90%	0.4	0.3	0.4
>90 -100%	2.1	2.1	2.0
total:	100.0	100.0	100.0
mean defoliation :	15.1	14.8	15.3

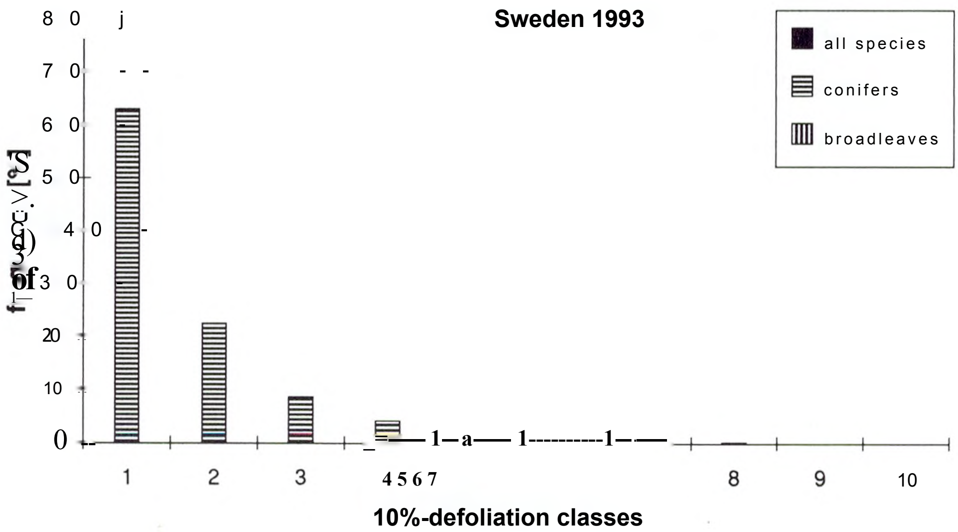
Sweden 1993

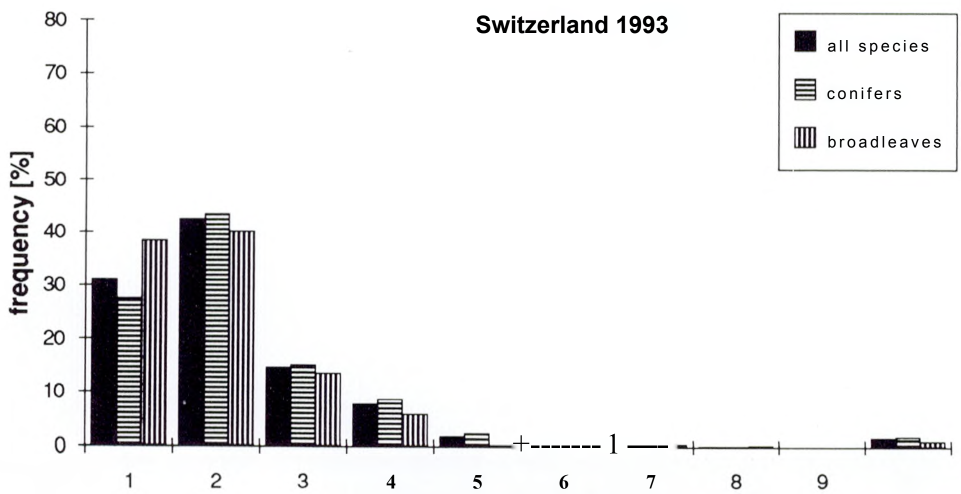
10%-defoliation classes	defoliation-%
	all species conifers broadleaves
0- 10%	63.0
>10- 20%	22.3
>20- 30%	8.4
>30- 40%	3.9
>40- 50%	1.2
>50 - 60%	0.5
>60- 70%	0.5
>70- 80%	0.2
>80- 90%	0.0
>90 -100%	0.0
total:	100.0
mean defoliation :	11.3

Switzerland 1993

10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0- 10%	31.0	27.6	38.5
>10- 20%	42.5	43.5	40.1
>20 - 30%	14.6	15.1	13.6
>30 - 40%	7.8	8.7	5.9
>40- 50%	1.7	2.4	0.2
>50 - 60%	0.4	0.5	0.1
>60- 70%	0.3	0.2	0.4
>70 - 80%	0.1	0.1	0.2
>80 - 90%	0.0	0.0	0.0
>90 -100%	1.6	1.9	1.0
total:	100.0	100.0	100.0
mean defoliation :	17.1	18.1	14.9


Spain 1993
all species
conifers
broadleaves
frequency [%]
0
10
20
30
40
50
60
70
80
1
2
3
4
5
6
7
8
9
10
10%-defoliation classes


Sweden 1993
all species
conifers
broadleaves
0
10
20
30
40
50
60
70
80
1
2
3
4
5
6
7
8
9
10
10%-defoliation classes


Switzerland 1993
all species
conifers
broadleaves
frequency [%]
0
10
20
30
40
50
60
70
80
1
2
3
4
5
6
7
8
9

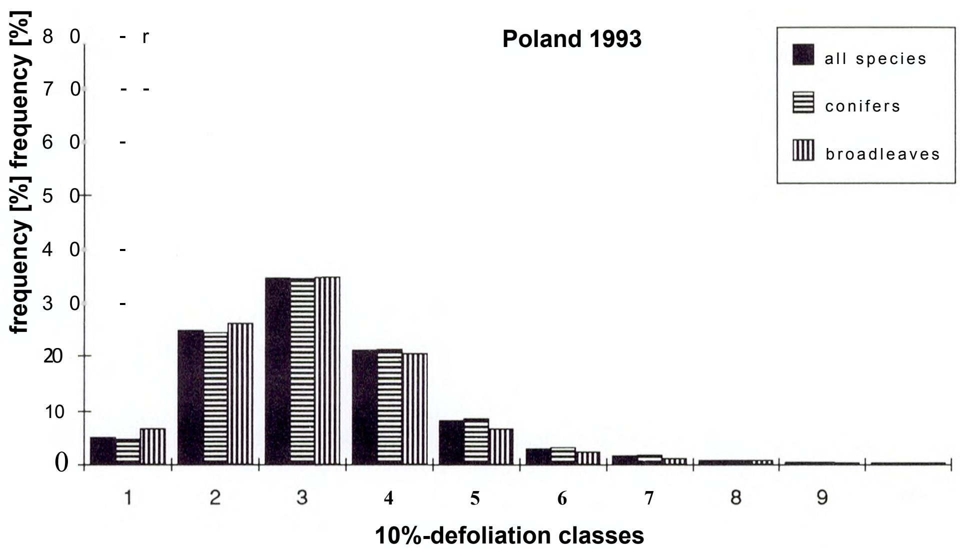
United Kingdom 1993

10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0- 10%	38.9	40.9	35.6
>10- 20%	34.3	33.1	36.4
>20- 30%	16.9	15.8	18.6
>30- 40%	5.8	5.8	5.9
>40- 50%	2.0	2.1	1.9
>50 - 60%	1.1	1.2	0.8
>60- 70%	0.5	0.5	0.5
>70 - 80%	0.2	0.2	0.1
>80- 90%	0.1	0.1	0.1
>90 -100%	0.3	0.4	0.1
total:	100.0	100.0	100.0
mean defoliation :	15.6	15.5	15.8

Poland 1993

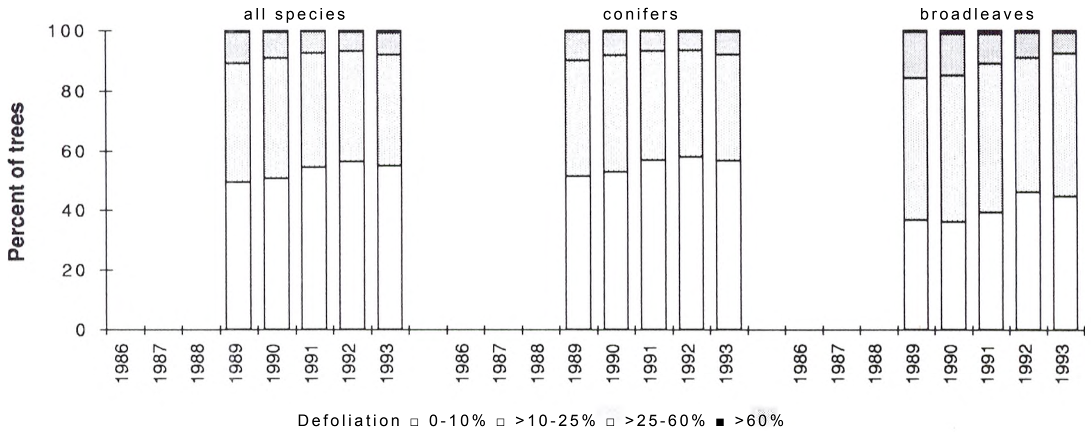
10%-defoliation classes	defoliation-%		
	all species	conifers	broadleaves
0- 10%	6.3	5.8	8.8
>10- 20%	25.9	25.3	29.3
>20- 30%	34.7	34.9	33.3
>30- 40%	19.4	19.8	17.5
>40- 50%	7.9	8.3	6.0
>50- 60%	2.9	3.0	2.4
>60- 70%	1.4	1.4	1.2
>70 - 80%	0.7	0.7	0.6
>80- 90%	0.4	0.4	0.4
>90 -100%	0.4	0.4	0.5
total:	100.0	100.0	100.0
mean defoliation :	27.0	27.3	25.4


United Kingdom 1993
all species
H conifers
DIO broadleaves
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
10%-defoliation classes

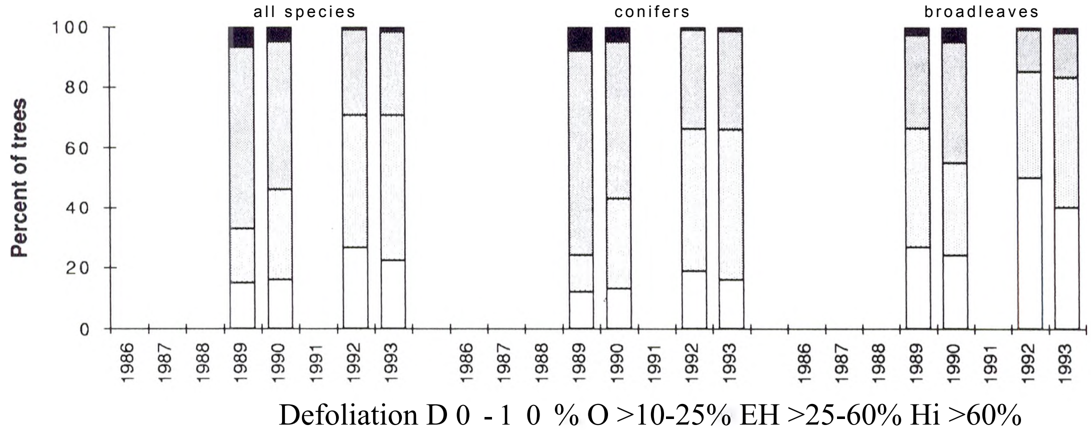

Poland 1993
all species
conifers
broadleaves
frequency [%] frequency [%]
8 0
7 0
6 0
5 0
4 0
3 0
20
10
0
1
2
3
4
5
6
7
8
9
10%-defoliation classes

Annex II-9
Changes in defoliation (1986-1993)

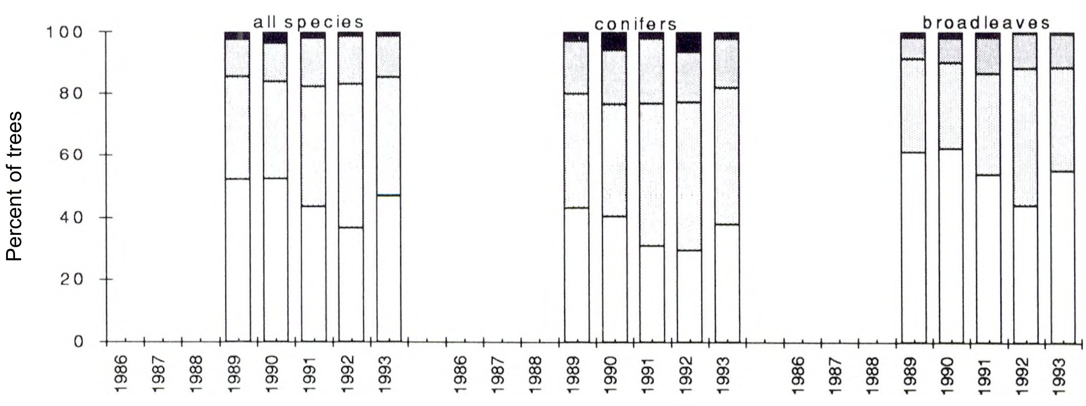
Austria



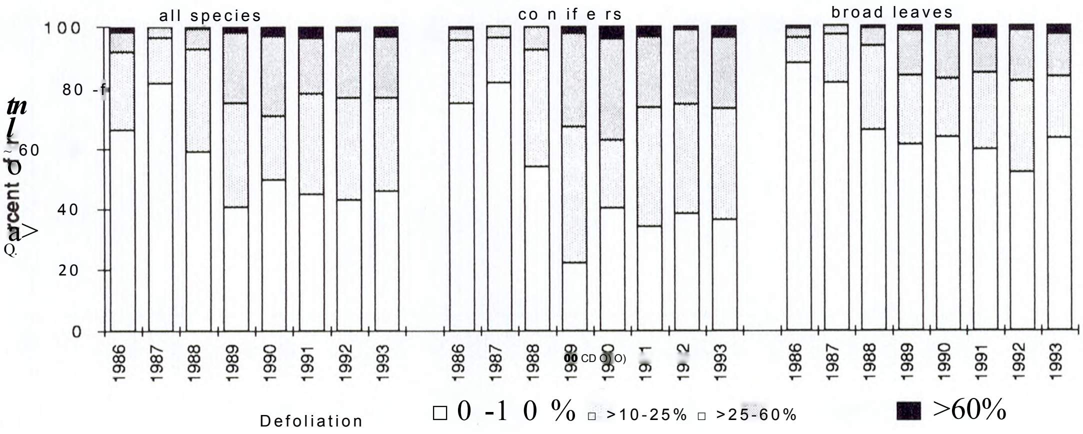
Belarus



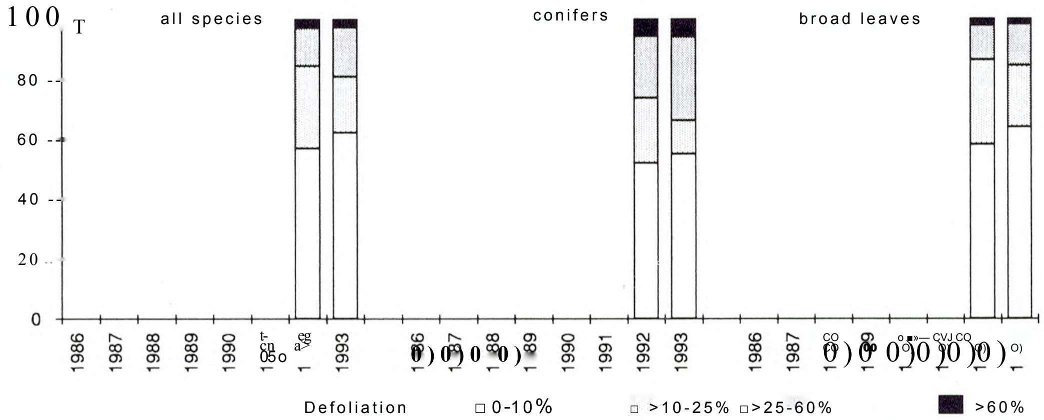
Belgium



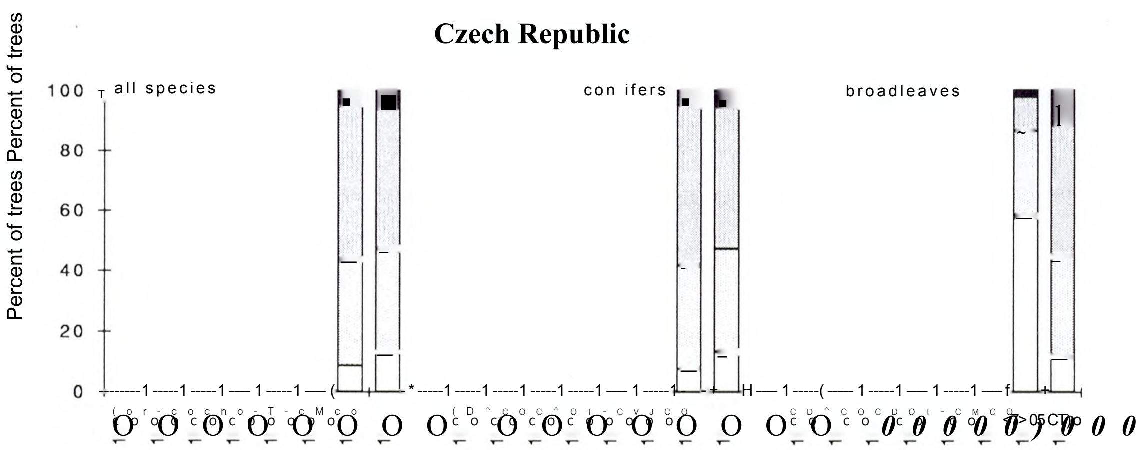
Bulgaria



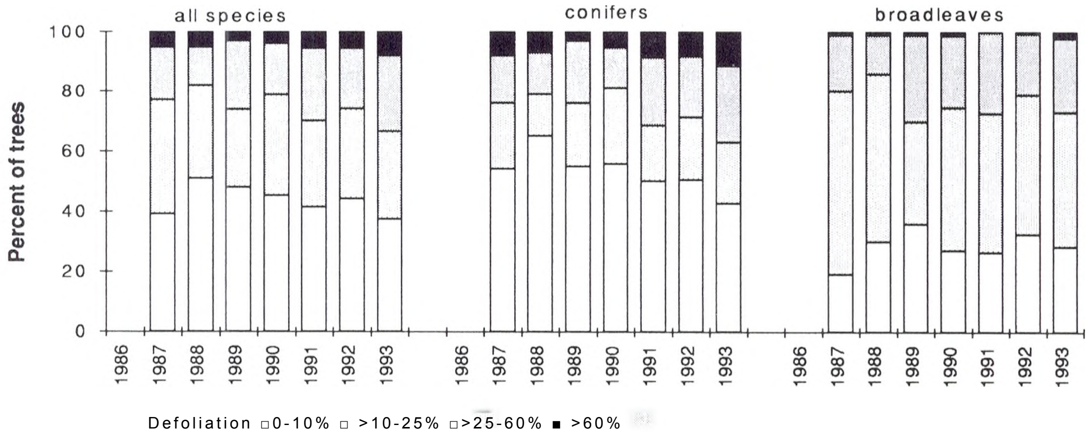
Croatia



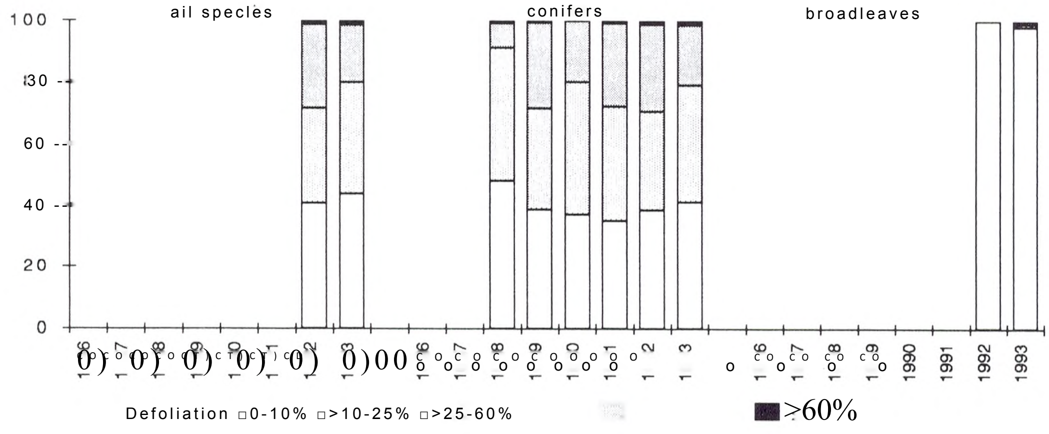
Czech Republic



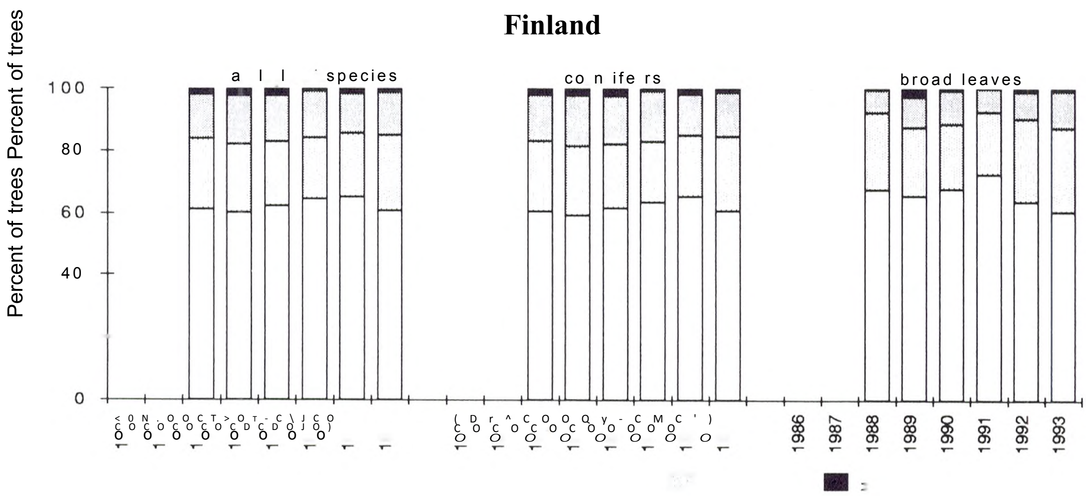
Denmark



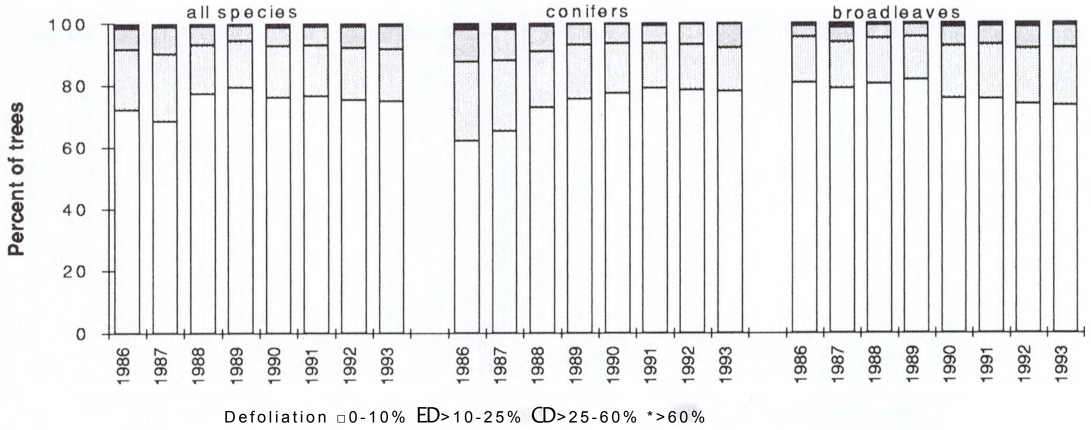
Estonia



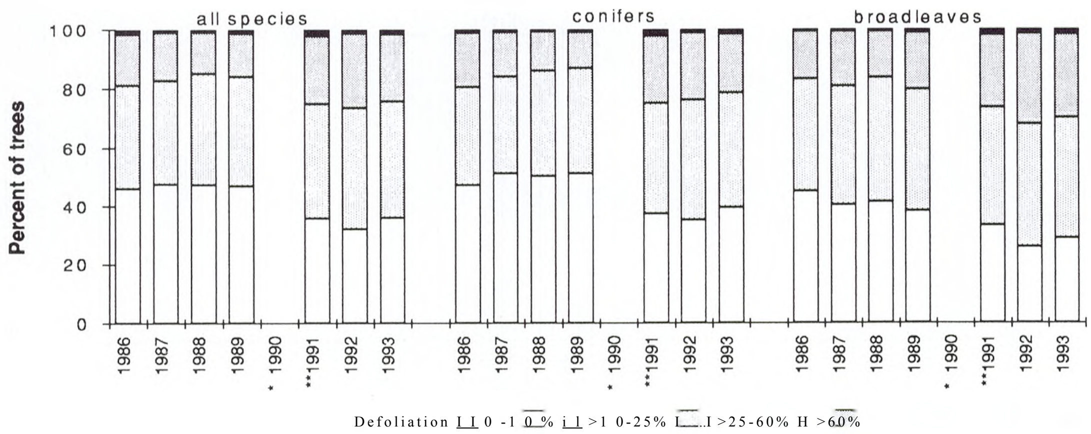
Finland



France

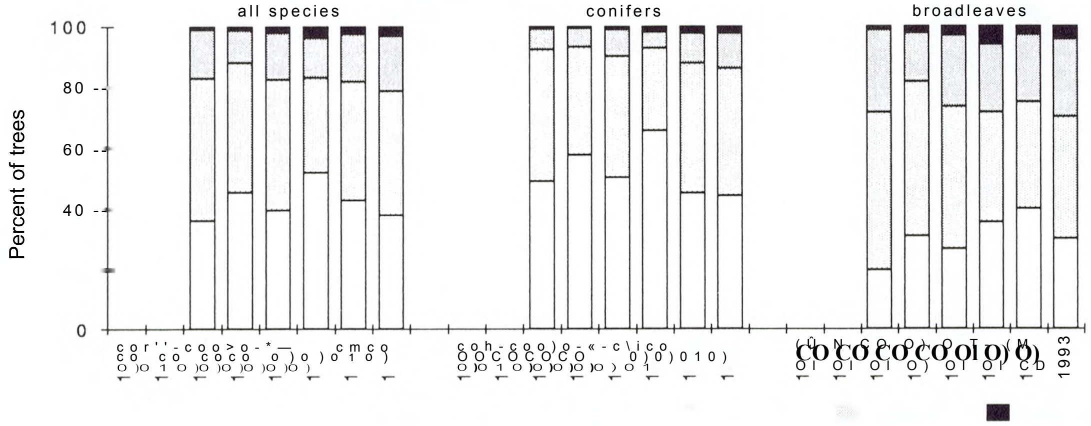


Germany

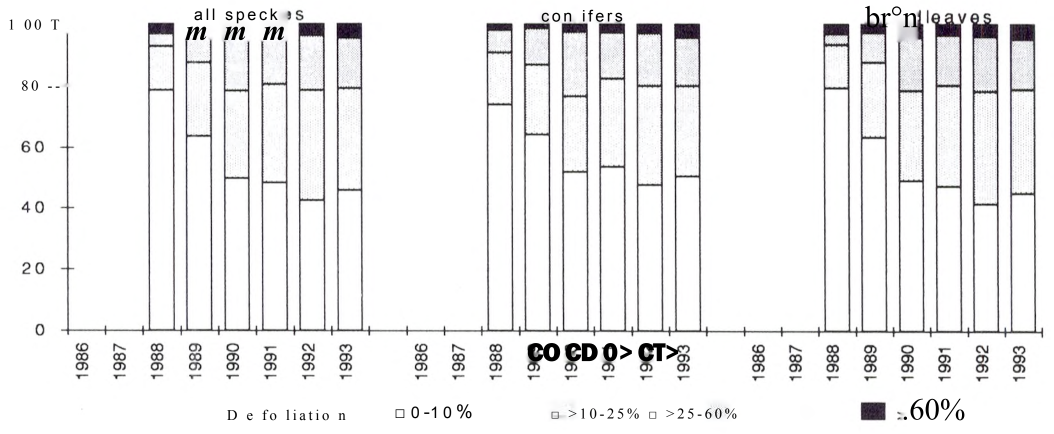


*** due to storm damage no results for 1990 ** since 1991 with former GDR**

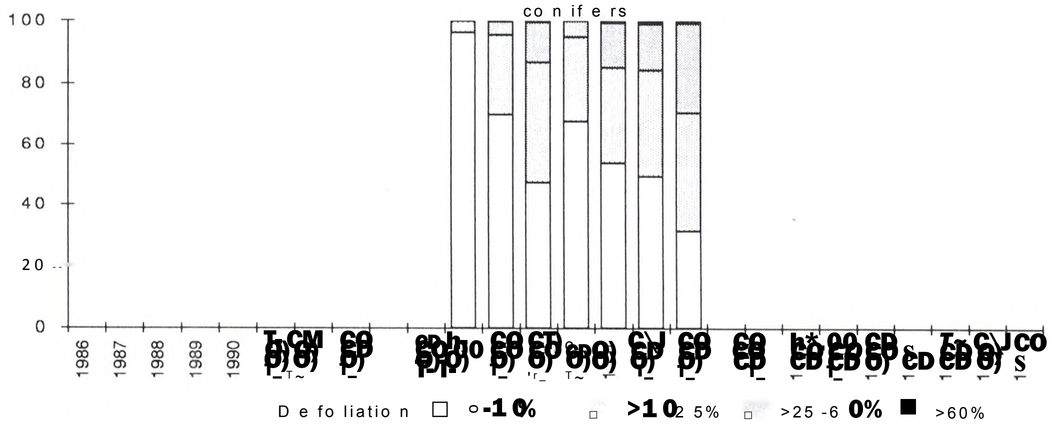
Greece



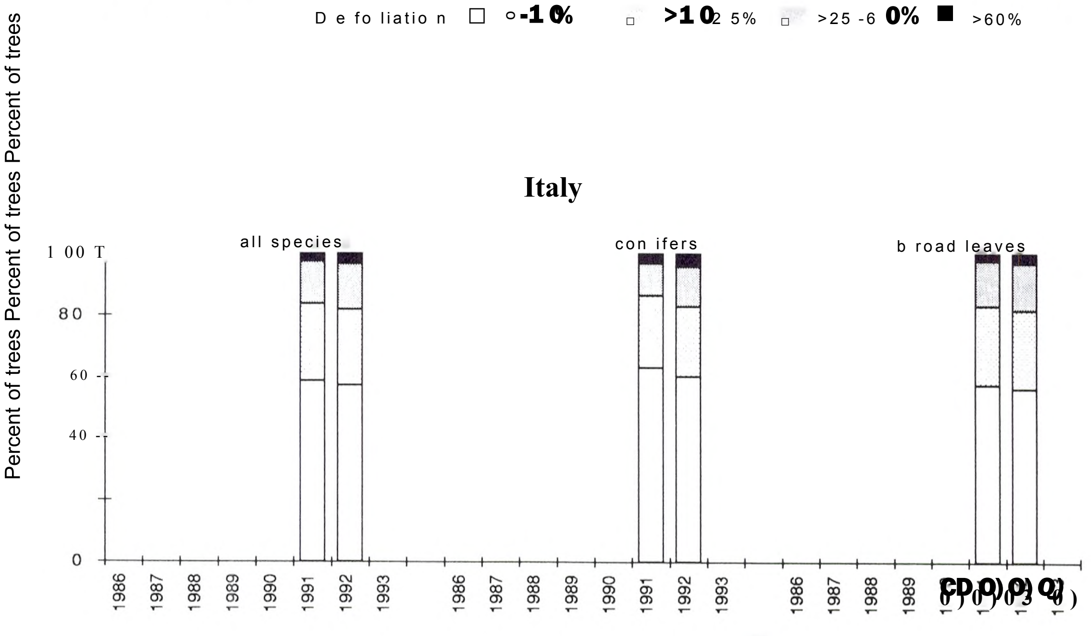
Hungary



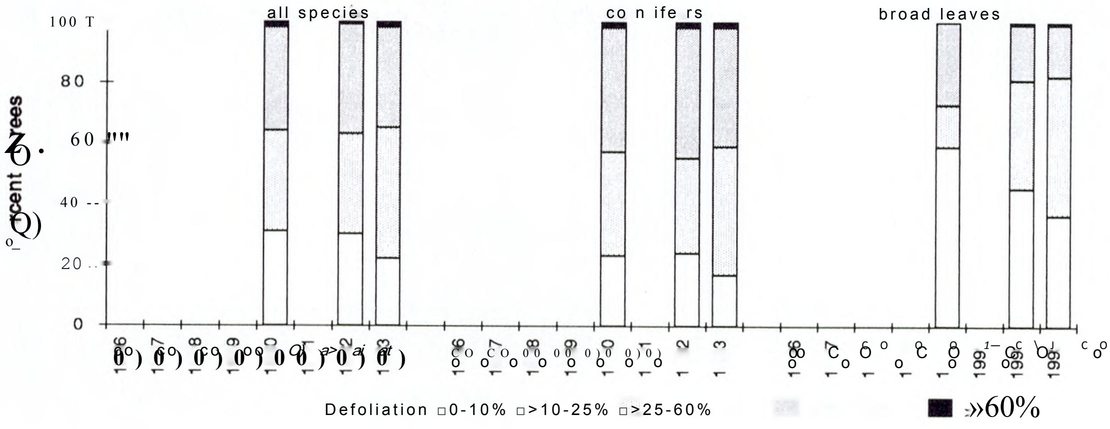
Ireland



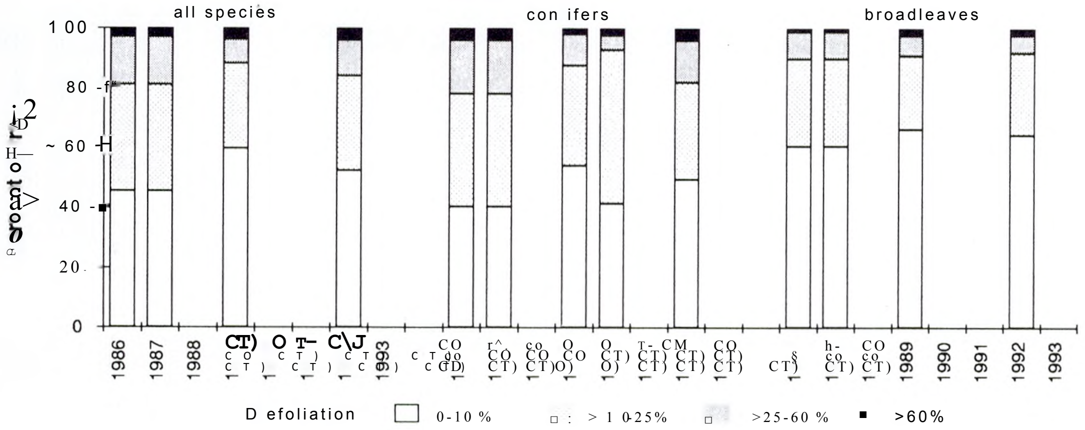
Italy



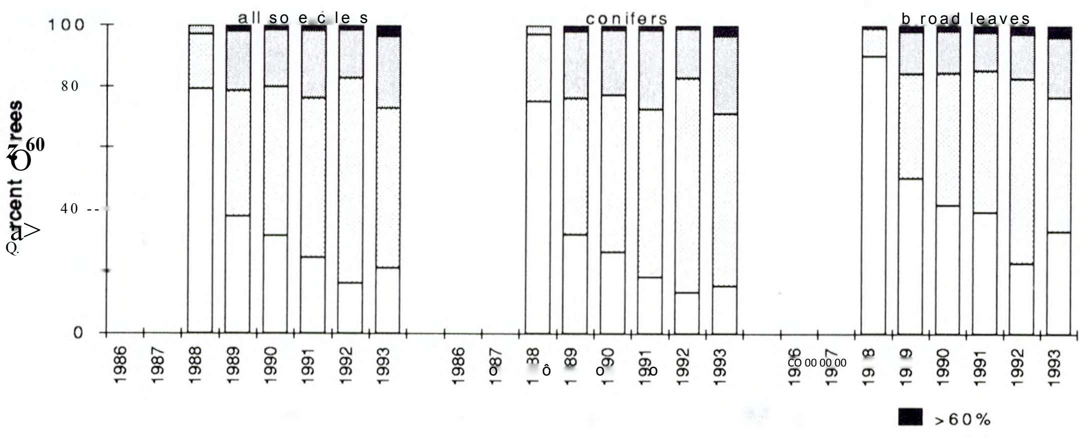
Latvia



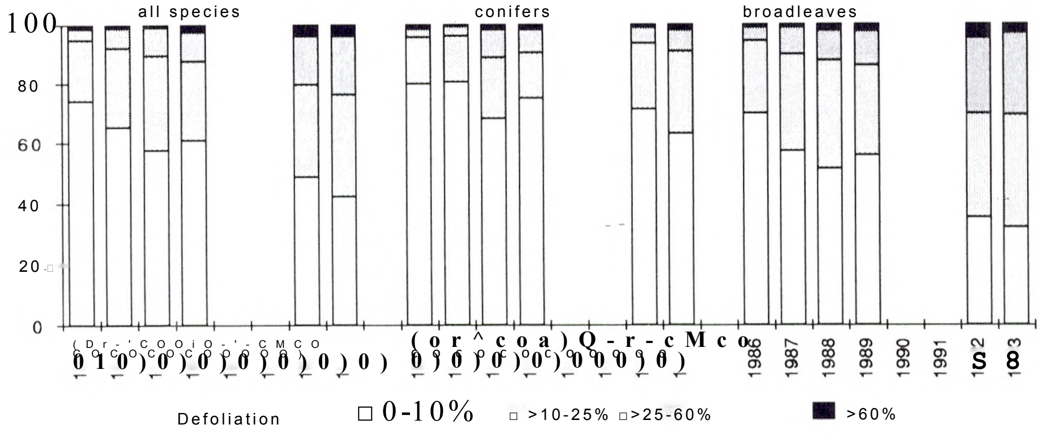
Liechtenstein



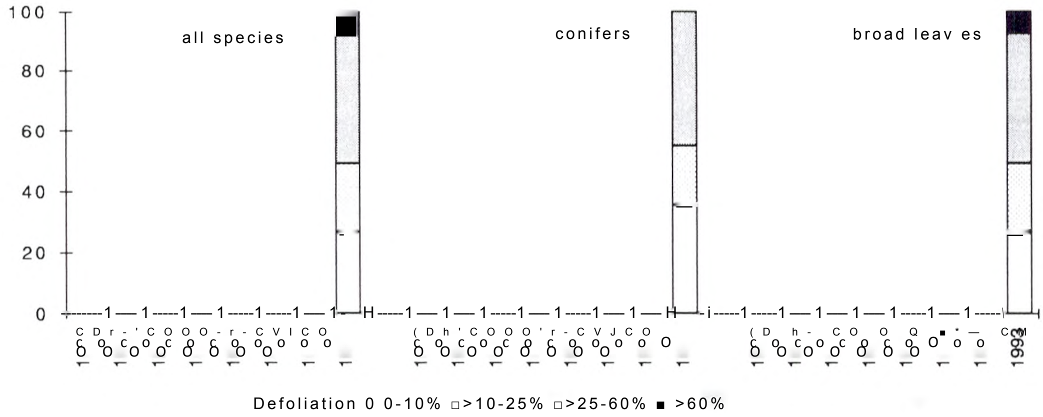
Lithuania



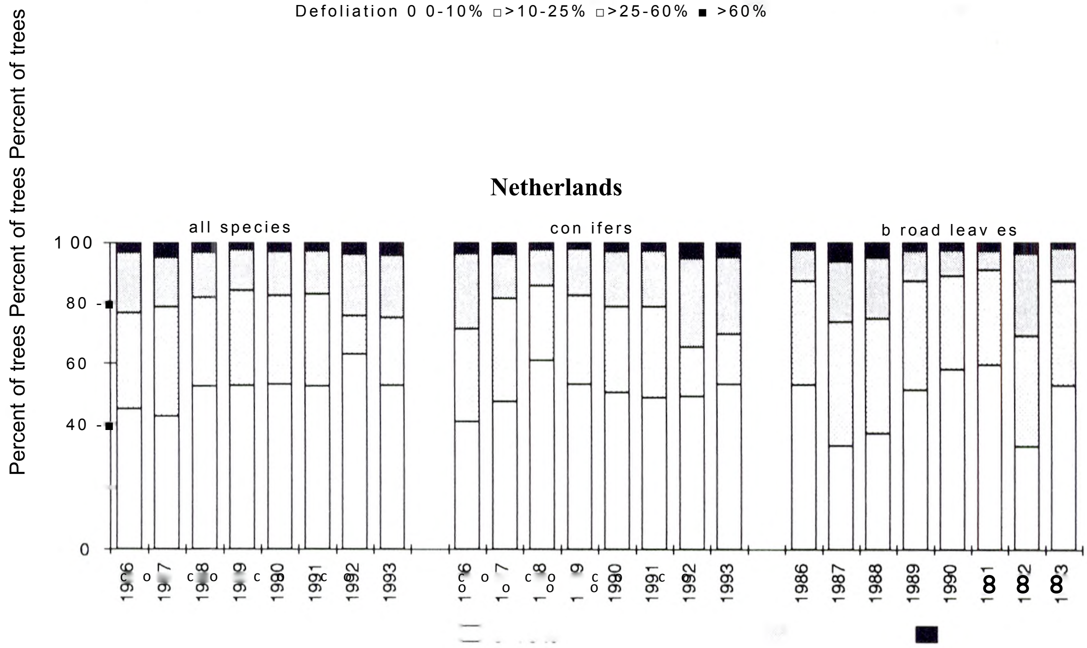
Luxembourg



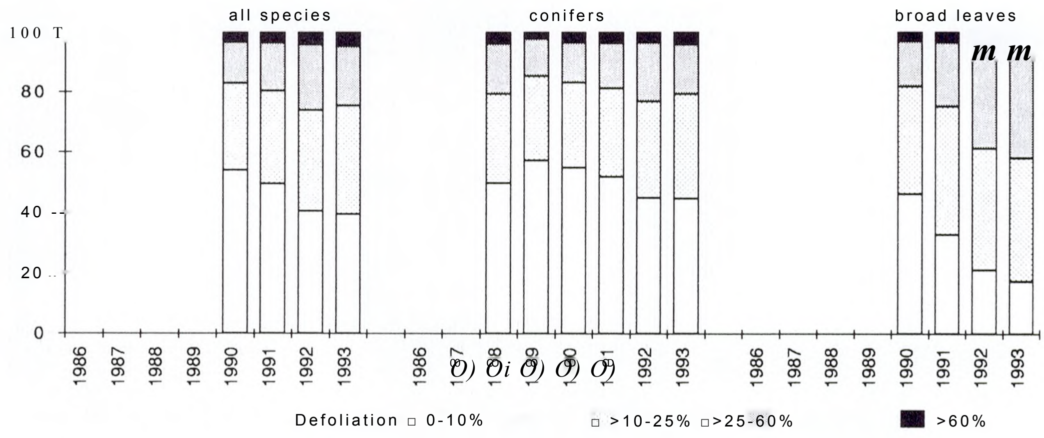
Moldavia



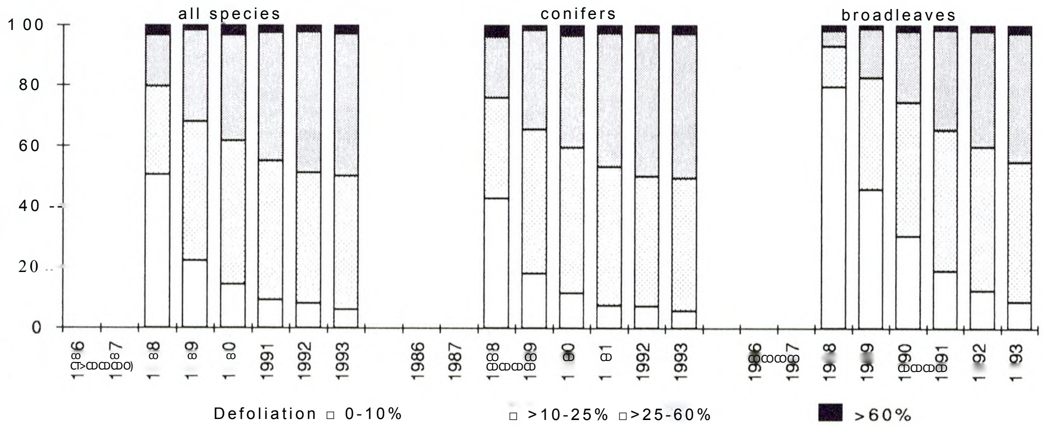
Netherlands



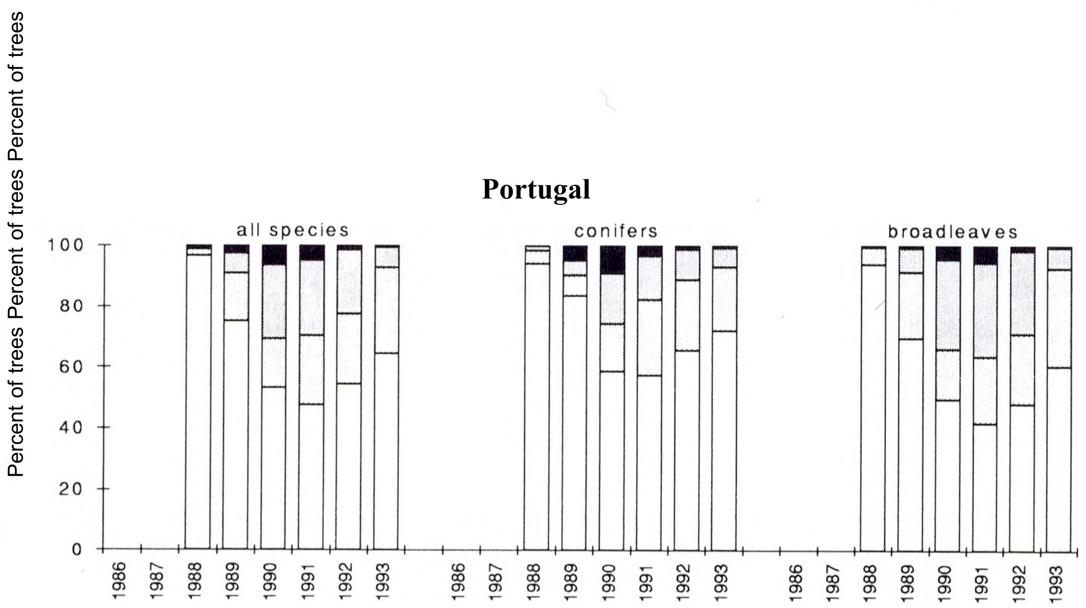
Norway



Poland



Portugal



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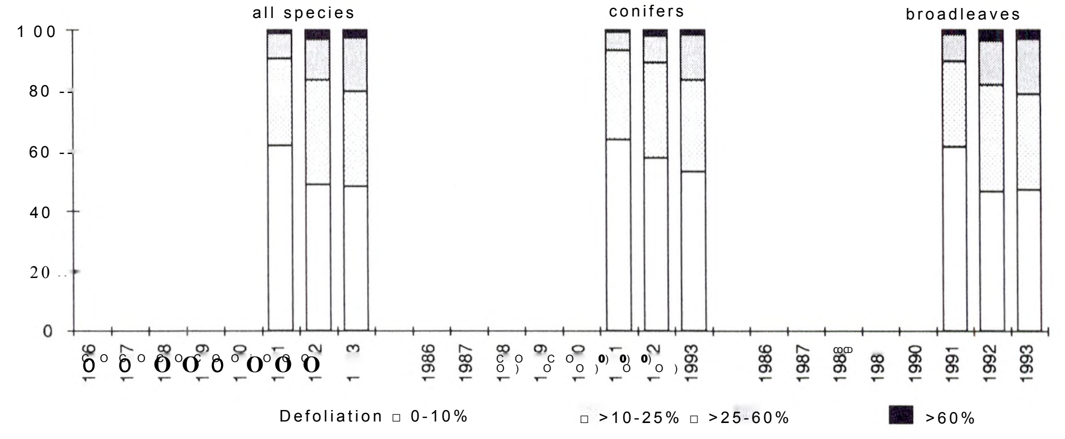

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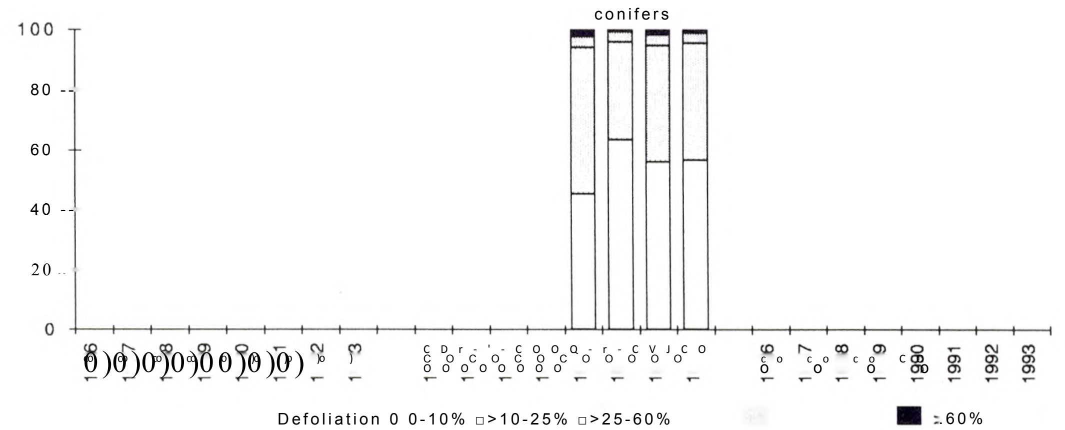
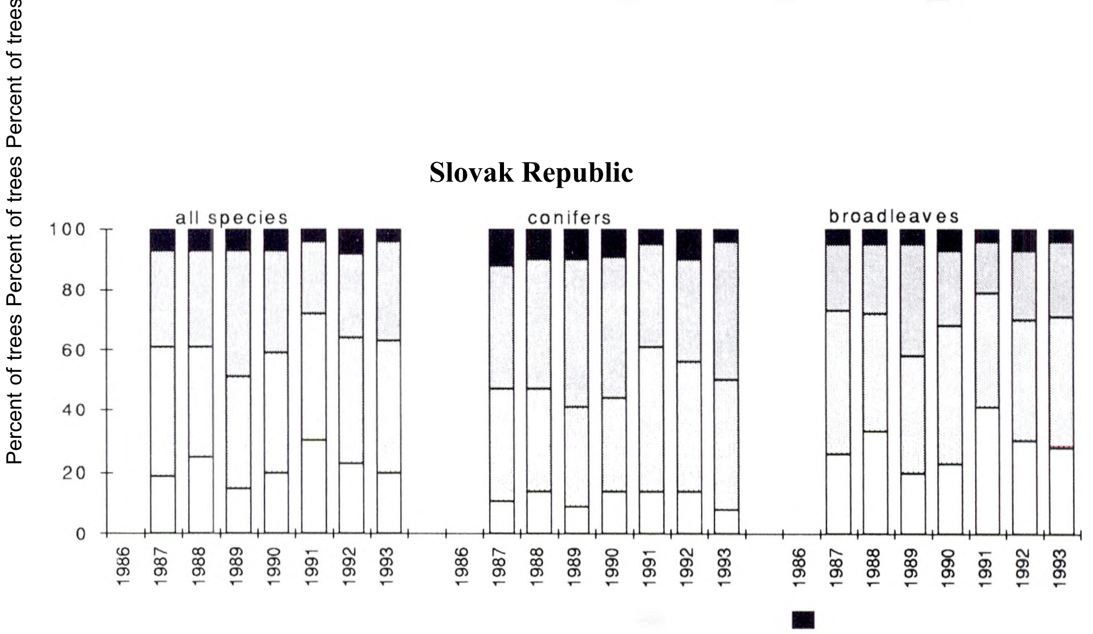


Slovak Republic



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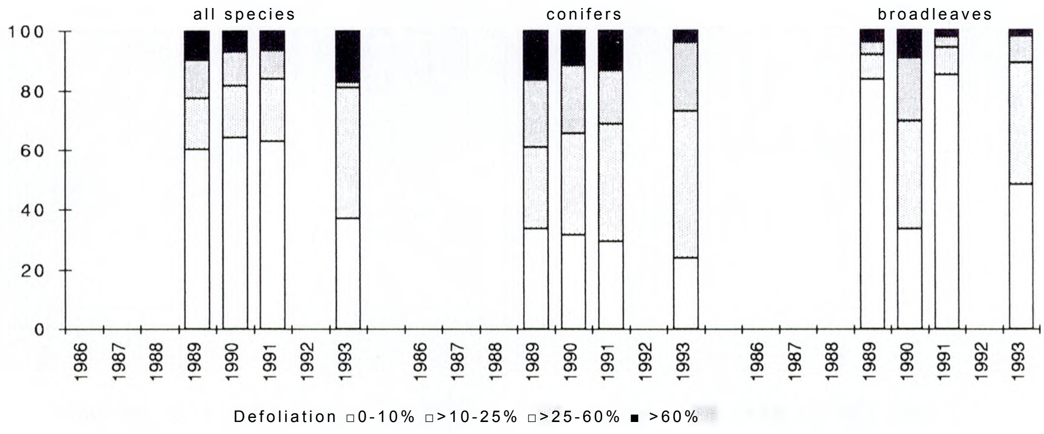
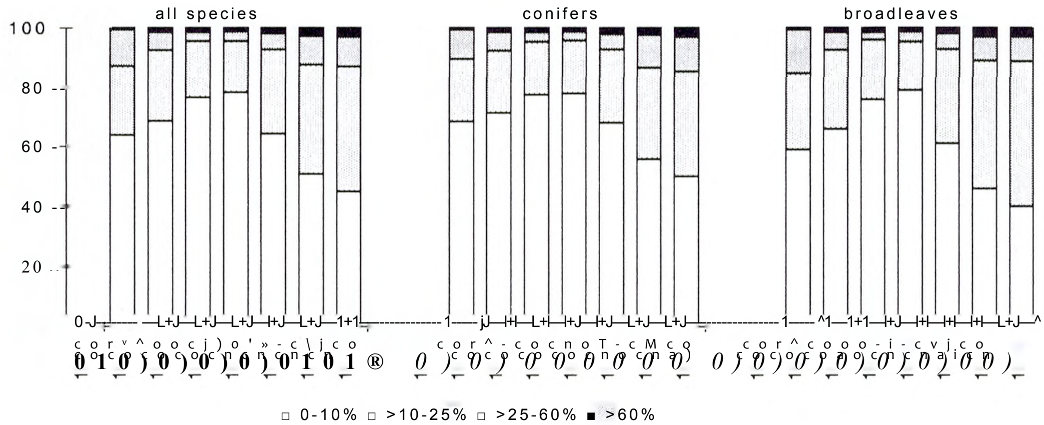
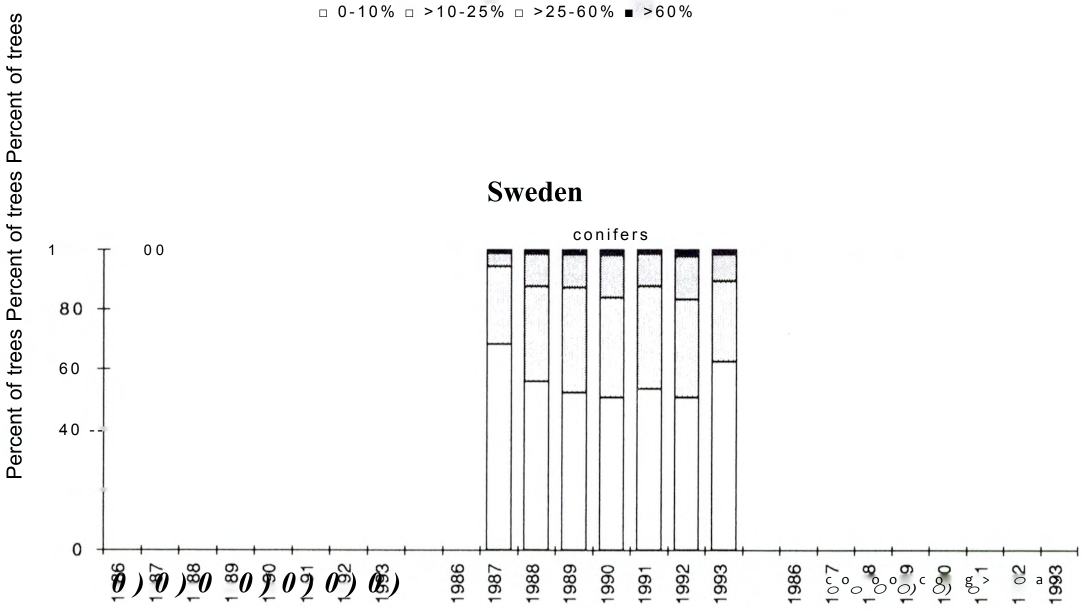


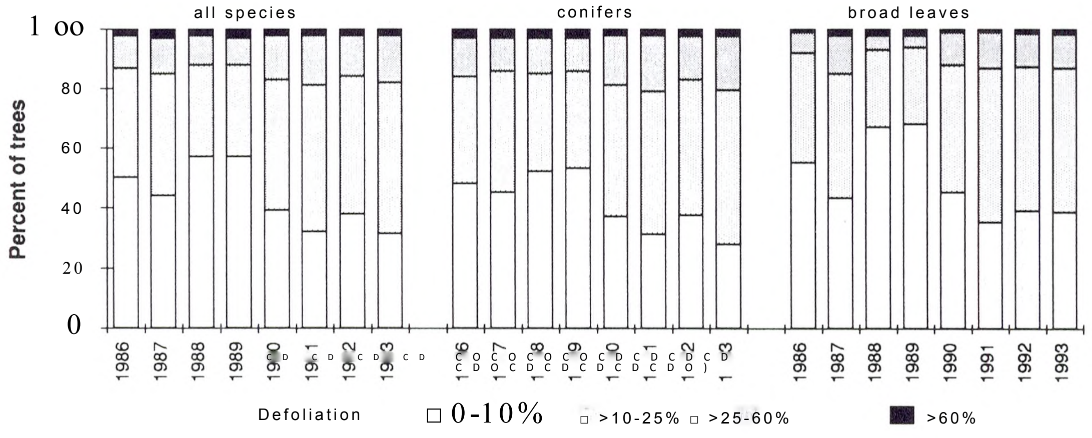
Spain



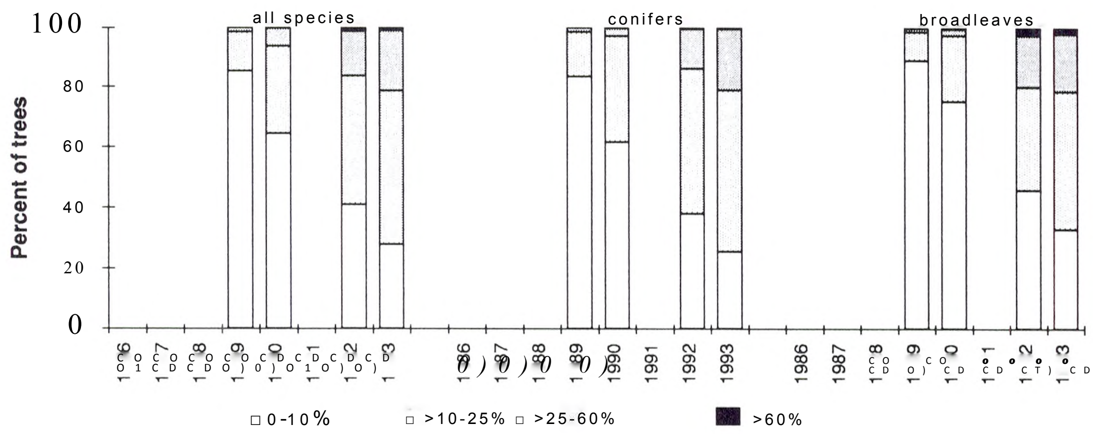
Sweden



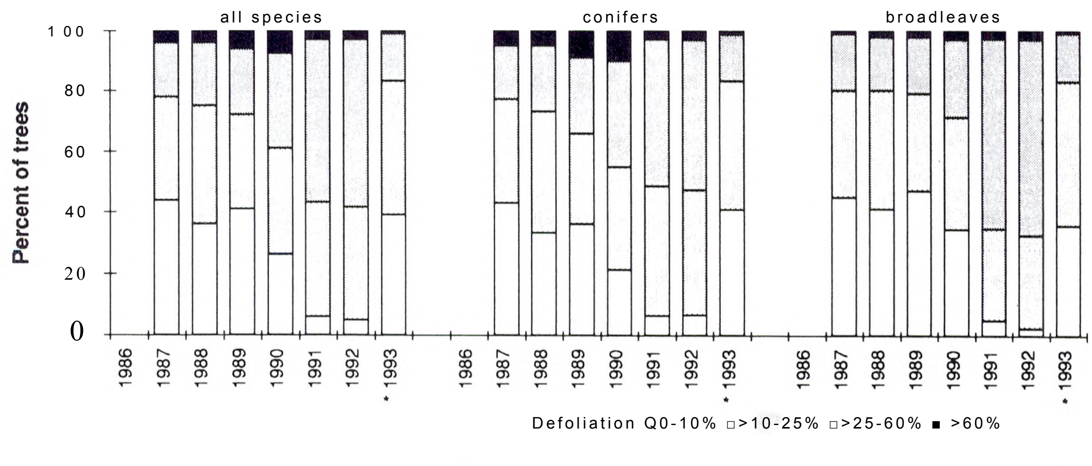
Switzerland



Ukraine



United Kingdom



* change of assessment method in 1993

Annex III

Main species referred to in the text

Annex III
Main species referred to in the text

Latin	English	German	French	Spanish	Italian
Fagus sylvatica	Common beech	Rotbuche	Hĉtre	Haya	Faggio
Qucrcus pctiaca	Sessile oak	Traubcnciche	Chêne rouvre	Roble albar	Rovere
Qucrcus robur	European oak	Stieleiche	Chĉne pédonculé	Roble común	Farnia
Qucrcus ilex	Holm oak	Steineiche	Chêne vert	Encina	Leccio
Quercus suber	Cork oak	Korkeiche	Chêne liège	Alcornoque	Sughera
Pinus sylvestris	Scots pine	Gemeine Kiefer	Pin sylvestre	Pino silvestre	Pino commune
Pinus nigra	Corsican/Austrian black pine	Schwarzkiefer	Pin noir	Pino laricio	Pino nero
Pinus pinaster	Maritime pine	Seestrandkiefer	Pin maritime	Pino negral	Pino marittimo
Pinus halcpcnsis	Aleppo pine	Aleppokiefer	Pin d'Alcp	Pino carrasco	Pino d'Alcppo
Picca abics	Norway spruce	Rotfichte	Epicéa commun	Abeto rojo	Picea comune
Picca sitchensis	Sitka spruce	Sitkafichte	Epicéa de Sitka	Picea de Sitka	Picea di Sitka
Abies alba	Silver fir	Weißtanne	Sapin pcctiné	Abeto común	Abete bianco
Larix decidua	European larch	Europäische Lärche	Mélèze d'Europe	Alerce	Larice europeo

Annex III
Main species referred to in the text

Dutch	Danish	Portuguese	Greek	Finnish	Russian
Beuk	B0g	Faia	0^\)& Saouct'i	Pyökki	6yK necHoñ
Wintereik	Vintereg	Carvalho branco Americano	Apvq ajtó5ioKo<;	Talvitammi	ny6 cxanBHHíí
Zomereik	Slilkeg	Carvalho roble	Ap\)<; 7co8ioKO(j)ópo(;	Metsätammi	ny6 yepem,aTua
Steeneik	Stcneg	Azinheira	Api&	Rautatammi	ny6 KaweHHHg
Kurkeik	Korkcg	Sobreiro	OeXA.o8pí)<;	Korkkitammi	ny6 npoßxoBHii
Grove den	Skovfyr	Pinhciro silvcsü'c	Accaua[1]) πεύκη	Metsämänty	cocHa OÖHKHOBeHHail
Oostenrijkse/ Corsicaanse zwarte den	0strisk fyr	Pinhciro Ausuíaco	Maúpn Tteijicn	Euroopanniusta-miinty	cocHa wëpHan
Zccdcn	Strandfyr	Pinhciro bravo	©cdaaafa 7t£Í)ICr|	R;innikkom;inty	cocHa npHMopcKaíi
Aleppodcn	Alcppofyr	Pinhciro de alepo	XaXé7iio<; jteúicri	Aleponmänty	cocHa anennexan
Fijnspar	R0dgran	Picea	Ep\)0pe^áTri υψηλή	Metsäkuusi	enh eBponeñcKan
Sitk aspar	Sitkagran	Picea de Sitka	Ep\)0peA.&xn	Sitkankuusi	enh CHTXHHCKaíí
Zilverden	/Edelgran	Abeto branco	Ae-uicfi eXáTr)	S;iks;uipihta	nHXTa 6enafl
Europese lariks	La;rk	Laricio Europeu	A&pi£, e\)pa)7rai'Ki^	Euroopanlehti-kuusi	nHCTB0HHHIXa eBponeñcxaH

Annex IV

Ministries (Min) and National Focal Centres (NFC)

Ministries (Min) and National Focal Centres (NFC)

Chairman	Mr. Ernst Wermann, Chairman ICP Forests Bundesministerium für Ernährung, Landwirtschaft und Forsten - UAL 61 Postfach 14 02 70 D-53107 BONN Tel.: 0049 (228) 529-4325/Fax: 529-4262
PCC East	- PROGRAMME COORDINATING CENTRE EAST - Forestry and Game Management Research Institute (VULHM) Jiloviste-Strnady CZ-15604 PRAHA 516, Zbraslav Tel.: 0042 (2) 59 16 12/Fax: 59 14 13 Telex: 066-121203 Mr. Karel Vancura, Dipl.-Ing.
PCC West	- PROGRAMME COORDINATING CENTRE WEST - Bundesforschungsanstalt für Forst- und Holzwirtschaft Leuschnerstr. 91 D-21031 Hamburg Tel.: 0049 (40) 73962-119/Fax: 73962-480 Mr. Martin Lorenz, Dr.
Expert Panel on Soil Analysis	Laboratorium Bodenkunde Geologisch Instituut Krijgslaan 281 B-9000 GENT Tel.: 0032 (92) 64 46 34/Fax: 224 045 Mr. F. de Coninck, Prof.Dr., Chairman
	Faculteit Landbouw Laboratorium voor Landbeheer Kard. Mercierlaan 92 B-3030 LEUVEN Tel.: 0032 (16) 22 09 31/ Fax: 20 50 32 Mr. van Orshoven, Ir., Vice-Chairman
Expert Panel on Foliar Analysis	Norwegian Forest Research Institute (NISK) Högskolevein 12 N-1432 AS Tel.: 0047 64 94 89 96/ Fax:0047 64 94 89 71 Mr. Svein Solberg
Expert Panel on Increment Analysis	Eidgenössische Forschungsanstalt für Wald, Schnee und Landschaft (WSL) Zürcherstr. 111 CH-8903 BIRMENSDORF Tel.: 0041 (1) 73 92 354/Fax: 739 22 15 Mr. John L. Innes

Expert Panel on Deposition Measurements	Swedish Environmental Research Institute Institutet för Vatten- och Luftvardsforskning (IVL) P. O. Box 47086 Dagjämningsgatan 1 S-4025 8 GOTEBORG Tel: 0046 31 46 00 80/Fax: 0046 31 48 21 80 Mrs. Gun Lövblad
Austria (NFC)	Forstliche Bundesversuchsanstalt Seckendorff-Gudent-Weg 8 A-1131 WIEN Tel: 00 43 (1) 87 838-0/Fax: 87 75 907 Mr. HR Friedrich Ruhm, Dipl.-Ing., Direktor
(Min)	Bundesministerium für Land- und Forstwirtschaft Stubenring 1 A-1012 WIEN Tel.: 0043 (1) 51 50-0/Fax: 71 39 311 Telex: 111145, 111780 Mr. R. Themessel, Dipl.-Ing.
Belarus (Min) (NFC)	Ministry of Forestry Chkalov-Street 6 220039 MINSK Belarus Tel.: 007 (0172) 24 47 05/Fax: 24 41 83 Mr. V. P. Romanovskii Deputy Minister for Forestry
Belgium (NFC) (Min)	Ministère de l'Agriculture Administration de la Recherche Agronomique Manhattan Office Tower 21, Avenue du Boulevard, (7e étage) B-1210 BRUXELLES Tel: 0032 (2) 21 17 211/Fax: 21 17 216 Telex: 22033 Mr. R. Piscaglia, Directeur général f.f.
Wallonia (NFC) (Min)	Ministère de la Région Wallonne Direction Générale des Ressources Naturelles et de TEnvironnement Avenue Prince de Liège, 15 B-5000 NAMUR Tel.: 0032 (81) 24 66 11/24 68 71/Fax: 32 56 02 Mr. C. Delbeuck, Directeur général Mr. E. Gérard, Ingénieur principal
Flanders (NFC)	Institute for Forestry and Game Management Gaverstraat 4 B-9500 GERAARDSBERGEN Tel. 0032 54 41 87 97/Fax: 54 41 08 96 Mr. Peter Roskams, Ir.

Flanders (Min)	Ministerie van de Vlaamse Gemeenschap AMINAL Bestuur Natuurbehoud en -ontwikkeling Belliardstraat 14-18 B-1040 BRUSSELS Tel.: 0032 (2) 507 30 60/Fax: 507 30 65 Tel.: 0032 (2) 507 30 61 (Secretary) Mr. M. Cherrette
Bulgaria (NFC)	Higher Forestry Institute Dept. "Ecology and Environmental Protection" Kl. Ochridski 10 BG-1757 SOFIA Tel.: 00359 (2) 62 30 59/Fax: 62 28 30 Mrs. Ekaterina Pavlova, Dr.
Canada (NFC) (Min)	ARNEWS Canadian Forestry Service 351 St. Joseph Boulevard CDN-OTTAWA, ONT K1A 1G5 Tel.: 001 (705) 94 99 461/Fax: 75 95 700 Mr. Peter Hall, Dr.
Quebec (NFC) (Min)	Ministère de lEnvironnement Direction des Relations intergouvemementales 3900, rue Marly, CDN-STE. FOY - QUEBEC GIX 4E4 Tel.: 001 (418)643-8232 Mr. L. Lapointe
Croatia (NFC)	Sumarski Institut Cvjetno Naselje 41 41420 JASTREBARSKO Tel.: 00385(41)831 023, 83 10 22/Fax: 83 14 93 Mr. Nikola Komlenovic, Dr.
Czech Republic (NFC)	Forestry and Game Management Research Institute (VULHM) Jiloviste-Strnady CZ-15604 PRAHA 516, Zbraslav Tel.: 0042 (2) 59 16 12/Fax: 59 14 13 Telex: 066-121203 Mr. Karel Vancura, Dipl.-Ing.
Czech Republic (Min)	Ministerstvo zemedelstvi CR, Odbor lesniho hospodarstvi Tesnov 17 CZ-11705 PRAHA 1 Tel.: 0042 (2) 23 28 912/Fax: 23 12 836 Mr. Karel Kopecny, Dipl.-Ing.
Denmark (NFC) (Min)	The National Forest and Nature Agency Division of Silviculture and Forest Law 53 Haraldsgade DK-2100 COPENHAGUE Tel.: 0045 39 27 20 00/Fax: 39 27 98 99 Mrs. Inge Gillesberg

Denmark (Min)	The Danish Forest Research Institute Skovbrynet 16 DK-2800 LYNGBY Tel.: 0045 93 12 00/Fax: 93 48 49 Mr. Lennart Rasmussen, Dr. Mr. Morten L_ber
Estonia (NFC)	Eesti Metsamajanduse ja Looduskaitse Teadusliku Uurimise Instituut Rôômu tee 2 EE-2400 TARTU Tel.:0037234 36375 or 36381/Fax: 0037234 36 375 Mr. Kalle Karoles, Dr., Director Chief Forest Pathologist
Estonia (Min)	Ministry of Environment State Forest Department of Estonian Republic Toompuiestee 24 EE-200100 TALLINN Tel.: + 45 29 82
Finland (NFC)	Finnish Forest Research Institute P.O. Box 18 SF-01301 VANTA A Tel: 00358 (0) 85 70 51/ 85 70 54 60 Fax: 85 72 575 Prof. Dr. Eino Màlkônen Eeva-Liisa Jukola-Sulonen, Dr. Mr. Michael Starr
Finland (Min)	Ministry of Agriculture and Forestry Dep. of Forest Policy Hallituskatu 3 A SF-00500 HELSINKI Tel.: 00-358-0-160 3344/Fax: 160 5078 Mrs. Marjukka Mâhônen / Mr. Jan Heino
France (NFC)	D.S.F. - antenne spécialisée INRA - Centre de Nancy- F-54280 CHAMPENOUX Tel.: 0033 (83) 39 40 72/Fax: 31 71 60/39 40 69 Mr. Guy Landmann
France (Min)	Ministère de l'Agriculture et du Développement Rural Direction de l'Espace Rural et de la Forêt Dépt. Santé des Forêts lter, Avenue de Lowendal F-75700 PARIS 07 SP Tel.: 00 33 (1) 49 55 51 95/Fax: 49 55 57 67 Mr. Christian Barthod
	Département Santé des Forêts Quartier Cantarel B.P. 99 F-84140 MONFAVET CEDEX Tel.: 0033 (90) 87 67 53/Fax: 89 18 80 Mr. Jacques Mirault

Germany (NFC) (Min)	Bundesministerium für Ernährung, Landwirtschaft und Forsten - Ref. 615 Postfach 14 02 70 D-53107 Bonn Tel.: 0049 (228) 529-4321/Fax: 529-4318 Mr. H. Intemann
Greece (NFC)	Institute of Mediterranean Forest Ecosystems Terma Alkmanos GR-11528 ATHENS-ILISSIA Tel.: 0030 (1) 77 82 40/Fax: 77 84 602 Mr. G. Nakos, Dr.
Greece (Min)	Ministry of Agriculture Office of Forestry 2-6, Acharnon Str. GR-10176 ATHENS
Hungary (NFC)	Forest Management Planning Service Szechenyi u. 14 H-1054 BUDAPEST 5 Tel.: 0036 (1) 13 23 911/Fax: 11 26 112 Telex: 061-224 492 fgazd h Mr. Peter Csoka, Dr.
Hungary (Min)	Mezögazdasagi es Elelmezesugyi Miniszterium Kossuth Lajos tér 11 H-1055 BUDAPEST Tel: 0036 (1) 11 19 604/Fax: 15 30 518 Mr. Gyula Holdampf
Ireland (NFC)	Coillte Teoranta The Irish Forestry Board Research Division 1-3, Sidmonton Place IRL-BRAY, CO. WICKLOW Tel.: 003531 (2) 86 77 51/Fax: 86 81 26 Mr. Richard McCarthy, Dr.
Ireland (Min)	Department of Energy - Forest Service Leeson Lane IRL-DUBLIN 2 Tel: 00353 (1) 61 56 66/Fax: 61 13 26 Telex: 90253 Mr. Gallagher, Dr.
Italy (Min) (NFC)	Ministero dell' Agricoltura e delle Foreste Direzione Generale per l'Economia Montana e per le Foreste Via Sallustiana 1 1-00187 ROMA Tel.: 0039 (6) 47 44 65/Fax: 47 42 314 Tel.: 0039 (6) 48 34 98/Fax: 48 20 660 Telex: 043-622 343 Mr. Stefano Allavena, Dr./Mr. Marco Avanzo

(NFC)	Forstwirtschaftsinspektorat Bozen Brennerstr. 6 1-39100 BOZEN Tel.: 0039 (471) 99 53 19/Fax: 99 53 13 Mr. Stefano Minerbi, Dr.
(NFC)	Dipartimento di Biologia Vegetale Università di Firenze Piazzale delle Cascine, 28 1-50144 FIRENZE Tel.: 0039 (55) 36 57 98/Fax: 36 01 37 Mr. Filippo Bussotti, Dr.
(NFC)	Azienda Foreste Domaniali Reg. Sarda Vico II Barone Rossi, 2 I-CAGLIARI-SARDINIA Tel: 0039 (70) 27 991/Fax: 27 21 33 Mr. Enea Beccu
Latvia (Min)	Ministry of Agriculture State Forest Service 13. Jan vara iela 15 LV-1050 RIGA Tel.: 003712 22 6600/Fax:003712 211 176 Mr. Arvids Ozols
(NFC)	State Institute of Forest Inventory Rigas iela 113 LV-2169 SALASPILS Tel.: 00371294 2388 or 22 00/Fax: 003712 211176 Mr. M. Sipols / Mr. M. Laivins
Liechtenstein (NFC) (Min)	Landesforstamt St. Florinsgasse 3 FL-9490 VADUZ Tel.: 0041 (75) 23 66 400/Fax: 23 66 411 Telex: 045-889290 Mr. Felix Näscher, Dr.
Lithuania (NFC)	Lietuvos misku institutas (LMI) LIT-4312 GIRIONYS, Kaunas Distr. Tel.: 00370-7-/54 72 21 /Fax: 00370-7-/ 547 446 Mr. Mecislovas V. Vaicys, Prof. Dr., Head, Forest Soil Laboratory Mr. Remigijus Ozolincius, Head, Forest Monitoring Sector, Tel: 00370-7-74 44 60 Fax: 00370-7-547 446
(Min)	Ministerium für Forstwirtschaft Gedimino pr. 56 LIT-232685 VILNIUS Tel.: +62 68 64/Fax: +61 21 78

Luxembourg (NFC) (Min)	Administration des Eaux et Forêts Service de lAménagement des Bois et de lEconomie Forestière 49, bd de la Pétrusse B.P. 411 L-2014 LUXEMBOURG Tel.: 003 (52) 49 60 71/FAX: 003 (52) 407 840 Mr. Marc Wagner
Netherlands (NFC)	Department of Nature, Forest and Landscape IKC-NBLF Postbus 30 NL-6700 AA WAGENINGEN Tel.: 0031 83 70 74 875/Fax: 27 561 Telex: 044-47542 Mr. Gijs van Toi, Ir.
(Min)	Ministry of Agriculture /IKC-NBLF Postbus 20401 NL-2500 EK DEN HAAG Tel.: 0031 70-37 92 415/0031 71-31 50 53 Fax: 0031 70-34 78 228 Mr. IR T.F. C. Smits
Norway (NFC)	Norwegian Forest Research Institute P.O. Box 61 N-1432 ÁS-NLH Tel.: 0047 (64) 94 90 31/Fax: 94 89 71 Mr. Káre Venn, Prof. Dr.
Norway (Min)	State Pollution Control Authority Strömsveien 96 N-0032 OSLO 1 Tel.: 0047 (2) 57 34 00/Fax: 676 706 Mrs. Berit Kvaeven, Dr.-Ing.
Poland (NFC)	Forest Research Institute Bitwy Warszawskiej 1920 nr. 3 PL-00993 WARSZAWA Tel.: 0048 (22) 22 32 01, 46 46 23/Fax: 224 935 Telex: 063-812476 ibl pi Mr. Jerzy Wawrzoniak
Poland (Min)	Ministerstwo Lesnictwa i Ochrony Srodowiska Wawelska 52/54 PL-00-100 Warszawa Instytut Ochrony Srodowiska Krucza 5-11 PL-00-789 WARSZAWA Mrs. Apolonia Ostrowska, Dr.

Portugal (NFC) (Min)	Direcgao Geral das Florestas Divisao de Defesa e Protecgao dos Arvoredos Av. Joao Crisostomo 28-4° P-1000 LISBOA Tel: 00351(1)56 18 94/Fax: 54 14 62 or 5219 13 Telex: 0404-64 238 dgf p Mrs. Maria Andrada
Romania (NFC)	Forest Research and Management Institute Soseana Stefanesti nr. 128 sector 2 R0-7000 BUCURESTI Tel: 0040 (1) 655 6 8 45/Fax: 00401-312 84 28 Mr. Nicolae Geambasu, Dr.-Ing.
Romania (Min)	Ministerul Mediului Bd. Liberatii, Tronson 5 si 6 R0-7000 BUCURESTI Tel.: 0040 1 631 04/Fax: 0040 1 312 0403 Mr. Constantin Corduneanu
Russian Fed. (Min)	Vserossiiskii Nauchno-issledovatelskii i Informatsionnyi Tsentr po Lesnym Ressursam (VNHTSlesresurs) Novocheremushkinskaya 69 117877 Moskva GSP 7 Tel.: (007) 332 53 38/Fax: 007-095-331 05 33 Telex: 064-411667 kedr su Mr. Valentin Viktorovich Strakhov, Director
(NFC)	Lesoustroitel'noe Spetsial'noe Predpriyatie VNIITS le sresursa Novocheremushkinskaya 69 117 877 MOSKVA GSP 7 Fax: 007-095-332 51 45 Telex 064-411 667 kedr su Mr. Vasilii Konstantinovich Tuzov
Slovak Republic (NFC)	Lesnicky vyskumny ustav T.G. Masaryka 22 SR-96092 ZVOLEN Tel: 0042 (855) 27 311/Fax: 23 397 Telex: 066-72284 Mr. Jan Racko, Dipl.-Ing.
Slovak Republic (Min)	Ministerstvo podohospodarstva Dobrovicova 12 SR-81266 BRATISLAVA Tel.: 0042-7-324 218 Fax: 0042-7-326 509
Slovenia (NFC)	Institut za gozdno in lesno gospodarstvo Vecna pot 2 SLO-61000 LJUBLJANA Tel: 00386 61 26 89 63/Fax: 00386 61 273 589 Telex: 062-3112 Mrs. Nevenka Bogataj

Spain (NFC)	Instituto Nacional para la Conservación de la Naturaleza (ICONA) Servicio de Protección de Agentes Nocivos Gran Via de San Francisco, no 35 E-28005 MADRID Tel.: 0034 (1) 347 60 08/Fax: 347 63 02 Telex: 052-47 591 aeico e Mr. Ramón Montoya, Ing.
(Min)	Ministerio de Agricultura, Pesca y Alimentation Subdirección General de Sanidad Vegetal Velazquez, 147 E-28002 MADRID Tel.: 0034 (1) 347 82 43/Fax: 347 82 48 Mr. R. Vázquez Hombrados
Sweden (NFC) (Min)	National Board of Forestry Vallgatan 6 S-551 83 JÓNKÓPING Tel.: 0046 (36) 15 57 15/Fax: 16 61 70 Telex: 054-70358 Mr. Sture Wijk
Switzerland (NFC)	Eidgenössische Forschungsanstalt für Wald, Schnee und Landschaft (WSL) Zürcherstr. 111 CH-8903 BIRMENSDORF Tel.: 0041 (1) 73 92 354/Fax: 739 22 15 Telex: 045-827203 wse ch Mr. John L. Innes
Switzerland (Min)	Eidgenössische Forstdirektion Postfach 5662 CH-3003 BERN Tel.: 0041 (31) 67 77 80/Fax: 677 789 Mr. Volz
Turkey (NFC)	Ormancilik Arastirma Enstitiisii Miidiirluğu¨ P.K. 24 Bahcelievler TR-06561 GAZI-ANKARA Tel.: 0090 (312) 21 31 734/Fax: 21 22 944 Mr. Yasar Simsek, Prof. Dr.
Turkey (Min)	General Directorate of Forestry P.K. 20 Atatiirk Orman^iftligi TR-06561 GAZI-ANKARA Tel: 0090 (312)22 25 148
Ukraine (NFC)	Ecology laboratory Ukrainsky nauchno-issledovatelsky institut lesnogo hozyaistva i agroleosomelioratsii (the Ukr. SRI of FPP) Pushkinskaja 86 310024 Kharkov Mr. Igor F. Buksha, Dr.

(Min)	Ministry of Forestry of the Ukrainian Republic Kreshchatik 5 252001 Kiev Mr. Anatolii Pavlovich Moros, Head Tel: 007 (044) 22 80 943/22 88 546
United Kingdom (NFC)	Pathology Branch Forestry Authority Northern Research Station Roslin UK-MIDLOTHIAN EH25 9SY Tel: 0044 (31) 44 52 176/Fax: 44 55 124 Mr. B. Redfern, Dr.
(Min)	Department of the Environment Working Group on Effects Room B 352 - Romney House 43, Marsham St. UK-LONDON SW1B 3PY Mr. Burgess, Dr.
United States of America (NFC)	National Program Manager Forest Health Monitoring Program Forestry Sciences Laboratory P.O. Box 12254 USA-RESEARCH TRIANGLE PARK, NC 27709 Tel.: 001 (919) 549-4020
United States of America (Min)	Director, FFASR USD A Forest Service P.O. Box 96090 US A-WASHINGTON, DC 20090-6090 Tel.: 001 (202) 235-10 71/Fax: 001 202 4476 053 Telex: 023-7400631 fasr
Yugoslavia (Min)	Savezni Sekretarijat za Poljoprivredu Bulevar AVNOJ - a 104 YU-11001 BEOGRAD Tel: 0038 (11) 12 93 29/Fax: 19 52 44 Telex: 062-12804 / 11062 YU SIV Mr. Milan Sasic, Dr.
(NFC)	Sumarski Fakultet Katedra Zastita Suma Ul. Kneza Viselava Br. 1 YU-11030 BEOGRAD Fax: 0038 (11) 54 54 85 Mr. Vladimir Vujanovic, S.M.

F o r further information please contact:

Federal Research Centre for Forestry and Forest Products
PCC West of ICP Forests
Attention Dr. M. Lorenz, Mr. G. Becher
Leuschnerstr. 91
D-21031 HAMBURG

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Rue de la Loi 130
B-1049 BRUSSELS

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PCC West of ICP Forests
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